April/May/1961

INTERNATIONAL RECTIFIER CORPORATION

IOR

SYMBOL OF QUALITY IN SEMICONDUCTORS

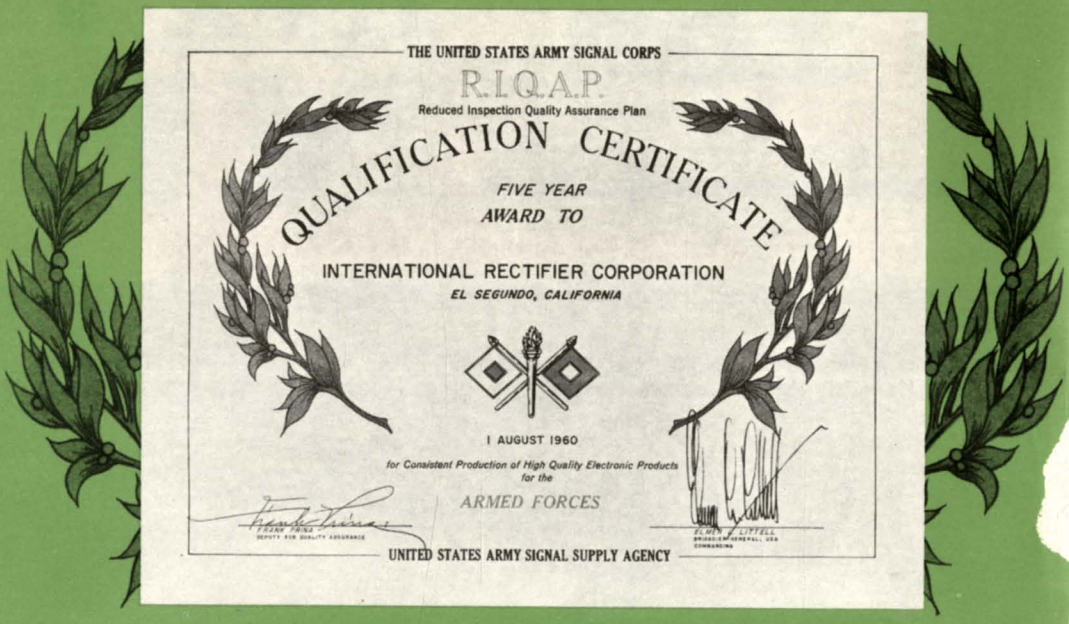
RECTIFIER NEWS

PUBLISHED BY INTERNATIONAL RECTIFIER CORPORATION • EL SEGUNDO • CALIFORNIA

A Spectacular Example of Applied Semiconductor Technology...

SEE PAGE 4

Now in Our
SIXTH YEAR
under
RIQAP...



U. S. Army Signal Corps presents "Q for Quality" pennant to International Rectifier Corporation

Ceremony Highlights Almost Six Years of Consistent Production Under the RIQAP Program — the Highest Quality Recognition and Honor the Signal Corps Can Bestow

The RIQAP pennant now flying over the IR Administration Building and the five-year certificate pictured above testify to a history of high quality production important to you and to everyone who specifies semiconductor devices. Important... because they give maximum recognition to International Rectifier's rigid quality control and inspection system; a plant-wide program governing ALL PRODUCTION — industrial and commercial devices as well as military types. Important... because the result of these programs is reliability!

International Rectifier completed five years of RIQAP performance on August 1, 1960. At a ceremony held April 12, 1961 a RIQAP pennant was presented to the company by Col. B. R. Painter, Commanding Officer, U. S. Army Signal Corps, Western Region. Dr. George Krsek, executive vice president and general manager, accepted it for the company, in the presence of Leon Lidow, secretary-treasurer of the company; Signal Corps representatives, and administrative and supervisory personnel responsible for the success of the program.

Pictured, left to right: Gene Rasco, plant Quality Assurance representative; A. Anthony Scarpa, civilian executive assistant to Col. Painter; Col. B. R. Painter, Dr. George Krsek, Leon Lidow, James B. Lee, chief of the technical branch, Signal Corps Quality Assurance Division; William Roach, plant Quality Assurance representative in charge, and Ed Drabek, L. A. Area Supervisor, Signal Supply Agency.

INTERNATIONAL RECTIFIER CORPORATION: EL SEGUNDO, CALIFORNIA • PHONE OREGON 8-6281 • CABLE RECTUSA

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6 Ways to Employ the Low Potential Barrier of Silicon Diode Junctions in Electronic Circuitry

How the Inherent Characteristics of the Silicon Rectifier Cell Can be Put to Work in Unusual and Practical Ways Not Associated with Its Prime Use as an ac to dc Converter

Because the circuit designer generally confines his thinking along specific lines, he may lose sight of the fact that the silicon diode has many more uses than are immediately obvious. By taking a more abstract look at the diode, one can devise many applications not usually associated with the device.

Applications Using the Barrier Potential

It is well known that a low potential barrier exists in silicon junctions. Even in the forward bias condition the diode exhibits a relatively high resistance at low potentials. Electrons from the N-region tend to neutralize the holes trying to flow out of the P-region which prevents total recombination. This produces a depletion region about one micron thick which can only be overcome by applying sufficient forward potential to propel charge carriers across the region. The voltage required to break down the depletion area is called the barrier potential.

In silicon junctions this barrier potential amounts to approximately 0.6 volts at 25°C. Knowing this fact, the circuit designer can put the phenomena to work in practical applications.

Tunnel Diode Regulator

Fig. 1 shows a constant voltage source useful in tunnel diode work, where extremely low source impedances are generally required. Current supplied by a d.c. source flows through the diode developing a fixed potential of 0.6 volts across the junction. A degree of voltage control can be had by adjusting the current flow through the diode. For more voltage control range, a 10 ohm potentiometer can be connected across the cell as shown.

Emitter Stabilization

The silicon junction is useful as a stabilization device, particularly in transistor circuitry. In many applications it may be desirable to have a constant emitter voltage in the presence of a varying base bias. A single audio stage with emitter stabilization is shown in Fig. 2.

An example of a circuit where a fixed emitter potential is required is the relayless voice actuated switch. To simulate the on-off conditions of a relay requires that the amplifier and control circuit change states abruptly. Unless some non-linear element is employed, such as a silicon diode junction, the control potential will increase in proportion to the speech level. Fig. 3 shows a voice actuated switch which produces either zero or minus 12 volts, but no intermediate values. The first transistor has no forward bias and conducts only on negative audio peaks. The peak must exceed the barrier potential of the silicon diode before Q1 conducts. When this occurs, current flows through the 15K resistor and the associated capacitor charges to the peak value. Thus when Q1 conducts, it saturates the control transistor, Q2, which switches to the "on" state. The release time constant is controlled by inserting a variable resistance in the discharge path.

Bias Stabilization

The transistor class B linear amplifier presents a design problem which can most easily be solved with a silicon junction. When the circuit shown in Fig. 4 is driven by a modulated envelope, a form of crossover distortion will appear in the output unless forward bias is applied to raise the transistor above the knee of its characteristic curve. However, any resistance (such as the bias divider) inserted in the base

continued on Page 6

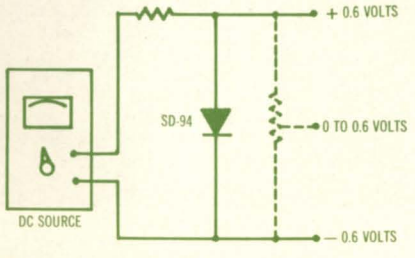


Fig. 1. Diode Used as Tunnel Diode Regulator

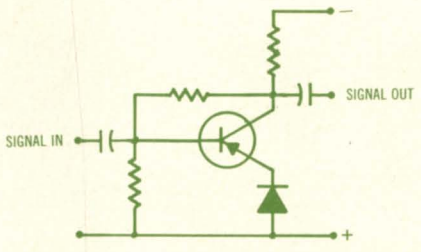


Fig. 2. Diode Used for Emitter Stabilization

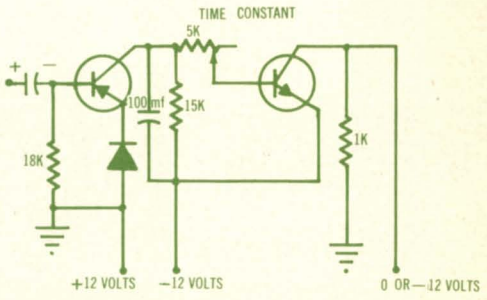


Fig. 3. Diode Used for Fixing Emitter Potential

For Contemporary Circuitry—A Vast Selection of Standard Devices Rated from Milliwatts to Megawatts... the Product of 14 Years of Specialized Experience in

Semiconductor High Voltage

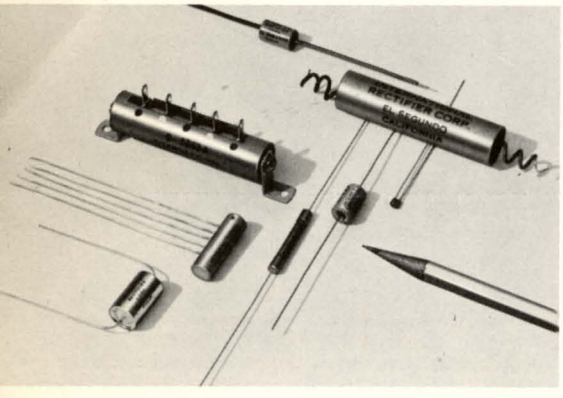
How *high* is "high Voltage"? For a hand-held Geiger counter, 900 volts might be termed high voltage. On the other hand, the designer of equipment for plasma research may be thinking in terms of several million volts. Whatever the range, success in the design and operation of high voltage equipment is wholly dependent upon a thorough knowledge and understanding of the capabilities of the devices involved and the characteristics of the system under development.

Since 1948, International Rectifier engineers have been pioneers in the development and application of semiconductor devices which have brought simplicity and compactness to countless circuits formerly designed around the cumbersome vacuum tube. The results of this specialized experience and highly developed technology are pictured on these pages.

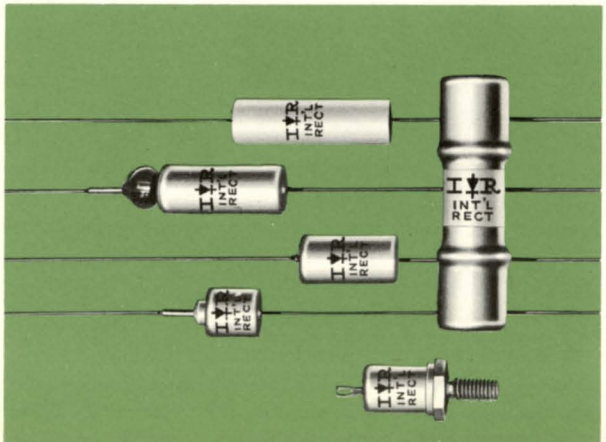
The contemporary circuit, designed with semiconductor high voltage rectifier elements, is free from the complexities associated with vacuum tube operation. A tubeless design eliminates warm-up time filament circuit complications, radiates less heat, and — in contrast to the relatively short life and fragile structure of the tube — the semiconductor rectifier affords incomparable physical ruggedness and operating life. Coupled with the size, weight and cost savings made possible by a semiconductor's small size and self-sufficiency (no need for filament transformers, etc.) these advantages assume great importance to the design engineer besieged with the challenge to develop more efficient, more reliable circuitry.

Early methods of obtaining high direct voltages by cascading vacuum tubes at low currents yielded to better design techniques with the introduction of International Rectifier multi-cell selenium "cartridge rectifiers" in 1948. Ideal for high voltage, low current applications, this extensive line continues to excel in hundreds of circuits — economically and with high reliability.

In 1956, International Rectifier introduced the first silicon high voltage cartridge rectifiers. This innovation spawned an ever-expanding line of silicon multi-junction devices offering high operating temperature characteristics and miniaturization qualities not previously available. The most familiar configuration is the ceramic "cartridge" rated to 16,000 volts PRV @ 440 ma in a compact assembly the size of a cigar. Though often copied in exterior appearance, the internal construction of these units remains superior.



Selenium cartridge high voltage rectifiers are assemblies of seriesed cells in intimate contact. Available in various circuit and physical configurations. Ratings: From 200 microamps to 200 milliamps current — up to 9900 volts RMS input per unit. For complete details request Bulletin H2S-1



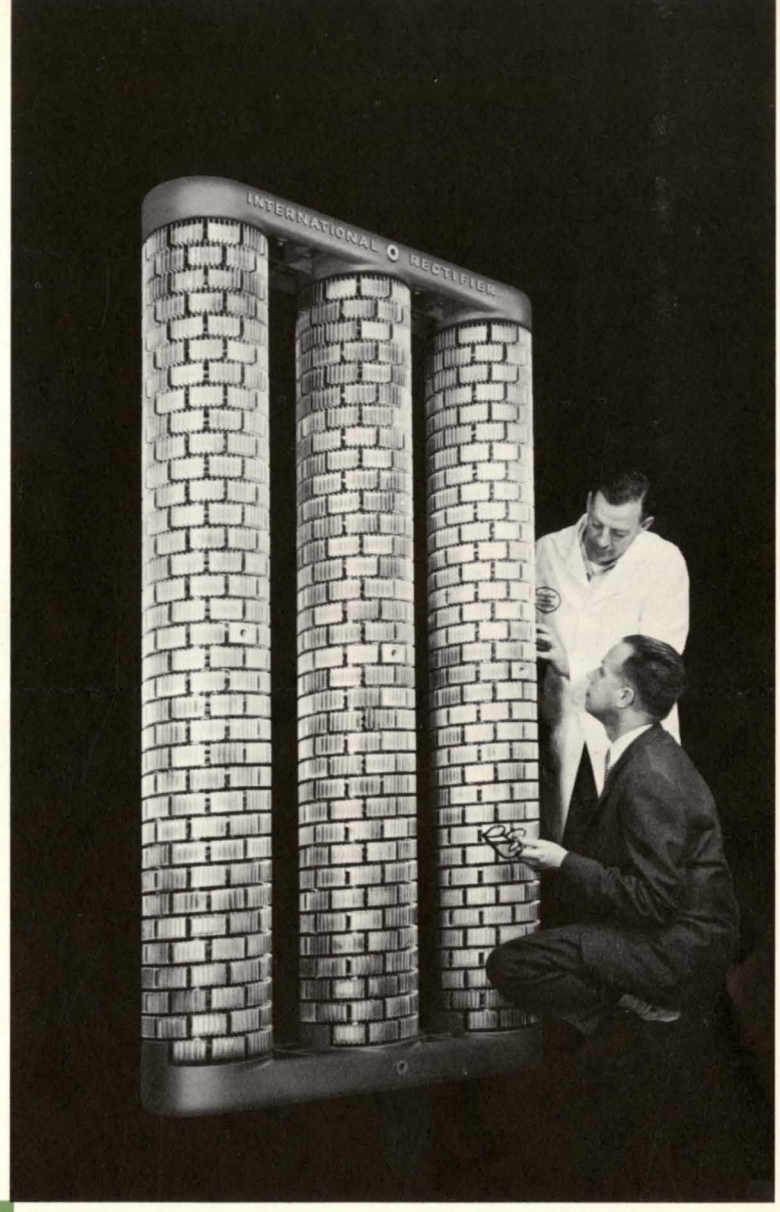
Silicon cartridge types are composed of series p-n junctions in intimate contact, hermetically sealed in metal or ceramic housings terminating in axial leads or studs. Pictured at right — typical units rated to 10,000 PRV, up to 300 ma. Request SR Bulletins 138E, 157, 226 and 227.

International Rectifier was the first to design and develop this configuration for ceramic encased silicon cartridges. Rated to 16,000 volts PRV — up to 440 ma @ 75°C, they feature ferrule ends for insertion into standard fuse clips. Request Bulletin SR 225 for ratings on 36 standard types.

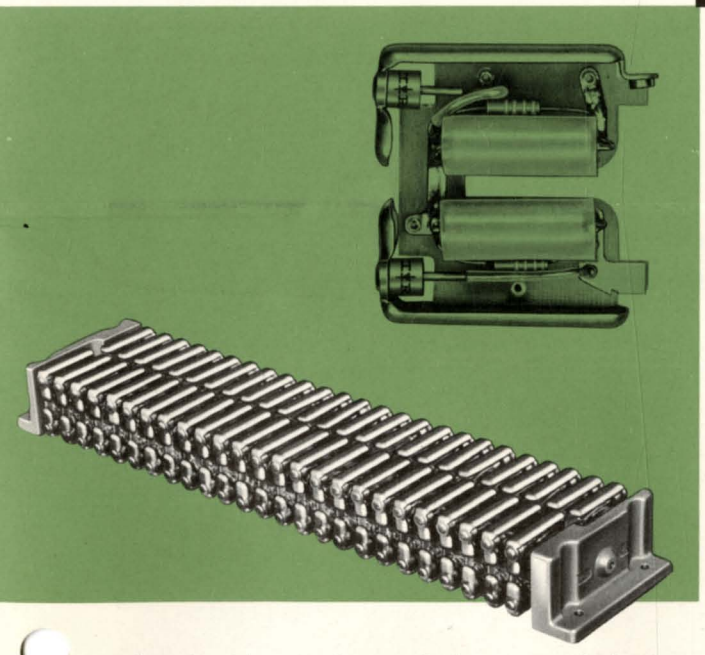
Technology

The demand for reliable high frequency high voltage at *high currents,* brought on by radar, plasma research and other advanced equipment, has been the basis for the development of a complete series of high voltage, high current rectifier columns. They are significant to industry in that they present new opportunities for the design of power supplies for induction welding, induction curing, induction heating, and for the direct use of electron beams as a tool. Modular in concept, these spectacular devices open the way to assemblies in size and ratings limited only by the imagination!

Considering the scope of standard items, and the technology IR has developed over the years, the chances are good that your *special* high voltage requirement is a standard with us. It's worth looking into.

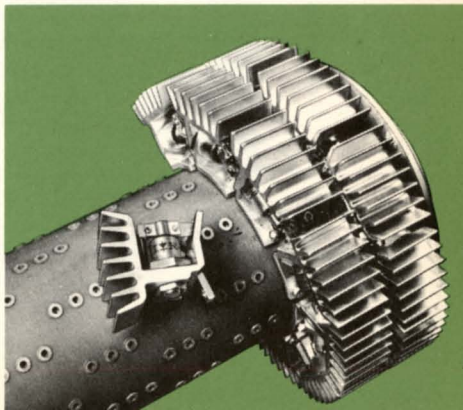


The assembly pictured above is one of two three-phase bridge rectifiers supplied by International Rectifier for a radar beam power supply. Each bridge is rated at 35,000 volts d.c. @ 55 amperes continuous. Connected in parallel, the two bridges will produce 35,000 volts @ 110 amperes . . . in series: 70,000 volts @ 55 amperes. They will withstand a 1000-ampere d.c. short circuit current for 10 cycles (⅙ sec.). Each of the three columns in the above assembly consists of 360 modules, each containing one IR 45 series rectifier cell. The modular concept of this design provides optimum reliability through equalized voltage distribution — and high surge current capacity. Contact the factory for full details.



Introduced in 1960, these standard superpower high voltage rectifier columns feature a power density up to 1 kw per cubic inch! Modular construction incorporates capacitors and resistors — yields a system reliability exceeding that of its MIL type components. Three series available for ratings to 1200 kw are described in 16-page Bulletin SR-370.

Pictured at right is a standard module consisting of an extruded aluminum heat exchanger, a 150-ampere silicon rectifier cell, a resistor and a capacitor. These modules, which can incorporate either 150 or 250 ampere cells, are mounted in spiral strings on fiberglass cores of varying length, depending upon the rating required.



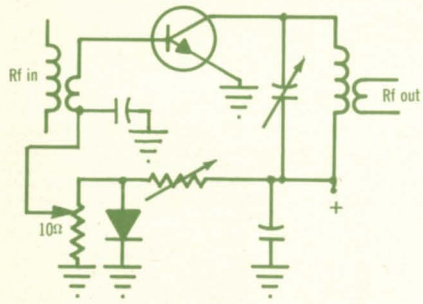


Fig. 4. Diode Used for Bias Stabilization

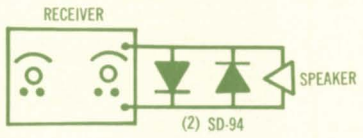


Fig. 5. Diode Used for Noise Clipping

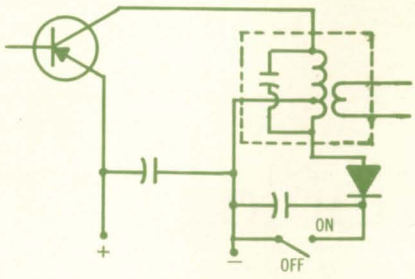


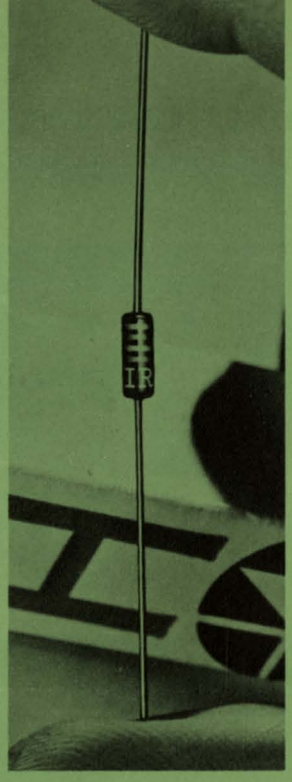
Fig. 6. Diode Used to Clip Noise Pulses at a Fixed Level

circuit will cause a change in bias voltage due to signal rectification. This variation in bias drives the stage into class C and deteriorates the stage linearity. A silicon junction in parallel with the smaller divider resistor will provide a constant bias source. A potentiometer, as shown in the schematic, permits adjustment to class B conditions. Additional current flow through the silicon junction, caused by signal rectification, will not increase the bias significantly.

Noise Clipping

It has been said that the silicon diode will conduct only when the forward bias exceeds a certain potential. This is true not only for d.c. but also applies to audio and r.f. waveforms. For some time diodes have been used for limiting external noise in communications equipment. A simple but very effective limiter can be constructed as shown in Fig. 5. Whenever a burst of static or ignition pulses exceed the barrier potential, the diodes conduct and place a very low resistance in shunt with the line. In cases where there is insufficient signal to initiate conduction, or when a degree of adjustment is required, a step-up transformer can be used. When the diodes conduct, the transformer will reflect a very low impedance across the line. A potentiometer in shunt with the diodes will vary the clipping level.

The same technique can be employed in the receiver i.f. amplifier where noise limiting is usually more effective. Fig. 6 shows a method of clipping noise pulses at a fixed level by shunting the i.f. transformer with a silicon diode. For proper operation the r.f. envelope should not exceed the clipping level and, of course, the age characteristic should be very flat. Because no time constant is involved (other than carrier storage) the clipping is quite effective even on extremely narrow pulses. This also eliminates a very annoying fault of most limiters, that is long pulse decay or "tails" on the clipped waveform, which tend to increase the average energy level of the pulse. This limiter also exhibits a self compensating characteristic. A modulated r.f. envelope which exceeds the diode conduction level does not produce the degree of clipping and distortion that might be expected. Rather, it would appear that the continuous conduction caused by this condition reduces the coil "Q" and the voltage developed across it. This, in turn, decreases the junction voltage and raises the clipping level. When the switch is open, the capacitor charges to the peak level and no clipping occurs.



NOW!

ADDED TO THE INDUSTRY'S MOST COMPREHENSIVE SEMICONDUCTOR VOLTAGE REGULATOR LINE...

7 JEDEC SERIES...

167 250 AND 400 MILLIWATT GLASS ZENER DIODE TYPES!

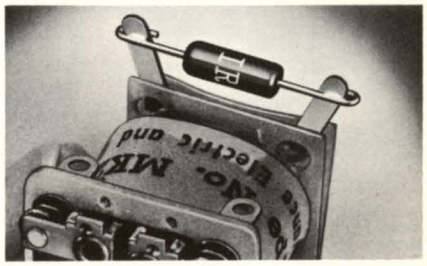
Select from 1%, 5%, 10% and 20% tolerance types.
Dynamic impedance as low as 3.6 ohms—Temperature coefficient as low as 0.006%/°C.

These highly reliable, fusion-sealed glass zeners assure you of excellent voltage regulation with optimum stability. Eighty-eight 250 mw and seventy-nine 400 mw rated types span a voltage range from 2.0 to 39 volts . . . allow you to pinpoint the exact value for your precision circuitry. Series include 5%, 10% and 20% voltage tolerance types—in production quantities! The addition of these 167 types to the IR line of premium quality voltage regulators provides you with the most comprehensive selection in the industry . . . products of 14 years of leadership in semiconductors.

JEDEC TYPES	POWER DISS. MW	VOLTAGE RANGE, VOLTS	VOLTAGES TOLERANCE
1N465 thru 1N470	250	2 to 8	1%, 5%
1N702 " 1N716	250	2 to 12	5%, 10%
1N746 " 1N759	400	3.3 to 12	5%, 10%
1N761 " 1N766	250	4.3 to 14.5	10%
1N957 " 1N973	400	6.8 to 33	5%, 10%, 20%
1N1313 " 1N1320	250	7.5 to 39	5%, 10%
1N1929 " 1N1937	250	5.1 to 30	5%, 10%

For complete specs, write for Bulletin SR-265.

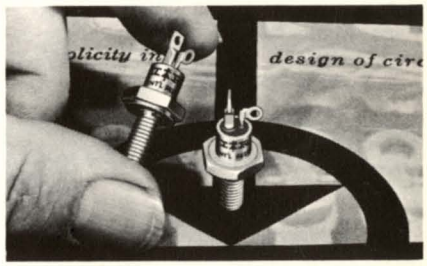
new developments



SUBMINIATURE SILICON DIODES CUT ARCING AND EROSION ACROSS MINIATURE RELAY CONTACTS

Developed to eliminate arcing and erosion across miniature relay contacts, a new series of 8 subminiature silicon glass diode contact protectors provides a maximum working voltage range from 30 to 300 volts, with max. coil current rating of 1.25 Amps @ 70°C Ambient. These hermetically fusion-sealed units are particularly applicable where severe environmental conditions are encountered, and have an operating temperature range from—55°C to +165°C.

All units are designed to afford optimum protection to relay contacts with minimum effect on the operation of the circuit. Designated Types ASG3 through ASG30, the new subminiature devices measure 0.265 x 0.110" (dia). Request Bulletin XSR-168.



5 AMP RATED CONTROLLED RECTIFIER PROVIDES MICROSECOND SWITCHING WITH MINUTE FIRING REQUIREMENTS

Silicon controlled rectifiers that will switch up to 5 amperes of current over a peak reverse voltage range from 20 to 400 volts are now available from stock. The new series are designed specifically for low power switching and control applications, and enable rapid firing (1 to 5 usec.) with a minimum of current (2 to 5 ma typical) on such applications as static inverters, dc power regulators, dc motor control, frequency changing, temperature controls, and lighting controls, dynamic braking, ignitron firing, contactors, welding controls, etc.

Designated types X5RC2 through X5RC40, these devices are comparable in many respects to the gas thyratron, but provide faster triggering and recovery, much lower forward voltage drop, simplicity of control, and high temperature operation. All units feature hermetically sealed, all welded construction, and measure approximately 1.18" overall length. Request Bulletin XSR-355.

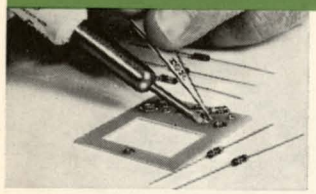
WRITE FOR FREE ZENER DIODE WALL CHART THAT GIVES DESIGN INFORMATION ON 1584 TOP HAT TYPES.

Engineering data including maximum current limits, dynamic impedance and other characteristics are shown in this handy wall chart. Also included are descriptions on the permanent design data, application information and breadboard instrumentation services available to simplify your voltage regulation circuitry. Your request on a post card will send it on its way to you.

IS YOUR SEMICONDUCTOR FILE UP-TO-DATE?

Write for complete data on these selected types from the industries' widest line

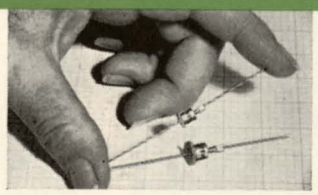
SILICON ZENER DIODES AND REFERENCE ELEMENTS



SUBMINIATURE 250 AND 400 MW SERIES

Ratings: 3.3 to 30 volts. Glass fusion sealed... diffused junction... low dynamic impedance to 5Ω @ 20 ma... excellent voltage regulation over −55°C to +150°C range... IN702 and IN746 series.

Bulletins SR-261 and SR-263



TOP-HAT 750 MW AND 1W SERIES

Ratings: 3.9 to 30 volts. Hermetically sealed... welded construction... low dynamic impedance to 1.1Ω @ 25 ma... excellent regulation and stability over −55°C to +150°C range... IN1507 and IN1518 series.

Bulletin SR-260

STUD-MOUNTED 3.5 AND 10W SERIES

Ratings: 3.9 to 30 volts. Hermetically sealed... welded construction... low dynamic impedance to 0.2Ω @ 300 ma... excellent voltage regulation and stability over −55°C to +150°C range... IN1588 and IN1599 series.

Bulletin SR-260

VOLTAGE REFERENCE PACKS

Ratings: 8.4 and 16.8 vdc. High stability operation ... reference voltages within ±0.01%... temperature coefficient ±0.001%/°C... operate from 28 vdc or 115 vac, 60 or 400 cycle inputs... IR 4RV8 and 4RV16 series.

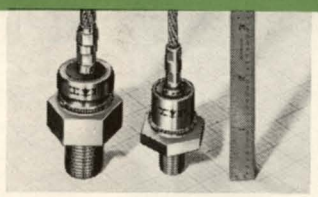
Bulletin SR-401

POWER RECTIFIER CELLS AND STACKS

SILICON POWER RECTIFIER CELLS

Ratings: to 45 amps—50 to 600 PRV. Hermetically sealed all welded construction... designed for operation at junction temperatures to 190°C... operating frequencies to 1,000 cps... IN1199, IN1341, IN2128A series.

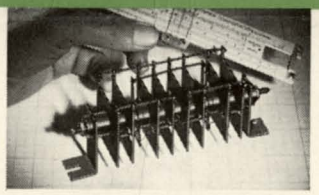
Bulletins SR-311 and SR-304



SILICON HIGH POWER RECTIFIER CELLS

Ratings: to 250 amps—50 to 600 PRV. Rugged all welded construction... hermetically sealed... designed for operation at junction temperatures to 190°C... operating frequencies to 1,000 cps... IN3085 and IN2054 series.

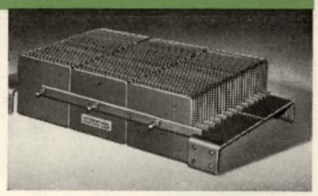
Bulletins SR-300 and SR-305



SILICON RECTIFIER STACKS

Ratings: to 750 amps—31 to 1500 vdc output. High forward conductance and low reverse leakage... rectification efficiencies to 99% at power frequencies... operation over −65°C to +170°C range ... 1N2638 and IR66-4626 series.

Bulletins SR-330 and SR-335

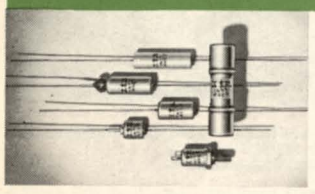


SELENIUM POWER RECTIFIER STACKS

Ratings: to 2300 amps—6 to 30,000 volts. Standard, double, and triple density types... all standard single phase and triple phase circuit configurations... high rectification efficiency over −65°C to +100°C range.

Bulletin SR-170

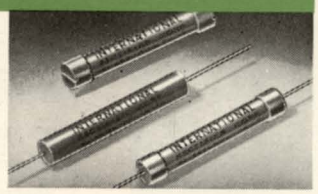
HIGH VOLTAGE RECTIFIERS



SILICON CARTRIDGE RECTIFIERS

Ratings: to 440 ma—600 to 16,000 PRV. High rectification efficiency... low reverse leakage current at rated PRV... −55°C to +150°C operating range... IN596, IN1130, IN1133, IN1406, IN1745 and IN2373 series.

Bulletins SR-138, SR-226, SR-157, SR-225 and SR-227



SELENIUM CARTRIDGE RECTIFIERS

Ratings: to 200 ma—20 to 14,400 PRV. High efficiency rectification over −65°C to +100°C temperature range... available in half-wave, full-wave center tap, voltage doubler, and single-phase bridge configurations.

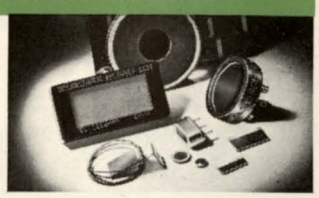
Bulletin H2S-1

SPECIAL SEMICONDUCTOR DEVICES

SILICON CONTROLLED RECTIFIERS

Ratings: 1, 5, 10, & 16 amps—20 to 400 PRV. Extremely efficient high-current switching... hermetically sealed... ideal static switch turn-on times to 2 μsec (typ)... IR X1RC2, X5RC2, X10RC2, and X16RC2 series.

Bulletins SR-353, SR-355, SR-350 and SR-351



SOLAR CELLS AND PHOTOCELLS

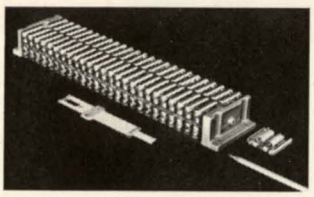
Wide range of silicon and selenium types. Silicon solar cells with conversion efficiencies to 13%... silicon readout photocells with response times to 5 μsec ... selenium photocells in wide variety of sizes and shapes.

Bulletins SR-280 (Silicon) and PC-649 (Selenium)

SILICON RECTIFIER TUBE EQUIVALENTS

Ratings: to 1250 ma—1500 to 10,000 PRV. Solid-state rectifiers replace vacuum tube types... reduce space... eliminate filament supply and warmup time... long life... high reliability operation... IN570 and IN2630 series.

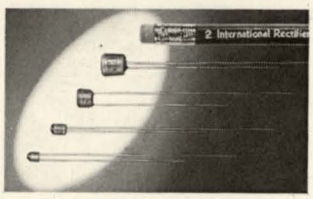
Bulletin SR-209



SILICON SUPER-POWER RECTIFIERS

Ratings: to 50 amps—to 100 KV. Maximum power capacities exceed 1,000 kw... up to 1,000 watts per cubic inch... high overload capacity... reliability of column exceeds that of its individual components... IR 1HV series.

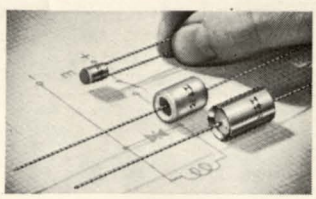
Bulletin SR-370



SUBMINIATURE SELENIUM DIODES

Ratings: to 28 ma—48 to 384 PRV. High efficiency/low cost diodes provide stable operation over −50°C to +100°C range... reverse resistance to 30 megohms at 30 volts... withstand 1 second surges to 550 ma... IN1625 series.

Bulletin SR-163A



SELENIUM CONTACT PROTECTORS

Ratings: 26 to 156 vac—.2 to 1.2 amp coil current 15 to 133 vdc—.25 to 3 amps coil current. Low cost contact protectors... eliminate arcing and pitting of relay and switch contacts... IR S1V series.

Bulletin SR-150

6-61-M-72 LITHO U.S.A.