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Knight KG-663 **Regulated DC Power Supply**

If you're experimenting with transistors and integrated circuits these days, you need a good reliable variable dc source—regulated, stable and usually, pretty *stiff*. The new Knight KG-663 Regulated DC Supply fills all of these requirements plus several interesting features not usually economically available to the amateur or experimenter: current limiting, short-circuit protection, and remote programming and sensing.

The KG-663 features variable voltage from zero to 40 volts and *variable* current limiting up to 1.5 amperes with a completely solid-state circuit. The basic power supply consists of a dual full-wave rectifier and capacitive filter system and a series regulator. A dual potentiometer across the output is used to adjust the voltage; the dual feature permits both *coarse* and *fine* control of the output voltage. The voltage adjust pots actually control the base bias on the error detector transistor. The emitter of this transistor is maintained at 0.9 volts by a bias reference source. Once the voltage adjust knob is set, any change in output voltage is detected by the error detector, amplified by the error-amplifier transistor, and adjusts the series-regulating transistors to compensate for the change.

Since this action is almost instantaneous, the regulator action provides additional filtering action and reduces ripple on the output to a very low level. Capacitors connected across the voltage-adjusting pots make the error detector much more sensitive to ac ripple components. The result is a supply which exhibits less than 0.6 millivolts rms (0.0006 V rms) ripple, even at the full-rated load of 1.5 amps.

If the output of a regulated supply is short circuited, the regulator tries to main-

tain the output voltage present before the short occurred. Since the current quickly reaches very high values with a short circuit across the output terminals, the supply will burn out if it is not protected in some way. Fuses have been used for this purpose, but their action is usually so slow that the semiconductors in the supply will be destroyed before the fuse blows.

In the KG-663 this sad series of events is curtailed by a current-limiting circuit. The current-limit transistor samples the output current and is normally cut off. If a short circuit occurs with the current-limit control set to maximum, the current-limit transistor is turned on, removes control from the error detector and error amplifier transistors, and biases the series regulator transistors down to the point where two amps is maintained. This is a safe current level for a limited time. When the short circuit is removed, the output voltage returns to its preset value. With this circuitry, the KG-663 supply is not damaged by external short circuits. The current limit control permits the maximum current to be adjusted from two amperes down to 100 to 200 milliamperes.

In addition to current limiting, protection is also provided for reverse voltage. A diode connected across the output terminals protects the electrolytic capacitors and series regulator transistors from externally applied reverse voltages. This reverse voltage diode is particularly important where two or more supplies are connected in series for higher supply voltages. If, in this case, the ac power is removed from one of the supplies and not the other, the protective diode prevents damage to the unenergized supply which would result from a reverse

polarity.

If two or more KG-663 power supplies are connected in parallel to provide more output current, the series-regulator transistors must be protected from reverse voltages. This is accomplished with a diode connected across them. The only other requirement for operating these supplies in parallel is to connect a 0.1 ohm, 1 watt resistor in the positive lead of each supply. Then each of the supplies must be adjusted to exactly the same output voltage. This may be confirmed by connecting the positive leads together—there should be no deflection of either voltmeter.

Two interesting features incorporated into the KG-663 supply are remote error sensing and programming. These items are usually found only in very expensive commercial units. For most applications the load is connected to either the front-panel binding posts or the rear output terminals, but in some cases the load must be separated from the power supply by a relatively great distance. In this case the remote sensing feature can be used if precise voltage regulation is required.

The regulator will maintain the voltage at the output terminals, but if long leads are required to the load and the current is high, there may be a significant voltage drop. To maintain the desired voltage at the load itself, external voltage sensing leads may be connected across the load. These leads are connected directly to the voltage adjusting controls and error detector transistor. Since they only carry about 10 milliamps, 22 gauge or larger wires are sufficient. With the external sensing connected, the power supply compensates for line loss due to lead resistance and a constant voltage is maintained at the load.

In some applications it may be desirable to control the output voltage from a remote point. This may be accomplished with the KG-663 through the remote programming feature. Basically, an external 4000-ohm voltage-adjust potentiometer is connected across the remote programming terminals at the rear of the supply. If desired, both the remote programming and remote error sensing may be used simultaneously.

Although the current-limiting circuitry provides sufficient current regulation for most applications, in some cases precise current regulation is required. This may be obtained in the KG-663 with an external

Knightkit KG-663 Specifications

Output voltage:	0-40 volts.
Output current:	0-1.5 amperes.
Output load regulation:	Less than 60 millivolts (0.6 V) from no load to full-rated load.
Line regulation:	Less than 0.3 volts change under all load conditions.
Ripple:	Less than 0.6 mV rms at full load.
Output impedance:	Less than 0.1 ohm from dc to 10 kHz; less than 0.5 ohm to 100 kHz.
Current limiting:	Continuous, adjustable from front panel.
Short-circuit protection:	Continuous dissipation type.
Features:	Remote error sensing, remote programming, precise current regulation, positive or negative ground, may be stacked for series or parallel operation.
Semiconductors:	6 transistors, 11 diodes.
Meters:	Voltage and current.
Size and weight:	7 $\frac{3}{4}$ x 7 $\frac{1}{2}$ x 10 $\frac{3}{4}$ inches. 16 pounds.
Power requirements:	110-130 volts, 50/60 Hz, 20 watts at no load; 110 watts at full-rated load.
Price:	\$99.95 kit; \$149.00 factory assembled.

current-sensing resistor and the external sensing feature.

Assembly of the Knightkit KG-663 is very straight forward and only requires three or four evenings work. The instruction manual is well laid out, well illustrated and easy to follow. If you have not assembled a Knightkit before, you will be pleased with the ease with which they go together and the high quality components used. For example, instead of providing several rolls of hookup wire, Knightkit furnishes labor-saving pre-cut and stripped lengths. Wiring errors are practically eliminated by the pre-power resistance checks and preliminary tests outlined in the construction manual.

The KG-663 variable dc power supply is a very versatile unit which should find a lot of use on the amateur's bench. The 1.5 ampere capability of the supply is particularly useful when breadboarding integrated circuit projects. The 0-40 volt output meets almost every requirement for transistor work. In addition, the current-limiting circuit may save that expensive transistor circuit you're working on. These features, coupled with the remote error sensing and programming, comprise a power supply that's hard to beat in terms of versatility, regulation, convenience and cost.

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