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A New Low-Power Klystron Supply

AS MORE and more types of low-power klystrons have become available, need has grown for a small, bench-type power supply to operate these klystrons. The new -hp- Model 715A Power Supply shown in Figure 1 has been designed specifically for this purpose. The new unit provides—

(1) a regulated beam supply adjustable by a calibrated panel control from —250 to —400 volts d-c at currents up to 50 milliamperes. Beam current is monitored by the panel meter visible in Figure 1.

(2) a regulated reflector supply adjustable by calibrated panel controls from —10 to —900 volts d-c.

(3) square-wave modulation on the reflector supply at a nominal repetition frequency of 1000 cps.* Square-wave amplitude can be adjusted up to a maximum of 120 volts peak-to-peak.

(4) a 6.3-volt a-c filament supply.

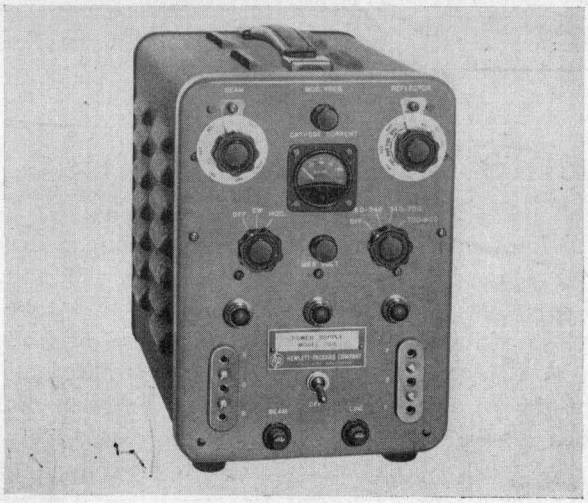

Figure 1. *-hp- Model 715A Power Supply designed for supplying low-power klystrons.*

The beam supply is obtained from a conventional degenerative regulator circuit that uses a 6AU5-GT regulator tube and a 12AX7 control tube. Under various combinations of load and line voltage, regulation is constant within approximately 1%. Maximum allowable power dissipation of the 6AU5-GT regulator tube permits 50 ma to be drawn externally at beam voltages of 400 volts. At lower load voltages, the maximum allowable load current decreases as shown in the de-rating curve of Figure 2. Beam-voltage-selecting controls are calibrated to eliminate the need for external meters when adjusting beam voltage. Ripple in the beam supply is less than 10 millivolts. The beam supply can be switched off independently from the reflector supply and is electrically interlocked so that beam voltage can not be applied before reflector voltage.

The reflector voltage is obtained from a regulated r-f type supply that provides high d-c voltages without sacrifice in economy of weight and space. The circuit includes a 6AQ5 beam power amplifier tube operating as an oscillator at 150 kc and a 12AU7 twin-triode used with a 5841 corona-discharge tube to regulate the screen of the oscillator supply is designed to provide the small

*On special order, other common modulating frequencies such as 400 cps can be substituted at no extra cost.

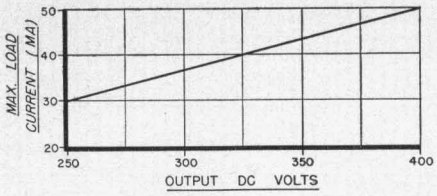

Figure 2. *Current de-rating curve for -hp- Model 715A.*

currents drawn by klystron reflectors and will thus supply up to 10 microamperes without substantial change in the calibration of the reflector voltage controls.

To minimize the possibility of accidental damage to a klystron, the reflector supply is arranged with a protective circuit that prevents the reflector from becoming appreciably more positive than the resonator. The circuit consists of a 6X4 rectifier connected between the reflector and beam supply terminals. Accidental over-modulation of the reflector supply or excessive current in the reflector circuit are thus virtually eliminated as possible sources of damage to the klystron.

The reflector supply can be internally square-wave modulated at a nominal repetition frequency of 1000 cps. A panel vernier adjusts the square-wave frequency over approximately a ±100-cycle range so that the acceptance frequency of standing-wave indicators, etc., can be matched. The square-wave amplitude is adjustable over a range from 0 to 120 volts peak-to-peak. To minimize incidental f-m in the klystron, the rise and decay times of the square-wave modulation are kept short, less than 15 microseconds each. When the reflector supply is internally square-wave modulated, a trigger voltage is available for synchronizing external equipment. The reflector supply can also be modulated by external voltages.

The supply is housed in a small case that facilitates bench use. The width is 7¼ inches, height 11 inches, and depth 12 inches. A snap-down carrying handle is provided on the top of the case. The unit is provided with a plug-in output cable that is shielded to minimize hum pick-up.

The -hp- 715A has been designed specifically for new types of klystrons that do not have modulating electrodes. Therefore, no bias supply is provided by the unit. However, it can be used in many cases with klystrons that have modulating electrodes by connecting the modulating electrode to the klystron resonator. Some klystrons with which the Model 715A can be used are given in the following list.

2K22	X-12 (Varian)
2K25	X-13 (")
2K26	X-17 (Varian)
2K28	X-18 (")
2K29	X-19 (")
5976	X-20 (")
6BL6	X-26 (")
6BM6	

—*J. R. Petrak*

SPECIFICATIONS
-hp- MODEL 715A
POWER SUPPLY
(for use with low-power klystrons)

SUPPLY No. 1: (Beam supply) Voltage range, 250-400 volts; max. current, 30 ma at 250 volts, 50 ma at 400 volts (see de-rating curve); regulation, approx. 1% from no load to full load at line voltages from 105 to 125 volts; ripple, less than 10 mv; calibrated voltage control provided.

SUPPLY No. 2: (reflector supply) Voltage range 10-900 volts; max. current, 10 microamperes; regulation, within 1% for line voltages from 105 to 125 volts for fixed currents; ripple, less than 10 mv; calibrated voltage controls provided.

FILAMENT SUPPLY: Provides 1.5 amperes max. at 6.3 volts a-c ±5%.

MODULATION: Square-wave modulation provided on supply No. 2; amplitude adjustable from 0 to 120 volts peak-to-peak. Square-wave rise and decay times less than 15 microseconds each; square-wave frequency adjustable over ±100-cycle range from nominal 1000 cps center frequency.

EXTERNAL MODULATION: Terminals and circuit provided for modulation from external source. Input impedance at external modulation terminals is approx. 50,000 ohms.

TRIGGER VOLTAGE: During internal modulation, trigger voltage is supplied for synchronizing external equipment.

CABLES SUPPLIED: Provided with shielded plug-in output cable and with attached 8-foot power cable.

POWER SOURCE: Operates from nominal 115/220 volt, 50/60 cycle source; draws approx. 150 watts.

DIMENSIONS: 7¼" wide, 11" high, 12" deep.

WEIGHT: 18 lbs.; shipping weight, approx. 30 lbs.

Data subject to change without notice.

Balanced Load Measurements with VHF Bridge

THE -hp- Model 803A VHF Bridge, described in the April, 1950 issue of the *Hewlett-Packard Journal,* has made possible the direct measurement of impedance up into the UHF region. This bridge measures the impedance magnitude and phase angle of most types of high-frequency devices over a range from below 50 to above 500 mc.

One type of impedance measurement sometimes desired is the measurement of balanced impedances such as balanced antennas fed by balanced transmission lines. Since the connection for the unknown impedance on the -hp- 803A Bridge is single-ended, some type of balancing device is required when measuring balanced unknowns.

A suitable balancing device for many such measurements is the balun shown in the drawing of Figure 1. The balun is cut to be exactly one-half wavelength long at the operating frequency so that the voltage at the input to the balun will be reproduced (out of phase) at the load end of the balun. Thus, the balun is effectively driving one half of the load while the bridge drives the other half, making the voltage across the load as a whole equal to twice the voltage delivered by the bridge. This balancing system is therefore roughly equivalent to a 1:2 voltage

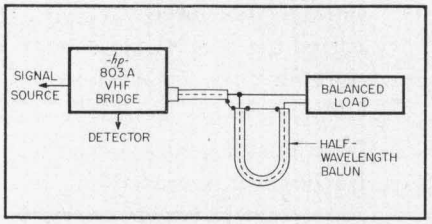

Figure 1. *Measurement set-up using balun with balanced load.*

transformer or a 1:4 impedance transformer, and readings made by the bridge will be one-fourth of the actual impedance (magnitude) of the load. Phase angle measurements theoretically are not transformed by the balun.

If the balun is exactly one-half wave-length long, measurements can be made with only small errors. In practice, however, it is often inconvenient to determine precisely the electrical length of the balun, and small deviations from the desired length usually exist. Errors caused by such deviations can be shown to depend upon the relation of the characteristic impedance of the cable used for the balun to the impedance of the load. For resistive loads or loads with moderate phase angles, the measured phase angle of the load is affected more seriously than the magnitude by the deviation in balun length. The optimum condition occurs when the cable impedance is half the impedance of the load. When this condition exists, there is theoretically no phase error introduced by deviations in balun length. With small deviations of the order of 2-3% in balun length, the phase angle is affected roughly five degrees in typical cases. If load phase angle is not critical, the impedance of the balun can vary from roughly one-fourth to four times the load impedance without introducing magnitude errors greater than a few per cent.

—*W. B. Wholey*

Repair of Hewlett-Packard Instruments

THE -hp- repair department is organized to give rapid service on repair work so that out-of-use time for your instrument is minimized. Repair work other than that done under the -hp- guarantee is made at cost plus a slight service charge that covers packing labor, packing material, handling, etc.

An instrument that has seen considerable usage can be repaired in one of two ways—completely or partially. A complete repair consists of the correction of the basic trouble as well as the replacement of certain components that experience has shown to have the highest replacement rate. Tubes and electrolytic capacitors are especially subject to replacement in a complete repair. Refinishing operations such as repainting, cabinet resurfacing, and the like are done only when specifically requested. Instruments that have been completely repaired are made to pass the same performance specifications that were required of the instrument when new.

A partial repair consists merely of correcting the primary cause of trouble without regard to the condition or age of other components. When a repair of this type is made, the instrument is not necessarily made to meet the performance requirements of a new instrument. Experience has shown that partial repairs are not a satisfactory solution to the repair problem and they are not recommended.

RETURNING AN INSTRUMENT

It is not necessary to obtain special papers from the -hp- factory before returning an instrument for repair, but it *is* necessary to send a notice that the instrument is to be returned. This notice should cover five important points:

(1) The model number and serial number of the instrument to be returned.

(2) A description of the trouble *in detail.* Detailed descriptions of trouble can substantially reduce the repair time—and thus the repair cost.

(3) Special directions, if any, concerning the repair work.

(4) Enclose purchase order or other authority to repair instrument.

(5) State the shipping address to which the instrument is to be returned as well as the desired manner of handling the return shipping charges. Repaired instruments are returned with shipping charges collectable by the carrier unless other instructions are given.

PACKING AND SHIPPING

Before packing an instrument for return to the factory, attach to the instrument either an identifying tag or a copy of the letter described above.

If the instrument contains a crystal oven, remove the oven before packing and wrap separately. Crystal ovens pull free from their sockets in shipment and damage the interior of the instrument. Instruments containing crystal ovens at present are: Models 100A, 100B, 100C, 100D, 335B, 335C, 335D, 336C, 336D, 337A, and 337B. Late production runs of these instruments are provided with oven clamps, in which case the ovens do not require separate packing.

Handles on knobs should be removed or other precautions taken to prevent breakage or bending of shafts. Instruments that have such handles at present are the Models 608A, 610A, 610B and 618A.

A satisfactory method for packing -hp- instruments has been to enclose the instrument in a wooden box or wirebound crate that is lined with a layer of good cushioning material such as excelsior or similar shock-absorbing material. For light-weight instruments, the cushioning layer should be 2-3 inches thick around all surfaces; for heavy instruments, 3-5 inches is sufficient. The material must be firmly packed and compressed to be effective.

When an instrument having meters or other fragile parts mounted on the panel is to be packed, special precautions are necessary to prevent breakage. A suitable method has been to make up shock-pads from flexible corrugated paperboard and to place these pads against accessible portions of the instrument's front panel. The meter itself should also be covered with a small pad to protect the glass.

Experience has shown that shipments of instruments are best made by rail express or, where time is important, by air freight. Shipping charges must be prepaid. The shipping address for repair work is

Hewlett-Packard Company
Attention: Repair Dep't.
395 Page Mill Road
Palo Alto, California

ESTIMATES

Advance estimates based on our past experience can be submitted before performing any repair work. However, it is difficult to submit an estimate in the form of a fixed-fee repair charge, especially when such an estimate is desired before the instrument is sent to us. When a fixed-fee proposal is desired, our estimate is usually given in the form of a probable minimum-probable maximum proposal.

OTHER REPAIR PLACES

For your convenience repair stations are operated at the following places:

Chicago 40, Illinois
Alfred Crossley & Associates
4501 Ravenswood Avenue
UPtown 8-1141

New York 13, New York
Burlingame Associates
103 Lafayette Street
DIgby 9-1240

These stations are privately operated but are authorized to make repairs on -hp- instruments and are supplied with -hp- parts and methods. The stations have the proper equipment for repairing all but VHF and UHF instruments, which in general should be repaired at the factory.

AIEE-IRE-NBS Conference on High Frequency Measurements

The second High Frequency Measurements Conference will be held in Washington, D.C., from January 10 to 12, 1951. Joint sponsors of the Conference are the AIEE, IRE, and the National Bureau of Standards. The conference program includes a number of interesting papers as well as field tours and demonstrations.

-hp- REPRESENTATIVES AT YOUR SERVICE

Other technical field representatives are located at the following places. Whenever you desire first-hand information regarding -hp- instruments, contact the nearest representative.

ALBUQUERQUE, NEW MEXICO
Neely Enterprises
8211 E. Central Avenue
Albuquerque 3-2245

BOSTON 16, MASSACHUSETTS
Burlingame Associates
270 Commonwealth Avenue
KEnmore 6-8100

CHICAGO 40, ILLINOIS
Alfred Crossley & Associates
4501 Ravenswood Avenue
UPtown 8-1141

CLEVELAND 15, OHIO
M. P. Odell Company
2536 Euclid Avenue
PRospect 1-6171

DALLAS 5, TEXAS
Earl Lipscomb Associates
3561 Marquette Street
LOgan 6-5097

DAYTON 2, OHIO
Alfred Crossley & Associates
410 W. First Street
Michigan 8721

DENVER 3, COLORADO
Ronald G. Bowen
852 Broadway
AComa 5211

DETROIT 5, MICHIGAN
S. Sterling Company
13331 Linwood Avenue
TOwnsend 8-3130

FORT MYERS, FLORIDA
Arthur Lynch & Associates
P. O. Box 466,
Fort Myers 1269M

HOUSTON 5, TEXAS
Earl Lipscomb Associates
3919 Riley Street
LInden 9303

HIGH POINT, NORTH CAROLINA
Bivins & Caldwell
Rm. 807, Security Bank Bldg.
High Point 3672

LOS ANGELES 46, CALIFORNIA
Neely Enterprises
7422 Melrose Avenue
WHitney 1147

NEW YORK 13, NEW YORK
Burlingame Associates
103 Lafayette Street
DIgby 9-1240

PHILADELPHIA 44, PENNSYLVANIA
Burlingame Associates
422 Coulter Street
TEnnessee 9-2006

SACRAMENTO, CALIFORNIA
Neely Enterprises
309 Ochsner Bldg.
GIlbert 3-7461

SAN FRANCISCO 18, CALIFORNIA
Neely Enterprises
2830 Geary Blvd.
WAlnut 1-3960

ST. LOUIS 3, MISSOURI
Harris-Hanson Company
208 North 22nd Street
MAin 5464

SYRACUSE, NEW YORK
Burlingame Associates
712 State Tower Bldg.
SYracuse 2-0194

TORONTO 2-B, ONTARIO, CANADA
Atlas Radio Corporation, Ltd.
560 King Street
WAverley 4761

WASHINGTON 9, D. C.
Burlingame Associates
2017 S Street, N.W.,
DEcatur 8000