The Heathkit HW-101
by Greg Latta, AA8V

HP-23/PS-23 Schematic Diagrams and Circuit Descriptions

Click on the image for a super detailed view.

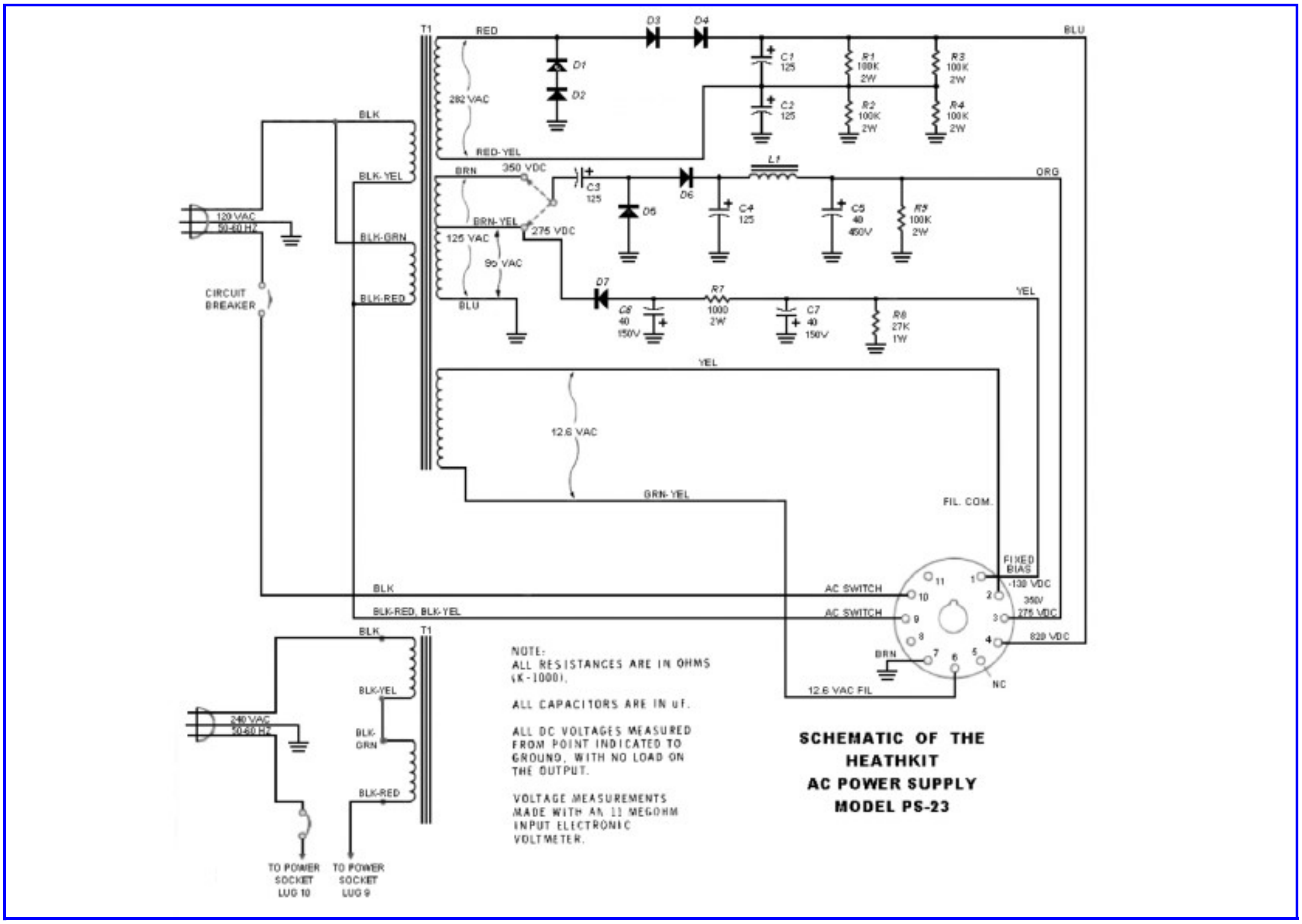
The Heathkit HW-101 Pages:

Important Safety Note: Working on or testing equipment such as the Heathkit HW-101 and HP-23 is extremely dangerous since very high voltages are present when the equipment is turned on, and may even be present when the equipment is turned off and unplugged. If at all possible, do all work with the equipment off and unpluggedand be sure that the capacitors are properly discharged before working on the equipment. The operator assumes all risk and liability in such matters! Do not work on this type of equipment unless you are experienced with working around very high voltages!

Schematic Diagrams and Circuit Descriptions:

Schematic Diagram:

Click on any area of the schematic diagram to learn about that part of the circuit.



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Scroll Down or Select A Link Below:

120V AC Primary Circuit
240V AC Primary Circuit
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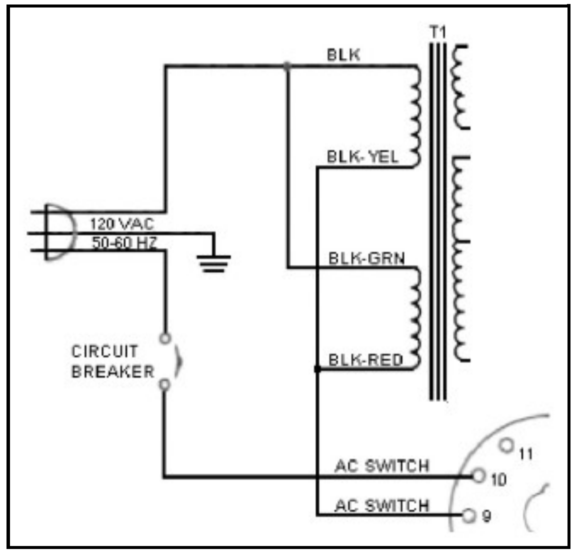
Click Here For A Complete PS-23 Manual In .PDF Format

120V AC Primary Circuit:
The power transformer is set up with dual primaries that can be placed either in series or in parallel. In this case they are placed in parallel for 120V AC operation. Power flows in via a

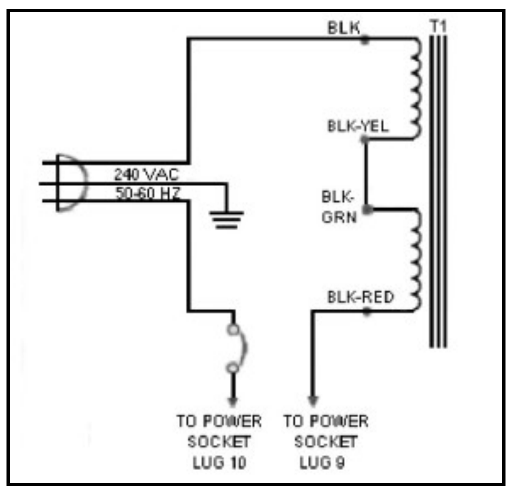
3-wire cord from the AC outlet. The neutral side connects to the black/black-green side of the primaries. The hot side flows through a circuit breaker/fuse, an on-off switch on the power supply (in some versions), to a switch in the transceiver via pins 9 and 10 of the output connector, and back to the black-yellow/black-red leads..

When connected in parallel, it is important that the black and black-green leads be connected together and that the black-yellow and black-red leads be connected together, otherwise the phasing is wrong.

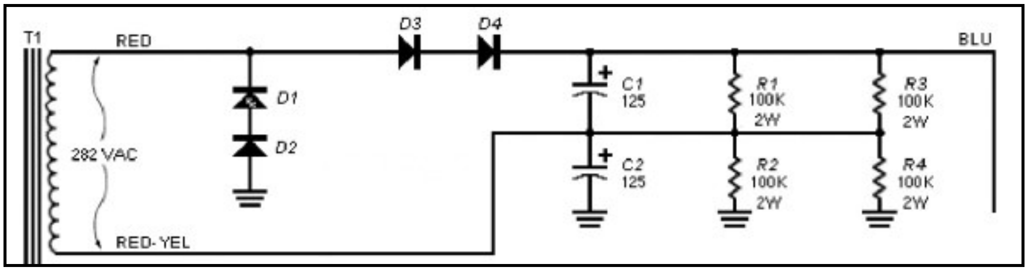


240V AC Primary Circuit:
The power transformer is set up with dual primaries that can be placed either in series or in parallel. In this case they are placed in series for 240 AC operation. Power flows in via a 3-wire cord from the AC outlet. One side of the 240V line connects to the black lead of the first primary. The other side of the 240V line flows through a circuit breaker/fuse, an on-off switch on the power supply (in some versions), and to a switch in the transceiver via pins 9 and 10 of the output connector and back to the black-red lead of the second primary.

When connected in series, it is important that the black-yellow and black-green leads be connected together, otherwise the phasing is wrong.



High Voltage Circuit



High Voltage Circuit:
The high voltage circuit operates as a full wave voltage doubler driven by a separate 282V secondary on transformer T1. By using a lower transformer voltage and then a voltage doubler, less insulation is needed on the transformer and the transformer can be kept more compact.

The full wave voltage doubler works in the following manner:
(for the moment assume very little current is drawn from the circuit, and R1-R4 are not present.)

When the top of the transformer secondary is positive, current flows through D3 and D4 to charge capacitor C1 up to the peak voltage of the transformer secondary, which is 1.41 x 282V or 398V. D1 and D2 are reverse biased and permit no current to flow.

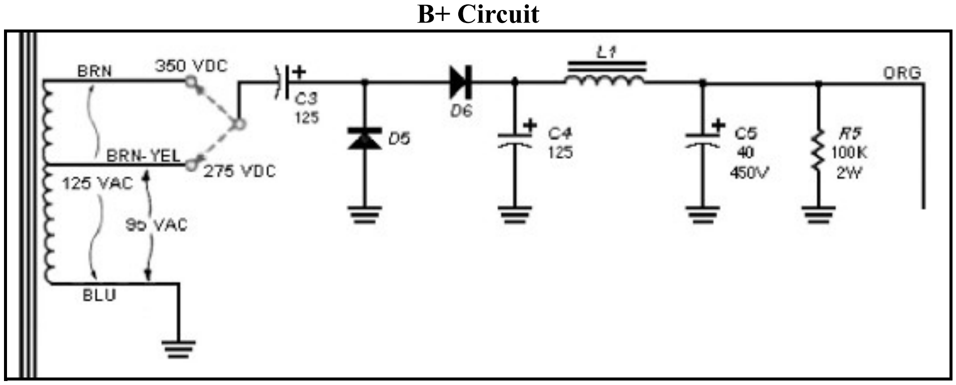
On the next half cycle, when the bottom of the transformer is positive, current flows through C2 and D1 and D2 charging C2 up to the peak voltage of the secondary, which is 1.41 x 282V=398V. D3 and D4 are reverse biased and permit no current to flow.

The output is taken across C1 and C2, which are in series, so the output voltage is 398V + 398V or 796V. The effective output capacitance is the capacitance of C1 and C2 in series, or 125uF/2=62.5uF. Since both halves of the AC cycle charge the output capacitance, this is a full wave circuit.

Note that when the diodes are reverse biased, the voltage across each pair (PIV) is the transformer voltage plus the charged capacitor voltage, or twice the peak transformer voltage. The PIV is thus 796V. Since the 1N2071 diodes used by Heathkit had a PIV of about 500V, two were needed is series to give an adequate PIV of 1000V. By that time solid state rectifiers had eveloved enough that equalizing resistors and capacitors were not needed across the diodes.

Bleeder resistors R1-R4 are present to make sure that the capacitors discharge when the power supply is turned off, and to present a minimum load on the supply.

B+ Circuit



B+ Circuit:

The B+ circuit operates as a half wave voltage doubler driven by the 95V or 125V tap on transformer T1. By using a lower transformer voltage and then a voltage doubler, less insulation is needed on the transformer and the transformer can be kept more compact.

The half wave voltage doubler works in the following manner:
(for the moment assume very little current is drawn from the circuit, and R5 is not present.)

When the bottom of the transformer secondary is positive, current flows through D5 to charge capacitor C3 up to the peak voltage of the transformer secondary (134V low, 178V high), D6 is reverse biased and permits no current to flow through C4.

On the next half cycle, when the top of the transformer is positive, current flows through C3 and D6, charging C4. Since the transformer secondary and C3 are in series, C4 is charged up to twice the peak voltage of the secondary. D5 is reverse biased, and permits no current to flow.

The output is taken across C4, so the output is twice the peak voltage of the secondary (268V low, 356V high). Since only one half of the AC cycle charges the output capacitance, this is a half wave circuit.

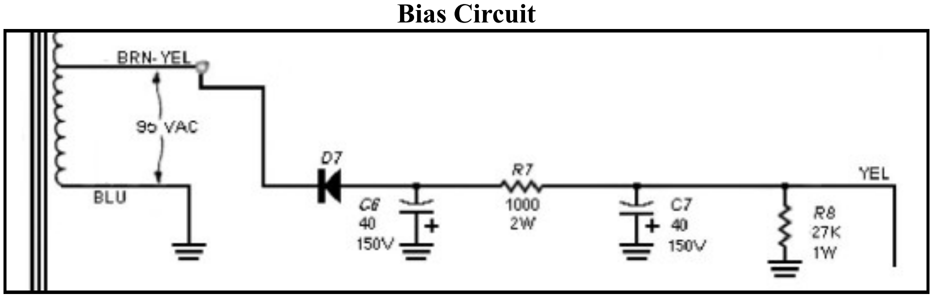
The ripple for a half wave rectifier is higher than that of a full wave rectifier, so choke L1 and capacitor C5 are needed to provide extra filtering under load to bring the ripple down do an acceptable value.

Note that when the diodes are reverse biased, the PIV across D5 is the voltage across C3 plus the peak transformer voltage=twice the peak transformer voltage. The PIV across D6 is the peak transformer voltage, plus the voltage across C4, minus the voltage across C3=twice the peak transformer voltage. The PIV is thus at most 356V. Since the PIV rating of the 1N2071 diodes is 500V, only one diode is needed at D5 and D6.

Bleeder resistor R5 is present to make sure that the capacitors discharge when the power supply is turned off, and to present a minimum load on the supply.

The transformer switch allows the choice of two output voltages for the B+ circuit. Which position is used depends on the equipment that the power supply is powering. For example, when powering an HW-101, the switch is set to the high position.

Bias Circuit



Bias Circuit:

The bias circuit operates as simple half wave rectifier driven by the 95V tap on transformer T1.

Since very little current is drawn from the circuit, a half wave rectifier will work fine.

The half wave circuit works in the following manner:
(for the moment assume very little current is drawn from the circuit, and R8 is not present.)

When the bottom of the transformer secondary is positive, current flows through D7 to charge capacitor C6 up to the peak voltage of the transformer secondary, 1.41 x 95V=134V.

On the next half cycle, when the top of the transformer is positive, D7 is reverse biased and no current flows.

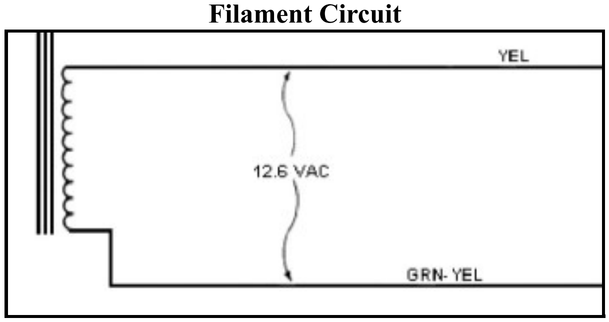
The output is taken across C6, so the output is the equal to the peak voltage of the transformer secondary, 134V. Since only one half of the AC cycle charges the output capacitance, this is a half wave circuit.

The ripple for a half wave rectifier is higher than that of a full wave rectifier, so resistor R7 and and capacitor C7 are needed to provide extra filtering under load to bring the ripple down do an acceptable value. A choke is not needed as in the case of the B+ supply because very little current is drawn from the supply. A simple resistor will do to isolate C7 from C6.

Note that when D7 is reverse biased, the PIV across D7 is the voltage across C6 plus the peak transformer voltage=twice the peak transformer voltage, or 268V. Since the PIV rating of the 1N2071 diode is 500V, only one diode is needed at D7.

Bleeder resistor R8 is present to make sure that the capacitors discharge when the power supply is turned off, and to present a minimum load on the supply.

Filament Circuit



Filament Circuit:
The filament circuit obviously needs no explanation, other than that some units have a 6.3V center tap, and others do not. One question that does arise is "Why not just run everything on 6.3V and forget 12.6V altogether?". All of the tubes in the transceivers typically run by the power supply, such as the HW-101, can be run on 6.3V, Why bother with 12.6V at all? Another question is "If everything is set up for 12.6V, why not keep a 6.3V center tap for versatility?"

I can only guess on the answers, which I think are as follows:

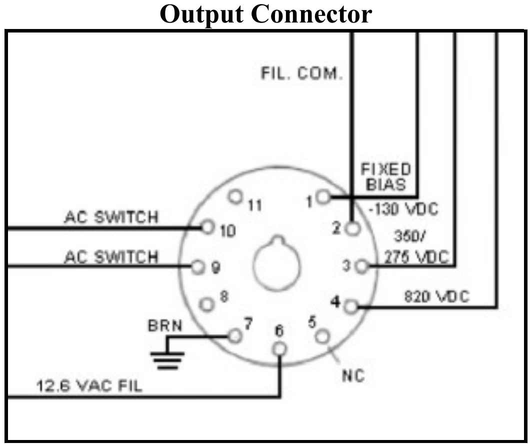
1. A transceiver such as the HW-101 needs 5.5A at 12.6V to run. If set up for 6.3V operation, it would require 11A at 6.3V. This is a lot of current to run through the cord connecting the power supply to the transceiver. Such current could cause a voltage drop of a few tenths of a volt. This might not seem like much, but at 6.3V a drop of, for example, 0.3V is about 5%. However, if the current is halved due to 12.6V operation, the voltage drop would become only 0.15V. This is

only about 1%, a significant improvement.

2. 11A is a lot of current to run through a single pin in the 11-pin connector. These pins are no heavier than the pins on an octal tube. 11A could potentially overheat the pins. Running at 12.6V cuts the current to 5.5A, something the pins can easily handle.

By omitting the 6.3V center tap on later models, I think the engineers were trying to head off these problems and eliminate them before they started..

Output Connector



Output Connector:
The output connector carries the various voltages from the power supply to the equipment being powered. The pinouts are as follows:

1. Fixed Bias -130V DC
2. Filament Common 12.6V AC
3. B+ 250V DC or 300V DC (depends on which tap is used for the B+ circuit)
4. High Voltage 700V DC
5. No Connection
6. Filament 12.6V AC
7. DC Ground
8. 6.3V AC Filament (Not on all units)
9. AC Switch (Pins 9 and 10 must be connected together for unit to operate.)
10. AC Switch (Pins 9 and 10 must be connected together for unit to operate.)
11. No Connection

General Specifications:

SPECIFICATIONS

High Voltage.	820 volts DC, no load. 700 volts DC, at 250 ma.
Effective Output Capacitance.	62.5 µfd.
Ripple.	Less than 1% at 250 ma.
Duty Cycle.	Continuous up to 150 ma, to 300 ma at 50%.
Low Voltage (High Tap).	350 volts DC, no load. 300 volts DC, at 150 ma (with 100 ma load on High Voltage).
Ripple.	Less than .05% at 150 ma.
Duty Cycle.	Continuous up to 175 ma.
Low Voltage (Low Tap).	275 volts DC, no load. 250 volts DC, at 100 ma (with 100 ma load on High Voltage).
Ripple.	Less than .05% at 150 ma.
Duty Cycle.	Continuous up to 175 ma.
Fixed Bias.	-130 volts DC, no load. -100 volts DC, at 20 ma.
Ripple.	Less than .5% at 20 ma.
Duty Cycle.	Continuous up to 20 ma.
Adjustable Bias.	-80 to -40 volts DC, at 1 ma maximum.
Filaments.	6.3 volts AC at 11 amperes, 12.6 volts AC at 5.5 amperes.
Power Requirements.	120 volts AC, 50/60 cps, 350 watts maximum.
Dimensions.	9" long x 4-3/4" wide x 6-3/4" high.

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Questions, Comments, and E-Mail

If you have any questions or comments, you can send E-Mail to Dr. Greg Latta at glatta@frostburg.edu

Thanks for stopping by!