ELGAR

TrueWave™
Switching Amplifier

Service Manual

Models:
TW5250
TW3500
TW1750

This Service Manual is incomplete without the TrueWave Operation Manual, which contains detailed descriptions of the TrueWave system, installation instructions, and operating instructions.

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ELGAR ONE-YEAR WARRANTY

Elgar Electronics Corporation (hereinafter referred to as Elgar) warrants its products to be free from defects in material and workmanship. This warranty is effective for one year from the date of shipment of the product to the original purchaser. Liability of Elgar under this warranty shall exist provided that:

- the Buyer exposes the product to normal use and service and provides normal maintenance on the product;
- Elgar is promptly notified of defects by the Buyer and that notification occurs within the warranty period;
- the Buyer receives a Return Material Authorization (RMA) number from Elgar's Repair Department prior to the return of the product to Elgar for repair, phone 800-73-ELGAR (800-733-5427), ext. 2295;
- the Buyer returns the defective product in the original, or equivalent, shipping container;
- if, upon examination of such product by Elgar it is disclosed that, in fact, a defect in materials and/or workmanship does exist, that the defect in the product was not caused by improper conditions, misuse, or negligence; and,
- that Elgar QA seal and nameplates have not been altered or removed and the equipment has not been repaired or modified by anyone other than Elgar authorized personnel.

This warranty is exclusive and in lieu of all other warranties, expressed or implied, including, but not limited to, implied warranties of merchantability and fitness of the product to a particular purpose. Elgar, its agents, or representatives shall in no circumstance be liable for any direct, indirect, special, penal, or consequential loss or damage of any nature resulting from the malfunction of the product. Remedies under this warranty are expressly limited to repair or replacement of the product.

CONDITIONS OF WARRANTY

- To return a defective product, contact an Elgar representative or the Elgar factory for an RMA number. Unauthorized returns will not be accepted and will be returned at the shipper's expense.
- For Elgar products found to be defective within thirty days of receipt by the original purchaser, Elgar will absorb all ground freight charges for the repair. Products found defective within the warranty period, but beyond the initial thirty-day period, should be returned prepaid to Elgar for repair. Elgar will repair the unit and return it by ground freight pre-paid.
- Normal warranty service is performed at Elgar during the weekday hours of 7:30 am to 4:30 pm Pacific time. Warranty repair work requested to be accomplished outside of normal working hours will be subject to Elgar non-warranty service rates.
- Warranty field service is available on an emergency basis. Travel expenses (travel time, per diem expense, and related air fare) are the responsibility of the Buyer. A Buyer purchase order is required by Elgar prior to scheduling.
- A returned product found, upon inspection by Elgar, to be in specification is subject to an inspection fee and applicable freight charges.
- Equipment purchased in the United States carries only a United States warranty for which repair must be accomplished at the Elgar factory.

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SAFETY NOTICE

Before applying power to the system, verify that the SW Series unit is configured properly for the user's particular application.

WARNING!

HAZARDOUS VOLTAGES IN EXCESS OF 280 VRMS, 600V PEAK MAY BE PRESENT WHEN COVERS ARE REMOVED. QUALIFIED PERSONNEL MUST USE EXTREME CAUTION WHEN SERVICING THIS EQUIPMENT. CIRCUIT BOARDS, TEST POINTS, AND OUTPUT VOLTAGES MAY BE FLOATING ABOVE (BELOW) CHASSIS GROUND.

Installation and service must be performed by qualified personnel who are aware of dealing with attendant hazards. This includes such simple tasks as fuse verification.

Ensure that the AC power line ground is connected properly to the SW Series unit 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 the input/output power cables.

During 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 generated normally on the output terminals. Ensure that the output power lines are labeled properly as to the safety hazards and that any inadvertent contact with hazardous voltages is eliminated. To guard against risk of electrical shock during open cover checks, do not touch any portion of the electrical circuits. Even when the power is off, capacitors can retain an electrical charge. Use safety glasses during open cover checks to avoid personal injury by any sudden failure of a component.

Due to filtering, the unit has high leakage current to the chassis. Therefore, it is essential to operate this unit with a safety ground.

Some circuits are live even with the front panel switch turned off. Service, fuse verification, and connection of wiring to the chassis must be accomplished no less than five minutes after power has been removed via external means; all circuits and/or terminals to be touched must be safety grounded to the chassis.

After the unit has been operating for some time, the metal near the rear of the unit may be hot enough to cause injury. Let the unit cool before handling.

Qualified service personnel need to be aware that some heat sinks are not at ground, but at high potential.

CAUTION!

400V 3-PHASE INPUT POWER SYSTEMS (4 WIRE) MUST HAVE A NEUTRAL CONNECTION. THE NEUTRAL MUST NOT BE SWITCHED. APPLY NEUTRAL BEFORE PHASE VOLTAGE OR SERIOUS DAMAGE TO THE EQUIPMENT MAY RESULT.

For safe operation, it is required that output power neutral be connected to chassis ground. The SW system is shipped with a ground wire between power neutral and chassis ground.

SAFETY SYMBOLS

CAUTION
Risk of Electrical Shock

CAUTION
Refer to Accompanying Documents

Off (Supply)

Standby (Supply)

On (Supply)

Protective Conductor Terminal

Direct Current (DC)

Alternating Current (AC)

3~ Three–Phase Alternating Current

Fuse

Earth (Ground) Terminal

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SECTION 1 – THEORY OF OPERATION

1.1 INTRODUCTION

This service manual is intended to assist in the maintenance, troubleshooting, repair to the module level, and calibration of the Elgar TrueWave (TW) products. The topics discussed in this manual may require a level of understanding of analog and digital circuit theory somewhat higher than that required for normal Operator/Programmer activities. For this reason, only qualified personnel should attempt to troubleshoot and repair TrueWave products.

This section describes the TW Power Sources and associated circuit boards, assemblies and interconnecting signals. Topics of this section provide a basis for understanding the roles performed by the system electronics and should be a precursor to any troubleshooting or maintenance.

Prior to the module level discussion of the assemblies and boards within the TW system, a top-level system overview is provided. An understanding of both top level and circuit activities at the module or board level is most valuable should the service person find it necessary to investigate a suspected fault or malfunction within the power source.

1.2 SYSTEM OVERVIEW

Figure 1-1 shows a simplified block diagram of the TW system. The 3 phase input voltage is delivered via the input filter to the power module(s) where it is rectified providing bus voltages for the amplifier(s). Voltage and waveform control signals are delivered to the amplifier(s) from the front panel assembly. The front panel assembly contains the Digital Control Board, and the Analog Processor Board (see sections 1.4 and 1.5). From the bus voltages and control signals, the amplifiers then produce output waveforms, which are delivered via the output filter to the output terminals.

There are three primary options that are available when ordering a TW system, which with all permutations considered, translates into many different configurations of TW systems. The options are: PFC or rectifier input, 208VAC or 400VAC input voltage, power rating of the unit (number of phases installed).

The PFC/rectifier and input voltage options will be discussed in more detail later in this manual.

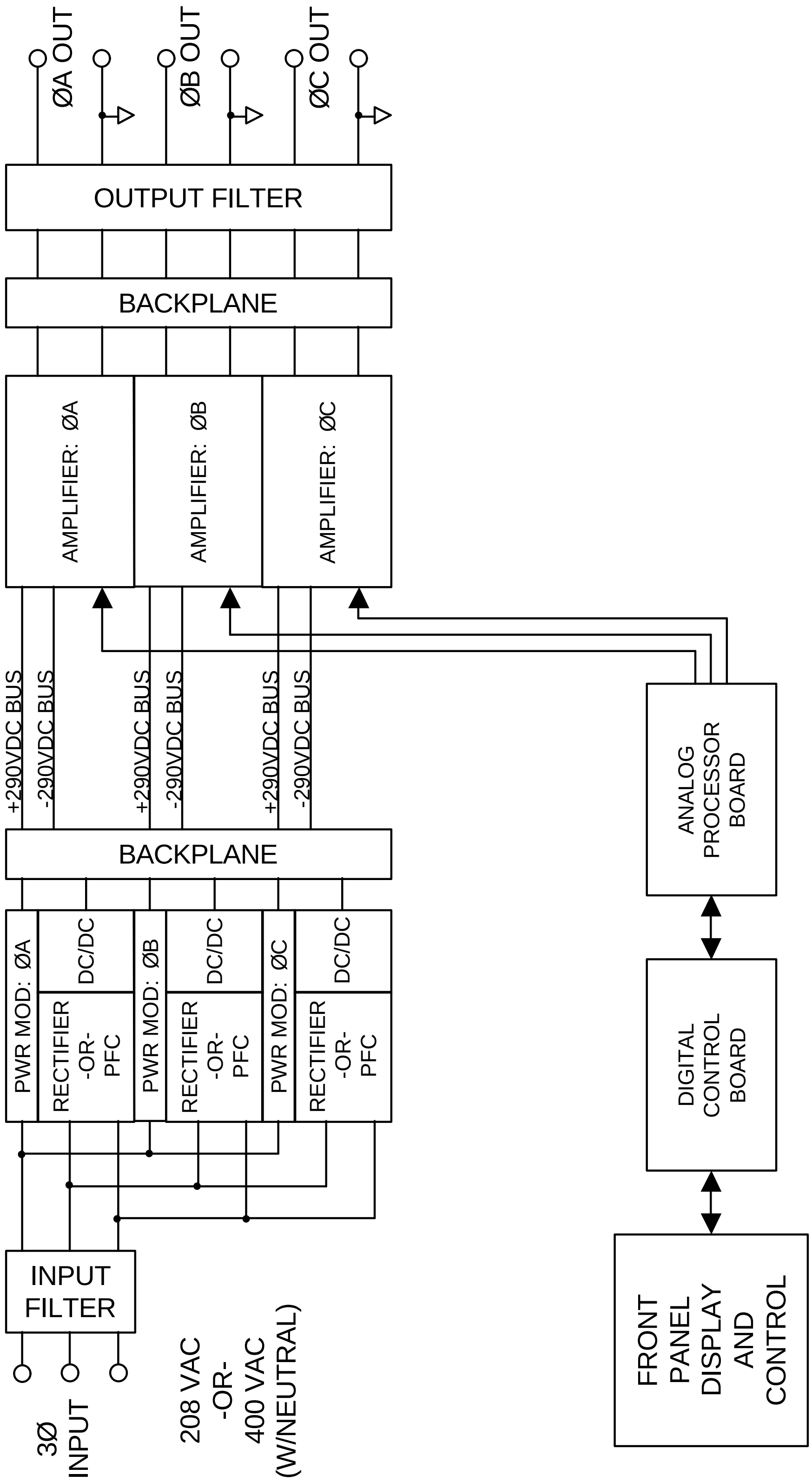


FIGURE 1-1. TW5250

The system shown in Figure 1-1 is a TW5250 meaning that it contains three identical output channels A, B, and C, with a channel consisting of a power module and an amplifier module. Each channel is capable of delivering 1750 VA to the output. One and two channel systems, TW1750 and TW3500, can be achieved by removing channels B and C, or C only (Note: adding or removing a channel requires reprogramming of the system). TW10500, TW15750, and TW21000 systems can be produced by adding additional TW chassis.

1.3 INTERCONNECTION

The 3 phase input voltage is delivered via the fuse block and input filter to the power module(s), through W1, 2 and 3, where it is rectified via the PFC or rectifier input stage(s). The rectified voltages are then delivered to the DC/DC converter(s) where 290V buses are produced and delivered via the backplane board to the amplifier(s). A 48V bus is also produced by the DC/DC converter(s) and delivered via the backplane to the HSKP board (see section 1.6). The amplifier(s) receive waveform drive signals and power supply voltages via ribbon cables and a signal routing board. The Digital Control Board receives external input locally from the front panel keypad or remotely from the RS232 or GPIB (IEEE 488.2). The Digital Control Board then sends data and commands to the Analog Processor Board with the desired waveform information to drive the amplifiers as mentioned above.

1.4 DIGITAL CONTROL BOARD

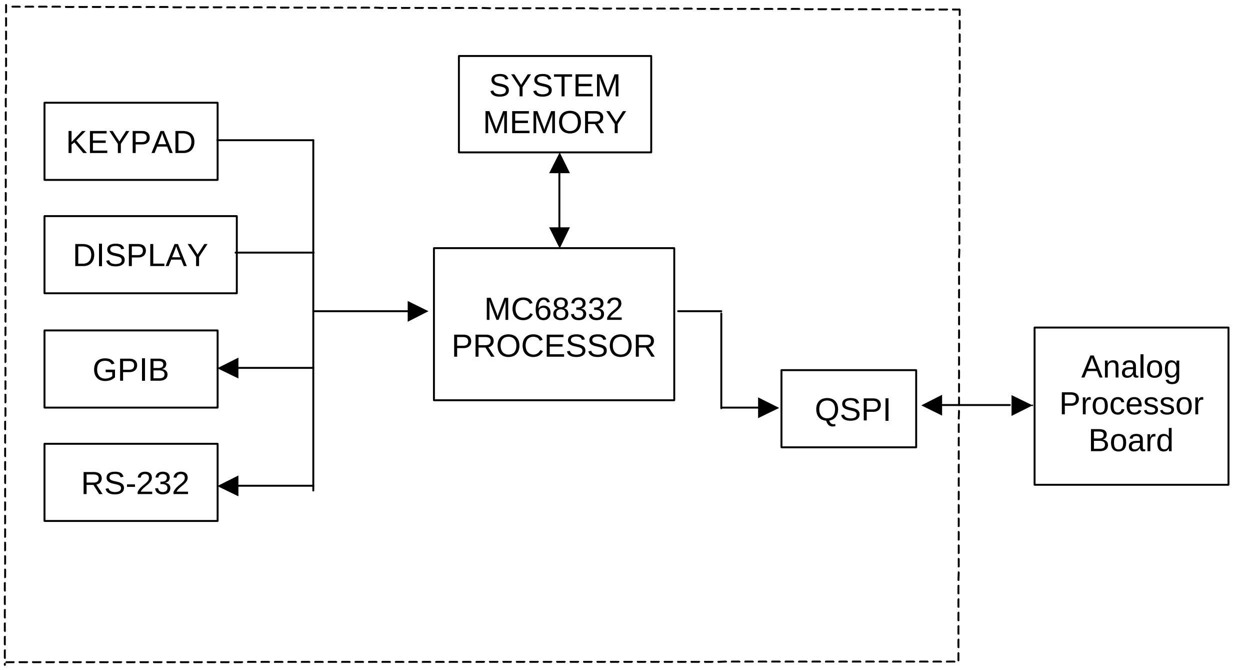


FIGURE 1-2. DIGITAL CONTROL BOARD BLOCK DIAGRAM

The Digital Control Board is the central controller of the TW system. It handles all communication with the outside world and the Analog Processor Board. It consists of the following interfaces:

- Front panel keypad and display elements
- GPIB (IEEE 488.2 interface) SCPI Protocol
- RS-232 (9600 baud, 1 start bit, 8 data bit, no parity, 1 stop bit) SCPI Protocol
- QSPI for Analog Processor Board interface

The Digital Control Board is controlled by a Motorola 68332 processor, operating with a 16-bit data bus. The processor system memory consists of one 256K x 16 20ns static RAM, one 256K x 16 90ns FLASH ROM, 64K x 8 120ns PROM and 8K x 8 EEPROM. The PROM is used during boot for processor execution, the EEPROM is used for calibration data, the FLASH is used for processor execution, and the RAM is used for system data storage. For more information on the MC68332 processor, refer to the Motorola MC68332 User's Manual.

At power up the 68332 boots from a dedicated PROM. This PROM contains executable code that allows the FLASH memory to be programmed from data received either from the GPIB or serial port. During the boot process the FLASH memory is checked for corruption, and if no corruption is found program control is passed to the FLASH memory.

The Digital Control Board communicates to the Analog Processor Board via the 68332 processor's dedicated high speed QSPI. The Digital Control Board is the master in this interface. Upon power-up of the TW system, the Digital Control Board performs the following functions:

- Initializes all chip selects, PortE and PortF of the 68332 processor.
- Initializes the QSPI, QSCI, TPU, GPIB, display and keypad.
- Resets and loads run-time DSP code to the Analog Processor Board.
- Initializes Analog Processor Board to front panel settings.
- Programs the amplifier(s) to power-on reset values (either default or user defined values).
- Performs system self test.
- Enters main control loop.

The main control loop reads the keypad for user input, updates the displays and data buffers with current readback values from the Analog Processor Board, and interprets SCPI strings received from either the RS-232 or GPIB bus. Additionally, the Analog Processor Board is monitored for fault conditions. If a fault occurs, the fault is logged to the front panel display and the appropriate fault buffer is generated for the remote interfaces.

All calibration data is stored on the Digital Control Board. When an incoming SCPI command or front panel programming value is processed, the appropriate calibration data are applied to the value and the information is passed to the Analog Processor Board for implementation. The TW relies heavily on software calibration and a detailed calibration procedure can be found in section 3 of this manual.

1.5 ANALOG PROCESSOR BOARD

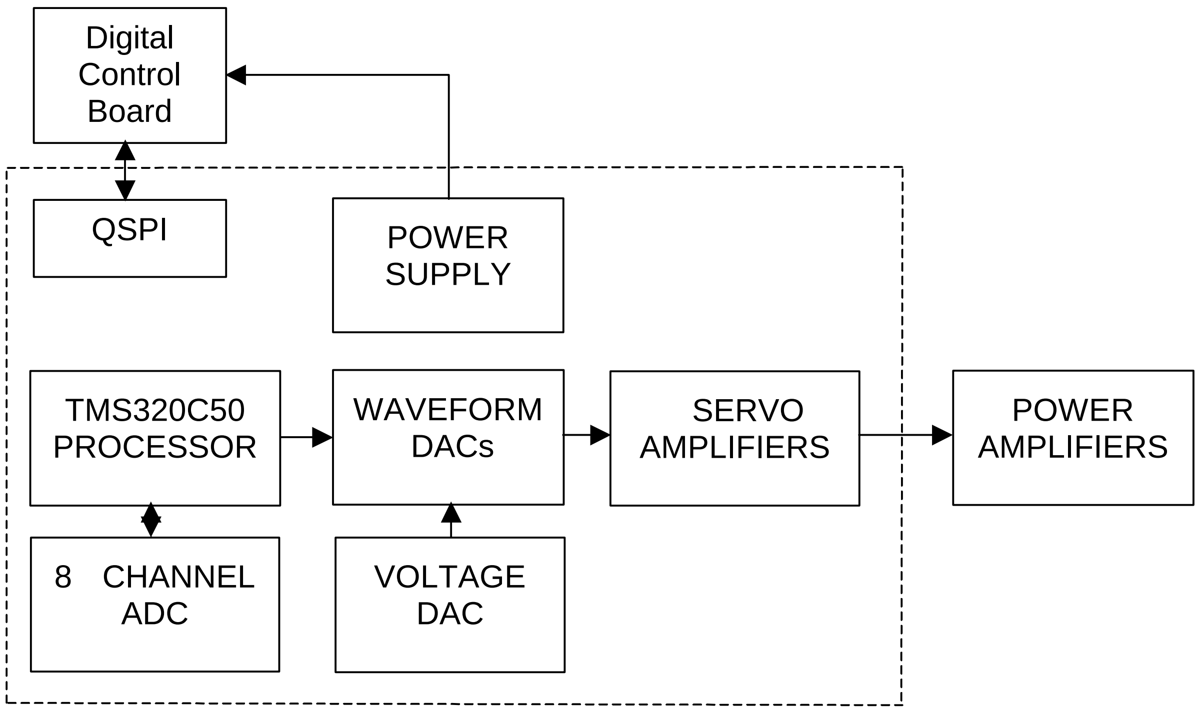


FIGURE 1-3. ANALOG PROCESSOR BOARD BLOCK DIAGRAM

The Analog Processor Board generates the three–phase sinewave references, signal processes the sampled currents and voltages, performs output voltage servoing, and drives the power amplifiers. Additionally the Analog Processor Board has a power supply that provides fan power and front panel power.

Processing power is provided by a TMS320C50 digital signal processor (DSP). The DSP's firmware is loaded into the processor at power up from the Digital Control Board. After initializing all registers and calibrating the analog to digital converter, the DSP enters its main control loop. All waveform generation and measurements are handled by the DSP. Current mode of operation is also controlled by the DSP. Hardware faults are monitored by the DSP and appropriate actions are taken by the DSP when a fault occurs.

The sinewave references are constructed using three waveform DACs and one amplitude DAC driving the voltage reference. The DSP updates each of the waveform DACs every 37.5 microseconds with the appropriate amplitude value for the phase waveform being constructed. The output of the DACs are filtered by a 5 pole waveform construction filter to eliminate any steps in the waveform. The amplitude DAC is updated as necessary to set the maximum peak to peak output voltage generated by the TW.

The sinewave references are fed either directly to the servo amplifiers or are AC coupled, depending on the selected coupling mode of operation. The servo amplifiers operate on the sinewave reference and the local or remote sense lines. The output of the servo amplifiers feed the power amplifier drivers. Phases B and C have a mux that selects between the output of their respective servo amplifiers or phase A's servo amplifier. This allows the power supply to operate in multiphase or single–phase mode.

Each power amplifiers current is sampled and processed through a summing bus that allows multiple TW chassis to be paralleled. This summing bus output is then filtered and fed into the front end of the eight–channel analog to digital converter. The ADC also samples sense voltage, redundant over–voltage, and external user input.

The DSP reads one of the eight analog inputs to the ADC once every 12.5 microseconds. The sampled values of voltage and current are processed into RMS current, RMS voltage, peak current, and instantaneous power. These values are passed to the Digital Control Board for further calibration scaling and presentation to the user.

1.6 HOUSEKEEPING BOARD (HSKP)

The HSKP board receives 48Vdc input from the power module(s) via the backplane board where the 48V inputs are paralleled and delivered via J7A connector to the HSKP board. The 48V is then delivered to the housekeeping circuit and also via the J3 connector to power the fans of the fan panel assembly. The housekeeping power supply circuit consists of a push-pull converter producing two non-isolated and five isolated outputs. These seven output voltages supply power throughout the TW chassis. The voltages developed by the housekeeping supply are as follows:

- +/- B (+/-13V) supplies (chassis potential): Used to power circuitry at chassis ground potential throughout the front panel boards.
- +/-15V analog supplies: Used to power circuitry at analog ground potential throughout the amplifiers and front panel boards.
- +5V & -24V supplies (chassis potential): Used to power circuitry at chassis ground potential throughout the front panel boards.
- +5V digital supply: Used to power circuitry at digital ground potential throughout the amplifiers and front panel boards.

Note that the HSKP board does not supply voltages to the PFC, rectifier, or DC/DC assemblies. For an explanation on how the bus voltages for these assemblies are supplied, consult the theory of operation for each individual assembly.

1.7 POWER CONDITIONER MODULE

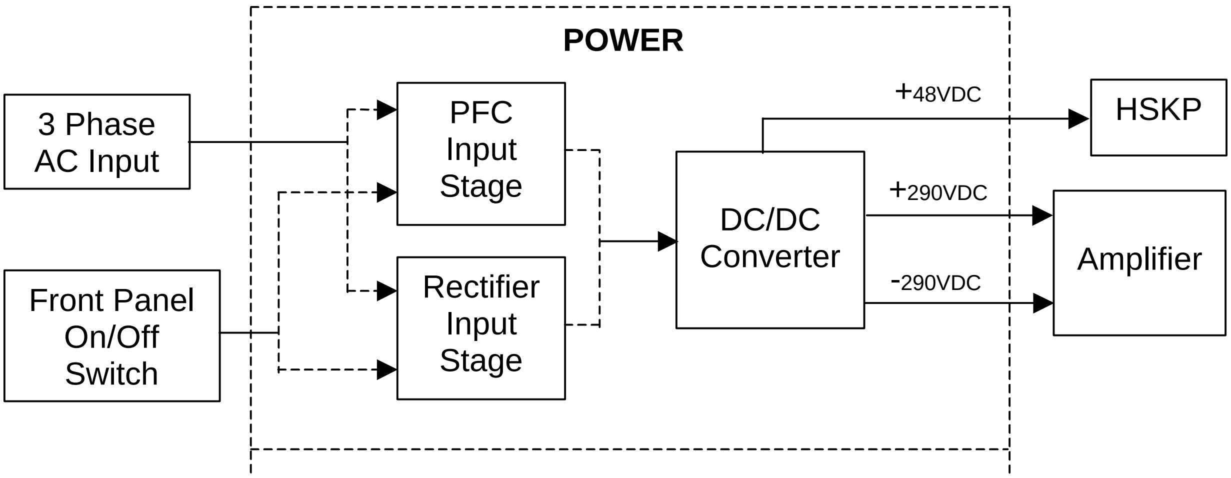


FIGURE 1-7. POWER CONDITIONER MODULE BLOCK DIAGRAM

The power conditioner module, or power module, rectifies the AC input voltage into one 48 Vdc and two isolated 290 Vdc buses. This is accomplished in two separate stages of the power module. The first stage (input stage) can consist of either a rectifier or a PFC stage. Both the rectifier and the PFC input stages are configurable for two different nominal AC input voltages: 208VAC L-L (USA) or 400VAC L-L (INTERNATIONAL). For further information on configuring input voltages, contact the Elgar Customer Service Department. The second stage consists of a DC/DC converter module that converts the 380 Vdc output of the input stage to one 48 Vdc and two isolated 290 Vdc buses.

1.7.1 RECTIFIER INPUT

The 3 phase AC input voltage to the rectifier input stage is delivered through a soft-start circuit and rectified by a 3 phase bridge rectifier developing a 380 Vdc bus. When the system is configured for USA input, the rectifier is wired as a 3 phase full-wave bridge rectifier. When the system is configured for INTERNATIONAL input, the rectifier is wired as a 3 phase half-wave rectifier. The rectified 380 Vdc bus is then delivered to the DC/DC stage of the power module. The 380 Vdc bus is also used to power a series regulator circuit, which provides +24 Vdc bus power for the control circuitry of the rectifier stage.

1.7.2 POWER FACTOR CORRECTION (PFC) INPUT

The PFC module is used to limit the peak input current to the TW system by as much as three to one, compared to the peak input current of the rectifier module. This equates to a PFC input power factor of .99, compared to the power factor of the rectifier module that is .6 (USA) and can be as low as .35 (INTERNATIONAL).

The PFC module is a two–board assembly consisting of a PFC Power and a PFC Control board. The single–phase AC input voltage enters the PFC power board where it is rectified by the full-wave bridge rectifier circuit, developing a raw 380 Vdc bus. The raw 380 Vdc bus is then delivered through a soft–start relay to the PFC circuit, which is comprised of a boost converter. The output of the PFC, a regulated 380 Vdc bus, is then delivered to the DC/DC stage of the power module. The 380 Vdc bus is also converted down to a 24 Vdc bus used to power the control circuitry for the PFC power and control boards.

CAUTION

When the PFC module is configured for the INTERNATIONAL input configuration, the input neutral must be connected. Failure to do so will result in catastrophic damage to the PFC input.

1.7.3 DC/DC CONVERTER

The DC/DC converter module, or just DC/DC, is a two–board assembly consisting of a DC/DC Converter Power and a DC/DC Converter Control board. The DC/DC serves two purposes. First, to provide isolation between the 3 phase input voltage and the eventual output voltage used by the customer. Second, to generate the two isolated 290 Vdc buses used by the amplifier and a 48 Vdc bus used by the HSKP board and fan panel assembly. The DC/DC converter circuit is rated for 2000 watts and consists of a PWM controlled full H-bridge, which chops (switches) the 380 Vdc bus supplied by the rectifier or PFC input stage at a rate of 140 kHz. The output transformer and three full-wave bridge rectifier circuits then generate the two 290 Vdc and 48 Vdc buses. The output transformer and associated rectifier circuitry also produces a 27 Vdc bus which provides power for the DC/DC PWM control circuit.

1.8 AMPLIFIER MODULE

The amplifier module is a four board assembly consisting of an Amplifier Power, an Amplifier Control and two Gate Drive boards. The amplifier module is in fact comprised of two 156 V / 6.5 A amplifiers (upper and lower) which can be series or paralleled by relay K1 on the Amplifier Power board to produce a single 312 V / 6.5 A or 156 V / 13 A output. Relay K2 is the amplifier output relay but breaks only the line connection to the output filter and not the neutral. The drive circuits for K1 and K2 are located on the amplifier control board and respond to commands from the Analog board. Both the upper and lower amplifiers consist of identical full H-bridges that vary only in the method in which the bridge current is measured. The lower bridge uses a shunt resistor to monitor the bridge current while the upper bridge uses a hall-effect current transformer to provide isolation.

The amplifier control board contains the PWM circuit that generates the drive waveforms to the upper and lower H-bridges from the input voltage reference signal sent by the Analog board and the current feedback signals from the upper and lower bridges. The amplifier runs at a frequency of 200 kHz, interleaved, which equates to an overall switching frequency of 400 kHz. This high switching frequency allows smaller filtering components to be used in the output filter network. The gate drive boards provide isolation between the amplifier control and power boards. The amplifier control board contains supervisory circuitry that monitors the amplifier bus voltages and output neutral to chassis voltages for overvoltage conditions. Also monitored are amplifier heatsink temperatures as well as output voltage and current feedback signals, all of which are reported back to the Analog board.

1.9 GLOSSARY

DAC: Digital to Analog Converter

DC/DC: DC/DC Converter

HSKP: Housekeeping Supply Board

PFC: Power Factor Correction

Power Factor: Ratio of the real or active power (watts) to the apparent power (VA).

PLL: Phase Locked Loop

PWM: Pulse Width Modulator

QSPI: Queued Serial Peripheral Interface

SECTION 2 – MAINTENANCE AND TROUBLESHOOTING

2.1 GENERAL

This section contains procedures for corrective maintenance of the TrueWave products. Information is provided for the troubleshooting, disassembly and re-assembly for repair at the module level. A list of test equipment required for maintenance is also included in this section. TW systems are delivered with all adjustments and calibrations completed. Further adjustment should not be required unless a malfunction occurs and/or certain critical parts or assemblies are replaced.

If the procedures in this section and the circuit descriptions contained in Section 1 do not provide sufficient information to locate and correct a malfunction, request assistance from the Elgar Customer Service Department. Equipment should not be returned to the Elgar factory without express authorization from Elgar or its appointed representative. Elgar cannot assume the responsibility for equipment returned without authorization.

WARNING

Hazardous voltages are present when operating this equipment. Please read the Safety Notice at the beginning of this manual before performing any installation, operation, or maintenance procedures.

2.2 FACTORY REPAIR

TW systems requiring repair during their warranty period should be returned to Elgar for service. Unauthorized repairs performed by anyone other than Elgar during the warranty period may void the warranty. Any questions regarding repair should be directed to the Elgar Customer Service Department.

This service manual was intended for use in the troubleshooting and repair of TW systems down to the module level. Do not attempt to repair damaged modules as further damage or personal injury may result.

Some systems may not be field repairable and will need to be returned to the factory for repair. If it is necessary to return a module or entire system to the factory for repair, first contact the Elgar Customer Service Department to obtain a Return Material Authorization (RMA) number. See the warranty page at the front of this manual for details. **DO NOT RETURN THE UNIT FOR REPAIR WITHOUT AUTHORIZATION.**

2.3 REQUIRED TEST EQUIPMENT

The test equipment required to conduct performance verification procedures and troubleshooting is listed in Table 2-1. Substitute equipment may be employed provided said equipment meets the accuracy specifications of the equipment specified.

Description	Model Number
Digital Multimeter (DMM)	Fluke 8012A
Oscilloscope	Tektronix Model 2232
Computer with IEEE-488.2 Interface	Any

TABLE 2-1. REQUIRED TEST EQUIPMENT

WARNING

Remove power when performing maintenance on the unit. Failure to comply can result in serious electrical shock to individuals coming in contact with live voltages at exposed terminals when the unit is energized. Once the unit is de-energized, a wait period of at least 5 minutes should be observed to allow internal capacitors to discharge.

2.4 PERIODIC MAINTENANCE

Other than calibration and cleaning, no periodic maintenance is required on TW systems. Calibration is discussed in Section 3 of this manual. Periodic cleaning is required to insure that dust build-up within the chassis does not restrict airflow through the modules leading to overheating of the system. A strong vacuum cleaner may be used to remove dust from the various assemblies within the TW chassis. Compressed air is not recommended.

2.5 FAULT SYMPTOMS/TROUBLESHOOTING

The troubleshooting approach taken in this section will be at the assembly or module level. That is, a fault symptom will be described followed by a suggestive course of action in which to take. That course of action will often include the swapping out of an assembly or module in order to isolate and resolve the failure. Once again, due to the complexity of the assemblies and modules within the TW system and the fact that specialized test stations are required for troubleshooting, field repair of failed assemblies and modules is not feasible.

Although it is virtually impossible to identify every possible fault scenario, the following are some of the more probable failure modes of a TW system. Since the TW is such a complex system, any fault could be caused by one or more of several assemblies. For that reason, this manual will list the suspect assemblies in order with the first assembly listed being the most likely cause of the fault. Along with the suspect assemblies listed, the cables connecting those assemblies are also suspect and must be inspected and replaced if necessary, especially if replacing the assemblies does not resolve the failure. This is a very important consideration, and should not be overlooked since failures can indeed be caused by defective cables or connections.

For reference, fuses are identified in Table 2-2. See *TW Operation Manual* for model specific information.

Name	Type	Manufacturer and Part Number
INPUT FUSE	600V 20A SLOW BLOW	GOULD SHAWMUT - ATDR20 LITTELFUSE – CCMR20
INPUT FUSE	480V 40A SLOW BLOW	BUSSMANN – SC40 LITTELFUSE – SLC40
INPUT FUSE	480V 50A SLOW BLOW	BUSSMANN – SC50 LITTELFUSE – SLC50

TABLE 2-2. FUSES

TABLE 2-3. TROUBLESHOOTING

Fault Symptom	Troubleshooting / Corrective Action
With unit turned on, front panel display and fans remain de-energized.	• Check for proper input voltage to TW unit. Correct the input voltage as necessary. • De-energized unit, check and replace input fuses as necessary. Re-energize unit and test. If fuses open a second time, de-energize unit and perform disassembly steps 2.6.1 thru 2.6.12, replacing the power modules of the phases with the open fuses. (Note: phase A power module located nearest to fuse block and phase B in center). Re-assemble unit and test.
With unit turned on, front panel display comes on, but fans remain de-energized.	• De-energize unit and perform disassembly step 2.6.1. Insure that fan panel cable 5161563-01 is properly installed. Re-energize unit and test.
Unit comes up momentarily and shuts off immediately.	• De-energize unit and perform disassembly steps 2.6.1 thru 2.6.5. Insure that the connectors of cable 5161524-01 are properly seated. Re-assemble unit and test.
Loss of GPIB communication, unable to communicate with SW system via GPIB (IEEE 488.2) connector.	• Probable cause is ribbon cable/connector damage. De-energize unit and perform disassembly steps 2.6.1 thru 2.6.20 replacing rear panel assembly. Special care must be taken not to damage ribbon cables during installation in passageway on side of chassis. Re-assemble unit and test.
No -or- incorrect output voltage when unit is programmed correctly and output relay is closed.	• De-energize unit and perform disassembly steps 2.6.1 thru 2.6.7. Inspect cable 5161524-01 for seating problems.
Unit comes up and displays SELF TEST FAILURE	• Hit ENTER key. Go into the menu under CONFIG and verify that the INSTALLED number reflects the actual quantity of modules installed.

Fault Symptom	Troubleshooting / Corrective Action
Unit comes up normally. Upon relay closure unit display “PS FAULT 1” indicating that a redundant overvoltage has occurred.	• Check external sense and power lead wiring. • If problem persists, de-energize unit and perform disassembly steps 2.6.1 to 2.6.9. Inspect the 5161489-01 cable for proper installation. Re- assemble unit and test.

Note: If the previous procedures fail to isolate the faulty module, contact the Elgar Customer Service Department for additional assistance.

2.6 DISASSEMBLY & RE-ASSEMBLY

The following is the disassembly procedure for the TW system. Once disassembled, the unit can be re-assembled by performing the following procedure in reverse and referring to the Final Assembly drawing 5161469 located in Section 5 of this manual.

WARNING
Prior to beginning disassembly procedures, ensure that AC power has been disconnected from the TW system.

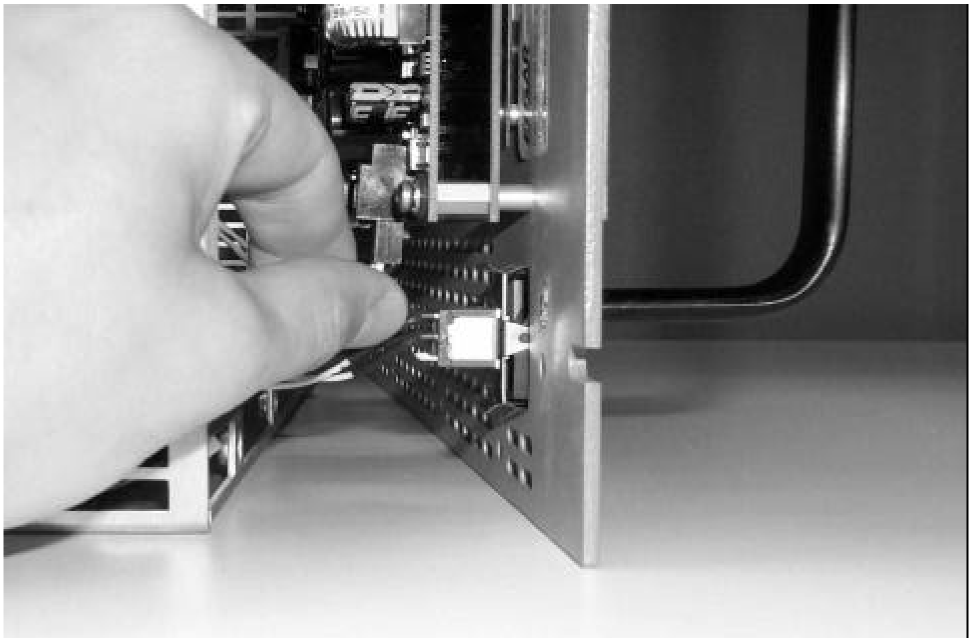
During re-assembly of the unit, it is very important that all removed cable-ties and adhesives are replaced and that cables are routed as they were originally. Incorrect routing of cables could lead to fan blade obstruction resulting in noisy operation, restricted airflow or cable damage. In addition, special care must be taken so that no exposed connector pins are damaged or broken.

QUICK REFERENCE GUIDE

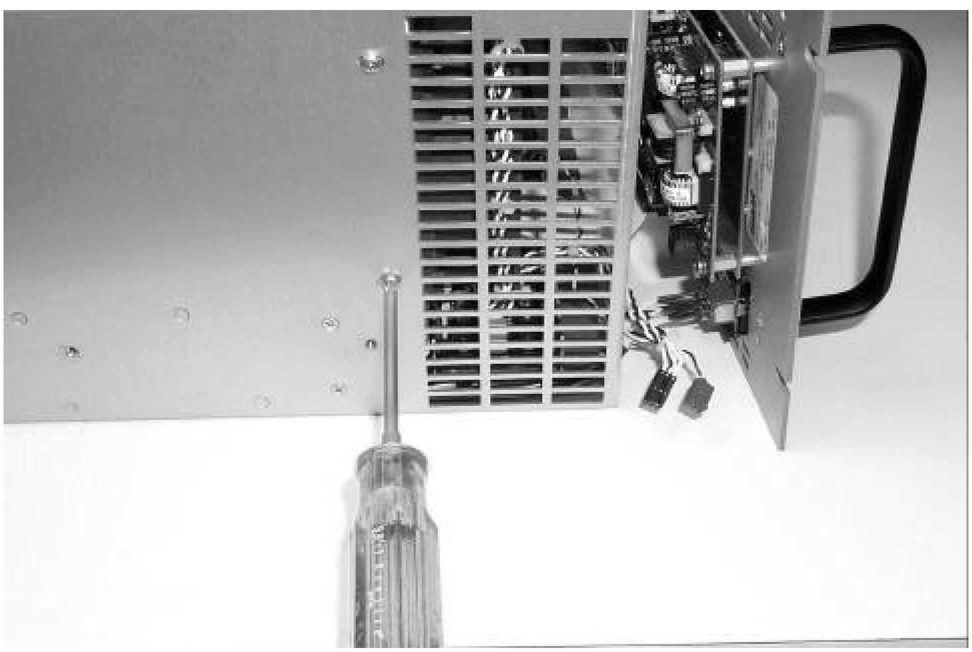
To Remove:	Perform Steps:
Fan Panel Assembly	2.6.1 – 2.6.5
Power Module or Amplifier	2.6.1 – 2.6.19
Housekeeping Board	2.6.1 – 2.6.8
Signal Board	2.6.1 – 2.6.14
Front Panel Assembly	2.6.1 – 2.6.8
Analog Board	2.6.1 – 2.6.9
Control Board	2.6.1 – 2.6.9
Rear Panel Assembly	2.6.1 – 2.6.20

2.6.1 Remove the (20) flat-head screws securing the top cover to the chassis. Note that some of the screws may be covered by white quality seals, and therefore, the seals will need to be broken. Remove cover as shown above.

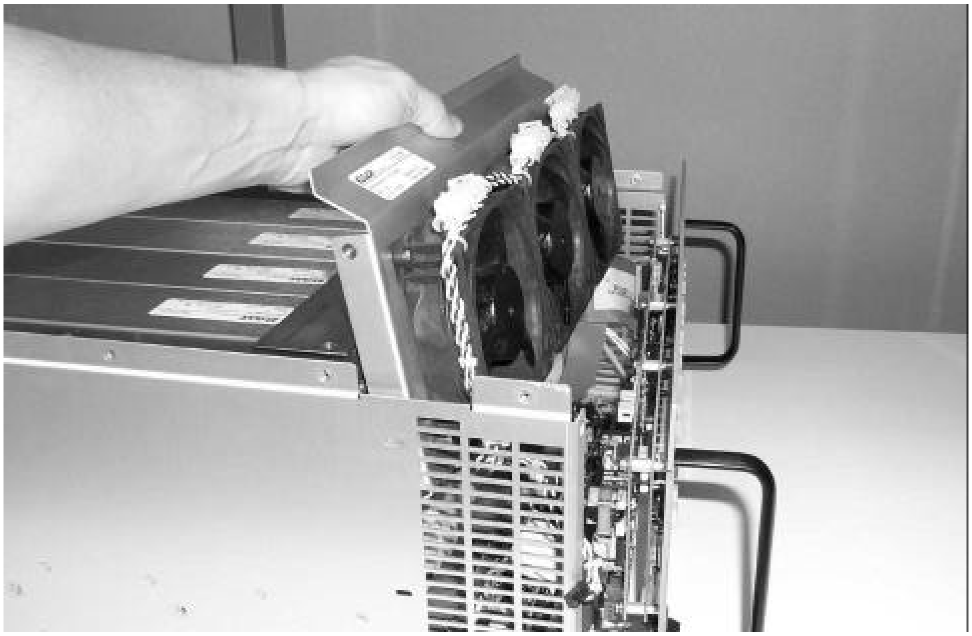
2.6.2 Loosen the front panel by removing the remaining (8) screws securing the front panel to the chassis. ⚠ The front panel will still be connected to the unit by several ribbon cables. Extreme care must be taken not to damage these cables.



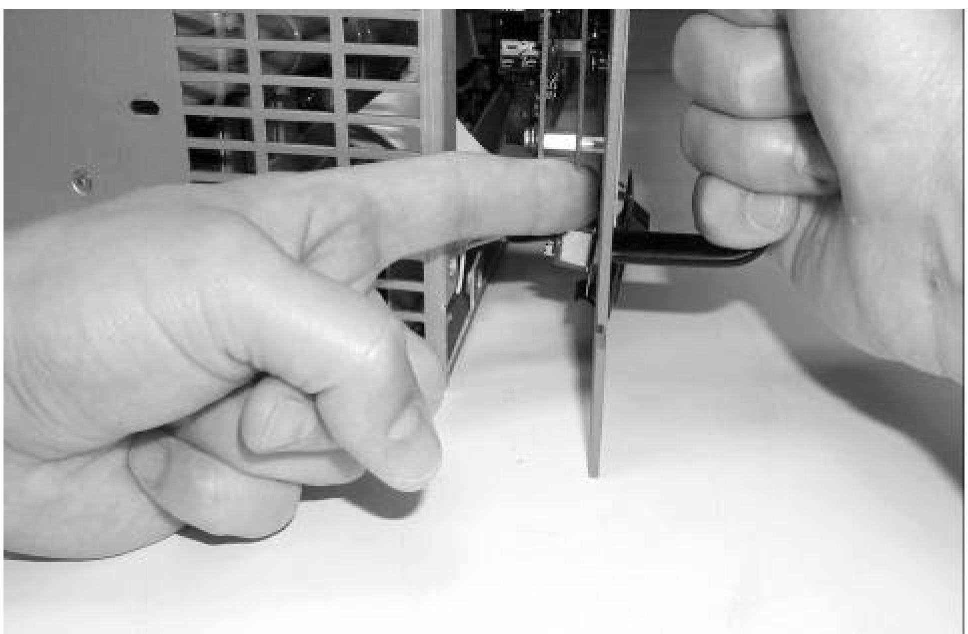
2.6.3 Remove the fan panel power cables from the Analog board connectors, J10 and J11, as shown above.



2.6.4 Remove the (4) pan head screws (two screws on either side of unit) securing the fan panel assembly to the chassis as shown above.

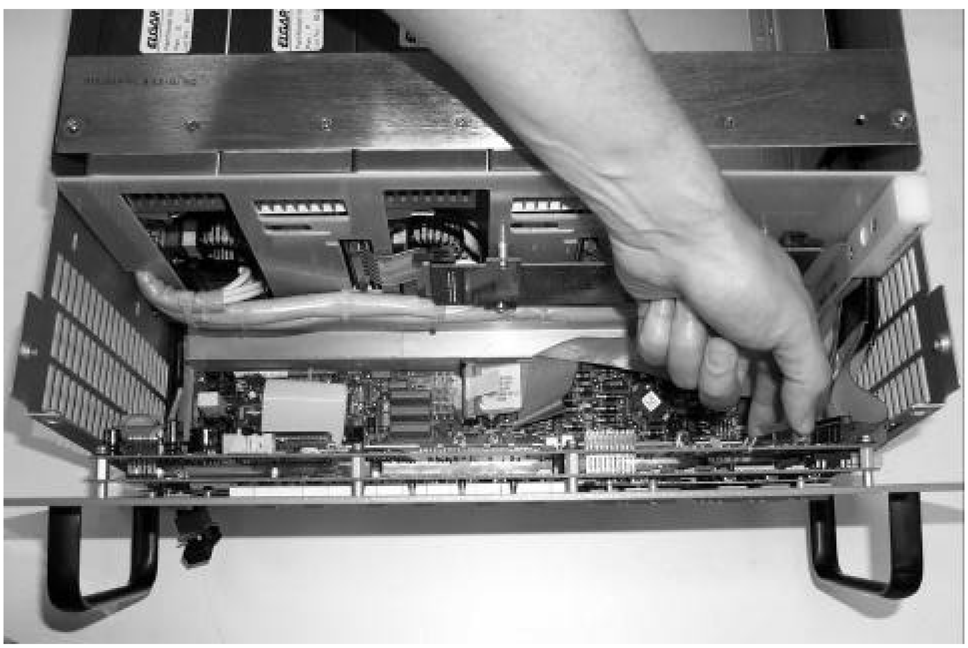


2.6.5 Disconnect fan panel power cable at J3 on the Housekeeping board mounted on the chassis floor. The fan panel assembly can now be carefully removed from the chassis as shown above. ⚠ Extreme care must be taken not to damage any components on the Analog board as the fan panel assembly is being removed.

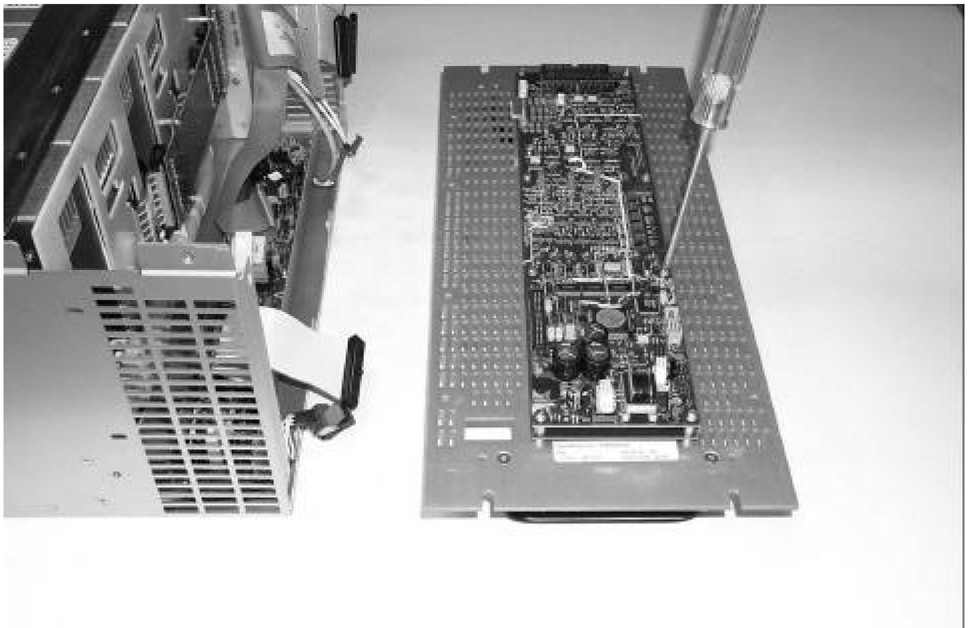


2.6.6 Slightly separate the ‘Power On’ switch end of the front panel from the chassis as shown above. Using the index finger of the left hand, gently push the ‘Power On’ switch from the back side of the front panel, out through the front side.

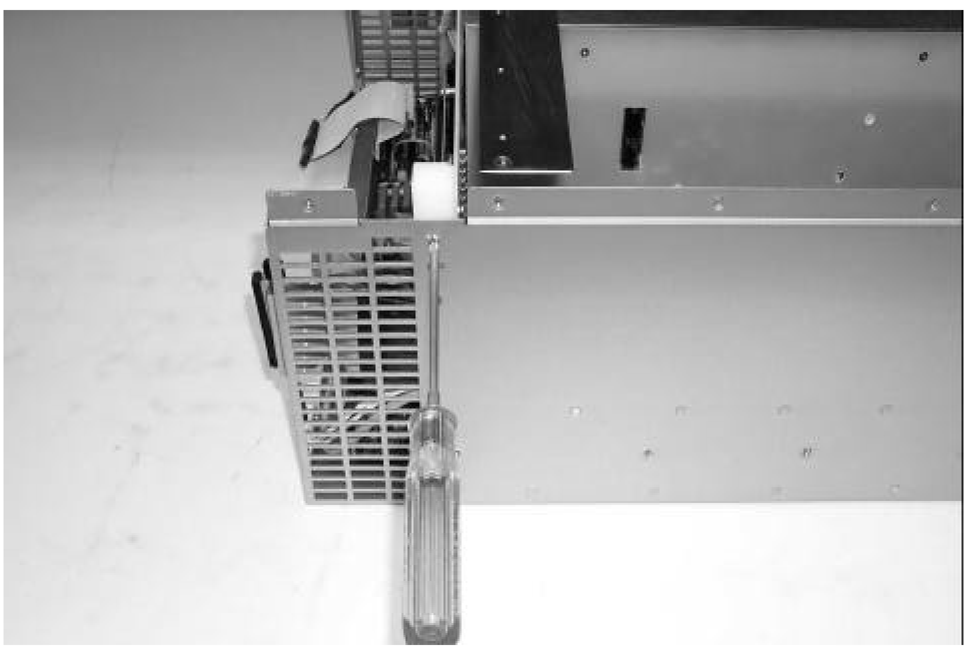
2.6.7 Gently remove the retaining clip as shown above. The switch can now be slid back through the front panel.



2.6.8 Remove cables from J1, J4, J7 & J8 on Analog board and J2 & J6 on Control board. The front panel assembly can now be completely removed. The Housekeeping board can also be removed, if necessary, by disconnecting the cables to J3, J7A, and J28B and then removing the (7) screws securing the board to the chassis.



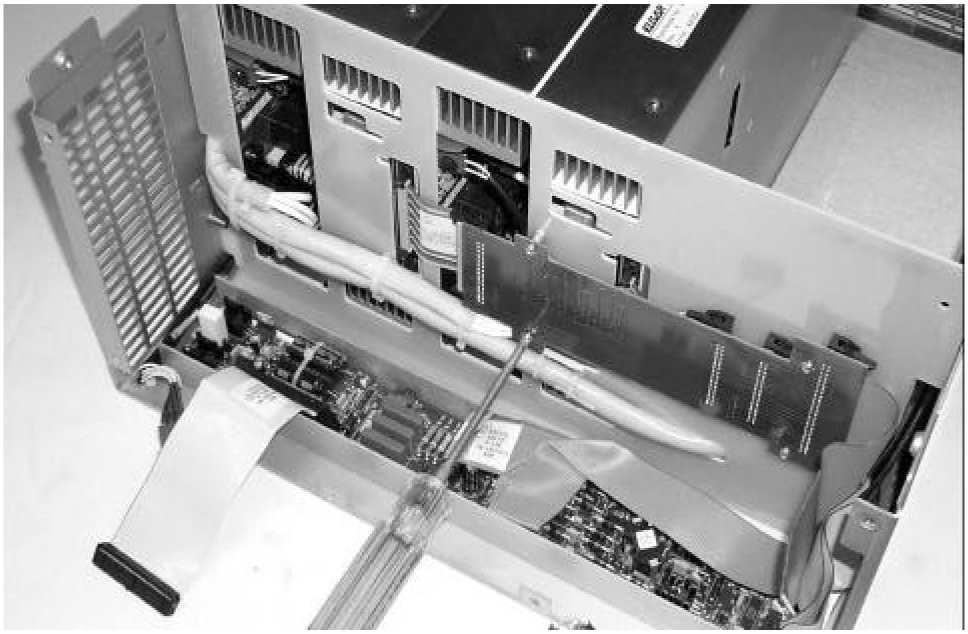
2.6.9 To remove the Analog and Control boards from the front panel assembly, remove the (8) mounting screws securing the boards to the panel and gently separate the boards.



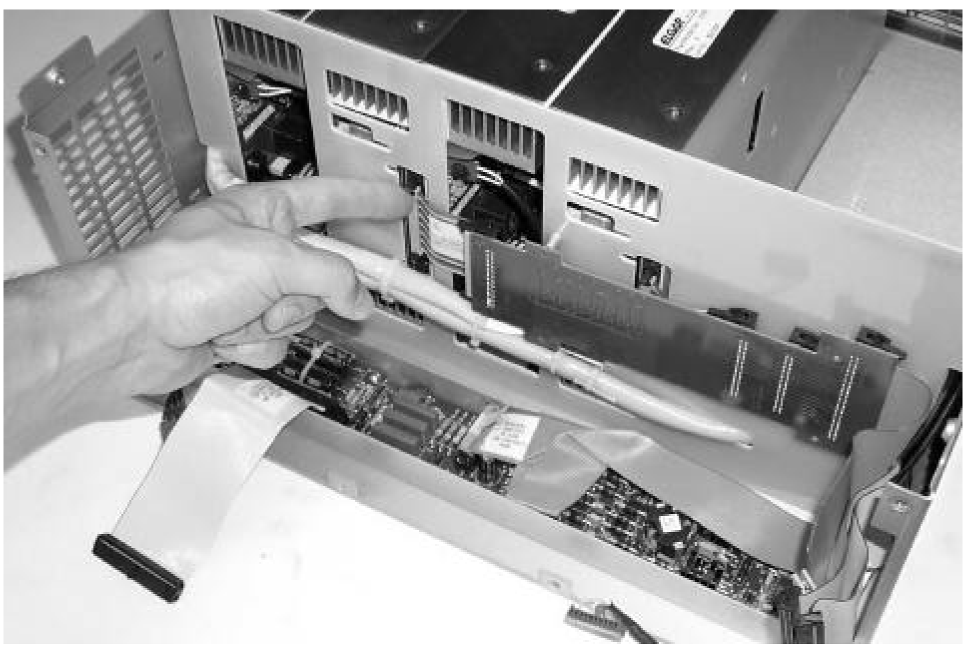
2.6.10 Remove the (4) screws attaching the ribbon cable bracket to the chassis assembly as shown above.

2.6.11 Remove the (2, 4 or 6) screws, depending on model, that secure the top bracket to the modules as shown above.

2.6.12 To remove the ribbon cable bracket, remove the top screw (only) that secures the bracket to the air baffle as shown above. (The bottom screw mechanism wraps around the edge of the air baffle and, thus, does not need to be removed.)

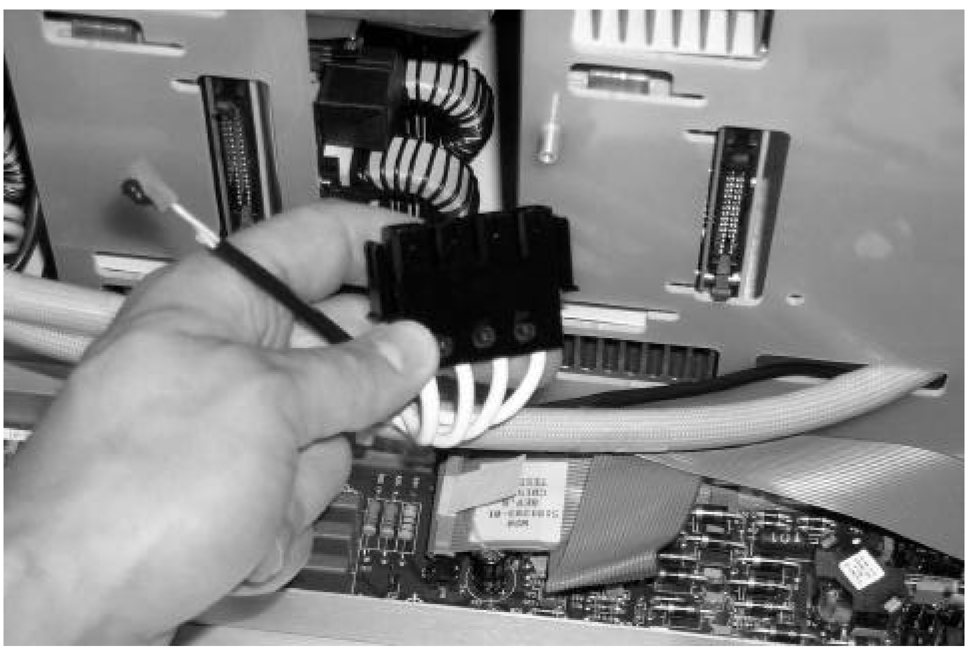


2.6.13 Remove the (4) screws that secure the Signal board to the air baffle.

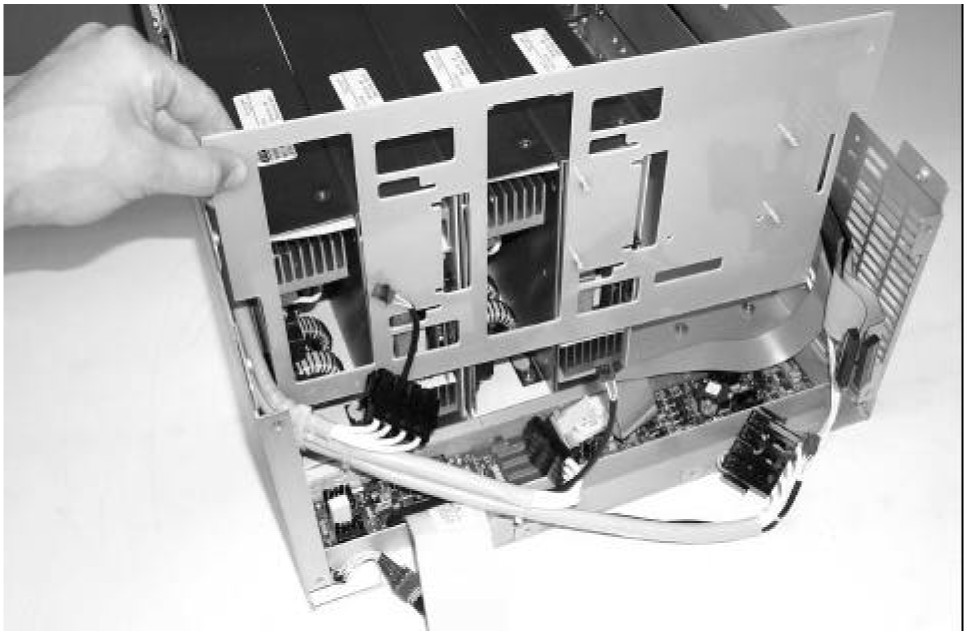


2.6.14 The Signal board can now be removed by disconnecting the (1, 2 or 3) ribbon cable connector(s), depending on model, from the Amplifier module(s) as shown above.

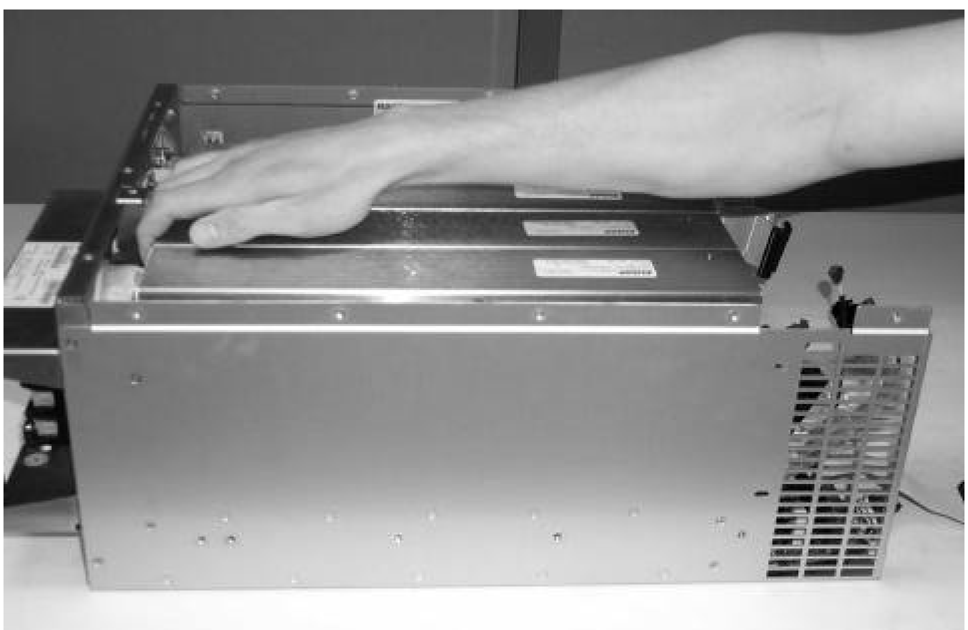
2.6.15 Cut all tie-wraps securing the cable assembly to the air baffle as shown above.



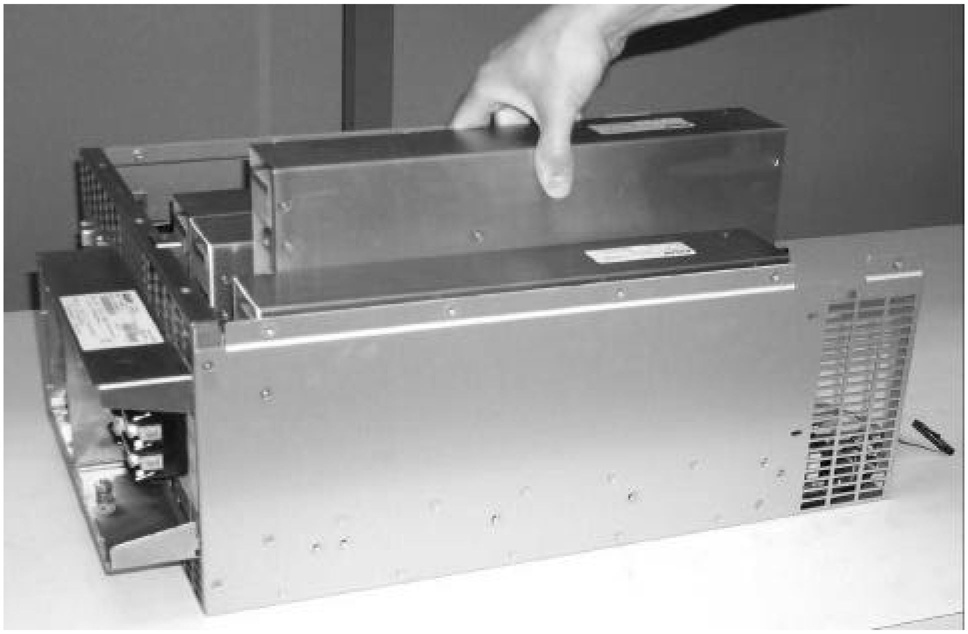
2.6.16 Disconnect both the small enable connector (P1) and the large input power connector (P2) from each of the power modules as shown above. (Note: There may be a small amount of RTV securing the P1 connector, and, the locking tabs of P2 must be depressed before the connector can be removed.)



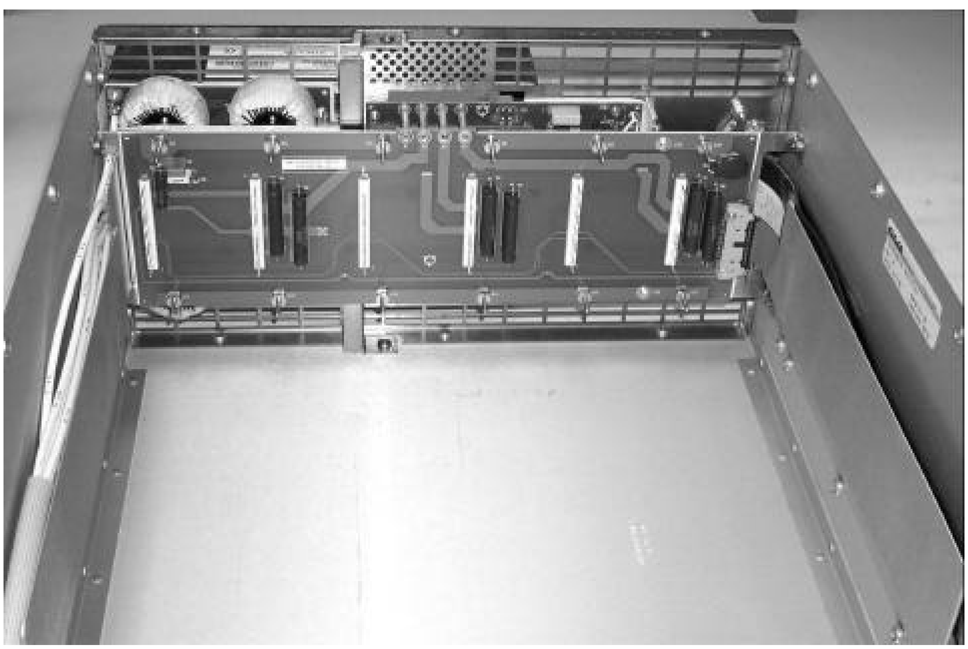
2.6.17 Remove the air baffle by lifting straight out as shown above.



2.6.18 Any module can now be removed by, first, gently pulling module towards the front of unit to unlock…



2.6.19 … And then lifting the module straight up and out of the chassis as shown above.



2.6.20 The rear panel assembly can now be detached by removing the (13) screws around the rear perimeter of the chassis (4 screws on the left side, 5 screws on the right side and 4 screws on the bottom). ⚠ When removing the rear panel assembly from the chassis, extreme care must be taken not to damage any of the ribbon cable assemblies connected to the rear panel assembly.

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SECTION 3 – CALIBRATION

3.1 SCOPE

These procedures cover the calibration of TrueWave models TW1750, TW3500, and TW5250. Calibrating the TrueWave requires no internal adjustment, therefore the covers do not need to be removed (i.e., software calibration). Calibration is accomplished by connecting test equipment to the unit's output and entering externally measured data via computer over the GPIB port.

3.2 APPLICABLE DOCUMENTS

TrueWave Operating Manual:	Elgar Document No. M161469-01
TrueWave SCPI Specification:	Elgar Document No. M161469-02

3.3 REQUIRED TEST EQUIPMENT

The equipment listed below or equipment with equivalent capabilities can be used to calibrate the TrueWave's output and measurement. The measurement equipment listed meets the 4:1 ratio required by many calibration standards.

Description	Accuracy	Model & Model No.
Digital Multimeter 6½ digits AC	AC Volts Range: 0-350 VAC Accuracy: 0.025%	Fluke 1271 with high accuracy (option 12)
Power Analyzer, three-phase	RMS Current Range: 0-13 A/phase Accuracy: 0.25% Peak Current Range: 0-56 Apk/phase Accuracy: 1.25% Power Range: 0-1800W/phase Accuracy: 0.625%	Voltech PM3000A
Counter Timer	Phase Angle Accuracy: 0.25°	Agilent 53131A
Resistor Divider	10:1 ration > 100KΩ	Any
Resistive Loads	12Ω, 2000W (min.) 48Ω, 2000W (min.)	Any Any
Computer with IEEE-488.2 Interface	N/A	Any

TABLE 3-1. CALIBRATION TEST EQUIPMENT

3.4 SETUP

In each calibration section the appropriate setup is listed for the calibration step.

WARNING

If the TrueWave is configured for International input power (380 VAC 4-wire), ensure that the Neutral is connected and not switched. If the Neutral connection is not made, severe damage to the TrueWave may result.

Connect the appropriate input power to the TrueWave.

Once power is applied, the TrueWave system can be powered up by turning on the switch located on the front panel. The power up sequence will take 5-10 seconds.

A 30-minute warm-up period of the TrueWave is recommended prior to calibration. (A 15-minute warm-up period is required.)

3.5 CALIBRATION RESET

The initial step for calibration is to clear the unique existing calibration. This is accomplished by sending the following GPIB commands to the TrueWave:

CAL:UNIQ:OPHA 0.0 0.0 0.0 0.0 0.0
CAL:UNIQ:OPHAB 0.0 0.0 0.0 0.0 0.0
CAL:UNIQ:MOPHAB 0.0 0.0 0.0 0.0 0.0
CAL:UNIQ:OPHAC 0.0 0.0 0.0 0.0 0.0
CAL:UNIQ:MOPHAC 0.0 0.0 0.0 0.0 0.0
CAL:UNIQ:GEXTG 1.0
CAL:UNIQ:OEXTG 0.0

The second step for calibration is clearing the phase specific calibration constants. Each phase has its own calibration data. The *{1,2,3}* symbol should be replaced by 1,2 or 3. For a TW1750, only CAL1 constants need clearing. For a TW3500, CAL1 and CAL2 must be cleared. For a TW5250, CAL1, CAL2 and CAL3 must all be cleared. This is accomplished by sending the following GPIB commands to the TrueWave:

CAL*{1,2,3}*:OUTP:LOCAL:LOR:VOLT:GAIN 1.00
CAL*{1,2,3}*:OUTP:LOCAL:LOR:VOLT:OFFSET 0.0
CAL*{1,2,3}*:OUTP:LOC:LOR:VOLT:FREQCAL 1.0 1.0 1.0 1.0 1.0
CAL*{1,2,3}*:OUTP:LOCAL:HIR:VOLT:GAIN 1.00
CAL*{1,2,3}*:OUTP:LOCAL:HIR:VOLT:OFFSET 0.0
CAL*{1,2,3}*:OUTP:LOC:HIR:VOLT:FREQCAL 1.0 1.0 1.0 1.0 1.0
CAL*{1,2,3}*:OUTP:REMOTE:LOR:VOLT:GAIN 1.00
CAL*{1,2,3}*:OUTP:REMOTE:LOR:VOLT:OFFSET 0.0
CAL*{1,2,3}*:OUTP:REM:LOR:VOLT:FREQCAL 1.0 1.0 1.0 1.0 1.0
CAL*{1,2,3}*:OUTP:REMOTE:HIR:VOLT:GAIN 1.00

CAL*{1,2,3}*:OUTP:REMOTE:HIR:VOLT:OFFSET 0.0
CAL*{1,2,3}*:OUTP:REM:HIR:VOLT:FREQCAL 1.0 1.0 1.0 1.0 1.0
CAL*{1,2,3}*:MEAS:LOCAL:LOR:VOLT:GAIN 1.00
CAL*{1,2,3}*:MEAS:LOCAL:LOR:VOLT:OFFSET 0.0
CAL*{1,2,3}*:MEAS:LOC:LOR:VOLT:FREQCAL 1.0 1.0 1.0 1.0 1.0
CAL*{1,2,3}*:MEAS:LOCAL:HIR:VOLT:GAIN 1.00
CAL*{1,2,3}*:MEAS:LOCAL:HIR:VOLT:OFFSET 0.0
CAL*{1,2,3}*:MEAS:LOC:HIR:VOLT:FREQCAL 1.0 1.0 1.0 1.0 1.0
CAL*{1,2,3}*:MEAS:REMOTE:LOR:VOLT:GAIN 1.00
CAL*{1,2,3}*:MEAS:REMOTE:LOR:VOLT:OFFSET 0.0
CAL*{1,2,3}*:MEAS:REM:LOR:VOLT:FREQCAL 1.0 1.0 1.0 1.0 1.0
CAL*{1,2,3}*:MEAS:REMOTE:HIR:VOLT:GAIN 1.00
CAL*{1,2,3}*:MEAS:REMOTE:HIR:VOLT:OFFSET 0.0
CAL*{1,2,3}*:MEAS:REM:HIR:VOLT:FREQCAL 1.0 1.0 1.0 1.0 1.0
CAL*{1,2,3}*:MEAS:LOCAL:LOR:CURR:GAIN 1.00
CAL*{1,2,3}*:MEAS:LOCAL:LOR:CURR:OFFSET 0.0
CAL*{1,2,3}*:MEAS:LOC:LOR:CURR:FREQCAL 1.0 1.0 1.0 1.0 1.0
CAL*{1,2,3}*:MEAS:LOCAL:HIR:CURR:GAIN 1.00
CAL*{1,2,3}*:MEAS:LOCAL:HIR:CURR:OFFSET 0.0
CAL*{1,2,3}*:MEAS:LOC:HIR:CURR:FREQCAL 1.0 1.0 1.0 1.0 1.0
CAL*{1,2,3}*:MEAS:REMOTE:LOR:CURR:GAIN 1.00
CAL*{1,2,3}*:MEAS:REMOTE:LOR:CURR:OFFSET 0.0
CAL*{1,2,3}*:MEAS:REM:LOR:CURR:FREQCAL 1.0 1.0 1.0 1.0 1.0
CAL*{1,2,3}*:MEAS:REMOTE:HIR:CURR:GAIN 1.00
CAL*{1,2,3}*:MEAS:REMOTE:HIR:CURR:OFFSET 0.0
CAL*{1,2,3}*:MEAS:LOCAL:LOR:WATT:GAIN 1.00
CAL*{1,2,3}*:MEAS:LOCAL:LOR:WATT:OFFSET 0.0
CAL*{1,2,3}*:MEAS:LOC:LOR:WATT:FREQCAL 1.0 1.0 1.0 1.0 1.0
CAL*{1,2,3}*:MEAS:REMOTE:LOR:WATT:GAIN 1.00
CAL*{1,2,3}*:MEAS:REMOTE:LOR:WATT:OFFSET 0.0
CAL*{1,2,3}*:MEAS:REM:LOR:WATT:FREQCAL 1.0 1.0 1.0 1.0 1.0
CAL*{1,2,3}*:MEAS:LOCAL:HIR:WATT:GAIN 1.00
CAL*{1,2,3}*:MEAS:LOCAL:HIR:WATT:OFFSET 0.0
CAL*{1,2,3}*:MEAS:LOC:HIR:WATT:FREQCAL 1.0 1.0 1.0 1.0 1.0
CAL*{1,2,3}*:MEAS:REMOTE:HIR:WATT:GAIN 1.00
CAL*{1,2,3}*:MEAS:REMOTE:HIR:WATT:OFFSET 0.0
CAL*{1,2,3}*:MEAS:REM:HIR:WATT:FREQCAL 1.0 1.0 1.0 1.0 1.0

3.6 DC OFFSET CALIBRATION

Connect the DMM to the output phase of the TW to be calibrated. Set the DMM for auto–ranging volts DC. Send the following GPIB commands to the TW:

OUTPUT OFF
OUTP:COUP DC

Wait for the TW to complete its coupling change to DC. Continue with the following GPIB commands:

SOUR:VOLT:RANGE LOW
SOUR:SENSE LOCAL
SOUR*{1,2,3}*:CURR 5.00
SOUR*{1,2,3}*:VOLT:OFFSET 0.0
SOUR0:VOLT:PROT 200.0
CAL:UNIQ:DCDAC*{A,B,C}* 0
OUTPUT ON

Wait for the DMM to settle. Record the DMM reading as **RDNG1**.

Send the following GPIB command:

CAL:UNIQ:DCDAC*{A,B,C}* 255

Wait for the DMM to settle. Record the DMM reading as **RDNG 2**.

Calculate the required offset DAC setting.

VALUE1 = (256 * RDNG1) / (RDNG1 – RDNG2)

Set the dc offset calibration register:

OUTPUT OFF
CAL:UNIQ:DCDAC*{A,B,C}* **VALUE1**

3.7 DC LOCAL LOW RANGE CALIBRATION

Both the measurement and output subsystems are calibrated at the same time. Connect the DMM to the output phase of the TW to be calibrated. Set the DMM for auto–ranging volts DC. Send the following GPIB commands to the TW:

OUTPUT OFF
OUTP:COUP DC

Wait for the TW to complete its coupling change to DC. Continue with the following GPIB command:

SOUR:VOLT:RANGE LOW
SOUR:SENSE LOCAL
SOUR*{1,2,3}*:CURR 5.00
OUTPUT ON
SOUR*{1,2,3}*:VOLT:OFFSET 0.0

Wait for the DMM to settle and record the value as **RDGN1**.

Send the following query command to the TW and record the return string as **MEAS1**:

MEAS*{1,2,3}*:VOLT?

Calculate the offset value:

VALUE1 = RDGN1 – MEAS1

Send the offset value to the TW:

CAL*{1,2,3}*:MEAS:LOC:LOR:VOLT:OFFSET **VALUE1**

Measure the current offset by sending the following GPIB query and record the return string as **MEAS1**:

MEAS*{1,2,3}*:CURR?

Calculate the offset value:

VALUE1 = -1.0 * **MEAS1**

Send the calculated offset to the TW:

CAL*{1,2,3}*:MEAS:LOC:LOR:CURR:OFFSET **VALUE1**

Set the TW to 220 volts DC by sending the following GPIB string:

SOUR*{1,2,3}*:VOLT:OFFSET 220

Wait for the DMM to settle. Take a DMM reading and record the value as **RDGN1**.

Query the output voltage of the TW and record the return string as **MEAS1**:

MEAS*{1,2,3}*:VOLT?

Set the TW to -220 volts DC by sending the following GPIB string:

SOUR*{1,2,3}*:VOLT:OFFSET –220

Wait for the DMM to settle. Take a DMM reading and record the value as **RDGN2.**

Query the output voltage of the TW and record the return string as **MEAS2**:

MEAS*{1,2,3}*:VOLT?

Calculate the gains and offset for the phase being calibrated:

GAIN1 = (**MEAS1** – **MEAS2**) / (**RDGN1** – **RDGN2**)
GAIN2 = (440.0) / (**MEAS1** – **MEAS2**)
OFFSET = **GAIN2** * **MEAS1** – 220.0

Update the TW calibration registers by sending the following GPIB strings:

CAL*{1,2,3}*:MEAS:LOC:LOR:VOLT:GAIN **GAIN2**
CAL*{1,2,3}*:OUTP:LOC:LOR:VOLT:GAIN **GAIN1**
CAL*{1,2,3}*:OUTP:LOC:LOR:VOLT:OFFSET **OFFSET**

Reset the TW's output to a safe condition:

SOUR*{1,2,3}*:VOLT:OFFSET 0.0
OUTPUT OFF

3.8 DC LOCAL HIGH RANGE CALIBRATION

Both the measurement and output subsystems are calibrated at the same time. Connect the DMM to the output phase of the TW to be calibrated. Set the DMM for auto–ranging volts DC. Send the following GPIB commands to the TW:

OUTPUT OFF
OUTP:COUP DC

Wait for the TW to complete its coupling change to DC. Continue with the following GPIB command:

SOUR:VOLT:RANGE HIGH
SOUR:SENSE LOCAL
SOUR*{1,2,3}*:CURR 5.00
OUTPUT ON
SOUR*{1,2,3}*:VOLT:OFFSET 0.0

Wait for the DMM to settle and record the value as **RDGN1**.

Send the following query command to the TW and record the return string as **MEAS1**:

MEAS*{1,2,3}*:VOLT?

Calculate the offset value:

VALUE1 = RDGN1 – MEAS1

Send the offset value to the TW:

CAL*{1,2,3}*:MEAS:LOC:HIR:VOLT:OFFSET **VALUE1**

Measure the current offset by sending the following GPIB query and record the return string as **MEAS1**:

MEAS*{1,2,3}*:CURR?

Calculate the offset value:

VALUE1 = -1.0 * **MEAS1**

Send the calculated offset to the TW:

CAL*{1,2,3}*:MEAS:LOC:HIR:CURR:OFFSET **VALUE1**

Set the TW to 440 volts DC by sending the following GPIB string:

SOUR*{1,2,3}*:VOLT:OFFSET 440

Wait for the DMM to settle. Take a DMM reading and record the value as **RDGN1**.

Query the output voltage of the TW and record the return string as **MEAS1**:

MEAS*{1,2,3}*:VOLT?

Set the TW to -440 volts DC by sending the following GPIB string:

SOUR*{1,2,3}*:VOLT:OFFSET –440

Wait for the DMM to settle. Take a DMM reading and record the value as **RDGN2**.

Query the output voltage of the TW and record the return string as **MEAS2**:

MEAS*{1,2,3}*:VOLT?

Calculate the gains and offset for the phase being calibrated:

GAIN1 = (**MEAS1** – **MEAS2**) / (**RDGN1** – **RDGN2**)
GAIN2 = (880.0) / (**MEAS1** – **MEAS2**)
OFFSET = **GAIN2** * **MEAS1** – 440.0

Update the TW calibration registers by sending the following GPIB strings:

CAL*{1,2,3}*:MEAS:LOC:HIR:VOLT:GAIN **GAIN2**
CAL*{1,2,3}*:OUTP:LOC:HIR:VOLT:GAIN **GAIN1**
CAL*{1,2,3}*:OUTP:LOC:HIR:VOLT:OFFSET **OFFSET**

Reset the TW’s output to a safe condition:

SOUR*{1,2,3}*:VOLT:OFFSET 0.0
OUTPUT OFF

3.9 DC REMOTE LOW RANGE CALIBRATION

Both the measurement and output subsystems are calibrated at the same time. Connect the DMM to the output phase of the TW to be calibrated. Set the DMM for auto–ranging volts DC. Send the following GPIB commands to the TW:

OUTPUT OFF
OUTP:COUP DC

Wait for the TW to complete its coupling change to DC. Continue with the following GPIB command:

SOUR:VOLT:RANGE LOW
SOUR:SENSE REMOTE
SOUR*{1,2,3}*:CURR 5.00
OUTPUT ON
SOUR*{1,2,3}*:VOLT:OFFSET 0.0

Wait for the DMM to settle and record the value as **RDGN1**.

Send the following query command to the TW and record the return string as **MEAS1**:

MEAS*{1,2,3}*:VOLT?

Calculate the offset value:

VALUE1 = RDGN1 – MEAS1

Send the offset value to the TW:

CAL*{1,2,3}*:MEAS:REM:LOR:VOLT:OFFSET **VALUE1**

Measure the current offset by sending the following GPIB query and record the return string as **MEAS1**:

MEAS*{1,2,3}*:CURR?

Calculate the offset value:

VALUE1 = -1.0 * **MEAS1**

Send the calculated offset to the TW:

CAL*{1,2,3}*:MEAS:REM:LOR:CURR:OFFSET **VALUE1**

Set the TW to 220 volts DC by sending the following GPIB string:

SOUR*{1,2,3}*:VOLT:OFFSET 220

Wait for the DMM to settle. Take a DMM reading and record the value as **RDGN1**.

Query the output voltage of the TW and record the return string as **MEAS1**:

MEAS*{1,2,3}*:VOLT?

Set the TW to -220 volts DC by sending the following GPIB string:

SOUR*{1,2,3}*:VOLT:OFFSET –220

Wait for the DMM to settle. Take a DMM reading and record the value as **RDGN2**.

Query the output voltage of the TW and record the return string as **MEAS2**:

MEAS*{1,2,3}*:VOLT?

Calculate the gains and offset for the phase being calibrated:

GAIN1 = (**MEAS1** – **MEAS2**) / (**RDGN1** – **RDGN2**)
GAIN2 = (440.0) / (**MEAS1** – **MEAS2**)
OFFSET = **GAIN2** * **MEAS1** – 220.0

Update the TW calibration registers by sending the following GPIB strings:

CAL*{1,2,3}*:MEAS:REM:LOR:VOLT:GAIN **GAIN2**
CAL*{1,2,3}*:OUTP:REM:LOR:VOLT:GAIN **GAIN1**
CAL*{1,2,3}*:OUTP:REM:LOR:VOLT:OFFSET **OFFSET**

Reset the TW's output to a safe condition:

SOUR*{1,2,3}*:VOLT:OFFSET 0.0
OUTPUT OFF

3.10 DC REMOTE HIGH RANGE CALIBRATION

Both the measurement and output subsystems are calibrated at the same time. Connect the DMM to the output phase of the TW to be calibrated. Set the DMM for auto–ranging volts DC. Send the following GPIB commands to the TW:

OUTPUT OFF
OUTP:COUP DC

Wait for the TW to complete its coupling change to DC; continue with this command:

SOUR:VOLT:RANGE HIGH
SOUR:SENSE REMOTE
SOUR*{1,2,3}*:CURR 5.00
OUTPUT ON
SOUR*{1,2,3}*:VOLT:OFFSET 0.0

Wait for the DMM to settle and record the value as **RDGN1**.

Send the following query command to the TW and record the return string as **MEAS1**:

MEAS*{1,2,3}*:VOLT?

Calculate the offset value:

VALUE1 = RDGN1 – MEAS1

Send the offset value to the TW:

CAL*{1,2,3}*:MEAS:REM:HIR:VOLT:OFFSET **VALUE1**

Measure the current offset by sending the following GPIB query and record the return string as **MEAS1**:

MEAS*{1,2,3}*:CURR?

Calculate the offset value:

VALUE1 = -1.0 * **MEAS1**

Send the calculated offset to the TW:

CAL*{1,2,3}*:MEAS:REM:HIR:CURR:OFFSET **VALUE1**

Set the TW to 440 volts DC by sending the following GPIB string:

SOUR*{1,2,3}*:VOLT:OFFSET 440

Wait for the DMM to settle. Take a DMM reading and record the value as **RDGN1**.

Query the output voltage of the TW and record the return string as **MEAS1**:

MEAS*{1,2,3}*:VOLT?

Set the TW to -440 volts DC by sending the following GPIB string:

SOUR*{1,2,3}*:VOLT:OFFSET –440

Wait for the DMM to settle. Take a DMM reading and record the value as **RDGN2**.

Query the output voltage of the TW and record the return string as **MEAS2**:

MEAS*{1,2,3}*:VOLT?

Calculate the gains and offset for the phase being calibrated:

GAIN1 = (**MEAS1** – **MEAS2**) / (**RDGN1** – **RDGN2**)
GAIN2 = (880.0) / (**MEAS1** – **MEAS2**)
OFFSET = **GAIN2** * **MEAS1** – 440.0

Update the TW calibration registers by sending the following GPIB strings:

CAL*{1,2,3}*:MEAS:REM:HIR:VOLT:GAIN **GAIN2**
CAL*{1,2,3}*:OUTP:REM:HIR:VOLT:GAIN **GAIN1**
CAL*{1,2,3}*:OUTP:REM:HIR:VOLT:OFFSET **OFFSET**

Reset the TW's output to a safe condition:

SOUR*{1,2,3}*:VOLT:OFFSET 0.0
OUTPUT OFF

3.11 LOCAL LOW RANGE FREQUENCY CALIBRATION

Connect the TW output to the DMM. Set the DMM up for auto–ranging AC voltage.

Set the TW into AC coupling, local sense, 40 Hz, 120V, and low range by sending the following GPIB strings:

OUTP:COUP AC
SOUR:VOLT:RANGE LOW
SOUR:SENSE LOCAL
SOUR:FREQ 40.0
SOUR*{1,2,3}*:VOLT 120.00

Close the TW's output relay:

OUTPUT ON

Wait for the DMM to settle and record the voltage as **MEAS1**.

Set the TW to 80 Hz.

SOUR:FREQ 80.0

Wait for the DMM to settle and record the voltage as **MEAS2**.

Set the TW to 160 Hz.

SOUR:FREQ 160.0

Wait for the DMM to settle and record the voltage as **MEAS3**.

Set the TW to 320 Hz.

SOUR:FREQ 320.0

Wait for the DMM to settle and record the voltage as **MEAS4**.

Set the TW to 500 Hz.

SOUR:FREQ 500.0

Wait for the DMM to settle and record the voltage as **MEAS5**.

Set the TW to 60 Hz and open the output relay.

SOUR:FREQ 60.0
OUTPUT OFF

Calculate the calibration constants:

VALUE1 = 120.0 / **MEAS1**
VALUE2 = 120.0 / **MEAS2**
VALUE3 = 120.0 / **MEAS3**
VALUE4 = 120.0 / **MEAS4**
VALUE5 = 120.0 / **MEAS5**

Update the local low range frequency calibration of the TW by sending the following GPIB string:

CAL*{1,2,3}*:OUTP:LOC:LOR:VOLT:FREQCAL **VALUE1 VALUE2 VALUE3 VALUE4 VALUE5**

Close the TW's output relay:

OUTPUT ON

Wait for the DMM reading to settle and record the value as **RDNG1**.

Query the TW's output put voltage with the GPIB string below and record this value as **MEAS1**.

MEAS*{1,2,3}*:VOLT?

Set the TW's frequency to 80 Hz with the following GPIB command:

SOUR:FREQ 80.0

Wait for the DMM reading to settle and record the value as **RDNG2**.

Query the TW's output put voltage with the GPIB string below and record this value as **MEAS2**.

MEAS*{1,2,3}*:VOLT?

Set the TW's frequency to 160 Hz with the following GPIB command:

SOUR:FREQ 160.0

Wait for the DMM reading to settle and record the value as **RDNG3**.

Query the TW's output put voltage with the GPIB string below and record this value as **MEAS3**.

MEAS*{1,2,3}*:VOLT?

Set the TW's frequency to 320 Hz with the following GPIB command:

SOUR:FREQ 320.0

Wait for the DMM reading to settle and record the value as **RDNG4**.

Query the TW's output put voltage with the GPIB string below and record this value as **MEAS4**.

MEAS*{1,2,3}*:VOLT?

Set the TW's frequency to 500 Hz with the following GPIB command:

SOUR:FREQ 500.0

Wait for the DMM reading to settle and record the value as **RDNG5**.

Query the TW's output put voltage with the GPIB string below and record this value as **MEAS5**.

MEAS*{1,2,3}*:VOLT?

Set the TW's frequency to 60 Hz and open the output with the following GPIB commands:

SOUR:FREQ 60.0
OUTP OFF

Calculate the measurement system frequency compensation values:

VALUE1 = **RDGN1** / **MEAS1**
VALUE2 = **RDGN2** / **MEAS2**
VALUE3 = **RDGN3** / **MEAS3**
VALUE4 = **RDGN4** / **MEAS4**
VALUE5 = **RDGN5** / **MEAS5**

Update the TW's calibration data with the following GPIB command:

CAL*{1,2,3}*:MEAS:LOC:LOR:VOLT:FREQCAL **VALUE1 VALUE2 VALUE3 VALUE4 VALUE5**

3.12 LOCAL HIGH RANGE FREQUENCY CALIBRATION

Connect the TW output to the DMM. Set the DMM up for auto–ranging AC voltage.

Set the TW into AC coupling, local sense, 40 Hz, 120V, and high range by sending the following GPIB strings:

```
OUTP:COUP AC
SOUR:VOLT:RANGE HIGH
SOUR:SENSE LOCAL
SOUR:FREQ 40.0
SOUR{1,2,3}:VOLT 240.00
```

Close the TW's output relay:

```
OUTPUT ON
```

Wait for the DMM to settle and record the voltage as **MEAS1**.

Set the TW to 80 Hz.

```
SOUR:FREQ 80.0
```

Wait for the DMM to settle and record the voltage as **MEAS2**.

Set the TW to 160 Hz.

```
SOUR:FREQ 160.0
```

Wait for the DMM to settle and record the voltage as **MEAS3**.

Set the TW to 320 Hz.

```
SOUR:FREQ 320.0
```

Wait for the DMM to settle and record the voltage as **MEAS4**.

Set the TW to 500 Hz.

```
SOUR:FREQ 500.0
```

Wait for the DMM to settle and record the voltage as **MEAS5**.

Set the TW to 40 Hz and open the output relay.

```
SOUR:FREQ 40.0
OUTPUT OFF
```

Calculate the calibration constants:

> **VALUE1** = 240.0 / **MEAS1**
> **VALUE2** = 240.0 / **MEAS2**
> **VALUE3** = 240.0 / **MEAS3**
> **VALUE4** = 240.0 / **MEAS4**
> **VALUE5** = 240.0 / **MEAS5**

Update the local high range frequency calibration of the TW by sending the following GPIB string:

> CAL*{1,2,3}*:OUTP:LOC:HIR:VOLT:FREQCAL **VALUE1 VALUE2 VALUE3 VALUE4 VALUE5**

Close the TW's output relay:

> OUTPUT ON

Wait for the DMM reading to settle and record the value as **RDNG1**.

Query the TW's output put voltage with the GPIB string below and record this value as **MEAS1**.

> MEAS*{1,2,3}*:VOLT?

Set the TW's frequency to 80 Hz with the following GPIB command:

> SOUR:FREQ 80.0

Wait for the DMM reading to settle and record the value as **RDNG2**.

Query the TW's output put voltage with the GPIB string below and record this value as **MEAS2**.

> MEAS*{1,2,3}*:VOLT?

Set the TW's frequency to 160 Hz with the following GPIB command:

> SOUR:FREQ 160.0

Wait for the DMM reading to settle and record the value as **RDNG3**.

Query the TW's output put voltage with the GPIB string below and record this value as **MEAS3**.

> MEAS*{1,2,3}*:VOLT?

Set the TW's frequency to 320 Hz with the following GPIB command:

> SOUR:FREQ 320.0

Wait for the DMM reading to settle and record the value as **RDNG4**.

Query the TW's output put voltage with the GPIB string below and record this value as **MEAS4**.

MEAS*{1,2,3}*:VOLT?

Set the TW's frequency to 500 Hz with the following GPIB command:

SOUR:FREQ 500.0

Wait for the DMM reading to settle and record the value as **RDNG5**.

Query the TW's output put voltage with the GPIB string below and record this value as **MEAS5**.

MEAS*{1,2,3}*:VOLT?

Set the TW's frequency to 60 Hz and open the output with the following GPIB commands:

SOUR:FREQ 60.0
OUTP OFF

Calculate the measurement system frequency compensation values:

VALUE1 = **RDGN1** / **MEAS1**
VALUE2 = **RDGN2** / **MEAS2**
VALUE3 = **RDGN3** / **MEAS3**
VALUE4 = **RDGN4** / **MEAS4**
VALUE5 = **RDGN5** / **MEAS5**

Update the TW's calibration data with the following GPIB command:

CAL*{1,2,3}*:MEAS:LOC:HIR:VOLT:FREQCAL **VALUE1 VALUE2 VALUE3 VALUE4 VALUE5**

3.13 REMOTE LOW RANGE FREQUENCY CALIBRATION

Connect the TW output to the DMM. Set the DMM up for auto–ranging AC voltage.

Set the TW into AC coupling, remote sense, 40 Hz, 120V, and low range by sending the following GPIB strings:

OUTP:COUP AC
SOUR:VOLT:RANGE LOW
SOUR:SENSE REMOTE
SOUR:FREQ 40.0
SOUR*{1,2,3}*:VOLT 120.00

Close the TW's output relay:

OUTPUT ON

Wait for the DMM to settle and record the voltage as **MEAS1**.

Set the TW to 80 Hz.

SOUR:FREQ 80.0

Wait for the DMM to settle and record the voltage as **MEAS2**.

Set the TW to 160 Hz.

SOUR:FREQ 160.0

Wait for the DMM to settle and record the voltage as **MEAS3**.

Set the TW to 320 Hz.

SOUR:FREQ 320.0

Wait for the DMM to settle and record the voltage as **MEAS4**.

Set the TW to 500 Hz.

SOUR:FREQ 500.0

Wait for the DMM to settle and record the voltage as **MEAS5**.

Set the TW to 60 Hz and open the output relay.

SOUR:FREQ 80.0
OUTPUT OFF

Calculate the calibration constants:

VALUE1 = 120.0 / **MEAS1**
VALUE2 = 120.0 / **MEAS2**
VALUE3 = 120.0 / **MEAS3**
VALUE4 = 120.0 / **MEAS4**
VALUE5 = 120.0 / **MEAS5**

Update the remote low range frequency calibration of the TW by sending the following GPIB string:

CAL*{1,2,3}*:OUTP:REM:LOR:VOLT:FREQCAL **VALUE1 VALUE2 VALUE3 VALUE4 VALUE5**

Close the TW's output relay:

OUTPUT ON

Wait for the DMM reading to settle and record the value as **RDNG1**.

Query the TW's output put voltage with the GPIB string below and record this value as **MEAS1**.

MEAS*{1,2,3}*:VOLT?

Set the TW's frequency to 80 Hz with the following GPIB command:

SOUR:FREQ 80.0

Wait for the DMM reading to settle and record the value as **RDNG2**.

Query the TW's output put voltage with the GPIB string below and record this value as **MEAS2**.

MEAS*{1,2,3}*:VOLT?

Set the TW's frequency to 160 Hz with the following GPIB command:

SOUR:FREQ 160.0

Wait for the DMM reading to settle and record the value as **RDNG3**.

Query the TW's output put voltage with the GPIB string below and record this value as **MEAS3**.

MEAS*{1,2,3}*:VOLT?

Set the TW's frequency to 320 Hz with the following GPIB command:

SOUR:FREQ 320.0

Wait for the DMM reading to settle and record the value as **RDNG4**.

Query the TW's output put voltage with the GPIB string below and record this value as **MEAS4**.

MEAS*{1,2,3}*:VOLT?

Set the TW's frequency to 500 Hz with the following GPIB command:

SOUR:FREQ 500.0

Wait for the DMM reading to settle and record the value as **RDNG5**.

Query the TW's output put voltage with the GPIB string below and record this value as **MEAS5**.

MEAS*{1,2,3}*:VOLT?

Set the TW's frequency to 60 Hz and open the output with the following GPIB commands:

SOUR:FREQ 60.0
OUTP OFF

Calculate the measurement system frequency compensation values:

VALUE1 = **RDGN1** / **MEAS1**
VALUE2 = **RDGN2** / **MEAS2**
VALUE3 = **RDGN3** / **MEAS3**
VALUE4 = **RDGN4** / **MEAS4**
VALUE5 = **RDGN5** / **MEAS5**

Update the TW's calibration data with the following GPIB command:

CAL*{1,2,3}*:MEAS:REM:LOR:VOLT:FREQCAL **VALUE1 VALUE2 VALUE3 VALUE4 VALUE5**

3.14 REMOTE HIGH RANGE FREQUENCY CALIBRATION

Connect the TW output to the DMM. Set the DMM up for auto–ranging AC voltage.

Set the TW into AC coupling, remote sense, 40 Hz, 120V, and high range by sending the following GPIB strings:

OUTP:COUP AC
SOUR:VOLT:RANGE HIGH
SOUR:SENSE REMOTE
SOUR:FREQ 40.0
SOUR*{1,2,3}*:VOLT 240.00

Close the TW's output relay:

OUTPUT ON

Wait for the DMM to settle and record the voltage as **MEAS1**.

Set the TW to 80 Hz.

SOUR:FREQ 80.0

Wait for the DMM to settle and record the voltage as **MEAS2**.

Set the TW to 160 Hz.

SOUR:FREQ 160.0

Wait for the DMM to settle and record the voltage as **MEAS3**.

Set the TW to 320 Hz.

SOUR:FREQ 320.0

Wait for the DMM to settle and record the voltage as **MEAS4**.

Set the TW to 500 Hz.

SOUR:FREQ 500.0

Wait for the DMM to settle and record the voltage as **MEAS5**.

Set the TW to 60 Hz and open the output relay.

SOUR:FREQ 80.0
OUTPUT OFF

Calculate the calibration constants:

VALUE1 = 240.0 / **MEAS1**
VALUE2 = 240.0 / **MEAS2**
VALUE3 = 240.0 / **MEAS3**
VALUE4 = 240.0 / **MEAS4**
VALUE5 = 240.0 / **MEAS5**

Update the remote high range frequency calibration of the TW by sending the following GPIB string:

CAL*{1,2,3}*:OUTP:REM:HIR:VOLT:FREQCAL **VALUE1 VALUE2 VALUE 3VALUE4 VALUE5**

Close the TW's output relay:

OUTPUT ON

Wait for the DMM reading to settle and record the value as **RDNG1**.

Query the TW's output put voltage with the GPIB string below and record this value as **MEAS1**.

MEAS*{1,2,3}*:VOLT?

Set the TW's frequency to 80 Hz with the following GPIB command:

SOUR:FREQ 80.0

Wait for the DMM reading to settle and record the value as **RDNG2**.

Query the TW's output put voltage with the GPIB string below and record this value as **MEAS2**.

MEAS*{1,2,3}*:VOLT?

Set the TW's frequency to 160 Hz with the following GPIB command:

SOUR:FREQ 160.0

Wait for the DMM reading to settle and record the value as **RDNG3**.

Query the TW's output put voltage with the GPIB string below and record this value as **MEAS3**.

MEAS*{1,2,3}*:VOLT?

Set the TW's frequency to 320 Hz with the following GPIB command:

SOUR:FREQ 320.0

Wait for the DMM reading to settle and record the value as **RDNG4**.

Query the TW's output put voltage with the GPIB string below and record this value as **MEAS4**.

MEAS*{1,2,3}*:VOLT?

Set the TW's frequency to 500 Hz with the following GPIB command:

SOUR:FREQ 500.0

Wait for the DMM reading to settle and record the value as **RDNG5**.

Query the TW's output put voltage with the GPIB string below and record this value as **MEAS5**.

MEAS*{1,2,3}*:VOLT?

Set the TW's frequency to 60 Hz and open the output with the following GPIB commands:

SOUR:FREQ 60.0
OUTP OFF

Calculate the measurement system frequency compensation values:

VALUE1 = **RDGN1** / **MEAS1**
VALUE2 = **RDGN2** / **MEAS2**
VALUE3 = **RDGN3** / **MEAS3**
VALUE4 = **RDGN4** / **MEAS4**
VALUE5 = **RDGN5** / **MEAS5**

Update the TW's calibration data with the following GPIB command:

CAL*{1,2,3}*:MEAS:REM:HIR:VOLT:FREQCAL **VALUE1 VALUE2 VALUE3 VALUE4 VALUE5**

3.15 EXTERNAL PHASE REFERENCE CALIBRATION

Connect the counter timer channel 1 to the TW's A phase through a 10:1 resistor divider. Connect the counter timer channel 2 to the TW's clock/lock/sync BNC. Set the counter time up to measure phase angle.

Set up the TW for the external refout, low range, local sense, 40 Hz, 120 V and close the output relay by sending the following GPIB commands:

SYST:EXT:CLOCK REFOUT
SOUR:VOLT:RANGE LOW
SOUR:SENSE LOCAL
SOUR:FREQ 40.0
SOUR:VOLT 120.00
OUTPUT ON

Wait for the phase angle measurement to stabilize on the counter timer. Record the phase angle as **RDGN1**.

Set the TW frequency to 80 Hz:

SOUR:FREQ 80.0

Wait for the phase angle measurement to stabilize on the counter timer. Record the phase angle as **RDGN2**.

Set the TW frequency to 160 Hz:

SOUR:FREQ 160.0

Wait for the phase angle measurement to stabilize on the counter timer. Record the phase angle as **RDGN3**.

Set the TW frequency to 160 Hz:

SOUR:FREQ 160.0

Wait for the phase angle measurement to stabilize on the counter timer. Record the phase angle as **RDGN4**.

Set the TW frequency to 320 Hz:

SOUR:FREQ 320.0

Wait for the phase angle measurement to stabilize on the counter timer. Record the phase angle as **RDGN5**.

Set the TW frequency to 60 Hz and output off:

SOUR:FREQ 60.0
OUTP OFF

Calculate the phase angle compensation values:

VALUE1 = -1.0 * **RDGN1**
VALUE2 = -1.0 * **RDGN2**
VALUE3 = -1.0 * **RDGN3**
VALUE4 = -1.0 * **RDGN4**
VALUE5 = -1.0 * **RDGN5**

Update the phase A offset calibration data via the GPIB:

CAL:UNIQ:OPHA **VALUE1 VALUE2 VALUE3 VALUE4 VALUE5**

3.16 PHASE A TO PHASE B CALIBRATION

Note: this calibration step only applies to TW3500 and TW5250 systems.

Connect the counter timer channel 1 to the TW's A phase through a 10:1 resistor divider. Connect the counter timer channel 2 to the TW's B phase through a 10:1 resistor divider. Set the counter time up to measure phase angle.

Set the TW up for 0 degrees phase A to phase B, low range, local sense, 40 Hz, 120V and close the output by sending the following GPIB commands:

SOUR2:PHAS 0
SOUR:VOLT:RANGE LOW
SOUR:SENSE LOCAL
SOUR:FREQ 40.0
SOUR:VOLT 120.00
OUTPUT ON

Wait for the counter timer to settle and record the phase angle as **RDNG1**.

Query the TW for the phase angle with the following command and record the value as **MEAS1**.

MEAS2:PHASE?

Set the TW frequency to 80 Hz via the GPIB:

SOUR:FREQ 80.0

Wait for the counter timer to settle and record the phase angle as **RDNG2**.

Query the TW for the phase angle with the following command and record the value as **MEAS2**.

MEAS2:PHASE?

Set the TW frequency to 160 Hz via the GPIB:

SOUR:FREQ 160.0

Wait for the counter timer to settle and record the phase angle as **RDNG3**.

Query the TW for the phase angle with the following command and record the value as **MEAS3**.

MEAS2:PHASE?

Set the TW frequency to 320 Hz via the GPIB:

SOUR:FREQ 320.0

Wait for the counter timer to settle and record the phase angle as **RDNG4**.

Query the TW for the phase angle with the following command and record the value as **MEAS4**.

MEAS2:PHASE?

Set the TW frequency to 500 Hz via the GPIB:

SOUR:FREQ 500.0

Wait for the counter timer to settle and record the phase angle as **RDNG5**.

Query the TW for the phase angle with the following command and record the value as **MEAS5**.

MEAS2:PHASE?

Set the TW frequency to 60 Hz and open the output via the GPIB:

SOUR:FREQ 60.0
OUTP OFF

Calculate the phase offset calibration data:

VALUE1 = -1.0 * **RDGN1**
VALUE2 = -1.0 * **RDGN2**
VALUE3 = -1.0 * **RDGN3**
VALUE4 = -1.0 * **RDGN4**
VALUE5 = -1.0 * **RDGN5**

Update the calibration data via the GPIB:

CAL:UNIQ:OPHAB **VALUE1 VALUE2 VALUE3 VALUE4 VALUE5**

Calculate the phase angle readback calibration data:

VALUE1 = -1.0 * (**RDGN1** + **MEAS1**)
VALUE2 = -1.0 * (**RDGN2** + **MEAS2**)
VALUE3 = -1.0 * (**RDGN3** + **MEAS3**)
VALUE4 = -1.0 * (**RDGN4** + **MEAS4**)
VALUE5 = -1.0 * (**RDGN5** + **MEAS5**)

Update the calibration data via the GPIB:

CAL:UNIQ:MOPHAB **VALUE1 VALUE2 VALUE3 VALUE4 VALUE5**

3.17 PHASE A TO PHASE C CALIBRATION

Note: this calibration step only applies to TW5250 systems.

Connect the counter timer channel 1 to the TW's A phase through a 10:1 resistor divider. Connect the counter timer channel 2 to the TW's C phase through a 10:1 resistor divider. Set the counter time up to measure phase angle.

Set the TW up for 0 degrees phase A to phase C, low range, local sense, 40 Hz, 120V and close the output by sending the following GPIB commands:

SOUR3:PHAS 0
SOUR:VOLT:RANGE LOW
SOUR:SENSE LOCAL
SOUR:FREQ 40.0
SOUR:VOLT 120.00
OUTPUT ON

Wait for the counter timer to settle and record the phase angle as **RDNG1**.

Query the TW for the phase angle with the following command and record the value as **MEAS1**.

MEAS2:PHASE?

Set the TW frequency to 80 Hz via the GPIB:

SOUR:FREQ 80.0

Wait for the counter timer to settle and record the phase angle as **RDNG2**.

Query the TW for the phase angle with the following command and record the value as **MEAS2**.

MEAS2:PHASE?

Set the TW frequency to 160 Hz via the GPIB:

SOUR:FREQ 160.0

Wait for the counter timer to settle and record the phase angle as **RDNG3**.

Query the TW for the phase angle with the following command and record the value as **MEAS3**.

MEAS2:PHASE?

Set the TW frequency to 320 Hz via the GPIB:

SOUR:FREQ 320.0

Wait for the counter timer to settle and record the phase angle as **RDNG4**.

Query the TW for the phase angle with the following command and record the value as **MEAS4**.

MEAS2:PHASE?

Set the TW frequency to 500 Hz via the GPIB:

SOUR:FREQ 500.0

Wait for the counter timer to settle and record the phase angle as **RDNG5**.

Query the TW for the phase angle with the following command and record the value as **MEAS5**.

MEAS2:PHASE?

Set the TW frequency to 60 Hz and open the output via the GPIB:

SOUR:FREQ 60.0
OUTP OFF

Calculate the phase offset calibration data:

VALUE1 = -1.0 * **RDGN1**
VALUE2 = -1.0 * **RDGN2**
VALUE3 = -1.0 * **RDGN3**
VALUE4 = -1.0 * **RDGN4**
VALUE5 = -1.0 * **RDGN5**

Update the calibration data via the GPIB:

CAL:UNIQ:OPHAC **VALUE1 VALUE2 VALUE3 VALUE4 VALUE5**

Calculate the phase angle readback calibration data:

VALUE1 = -1.0 * (**RDGN1** + **MEAS1**)
VALUE2 = -1.0 * (**RDGN2** + **MEAS2**)
VALUE3 = -1.0 * (**RDGN3** + **MEAS3**)
VALUE4 = -1.0 * (**RDGN4** + **MEAS4**)
VALUE5 = -1.0 * (**RDGN5** + **MEAS5**)

Update the calibration data via the GPIB:

CAL:UNIQ:MOPHAC **VALUE1 VALUE2 VALUE3 VALUE4 VALUE5**

3.18 EXTERNAL GAIN CONTROL CALIBRATION

Connect the DC power supply to the external analog in BNC of the TW. Connect the DMM to phase A of the TW. Set the DC power supply to 2.000 ± 0.005 volts. Setup the DMM for AC volts.

Setup the TW with the following GPIB commands:

SOUR:VOLT:RANGE LOW
SOUR:SENSE REMOTE
SYST:EXT:GAIN 1
SOUR*{1,2,3}*:CURR 5.00
SOUR*{1,2,3}*:VOLT 100.0
OUTPUT ON

Wait for the DMM to settle and record the value as **RDNG1**.

Set the DC power supply to 8.000 ± 0.005 volts.

Wait for the DMM to settle and record the value as **RDNG2**.

Calculate the gain and offset for the external input:

> **GAIN** = 60.0 / (**RDNG2** – **RDNG1**)
> **OFFSET** = 10 – (**RDNG2** / (42.0 * **GAIN**))

Open the output relay and turn off the external gain port with the following GPIB commands:

> OUTPUT OFF
> SYST:EXT:GAIN 0

Send the updated calibration constants to the TW with the following GPIB strings:

> CAL:UNIQ:GEXTG **GAIN**
> CAL:UNIQ:OEXTG **OFFSET**

3.19 LOW RANGE CURRENT CALIBRATION

Connect the 12 ohm resistor to the output of the TW through the power analyzer. Set up the power analyzer to measure current.

Set up the TW to DC coupling, low range, local sense, 13 ampere current limit, output relay closed and 12 volts with the following GPIB programming strings:

> OUTP:COUP DC
> SOUR:VOLT:RANGE LOW
> SOUR:SENSE LOCAL
> SOUR*{1,2,3}*:CURR 13.00
> OUTPUT ON
> SOUR*{1,2,3}*:VOLT:OFFSET 12

Wait until the power analyzer has stabilized and record the current reading as **RDNG1**.

Query the TW's current using the GPIB string below, and record this value as **MEAS1**.

> MEAS*{1,2,3}*:CURR?

Program the TW to 120 volts DC using the string below:

> SOUR*{1,2,3}*:VOLT:OFFSET 120

Wait until the power analyzer has stabilized and record the current reading as **RDNG2**.

Query the TW's current using the GPIB string below, and record this value as **MEAS2**.

> MEAS*{1,2,3}*:CURR?

Reset the TW back to AC coupling mode, output off.

SOUR*{1,2,3}*:VOLT:OFFSET 0.0
OUTP OFF
OUTP:COUP AC

Calculate the gain from the collected data:

GAIN = (**RDGN2** – **RDNG1**) / (**MEAS2** – **MEAS1**)

Update the TW's gain setting using the GPIB strings below:

CAL*{1,2,3}*:MEAS:LOC:LOR:CURR:GAIN **GAIN**
CAL*{1,2,3}*:MEAS:REM:LOR:CURR:GAIN **GAIN**

3.20 LOCAL LOW RANGE WATTS CALIBRATION

Connect the 12 ohm resistor to the output of the TW through the power analyzer. Set up the power analyzer to measure watts.

Set up the TW to AC coupling, low range, local sense, 13 ampere current limit, output relay closed and 54 volts with the following GPIB programming strings:

OUTP:COUP AC
SOUR:VOLT:RANGE LOW
SOUR:SENSE LOCAL
SOUR*{1,2,3}*:CURR 13.00
OUTPUT ON
SOUR*{1,2,3}*:VOLT 54

Wait until the power analyzer has stabilized and record the watts reading as **RDNG1**.

Query the TW's watts using the GPIB string below, and record this value as **MEAS1**.

MEAS*{1,2,3}*:POW?

Program the TW to 134 volts AC using the string below:

SOUR*{1,2,3}*:VOLT 134

Wait until the power analyzer has stabilized and record the watts reading as **RDNG2**.

Query the TW's watts using the GPIB string below, and record this value as **MEAS2.**

MEAS*{1,2,3}*:POW?

Turn the TW's output off via the GPIB:

OUTP OFF

Calculate the gain and offset values for updating the TW:

GAIN = (**RDGN2** – **RDGN1**)/(**MEAS2** – **MEAS1**)
OFFSET = **RDGN2** – **GAIN** * **MEAS2**

Update the TW's gain and offset calibration values with the following GPIB strings:

CAL*{1,2,3}*:MEAS:LOC:LOR:WATT:GAIN **GAIN**
CAL*{1,2,3}*:MEAS:LOC:LOR:WATT:OFFSET **GAIN**

3.21 REMOTE LOW RANGE WATTS CALIBRATION

Connect the 12 ohm resistor to the output of the TW through the power analyzer. Set up the power analyzer to measure watts.

Set up the TW to AC coupling, low range, local sense, 13 ampere current limit, output relay closed and 54 volts with the following GPIB programming strings:

OUTP:COUP AC
SOUR:VOLT:RANGE LOW
SOUR:SENSE REMOTE
SOUR*{1,2,3}*:CURR 13.00
OUTPUT ON
SOUR*{1,2,3}*:VOLT 54

Wait until the power analyzer has stabilized and record the watts reading as **RDNG1.**

Query the TW's watts using the GPIB string below, and record this value as **MEAS1**.

MEAS*{1,2,3}*:POW?

Program the TW to 134 volts AC using the string below:

SOUR*{1,2,3}*:VOLT 134

Wait until the power analyzer has stabilized and record the watts reading as **RDNG2**.

Query the TW's watts using the GPIB string below, and record this value as **MEAS2.**

MEAS*{1,2,3}*:POW?

Turn the TW’s output off via the GPIB:

OUTP OFF

Calculate the gain and offset values for updating the TW:

GAIN = (**RDGN2** – **RDGN1**)/(**MEAS2** – **MEAS1**)
OFFSET = **RDGN2** – **GAIN** * **MEAS2**

Update the TW’s gain and offset calibration values with the following GPIB strings:

CAL*{1,2,3}*:MEAS:REM:LOR:WATT:GAIN **GAIN**
CAL*{1,2,3}*:MEAS:REM:LOR:WATT:OFFSET **GAIN**

3.22 LOW RANGE CURRENT FREQUENCY CALIBRATION

Connect the 12 ohm resistor to the output of the TW through the power analyzer. Set up the power analyzer to measure current.

Set up the TW to AC coupling, low range, remote sense, 40 Hz, 13 ampere current limit, output relay closed and 120 volts with the following GPIB programming strings:

OUTP:COUP AC
SOUR:VOLT:RANGE LOW
SOUR:SENSE REMOTE
SOUR:FREQ 40
SOUR*{1,2,3}*:CURR 13.00
OUTPUT ON
SOUR*{1,2,3}*:VOLT 120

Wait until the power analyzer has stabilized and record the current reading as **RDNG1**.

Query the TW’s current using the GPIB string below, and record this value as **MEAS1**.

MEAS*{1,2,3}*:CURR?

Program the TW to 80 Hz using the string below:

SOUR*{1,2,3}*:FREQ 80

Wait until the power analyzer has stabilized and record the current reading as **RDNG2**.

Query the TW’s current using the GPIB string below, and record this value as **MEAS2**.

MEAS*{1,2,3}*:CURR?

Program the TW to 160 Hz using the string below:

SOUR*{1,2,3}*:FREQ 160

Wait until the power analyzer has stabilized and record the current reading as **RDNG3**.

Query the TW's current using the GPIB string below, and record this value as **MEAS3**.

MEAS*{1,2,3}*:CURR?

Program the TW to 320 Hz using the string below:

SOUR*{1,2,3}*:FREQ 320

Wait until the power analyzer has stabilized and record the current reading as **RDNG4**.

Query the TW's current using the GPIB string below, and record this value as **MEAS4.**

MEAS*{1,2,3}*:CURR?

Program the TW to 500 Hz using the string below:

SOUR*{1,2,3}*:FREQ 500

Wait until the power analyzer has stabilized and record the current reading as **RDNG5**.

Query the TW's current using the GPIB string below, and record this value as **MEAS5**.

MEAS*{1,2,3}*:CURR?

Program the TW to 60 Hz and open the output relay using the strings below:

SOUR*{1,2,3}*:FREQ 60
OUTP OFF

Calculate the calibration constants using the following equations:

VALUE1 = **RDGN1**/**MEAS1**
VALUE2 = **RDGN2**/**MEAS2**
VALUE3 = **RDGN3**/**MEAS3**
VALUE4 = **RDGN4**/**MEAS4**
VALUE5 = **RDGN5**/**MEAS5**

Update the TW's calibration data:

CAL*{1,2,3}*:MEAS:REM:LOR:CURR:FREQCAL VALUE1 VALUE2 VALUE3 VALUE4 VALUE5
CAL*{1,2,3}*:MEAS:LOC:LOR:CURR:FREQCAL VALUE1 VALUE2 VALUE3 VALUE4 VALUE5

3.23 LOCAL LOW RANGE WATTS FREQUENCY CALIBRATION

Connect the 12 ohm resistor to the output of the TW through the power analyzer. Set up the power analyzer to measure watts.

Set up the TW to AC coupling, low range, local sense, 40 Hz, 13 ampere current limit, output relay closed and 120 volts with the following GPIB programming strings:

OUTP:COUP AC
SOUR:VOLT:RANGE LOW
SOUR:SENSE LOCAL
SOUR:FREQ 40
SOUR*{1,2,3}*:CURR 13.00
OUTPUT ON
SOUR*{1,2,3}*:VOLT 120

Wait until the power analyzer has stabilized and record the watts reading as **RDNG1**.

Query the TW's watts using the GPIB string below, and record this value as **MEAS1**.

MEAS*{1,2,3}*:POW?

Program the TW to 80 Hz using the string below:

SOUR*{1,2,3}*:FREQ 80

Wait until the power analyzer has stabilized and record the watts reading as **RDNG2**.

Query the TW's watts using the GPIB string below, and record this value as **MEAS2**.

MEAS*{1,2,3}*:POW?

Program the TW to 160 Hz using the string below:

SOUR*{1,2,3}*:FREQ 160

Wait until the power analyzer has stabilized and record the watts reading as **RDNG3**.

Query the TW's watts using the GPIB string below, and record this value as **MEAS3**.

MEAS*{1,2,3}*:POW?

Program the TW to 320 Hz using the string below:

SOUR*{1,2,3}*:FREQ 320

Wait until the power analyzer has stabilized and record the watts reading as **RDNG4**.

Query the TW's watts using the GPIB string below, and record this value as **MEAS4.**

MEAS*{1,2,3}*:POW?

Program the TW to 500 Hz using the string below:

SOUR*{1,2,3}*:FREQ 500

Wait until the power analyzer has stabilized and record the watts reading as **RDNG5.**

Query the TW's watts using the GPIB string below, and record this value as **MEAS5**.

MEAS*{1,2,3}*:POW?

Program the TW to 60 Hz, output off using the string below:

SOUR*{1,2,3}*:FREQ 60
OUTP OFF

Calculate the calibration constants:

VALUE1 = **RDGN1**/**MEAS1**
VALUE2 = **RDGN2**/**MEAS2**
VALUE3 = **RDGN3**/**MEAS3**
VALUE4 = **RDGN4**/**MEAS4**
VALUE5 = **RDGN5**/**MEAS5**

Update the TW's calibration data:

CAL*{1,2,3}*:MEAS:LOC:LOR:WATT:FREQCAL **VALUE1 VALUE2 VALUE3 VALUE4 VALUE5**

3.24 REMOTE LOW RANGE WATTS FREQUENCY CALIBRATION

Connect the 12 ohm resistor to the output of the TW through the power analyzer. Set up the power analyzer to measure watts.

Set up the TW to AC coupling, low range, remote sense, 40 Hz, 13 ampere current limit, output relay closed and 120 volts with the following GPIB programming strings:

OUTP:COUP AC
SOUR:VOLT:RANGE LOW
SOUR:SENSE REMOTE
SOUR:FREQ 40
SOUR*{1,2,3}*:CURR 13.00
OUTPUT ON
SOUR*{1,2,3}*:VOLT 120

Wait until the power analyzer has stabilized and record the watts reading as **RDNG1.**

Query the TW's watts using the GPIB string below, and record this value as **MEAS1**.

MEAS*{1,2,3}*:POW?

Program the TW to 80 Hz using the string below:

SOUR*{1,2,3}*:FREQ 80

Wait until the power analyzer has stabilized and record the watts reading as **RDNG2**.

Query the TW's watts using the GPIB string below, and record this value as **MEAS2**.

MEAS*{1,2,3}*:POW?

Program the TW to 160 Hz using the string below:

SOUR*{1,2,3}*:FREQ 160

Wait until the power analyzer has stabilized and record the watts reading as **RDNG3**.

Query the TW's watts using the GPIB string below, and record this value as **MEAS3**.

MEAS*{1,2,3}*:POW?

Program the TW to 320 Hz using the string below:

SOUR*{1,2,3}*:FREQ 320

Wait until the power analyzer has stabilized and record the watts reading as **RDNG4**.

Query the TW's watts using the GPIB string below, and record this value as **MEAS4**.

MEAS*{1,2,3}*:POW?

Program the TW to 500 Hz using the string below:

SOUR*{1,2,3}*:FREQ 500

Wait until the power analyzer has stabilized and record the watts reading as **RDNG5**.

Query the TW's watts using the GPIB string below, and record this value as **MEAS5**.

MEAS*{1,2,3}*:POW?

Program the TW to 60 Hz, output off using the string below:

SOUR*{1,2,3}*:FREQ 60
OUTP OFF

Calculate the calibration constants:

> **VALUE1** = **RDGN1**/**MEAS1**
> **VALUE2** = **RDGN2**/**MEAS2**
> **VALUE3** = **RDGN3**/**MEAS3**
> **VALUE4** = **RDGN4**/**MEAS4**
> **VALUE5** = **RDGN5**/**MEAS5**

Update the TW's calibration data:

> CAL*{1,2,3}*:MEAS:REM:LOR:WATT:FREQCAL **VALUE1 VALUE2 VALUE3 VALUE4 VALUE5**

3.25 HIGH RANGE CURRENT CALIBRATION

Connect the 48 ohm resistor to the output of the TW through the power analyzer. Set up the power analyzer to measure current.

Set up the TW to DC coupling, high range, local sense, 6.5 ampere current limit, output relay closed and 24 volts with the following GPIB programming strings:

> OUTP:COUP DC
> SOUR:VOLT:RANGE HIGH
> SOUR:SENSE LOCAL
> SOUR*{1,2,3}*:CURR 6.5
> OUTPUT ON
> SOUR*{1,2,3}*:VOLT:OFFSET 24

Wait until the power analyzer has stabilized and record the current reading as **RDNG1**.

Query the TW's current using the GPIB string below, and record this value as **MEAS1**.

> MEAS*{1,2,3}*:CURR?

Program the TW to 240 volts DC using the string below:

> SOUR*{1,2,3}*:VOLT:OFFSET 240

Wait until the power analyzer has stabilized and record the current reading as **RDNG2**.

Query the TW's current using the GPIB string below, and record this value as **MEAS2**.

> MEAS*{1,2,3}*:CURR?

Reset the TW back to AC coupling mode, output off.

> SOUR*{1,2,3}*:VOLT:OFFSET 0.0
> OUTP OFF
> OUTP:COUP AC

Calculate the gain from the collected data:

GAIN = (**RDGN2 – RDNG1**) / (**MEAS2 – MEAS1**)

Update the TW's gain setting using the GPIB strings below:

CAL*{1,2,3}*:MEAS:LOC:HIR:CURR:GAIN **GAIN**
CAL*{1,2,3}*:MEAS:REM:HIR:CURR:GAIN **GAIN**

3.26 LOCAL HIGH RANGE WATTS CALIBRATION

Connect the 48 ohm resistor to the output of the TW through the power analyzer. Set up the power analyzer to measure watts.

Set up the TW to AC coupling, high range, local sense, 6.5 ampere current limit, output relay closed and 108 volts with the following GPIB programming strings:

OUTP:COUP AC
SOUR:VOLT:RANGE HIGH
SOUR:SENSE LOCAL
SOUR*{1,2,3}*:CURR 6.5
OUTPUT ON
SOUR*{1,2,3}*:VOLT 108

Wait until the power analyzer has stabilized and record the watts reading as **RDNG1**.

Query the TW's watts using the GPIB string below, and record this value as **MEAS1**.

MEAS*{1,2,3}*:POW?

Program the TW to 268 volts AC using the string below:

SOUR*{1,2,3}*:VOLT 268

Wait until the power analyzer has stabilized and record the watts reading as **RDNG2**.

Query the TW's watts using the GPIB string below, and record this value as **MEAS2**.

MEAS*{1,2,3}*:POW?

Turn the TW's output off via the GPIB:

OUTP OFF

Calculate the gain and offset values for updating the TW:

GAIN = (**RDGN2** – **RDGN1**)/(**MEAS2** – **MEAS1**)
OFFSET = **RDGN2** – **GAIN** * **MEAS2**

Update the TW's gain and offset calibration values with the following GPIB strings:

CAL*{1,2,3}*:MEAS:LOC:HIR:WATT:GAIN **GAIN**
CAL*{1,2,3}*:MEAS:LOC:HIR:WATT:OFFSET **GAIN**

3.27 REMOTE HIGH RANGE WATTS CALIBRATION

Connect the 48 ohm resistor to the output of the TW through the power analyzer. Set up the power analyzer to measure watts.

Set up the TW to AC coupling, high range, local sense, 6.5 ampere current limit, output relay closed and 108 volts with the following GPIB programming strings:

OUTP:COUP AC
SOUR:VOLT:RANGE HIGH
SOUR:SENSE REMOTE
SOUR*{1,2,3}*:CURR 6.5
OUTPUT ON
SOUR*{1,2,3}*:VOLT 108

Wait until the power analyzer has stabilized and record the watts reading as **RDNG1.**

Query the TW's watts using the GPIB string below, and record this value as **MEAS1**.

MEAS*{1,2,3}*:POW?

Program the TW to 268 volts AC using the string below:

SOUR*{1,2,3}*:VOLT 268

Wait until the power analyzer has stabilized and record the watts reading as **RDNG2**.

Query the TW's watts using the GPIB string below, and record this value as **MEAS2.**

MEAS*{1,2,3}*:POW?

Turn the TW's output off via the GPIB:

OUTP OFF

Calculate the gain and offset values for updating the TW:

GAIN = (**RDGN2** – **RDGN1**)/(**MEAS2** – **MEAS1**)
OFFSET = **RDGN2** – **GAIN** * **MEAS2**

Update the TW's gain and offset calibration values with the following GPIB strings:

CAL*{1,2,3}*:MEAS:REM:HIR:WATT:GAIN **GAIN**
CAL*{1,2,3}*:MEAS:REM:HIR:WATT:OFFSET **GAIN**

3.28 HIGH RANGE CURRENT FREQUENCY CALIBRATION

Connect the 48 ohm resistor to the output of the TW through the power analyzer. Set up the power analyzer to measure current.

Set up the TW to AC coupling, low range, remote sense, 40 Hz, 6.5 ampere current limit, output relay closed and 240 volts with the following GPIB programming strings:

> OUTP:COUP AC
> SOUR:VOLT:RANGE HIGH
> SOUR:SENSE REMOTE
> SOUR:FREQ 40
> SOUR*{1,2,3}*:CURR 6.5
> OUTPUT ON
> SOUR*{1,2,3}*:VOLT 240

Wait until the power analyzer has stabilized and record the current reading as **RDNG1**.

Query the TW's current using the GPIB string below, and record this value as **MEAS1**.

> MEAS*{1,2,3}*:CURR?

Program the TW to 80 Hz using the string below:

> SOUR*{1,2,3}*:FREQ 80

Wait until the power analyzer has stabilized and record the current reading as **RDNG2**.

Query the TW's current using the GPIB string below, and record this value as **MEAS2**.

> MEAS*{1,2,3}*:CURR?

Program the TW to 160 Hz using the string below:

> SOUR*{1,2,3}*:FREQ 160

Wait until the power analyzer has stabilized and record the current reading as **RDNG3**.

Query the TW's current using the GPIB string below, and record this value as **MEAS3**.

> MEAS*{1,2,3}*:CURR?

Program the TW to 320 Hz using the string below:

> SOUR*{1,2,3}*:FREQ 320

Wait until the power analyzer has stabilized and record the current reading as **RDNG4**.

Query the TW’s current using the GPIB string below, and record this value as **MEAS4**.

MEAS*{1,2,3}*:CURR?

Program the TW to 500 Hz using the string below:

SOUR*{1,2,3}*:FREQ 500

Wait until the power analyzer has stabilized and record the current reading as **RDNG5**.

Query the TW’s current using the GPIB string below, and record this value as **MEAS5**.

MEAS*{1,2,3}*:CURR?

Program the TW to 60 Hz and open the output relay using the strings below:

SOUR*{1,2,3}*:FREQ 60
OUTP OFF

Calculate the calibration constants using the following equations:

VALUE1 = **RDGN1**/**MEAS1**
VALUE2 = **RDGN2**/**MEAS2**
VALUE3 = **RDGN3**/**MEAS3**
VALUE4 = **RDGN4**/**MEAS4**
VALUE5 = **RDGN5**/**MEAS5**

Update the TW’s calibration data:

CAL*{1,2,3}*:MEAS:REM:HIR:CURR:FREQCAL VALUE1 VALUE2 VALUE3 VALUE4 VALUE5
CAL*{1,2,3}*:MEAS:LOC:HIR:CURR:FREQCAL VALUE1 VALUE2 VALUE3 VALUE4 VALUE5

3.29 LOCAL HIGH RANGE WATTS FREQUENCY CALIBRATION

Connect the 48 ohm resistor to the output of the TW through the power analyzer. Set up the power analyzer to measure watts.

Set up the TW to AC coupling, high range, local sense, 40 Hz, 6.5 ampere current limit, output relay closed and 240 volts with the following GPIB programming strings:

OUTP:COUP AC
SOUR:VOLT:RANGE HIGH
SOUR:SENSE LOCAL
SOUR:FREQ 40
SOUR*{1,2,3}*:CURR 6.5
OUTPUT ON
SOUR*{1,2,3}*:VOLT 240

Wait until the power analyzer has stabilized and record the watts reading as **RDNG1**.

Query the TW's watts using the GPIB string below, and record this value as **MEAS1**.

MEAS*{1,2,3}*:POW?

Program the TW to 80 Hz using the string below:

SOUR*{1,2,3}*:FREQ 80

Wait until the power analyzer has stabilized and record the watts reading as **RDNG2**.

Query the TW's watts using the GPIB string below, and record this value as **MEAS2**.

MEAS*{1,2,3}*:POW?

Program the TW to 160 Hz using the string below:

SOUR*{1,2,3}*:FREQ 160

Wait until the power analyzer has stabilized and record the watts reading as **RDNG3**.

Query the TW's watts using the GPIB string below, and record this value as **MEAS3**.

MEAS*{1,2,3}*:POW?

Program the TW to 320 Hz using the string below:

SOUR*{1,2,3}*:FREQ 320

Wait until the power analyzer has stabilized and record the watts reading as **RDNG4**.

Query the TW's watts using the GPIB string below, and record this value as **MEAS4**.

MEAS*{1,2,3}*:POW?

Program the TW to 500 Hz using the string below:

SOUR*{1,2,3}*:FREQ 500

Wait until the power analyzer has stabilized and record the watts reading as **RDNG5**.

Query the TW's watts using the GPIB string below, and record this value as **MEAS5**.

MEAS*{1,2,3}*:POW?

Program the TW to 60 Hz, output off using the string below:

SOUR*{1,2,3}*:FREQ 60
OUTP OFF

Calculate the calibration constants:

VALUE1 = **RDGN1**/**MEAS1**
VALUE2 = **RDGN2**/**MEAS2**
VALUE3 = **RDGN3**/**MEAS3**
VALUE4 = **RDGN4**/**MEAS4**
VALUE5 = **RDGN5**/**MEAS5**

Update the TW's calibration data:

CAL*{1,2,3}*:MEAS:LOC:HIR:WATT:FREQCAL **VALUE1 VALUE2 VALUE3 VALUE4 VALUE5**

3.30 REMOTE HIGH RANGE WATTS FREQUENCY CALIBRATION

Connect the 48 ohm resistor to the output of the TW through the power analyzer. Set up the power analyzer to measure watts.

Set up the TW to AC coupling, high range, remote sense, 40 Hz, 6.5 ampere current limit, output relay closed and 240 volts with the following GPIB programming strings:

OUTP:COUP AC
SOUR:VOLT:RANGE HIGH
SOUR:SENSE REMOTE
SOUR:FREQ 40
SOUR*{1,2,3}*:CURR 6.5
OUTPUT ON
SOUR*{1,2,3}*:VOLT 240

Wait until the power analyzer has stabilized and record the watts reading as **RDNG1**.

Query the TW's watts using the GPIB string below, and record this value as **MEAS1**.

MEAS*{1,2,3}*:POW?

Program the TW to 80 Hz using the string below:

SOUR*{1,2,3}*:FREQ 80

Wait until the power analyzer has stabilized and record the watts reading as **RDNG2.**

Query the TW's watts using the GPIB string below, and record this value as **MEAS2.**

MEAS*{1,2,3}*:POW?

Program the TW to 160 Hz using the string below:

SOUR*{1,2,3}*:FREQ 160

Wait until the power analyzer has stabilized and record the watts reading as **RDNG3**.

Query the TW's watts using the GPIB string below, and record this value as **MEAS3**.

MEAS*{1,2,3}*:POW?

Program the TW to 320 Hz using the string below:

SOUR*{1,2,3}*:FREQ 320

Wait until the power analyzer has stabilized and record the watts reading as **RDNG4**.

Query the TW's watts using the GPIB string below, and record this value as **MEAS4**.

MEAS*{1,2,3}*:POW?

Program the TW to 500 Hz using the string below:

SOUR*{1,2,3}*:FREQ 500

Wait until the power analyzer has stabilized and record the watts reading as **RDNG5**.

Query the TW's watts using the GPIB string below, and record this value as **MEAS5**.

MEAS*{1,2,3}*:POW?

Program the TW to 60 Hz, output off using the string below:

SOUR*{1,2,3}*:FREQ 60
OUTP OFF

Calculate the calibration constants:

VALUE1 = **RDGN1**/**MEAS1**
VALUE2 = **RDGN2**/**MEAS2**
VALUE3 = **RDGN3**/**MEAS3**
VALUE4 = **RDGN4**/**MEAS4**
VALUE5 = **RDGN5**/**MEAS5**

Update the TW's calibration data:

CAL*{1,2,3}*:MEAS:REM:HIR:WATT:FREQCAL **VALUE1 VALUE2 VALUE3 VALUE4 VALUE5**

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SECTION 4 – PARTS LIST

4.1 GENERAL

This section contains the top assembly parts list for the TrueWave products. The parts lists below directly correlate to the diagrams in Section 5 of this manual.

4.2 PARTS LIST

Number	Assembly Name
5161469-01	FINAL ASSEMBLY, TW1750-1
5161469-02	FINAL ASSEMBLY, TW1750-2
5161469-05	FINAL ASSEMBLY, TW1750-3
5161469-06	FINAL ASSEMBLY, TW1750-4
5161469-09	FINAL ASSEMBLY, TW3500-1
5161469-10	FINAL ASSEMBLY, TW3500-2
5161469-13	FINAL ASSEMBLY, TW3500-3
5161469-14	FINAL ASSEMBLY, TW3500-4
5161469-17	FINAL ASSEMBLY, TW5250-1
5161469-18	FINAL ASSEMBLY, TW5250-2
5161469-21	FINAL ASSEMBLY, TW5250-3
5161469-22	FINAL ASSEMBLY, TW5250-4
5161469-25	FINAL ASSEMBLY, TW1750-1-101
5161469-26	FINAL ASSEMBLY, TW1750-2-101
5161469-27	FINAL ASSEMBLY, TW1750-3-101
5161469-28	FINAL ASSEMBLY, TW1750-4-101
5161469-29	FINAL ASSEMBLY, TW3500-1-101
5161469-30	FINAL ASSEMBLY, TW3500-2-101
5161469-31	FINAL ASSEMBLY, TW3500-3-101
5161469-32	FINAL ASSEMBLY, TW3500-4-101
5161469-33	FINAL ASSEMBLY, TW5250-1-101
5161469-34	FINAL ASSEMBLY, TW5250-2-101
5161469-35	FINAL ASSEMBLY, TW5250-3-101
5161469-36	FINAL ASSEMBLY, TW5250-4-101

4.3 ORDERING SPARE PARTS

Contact Elgar Electronics Corporation to order spare parts or assemblies. Please specify the assembly number, instrument name, and instrument series number when ordering.

Elgar Electronics Corporation
9250 Brown Deer Road
San Diego, CA 92121-2294
1-800-733-5427
Tel: (858) 450-0085
Fax: (858) 458-0267
www.elgar.com

SECTION 5 – DIAGRAMS

5.1 GENERAL

This section contains the interconnect diagrams and top assembly diagrams for the TrueWave series. The interconnect diagrams can be used to understand the theory of operation and as an aid in troubleshooting the unit.

5.2 DIAGRAMS

Table 5-1 lists the diagrams included in this section.

Number	Drawing Title	Sheet
6161469	INTERCONNECT DIAGRAM, SYSTEM, TRUEWAVE	1 of 2
5161469	FINAL ASSEMBLY, TRUEWAVE	1 of 8

TABLE 5-1. TRUEWAVE SYSTEM DIAGRAMS

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