Operation and Maintenance Manual

For

Kinetics Industries Type “SVR”

Stabilized / Regulated Direct Current Output Rectifiers

SVR6 – 6-Pulse SCR Regulated Rectifier
SVRJ6 – Fuseless 6-Pulse SCR Regulated Rectifier
SVR3 – 3-Pulse SCR Regulated Rectifier
SVRJ3 – Fuseless 3-Pulse SCR Regulated Rectifier
RGA – Regenerative Absorption Protection

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Kinetics Manufacturer of:

• Regulated & Line Regulated Rectifiers 1 to 2000Kw
  • DC Substations
  • Crane & Magnet Rectification Systems
  • JVR Fuseless Magnet Rectifier
• Synchronous Motor Field Excitation Systems
• Kinetsync™ Digital Annunciation & Logic Module for Synchronous Motors
  • Generator Field Excitation Systems
  • Dry Type Transformers
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Thank you for purchasing a Kinetics Rectifier.

PROPRIETARY INFORMATION STATEMENT

This manual has been furnished as a guide for the operation and maintenance of the product manufactured by Kinetics Industries Inc as described herein. The information is provided to owners of this equipment for this purpose and is not to be used for any other purpose. No part of this document may be reproduced or transmitted in any form or by any means, electronic or mechanical, for any purpose, without the express written permission of Kinetics Industries Inc.

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HANDLING INSTRUCTIONS AND PRECAUTIONS:

WARNING

Proper handling is necessary to avoid injury to personnel and damage to equipment. Have moving equipment that is adequate for lifting the control device at the installation site. Consult professional machinery movers if you have any doubt about proper handling means.

Observe the following precautions when handing or lifting equipment:

Moving:
- Your moving equipment must be capable of handling the weight and size of the equipment being moved. Verify the lifting capacity of your equipment against the weight indicated on the unit packaging, unit nameplate and mechanical drawings included within the unit instruction manual.
- The equipment should remain secured to the shipping skid, if provided, to prevent distortion of the bottom of the equipment frame during moving.
- Rod or pipe rollers, with the aid of pinch bars, provide a simple method of moving the unit on one floor level if there is little or no incline.
- When the unit must be moved between elevations without a suitable platform, elevator or forklift, overhead hoisting may be required. Lifting plates and eyebolts or channels, angles or bars with lifting eyes may be provided as a permanent or removable part of the equipment. If they are not, cables, chains or band sling may be used under the base of the unit. Care must be taken to not distort the enclosure, base frame, enclosure doors, roof drip cap or crush unit annunciation, control knobs or operator controls.

Lifting:
- Before lifting the equipment, inspect lifting plates or eyebolts for any damages and attach a spreader bar.
- A forklift may be a more convenient method for handling equipment and has the advantage of permitting lifting between levels. Before using a forklift, verify that the equipment base is designed for this type of lifting. The majority of Kinetics enclosures are designed for base forklift lifting. Suitability for base lifting via a fork lift is identified on the unit mechanical drawings within the unit specific instruction manual.
- Always use a safety strap to secure the unit to the forklift to prevent the potential of the unit tipping over.
- Lift equipment only at the points provided or indicated on the packaging or within the instruction manual mechanical drawings. Equipment may be damaged if laid on its sides or back. Equipment should always be oriented in the shipping position or normal mounting position.
- Keeping lifting force vertical and limit sling angle to less than 45°.
- Use spreaders or spanner bars to provide the vertical lift on eyebolts and lifting slings to avoid crushing or otherwise damaging the enclosure or its finish. Lifting bars, on long line-ups, may require additional spreaders to reduce the horizontal compressive load.
- Do not press ropes and cables through the lift holes in bars, angles, or channels. Use slings with safety hooks and shackles.
- Select or adjust the rigging length to compensate for any unequal weight distribution of load and maintain the equipment in an upright position.
RECEIPT INSPECTION:

Immediately upon receipt, the Kinetics SVR unit should be inspected to assure that the unit has not been damaged, internally and external, during transport. The unit should be immediately unpacked and a general inspection for mechanical integrity performed for items such as fractures, dents, damaged paint, loose bolts, broken annunciation, missing parts and any indication of impact stress or trauma to the unit from improper or rough handing. Particular care should be taken to prevent small parts or documentation from being mislaid or thrown away in the packing material. All Shipping damage found should be documented and immediately reported to both the shipping carrier and to Kinetics Industries, Inc.

- Please read packaging labels. If the instruction manuals have been included within a unit or a system section, a “YELLOW” indication label will be mounted to the exterior of the shipping packaging.
- Look for “Tip & Tell” stickers mounted to the exterior packaging of tall enclosures, units without base mounted power transformers or units that have the potential to be “walked” by handlers. If the unit handling exceeds 45’ from vertical, the tip & sticker will permanently identify the event. If the unit exceeds 45’ from vertical, the possibility exists that unit has been knocked over and a significant potential exists for internal / hidden damage. If the “tip & tell” sticker indicates “tipping”, immediately file a freight claim of improper handling with the transporting company, report the event to Kinetics, make a photographic and written record and immediately inspect the unit inside and out. The risk of hidden damage exists.

STORAGE:

If the equipment is not to be installed and commission immediately after unpacking and inspection, the unit should be stored in a clean, dry place and protected from accidental damage. Particular care should be exercised to avoid storing the equipment in locations where construction work is in progress.

- Unit storage temperature: 40°F to 100°F
- Units should not be stored in direct sunlight for extended periods without protective packaging.
- Storage environment should be low moisture and free of corrosive air – including ocean, salt laden, air.

PREFACE – INTRODUCTION

This is the general Reference Manual for the Kinetics SVR Series of stabilized/regulated rectifiers. It is intended for use with the SVR3 and SVR6 model series of regulated rectifiers as well as the fuseless SVRJ3 and SVRJ6 models. This manual is intended to provide only general reference and maintenance information for the SVR regulated rectifier series. In addition to this manual, each Kinetics SVR rectifier system is provided with additional, system-specific, electrical schematics and mechanical overview drawings as well as a System Bill of Materials and Recommended Spare Parts List. This manual is meant to be a companion with these other, system-specific, drawings and materials supplied to ensure satisfactory, reliable and safe operation of Kinetics SVR Regulated Rectifiers.

This material in this manual applies to SVR Regulated Rectifiers of all sizes, spanning a large range of available input and output voltages. The instructions and drawings in this manual apply to systems with standard distribution voltage input configurations (600VAC and less). For models with Medium Voltage or Intermediate Voltage inputs please refer to the addendum instructions, drawings and materials supplied with this manual.

Kinetics Industries, Inc. recommends that only properly trained and qualified electrical workers perform maintenance on any electrical equipment. Kinetics Industries also recommends that personnel review all drawings and illustrations contained in, and provided with, this manual prior to performing any work on SVR Regulated Rectifiers. Please refer to the additional system-specific drawings and materials when performing maintenance on your particular SVR model.

Kinetics Industries’ products are subject to change through continual improvement processes. Therefore, specifications and/or design layouts may vary slightly from descriptions included in this manual.

Please note that while every effort has been made to ensure that the data given in this document is accurate, the information, figures, tables, specifications and schematics contained herein are subject to change without notice. Kinetics makes no warranty or representation, either expressed or implied with respect to this document. In no event will Kinetics be liable for any direct, indirect, special, incidental or consequential damages resulting from any inconsistencies in its documentation.
SVR MODEL NUMBERS AND NAMEPLATE DATA

SVR MODEL NUMBER DESIGNATIONS

SVR 6 – 100 PB 4 2 XXX

REGULATED RECTIFIER
3 OR 6 PULSE
KILOWATT RATING
BRIDGE DEVICE
VOLTAGE RATING (MIN.) (M=600, PB=1200, PM=1600, †)

INPUT VOLTAGE CLASS †
1 115V / 120V
2 220V / 240V
3 370V / 380V
4 440V / 480V

OUTPUT DC VOLTAGE †
1 125V
2 250V

ADDITIONAL SVR OPTIONS †
( † - Consult Kinetics Industries for information on additional model number codes)

SVR SYSTEM NAMEPLATE LAYOUT

Kinetics

CONTROL SYSTEMS

140 STOKES AVENUE
TRENTON, NEW JERSEY 08638-3796
TEL: 609-883-8700 FAX: 609-883-2625

A - MODEL NUMBER
B - SYSTEM ID NUMBER
C - INPUT VOLTAGE RATING
D - OUTPUT VOLTAGE RATING
E - INPUT AC/DC PHASE CONFIG
F - INPUT CURRENT RATING
G - OUTPUT AC/DC PHASE CONFIG
H - OUTPUT CURRENT RATING
I - INPUT KW RATING
J - OUTPUT KW RATING
K - UNIT SERIAL NUMBER
L - ADDITIONAL INFORMATION

KINETICS SVR RECTIFIER DESCRIPTION & OPERATION

The Kinetics type SVR is a solid state, closed-loop, regulated rectifier system designed for general industrial applications. The SVR is available in a wide variety of sizes (from 1 to 2000 kW) in a large range of available input and output voltages. The rectifier systems are designed to provide a tightly regulated DC voltage or current output proportional to a control reference input signal while operating within the rating limits of the rectifier.

The Kinetics type SVR rectifier is available in either a 6-pulse SVR6 version (with 6 controlling SCRs) or 3-pulse SVR3 (with 3 SCRs and 4 Diodes). Kinetics SVR rectifier bridges are constructed using hermetically sealed silicon rectifier power semiconductors typically connected in a 3-phase bridge configuration. A free-wheeling device is often included to reduce ripple and allow a commutating path for highly inductive loads. The power bridges are either convection cooled or convection-aided, dependent upon KVA and voltage rating.

The SVR6 and SVR3 are also available in “SVRJ” models (SVRJ6 and SVRJ3). SVRJ regulated rectifiers are fuseless rectifiers that, under fault conditions, are designed to withstand fault currents until protection circuitry trips the AC Circuit Breaker. SVRJ designs combine proprietary design elements and fault coordination to limit fault current and trip the AC Circuit Breaker without the nuisance of blown fuses. They are ideal for heavy industrial or scrap yard applications where short circuits on the DC bus are probable or commonplace and downtime for fuse replacement can represent a lost production time problem. With an SVRJ rectifier in use, one has only to clear the DC Bus fault and reset the AC Circuit Breaker and the unit is back in operation.

SVR regulated rectifier systems normally include a dual winding isolation power transformer specifically designed and manufactured for use with power rectifiers. Kinetics Rectifier Transformers are dry-type, industrial duty, transformers manufactured for class F (155°C) operation with a class H (200°C) insulation system. Over-temperature protection against overloads and single phasing can be provided in the form of Transformer Winding Thermal Cutout Switches in each coil that interlock with the AC circuit breaker or switchgear to remove power. Primary voltage taps are included for added operational flexibility and to correct for variations in the incoming line voltage.
SVR Rectifier Variable Output Ratings:

The standard SVR rectifier is capable of providing full rated load current to the output when operating from 80% to 100% of maximum rated voltage – with a linearly decreasing current rating from 80% rated output volts to zero. A “Stabilized Bus” output rating is also available for systems designed to operate continuously at a tightly-regulated fixed bus voltage; In Stabilized Bus systems the SVR output rating is based on the expectation that the rectifier voltage output is not expected to drop below 90% of rated Volts. (see figure 1)

These ranges of the full load current operation may be expanded, reduced or modified under special conditions of design allowing higher load current operation at lower output voltages or to match the application requirements. (See the system-specific instruction book specifications if applicable).

Kinetics SVR Regulated Rectifiers are available in either rugged industrial grade steel enclosures or as “open panel” systems for mounting in existing or customer provided switchgear or control enclosures (per UL508A). When open panel designs are supplied, the customer is responsible for ensuring that adequate ventilation is available to provide proper cooling for the SVR rectifier system.

Shunt & Signal Transducer Application Designer Note: Drawings SVR3, SVR6 and SVRJ
Annunciation and feedback loop can incorporate the use of either a shunt or signal transducers. The universal drawings within this manual depict the use of signal transducers. The Kinetics unit design engineer may select either a 50 millivolt shunt for generation of a DC current signal or incorporation the use of a current and / or voltage transducer. Electrical - mechanical bussing constraints, cost and vendor availability enter into the component selection process for a given unit. Although the electrical connections for both sign transducers and shunts are elementary. The more “complex” electrical connections of signal transducers have been selected to be depicted within this manual. As a general guide, units below 100 ADC use shunts, units above 100 ADC use transducers.
KINETICS SVR6 6-PULSE RECTIFIER

Figure 2: TYPICAL SVR6 6-PULSE REGULATED RECTIFIER SCHEMATIC

Typical SVR6 Design Features:

1. Molded Case AC Circuit Breaker Input
2. Readily Visible "Power On" Indicating Light(s) warn when system is energized
3. Dual Winding, Dry-Type, Isolation Rectifier Power Transformer
4. SCR Bridge Assembly: Hermetically sealed SCR semiconductors mounted on extruded aluminum heat sinks
5. AC & DC Metal-Oxide Varistor
6. Reliable Solid-State Regulation, Reference, and Triggering circuitry
7. DC Analog Output Meters
8. Optional Blown-Fuse Ind. Lights
9. Semiconductor-type Rectifier Power Fuses

NOTES:
*
FREE-WHEELING RK10 & RK11 ARE OPTIONAL IN SVR6

\* = INTERNAL OR EXTERNAL CONTROL CONNECTION

Figure 2: TYPICAL SVR6 6-PULSE REGULATED RECTIFIER SCHEMATIC

Typical SVR6 Design Features:

1. Molded Case AC Circuit Breaker Input
2. Readily Visible “Power On” Indicating Light(s) warn when system is energized
3. Dual Winding, Dry-Type, Isolation Rectifier Power Transformer
4. SCR Bridge Assembly: Hermetically sealed SCR semiconductors mounted on extruded aluminum heat sinks
5. AC & DC Metal-Oxide Varistor
6. Reliable Solid-State Regulation, Reference, and Triggering circuitry
7. DC Analog Output Meters
8. Optional Blown-Fuse Ind. Lights
9. Semiconductor-type Rectifier Power Fuses

NOTES:
*
FREE-WHEELING RK10 & RK11 ARE OPTIONAL IN SVR6

\* = INTERNAL OR EXTERNAL CONTROL CONNECTION
Figure 3: TYPICAL SVRJ6 FUSELESS RECTIFIER SCHEMATIC

Typical SVRJ6 Design Features:

1. Molded Case AC Circuit Breaker Input
2. Readily Visible “Power On” Indicating Light(s) warn when system is energized
3. Dual Winding, Dry-Type, Isolation Rectifier Power Transformer
4. SCR Bridge Assembly: Hermetically sealed SCR semiconductors mounted on extruded aluminum heat sinks
5. AC & DC Metal-Oxide Varistor Transient Surge Suppressors
6. Reliable Solid-State Regulation, Reference, and Triggering circuitry
7. DC Analog Output Meters
8. CBTRIP High-Speed Breaker Trip Circuit and Secondary Current CT Network
SVR6 Power Rectifier Bridge Description

The SVR6 power rectifier consists of six (6) SCRs connected in a 3-phase bridge configuration. Some rectifier designs also include freewheeling devices connected across the rectifier output to provide a commutating path for the SCRs and reduced current ripple.

The power semiconductors are protected against voltage transients and erroneous (dV/dt) triggering by a RC Snubber circuit on the AC side of the bridge, and by metal oxide varistors (MOV) on both the AC and DC sides of the bridge. Additionally, the DC output side normally has a heavy bleed resistor to create a conduction path to swamp small regenerative conditions and other transient conditions. (This same bleed resistor is used to discharge the filter capacitors when used).

SVR RECTIFIER POWER FUSES

Current limiting semi-conductor fuses on the input to the bridge provide short circuit protection of the rectifying elements.

CAUTION: -- DO NOT REPLACE THESE FUSES WITH OTHER THAN THE EXACT PART NUMBER FUSE SUPPLIED BY KINETICS. These fuses are specifically selected to match the current characteristics of the rectifying elements. Use of other fuses than those supplied may not protect the devices and would be a cause for voiding of warranties.

SVRJ regulated rectifiers are fuseless rectifiers that, under fault conditions, are designed to withstand fault currents until protection circuitry trips the AC Circuit Breaker. Removing or modifying this protection circuitry or changing to a different manufacturer or model Circuit Breaker may compromise the SVRJ protection coordination and is cause for voiding warranties.
ADDITIONAL OVER-CURRENT PROTECTION

SVR rectifiers are equipped with over-current protection in the form of solid-state Current Limit and IOC functions in the RF3 regulator circuit.

The RF3 Current Limit circuit automatically reduces the rectifier voltage output to limit current when the maximum DC output current set point is reached. The Current Limit circuit will control the rectifier output and limit output current as long as over-current load conditions exist, keeping the rectifier from exceeding this level of maximum current protection.

The IOC circuit (Immense Over Current) locks off the SCR triggers (disabling the rectifier output) in the event of a high di/dt fault. It will normally protect the unit even under normal fault or overload conditions. The IOC function “latches on” when triggered and has a red LED indicator on the RF3 circuit board to indicate it has tripped. To RESET the IOC and re-enable the rectifier output, it is necessary to cycle power (off and on) to the RF3 circuit that usually requires removing power from the rectifier.

INPUT PHASE SEQUENCE REQUIREMENTS

The standard Kinetics Industries 3-phase SVR rectifier is not dependant on a particular phase rotation at the input to the rectifier system. However, if 3-phase fan motors are provided in cases of forced enclosure ventilation, the input phasing is important for the proper fan rotation and direction of airflow through the enclosure.

CAUTION: The rectifier is not sensitive to input line phase rotation but it is necessary that the SCRs and their triggers are properly in phase. This is an internal control connection and, in the event of any field changes, it is important that this phase relationship be maintained.
SVR RECTIFIER VOLTAGE & CURRENT RIPPLE

The nature of a SCR controlled power supply is such that as the output voltage is decreased, the AC ripple on the DC output is increased. Ripple filtering networks are optional add on feature to the SVR designed and rated to specific to a customer’s requirements or an industry standard to a specific set of parameters. (The larger the number of “SCR pulse” configuration of the rectifier, the lower RMS and peak-to-peak ripple values.)

Rectifier output ripple can be defined in terms of the root mean squared (RMS) and / or peak-to-peak. The method of defining ripple is best associated with the requirements of the application.

**Root Mean Squared (RMS):** 100 times the ratio of the AC RMS value of the AC component of the rectifier output waveform divided by the maximum average DC value of the rectifier output waveform when feeding into a 100% resistive load.

**Peak-To-Peak:** The ripple amplitude is the maximum value of the difference between the average and the instantaneous value of a pulsating unidirectional wave.

There are two methods commonly incorporated to reduce output ripple:
I) A “Freewheeling” or commutating semi-conductor may be used to reduce current ripple when the SVR is used to supply highly inductive loads such as motor and generator fields or magnets. This free wheeling device is connected across the output of the rectifier bridge and allows the field discharge current to circulate when the SCRs are not conducting, thereby reducing the ripple on the output.
II) An Inductive-Capacitive (LC) Filter can be provided for other types of loads to reduce the SVR rectifier output ripple. CAUTION: Filter capacitors may retain charge after the rectifier is turned off. Before touching any electrical components, the capacitor bank output should be discharged by shorting the output.

*Graphic Displaying 3 Pulse vs. 6 Pulse vs. 12 Pulse SCR Regulated Rectifiers*
KINETICS SVR3 3-PULSE RECTIFIER

The SVR3 Regulated Rectifier is identical to the SVR6 except that it uses three (3) SCRs and three (3) diodes connected in a 3-phase hybrid bridge configuration with a 4th commutating or free-wheeling device if the load is expected to be anything other than purely resistive. With 3 SCRs instead of 6, the SVR3 requires only ½ of the associated SCR firing circuitry (TRIG3 circuits) but the result is a 3-pulse voltage output.

KINETICS SVR3 RECTIFIER

![Typical SVR3 Design Features]

1. Molded Case AC Circuit Breaker Input
2. Readily Visible “Power On” Indicating Light(s) warn when system is energized
3. Dual Winding, Dry-Type, Isolation Rectifier Power Transformer
4. SCR Bridge Assembly: Hermetically sealed SCR semiconductors mounted on extruded aluminum heat sinks
5. AC & DC Metal-Oxide Varistor Transient Surge Suppressors
6. Reliable Solid-State Regulation, Reference, and Triggering circuitry
7. DC Analog Output Meters
8. Optional Blown-Fuse Ind. Lights
9. Semiconductor-type Rectifier Power Fuses

Figure 4: TYPICAL SVR3 3-PULSE REGULATED RECTIFIER SCHEMATIC

Typical SVR3 Design Features:
Figure 5: TYPICAL SVRJ3 3-PULSE FUSELESS RECTIFIER SCHEMATIC

Typical SVRJ3 Design Features:

1. Molded Case AC Circuit Breaker Input
2. Readily Visible “Power On” Indicating Light(s) warn when system is energized
3. Dual Winding, Dry-Type, Isolation Rectifier Power Transformer
4. SCR Bridge Assembly: Hermetically sealed SCR semiconductors mounted on extruded aluminum heat sinks
5. AC & DC Metal-Oxide Varistor Transient Surge Suppressors
6. Reliable Solid-State Regulation, Reference, and Triggering circuitry
7. DC Analog Output Meters
8. CBTRIP High-Speed Breaker Trip Circuit and Secondary Current CT Network
**SVR REGULATOR REFERENCE (RF3) CIRCUIT**

SVR Rectifier output and SCR triggering control is incorporated into several different Kinetics PC boards. The RF3 Regulator circuit provides output control of the SVR and the TRIG3 are trigger generator circuit boards.

The RF3 regulator circuit serves as the reference source, signal mixing circuit, error amplifier and over-current protection circuit for the SVR rectifier. A Zener-regulated voltage (nominal 20VDC) is used as both the error amplifier power bus and as an internal reference voltage source for the regulator. When used as a reference source, this Zener voltage is applied to an external Output Adjust Potentiometer (points 4 & 22) with the potentiometer wiper voltage used as the reference control value (points 6A & 22).

**RF3 Regulator Circuit Adjustments – Adjusting the SVR Output Performance**

The feedback signal to the regulator is taken directly from the rectifier output or an output controlled signal. This feedback signal is interjected in the regulation circuit at points 9 and 10 in voltage-regulated systems. The SVR rectifier maximum DC output is adjusted using the MAX (P3) Pot that coordinates the voltage feedback signal with the input reference signal for proper driving of the error amplifier, transistor Q1.

The LO (P1) Pot on the RF3 circuit provides a biasing adjustment of the lower end of the output range of operation, (sets the SVR output level for zero reference input).

*Figure 6: TYPICAL RF3 REGULATOR SCHEMATIC*
RF3 REGULATOR REFERENCE CIRCUIT (continued)

An external reference signal can also be used in place of the internal Zener voltage to allow the unit to track with a remote signal. (An optional 0-10V, 0-20mA or 4-20mA interface can be supplied to co-ordinate with external signals)

The rectifier is provided with a controlled ramp or output acceleration circuit that provides a soft ramp of the rectifier output (on and off). The ACCEL (P9) Pot adjusts the time constant or the RC network consisting of R1, R34, ACCEL, and capacitor C1. The “ACCEL” rate can be adjusted using the ACCEL pot or, for larger changes, by changing the capacitance C1 - (More capacitance slows the acceleration). An optional Linear Acceleration Module (LAM) package, with separately adjustable “ACCEL” (ON) and “DECEL” (OFF) rates, is also available.

When power factor control or some other external signal is provided, the output of the power factor or phase angle sensing circuit is interjected at the summing junction of the error amplifier at TP3. This “power factor” signal is used as a vernier to the reference signal to maintain the rectifier output at the desired power factor value.

The output of the error amplifier (Q1) is applied to the trigger circuit input to adjust the SCR triggers in response to the variable or regulated output of the RF3 circuit thus regulating the rectifier output.

OTHER REGULATOR ADJUSTMENTS

The Kinetics SVR Rectifier systems are usually provided with factory calibration per customer specification. These factory settings should not normally be changed unless, during setup, the unit does not initially track to the desired output range.

LO Pot – Adjust SVR rectifier minimum output to 0% reference value (normally 0 output)
MAX Pot - Adjust SVR rectifier maximum output value at 100% reference signal

The LO Pot will adjust the slope of the rectifier response curve. The MAX pot will adjust the proportionality of the response. Standard tracking procedures using alternate min-max adjustment iterations should be used to calibrate the output range of the rectifier.

The STAB (P10) Pot (stability) on the RF3 circuit directly affects the stability time constant of the regulator. The STAB Pot may need adjustment to correct for output instability depending on the characteristics of the load being supplied by the SVR rectifier. If rectifier instability occurs, mark the present setting of the STAB pot and then adjust. NOTE: An improved stability point may be found with an adjustment in either a CW or CCW direction.

The SENS Pot (sensitivity) has been factory adjusted and sealed.
The SENS Pot has been adjusted to achieve optimum regulation and stability. Under normal conditions it should not be field adjusted as tampering with this adjustment can lead to stability problems with attendant warranty voiding.

The CL Pot has been factory adjusted and sealed - DO NOT FIELD ADJUST
The IOC Pot has been factory adjusted and sealed - DO NOT FIELD ADJUST

TRIG3 CIRCUIT - SCR TRIGGER FIRING CIRCUITS

The TRIG3 Circuit boards serve as the source for firing triggers to the SVR rectifier bridge SCRs that control the output. These trigger circuits use a 3-phase AC input that is synchronized with the 3-phase power to the SVR Bridge, along with a regulator output signal from the RF3 reference circuit, to generate precisely timed firing signals to the gates of three SCRs. Each TRIG3 circuit board includes a 3-phase, dual secondary, transformer feeding 3 discrete and isolated firing circuits. In addition to power and signal synchronization, the transformer provides isolation between the regulator circuitry and the power bridge portion of the SVR rectifier.
SVR3 rectifiers have one (1) TRIG3 circuit while SVR6 rectifiers have two (2) similar but not identical TRIG3 circuit boards. The two SVR6 TRIG3 boards (-CA, -CK) have different internal connections and cannot be interchanged. The SVR6 (CA & CK) boards are factory-balanced as a pair and should be replaced as a set with care being taken to ensure the boards are properly located and connected.

The TRIG3 circuits consist of 3 individual phase trigger pulse generators, which feed optical couplers to create isolated power SCR triggers for each rectifier SCR. The trigger pulse generators are ramp and pedestal circuits to provide the SCR trigger phase control. The output of the RF3 circuit provides the pedestal, which adjusts the pulse position of the amplifier. The output of each trigger pulse generator is placed on an isolating optically coupled SCR that, in turn, fires the trigger pulse amplifier. This trigger pulse amplifier output provides an isolated SCR trigger of the proper phasing to control the SCR output. (Longer phase delay means shorter SCR conduction time and thus lower regulator output.

- **Balanced Output and Presence Of Firing Signals To SCRs From The TRIG3 Circuit: LEDs**

Three LED’s are provided on the TRIG3, three phase – three pulse, circuit card to provide a visual indication of the triggering signals to each SCR being fired. If the circuit is operating properly and all three SCRs are functioning properly, all three LED’s should be approximately the same light intensity from 0 to 100% output adjustment of the rectifier. An imbalance in LED light illumination is an indication of a unit performance problem, such as a blown SCR power fuse, an SCR failure, problem with the TRIG3 circuit board or loss of an AC input phase.
Trigger Circuit Adjustments

There are six potentiometers on the TRIG3 circuit boards (two per channel) to adjust the tracking of the trigger circuits and balancing the system output. These adjustments have been factory set and the potentiometers sealed. They should not be field adjusted by untrained personnel. Doing so can void regulatory warranties. The two SVR6 TRIG3 circuit boards (CA & CK) are factory-balanced as a pair and should be replaced as a set with care being taken that replacement circuit boards pairs are installed in the exact orientation as the original pair.

COMMON CIRCUITRY OPTIONS FOR SVR REGULATED RECTIFIERS

CBTRIP Circuit Module
The CBTRIP is a versatile high-speed circuit breaker trip circuit. This solid-state controlled module can be used with a wide variety and range of inputs (both AC & DC Volts and Amps) to provide a trip signal to an external Circuit Breaker Trip Coil. It can be set-up to provide an instantaneous or time delayed trip to remove power from the SVR system in the event of a fault condition. The CBTRIP circuit is normally used in the Kinetics SVRJ type fuseless rectifiers.

FLR DC Sensing Relay Circuit
The FLR1M2 board is a solid-state controlled relay circuit with pick up and drop out points that are very close together making it an ideal low signal Voltage sensing circuit. The FLR circuit is able to operate at DC signal levels in the milli-Volt range allowing the circuit to operate over a wide range of voltages. The Circuit typically uses the input from a DC current shunt or transducer to indicate the presence of a minimum threshold current (ie. Field Loss Relay) but it can be configured to operate at most any level of input Voltage for a variety of functions.

(LAM) Linear Acceleration Module Circuit
The Linear Acceleration Module circuit is an optional module for the RF3 regulator circuit to provide adjustable linear ramping reference signal. The LAM circuit limits the rate of change of the SVR rectifier output regardless of how quick the change at the reference signal input (Output Adjust Pot or External Reference Source). The LAM circuit provides independent adjustments for the rate of increase AND decrease of the SVR regulated output but otherwise does not affect steady state SVR operation.

ISO-BAL Load Sharing Control Circuit
The Kinetics ISOL-BAL load sharing control system allows multiple Voltage-regulated rectifier systems to operate in parallel and maintain an acceptable load sharing between the units. Small differences in Voltage regulated systems tend to create large “load hogging” differences between paralleled voltage supplies feeding a common bus. The Kinetics ISOL-BAL system provides circuitry to enable the dynamic sharing of the bus load between multiple sources depending on the size of the individual voltage supplies. The ISOL-BAL system also provides complete electrical isolation between the control signals of the different power supplies so the voltage regulators maintain the electrical isolation of their respective control systems.

Power Factor Signal Transducer
The Power Factor Signal Transducer and relay provides a means of monitoring the power factor of an electrical circuit (motor) and providing a proportional output signal that can be used to control the output of a Kinetics SVR Regulated Rectifier. The PF Transducer is commonly used with SVR Rectifiers that are providing excitation for synchronous motors thus providing a means for maintaining a particular motor power factor despite changing environmental or load conditions. The PF Transducer requires external PT and CT signals from the motor switchgear for proper operation.
Select-A-Pick – Type SVR Rectifiers
The Kinetics “Select-A-Pick” SVR rectifier voltage control system uses remote contacts to select different pre-set Voltage output levels, allowing a customer to selectively charge a magnet to one of several pre-programmed discrete values for the "pick" process of the magnet lift. This allows a customer to customize the SVR outputs for the different “magnet strengths” required by their individual process.

The Select-A-Pick system is designed to be a complete solid-state magnet controller. This magnet control system is designed to initially “Flux-Force” the rectifier FULL ON for a short time before switching to the selected "pick" voltage - (This full voltage period is used to decrease magnet charging time and thereby process cycle times). An operator would then perform his lift while the system maintains the selected "pick" voltage output. After completing the lift the operator must switch the magnet to full volts prior to any crane movement to secure the load on the magnet and prevent possible shifting or dropping of the load. The SVR system output then stays at full volts until drop. The Select-A-Pick magnet control system is available in either SVR or SVRJ configurations.

CDRC (Clean Drop Reverse Current) Modules are provided for Select-A-Pick Rectifiers when a clean drop is required by the customers’ system process. The CDRC applies reverse current to the magnet to drive the residual magnetic flux to zero or slightly negative to allow for demagnetization of the load.

SMOP – Static (Digital) Motor Operated Potentiometer Module
The SMOP Control Module is an electronic (digital) version of a motor-operated potentiometer, an output control device that uses Up and DOWN push buttons to raise or lower the SVR output. The SMOP is used in place of the system Output Adjust Potentiometer to return the Reference (operating point) signal to the RF3 Regulator Circuit. This module is commonly used to allow remote PLC contacts or push button controls to raise and lower the SVR output.

RGA – Regeneration Absorption Circuit
The Kinetics Regeneration Absorption Circuit, or "RGA", is used to provide a dissipating path for regenerative energy from the load. Regeneration occurs in motor drive systems, when the load overhauls and drives the motor faster than the base speed set by its armature and field volts, or in highly inductive systems by the reversal of the inductive load. A diode or SCR type rectifier, by its nature, does not have any means of absorbing this regenerative power.

Regeneration typically occurs in cranes and elevator systems, or variable speed DC motors drives in applications such as machine tools or calandering systems. Typical inductive load regeneration occurs in cases like the polarity reversal of electro-magnets. If this regenerative power is not dissipated, the bus voltage can increase to sometimes-dangerous levels with danger of rectifier semiconductor failure, blown rectifier fuses and DC surge suppressor failure. DC surge suppression devices are often the first to fail but motor commutator arcing and field coil failures can also be attributed to high regenerative voltage conditions.

Standard Duty RGAs are rated for a normal operation of 5 sec. out of 80 with a maximum of two successive operations for every four cycles. Continuously Repetitive duty RGAs are sized to operate repetitively with no limit to number of consecutive cycles. Continuously Repetitive duty RGAs are recommended for elevator and multiple crane mill duty.

The circuit uses a voltage-sensing device to sense when the DC bus voltage exceeds a pre-set voltage level (normally 115 to 116% of rectifier rated output volts). When the bus voltage exceeds this threshold level, a regenerative power absorption load resistor is applied directly across the rectifier output for a fixed period of time (normally 5-10 sec.). If, at the end of this time period, the bus voltage has not dissipated to a level below the preset voltage, the control picks up a second time and continues to repeat until the regenerative power is dissipated. The RGA is sized in KW and sizing is based on the type of load.
Figure 8: TYPICAL RGA SCHEMATIC AND CONNECTION

STANDARD RGA CIRCUIT OPERATION

When the SVR Rectifier (DC Bus) is energized, Voltage is applied to the RGA controls and the TD Relay on the RGA PC board is energized and picks up. At the same time, Power is also applied to the RGA Load Contactor (RB) through the series-dropping resistor RP. The variable-resistance RP Resistor is adjusted so that, under normal operating voltage conditions, the coil current through the RGA RB Contactor is insufficient to pick up the contactor. The RB Contactor becomes the RGA Voltage-sensing device where, as regeneration raises the DC Bus Voltage to a predetermined increased voltage, the proportionally higher coil current picks up the RB contactor, connecting the RGA Load Resistor across the DC Bus to dissipate the regenerative power. Resistor RP is adjusted so that the RB contactor picks up at the desired predetermined voltage.

When the RB Contactor picks up, DC Bus power is applied to the RGA Load Resistor and the A Relay (in the RGA controls circuit) simultaneously. A set of A Relay contacts short out the RP Resistor applying full bus volts to the RB coil providing adequate wiping action to assure clean make and break of the power contacts. A second set of A Relay contacts (NC) opens the coil circuit to TD Relay. The TD Relay temporarily remains energized by the capacitor discharge current of caps C through TD coil (time is approximately 5 sec.). When TD Relay drops out, The RB Contactor is de-energized, disconnecting the RGA Load Resistor and de-energizing the A Relay. When the A Relay drops out, the A Relay (NC) contacts re-establish the circuit to the TD coil circuit. A small time delay in the TD Relay pickup, due to the charging of Capacitor C, allows time for the rest of the circuit to reset.
SVR RECTIFIER INSTALLATION

WARNING – CAUTION - HAZARD!

- Hazard of electrical shock, burn or explosion.
  - Electrical equipment must be installed and serviced only by qualified electrical personnel.
  - Turn off all power supplying equipment before working on or inside equipment.
  - Always use a properly rated voltage sensing device to confirm power is off.
  - Replace all devices, doors and covers before turning on power to equipment.
  - Ground equipment per the National Electric Code.
  - Replacement parts must comply with the equipment manufacturer’s requirements. Refer to the equipment nameplate and unit specific bill of material included within the unit instruction manual.
- Combustion Hazard: Ensure that equipment enclosure has sufficient space between ceiling and enclosure, unless adequate heat shield is provided.
- Accidental Equipment Operation:
  - Provide adequate, clear working space operator control stations.
  - Guard or locate control station so it is not subject to accidental actuation or damage.
- Failure to follow these instructions can result in death, serious injury, or equipment damage.

MECHANICAL INSTALLATION:
The Rectifier is a static device, having no moving parts; therefore fastening down the system enclosure is not normally required for successful normal operation. However, bolt down holes are normally provided in the rectifier feet.

Normal ventilation of a KINETICS rectifier has the air inlet at the base of the rectifier and air discharge at the top, (on the sides, front, and rear). Consideration should be given to location of the rectifier so that an adequate supply of clean air is available for convection cooling. Areas around the rectifier enclosure should be free of any obstructions. Do not block the air inlet OR discharge areas.

IMPORTANT NOTE: If the rectifier system is to be installed in a forced-air cooled environment, care should be taken that cold air is not fed to the top of the SVR enclosure. Cold air delivered in this manner can create a temperature inversion that interferes with the normal convection airflow through the enclosure and interrupts the normal equipment cooling. Before installing as SVR in a pressurized ambient, no matter how minimal, contact Kinetics for a copy of an engineering bulletin on the subject.

When SVR systems are delivered in an “Open Panel” configuration, for installation in existing switchgear or control cabinets, the customer is responsible for ensuring that adequate ventilation is available to provide proper cooling for the SVR Transformer, Power Bridge, and controls.

ELECTRICAL INSTALLATION:

HAZARDOUS VOLTAGE: Power rectifiers present a risk of hazardous electrical shock, burns or an electrical explosion if proper safety precautions are not strictly followed. Confirm that input power to the unit is OFF prior to servicing. Failure to follow this instruction will result in death or serious injury.

Standard SVR rectifiers require only a 3-phase power feed of adequate capacity conductor. If the rectifier enclosure has fans, phase rotation should be checked to see that the enclosure fans are running in the proper direction.

All electrical wiring should be done in accordance with local and national wiring codes by professional installers. Care should be taken that installed cabling does not interfere or block normal airflow into, out of, or through enclosure.
  - AC input cable should be a minimum of 75°C cable and sized for at least 125% of full load nameplate rating.
  - DC output cable should be a minimum of 75°C cable and sized for at least 125% of full load nameplate rating.

Kinetics enclosures typically allow for top, bottom or side entry of power and/or control cabling. Top or side penetrations into the systems enclosures should be properly sealed to prevent the entry of water into the enclosure. Consult local and national wiring codes and the Outline and Internal Layout Drawings specific for your system for guidance in determining required cable bend radiiuses and allowable enclosure entry points.
System enclosures should be properly grounded in accordance with local and national wiring codes. All Kinetics enclosures include designated grounding locations. Metal conduit mechanical connections should NOT be considered adequate as a system ground connection.

Kinetics recommends that all control wiring be run separate from power cabling. Control wiring should not be run in parallel to power cabling. To minimize the effects of electronic noise with remote controls and annunciation, shielded control wiring should be used with the shield grounded only at the rectifier end.

Paralleling of rectifiers and/or motor generator sets, installation/application concerns: Paralleling a regulated rectifier with, diode rectifiers, other regulated rectifiers and motor generator sets is accomplished with little difficulty provided some elementary installation concepts are applied.

- Rectifiers do not have the problem of one rectifier backfeeding into another rectifier, as is a common application problem with motor generator sets. Rectifiers inherently block reverse current.
- A properly designed and manufactured rectifier unit will have all power paths with equal circuit impedances. Thus, if the input and output impedances from the power nodes are identical, the units should adequately current balance.
- The rectifier should be fed from a common power source and the same phase cables to each rectifier should be of the same cross sectional area and length. Similarly, the output cables from the rectifiers to the common power node should be the same size and length.
- Although there will be no power disruption if AC input phasing rotation is not the same to other parallel rectifiers and/or MG sets, the best current load sharing will be obtained when the same AC phasing rotation relationship is maintained to all paralleled rectifier and/or MG sets.
- The rectifier should be fed from a common power source and the same phase cables to each rectifier should be of the same cross sectional area and length. Similarly, the output cables from the rectifiers to the common power node should be the same size and length.
- As an industry standard, the power transformer with a rectifier unit has voltage adjustment taps. To obtain proper “balance”, the transformers within parallel rectifier units should all be on the voltage tap connections.
- If the above criteria can’t be readily achieved or the cost of meeting the criteria is prohibitive, yet maintaining load balancing – current sharing between parallel power units is required or desirable, Kinetics offers the installation of our ISO-BAL LOAD SHARING CIRCUIT as a solid state control solution.

PRIOR TO ENERGIZING:
1. Confirm that input power service is the correct voltage and phase configuration for the SVR rectifier.
2. Perform a thorough visual inspection of the equipment with attention paid to inspecting for damage that may have occurred during installation. Check for tools, wire scraps, or jumpers that may not have been removed.
3. Check that all power and control connections are mechanically sound and correct per System Electrical Drawings and the SVR terminal connections.
4. Check that all power and control fuses are in place. Check all relays and contactors are free to operate.
5. Check that the input and output cabling has been inspected for short circuits or grounds (Do not Megger or Hi-Pot the line with the SVR rectifier connected). If this check has been previously performed during installation then a test with an Ohmmeter should be an adequate last check before energizing the equipment.

🌟 CAUTION – WARNING – HAZARD!
Equipment Operation Hazard:
- Verify that all installation and set up procedures have been completed.
- Before operation tests are performed, remove all blocks or other temporary holding means used for shipment from all component devices.
- Remove tools, meters and debris from equipment.
Failure to follow these instructions can result in damage to the rectifier, serious personal injury or death.
APPLICATION NOTES ON INSTALLATION OF CONVECTION COOLED AND CONVECTION AIDED UNITS IN FORCED VENTILATED AND/OR AIR CONDITIONED ENVIRONMENTS

KINETICS utilizes convection cooled and convection aided designs in the rectifiers they manufacture to provide highly efficient, relatively maintenance free, low noise, simplistic conversion devices. The design, when used in free air environments, utilizes convection air flow to effectively convey the heat generated in the equipment to the free air without the nuisance noise and maintenance problems of forced air cooling. Because the air flow is very low (in the order of 75 to 100 linear feet per minute - approx 1.14 mph air flow) the transformers and semiconductors are designed or selected for lower losses creating a more efficient system.

However, for this cooling system to function, it is required that the ambient air environment be a free air system or provisions be made to the forced air environment to assure that sufficient cooling air flows through the rectifier.

Care must be taken when installing electrical equipment in forced air or pressurized environments that the artificial air flow created by the forced air environment does not negate the normal air flow through the equipment thus, locking the heat generated into the enclosure and/or internal electrical components. It is very possible to have a cool room and create an overtemperature condition in the equipment and/or internal components at the same time.

The adjacent figure shows the normal convection air flow of a standard KINETICS convection cooled or convection aided rectifier.

In normal air flow, the cool air enters the enclosure through the screen floor of the enclosure and exhausts through the vents at the top creating a chimney effect. Restriction of this air flow by either mechanical blockage or high environment pressure will create overheating of the equipment.

Cooling of electrical equipment differs from comfort cooling in that it is essential, for proper cooling, that the cool air inlet into the room be not greater than 1 foot above the base of the electrical enclosure and the warm air exhaust be higher than 1 foot above the enclosure exhaust vents. Cool air delivered above these levels can create inversion layers which will effectively null out
convection air flow. Similarly, high positive or negative room pressures can stop the convection air flow which is in the general range of .025 to .05 inches of water column. Normal ambient pressures generated in air conditioned or forced ventilated rooms range from .25 to .5 in of water column (magnitudes of 10:1 times convection velocity pressures).

The sketches below show possible acceptable and unacceptable air flow systems for cooling electrical convection cooled equipment. The most effective means of providing assurance that the proper air flow is achieved is to duct the cooling air inlets directly under the electrical enclosures.

Another method of obtaining adequate flow-through air in forced air environments or pressurized ambient is to install air forcing fans in the top of the cabinets of sufficient capacity to assure 200 to 300 LFM of air through the cabinet under whatever ambient pressure conditions exist. The fan selection is a function of the air system which can be quite complex. Properly installed systems normally do not exceed .5 inches of water column above free air. The fan should be selected with capacity to overcome this pressure and deliver adequate volume to achieve the desired linear feet per minute air flow thru the rectifier.

There must be adequate clearance above the fan discharge (a minimum of 3 diameters before any obstruction) and the air inlets at the bottom of the enclosure must be unobstructed (a minimum of 3 feet on all sides of the enclosure).

Kinetics cannot honor warranty claims for overheating if the above criteria is not met.

aircond.des 391370 rhs
SVR RECTIFIERS IN SYNCHRONOUS FIELD EXCITATION APPLICATIONS

**Caution** must be taken when using an SVR rectifier as a synchronous motor exciter. When a synchronous motor is started it typically experiences extremely high, induced voltages in the field. These high voltages are normally limited by shunting the energy to a Field Discharge Resistor until the motor is up to speed and ready to have the field excitation applied. Synchronous motor field application control circuits supervise the sequence to excite the motor field and disconnect the Field Discharge Resistor when the induced voltages are low enough that no damage will occur when transitioning.

It is not uncommon to have this transition point set improperly to where the field application circuit picks up too soon while potentially damaging voltages are still present in the field circuit. THIS CONDITION CAN CREATE DESTRUCTIVE TRANSIENT SURGES THAT CAN SHORT DIODES AND SCRs, BLOW FUSES AND THE DC SURGE SUPPRESSORS. A rotating-type exciter system, being a softer system, may be able to cope with this problem for a while but the solid-state equipment will not tolerate this incorrect application condition. Indeed even rotating type exciters with a history of commutator problems typically have this problem as a root cause.

Kinetics recommends that, prior to connecting the rectifier, a test be performed to determine that the field application circuit does not pick up prior to the AC line current drop-off as the motor comes to speed. If the control picks up too soon, adjust the pick up point prior to installing the rectifier. Most synchronizing panels are easily adjusted. Look for either a potentiometer or slide wire resistor in the field discharge circuit.

KINETICS DOES NOT WARRANTY THE RECTIFIER AGAINST IMPROPER FIELD APPLICATION ADJUSTMENTS OR DEFECTIVE CONTROL SYSTEMS.

**Synchronous Motor Power Factor Control**

Kinetics SVR synchronous exciters are available with a power factor control option that allows the exciter to vary it’s DC output to maintain a given power factor operating point through changes in load conditions and/or supply voltages. This circuit option uses motor PT and CT signals to generate a motor power factor (error) signal to the regulator circuit. When the motor is running synchronized the regulator uses this vernier signal to vary the SVR output to compensate for a change in power factor.

**How to adjust an SVR Rectifier Exciter to other than 1.0 Power Factor:**

The nature of the Kinetics Power Factor control is such that 1.0 (unity) power factor corresponds to a 0.0 Volt error signal. This configuration allows for ideal operation at unity power factor. To operate at a non-unity power factor an operator need only to vary the excitation operating point using the SVR Output Adjust Potentiometer. If there is difficulty adjusting the SVR to other than 1.0 Power Factor, the Power Factor Adjust potentiometer (signal strength) may be set too high. Try adjusting as follows:

With the motor synchronized and FULLY loaded:

Turn the Output Adjust Potentiometer full CW, if the power factor is acceptable no adjustments are needed; If the power factor is too low, (i.e. you want 0.8 PF lead and only get to 0.9 PF lead) then do the following: With Output Adjust Potentiometer full CW, turn the Power Factor Adjust potentiometer CCW to decrease the power factor signal sensitivity. To operate at 0.8 PF lead, adjust this Power Factor Adjust Pot for an approximate motor PF of 0.7 lead. Leaving the Power Factor Adjust Pot alone, then adjust the Output Adjust Pot CCW until you get the desired 0.8 PF.

You are now set properly and should have some adjustment of the Output Adjust Pot left for vernier trim adjustment. The motor operating point can now be adjusted anywhere up to 0.7 PF lead (or to a substantial lagging power factor) by varying the Output Adjust Potentiometer.
PERIODIC MAINTENANCE SCHEDULE

A Rectifier is a static device requires only maintenance for cleanliness and calibration. A rigorous maintenance program will reduce energy consumption in rectifiers by keeping temperature-sensitive components cool. Caution should always be taken when working in and around energized equipment. Equipment should be de-energized prior to any maintenance and only qualified personnel should perform maintenance on electrical equipment.

### INSPECTION PERIOD
#### PERIODIC MAINTENANCE ACTIONS

| Every one (1) month | 1. Check for airflow obstructions in and around SVR rectifier.  
|                    | 2. Any air inlet and outlet filters should be checked and replaced if needed. |
| Every three (3) months | 1. Check cooling fans for excessive noise and proper airflow |
| Every six (6) months | 1. Check all electrical connections for corrosion and loose connections  
|                     | 2. Clean or tighten connections found to be corroded or loose. |
| Every twelve (12) months | 1. Check the calibration of meters and check inside of SVR units for dirt and corrosion.  
|                          | 2. Check external potentiometers for smooth resistance from zero to full output |

**Spare Parts:**
Kinetics strongly recommends that customers keep a supply of spare parts on hand for support of operation of the SVR rectifier. Although Kinetics maintains a stock of parts for immediate shipment, it is possible that a part might be out of stock at a given moment of need. Critical recommended items, as a minimum, include: all fuses, AC surge suppressors, DC surge suppressors, semi-conductors (one SCR and one diode) and one spare of each circuit board. Although low in probability, the unit’s isolation dry type transformer is the longest repair or replacement lead time item. If an application is critical and the rectifier can’t be out of commission while a transformer is repaired or placed, Kinetics recommends the purchase of a spare be purchased.
FIELD TESTING SCR DEVICES (Thyristors)

Elementary “Basic” First Stage Field Testing For Device Functionality:
A basic test of SCR function, or at least terminal identification, may be performed with an ohmmeter or megger. Because the internal connection between gate and cathode is a single PN junction, a meter should indicate continuity between these terminals with the red test lead on the gate and the black test lead on the cathode. All other continuity measurements performed on an SCR will show "open". It must be understood that this test is very crude and does not constitute a comprehensive assessment of the SCR. It is possible for an SCR to give good ohmmeter indications and still be defective. Ultimately, the only way to test an SCR is to subject it to a load current.

Elementary, Second Stage Evaluation, SCR Field Testing Module:
The test circuit for an SCR is both practical as a diagnostic tool for checking suspected SCRs and also an excellent aid to understanding basic SCR operation. A DC voltage source is used for powering the circuit, and two pushbutton switches are used to latch and unlatch the SCR, respectively:

Actuating the normally-open "on" pushbutton switch connects the gate to the anode, allowing current from the negative terminal of the battery, through the cathode-gate PN junction, through the switch, through the load resistor, and back to the battery. This gate current should force the SCR to latch on, allowing current to go directly from cathode to anode without further triggering through the gate. When the "on" pushbutton is released, the load should remain energized.

Pushing the normally-closed "off" pushbutton switch breaks the circuit, forcing current through the SCR to halt, thus forcing it to turn off (low-current dropout).

If the SCR fails to latch, the problem may be with the load and not the SCR. There is a certain minimum amount of load current required to hold the SCR latched in the "on" state. This minimum current level is called the holding current. A load with too great a resistance value may not draw enough current to keep an SCR latched when gate current ceases, thus giving the false impression of a bad (un-latchable) SCR in the test circuit. Holding current values for different SCRs should be available from the manufacturers. Typical holding current values range from 1 milliamp to 50 milliamps or more for larger units.
FIELD TESTING DIODES – TESTING A DIODE WITH A MULTIMETER:

The techniques used for each type of meter are very different so they are treated separately:

**Testing a diode with a DIGITAL multimeter**

- Digital multimeters have a special setting for testing a diode, usually labelled with the diode symbol.
- Connect the red (+) lead to the anode and the black (-) to the cathode. The diode should conduct and the meter will display a value (usually the voltage across the diode in mV, 1000mV = 1V).
- Reverse the connections. The diode should NOT conduct this way so the meter will display "off the scale" (usually blank except for a 1 on the left).

**Testing a diode with an ANALOGUE multimeter**

- Set the analogue multimeter to a low value resistance range such as × 10.
- It is essential to note that the polarity of analogue multimeter leads is reversed on the resistance ranges, so the black lead is positive (+) and the red lead is negative (-)! This is unfortunate, but it is due to the way the meter works.
- Connect the black (+) lead to anode and the red (-) to the cathode. The diode should conduct and the meter will display a low resistance (the exact value is not relevant).
- Reverse the connections. The diode should NOT conduct this way so the meter will show infinite resistance (on the left of the scale).
Procedure For Changing Semiconductors In Power Heat Sink Modules

This procedure, when followed step by step, will enable you to quickly and easily interchange a hockey puck type semiconductor device used in a power module. The procedure also allows servicing personnel to regain the factory preset torque levels on the clamping bolts to obtain the desired clamping pressure on the semiconductor device.

Necessary tools include a 7/16 socket wrench for the clamping bolts. If the devices to be changed are SCRs, then a screwdriver will also be required to remove and reconnect the cathode and gate terminals to the trigger terminal strip. A clean wiping cloth, some conductive, thermal, non-oxidizing grease as used for semiconductor mounting and an ohmmeter for testing continuity and shorts should also be available.

Figure 1 shows a semiconductor power module as it may be found in a typical rectifier or drive system.

The first step towards changing the device is to remove the air ducts which are attached to the heatsinks' front and sides with snap fasteners. The duct material can be released from the fastener by grasping the ducting material with the thumb behind the material and the forefinger on the tip of the fastener and squeezing, thus forcing the fastener through the hole in the ducting material as shown in figure 2.

If the semiconductors are SCRs, remove the gate and cathode leads from the trigger terminal strip at this time.

Using the 7/16 socket wrench, back off exactly 5 complete 360 degree turns on both clamping bolts as shown in figure 3. (It is important that the number of turns be exact.)

Note: An alignment mark has been placed on the clamping bolt head and heatsink so that the two can be exactly realigned easily. Loosening the bolts 5 turns will provide sufficient slack between the heatsinks for the device to be removed.
Using both hands, hold the upper heatsink in one hand and remove the device with the other, as shown in figure 4. The device may seem to stick to one of the heatsinks. This is normal, but a small amount of pressure will dislodge the device and allow easy removal.

Before installing a new device, check for proper polarity. It is normal for the devices to be installed differently in the modules where the continuous heatsinks can be both positive and negative. Look at the arrow on the device. The arrow points toward the cathode of the device or toward the more positive heatsink. One or both of the heatsinks for the device will be identified as positive or negative (+ or -).

i.e. If the long heatsink is marked +, then install the device with the arrow pointing toward the long heatsink. Conversely, if the long heatsink is marked -, install the device with the arrow pointing away from the long heatsink.

Caution: Improper polarity can create destructive short circuits.

Insert an exploratory finger between the heatsinks and locate the locating pin which will usually be found on the long heatsink. This pin will enable the device to be accurately positioned by slipping the hole in the center of the device over this pin.

Prepare the device for insertion by wiping both faces of the device with a clean cloth. Lightly lubricate the face of the device with a conductive, thermal, non-oxidizing grease and then lightly wipe the faces again so that only a thin film remains.

Holding the top heatsink with one hand, insert the device, being sure that (A.) the device is being installed with the proper polarity and (B.) that the locating pin is placed in the centering hole of the device. This is shown in figure 5.

Figure 6 shows the clamping bolts being retightened. It is important that the bolts be tightened alternately. We suggest that the following sequence be followed:

<table>
<thead>
<tr>
<th>Bolt #1</th>
<th>Bolt #2</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.0 turns then</td>
<td>3.0 turns then</td>
</tr>
<tr>
<td>1.5 turns then</td>
<td>1.0 turns then</td>
</tr>
<tr>
<td>1.0 turns then</td>
<td>1.0 turns then</td>
</tr>
<tr>
<td>.5 turns</td>
<td></td>
</tr>
</tbody>
</table>

Be sure that the markings on the clamping bolts are aligned with the heatsink marks. The bolt torque will now be within 2% of the original setting.

It is good practice to now test between the heatsinks with an ohmmeter to be sure that the insulation on the clamp has not been damaged or that the semiconductor is not faulted. (It is unheard of that a new semiconductor which has not been put under pressure will fail upon applying the necessary clamping pressure which ranges from 750 lbs for small devices to 5000 lbs for larger devices). The fuses should also be tested for continuity.

If the device is an SCR, reconnect the cathode and gate leads to the trigger terminal strip. Now reinstall the air ducting.

Manufacturing Concept:
To provide the customer with prompt deliveries and the highest quality products, Kinetics is a self-sufficient manufacturing facility containing:
- Production of rectifier and control assemblies.
- Design and assembly of printed circuit boards.
- Design and manufacture of power transformers - core & coil.
- Design and fabrication of enclosures.
- Unit operational testing facilities.

Being a self-contained manufacturing facility enables Kinetics to design and manufacture power systems to a customer's application requirements at competitive pricing with prompt deliveries.
### TROUBLESHOOTING GUIDE:

| No Rectifier Output | 1. Check for Tripped AC Circuit Breaker – Breaker trips can result from overloads, single-phasing/unbalanced AC power, inadequate ventilation, poor electrical-mechanical connection at breaker lugs, loss of cooling - If tripped: check any shunt trip devices (Heat Sink or Transformer Winding thermal cutout switches) or for problems with ventilation or airflow; Also check for indications of overload conditions that might result in breaker trip  
2. Check 3-Phase AC input to SVR - (All 3 Phases energized?)  
3. Check for blown Rectifier Power Fuses - (Ind. Lights?) – All blown fuses should be investigated for a cause prior to restoring power to SVR system. Note the warning in SVR description section about matching fuse types and ratings.  
4. Check for Loss of Control Power - (Lights on?, blown fuses?)  
5. Check for IOC over-current protection circuit operation – (Red LED annunciation on RF3 regulator board) This function is reset when control power is removed from RF3 circuit. Note: an IOC trip is usually indicative of a fault (short circuit or mechanical jam) and should be investigated prior to re-energizing output.  
6. Loss of Reference Signal – (the RF3 regulator circuit uses a reference signal to set the output level) - a bad reference, signal, low or missing, can yield zero output. Check for bad Output Adjust Pot or failed external reference source; Check for continuity between reference control (Output Adjust Pot or external ref) and RF3 circuit; RF3 circuit components should be visually checked for indications of over-heating or open circuits – (failed RF3 circuit components can result from power surges due to excessive regenerative voltages or outside power disturbances) |
| SVR Output “Full ON” Not Adjustable | 1. Check for feedback (Voltage or Other) signal to RF3 regulator circuit – If feedback signal is missing or too low, the RF3 circuit will respond by increasing the SVR rectifier output.  
2. Check Reference Signal input - (the RF3 regulator circuit uses a reference signal to set the output level) - a bad reference signal, too high, can result in an erroneously high output  
3. Bad TRIG3 circuit(s) - TRIG3 circuits vary their output supervised by a signal from the RF3 circuit (0.75V-1.75V 3-pulse output & 1.5V-3.5V 6-pulse) – if this RF3 signal voltage is low, or within the normal range, then the TRIG3 circuits should not be providing “Full On” triggering to the SVR rectifier SCRs – TRIG3 circuits or SCR may be bad  
4. Bad RF3 Circuit Board – if the feedback and reference signals are ok then the RF3 signal output to TRIG3 circuits should be within normal range (0.75-1.75V 3-pulse / 1.5-3.5V 6-pulse) |
| Output Instability or Oscillations, Irregular Variations in Output Volts | (Continued on next page…)

(Continued on next page…)

3. Check for radio frequency transmitter interference. – In rare cases, two-way radios transmitters when used in close proximity to system have affected some regulator circuit configurations.

4. Adjusting the regulator time constant can usually minimize persistent or excessive system oscillations. This is usually done during system setup using STAB Pot on RF3 circuit board (see “OTHER REGULATOR
## TROUBLESHOOTING GUIDE:

| Instability or excessive output oscillations can occur if the SVR regulation time constant is too close to a system time constant. | ADJUSTMENTS”)
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>5. A defective TRIG3 circuit can cause SCR triggers to drop off at the high end, resulting in an unstable condition – this can normally be observed by watching the LED trigger indicators on the TRIG3 circuit board. Replace the TRIG3 board.</td>
<td></td>
</tr>
<tr>
<td>6. If the SVR is not specifically designed for pulsating loads then this load condition can result in instability requiring the addition of regulator special stabilizing controls. Often this condition is a result of mechanical loading problems that should be remedied rather than attempt to control the problem with rectifier controls.</td>
<td></td>
</tr>
<tr>
<td>7. An incorrectly positioned SENS Pot on the RF3 circuit can result in instability. Only qualified personnel should make RF3 circuit pot adjustments (see “OTHER REGULATOR ADJUSTMENTS”).</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Voltage Drops Off Under Load</th>
<th>1. Check for an overload condition that causes system to go into Current Limit protection on RF3 circuit. The Current Limit function of the RF3 is designed to lower SVR rectifier output when the maximum allowable load current is reached. – Remedy is to remove the overload condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. If the SVR Rectifier Power Transformer secondary voltage is too low then the voltage drop under load conditions due to transformer impedance may limit top end output volts when rectifier SCRs are fully conducting. De-Energize and change the transformer taps to increase the available secondary voltage or reduce the maximum operating point of the SVR rectifier</td>
<td></td>
</tr>
<tr>
<td>3. Blown Power Fuses can result in a similar condition as described above as could a Loss of Triggers at the top end – Limiting the maximum observed SVR rectifier output.</td>
<td></td>
</tr>
<tr>
<td>4. An incorrectly adjusted SENS Pot on the RF3 circuit can result in a voltage drop off. Only qualified personnel should make RF3 circuit pot adjustments.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>High Noise Level</th>
<th>1. Loose Fan Blades or bad motor bearings. CAUTION: only qualified personnel should work on or near energized equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Loose covers or doors can rattle due to induced transformer vibration or air movement. Tighten loose covers / doors and replace failed or removed gasketing</td>
<td></td>
</tr>
<tr>
<td>3. High input Voltages can cause saturation of transformer steel and create loud transformer “hum”. This condition will also result in excessive transformer core heating resulting in possible transformer failure without an overload condition – change transformer taps to match input voltage.</td>
<td></td>
</tr>
<tr>
<td>4. Low or High Voltage can cause relays and contactors to chatter and/or hum excessively. If the (control) voltage is incorrect, change the transformer taps. Defective relays can also cause excessive noise but Voltage should be checked if relay coil failures are occurring</td>
<td></td>
</tr>
</tbody>
</table>

## KINETICS CONTACT INFORMATION

| Business / Manufacturing site: 140 Stokes Avenue, Trenton, NJ 08638 | Contact Parts: 609-883-9700 |
| Ship to / from site address: 140 Stokes Avenue, Trenton, NJ 08638 | Contact Technical Support: 609-883-9700 |

For Technical Support or Parts inquiries please have the following information available:
- Product Model Number
- Name Plate Manufacture System Number
UL 508A PANEL BUILDING SHOP

Kinetics Industries, Inc. is an authorized and certified manufacturer of Industrial Control Panels under UL Subject 508A (Outline of Investigation for Industrial Control Panels) and shop practices conform to industry standards for control panels using guidelines provided by NFPA and requirements of the National Electrical Code [NEC].

Kinetic Industries, Inc. has been authorized by Underwriters Laboratories to affix UL-508 labels to the products produced by its Control Panel Fabrication shop. UL File # E256763 has been assigned for our use.

This UL label, classified as UL-508, when applied to an industrial Control System, is a symbol of Quality and Reliability, and also guarantees Compliance with NEC and NFPA standards as well as Safety standards.

The UL-508 mark indicates to you that all details of the integration of the components within this system were done consistent with the manufacturers specifications and that the interconnecting of these components meets or exceeds any other Code requirements.

Kinetic Industries, Inc. must perform the following on all panels prior to affixing the UL-508 sticker:

♦ Each component is evaluated for compliance with UL, Safety and NEC / NFPA codes.
♦ Each component must be approved for use in the application and for compatibility with other components in the system.
♦ The proper Enclosure must be selected to insure that all environment considerations are met.
♦ Circuit protection within the panel must be engineered for compliance with UL and safety beginning with the incoming power source and carrying through to the field devices that are energized by this system.
♦ The Panel is engineered so as not to compromise any of the component ratings. Careful attention is paid regarding many areas of design such as component clearances, wire bending radius, conductor size and routing, ground fault, finger safety, heat buildup potentials, foreign voltage potentials and terminations to list just several of these considerations, all which must comply with UL specifications.
♦ Affix information stickers such as fuse charts, incoming power ratings, circuit protection ratings, grounding information, etc., along with any required safety stickers.

Once all of the above requirements are met, Kinetics Industries, Inc. can affix the UL-508 label to the panel. An Industrial Control Panel with the UL-508 mark is accepted by building inspectors nation wide. Kinetics Industries Inc. labels are dual rated and also bear the CUL mark, assuring the same approvals for panels to be used in Canada.
STANDARD STATEMENT OF WARRANTY AND LIMITATION OF LIABILITY

Equipment manufactured by Kinetics Industries, Inc., is guaranteed for a period of one year from date of shipment against defects in materials and/or workmanship and to operate in accordance with our proposals, specifications and nameplate data under conditions of proper installation, rated load, environment and usage. Any defects in materials and/or workmanship will be repaired or replaced at our option, F.O.B. our plant or, at our option, in the field under straight time conditions. Kinetics shall in no event be responsible for special, indirect, or consequential damages, nor for repairs or replacements made by others without written authorization of Kinetics. Correction of defects by repairing or replacing shall constitute the fulfillment of Kinetics warranty.

Kinetics’ liability on any claim of any kind, including negligence, for any loss or damage arising out of, connected with, or resulting from the sale of Kinetics’ equipment shall in no case exceed the total price paid to Kinetics for such equipment.

The foregoing warranty is in lieu of any other warranty or obligation, expressed or implied, and Kinetics Industries, Inc. assumes no liability except as is expressly stated above.

It is expressly understood and agreed that Kinetics makes no warranty with respect to any equipment not manufactured by Kinetics or with respect to any components of Kinetics equipment manufactured by others. In all such cases, the Buyer shall rely solely on the warranty of the manufacturers of such equipment or component, if any.

This document is based on information available at the time of its publication. While efforts have been made to ensure accuracy, the information contained herein does not cover all details or variations in components and programming, nor does it provide for every possible contingency in connection with installation, operation and maintenance. Features may be described herein that are not present in all physical components and logical sequence configuration. Kinetics Industries, Inc. makes no representation or warranty, expressed, implied, or statutory, with respect to, and assumes no responsibility for the accuracy, completeness, sufficiency, or usefulness of the information contained herein.

This product utilizes high gain analog and digital circuitry. Operation of high power radio transmitters in the immediate vicinity may create false triggering of control circuits. Although efforts to immunize the circuitry against external RFI sources have been taken, the system is not warranted to be totally immune to these external sources of RFI.
Operation and Maintenance Manual

For

Kinetics Industries Type “SVR”

Stabilized / Regulated Direct Current Output Rectifiers

SVR6 – 6-Pulse SCR Regulated Rectifier
SVRJ6 – Fuseless 6-Pulse SCR Regulated Rectifier
SVR3 – 3-Pulse SCR Regulated Rectifier
SVRJ3 – Fuseless 3-Pulse SCR Regulated Rectifier
RGA – Regenerative Absorption Protection

Manufacturers of:

♦ SCR Exciter Regulators
♦ Line Regulated Diode Rectifiers through 2000 kW
♦ SCR Regulated Rectifiers through 2000 kW
♦ Synchronous Generator Excitation Systems
♦ Dry Type Transformers
♦ Magnet Power Supplies
♦ Flux Forcing Magnet Rectifiers
♦ Select-A-Pick Variable Voltage Magnet Rectifiers
♦ Elevator Power Supplies
♦ Crane Power Supplies
♦ Third Rail Powered Emergency Motor Generator Systems
♦ KinetSync-NB™ and KinetSync-SR™ Synchronous Motor Monitor / Controller

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Meeting Your DC Needs 1 to 2000 Kw