DUAL-VOLTAGE POWER SUPPLIES

Tube Bridge
Germanium Full Bridge
Germanium Half Bridge
Dual Full Wave

Need two high voltages for your medium power transmitter? Build a dual-voltage power supply from one of these circuits, tailored to the contents of your junk box, or from inexpensive television receiver replacement components.

— Lighthouse Lanny

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DUAL-VOLTAGE POWER SUPPLIES

Preparation of a simple and stable 100-watt transmitter for the November–December, 1957
issue demanded an equally simple dual-voltage power supply. Our solution: Combine plentiful
replacement-type components in bridge and full-wave rectifier circuits, smooth with a high-
capacity filter, and package compactly in a corner of the transmitter cabinet.

Lighthouse Lorry

GENERAL CIRCUIT DETAILS

A majority of amateur transmitters in the medium power class (40 to 250 watts) require at least two
different high voltages, usually about 200 volts for the heater supplies, and 280 to 600 volts
for the power amplifier.

These voltages may be obtained by two of the three means:

A separate power supply for each high voltage required; or

A single power supply providing voltage

A full-wave rectifier with a tapped high-voltage winding feeding separate half-wave rectifiers; or

A single bridge rectifier with the lower DC voltage obtained from a center tap on the high-voltage winding. The two latter circuits

will be described here.

As the simplified schematic diagram of a vacuum
tube bridge rectifier in Fig. 1 shows, the cathodes of
diode tubes A and B, connected to opposite ends of the
high-voltage winding, each should be supplied from a
different filament transformer having adequate flux.

In addition, a third filament transformer is re-
quired for diodes C and D, having their cathodes con-

nected together. Thus, tube bridge rectifiers with
directly heated cathodes have complex heater circuits.

Development of rectifier tubes having separate
cathodes electrically isolated from the heater has made
possible tube bridge rectifiers with fewer filament transformers. Publication of the "Economy Power Supply" circuit a few years ago suggested this innova-
tion, in addition to more efficient utilization of replace-
ment type radio and television receiver power trans-
fomers in dual-voltage power supplies. Type 6AX-5 G-T
(transformer) provided the necessary adequate flux
for G-V; and in the original "Economy" type bridge rectifier shown in Fig. 2, A-T was operated with the cathode 40 volts positive or negative with the
heater.

Since the DC output current rating of the 6AX-5 G-T is only 70 milliamperes, connecting each pair of tube
plates in parallel still limits the maximum output current of the original economy power supply to about
140 milliamperes. By substituting a pair of similar full-
wave rectifier tubes, 6AX5-G-T's, for the 6AX-5 G-T's, the same circuit is capable of supplying up to 200 milli-
amperes from a single-phase AC input filter with up to 700 volts AC applied to the bridge rectifier.

A single filament transformer, T1, powers both tubes
and their diodes so that they can be turned on at
the same time—thereby reducing the voltage on V1 and V2, and within the rating. Fig. 1, one side of the bridge circuit should be connected so the plates are set on the high-voltage trans-
fomer winding. Beyond, the high-voltage transformer, T1, should not be turned on until the heaters of V1 and V2 are brought to operating temperature. Third, V1 and V2, should be hot before heater voltage is applied to V1, the full-wave rectifier forming the other two legs of the
bridge.

In the circuit of Fig. 2A, V1 and V2 are heated by T1,
the main power switch, S1, is closed. Plate power from the high-voltage transformer, and the filament transformer for V1 and V2, should be applied by turning S1, at least 30 seconds later than S2. If S2 is closed im-
mediately after S1, a negative voltage will appear at the "RI/2" output terminal until the heaters of V1 and V2 are warmed up. Heater power for S1 or S2 is taken from T1, if a suitable winding is available.

A single 5U4-GB or 5R4-GA will suffice for V1, with maximum current drains of 25 milliamperes or less. If sufficient heater power is available, two 5U4-GB, 5R4-GA or 5V4-GA tubes may be connected in parallel to reduce the voltage drop through the tubes. 

Close input filters, as shown in Fig. 2B, are recom-
nended for both the high-voltage and half-voltage output
circuits, even though the output DC voltage under full
load will be about 10 percent lower than with a capac-
tive input filter. However, the peak current through the high-voltage winding, and the excitation of the input
filter. Since 120-480, 450 volt electrolytic capacitors, C1, to C6 connected in series—resistors R1 to R6 are desirable for good dynamic voltage regulation, as described in "ABOUT POWER SUPPLIES" (See G-E'S HDL NEWS, January-February and March-April, 1954). Circuit capacitor, C2 in a single smoothing choke in each filter, reduce the AC ripple appearing on the output voltage to a fraction of one percent. Additional low-resistance filter chokes may be connected in series with L1 to further reduce the resonant frequency of the filter circuit.

A simple circuit by which the primary voltage applied to T1 may be adjusted also is shown in Fig. 2A. All heater windings on T1, or connected in series (the windings should be in phase) and placed in series with the primary. At the actual voltage on T1 will then be either higher or lower by the total voltage of the heater windings. A single-pole, double-throw switch, S6 applies normal primary voltage with the switch arm as shown, or alternate primary voltage with the switch arm in the "up" position.

If single 6.3 and 1.5 volt windings are connected in series, the primary voltage can be adjusted to about 10 percent above and below normal. A 15 percent change either way will result from connecting 3.2 volt and 1.8 volt windings in series. This ratio is possible to boost the output voltage of the transformer 10 volts or 600 volts. The method reversal the connections to the heater windings. How-

ever, the AC high voltage from T1 should not exceed the rating of the rectifiers under any conditions.

Fig. 1. Basic schematic diagram of a bridge rectifier cir-

Fig. 2A, V1 and V2 are heated by T1.

Fig. 2B, close input filters; as shown in Fig. 2B, are recom-

2
By substituting the alternate primary circuit for $T_2$, shown in Fig. 3, any of three primary voltages may be selected. The center position on $R_4$ supplies normal line voltage to $T_1$; the HIGH position connects the heater windings to add to the line voltage; and the LOW position reverses the heater windings and thus subtracts from the line voltage.

The primary voltage switching circuits and high-voltage filter circuits are recommended for the other rectifier circuits which follow. Of course, pilot lights, relay control circuits, cabinet safety interlock circuits, indicating meters, output voltage regulators and other extra features may be added as desired. Only the basic circuitry has been shown here.

The maximum output current rating given replacement type power transformers for most manufacturers apply for these conditions: One, continuous operation; two, a full-wave rectifier circuit; and three, a capacitor input filter. For intermittent amateur type-operation, approximately the same output current (and nearly twice the output power) can be drawn from the same transformer without excessive heating under the following conditions: First, connecting with a half-wave rectifier circuit, which more than doubles the average current drawn; second, a choke input filter which reduces the peak current drawn; third, a proper amount of power loss to the high-voltage winding as compared with a capacitor input filter.

It is a fairly simple matter to add the additional equipment to a good full-wave power supply to convert it to a bridge type circuit and thus considerably increase the total DC output power obtainable from the supply. The only chassis space needed is for the two 6AX5-OT rectifier tubes. The extra filament transformer ($T_3$) and metal can or tubular type electrolytic capacitors ($C_1$ and $C_2$) can be located beneath the chassis.

**SEMIQUAD BRIDGE RECTIFIERS**

Recent developments in the field of semiconductors have resulted in the manufacture of highly efficient, moderate cost germanium, silicon and selenium rectifiers. Even though the maximum ratings usually apply to half and full-wave rectifier circuits, several identical semiconductor rectifiers can be connected into a bridge rectifier circuit. In a bridge circuit, the peak inverse voltage across each leg will be only half as much as in a half- or full-wave rectifier for a given DC output.
Fig. 4. Schematic diagram of a bridge rectifier converted from a full-wave rectifier by adding three series-connected semiconductor rectifiers in each leg. The optional rectifier tube, V₁, should be included to handle maximum current drawn between 275 and 350 milliamperes.

Fig. 5. Schematic diagram of a semiconductor bridge rectifier having three rectifier cells in each leg. Voltage. Thus, each rectifier in a bridge circuit will withstand nearly twice the rated AC voltage without exceeding the peak inverse voltage rating.

The same-connected semiconductor rectifiers can be employed in the place of rectifier tubes in the two added legs in the previously described "Economy" bridge circuit, as shown in Fig. 4. This arrangement is adaptable to a power supply in which the extra filament transformer winding is not readily available.

The DC high voltage is taken from the heater circuit of V₁, and approximately half this voltage will be delivered from the center tap on the high-voltage winding, formerly connected to ground in the full-wave rectifier. The lower voltage is rectified by the two strings of semiconductor rectifiers operating in a full-wave circuit. An alternative method is to connect in parallel with V₁ to reduce the tube voltage drop if the additional heat power is available from T₂.

A bridge circuit in a new full-voltage power supply can employ semiconductor rectifiers in all four legs. This circuit, shown in Fig. 5, is also suitable when an existing power supply is being rebuilt. Three series-connected rectifier cells are shown in each leg of these circuits. Only two rectifiers per leg may be necessary for certain operating conditions, as shown in the circuits of Fig. 6a and 6b.

Table 1 shows the maximum recommended operating voltages and currents for several popular semiconductor rectifiers in the aforementioned circuits. The 550-ampere limitation rating shown for the combination tube and semiconductor rectifier circuits is the maximum current that two 550-ampere tubes in parallel will deliver. Note that the 1N118, 1N539 and 1N4004 rectifiers are capable of handling far more current than the average power transformer will deliver.

A bridge rectifier made from replacement selenium rectifiers costs less than a comparable germanium or silicon bridge, but the full-load voltage drop is almost four times higher. Also, the temperature of the V₂ surrounding selenium rectifiers should be kept below 155 degrees Fahrenheit. Germanium and silicon rectifiers are rated for normal operation in temperatures up to 130 degrees. In addition, the silicon rectifiers will operate at much higher temperatures with reduced current output.

Two-transistor DUAL-FULL-WAVE RECTIFIER

The high-voltage windings of two similar power transformers may be connected in series, instead of in parallel, and used in a power supply having separate full-wave tube rectifiers for the full and half DC output voltages. As shown in Fig. 7, the midpoint between the windings becomes the negative output voltage connection. The center taps of the two windings are connected to one full-wave rectifier, V₁, and the outer ends feed the other full-wave rectifier, V₂. The windings must be insulated from each other. If this circuit is used, it is practically no DC output voltage from either rectifier.

The diagram shows how the heater windings are connected in series to provide a greater adjustment in the primary voltage than is possible with two or three heater windings on a single transformer. All windings should be in phase.

A 550-DB, 5VA-4A, or 5Y3-CT full-wave rectifier is suitable for the moderate current actually drawn from the lower voltage output tap. A 550-DB may be used for V₁; only when the full secondary voltage of each transformer is below 550 volts. A 5VA-4A full-wave rectifier at V₂ can be operated with up to 950 volts DC transformer.
Even for intermittent amateur serv ice, the total current drain from both DC output voltage taps should not exceed the rated current of each transformer by more than 40 percent. The voltage regulation of this circuit is not as good as with a single power transformer, because the rectified current flows through the high-voltage windings only in one direction and tends to saturate the transformer cores at high current drains.

**CONSTRUCTION DETAILS**

The rectifier power supply shown on the front page, and in the top view, Fig. 8, were constructed on an 7 x 12 x 3-inch-deep aluminum chassis (Heat AC-408). When power transformers and chokes weighing more than 16 pounds each are used, a steel chassis is advisable, even though it is harder to cut and drill. The heavy transformer was placed at the back of the chassis midway to balance the weight load, with the smaller transformer in the front. The object between these transformers can be changed to suit the equipment which the chassis is to power.

The electrolytic capacitors should not be crowded against components which radiate considerable heat, such as the tube. Capacitors C1 and C2 in the filter circuit diagram, Fig. 3B, were mounted on the insulating fiber mounting plates furnished with the capacitors. Since the metal cans of these capacitors are several hundred volts positive with respect to the chassis, fiber insulating sleeves should be placed over them. Mica 1//4-inch in diameter were cut as the chassis for these capacitors to prevent the mounting lugs from shorting to the chassis.

Flame transformers, small filter chokes, bleeder resistors and other small parts are mounted under the chassis whenever convenient. The wiring is run along the chassis corners and between components, then fastened into place upon completion. External connections are made through suitable plugs and terminal strips. A high-voltage type connector is recommended for the full DC output voltage.

Semiconductor rectifiers should be mounted atop the chassis, rather than under it, to allow adequate circulation of air around them. Rectifiers having insulated mounting leafs may be fastened directly to the chassis in one or two rows. Small rectifiers having only leads can be mounted on a terminal board like that shown in Fig. 9. Connecting leads to the rectifiers are run up through rubber-grommeted holes in the chassis.

Another mounting method is recommended for selenium rectifiers in the half and full bridge circuits.

![Schematic diagram of a dual full-wave rectifier circuit using high-voltage winding of two replacement type power transformers in series. Extra "spigot" insulating tubing should be slipped over the transformer high-voltage leads to guard against insulation breakdown.]

![Top views of the four types of power supplies shown on the cover. Note that the rectifiers are placed well away from the filter capacitors. Cable size and layout may be varied to suit space requirements.]

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*Fig. 7.* Schematic diagram of a dual full-wave rectifier circuit using high-voltage winding of two replacement type power transformers in series. Extra "spigot" insulating tubing should be slipped over the transformer high-voltage leads to guard against insulation breakdown.

*Fig. 8.* Top views of the four types of power supplies shown on the cover. Note that the rectifiers are placed well away from the filter capacitors. Cable size and layout may be varied to suit space requirements.
Figs. 4 and 5. The thin fiber tubes through which the rectifier fastening screws pass may not withstand the voltages involved, so four rows of these rectifiers each were fastened to the 3 x 5 x ½-inch-thick laminated insulating board (Textolite or bakelite), shown in Fig. 10. The bottom edge of this board was drilled and tapped for fastening screws which run up through the chassis. A perforated metal shield should be placed over both germanium and silicon rectifiers to prevent curious fingers from touching dangerous voltages.

OPERATION

Power supplies do not have to be tested up or otherwise adjusted, but a wiring check is advisable before applying power for the first time. After testing on the AC power, both DC output voltages without a load, and with full load, should be checked. These may be raised or lowered by adjusting the transformer primary voltage, as previously outlined.

Output voltage tests were conducted on all power supply circuits to obtain the comparative voltage regulations figures shown in Table II. When testing each power supply, the primary voltage was adjusted so that the high-voltage wiring always delivered 700 volts AC regardless of the output current load. The figures thus will help determine the output voltage that can be expected from each type of rectifier when operated from a transformer having either 700 volts AC output. Other tests were run with the power supplies delivering twice the output current at which the power transformers were rated in full-wave rectifier service. The no-load output of this test, or the output voltage to be heated to the extent that they shrunk or showed other signs of failure. These tests, plus hundreds of hours of use in transmitters, offer proof that these simple power supplies made from low-cost components will "deliver the goods" in your 60 to 300-watt transmitter.
1957 EDISON RADIO AMATEUR AWARD

The Edison Award since 1924 has honored a radio amateur who has rendered outstanding public service. Any radio amateur who has rendered outstanding public service, anytime, and who is nominated by two radio amateurs, may be considered for the Edison Award, your petitionation and support are essential. Start now to think of a suitable candidate! The rules below will help you prepare your nominating letter.

WHO IS ELIGIBLE? Any men or women holding a valid amateur's license issued by the FCC, Washington, D.C., who in 1957 performed a meritorious public service in behalf of an individual or group. The service must have been performed while the candidate was pursuing his hobby in an amateur within the continental limits of the United States.

WINNER OF THE AWARD will receive the Edison Award trophy in a public ceremony in Washington, D.C. Expenses of his trip to that city will be paid.

$500 GIFT: Winner will be presented with a check for this amount in recognition of the public service he has rendered.

WHO CAN NOMINATE? Any individual, club, or organization favoring with the service performed.

HOW TO NOMINATE: Include in a letter a full description of the public service performed, the candidate's name, call sign, and address; and a statement of support from two other radio amateurs. Include with your nomination any other information (newspaper clippings, photographs, commendation documents, etc.) which will assist the judges in judging the candidate's public service. The letter must be postmarked no later than January 31, 1957. Address: Edison Awards Committee, General Electric Company, Overwood, Kentuck.

$600 Prize: The awards will be given to a group of distinguished and important judges. Their decisions will be based on the potential to the individual or group, the amount of ingenuity and sacrifice displayed while performing the service.

Winner of the award will be announced at or before January 30, 1957.

The General Electric Company may coordinate candidates for the Edison Radio Amateur Award, but are not permitted to receive the Award.

We have received numerous requests for simplified circuit diagrams of the 100-watt M.W. Power Ripper, (see G.-E. RAM. NEWS, July-August, 1957) without the output voltage switching, and with only the 450-volt DC output. Send a postal card requesting a copy if you are interested.

1957 ALL-AMERICAN AWARDS

General Electric has announced the establishment of a new nation-wide program of public service awards for television service technicians.

Called the "1957 All-American Awards," the program will bring national recognition to eleven television service technicians who have performed outstanding community service. Each winner will receive a handsome trophy and a $500 check for use in a public service activity of charity of his preference.

Under the program, eleven television service technicians will be chosen on the basis of their good citizenship. Only nominations submitted by letter to the Award committee administrator of the program will be considered. The winners will be chosen from among the nominees by a panel of distinguished judges who will base their decisions on the benefit derived from the winners' public service activities during the two-year period ending September 30, 1957. Decision of the judges will be final.

Typical examples of community service to which television service technicians might apply their specialized knowledge are: repairing TV sets without charge to children's hospitals, teaching television circuitry to students, designing and providing simple equipment, developing and launching Boy Scout and other youth group television relay broadcasts, and assisting with civil defense communications activities.

The award rules require that a letter of nomination be addressed to the All-American Awards Committee, General Electric Company, Overwood, Kentuck, containing the name and address of the nominee and a full description of his public service he has performed. Nominations may be submitted by any individual, club, or organization. To qualify for this year's All-American Awards, nominating letters must be postmarked on or before October 19, 1957.

 Officials who will administer the awards are Mrs. Culbert, noted radio and television master of ceremonies; Harmon Hickman, television announcer; Wendall Barnes, administrator, U.S. Small Business Administration; and Wendall Best, 55-year veteran, National Junior Chamber of Commerce.

Announcement of winners will be made in December.

PARASITES

The case of the missing "0"—In Fig. 13, page 8 of the July-August, 1957 issue of G.-E. RAM. NEWS (Vol. 12, No. 4), the current balancing resistors in the Nobilith tube heater circuits should have been 10 ohms instead of 1 ohm.

—Lighthouseerry
VITREOUS ENAMELED
WIRE-WOUND
STOCK RESISTORS

General Electric Vitreous Enamelled resistors are made in
fixed and slide-wire types, as follows: Fixed resistors, from
3 to 200 watts, standard resistance values from 1 to 250,000
ohms; slide-wire resistors, 10 to 300 watts, 1 to 100,000
ohms. See catalog of your authorized G-E tube distributor
for complete listing. Copies also are available from Lightwave
Larco.

Replace that burnt-out bleeder resistor in your high-
voltage power supply with a new G-E resistor. Remember—
an open bleeder resistor is an extremely dangerous shock
hazard.

Install these for the many voltage droppers and current
limiting applications in the radio shack. Quality composition
and high 300-degree Centigrade maximum temperature
rating permits operation of these resistors in confined under-
ground locations without developing hot spots which can
cause failure of ordinary resistors.

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G-E HAM NEWS
Available FREE from
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VOL. 12—NO. 5

published bi-monthly by
ELECTRONIC COMPONENTS DIVISION
GENERAL ELECTRIC
Schenectady, N. Y.

In Canada
CANADIAN GENERAL ELECTRIC CO. LTD.
185 Dunfield St., Toronto 2, Ontario

E. A. NEAL, W3JEK—SKUK
SEPTEMBER—OCTOBER, 1957

Form 3004? Supplied