TRYSTAR

RXPO DC POWER SUPPLY

OWNERS MANUAL

SERIES 50
AIR / WATER COOLED
MODEL 5012



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TRYSTAR.com

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ABOUT THIS MANUAL

When viewing electronically, click on the subject to jump to that page. Clicking the header on the front page will launch the Trystar web site. Clicking anywhere else on the front page will also jump to the Table of Contents. Clicking any blue text will take you to that section of our website.

⚠ CAUTION ⚠

The following symbol indicates that caution should be taken when performing the process required in this manual. Damage to the unit or personal harm could happen if proper precautions are not taken.

⚠ SHOCK HAZARD ⚠

The following symbol indicates that there is a risk of electrical shock if proper precautions are not followed. Only qualified personnel should perform the actions required in this manual.

IMPORTANT - SAVE THESE INSTRUCTIONS - PLEASE READ THIS MANUAL BEFORE USING EQUIPMENT

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INTRODUCTION

Trystar's "Series 50" Rectifier reflects a single transformer, secondary thyristor design, and is the preferred choice for electrocoating and other metal finishing applications which require 100VDC or higher. The "Series 50" Rectifier is available in both 6- and 12-pulse standard models. Compatible with current advanced manufacturing processes, this rectifier is designed for optimum, reliable performance in harsh industrial environments.

Input Breaker Protection - Standard main input AC circuit breaker, complete with a door-interlocked safety mechanism.

Cabinet Design - Available in NEMA 1, NEMA 2, and NEMA 4X enclosures, each "Series 50" Rectifier is designed and constructed to endure the harsh industrial environments associated with e-coating and metal finishing processes. NEMA 1 and NEMA 2 enclosure designs are industrial-grade, welded steel construction, with a durable, scratch-resistant powder coat finish. Specially-formulated, corrosion-resistant paint is also available for caustic environments. NEMA 4X enclosure designs are constructed with high-grade stainless steel, and are available with or without a powder coat finish.

Transformers - Designed for high efficiency, low inrush current, durability, and dynamic loading, the "Series 50" Rectifier transformers are constructed from high-grade steel and copper to ensure maximum conductivity and minimal loss. These transformers have a low temperature rise, and are mechanically and electrically designed to withstand the stress that occurs under fault conditions.

Thyristor (SCR's) - In the "Series 50" Rectifier, fully synchronized, phase lock loop gating circuitry is used to control the thyristors, eliminate gate misfiring, and insure that all phases are present before gating commences. Thyristors in each phase are surge protected using MOV suppression and an RC snubber circuit. For maximum efficiency and reliability, thyristors are conservatively rated to operate at a current level much lower than their device rating. Additionally, each thyristor is cooled to minimize the junction temperature and increase component life.

Controls And Monitoring - Standard analog metering and local controls on every "Series 50" Rectifier include:

- Output Voltage and Current Meters
- AC Power On and DC On Lights
- Output Voltage and Current Control Potentiometers
- Voltage or Current Regulation Mode Switch
- Voltage or Current Limit Control Potentiometer
- Automatic DC Overload Shut Off
- Optional local or remote controls are available to suit almost every application.

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Cooling - "Series 50" Rectifiers offer a choice of cooling methods to help minimize cost or increase longevity in harsh environments.

Air Cooled - Outside ambient air is drawn into the rectifier using a long-life fan, and directed over the semiconductor devices. The power transformer is convection cooled, but rectifiers with high power ratings also incorporate a fan in the transformer section to assist with heat removal from the enclosure. Replaceable air filters are available for all air inlets. With proper maintenance, long rectifier life will result in typical painting environments or protected electrical closets. Low power rectifiers are available with all-convection cooling to minimize dust/debris entry.

Water Cooled - Heated air from power semiconductors is drawn into an air-to-water heat exchanger. Thermal transfer effectively reduces the air temperature, and then circulates the cooled air back into the semiconductor area. This air circulation also removes heat from the power transformer. An internal thermostat is adjustable to maintain the water cycle for proper cooling, while minimizing internal condensation. Direct water-cooled semiconductor designs are also available and can help lower the component ratings to reduce costs. This method of cooling insures longrectifier life for extreme operating environments.

E-COAT RECTIFIER FEATURES AND BENEFITS

Amp-Hour Meter - Digital meter that counts the number of amp-hours pertaining to energy management and paint consumption.

Amp-Hour Meter With Pump-Stroke - Control And Optional Counters Digital amp-hour meter which measures accumulated amp-hours, and delivers a prescribed number of pump strokes for up to two (2) pumps. An option on this meter is the ability to receive confirming pump signals verifying that the stroke took place. Useful for 2-component paints.

Ripple Filtering - A standard component in e-coating and other metal finishing processes. Ripple filters for the "Series 50" Rectifier are available in 5% and 1% designs, and lower the AC ripple component of the DC output to the respective percentage from 25% - 100% of full voltage and current output ratings.

Anode Distribution And Monitoring - DC power distribution, as well as complete monitoring of each anode/cathode cell, is available with blocking diodes and current sensors. To insure safety, distribution enclosures remote from the e-coat tank incorporate fusing. Analog current signals are processed to integrate with any plant network or central workstation. This feature assists with anode maintenance, and can help with process debugging.

Job Design Specific Options - Air filters, 24VDC control circuitry, digital meters, color-coded wiring, safety switch and door interlocks, DC disconnect and transfer switches, Kirk key interlocking, NEMA 12 control cabinets, custom paint color, top or bottom entry of AC and DC power cables, and external or integrated PLC control, including touch screen graphics are all available to meet specific needs.

Adjustable Voltage / Current Slope - Ramping or "Sloping" the DC output at a user-adjustable time rate to control the application of paint and prevent imperfections. In addition, this option relieves surge current stresses on the rectifier and prevents premature current limits from being reached.

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Command Two-Level Control - Provides two (2) standard voltage levels at which the rectifier will operate. When a customer provided contact closes, the DC will fall to a low holding voltage. When the contact returns to its open state, the DC will rise to the maximum voltage setting. This feature is necessary for conveyor operations.

AACD (Automatic Average Current Density) - Automatically controls the DC voltage based upon the total current density of the tank. The AACD product optimizes paint usage by minimizing paint thickness deviation levels that would otherwise result from a large difference in surface area between various parts. Consult factory for additional AACD details.

Ripple Meter - An integral or remote digital meter which measures and displays the percentage of AC output ripple. This meter can be programmed to sound an alarm when the ripple voltage exceeds 5%, and also includes a DC voltage meter. DC voltage levels above or below the prescribed voltage can be monitored. The main benefit is to determine the "rectifier health" and annunciate an alarm that the e-coat process may be compromised.

Trystar "Series 50" Rectifiers" include two (2) distinct product models: Model 506 and Model 5012.

Model 506

The Model 506 is a 6-pulse, secondary thyristor rectifier used in e-coating and other metal finishing applications that require DC power > 100VDC. Available in output voltages ranging from 100VDC to 1000VDC, and in current ratings ranging from 100A to 5000A, the Model 506 incorporates a single transformer design, with thyristor semiconductors for rectification and regulation of DC power. In e-coating and other metal finishing applications where low ripple is required, the Model 506 incorporates an L/C ripple filter to smooth the pulsating DC and to effectively reduce the AC RMS voltage ripple.

Model 5012

The Model 5012 is a 12-pulse, secondary thyristor rectifier used in "low ripple, high current" e-coating and other metal finishing applications. Available with or without ripple filtering, the Model 5012 brings the output percent ripple to < 1% with filtering. The Model 5012 offers a significant advantage over the Model 506, in that it reduces input current harmonics, and delivers a smoother DC output. In large e-coating applications where the voltage is > 300V and the current is >1500A, the Model 5012 is often the best solution.

Performance Specifications

- Input Voltage: Standard 208V, 240V, or 480V; 3 phase. (Other voltages available. Consult factory.)
- Input Line Variation: ± 5% from nominal. (Optional wider ranges available. Consult factory.)
- Frequency: 60 Hz. Optional 50 Hz.
- Efficiency: 95% typical, size dependent.
- Power Factor: 90% typical at full output.
- % AC Output Ripple:

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Model 506 — 5% (full voltage and current).

Optional filter provides 5% when operating within 25% to 100% of full voltage and current.

Model 5012 — 3% (full voltage and current).

Optional filter provides 1% when operating within 25% to 100% of full voltage and current.

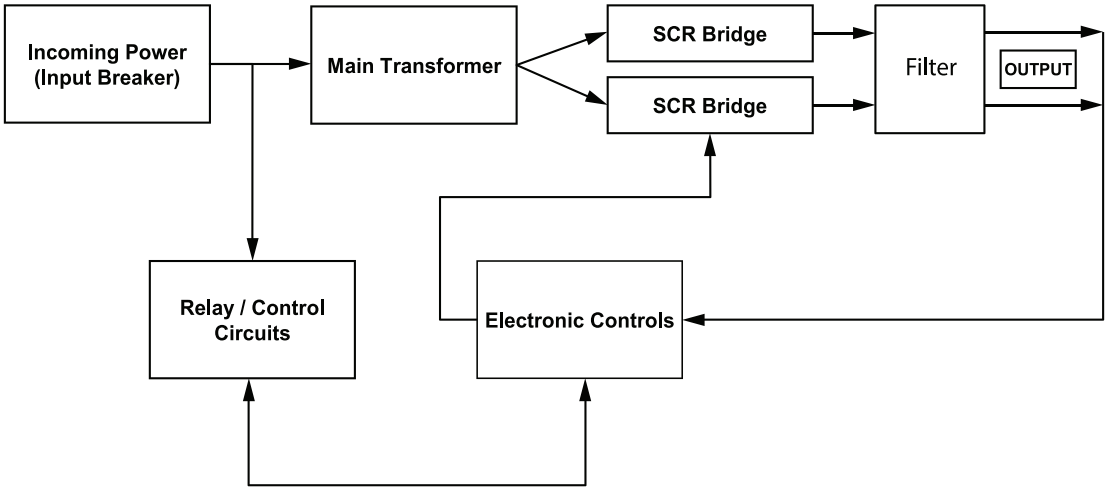
- Reliability: 65,000+ hours MTBF
- Voltage Regulation: ± 0.5%
- Current Regulation: ± 0.5%
- Ambient Temperature: 0^0 C (32^0 F) to 40^0 C (104^0 F) maximum.
- Humidity: 95% non-condensing.
- Elevation: Maximum elevation 1524 meters (5000 feet) without de-rating.
- Storage: -20^0 C (-4^0 F) to 50^0 C (122^0 F)

THEORY OF OPERATION

THEORY OF OPERATION

The basic function of a D.C. Power Supply is to take A.C. power and convert it to D.C. power.

BASIC BLOCK DIAGRAM



A.C. input power is supplied to the main disconnect. The control circuit consists of relay logic and monitoring devices that provide means for starting/stopping, temperature monitoring, automatic cycle timers, emergency stop, fault warnings, cooling fans, etc….The main transformer once energized, isolates the primary line voltage and steps the secondary voltage up or down to achieve the required A.C. voltage that is to be rectified. The secondary A.C. voltage is fed into the silicon controlled rectifier (SCR) assembly which is configured as a full wave bridge for A.C. to D.C.

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conversion. The SCR assembly provides (2) functions; (1) it rectifies the A.C. power and (2), it provides phase control allowing the D.C. output to be controlled from “0” to its rated output voltage. The output voltage is controlled and monitored by the “Electronic Regulator” which consists of electronic circuit boards and acts as the “brain” of the system. The electronic regulator constantly monitors the D.C. output and sends signals to the SCR assembly which turns on the SCR’s for your desired D.C. output.

The SCR assembly converts A.C. to D.C. leaving an A.C. component known as “A.C. Ripple” riding with the D.C. output. The “A.C. Ripple” is filtered with a inductive/capacitive circuit to provide a more pure D.C. before the final output is transferred to your loads. A typical “A.C. Ripple” specification is no more than 5% A.C. ripple on 25-100% D.C. output range. To verify A.C. ripple on your system, a true RMS multimeter can be used with the following formula to measure the amount of A.C. ripple on your D.C. output.

(A.C. / D.C.) 100= _____% A.C. Ripple

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RECEIVING THE UNIT

INSPECTION

Upon receipt of the unit, visually inspect for shipping damage. If any damage is found, the Purchaser must contact the Carrier immediately and file a shipping damage claim.

If any damage has occurred that could affect the operation of the unit, please contact Trystar.

IMPORTANT NOTICE

This shipment has been carefully inspected, checked and properly packaged at our company.

When it was delivered to the carrier it was in good condition and technically it became your property at that time. Thus, any damage, whether obvious or hidden, must be reported to the transportation company within FIVE days of receipt of the shipment at your premises to avoid forfeiting claims for damages.

FOR ALL SHIPMENTS DAMAGED IN TRANSIT

Leave the items, packing material and carton “AS IS”. Notify your carrier’s local office and ask for immediate inspection of the carton and contents.

After inspection has been made by the carrier, and you have received acknowledgment in writing as to the damage, notify our Customer Service Department to make any required repair arrangements.

It is your responsibility to follow the above instructions or the carrier will not honor any claims for damage. Also, if there are any shortages or questions regarding this shipment, please notify us within FIVE days.

Please note that we cannot be responsible for any service work or back-charges unless authorized by us in writing, before the work is performed.

STORAGE

If it is necessary to store the unit for a period of time before it is installed, be sure to place the unit in a clean, dry area. To prevent excessive dust from accumulating on the unit, it is advisable to protect it by replacing it in the original container (if possible). If the original container is not available it is recommended that all openings that lead internally into unit are covered so that dust, water or any other substance cannot enter the system. The unit must be handled at all times with the same care you would give to any piece of precision electrical equipment.

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REMOVING THE UNIT FROM THE SKID

Please take special care when removing the unit from the pallet and/or container. Proper equipment must be used when lifting and moving. Safety precautions should be taken. Larger sizes should be lifted with a pallet jack or a fork lift.

When removing the unit from the pallet and/or container, be sure to take proper safety precautions. Serious injury and/or unit damage can result from not taking proper precautions. Extreme care must be exercised when handling the unit. The weight distribution and center of gravity varies with the type and size of the unit.

SAFETY PRECAUTIONS

IMPORTANT SAFEGUARDS, READ AND FOLLOW ALL SAFETY INSTRUCTIONS. SAVE THESE INSTRUCTIONS.

⚠ WARNING ⚠

THERE ARE DANGEROUSLY HIGH VOLTAGES WITHIN THE DC POWER SUPPLY ENCLOSURES. UNDER NO CIRCUMSTANCES SHOULD ANYONE OPEN ACCESS DOORS TO THE DC POWER SUPPLY OR THE TANK WHILE THE SYSTEM IS ENERGIZED. ONLY QUALIFIED, TRAINED, ELECTRICAL PERSONNEL SHOULD SERVICE AND MAINTAIN THIS EQUIPMENT. LOCKOUT PROCEDURES MUST BE ENFORCED WHILE SERVICING OR MAINTAINING THE POWER SUPPLY.

- FOLLOW ALL STANDARD AND LOCAL ELECTRICAL CODES.
- BE SURE INPUT POWER TO THE POWER SUPPLY IS PROPERLY GROUNDED.
- DO NOT ALLOW WATER OR FOREIGN OBJECTS TO GET INSIDE THE POWER SUPPLY.
- DO NOT PLACE OBJECTS OR LIQUIDS ON TOP OF THE POWER SUPPLY.
- DO NOT MOUNT NEAR GAS OR ELECTRIC HEATERS.
- EQUIPMENT SHOULD BE MOUNTED IN LOCATIONS AND AT HEIGHTS WHERE IT WILL NOT READILY BE SUBJECTED TO TAMPERING BY UNAUTHORIZED PERSONNEL.
- THE USE OF ACCESSORY EQUIPMENT NOT RECOMMENDED BY THE MANUFACTURER MAY CAUSE AN UNSAFE CONDITION.
- DO NOT USE THIS EQUIPMENT FOR OTHER THAN INTENDED USE.
- KEEP UNAUTHORIZED PERSONNEL AWAY FROM THE POWER SUPPLY.
- READ AND FOLLOW ALL SAFETY INSTRUCTIONS. SAVE THESE INSTRUCTIONS.

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PRELIMINARY INSTALLATION

SELECTING A LOCATION

The D.C. power supply has been completely inspected and extensively operated under various load conditions prior to shipment. Care in locating the unit will assure long, trouble-free operation.

INSTALLATION CONSIDERATIONS

AIR COOLED UNITS

Install in a clean, dry and ventilated area with at least 24 inches of clearance on the air intakes and exhaust.

Allow clearance for door swings. Do not install near furnaces, radiators or other heat generating sources. It is desirable to locate the unit in a separate room adjacent to the operating area, thus isolating it from the poor environmental conditions which may exist.

If the unit is located in an operating area, precaution should be taken to protect it from splashing, fumes, vapor from the tanks, and dripping from overhead pipes. Do not install units in a location where they are subject to airborne dirt. Optional air filters are available and should be installed if the unit is operated in a dusty environment.

WATER COOLED UNITS

Water cooled units are sealed so that internal parts are protected from the plant atmosphere. However, when locating these units, keep in mind that people will have to maintain them and will need tolerable working conditions. It is critical that the water supply is clean, filtered and always available within the water specifications typically located on a tag near the water connections. The door seals must be checked annually and replaced if harsh outside environmental conditions are leaking into the power supply.

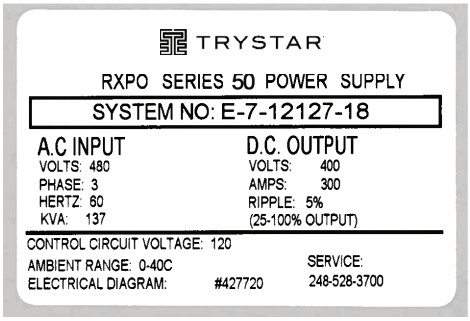
- Ventilation
- Weight Load
- Audible Noise Requirements
- Clean Environment
- Accessibility
- Proper Ground Techniques
- Input Source Voltage
- Distribution of Power
- Room Temperature
- Clearances

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ELECTRICAL INSTALLATION AND TYPICAL DATA PLATE

Check the data plate to be sure that the rated input voltage, frequency, and AC line current match the available power. The D.C. Power Supply should not be connected under any circumstances to a power source which does not match the data plate rating.

SAMPLE DATA PLATE



SYSTEM NO. : Used as a Serial Number to identify the unit. It should be referenced when service or spare parts are required.

AC INPUT

Volts: Input Voltage to System.

Phase: Number of Phases Required.

Hertz: Frequency Design of System.

KVA: Input KVA Required.

Ambient Range: Outside Operating Temperature

DC OUTPUT

Volts: Units Rated D.C. Voltage.

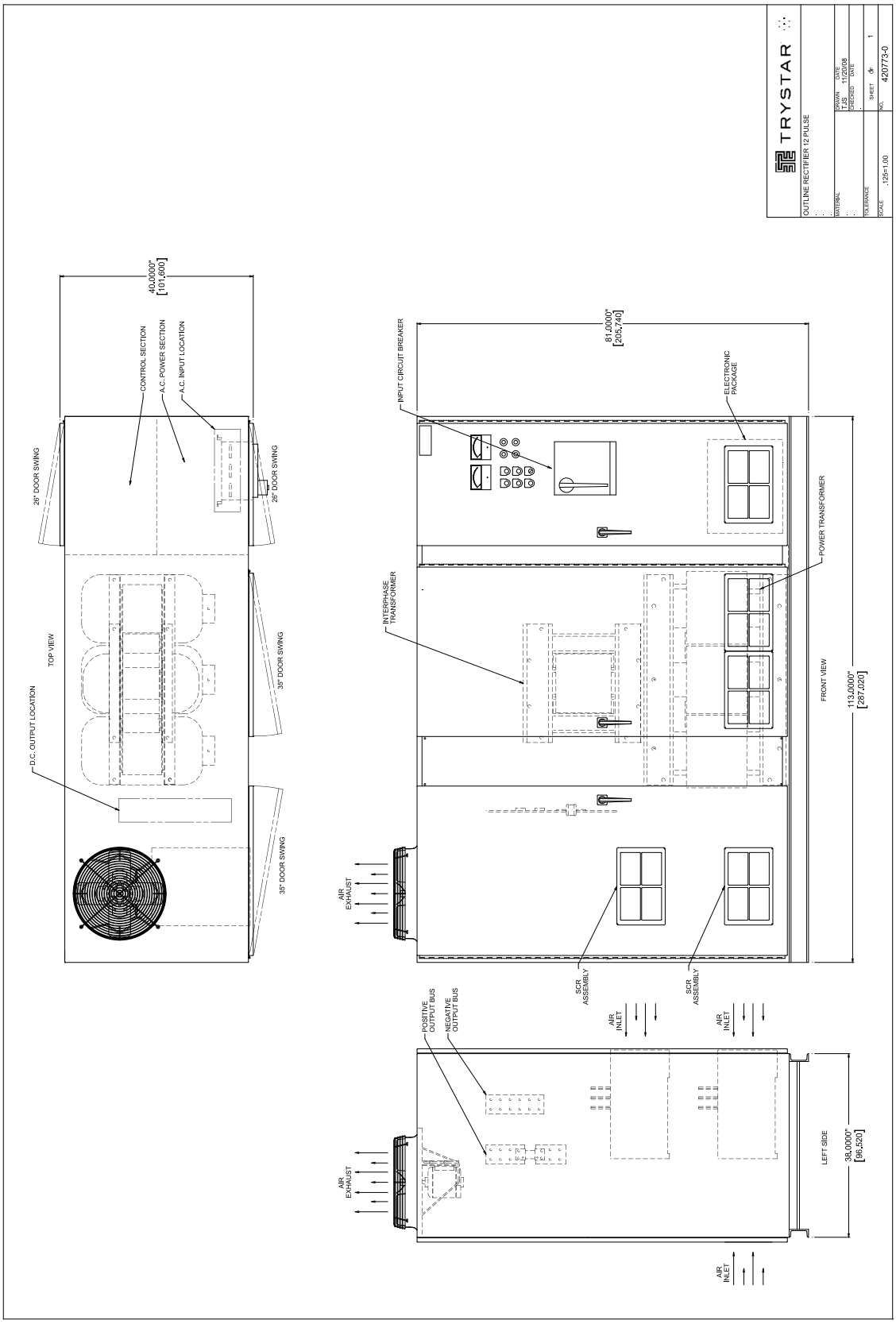
Amps: Units Rated D.C. Amps.

Ripple: Percentage of Ripple Defined as RMS Value of Peak-to Peak Voltage at Full Output.

Control Circuit Voltage: Voltage for Control Circuitry.

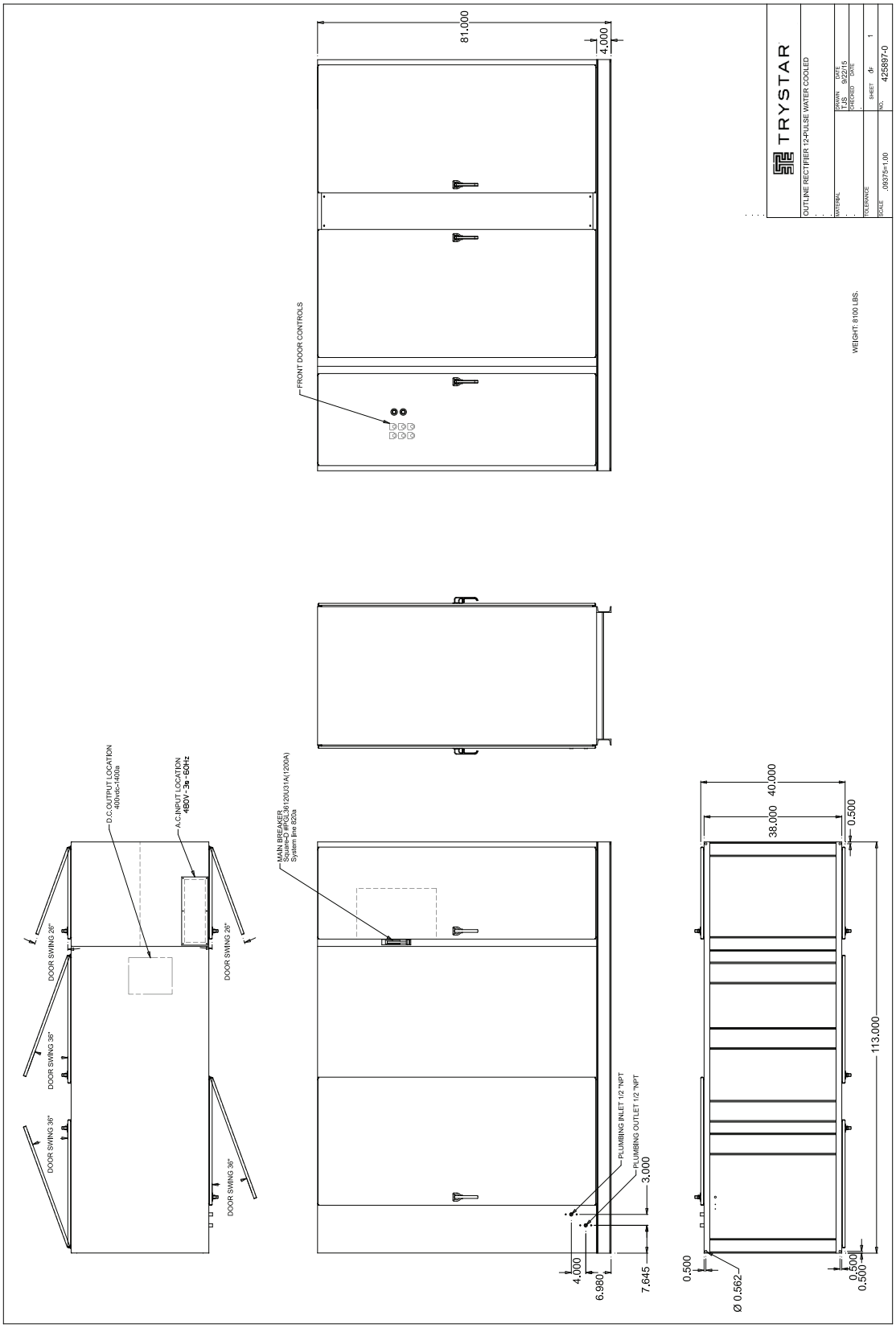
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CABINET OUTLINE - AIR COOLED



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CABINET OUTLINE - WATER COOLED



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INSTALLATION

AC INPUT CONNECTION

The primary input connections can be made through the top of the cabinet in the area of the starter panel or as specified in circuit drawings that accompany the unit. When cutting or drilling conduit entry holes, care must be exercised to keep all debris, **especially** metallic, out of the cabinet. The unit wiring must conform to National Electrical Code standards and/or local codes as required. Make sure to inspect the input circuit breaker terminals and match your wire size to the terminals supplied. Torque input wires as specified on the breaker terminals.

The input is phase sensitive and the phase rotation must be wired as labeled on the load-side wires of the main input circuit breaker.

Customers primary disconnect (fuses) or circuit breaker should be rated at least 25% greater than full KVA stamped on the data plate and calculated as follows:

$$\text{Circuit Breaker or Fuse Size} = 1.25 \times \frac{\text{KVA} \times 1000}{1.73 \times \text{Input Voltage}}$$

REMOTE CONTROL WIRING (Optional)

D.C. Power Supplies have optional remote control panels that interface with the main unit. The remote control typically includes output meters, potentiometer controls, start/stop push buttons and other special controls as required per order.

It is important to use the proper interface wire, size, color and type as described:

Note: Use #14 gauge wire for distances up to 100 ft.
Use #12 gauge wire for distances up to 200 ft.
Consult the National Electrical Code for longer lengths.

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Use #14 gauge wire for distances up to 100 ft.
Use #12 gauge wire for distances up to 200 ft.
Consult the National Electrical Code for longer lengths.

Three types of interface signals must be run in separate conduits as listed. Refer to the units circuit diagram for interconnecting wire diagram information.

1. 0-7.5 VDC signals interface the voltmeter, ammeter, and output control potentiometers. Use blue #14 or #12 gauge wire as noted above.
2. 120 VAC signals interface the start/stop pushbuttons and other controls as specified on the circuit diagram. Use red #14 or #12 gauge wire as noted above.
3. (Optional) PLC interface use 0-10 VDC or 4-20 made signals. Use 2 wire with ground shielded cable in accordance with NEC guidelines.

Note: Some units remote ammeter wire directly from the 0-50 mvdc shunt signal. Check the circuit diagram supplied with your unit and use the chart below for wire size. Run this wire in separate conduit.

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Wire Size	Maximum Length of Wire
#14	15 Ft.
#12	25 Ft.
#10	40 Ft.
#8	60 Ft.
#6	100 Ft.

DC OUTPUT CONNECTION

The D.C. output connection will vary in size depending on the rated D.C. output. Refer to the units circuit diagram and the units data plate to obtain the D.C. output rating. Follow the guidelines as specified in the National Electric Code. Make sure to inspect the units D.C. output connections in order to choose the proper terminals and wire size. Make sure to connect your output to the load side of the current shunt typically located on the positive D.C. output leg.

Refer to the units circuit diagram for D.C. output wiring information.

WATER COOLING SYSTEM (Optional)

The D.C. Power Supply is a totally sealed cabinet that circulates air in the power section of the cabinet via a fan motor. The fan draws air through a radiator. The radiator receives water from a customer supplied source. The water flow is controlled by a solenoid and air temperature thermostat located in the power section. As the temperature rises, the thermostat enables the solenoid allowing cool water to circulate in the radiator which then has air flow passed through the radiator in order to circulate cool air inside the cabinet. Normal thermostat setting is 85°F and should not be any cooler as condensation may build up inside the cabinet. The SCR regulator is thermally protected and will shut down the rectifier in the event of a cooling fan failure or water flow failure. Some units have an optional water flow switch to monitor proper water flow.

It is critical that the water supply is clean, filtered and always available within the water specifications typically located on a tag near the water connections. The door seals must be checked annually and replaced if harsh outside environmental conditions are leaking into the power supply.

MINIMUM WATER REQUIREMENTS FOR WATER COOLED RECTIFIERS

- pH of 7.0 to 9.0.
- Chloride content of not more than 20 parts per million (PPM).
- Nitrate content of not more than 10 PPM.
- Sulphate content of not more than 100 PPM.
- Solids content of not more than 250 PPM.
- Total hardness of not more than 150 PPM.
- Maximum conductivity 1500 Micro Ohms.

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Note: The water solenoid valve is located on the inlet line so water is turned off in the event of a leak. In order to prevent the water from draining during normal operation.

PREFERRED EQUIPMENT:

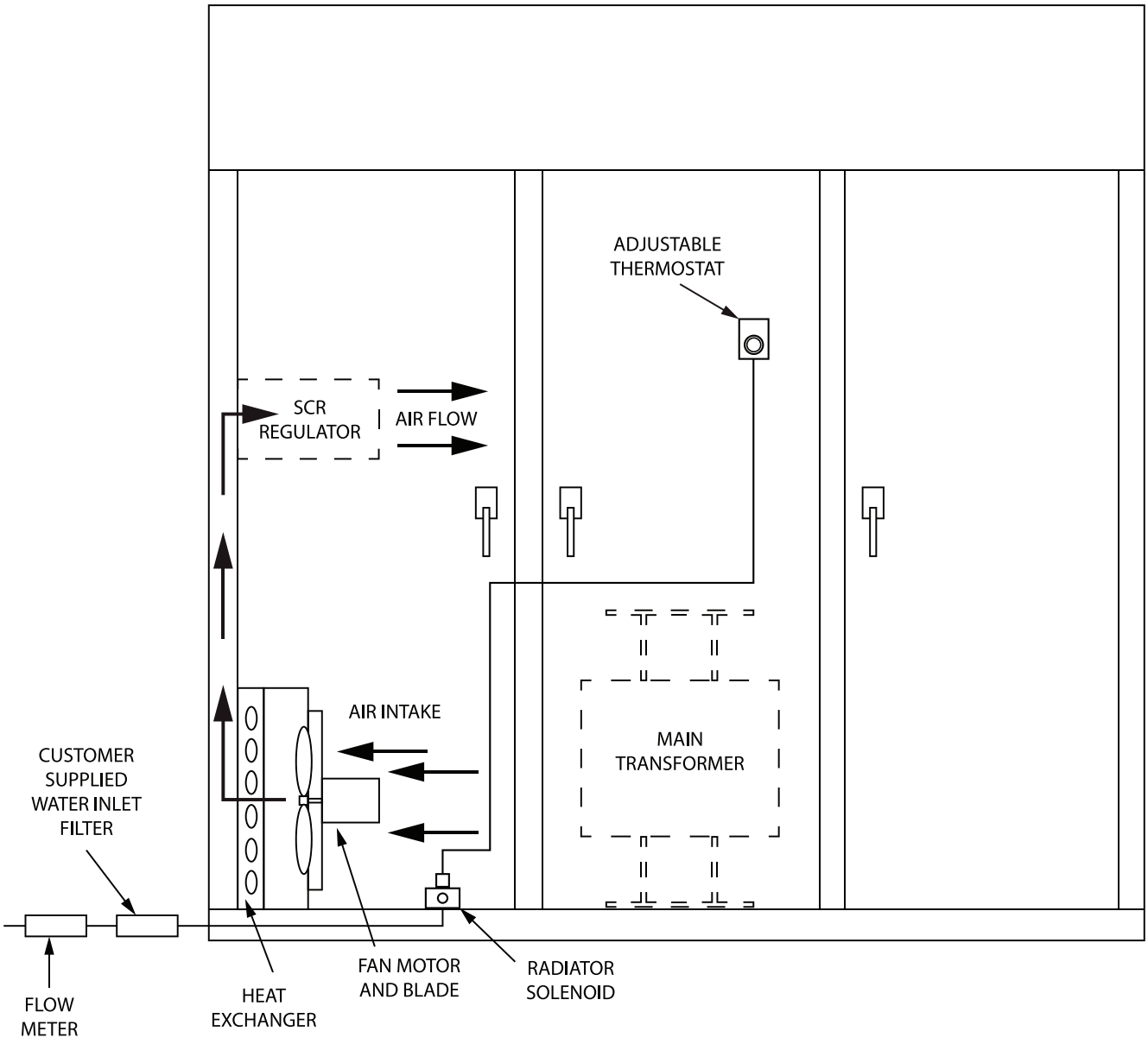
- A 150 micron filter on the system.
- Valves (Ball Cock) on inlet and outlet.
- Flow meter.
- Pressure gauge

Note: The water solenoid valve is located on the inlet line so water is turned off in the event of a leak. In order to prevent the water from draining during normal operation.

1. Connect the water outlet to a closed loop system (pressurized).
2. “Loop” the water outlet line to the height of the D.C. Power Supply cabinet.

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WATER COOLING SYSTEM (Optional) CONTINUED



AIR / WATER FLOW DIAGRAM

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COMPONENT DESCRIPTION

MAIN A.C. CIRCUIT BREAKER AND CONTACTOR

Three Phase input power is applied to the rectifier through the main A.C. circuit breaker which feeds the main A.C. contactor. The input breaker is equipped with an under voltage trip circuit. A customer supplied 120 VAC is required on terminals 100 and 101 for breaker operation. The A.C. contactor serves as a means to enable the power supply via various monitoring and interface circuitry.

MAIN TRANSFORMER

- The design of the power transformer is of the highest quality and reliability. The power transformer is a ventilated, dry type. The primary circuit is (3) three phase, ungrounded, delta connected. The dual secondary is wye and delta configured. ANSI circuit #23 standard 34.2
- The transformer has separate primary and secondary windings (autotransformer types are not used).
- All electrical conductor material is high conductive electrolytic copper of not less than 98% of the international annealed standard for conductivity. Insulation is Class 200 (200ºC rating), designed to operate within safety margins.
- The primary is separated from the core and secondary by a double layer arc resistant barrier (nomex) to minimize the possibility of shorts.
- All transformer leads are supported so that the weight is removed from the coils and they are securely braced to prevent damage in transit and during installation.
- All cores are manufactured from a high-grade, grain oriented silicon steel with high-magnetic permeability, low hystersis and eddy current losses. Magnetic flux densities are kept well below saturation to allow for a minimum of 5% over-voltage excitation. All laminations are free from burrs and stacked without gaps.
- All stand-off or support insulators for both transformer leads and other rectifier bus are glastic materials. Organic materials are not used for bus or cable support due to possible deterioration.
- All transformer coils and connections are thoroughly braced for the magnetic stresses for short circuits of 18.0 times the rated base RMS symmetrical current, phase to phase, or phase to neutral for a period of 3.35 seconds. The transformer is constructed to be capable of withstanding, without damage, the mechanical stresses of an external short circuit or ground fault of this magnitude while rated primary voltage is maintained.
- Taps are provided on the Primary for power factor and ripple correction.

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INTER-PHASE TRANSFORMER (Where applicable)

Used primarily to equalize current sharing between the transformer secondary coils and the two SCR assemblies. It also helps to reduce the RMS ripple. Units using the series secondary 12 pulse design does not use the interphase transformer.

ELECTRONIC PACKAGE

All electronic package adjustments are pre-set at Trystar. Any questions when attempting to re-calibrate should be referred back to Trystar. A certified electronic technician is available if re-calibration is desired. Technical training seminars are also available to train your personnel.

The function of the electronic package is to supply trigger pulses to the SCR regulator modules, which in turn gives the proper voltage and current versus load relationships. The electronic package is made up of electronic circuit cards arranged into one assembly.

OMNI CONTROL BOARD (Consists of the following circuits to control the rectifier):

- Power supplies, that energize the total electronic control system.
- An amplifier circuit that amplifies the difference between a regulated reference (also located on this card) and a feedback signal. The output of the amplifier drives the gate firing card.
- A current feedback circuit that amplifies the shunt signal and provides electrical isolation and current feedback signal for current control.
- A voltage feedback circuit to filter, isolate and provide a voltage feedback signal for voltage control.
- A D.C. overload circuit allows selection of one of four settings from zero (0) to three (3) restart attempts once an excessive output current is detected.

GATE FIRING BOARD

The gate drive card supplies the trigger signals to their associated SCR's. The gate card receives its command signal from the control card. The gate cards are specifically programmed via jumpers on the circuit board.

SCR ASSEMBLY CURRENT BALANCE CONTROL BOARD

The SCR Current Balance Control Board monitors the current difference between assemblies using current transformers (CTX1-3 and CTY1-3) and adjusts the gating signals.

OMNI INTERFACE (4 Cards total):

Voltage Control card: Isolates the 4-20mA Control signal and converts it to 0 –7.5 Vdc for controlling the unit's output voltage.

Current Control card: Isolates the 4-20mA Control signal and converts it to 0 –7.5 Vdc for controlling the unit's output voltage.

Voltage Monitor card: Provides an Isolated 4 – 20mA signal to monitor the Output DC Voltage.

Current Monitor card: Provides an Isolated 4 – 20mA signal to monitor

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the Output DC Current.

SCR ASSEMBLY (EACH)

The thyristors (SCR) are rated for continuous full load operation. The assembly is designed for a maximum junction temperature not to exceed 80% of the maximum rated junction temperature of the device to prolong the life of the device. The peak inverse voltage ratings of the devices are at least 2.5 times the peak voltage of the AC Supply.

The devices are mechanically clamped and mounted to an extruded heat sink in a manner which insures less than 10° C difference between the device and the heat sink. The heat sink is designed to provide proper cooling and to limit the maximum temperature rise to 40°C. This design is in conjunction with the appropriate air CFM maintained on the heat sink. The heat sink is machined to exceed thyristor manufacturer specifications.

The SCR (Silicon Controlled Rectifier) assembly receives A.C. power from the Secondary of the main transformer. The SCR assembly is configured in a three-phase full wave bridge to convert the A.C. power into pulse D.C. power. The SCR assembly consists of six individual SCR's that control one half cycle of each A.C. input phase. A signal or gate pulse generated by the electronic package determines the amount of voltage that a SCR will pass. The gate pulse is timed to line up with the proper phase for each SCR and is controlled by a closed loop feedback circuit within the electronic package.

PROTECTION CIRCUIT DESCRIPTIONS

INPUT BREAKER WITH UNDERVOLTAGE TRIP

The input breaker is equipped with an under voltage trip circuit. A customer supplied 120 VAC is required on terminals 100 and 101 for breaker under voltage trip circuit, breaker position indication and florescent light operation. Once the breaker is closed the Power On light will illuminate and the potential free Control Power On customer contact will close. Separate Manufacturer manuals have been provided for the Sq-D NW16H1 breaker.

DC OVERLOAD

The rectifier has a set of D.C. overload contacts that are located on the Omni Control Board. The D.C. overload circuit has selectable restarts of zero (0) to three (3) attempts. If the D.C. overload circuit detects overloads within 60 seconds after the selected number of restarts, the main contactor will open, the alarm buzzer will sound, the DC Overload light will illuminate, the DC ON light will turn off, and the potential free, customer contacts (1 each) for DC ON will open and for DC Overload will close. The Alarm Silence button will silence the alarm buzzer. Once the fault is cleared the Alarm Reset customer contact must be opened or the Alarm Reset button must be pressed.

SCR OVER TEMP

Thermals mounted on the SCR packs (180°F) will shut down the rectifier. The main contactor will open, the alarm buzzer will sound, the SCR Over Temp light will illuminate, the DC ON light will turn off, and the potential free, customer contacts (1 each) for DC ON will open and for SCR Over

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Temp will close. The Alarm Silence button will silence the alarm buzzer. Once the fault is cleared the Alarm Reset customer contact must be opened or the Alarm Reset button must be pressed.

POWER AND INTERPHASE TRANSFORMER OVER TEMP

Thermal mounted in the coils of the power and interphase transformers will shut down the rectifier. The main contactor will open, the alarm buzzer will sound, the Transformer Over Temp light will illuminate, the DC ON light will turn off, and the potential free, customer contacts (1 each) for DC ON will open and for Transformer Over Temp will close. The Alarm Silence button will silence the alarm buzzer. Once the fault is cleared the Alarm Reset customer contact must be opened or the Alarm Reset button must be pressed.

DOOR INTERLOCK

All of the rectifier doors are equipped with interlock switches. When one of the doors is opened the input breaker will shunt trip and open. The Breaker Open light will illuminate and the Breaker Closed light will turn off. The power section doors and the control section door which accesses the SCR Assemblies and Electronic Package will illuminate the florescent lamps in their respective sections when opened.

COOLING FAN OVERLOAD

The rectifier is equipped with a cooling fan that is used to cool the SCR assembly and cabinet. A three (3) phase starter with overload and fuses protect the fan motor. SCR or transformer over temp is likely without proper fan operation. The Start Enable relay (RM7) will de-energize and the DC ON circuit will open and be unable to be restarted if the fan overload contact (OL1) is open.

SCR FUSE BLOWN INDICATION

Trigger fuses (TF1-TF6) are wired in parallel with the (6) SCR fuses (SF1-SF6). When a SCR fuse opens the trigger fuse activates a limit switch. The main contactor will open, the alarm buzzer will sound, the SCR Fuse Blown light will illuminate, the DC ON light will turn off, and the potential free, customer contacts (1 each) for DC ON will open and for SCR Fuse Blown will close. The Alarm Silence button will silence the alarm buzzer. Once the fault is cleared the Alarm Reset customer contact must be opened or the Alarm Reset button must be pressed.

START UP PROCEDURE

When 480 VAC is supplied to the line side of the input breaker the power source on pilot light will illuminate. The input breaker is equipped with an under voltage trip circuit. The 120 volts AC must be supplied to terminals 100 and 101 and the maintained Emergency Stop button must be pulled out for the breaker under voltage trip circuit. Once the 120 VAC is supplied and the maintained Emergency Stop button is pulled out the Breaker Open pilot light will illuminate. Pump the lever on the breaker until the Charge OK indication is shown. Press the Breaker Close button to close the breaker. Once the breaker is closed the Breaker Closed and Power On light will illuminate and the potential free Control Power On customer contact will close. All of the rectifier doors must be closed and the customer's E-stop contact must be open or the breaker will shunt trip. Separate Sq-D breaker manuals have been provided.

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Before the AC contactor can close to start the DC output all faults must be cleared and the Start Enable relay (RM7) must be energized. The faults which will not allow RM7 to energize are DC Overload (RM3), SCR Over Temp (RM4), Transformer Over Temp (RM5), SCR Fuse Blown (RM6) and the fan motor overload (OL1).

With all faults cleared the DC may be started by pressing the start button or closing the Customer's Remote Start Contact provided the customer stop contact is maintained closed and the keyed selector switch is in the Auto position. When DC is started the AC Contactor (CM1) and the DC On customer contact (RM3) will close.

To Stop the DC output press the Stop button or open the Customer's Remote Stop Contact.

With the keyed selector switch (SS1) in manual and the DC on the voltage output level is controlled with the Voltage Adjust potentiometer (P1). The current level is controlled with the Current Adjust potentiometer (P2).

With the keyed selector switch (SS1) in Auto and the DC on the voltage output level is controlled by a 4-20mA signal between VC (+) and VC Common (-). The current level is controlled by a 4-20mA signal between IC (+) and IC Common (-).

Output voltage and current monitoring signals (4-20mA) are provided on VO (+) and VO Common (-) for voltage, IO (+) and IO Common for current.

Output voltage and current monitoring signals (4-20mA) are provided on VO (+) and VO Common (-) for voltage, IO (+) and IO Common for current.

OPERATION

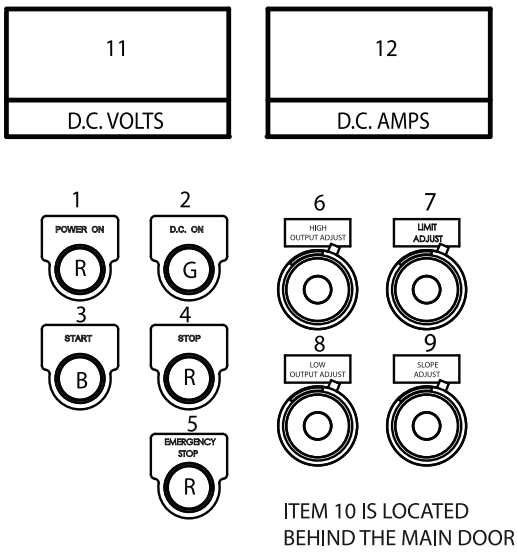
CONTROL FUNCTION

Each D.C. Power Supply is equipped with output adjust knobs, and various control circuits. Please reference your circuit diagrams to verify all the controls equipped with your system. The output adjust knobs are described in this section.

Note: Output adjust knobs are typically located on the front door and inside the front door directly behind any exterior adjust knobs. The volts/amp switch (when provided), is located inside the front door also.

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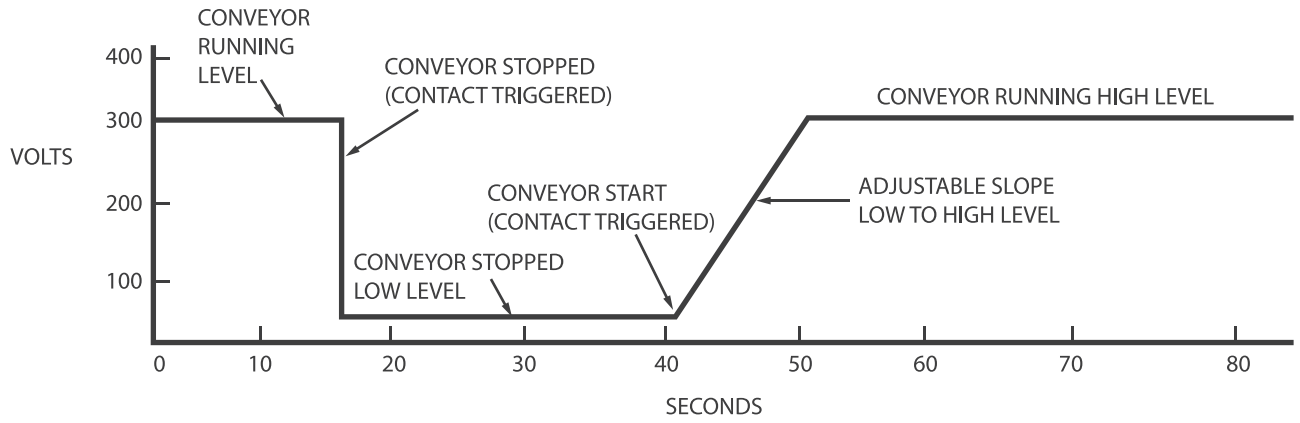
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1. **Power On** - Light to indicate that the main circuit breaker is energized.
2. **DC On** - Light to indicate that the AC contactor (where applicable) is energized and power is supplied to the rectifier electronics.
3. **Start** - Energizes the AC contactor (where applicable) and turns the DC output on.
4. **Stop** - De-energizes the AC Contactor (where applicable) shutting off the DC output.
5. **Emergency Stop** - opens the main AC input circuit breaker cutting power to the rectifier.
6. **Voltage High Output Adjust (Output Adjust)** - This control maintains the DC output voltage constant when the volt/amp switch is in "Volts" position at a level set by the output adjust knob. For example, the operator may adjust the DC voltage of a 400 volt (max) rectifier to 300 volts. The control will adjust the firing of the SCR's as needed to keep the voltage at constant 300 volts.
   If your load exceeds the current limit setting, the voltage control will be over-ridden and the voltage will drop to a level determined by the load while the current will maintain its maximum or limit setting.
7. **Current Output Adjust (Limit Adjust)** - This control maintains the DC output current constant when the volt/amp switch is in the "Amps" position at a level set by the "output adjust" knob. For example, the operator may adjust the DC current of a 1000 ampere (max) rectifier to 800 amperes. The control will adjust the firing of the SCR's in order to maintain the current constant at 800 amperes.
   The DC output voltage will not be allowed to exceed its rating or it will go into automatic voltage limit.
8. **Low Output Adjust or Holding Voltage (Optional)** - This control typically interfaces with a relay contact controlled by a conveyor running or conveyor stopped signal. When the conveyor stops, the "Low Adjust" or "Holding Voltage" knob takes control of the D.C. output and is typically set at a lower level then the "High Adjust" knob.

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When the conveyor starts, the D.C. output will slope up from the low adjust level to the high adjust level.



9. **Slope Adjust** - This control slope time of the D.C. output from its low adjust level to its high adjust level. The slope circuit is triggered by a relay contact. The contact open enables the low adjust level, and the contact held closed slopes the D.C. output from low adjust to high adjust. The slope adjust is variable from 0-2minutes or an optional 0-20 minute setting. The slope adjust knob turned fully counter clockwise is the fastest output slope time. Clockwise is the slowest.
10. **Volt/Amps Switch** - (Not Shown) This switch is located behind the output adjust knob and allows the rectifier to operate in either constant volts or a constant amps mode. In the volts position, the output adjust knob controls and regulates the rectifiers voltage. In the amps position, the output adjust knob controls and regulates the rectifiers current.

Note: In the amps position, a load is required otherwise the output may run out of control.

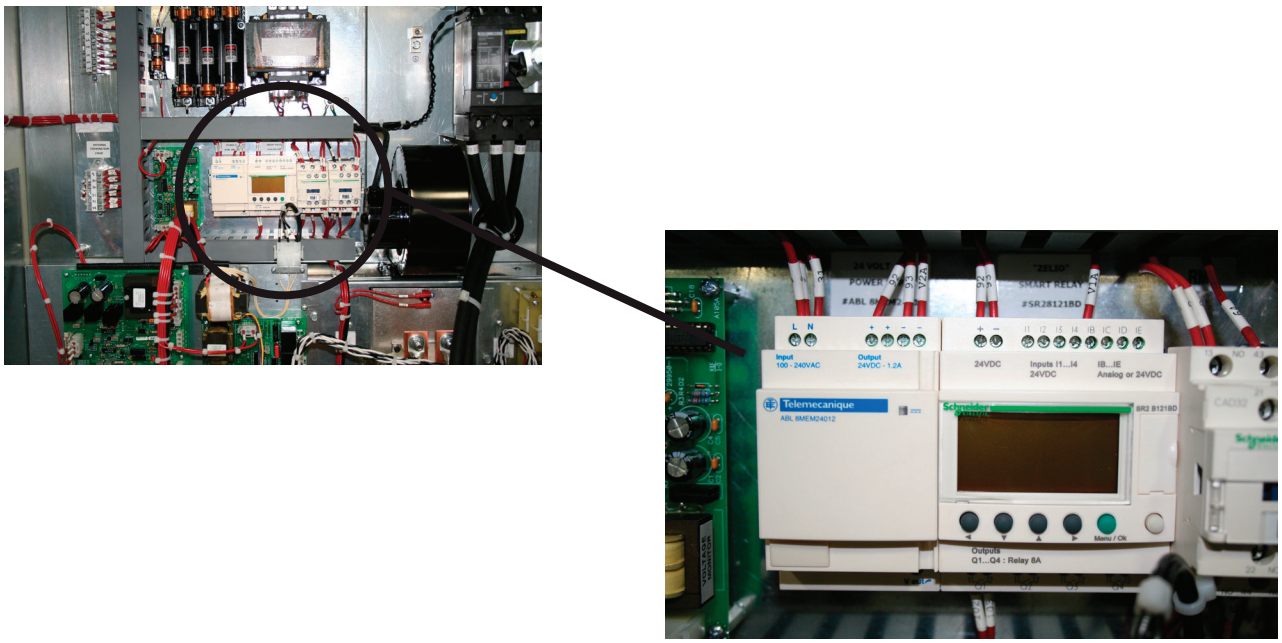
Note: In the amps position, a load is required otherwise the output may run out of control.

11. **D.C. Voltmeter** - D.C. Output Voltage reading.
12. **D.C. Amperes** - D.C. Output Amps reading.

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OPTIONAL SMART RELAY OPERATION AND PROGRAMMING

Relay Location: Inside main control section



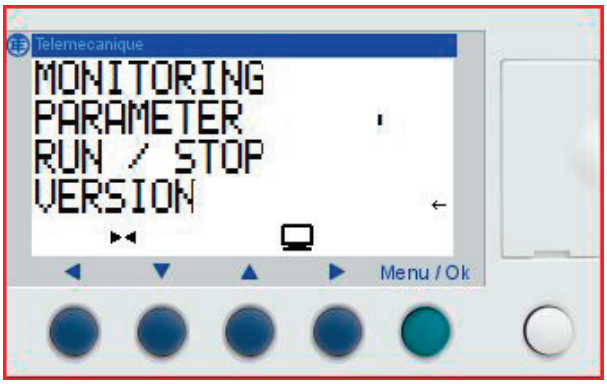
Adjusting the undervoltage alarm settings

Step 1

Make sure the DC power is ON. The DC ON Light will illuminate on the front door. If DC Power is off, press the “Start Button” on the front door of the rectifier.

Step 2

From the home screen of the smart relay device press the “Menu/ Ok” button in the lower right hand corner. The following screen will be displayed:

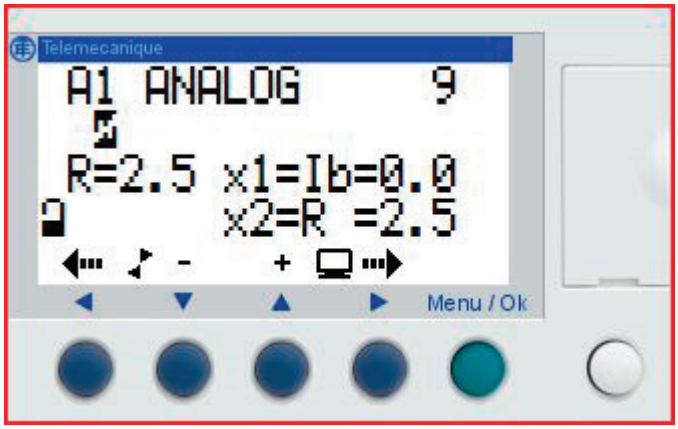


Using the up and down arrow keys select “Parameter” and press the “Menu/Ok” button.

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Step 3 - Changing the Under Voltage Setpoint

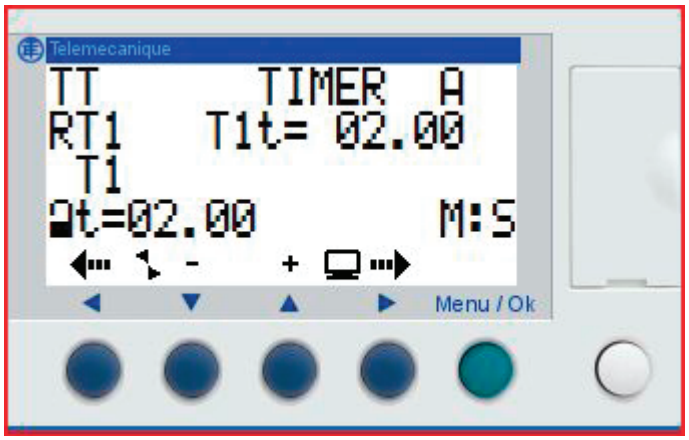
To adjust the under voltage setpoint, press the left or right arrow keys to highlight the “R=” parameter. Once the value is highlighted it will flash. Using the up and down arrow keys select the scaler value that represents the undervoltage alarm setpoint. To calculate a scaler value, multiply the desired low voltage setpoint by 0.025.



Once the desired value is set, press the “Menu/Ok” button. The device will ask you to confirm changes, select “Yes” using the up/down arrow keys then press the “Menu/Ok” button.

Step 4 - Changing the time delay setting to close the contact.

To change the time delay, follow the instructions in Step 2 to get to the parameters screen. Press the up arrow key to access the time delay setting screen (Note that the cursor must be on the “A1” parameter to be able to switch to the time delay setting screen) Using the right and left arrow keys highlight the “t=xx.xx” parameter at the bottom, Once it is highlighted it will flash. Use the up and down arrow keys to adjust the number of minutes and seconds of delay . When finished, press the “Menu/Ok” button and confirm the changes.



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OPTIONS

OPTIONS

11860 Remote Control Panel : The remote operators control panel allows operation of the power supply from a location away from the main power supply cubicle. The enclosure is constructed to NEMA 12 standards and is custom built for your operation with any variety of start/stop, cycle times, multi level output control, emergency stop etc.....

11870 Timed Automatic Cycle Control : The timed automatic cycle control consists of a heavy-duty timer that is initiated when the “start” button is depressed. The timer is configured as a count-up timer. Upon completion of the preset elapsed time the unit will shut down (or drop to holding voltage with slope option). The timer range may be set in seconds, minutes or hours. The values of three digits with a moveable decimal point may be set.

Note: See option #11871 “Audible Alarm with Pilot Light and Silence Switch” for cycle end annunciation.

11871 Audible Alarm with Pilot Light and Silence Switch : This option is used with Option #11870 (Cycle Timer) to provide an audible and visual indication of the end of cycle. When the timer times out a “cycle end” light will illuminate, and an audible alarm will sound. An alarm silence button is provided to silence the alarm and extinguish the light. At the end of the cycle, it is optional to allow the unit to operate or turn-off. A jumper wire determines which function is operational.

Note: The audible alarm may be a bell, horn or buzzer, to distinguish the rectifier from other equipment. Please specify when ordering.

11890 Command Two-Level Control : The command two-level control allows the adjustment of one level before a command signal and a second level after the command signal is applied. The command signal from the customer, is a potential free contact. This control consists of two, ten turn, adjustment potentiometers with locking dials. When the command signal is open, the low output potentiometer controls the output of the unit. When the command signal is closed, the high output potentiometer controls the output of the unit. When the command signal opens again, the unit will immediately switch to the low output level.

Note: If this option is used in conjunction with the Slope Control (option 11970) the unit output will slope (ramp) up from the low output level to the high output level when the command signal is closed. The unit will immediately return to the low output level when the command signal is opened.

11900 Command On/Off Control : The command on/off control allows the rectifier to be started from an external command contact closure and stopped when the external contact is opened. This circuit includes start and stop push buttons and a ready light.

Operation: Once the rectifier’s main breaker is energized and the “start” button is depressed the “ready” light will illuminate, indicating the

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rectifier is ready for the command start signal. A contact closure on the command signal will start the DC output. Upon a command signal opening the rectifier will return to the ready state and await the next command start signal. Depressing the “stop” button will remove the rectifier from the ready state.

11960 Cumulative Ampere-Hour Meter : The totalizing ampere-hour meter is microprocessor based and has a 12 digit, non-resettable display of the accumulated ampere-hour (or ampere-minute) product and a 12 digit, resettable, cumulative ampere-hour (or ampere-minute) display. See the additionally provided manual for more information on this option.

11961 Cumulative Ampere-Hour Meter with Preset, Time Based Control for Two Pumps : The totalizing ampere-hour meter with preset, time based control for two pumps is microprocessor based. See the additionally provided manual for more information on this option.

11962 Automatic 2 Pump Feeder for Paint / Chemical Adder with Pre-Set Pump Stroke Counters (Two Pump Operation) : The automatic solids or brightener adder and pre-set pump stroke counters is microprocessor based. See the additionally provided manual for more information on this option.

11970 Automatic Slope Control : The automatic slope control provides a step less increase in the voltage or current from zero (0) to a preset level. The slope is completely adjustable with a ten-turn potentiometer to give a linear rate of rise. The slope is initiated with the “start” button. The time ranges when going from zero (0) to full output are adjustable over two (2) ranges:

Short Duration: 3 seconds to 2 minutes maximum.

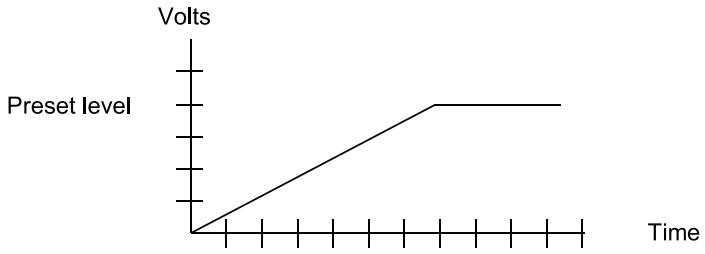
Long Duration: 3 seconds to 20 minutes maximum.

For extended times beyond 20 minutes consult factory.

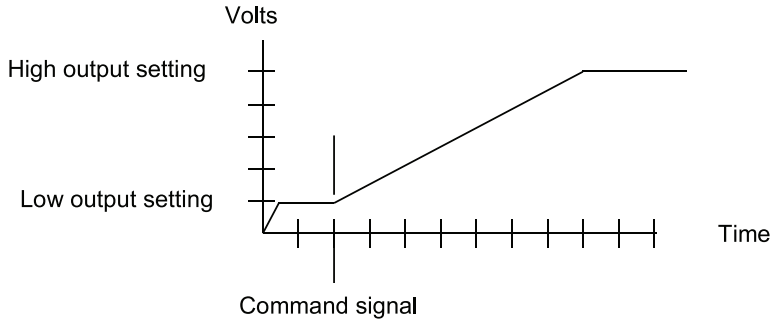
11970A Used in conjunction with the “Command Two-Level Control” (option 11890) the unit will slope up from the low output setting to the high output setting after a command signal (potential free contact) is given.

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Automatic Slope Control 11970



Automatic Slope with Command TwoLevel Control 11970A



12020 Parallel Control: The paralleling control allows the operation of (2) two or more units in direct parallel. One unit will be selected as master and will be operated as a voltage source and be responsible for the voltage control. The master unit will send a signal to all other units connected in parallel, which will operate as current sources to balance the load current between all units.

12231 Single Channel Computer Interface Board (29950): The single channel computer interface board (29950) is used in conjunction with the Omni Control board (408101). The single channel computer interface board can be configured to provide or accept isolated interface signals of 0 to 10 volts or 4 to 20 milliamps. The isolation devices have a "dielectric withstand voltage" of 750 volts maximum. The card may be used for an isolated output signal for voltage or current monitoring, or an isolated input signal for voltage or current control. One card is required for each signal to be used. When using input signals for control, only 1 signal is needed to control either voltage or current. *The other signal can be internally wired to achieve maximum rated output level.

12235 Ripple Filtering: The Ripple Filter consists of a Choke (L) and a capacitor (C). A bleed resistor (BR) is utilized to discharge the capacitor in approximately five (5) seconds when the power is turned off. The LC filter will provide 5% or less RMS ripple over the range of 25% to 100% output.

12236 Fuse Blown Indication: The fuse blown indication may be used for any fuse in the rectifier. The blown fuse indication may be relay contact, pilot light, horn, buzzer or any combination.

12238 Ripple Meter with Under/Over Voltage Alarm: The Ripple meter is a microprocessor based voltage meter. The DC and AC rms voltage is monitored and displayed on the LCD. The processor automatically

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calculates and displays the percentage of ripple.

The meter can also be programmed to monitor the DC voltage, and provide an alarm indication if it is over or under the alarm setpoints. The alarm circuit will activate for out-of specified voltage or ripple levels.

The alarm parameters for ripple and voltage are fully programmable using a simple 2-key "membrane" type keypad. A time delay adjustment is also included to prevent false alarms during initial power-on of the DC power supply.

An indicator light and a "potential-free" contact are provided as alarm signals. A jumper wire provision is included in the rectifier to automatically shut the DC off in the event of an alarm (remove jumper). An audible horn, bell, or buzzer may be provided as an option. See the additionally provided manual for more information on this option.

GENERAL TROUBLESHOOTING GUIDE

⚠ WARNING ⚠

THERE ARE DANGEROUSLY HIGH VOLTAGES WITHIN THE DC POWER SUPPLY ENCLOSURES. UNDER NO CIRCUMSTANCES SHOULD ANYONE OPEN ACCESS DOORS TO THE DC POWER SUPPLY OR THE TANK WHILE THE SYSTEM IS ENERGIZED. ONLY QUALIFIED, TRAINED, ELECTRICAL PERSONNEL SHOULD SERVICE AND MAINTAIN THIS EQUIPMENT. LOCKOUT PROCEDURES MUST BE ENFORCED WHILE SERVICING OR MAINTAINING THE POWER SUPPLY.

Equipment required: Digital multimeter, common hand tools, safety glasses and an AC current clamp.

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PROBLEM	PROBABLE CAUSE
Unit will not start.	1. Check fault circuits. Refer to circuit diagram.
	2. Check DC on -holding circuits. Refer to circuit diagram.
Main circuit breaker tripping.	1. Check for transformer ground fault. Check for shorted output.
	2. Refer to SCR assembly test procedure.
	3. Replace circuit boards.
	4. Bad shunt trip or breaker.- Replace.
DC turns on then shuts off.	1. Check fault alarms.- Refer to circuit diagram.
	2. Check SCR's. Refer to SCR test procedure.
	3. Replace circuit boards.
High temp warning.	1. Possible fan failure.
	2. Air intakes blocked.
	3. Outside air temp. excessive.
	4. No water flow. - Check solenoids, radiator, thermostat and water temperature.
Power on with no output voltage.	1. Check output adjust setting.
	2. Check DC on holding circuit. Refer to circuit diagram.
	3. Check PLC interface board.
	4. SCR fuse failure or SCR failure. Refer to SCR test procedure
	5. Replace circuit boards.
No lights on control console.	1. Check primary incoming AC power.
	2. Check console fuses.
Output voltage with no current.	1. No load in tank.
Output current with no voltage.	1. Check for shorts on output.
Output current with not enough voltage.	1. Check current limit. Adjust.
	2. Check for load increase.
	3. Circuit boards out of adjustment.
Excessive output ripple.	1. Check SCR's. Refer to SCR test procedure
	2. Replace gate board.
	3. Check filter capacitors and fuse.
Main input A.C. current unbalanced.	1. Check SCR's and SCR gate/cathode connections.
	2. Check SCR fuses
	3. Replace gate board.

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MAINTENANCE AND TROUBLESHOOTING

⚠ WARNING ⚠

THERE ARE DANGEROUSLY HIGH VOLTAGES WITHIN THE DC POWER SUPPLY ENCLOSURES. UNDER NO CIRCUMSTANCES SHOULD ANYONE OPEN ACCESS DOORS TO THE DC POWER SUPPLY OR THE TANK WHILE THE SYSTEM IS ENERGIZED. ONLY QUALIFIED, TRAINED, ELECTRICAL PERSONNEL SHOULD SERVICE AND MAINTAIN THIS EQUIPMENT. LOCKOUT PROCEDURES MUST BE ENFORCED WHILE SERVICING OR MAINTAINING THE POWER SUPPLY.

Frequency - Preventive maintenance should be performed annually and in harsh environments, perhaps 2-3 times annually. Training seminars are available for entire rectifier trouble shooting, operation, adjustments and preventive maintenance. Please contact the factory for more information.

Preparation - A shutdown period must be scheduled to complete maintenance of your rectifier. After the maintenance is complete, test loads should be applied and normal operation of the rectifier verified before using in a production situation.

Check off each item on the “Rectifier Performance Checklist” located at the end of this section as you go through this procedure.

EQUIPMENT

Digital multimeter, wire brush or emery cloth, safety glasses, common screwdrivers and wrenches, vacuum cleaner and A.C. current clamp.

INSPECT & TIGHTEN CONNECTIONS

1. Turn off all power to the rectifier including the utility feed breaker that supplies AC input power.
2. Remove any load from the output.
3. Open all doors and panels and visually check for loose connections, burnt, frayed or broken wires. Use the applicable screwdriver or wrenches to tighten all connections. Refer to the “Rectifier Performance Checklist” and check off each item in Section 1. Vacuum any debris accumulated inside the unit.
4. Correct and note any loose connections on the checklist, replace any physically burned or broken components. Use extreme care when replacing components to assure correct installation. Take apart and clean any corroded connections with a wire brush or emery cloth. Use electrical grease when re-assembling high current connections.

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CIRCUIT BOARD CHECKS

Circuit boards are very sensitive and should only be handled using electrostatic safe procedures. Special adjustment procedures and training is required to complete circuit board check out in accordance with the “Rectifier Performance Checklist”. Contact the factory for more information.

1. Inspect each circuit board closely for any loose connections or burned components. Correct or replace any bad circuit boards.

CIRCUIT BOARD CHECKS CONTINUED

2. Clean off any accumulation of dust or debris on the circuit boards. Use pre-packaged compressed air especially formulated for electronic circuit boards, available at any electronic distributor. If a circuit board is extremely dirty or corroded, send back to the factory for evaluation and cleaning.

OPERATION CHECKS

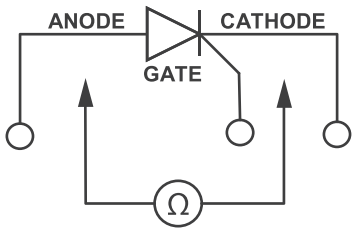
Follow the “Rectifier Performance Checklist” and the circuit diagram for the unit under test. Note: All items on the checklist may not apply to your unit. Verify that each item functions as it should in accordance with this manual and the circuit diagram for your rectifier. Make sure all cooling fans are working, verify all overtemp circuits, safety interlocks, emergency stops, output control knobs, etc….Make note of any item that is not working properly on the checklist and correct as required.

FINAL CHECKS

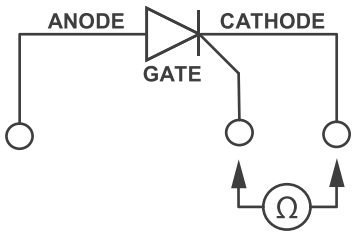
Place a test load on the system and verify that the rectifier functions normally before placing it into production.

SCR TESTING - Refer to your units circuit diagram to confirm how the SCR’s are configured in your unit.

1. SCR under test must be isolated from the rectifier.
2. Hockey puck style SCR’s must be clamped across the anode and cathode or left in its heat sink assembly when checking the SCR. Make sure the clamp does not damage the SCR surface and that the anode and cathode are not shorted by the clamping device.
3. With an ohm meter, measure as shown below:



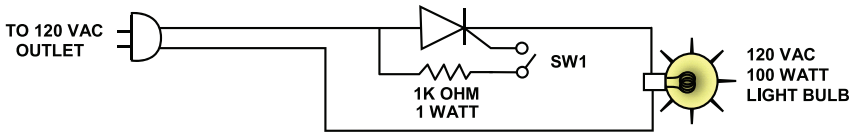
SHOULD READ (OPEN)



10 TO 60 OHMS

Note: Occasionally an ohm check may not detect a faulty SCR. A working test circuit can be easily constructed to insure a properly functioning SCR as follows:

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There should be no light with SW1 open and with SW1 closed, the lamp will glow with approximately ¾ brilliance.

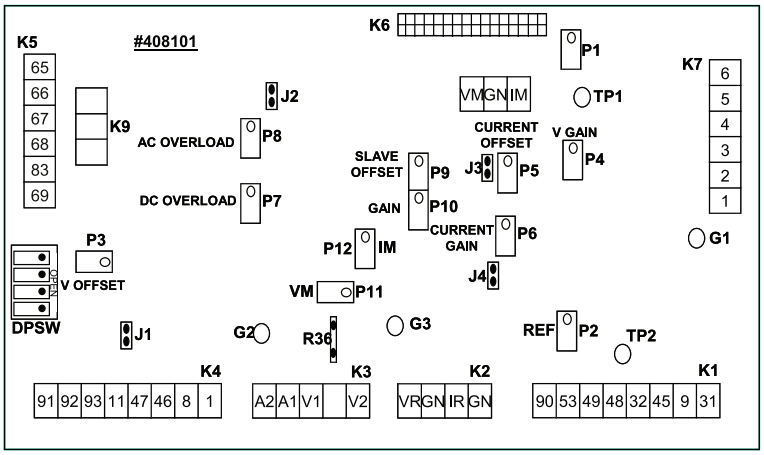
SCR INSTALLATION

Proper alignment and torque of a hockey puck style SCR is required to obtain correct thermal impedance between the SCR junction and the heat sink.

1. Apply a thin coating of semi-conductor thermal compound to each side of the SCR.
2. Align the hockey puck with the centering pins on the heat sinks.
3. Tighten each bolt evenly on the clamp assembly.
4. With each bolt finger tight, additionally tighten each bolt in half turn increments for a total of 1 ½ turns.

ELECTRONIC PACKAGE CHECKS AND ADJUSTMENTS

OMNI CONTROL #408101



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CONNECTORS

K1-9 & 31-120 VAC Supply.
K1-48 circuit common.
K1-53- D.C. disable (contact triggered).
K2-GN-circuit common.
K2-VR-output voltage PLC interface monitor signal.
K3-A2 & A1-0-50 MVDC D.C. output current feedback.
K4-46-0-7.5 VDC current control.
K4-11-0-5 VDC gate drive.
K5-65 & 66- slope enable (contact activated).
K5-68-slope input 0-7.5 VDC.
K5-83- slope adjust 0-7.5 VDC.
K7-1-output voltage interface.
K7-3-power supply + 14 VDC.
K7-5-circuit common.
K8-IM-0-7.5 VDC current output meter signal.
K8-GN-circuit common/K9-1-digital auxiliary input.
K1-32 & 45-Relay contact for D.C. on holding circuit.
K1-49 reference 7.5 VDC regulated.
K1-90 slave output signal 0-7.5 VDC.
K2-IR-output current PLC interface monitor signal.
K3-V2 & V1-D.C.output voltage feedback.
K4-1 & 8 module derating interface.
K4-47-0-7.5 VDC voltage control.
K4-91, 92, 93 A.C. current transformer signals.
K5-67 low output adjust 0-7.5 VDC.
K5-69- slope output 0-7.5 VDC.
K6- optional signal monitoring.
K7-2-amp hour output current interface.
K7-4- power supply-14 VDC.
K7-6 – power supply +5 VDC.
K8-VM-0-7.5 VDC voltage output meter signal.
K9-2-analog auxiliary input.

ADJUSTMENTS

P1-+5-CW increases.
P2-Ref-CW increases.
P3-V offset-CCW raises DC output.
P4-V gain-CW decreases DC output.
P5-I offset-CW-makes signal more neg. @ 1.
P6-I-gain CW lowers DC output I.
P7-DCOL CCW de-senses.
P8-ACOL CW de-senses.
P9-slave offset CCW more positive @ 90.
P10-slave gain- CCW raises gain.
P11-VM CW increases.
P12-AM CCW increases.

OMNI CONTROL #408101

TEST POINTS, JUMPERS, DIP SWITCH (DPSW), R36 (SCALE RESISTOR).

TP1 & G1-Regulated 5 VDC power supply for microprocessor.

TP2 & G1-Regulated 7.5 VDC reference.

G2-Isolated common for current feedback circuit.

G3-Isolated common for voltage feedback circuit.

N.O. Jumper-jump for normally open contact in D.C. on holding circuit @ connector K1-32 & 45.

N.C. Jumper-jump for normally closed contact in D.C. on holding circuit @ connector K1-32 & 45.

J1-Install jumper when using derating circuit on modular design units, otherwise remove jumper.

J2-Install jumper to de-sensitize D.C. overload circuit.

J3-Remove jumper to increase current feedback gain.

J4-Remove jumper to increase slave signal gain.

Connector K7 terminal 5 (common) to 4=-14 VDC regulated.

Connector K7 terminal 5 (common) to 3=+14 VDC regulated.

Connector K1 terminal 9 & 31=120 VAC supply voltage.

DPSW-4 position dipswitch controls D.C. overload retry circuit and slope

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circuit. Position 1 & 2 controls the number of tries the D.C. overload will disable D.C. output power before final shutdown which requires a manual restart. Position 3 determines either a 0-2 min. slope cycle or 0-20 minute slope cycle. Either slope cycle is controlled by a users slope adjust knob. Position 4 is not used.

HOW TO PROGRAM "DPSW"

OVERLOAD TRIES	DIP SWITCH	
	POSITION 1	POSITION 2
3	0	0
2	0	1
1	1	0
0	1	1

SLOPE TIME	DIP SWITCH
	POSITION 3
0-2 MINUTES	1
0-20 MINUTES	0

R36 Scale Resistor – Used to scale voltage feedback signal at connector K3-V1 & V2.

Formula: (Rated D.C. Output Voltage –2.5) x 1000 = R36.

ADJUSTMENTS OMNI CONTROL #408101

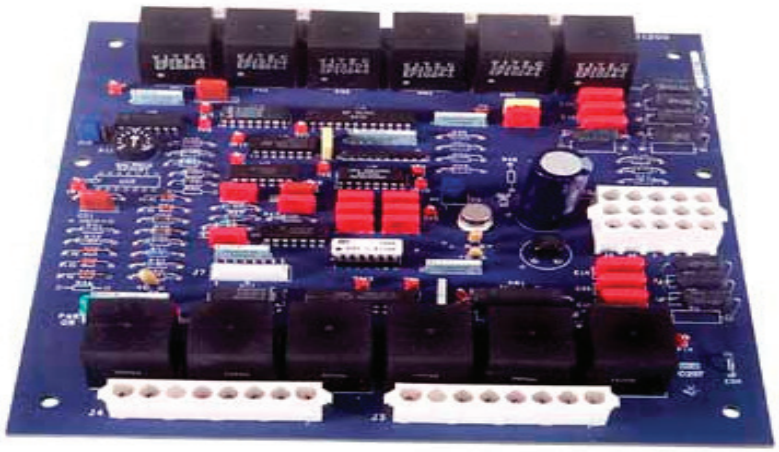
1. Turn off AC Power.
2. Disconnect all 4 Gate/Cathode connectors from gate firing board.
3. Turn AC Breaker ON.
4. Select Manual Mode of operation
5. Press Start.
6. Place DCVM on TP1 and G1, adjust P1 so the meter reads 5 VDC, clockwise increases voltage.
7. Place DCVM on TP2 and G1, adjust P2 so the meter reads 7.5 VDC, clockwise increases voltage.
8. Turn output adjust knob to "0".
9. Turn P3 completely clockwise (note this is a 10 turn pot).
10. Place DCVM on terminals 48 and 11 and you should read-.5 VDC. While watching DCVM, slowly turn P3 counterclockwise until you see the signal on your DCVM start to go positive, STOP turning P3 now! While watching your DCVM, turn P3 SLOWLY until the DCVM starts to go negative. STOP turning P3 now! The DCVM should keep going negative until it is at about -.5 VDC again. This is a voltage offset adjustment.
11. Press STOP
12. Turn off AC Power

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13. Reconnect Gate Cathode leads.
14. Turn AC Power ON.
15. Press START.
16. Place DCVM on connector K3 terminals V2 & V1. With no load on output, dial output adjust knob to maximum and adjust P4 (V Gain) to the units rated D.C. output. Clockwise decreases D.C. output.
17. With unit running at rated voltage output, place DCVM on connector K8 terminals GN & VM. Adjust P11 for proper Volt meter indication on Front Panel. Counter Clockwise increases signal.
18. Place a load on the output that will draw full output current continuously. Turn output adjust to “0”. Place DCVM on terminals 48 and 1 and adjust P5 (Current Offset) until DCVM reads -.05 volts. Clockwise makes signal go negative.
19. Turn P7 (D.C. Overload) completely counter clockwise. Calculate your maximum D.C. shunt signal by using this formula: .050/Shunt Size x Units Rated Output Current (In D.C. Amperes) = Maximum Shunt Signal @ A1, A2 in Millivolts. Example: .050 / 1000 x 800 =.004 or 40 Millivolts.
20. Place D.C. millivolt meter on connector K3 terminals A1 and A2. Turn output adjust to maximum and adjust P6 (Current Gain) to the calculated millivolt signal.
21. With unit running at rated current, place DCVM on connector K8 terminals GN and IM. Adjust P12 for proper Current meter indication on front Panel. Counter Clockwise increases signal.
22. With unit running at full current, turn P7 (D.C. Overload) clockwise until the D.C. output goes to “0”. STOP TURNING P7 NOW!
23. Turn P7 counter clockwise 3 turns to desensitize D.C. overload about 5% of rated current and 6 turns for about 10%.

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12 PULSE FIRING BOARD



Maximum Ratings:

• AC Mains Voltage (Vac)	600
• Pulse TransformerHipot (VAC) 1 Minute	3500
• Gate Delay Command voltage (Vdc)	-15 to +15
• Board Supply Voltage (Vac)	28
• Available Current (mAdc):	
+30V / +40 Vdc	300
+24 Vdc	20
+12 Vdc	5
+5 Vdc	5
• Operating Temperature (C°)	0 to 70
• Storage Temperature (C°)	-55 to +150

Electrical Characteristics:

• Gate Delay Command	0 to 5
Voltage Range (Vdc)*	
• Delay Angle Range (deg)*	6 to 174
• Phase Reference Angle Bias (deg)	0 or 30
• 3dB Bandwidth (Hz)	167
• Delay Angle Tracking (deg):	
Same Polarity	120 + 0.05
Different Phase	180 + 0.05
• Soft Start Range (s)	0.05 to 5.0
• Power Down Range (s)	0.05 to 10.0
• First Gate Pulse:	
Short Circuit Current (A)	1.8
• First Gate Pulse:	
Initial Rate-of Rise (A/µs)	1.0
Open Circuit Voltage (V)	14
• Sustaining Gate Pulse:	
Short Circuit Current (A)	.05
Open Circuit Voltage (V)	7
• Gate Pulse Width (µs)	
60Hz	24 to 26
50Hz	20 to 22
• Gate Burst Width (deg)	120
• Number Of Gate Pulses	384

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Phase Reference Sensing

Low level phase reference signals are produced by precision resistor attenuator networks and low-pass filters on the two sets of 30° phase-displaced 3Ø mains voltages. The mains voltages are accessed at the thyristor gate pulse transformer windings connected to each of the six phases. The attenuated mains voltage reference signals are processed by low-pass filters with 6dB attenuation and 60° phase shift at the mains frequency. The filters remove distortion from the reference signals caused by nonlinear loading of the mains by the thyristor converter / controller. The reference signals are then selected by means of CMOS switches to cancel the 60° filter phase shift and in turn are applied to voltage comparators to produce phase reference inputs to the phase-locked-loop of the gate delay determinator circuit.

Gate Delay Determinator

The gate delay determinator is a six phase phaselocked loop (PLL) consisting of a summing junction low-pass filter, voltage controlled oscillator (VCO) and two digital application-specific integrated circuit (ASIC) devices. The VCO frequency is locked to the power line frequency The DC control voltage is injected into the summing junction to vary the thyristor gate delay angle.

Gate Drive Outputs

Twelve isolated and 30° spaced hard-firing thyristor gate pulse outputs are provided. The twelve gate command logic signals produced by the ASIC devices are applied to pulse amplifiers which actuate pulse transformers via pulse-shaping RC networks.

Phase Balance Circuit

Ideally the phase shift transformer that powers the two six-pulse thyristors bridges provide two sets of three phase voltages that are equal in amplitude and phase shifted by 30°. However, common transformer imperfections cause small open circuit voltage unbalanced impedance unbalance and a slight deviation from the 30° phase shift. When two paralleled six-pulse bridges combine to make the twelve pulse rectifier, the result is unbalanced bridge currents of the twelve-pulse converters, presence of AC mains currents 5th and 7th harmonics, and DC ripple voltage at six times the mains frequency on the converter outputs.

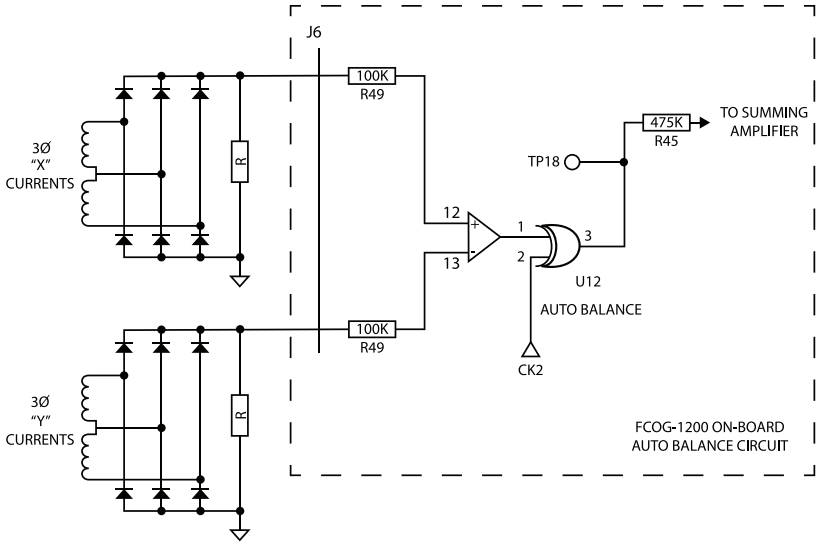
The on-board auto balance control method provides active control of the 3Ø group delay results in the optimization of the circuit at all DC output currents.

Phase Balance Circuit

As seen in the figure below, two customer provided feedback signals (derived from the AC bridge AC input currents or individual bridge output currents) along with the injection of a high frequency square wave into the Voltage Controlled Oscillator (VCO) summing amplifier help equalize the bridge input currents which result in optimum system performance.

The external auto balance control is ideal where a regulator is present in the circuit. This allows the regulator designer to incorporate the feedback rectifiers (if required) and current regulators into a single board simplify the system wiring.

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PERFORMANCE CHECKLIST

TRYSTAR

S-50 TWELVE PULSE RECTIFIER PERFORMANCE CHECKLIST

SRO #: Date:

COMPANY:

SYSTEM NUMBER:

RATED DC VOLTS: RATED DC AMPS:

COOLING: AIR

PROCESS: BATCH

ENVIRONMENTAL CHECKS	OK	NOT OK	N/A	EXPLANATION OF ITEMS CHECKED "NOT OK"
CLEANLINESS (inside unit)				
VENTILATION				
AIR FILTERS				
ROOM TEMP (Record Actual)				
CONNECTIONS TIGHTEN & INSPECT:				**COMMENTS**
A.C. BREAKER - LINE SIDE				
A.C. BREAKER - LOAD SIDE				
FAN MOTORS AND BRACKETS				
MAIN A.C CONTACTOR				
MAIN TRANSFORMER				
INTERPHASE TRANSFORMER				
CONTROL TRANSFORMERS				
TERMINAL STRIPS				
ELECTRONIC PACKAGE				
SCR ASSEMBLY				
SCR SNUBBER				
DC CAPACITORS				
CHOKE				
RELAYS				
DC BUSS				
SCR FUSES				
FUSE BLOCKS				

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D.C. SWITCH				
CIRCUIT BOARD CHECKS				
CONTROL BOARD				**ACTUAL VALUE**
POWER SUPPLY (+5VDC)				
POWER SUPPLY (+14VDC)				
POWER SUPPLY (-14VDC)				
REFERENCE				
DC OVERLOAD				
R SCALE				
GATE BOARD				**ACTUAL VALUE**
POWER SUPPLY (+5VDC)				
PULSE TRANSFORMER (1)				
PULSE TRANSFORMER (2)				
PULSE TRANSFORMER (3)				
PULSE TRANSFORMER (4)				
PULSE TRANSFORMER (5)				
PULSE TRANSFORMER (6)				
PULSE TRANSFORMER (7)				
PULSE TRANSFORMER (8)				
PULSE TRANSFORMER (9)				
PULSE TRANSFORMER (10)				
PULSE TRANSFORMER (11)				

QAF #: 19.31	SUBJECT: S-50 TWELVE PULSE PERFORMANCE CHECKLIST	Revision#:3
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SCR (1)	G-K (1)		A-K (1)		
SCR (2)	G-K (2)		A-K (2)		
SCR (3)	G-K (3)		A-K (3)		
SCR (4)	G-K (4)		A-K (4)		
SCR (5)	G-K (5)		A-K (5)		
SCR (6)	G-K (6)		A-K (6)		
SCR (7)	G-K (7)		A-K (7)		
SCR (8)	G-K (8)		A-K (8)		
SCR (9)	G-K (9)		A-K (9)		
SCR (10)	G-K (10)		A-K (10)		
SCR (11)	G-K (11)		A-K (11)		
SCR (12)	G-K (12)		A-K (12)		

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CIC BOARD				ACTUAL VALUE
VOLTAGE CONTROL				
VOLTAGE MONITOR				
CURRENT CONTROL				
CURRENT MONITOR				
EP VOLTAGE CHECKS				**ACTUAL VALUE**
SLOPE (48-83)				
SLOPE IN (48-68)				
SLOPE OUT (48-69)				
GATE DRIVE (48-11)				
SLAVE (48-90)				
VOLTAGE (48-47)				
CURRENT LIMIT (48-46)				
OPERATIONAL CHECKS				
SAFETY CIRCUITS				**COMMENTS**
TRANSFORMER OVERTEMP				
FILTER CHOKE OVERTEMP				
SCR ASSEMBLY OVERTEMP				
SCR ASSEMBLY OVERTEMP				
DOOR INTERLOCK				
MAIN SHUNT TRIP				
EMERGENCY STOP				
CONTROL CIRCUITS				**COMMENTS**
DC ON				
DC OFF				
HOLDING VOLTAGE				
SLOPE CONTROL				
UNDER VOLTAGE				
RIPPLE METER				
AC CONTACTOR				
MISC				**COMMENTS**
VOLTMETER				CALIBRATED? YES
AMMETER				CALIBRATED? YES
SLAVE CONTROL				
MASTER CONTROL				
CABINET FANS				
SCR FANS				

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FUSES					COMMENTS
CONTROL FUSES					
SCR FUSES					
DC FUSES					
FILTER FUSES					

QAF #: 19.31	SUBJECT: S-50 TWELVE PULSE PERFORMANCE CHECKLIST	Revision#:3
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OUTPUT RIPPLE				COMMENTS
VAC		VAC		
VDC		VDC		
% RIPPLE		@ AMPS DC		
CAPS		VAC		

INPUT MEASURMENTS						COMMENTS
PHASE ROTATION						
ØA - ØB		VOLTS				
ØB - ØC		VOLTS				
ØC - ØA		VOLTS				
ØA		AMPS				
ØB		AMPS				
ØC		AMPS				

WATER COOLED				COMMENTS
LEAK SENSOR				
RADIATOR				
THERMOSTAT				
WATER SOLENOIDS				
WATER LEAKS				

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CUSTOMER SUPPORT

PRODUCT SUPPORT SERVICES

Trystar offers total Customer Support that assures your critical equipment is maintained properly for trouble free operation.

SPARE PARTS

DC power supplies are made to order and do not always share the same parts. To obtain a complete parts list please contact Trystar's Customer Support Department. We highly recommend that spare parts are purchased for your stock since your rectifier controls a critical part of your operation. Any down time will surely exceed the cost of a simple part if it is not available when needed. When ordering parts please obtain the units system number located on the specification tag typically located on the inside door near the main AC input breaker.

TRAINING SEMINARS

Trystar offers hands on training at our factory in Troy, Michigan or at your site on your equipment.

PREVENTIVE MAINTENANCE

Scheduled preventive maintenance assures that your equipment is running 100% keeps your maintenance personnel familiar with the equipment, and makes sure your spare parts are working or in need of replenishing.

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WARRANTY

This Warranty applies only to the original purchaser who must properly register the product within thirty (30) days of receipt.

https://www.trystar.com/services/warranty-information/

Trystar warrants that our products and their components will remain free from defects in material and workmanship for the period of one (1) year from the date of shipment and agrees to replace, F.O.B. its factory, any parts which fail through defect in material or workmanship during such period.

1. This Warranty shall be effective only if and so long as the system is installed and operated in the manner specified in the manual which accompanied the product, and is operated within the ratings on the nameplate of the system.
2. This Warranty shall be effective provided the purchaser pays the cost of transporting the faulty component(s) to and from Trystar's factory at the purchaser's own expense. There is no cost for installation of the replacement component(s) when done at the factory. Otherwise installation of the replacement component(s) are the responsibility of the purchaser. If after inspection the faulty component has been caused by misuse or abnormal conditions in the judgment of Trystar, the purchaser will be charged for repairs based on parts and labor required. This Warranty does not cover fuses, light bulbs, and other normally expendable items. Trystar service personnel are not included in this warranty.
3. This Warranty shall be void if any alteration is made to the system, or any of its components are altered by anyone other than an authorized Trystar service person, without the written permission of Trystar.
4. This Warranty is in lieu of all other warranties, expressed or implied. Trystar neither assumes, nor authorizes any person to assume for it, any liability other than that specifically set forth in this Warranty. Except for its obligations, Trystar assumes no liability or responsibility for personal injury, loss of life, consequential or other damages resulting from defects in, or failure of, the system or any of its components.

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