OPERATION AND MAINTENANCE MANUAL

MVR - DIODE POWER SUPPLY 1 TO 15 KW
JVR - DIODE, "BOLTED FAULT' POWER SUPPLY
WVR - SEPARATION MAGNET APPLICATION, DIODE RECTIFIER
CVR - CONSTANT VOLTAGE RECTIFIER SYSTEMS 15 TO 2000 KW
RGA - REGENERATIVE ABSORPTION CIRCUIT

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MANUFACTURER'S OF:

* **Rectifiers 1 to 2000 Kw**
* **Regulated & Line Regulated Rectifiers**
* **MG Set & Ignitron Retro-fit Rectifiers**
* ***KinetSync-NB*** **and** ***KinetSync-SR*** **brushless & brush type Synchronous Motor Monitor/Controllers**
* **Synchronous Motor Field Exciters**
* **Field Application Panels**
* **Generator / Alternator Field Exciters**
* **Dry Type Transformers**

Since 1939
MEETING YOUR DC NEEDS I -TO 2000 KW

BASIC DATA: KINECTICS DIODE RECTIFIERS

The terms rectifier and power supply both describe solid state systems that convert alternating current at supplied voltage levels to direct current power.

KINETICS model types MVR, JVR and CVR incorporate the use of power diodes to convert AC power to DC power. Diode rectifier type units are direct ratio units with the DC output regulated directly by the AC input voltage. Incremental DC voltage adjustment is by the manual changing of taps on the isolation dry type transformer of the rectifier.

NOTE: Kinetics also manufactures SCR type regulated rectifiers (KINETICS Type SVR) that offer stabilized and/or adjustable DC output voltage independent of AC line variations.

MODEL TYPE DESCRIPTION:

MODEL MVR: 1 to 15 Kw, designed and rated for small industrial mill duty DC loads. Standard unit includes: AC circuit breaker, isolation dry type transformer, current limiting fuses, six pulse full wave diode bridge, heavy duty AG & DC surge suppression, no-load bleed resistance, DC ammeter & voltmeter, power-on indication light, enclosure grounding lug and a NEW enclosure.
* Numerous electrical and enclosure options available.

MODEL JVR: "Fuseless", able to withstand a “bolted fault” on the DC output of the rectifier. Units are designed and rated for applications where short circuits on the DC output bus are common or probable. In the event of a "bolted fault" condition on the DC bus, the unit's AG circuit breaker trips. After the fault is cleared, the circuit breaker is simply reset and the unit is again operational. No tools or entry into the unit's enclosure is required to reset the unit's circuit breaker. Units are ideally suited for applications such as scrap lifting magnets or cranes. Standard unit includes: AG circuit breaker, isolation dry type transformer, six pulse full wave diode bridge, heavy duty AC & DC surge suppression rated for highly inductive load kick DC bleed resister, power-on indication light, enclosure grounding lug and 4EMA1 enclosure. Units available 3 to 300 Kw.
* Numerous electrical and enclosure options available.

MODEL WVR: 1 to 100 Kw, designed and rated for scrap or waste separation magnet applications. Standard unit includes: 1 to 9 Kw thermal magnetic starter, 10 to 100 Kw AC three pole contactor with trip contacts, single AC voltage input, isolation dry type transformer, transformer taps one 5% above and below nominal voltage, current limiting fuses, six pulse full wave diode bridge, heavy duty AC & DC surge suppression, no-load bleed resistance, power on indication light, enclosure grounding lug and enclosure per application specification.

MODEL CVR: 15 to 2000 Kw, a complete DC mill duty rectification system designed and rated for common DC bus applications with designated or multiple loads. Standard unit includes: AC circuit breaker with under-voltage trip unit (AC < 600V) , isolation dry type transformer, current limiting fusing of semi-conductors, six pulse full wave diode bridge, diode heatsink and transformer thermal over-temperature protection, DC bleed resistance, heavy duty AC and DC surge suppression, DC ammeter & voltmeter, power-on indication light, fuse blown indication lights, enclosure ground lug and a NEW enclosure.

* Numerous electrical and enclosure options available.

STANDARD PARAMETERS OF OPERATION

KINETICS MODEL TYPES: MVR, JVR, WVR & CVR

AC INPUT VOLTAGES: THREE PHASE 60 Hz.

* MVR & CVR, rated under 600Volts nominal:
  208, 220, 230, 240, 440, 460, 480, 575, 600V.

* MVR & CVR, high voltage rated-over 600 volts nominal:
  2300 2400, 4160, 6900, 7200, 12,700, 13,200 and 13,800V.

* JVR: 208, 220, 240, 440, 460, 480 and 575V.

* Non-standard voltages available

* 50 & 25 Hertz available.

* Single phase available.

DC OUTPUT VOLTAGES:

* **MVR & CVR:** 28.5, 92.5, 115, 125, 230, 240, 250, 500, 750, 1000V.

* **JVR:** 125, 240V.

* **WVR:** 1153 230V.

DUAL VOLTAGE OUTPUT OF 250/125V

* All units can be connected to provide 250/125 volts DC wye. To obtain 125 volts DC, half wave rectification, a connection is made from one of the rectifier bridge arms, either positive or negative, and the wye bar of the isolation delta-wye wound power transformer. A lug point is provided on the transformer secondary wye bar as standard.

* The half wave, 125 volt DC configuration gives a higher ripple voltage but is suitable f or loads such as motors, heating, lighting or other loads which a higher ripple content would not affect appreciably.

* The rectifier is capable of operation at 100% rated current, based on the higher voltage rating in any of the output conductors. i.e. 100 Kw unit 250/125 wye could carry 400 amps. total in any of the three lines and could operate completely unbalanced.

* Dual output rectifiers with two independent, full wave bridges, 4.63% ripple, are available.

SERVICE FACTOR: TRANSFORMER & RECTIFIER

- 115% load continuously at 403C ambient.
- 100% load continuously at 50'C ambient.
- 125% load for two hours at 40'C ambient after 8 hours of 100% load operation.
- 200% load for two minutes at 40'C ambient after 8 hours of 100% load operation.

D**C OUTPUT RIPPLE:** 4.63% RMS at 100% resistive load.

DC OUTPUT REGULATION:

* **MVR, WVR & CVR:** 6% on 10% to 100% load variation and 0% AC line variation.

* **JVR:** 8% on 10% to 100% load variation and 0% AC line variation.

POWER FACTOR: 95% at 100% load.

EFFICIENCY: 95% or better at 100% load.

DESCRIPTION OF RECTIFIER COMPONENTS

KINETICS MODEL TYPES: MVR, JVR, WVR, CVR

AC LINE CIRCUIT PROTECTION:

CIRCUIT BREAKER: UNDER 600 VAC

An AC line molded case circuit breaker is provided on “standard” MVR, JVR and CVR (1 to 500 Kw) units for both line short circuit protection and as a connect -disconnect device for the rectifier unit. The breaker is manually operated to apply power to the rectifier unit.

WVR: Units between 1 and 9 Kw are supplied with an AC thermal-mechanical starter circuit. Unit 10 Kw and up are supplied with three pole industrial duty contactor with trip contacts for remote or enclosure door located ON/OFF pushbutton operation of unit.

JVR: The AC breaker size, rating and manufacturer has been specifically selected to perform within the "bolted fault" trip circuit system. The breaker should only be replaced with an exact duplicate of the breaker provided with the unit from Kinetics.

AC LINE PROTECTION ABOVE 600 VAC

Units above 600 volts AC do not come as standard with Ac line protection. AC line protection can be added as an option. If line protection is added to the rectifier system, an operational / maintenance description will be found in the back of the manuals with other data specific to the unit provided.

AC BREAKER UNDER-VOLTAGE TRIPS:

MVR: Does not include an under-voltage trip as a standard

JVR: Units 20 through 300 Kw come standard with a shunt trip which provides magnetic shut-off protection due to overloads or over-temperature. In event that the AC power into the breaker is turned off, the breaker will require resetting.

CVR: All units below 500 Kw come standard with an under-voltage trip which provides magnetic shut-off protection due to overloads or over-temperature. In event that the AC power into the breaker is turned off, the breaker will require resetting.

OPTION - SHUNT TRIP: These devices are used in place of under-voltage trips if specified or the application of the rectifier requires its use. The major difference is that the AC breaker does not trip when the AC into the unit is shut off.

OPTION - ELECTRONIC CIRCUIT BREAKER TRIP CIRCUIT: A solid state circuit breaker overcurrent trip relay as a transistor output circuit which is used to energize the shunt trip coil of a circuit breaker, AC or DC, from a "small" DC signal as can be obtained from an ammeter shunt (50 or 100 mv) or a rectified current transformer output.

* The input signal to the circuit is compared to a reference signal in a high gain comparator circuit which goes into a “full on” conducting state when the input signal exceeds the factory set bias signal. The bias adjustment is made by potentiometer P1 on the circuit board. The amplifier output is used to trigger an optical SCR which is then used to turn "on" a power transistor which, when put into the conducting mode, energizes the shunt trip coil of the circuit breaker to be controlled.
* The electronic trip circuit is provided as a factory calibrated and fixed set point and time delay of tripping trip circuit.***The time delay and trip point settings adjustments are factory sealed and breaking the seals voids the warranty on the entire rectifier unit.***
* Kinetics can provide rectifiers with circuitry that enables field adjustable current limit trip point and time delay before tripping potentiometers. The unit must be specifically designed for this feature and include system protection features for safe operation of the unit.

ISOLATION DRY TYPE RECTIFIER TRANSFORMER

MVR.JVR, WVR & CVR: All dry type power isolation transformers used In Kinetics rectifiers are designed and manufacturer by KINETICS Specifically for KINETICS rectifiers. Transformers should not be Replaced with other than KINETICS transformers designed and rated or a specific units operational features.

* Transformer core steel is grain-oriented silicon steel.
* Insulation materials and bonding varnish is class H (200'C).
* Temperature of operation, class F (155'C) or 1051C rise above 40'C ambient at sea level at 100% load and proper non-restricted air flow.
* Standard cooling design is convection.
* Standard units have matching service factors of the rectifier bridge and the power transformer.

MVR: Specifics for unit design & application.

* Taps - five 5% taps below rated output on the transformer secondary to provide adjustment of the DC output voltage.
* Optional: Two 2.5% taps above and below rated input voltages on the transformer primary.

JVR: Specifics for unit design & application.

* IMPORTANT - The JVR transformer is specifically designed for the "bolted-fault" trip system. Under no circumstance should a JVR transformer be replaced with any transformer other then a Kinetics JVR transformer of identical model number and parameter of operation rating.
* Taps - one 5% taps above and below the nominal rated output on the transformer primary to provide adjustment of the DC output voltage.

WVR: Specifics for unit design & application.

* Taps - one 5% tap above and below nominal voltage tap.
* Single voltage input voltage.

CVR,Specifics for unit design & application.

* Taps - two 2 1/2% taps above and below rated the nominal output on the transformer primary to provide adjustment of the DC output voltage.

TRANSFORMER THERMAL PROTECTION:

* Each transformer phase has a thermal over-temperature detection switch placed between the core and inner most winding layer. The thermals, selected to operate at a temperature below the maximum operating temperature of the insulation system, are interfaced with the AC line protection circuit. In event of a overload or single phase condition, the thermal switch operates and the unit is tripped off line.

MVR: - Not a standard feature.

JVR, WVR: - Standard feature 75 through 300 Kw. CVR - Standard feature on all units.

RECTIFICATION SECTION

* The rectification section of a unit converts the AC voltage from the transformer secondary to the desired DC output voltage. The rectifying elements are heavy duty industrially-rated silicon diodes. Oversized extruded aluminum heat sinks are utilized to conduct heat away from the diodes. Diodes are conservatively rated so that ample capacity for overloads and unbalance is provided.

SEMI-CONDUCTOR FUSING: MVR, WVR & CVR

* All MVR and CVR units incorporate diode fusing on the input to the devices. Fusing type is silver sand, quick-acting, current limiting, semi-conductor fuses selected to provide the maximum semi-conductor capacity usage and optimum protection against short circuits and high current surges.

* The diode protecting fuse will operate extremely fast on short circuits; much faster than smaller, standard type NEC or delay action fuses. For this reason, attention must be given to distribution fusing and circuit breaker coordination. This is particularly true if the unit is used to supply more than one unit or feeder.

* Replace blown fuses with only the identical rating and manufacturer.

* Option - trigger fuses provide an actuator mechanism that "pop" up when the fuse is blown. The actuator mechanism can be used for visual inspection or tripping of a micro-switch.

SEMI-CONDUCTORS:

* Kinetics uses three types of diode packaging.

"Packs": Diodes mounted in a packaged case with screw terminals. Packs mount to electrically isolated heatsinks.

"Stud": Diodes are bolted to the heatsink through a seating mounting hole. The heatsinks are electrically 'hot'. The DC output is by connection to the heatsinks. A flexible lead cable extends from the device for connection to the AC input connection.

"Pucks": Diodes have the appearance of a ‘hockey puck’. The device is pressure clamped between two electrically ‘hot’ heatsinks. The torque pressure applied to a device is as per specified by the device manufacturer.

A detailed and simple procedure that assures the proper torquing of devices is given in this manual.

CAUTION

When changing any of the diode packaging types it is imperative that a thin film of electrical / thermal joint compound be applied to the seating surface for the prevention of oxide build-up and assure adequate heat transfer. Failure to properly apply an electrical joint compound can result in reduction in capacity to conduct heat and/or electrical current, thus possibly causing a rectifier failure.

DIODE RATING:

* The diode peak inverse voltage, PIV, or peak reverse voltage, PRV, is the peak voltage that a diode can withstand without breaking down and the device failing.

* Minimum mill duty diode rectifier PIV/PRV rating for MVR, JVR and CVR units is six times the AC RMS voltage to the bridge. i.e. if the secondary transformer voltage feeding the diode is 185 VAC then the diode rating would be greater than 1110 volts.

NOTE: When applying rectifiers to applications with highly inductive load kicks, such as lifting magnets or synchronous motor field excitation, it is imperative that the diodes be six times the AC RMS voltage. Inductive loads with energy storing and/or regenerative capacities can subject the diodes to high reverse voltage surges that can damage or destroy a semi-conductor if the diode voltage capacity is not of a sufficiently high enough rating to withstand the surge. Never replace a diode with a lower than specified PIV / PRV rated device.

* Matching of diode resistance values is not required for current balancing.

PARALLEL OPERATING DIODES:

* The ability to rectify with one device per position is limited to the availability of semi-conductor manufacturer's to readily supply ample supplies of devices with a current and/or voltage capacity. When the rectifier output requirement is beyond the capability to perform with just one device, devices are paralleled. In larger rectifiers, to insure proper load balancing between paralleled devices, iron core balance reactors are incorporated into the system. This system eliminates the requirement of matched diodes for current balance.

N - 1. REDUNDANT DIODE:

* The redundant diode system is a feature that permits the rectifier to operate at 100% volts and current with one diode out of operation per phase and direction. The unit has an additional semi-conductor device in each phasing position to “stand-in” and carry the load in the event of a blown fuse or diode.

Standard method of operation:

One diode or fuse fails in an arm; a horn will sound and an indication light on the operation indication panel will light showing the location of the failure. A horn silence switch is available.

- In the event of a second fuse or diode failure in a rectifier arm, the unit is tripped off line.

TRANSIENT OR SURGE SUPPRESSION:

* All MVR, JVR, WVR and CVR rectifiers have voltage transient protection of the semi-conductors. The basic surge suppression device used is the “Metal Oxide Varistor" or abbreviated “MOV”. These devices are provided on both the AC & DC sides of the diodes. It is strongly recommended that spare AC and DC surge suppressors be keep on hand as spare parts.

NO-LOAD BLEED RESISTANCE:

* All Kinetics MVR, JVR, WVR and CVR units include a .5 to 1% bleed resister. Resister(s) are provided across the DC output bus to protect the rectifier diodes from light regeneration effects and help absorb line voltage spikes and surges.

COOLING:

* Transformers MVR, JVR, WVR and CVR - Kinetics designs and manufactures all standard transformers to be 100% convection cooled.

* Diodes MVR - 100% convection cooled.

* Diodes JVR, WVR and CVR - depending on the DC output voltage and current the kilowatt capacity where fans are incorporated into cooling of the diode heatsinks varies. Muffin type fans are mounted on the base of each heatsink stack and blown up the stack. The intent of these fans is not to force air through the enclosure but to accelerate the conduction of heat away from the diode n hot spot O throughout the heatsink and into the open air environment. The intake and exit of heat from the rectifier enclosure is by convection forces. The low CFM air movement system eliminates the need for air filters, air flow switches, and associated air handling equipment.

WARNING: Puck type, fan cooled, bridges require air containment covers be in place to assure proper air f low across all the devices. If the covers are removed the top diodes in the stack will not receive proper cooling , causing the rectifier to overheat.

NOTE: Ample clear space, non-pressurized air, must be provided for the rectifier air inlets and outlet to permit adequate air flow for the convection cooling system.

OPERATION IN AIR CONDITIONED ENVIRONMENTS / ROOMS:

KINETICS, convection cooled and convection aided cooled rectifiers may be utilized in air conditioned or forced ventilated ambients. It is very important that the room air system does not create thermal inversion layers or impede the natural convection cooling inside the rectifier enclosure from bottom entry to top exit. Before installing a unit in a pressurized ambient, no matter how minimal pressurization it may appear, contact KINETICS f or a copy of an engineering bulletin on the subject.

DIODE THERMAL OVERTEMPERATURE PROTECTION:

* Fan cooled, JVR, WVR & CVR, diode heatsinks stacks are protected from over-temperature operation by the use of thermally activated switches mounted at the top of each DC heatsink. The switch contacts are incorporated into a circuit that trips the AC circuit breaker under-voltage or shunt trip relay. In the event of over-temperature, the AC breaker trips, taking the rectifier off line.

OPTIONAL - AIR INLET FILTERS:

* If aluminum mesh filters or poly-urethane air filters are incorporated into the units cooling system it is imperative that a regular maintenance program be implemented to keep the filters clean. Dirty air filters can reduce air flow and raise the unit operating temperature which can result in tripping off line as a result of over-temperature.

ANNUNCIATION:

* Red power indication light: MVR, JVR, WVR and CVR.

* DC ammeter with 50 millivolt shunt: MVR and CVR. 2% accuracy, 3 1/2" meter.

* DC voltmeter: MVR and CVR. 2% accuracy, 3 1/2" meter.

* Red fuse monitoring lights: CVR

One light per power diode fuse assembly. On blown fuse, a light indicates the location of the blown fuse.

REGENERATIVE ABSORPTION CIRCUIT

A diode type rectifier, by its nature, does not have a means of absorbing regenerative power. Regeneration may occur in motor drives when the load can possibly overhaul or drive the motor faster then the base speed set by its armature and field volts or by the reversal of highly inductive loads.

* Regeneration is a phenomenon which occurs on curtain types of loads where the load has the ability to overdrive the power source supplying it or raise the DC bus voltage due to load electrical parameters. Situations where regeneration might occur:

* Overhauling load conditions: This occurs where the load may attempt to overdrive the power source, such as a crane or elevator.

* Field controlled motors: In cases where the speed of a drive is adjusted by controlling the field excitation of the motor. In the event that there is a rapid increase in the field excitation and the drive load is of an inertial nature, the inertia of the load will attempt to maintain the load speed even though the set base speed of the motor has been decreased by increasing the motor field excitation. In this instance, the motor, is driven above its base speed by the load and the motor becomes a generator, attempting to raise the bus voltage to the speed/voltage generation point of the machine. This circumstance can occur in loads such as lathes, boring mills, grinders, calendars or other inertial type loads.

* Highly inductive coils or fields where excitation polarity is reversed: In this instance, the load becomes a power source as it discharges the inductive storage and attempts to maintain current flow in the same direction before reversal. When the power supply voltage polarity is reversed, the load generated voltage now adds to the power supply voltage creating a regenerative or over-voltage condition.

* Regeneration power, not limited to the listed cases, if not dissipated, will cause the bus voltage may increase to dangerous levels that can result in rectifier semi-conductor failure, blown rectifier fuses and DC surge suppression failure. In many cases, when adequate regeneration protection is not available, the DC surge suppressor will fail

first. Arcing over of motor commutator(s) and/or field coil failures of a motor on the DC bus can be a result attributed to high regenerative voltage conditions.

A regenerative absorption circuit, normally designated as an "RGA", is used to provide a dissipating path for regenerative energy. The principle is similar to a dynamic braking circuit on a DC motor control.

* The KINETICS RGA control is a circuit used to protect the rectifier and load against these regenerative conditions by dissipating the regenerative power in a load shunt power resistor. A voltage sensing circuit is utilized to apply a regenerative absorbing resistor for a fixed period of time to absorb the, reset, and prepare to again recycle.

*** Standard Duty Regeneration:** rated for normal operation 5 seconds out of 80 seconds with a maximum of two successive operations for every four cycles.

*** Double Duty Regeneration:** rated for two cycles at 5 second pickups out of 80 seconds with a maximum of four successive pickups for every four cycles of operation.

*** Continuous Duty Regeneration:** all system components are sized to operate repetitively with no limit to the number of consecutive cycles. Continuous duty RGAs are recommended for elevator and heavy industry mill duty applications.

*** General Operation Of System:** The circuit utilizes a voltage sensing device to sense when the DC bus voltage exceeds a predetermined voltage level, normally 115% of the rectifier rated output volts. When the bus voltage exceeds this preset level, a regenerative absorption power resistor is applied directly across the rectifier output for a fixed period of time (normally 5 seconds). If at the end of the 5 second period, the bus voltage has not dissipated to a level below the preset voltage, the control picks up a second time. This cycling continues until the regenerative power has been dissipated.

*** Circuit Operation:** When the rectifier is energized, the RGA monitors the rectifier output volts. Normally open relay, TD is energized and closes. The contactor RB, used as both the power contactor and the voltage sensing device, has its coil circuit energized through the pick-up adjustment resistor RP. Under rated volts, the coil current is insufficient to pick-up the contactor. Resistor RP is adjusted so that the RB contactor picks up at the desired predetermined voltage. When the RB contactor picks up, bus power is applied to the regenerative absorption resistor and the A relay simultaneously. Relay A contacts short out the RP resistor applying full bus voltage to the RB coil which provides adequate wiping action to assure clean "make & break" of the power contacts. A second set of relay A contacts (NC) opens the circuit to relay TD. Relay LD times out by the capacitor discharge of capacitor C through the TD relay coil. (Time interval is approximately 5 seconds.) When the TD relay drops out, the RB relay is de-energized, removing the RGA resistor(s) and de-energizing relay A. The A relay's (NC) contacts re-establish the circuit to the relay TD. The TD relay has a time delay pick-up due to the charging of capacitor C. This delay gives time for the circuit to stabilize and reset.

******** DO NOT BE ALARMED !!: Cutting oil is used during the machining process in the manufacture of the regenerative absorption resistor(s). A light film of oil may still be on the resistor(s) when first operated. During the first few operations of the circuit a smell of burning oil or even a small amount of smoke may be noticeable coming from the resistor(s). After the first few operations both the smell and smoke will cease.***

***** The RGA voltage pick-up point has been factory set and should not be adjusted in the field. Adjustment of the RP resistor may void the unit warranty.***