8 NEW KITS

LAB POWER SUPPLIES

A new family of laboratory power supplies from the Heath Company. They offer a variety of voltage ranges, automatic output monitoring and adjustment of output. There's one for every bench

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FOR MANY YEARS BENCH POWER SUPPLIES WERE NOT VERY important to the technicians, experimenters and hobbyists that used them. Just about anything that would deliver 6 or 12 volts DC with enough amperage to power a car radio would meet most needs. But today it's a very different world. The modern power supply must provide precise voltages, be well regulated, offer constant currents and provide accurate monitoring and metering of the voltages and currents that it delivers.

The reason for this "revolution" is the semiconductor—the transistor, integrated circuit, or other solid-state device that is not very tolerant of extreme voltage and current changes. As we well know. even a small change in a DC supply voltage can play havoc with a solid-state circuit.

To fill the needs of the modern electronics bench, the Heath Company has introduced eight great new power supply kits. There are four pairs of fraternal twins, and are shown in the photo at the top of this page and on this month's front cover.

When we at Radio-Electronics previewed these kits, just a few months ago, we learned that they included several rather special features. They provide either constant current or constant voltage. A remote-sensing connection permits precise compensation for voltage drop at the load when the power supplies are used with long leads. The digital readout units have a two-decade auto-ranging to provide high resolution for low voltage and current settings. And the units are fully protected against shorted outputs or even the chance of open remote sensing leads.

A bit further on we'll take a closer look at each of these features, but for now, lets stop for just a moment and scan the specifications listed in Tables I, II and III.

Now that we've taken a moment to look at the specifications of this family of power supplies, let's take a quick run-down on how they work. All eight power supplies are pretty much alike, except for their output ratings. So we can talk about one unit and, in effect, be describing all of them at the same time.

The Heathkit Laboratory Power Supplies all consist of six basic circuits—a power source (the power transformer block in Fig. 1), the output amplifier current source (Q101 in Fig. 2), the output amplifier (Q1, Q2, Q3, Q4 in Fig. 1), the voltage regulator, and the display circuit (a block diagram of the digital display circuit is shown in Fig. 2).

Because of its size and complexity

TABLE I — SPECIFICATIONS
(TYPICAL FOR MODEL IP2731)

LOAD REGULATION
- **Voltage** ±0.05% + 1mV
- **Current** ±0.10% + 1mA

LINE REGULATION
- **Voltage** ±0.05% + 1mV
- **Current** ±0.10% + 1mA

RIPPLE & NOISE
- **Voltage** — 1mV RMS, 0.03% of rated output, peak-to-peak.

READOUT ACCURACY
- **Voltage: Analog** — ±3% of rated output.
- **Digital** — ±0.5% of reading ±1 count using lab standard. ±1% of reading ±1 count using built-in calibrator.
- **Current: Analog** — ±3% of rated output.
- **Digital** — ±1% of reading +4 counts using lab standard. ±1.5% of reading +4 counts using built-in calibrator.

STABILITY AT OUTPUT
- **Voltage** ±(0.01% + 1mV/hr
- **Current** ±(0.05% + 1mA)/hr

LOAD TRANSIENT RECOVERY
Output voltage within 0.05% + 1mV within 50 μs for rated output current change or 5A, whichever is less.

OUTPUT VOLTAGE OVERSHOOT
None, using power switch only.

OPERATING MODES
Constant voltage, constant current, auto-series, auto-parallel.

PROGRAMMING MODE
- **Voltage** — A—Zero to rated output with 0 to 5.0V applied; B-Zero to rated output with 0 to 5000-ohm external resistor.
- **Current**—Zero to rated output with applied voltage to 1.0 volt/amp.
- **Frequency response** — DC to 100 Hz, 2 dB.
- **Transient response** — 0.1 ms for low current to high current change. 1.0 ms for high current to low current change.

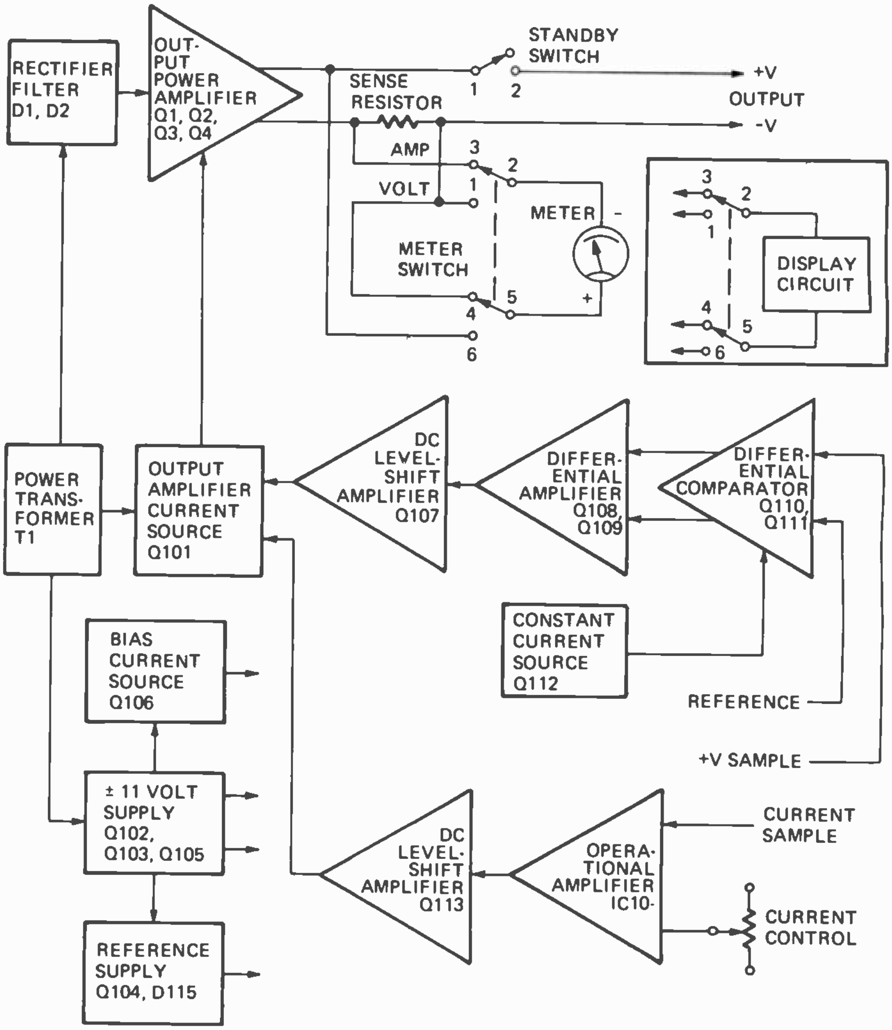


FIG. 1—BLOCK DIAGRAM OF THE COMPLETE power supply. When shown in this way it doesn't appear as elaborate as it really is.

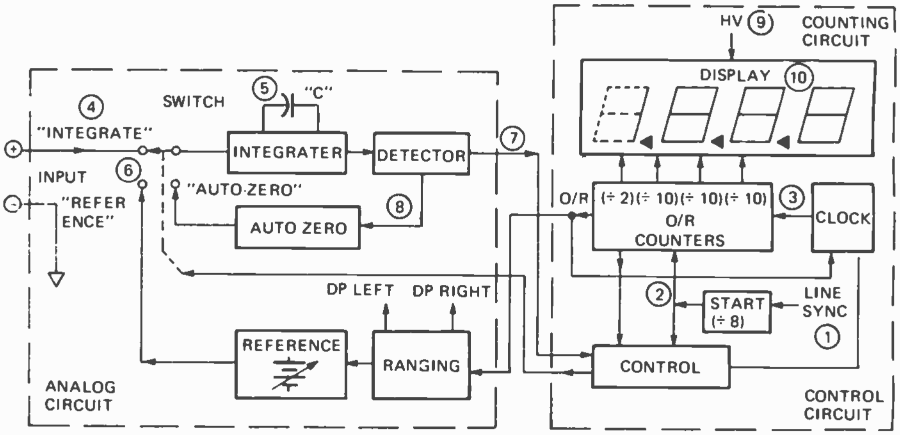


FIG. 2—BLOCK DIAGRAM OF THE DIGITAL READOUT CIRCUIT. Follow this diagram along with Fig. 3 when looking at how it works.

we are unable to present the full schematic of the power supply here, so for the purposes of this discussion we will use the block diagrams of Fig. 1 and Fig. 2.

The power source

The power transformer (T1) has a dual primary that can be switch selected to permit 120 VAC or 240 VAC, 50/60 Hz operation. The secondaries, of course, supply the AC voltages to power the various circuits in the unit.

One secondary is connected to the output amplifier current source. In addition, it supplies voltage to the meter lamps. Another secondary feeds a rectifier filter network to produce a 75 VAC output (for the 60-volt supply). Still another secondary is used to produce +20 and −20 VDC sources for the +11 VDC and −11 VDC supplies. This voltage is fed through a

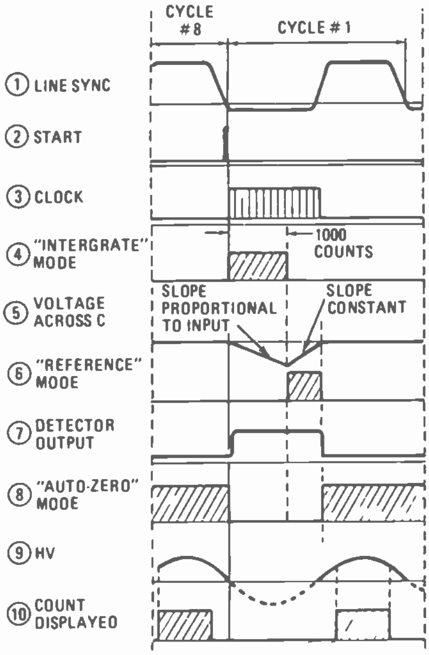


FIG. 3—WAVEFORMS IN THE digital readout circuit. Use along with Fig. 2.

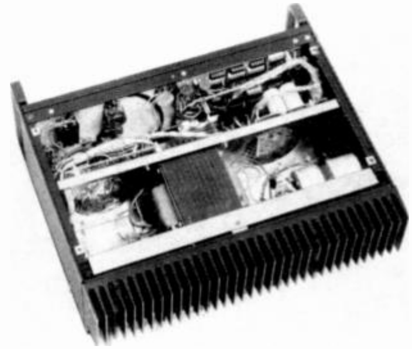
constant-current network so the regulated 11 volts is available for use in the current and voltage regulators.

Output amplifier current source

This circuit supplies drive current to the output amplifier. Its constant-current output is controlled by the current and voltage regulators to maintain the desired power supply output level.

Output amplifier

The output amplifier supplies the output power. The power transistors in this circuit are connected in parallel. Power from the output amplifier current source is amplified and coupled to the base of the power transistors. This current determines the voltage as well as the maximum current passed by the power transistors.



WITH ITS COVER REMOVED you can take a look inside the power supply.

The output amplifier current source operates at a higher DC voltage level than the output amplifier. This insures that up to six power supplies can operate in parallel with complete voltage and current control.

Voltage regulator

The voltage regulator maintains the output voltage level and consists of three primary circuits — a differential comparator that compares a sample of the output voltage to a reference voltage, a differential amplifier to amplify the error signal from the comparator, and a DC level-shift amplifier to sink current from the output amplifier current source.

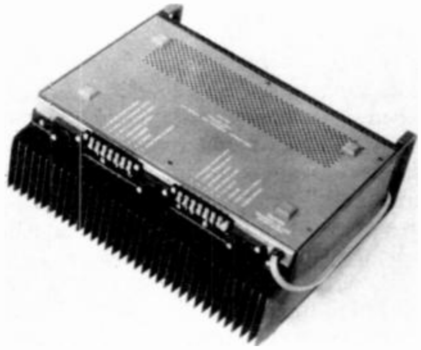
Current regulator

Current limiting is controlled by two basic circuits—an operational amplifier that compares a reference voltage to the voltage drop across the current sense resistor, and a DC level-shift amplifier to sink current from the output amplifier current source.

As the output current exceeds the level set by the current control, the comparator generates a positive voltage that is coupled to the base of the DC level shift amplifier (Q113). This increases the base current, which in turn increases the collector current and sinks current from the output amplifier current source. A lower current level to the output amplifier will limit the current the output amplifier can supply.

Display circuit

As we mentioned earlier there are two display options—an analog meter or a digital readout. In either case the



MASSIVE HEAT SINKS cover the entire rear panel of the power supply.

meter switch is used to read either voltage or current as desired. The analog circuit uses a conventional meter. The digital circuit is a bit more elaborate. A block diagram of this circuit is in Fig. 2. In the description that follows you will want to refer to this block diagram along with Fig. 3, which shows the functional waveforms.

The line sync signal (waveform 1) is derived from the line voltage frequency ot 50 or 60 Hz and is applied to the start circuit, a divide-by-8 counter. After 8 cycles, the start circuit generates a 1-μs pulse (waveform 2). This pulse resets the display counters to 9000, and resets the control circuit for a measurement cycle. When reset, the control circuit starts the clock (waveform 3) and switches the analog circuit to the "integrate" mode (waveform 4).

As the counters count the clock pulses, the integrator output develops a voltage on timing capacitor C (waveform 5), at a rate that is proportional to the positive input voltage (that is the charge voltage versus time increases with higher input voltage levels).

Integration continues as the counters count from 9000 to 9999. The next clock pulse "sets" the counters to 0000, which tells the control circuit to switch the analog circuit to the "reference" mode (waveform 6).

While the counters continue to count up from 0000, a negative reference voltage causes the voltage across timing capacitor C to ramp back toward zero. The ramp slope is constant, because of the fixed reference voltage.

TABLE II — ANALOG POWER SUPPLIES

	Max. Rated Output		Readout Range	
Model	**Voltage**	**Current**	**Voltage**	**Current**
IP/SP-2700	60 V	1.5 A	0 to 60	0 to 1.5
IP/SP-2710	30 V	3.0 A	0 to 30	0 to 3.0
IP/SP-2720	15 V	5.0 A	0 to 15	0 to 5.0
IP/SP-2730	7.5 V	10.0 A	0 to 7.5	0 to 10.0

TABLE III — DIGITAL POWER SUPPLIES

	Max. Rated Output		Readout Range	
Model	**Voltage**	**Current**	**Voltage**	**Current**
IP/SP-2701	60 V	1.5 A	0.00 to 19.99 20.0 to 60.00 *	.000 to 1.500
IP/SP-2711	30 V	3.0 A	0.00 to 19.99 20.0 to 30.0 *	.000 to 1.999 2.00 to 3.00 *
IP/SP-2721	15 V	5.0 A	0.00 to 15.00	.000 to 1.999 2.00 to 5.00 *
IP/SP-2731	7.5 V	10.0 A	0.00 to 7.50	.000 to 1.999 2.00 to 10.00 *

*Autoranged

When the detector senses a zero voltage across C, its output goes low (waveform 7) and signals the control circuit to turn off the clock. The count stored in the counters represents the input voltage. When the control circuit turns off the clock, it also switches the analog circuit to the "auto zero" mode (waveform 8). This lets the integrator and detector stabilize to prepare for a new measurement cycle.

During the preceding operations, the high voltage to the display tubes was low, as represented by the dotted portion of waveform 9, and the display was not lit. As the high voltage goes more positive, a level is reached where the gas in the tubes ionizes waveform 10) and the seven-segment digits display the count stored in the counters. Each of the next seven positive portions of the high voltage signal relight the display tubes.

If, during the "reference" mode of operation, the count exceeds 1999, the overrange (O/R) output of the counters turns the clock off and triggers the ranging circuit. This increased the reference voltage level by a factor of 10, and shifts the decimal point (DP) position. Thus, on the next measurement cycle, the timing capacitor will discharge 10 times more quickly and the count will be displayed with one decade less resolution.

Figure 4 shows a front panel diagram of one of the digital power supplies. Note that all front-panel control functions are clearly illustrated. These are the same for all four digital readout units.

Figure 5 shows the rear panel of the power supply. Each output terminal is identified to give you a better idea of the capabilities of these units.

Summary

There is little doubt that if you have been looking for a first-rate power supply for your bench at a practical price these new Heath units are what you have been looking for.

The manuals for assembly are just as easy to follow and as complete in detail as we have grown to expect from Heath. And while I haven't built one of these power supplies yet, I'm confident it will be as straightforward a job as all of the previous Heathkits.

Finally, all major circuitry is on individual circuit boards and wiring harnesses are provided to reduce complicated point-to-point wiring to a minimum.

Prices for all four analog units are $169.95 and the digital units are $219.95 in kit form. All eight are also available completely assembled at somewhat higher prices. I'm sure you'll be wanting to add one of these power supplies to your bench. **R-E**

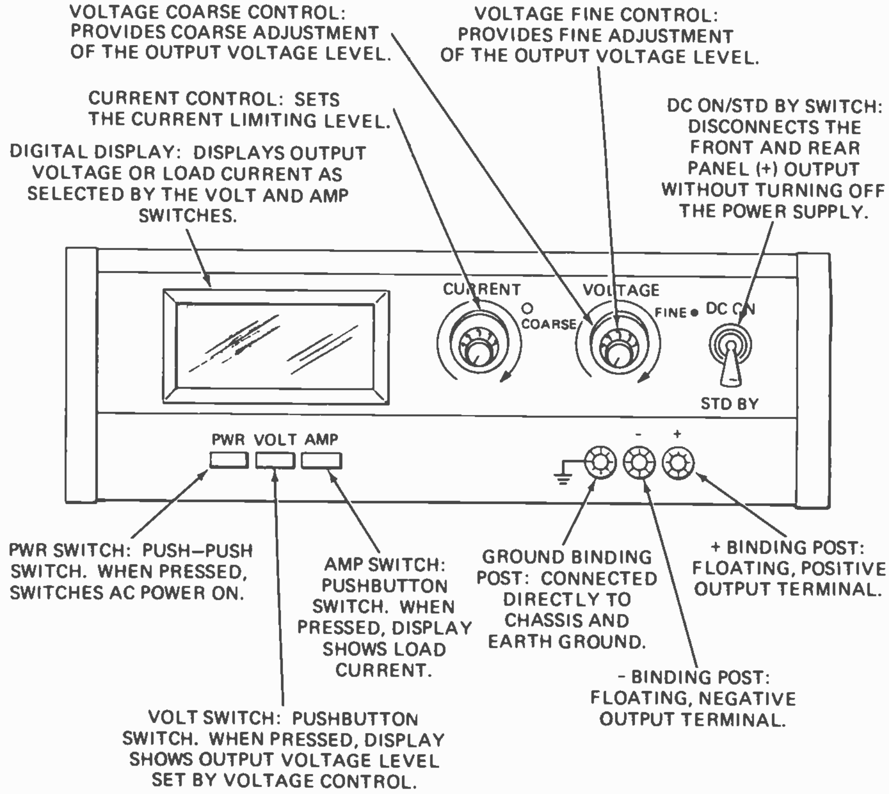


FIG. 4—FRONT PANEL CONTROLS ARE IDENTIFIED in this diagram and their functions are detailed. The units are easy to use yet versatile.

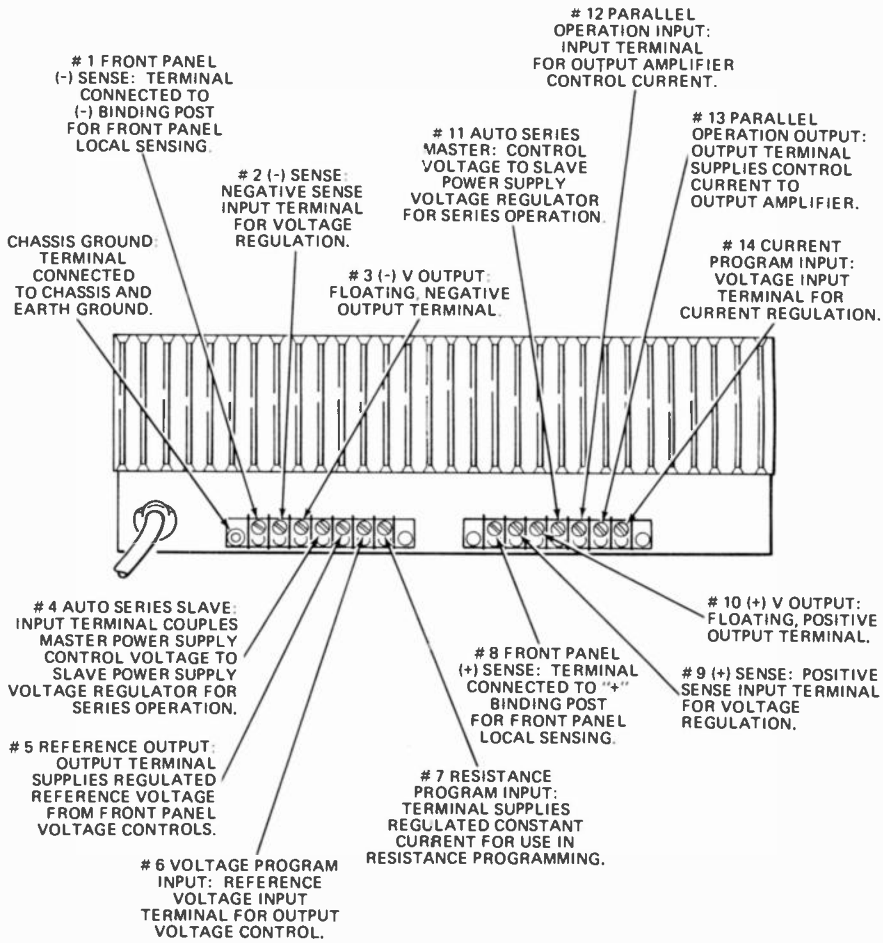


FIG. 5—OUTPUT TERMINALS OF THE LAB POWER SUPPLY are shown here. Again this helps give a picture of what the units can do.