



ICL8075-9

Ultra Precision Temperature Stabilized Voltage References

PRELIMINARY
Specifications Subject To Change Without Notice

FEATURES

- Laser-trimmed to precise voltage
- Extremely low temperature coefficient (typ <math>< 1\text{ ppm}/^\circ\text{C}</math>)
- Short-circuit protected
- Thermally isolated die for minimum power consumption
- Separate heater supply for good noise rejection, application flexibility
- Wide range of end-use oriented output voltages
- Wide operating voltage range on both reference and heater
- Heater control system operates correctly at low voltage, avoiding thermal latchup problems

The series of devices is produced by adjusting basic parts with various metal masks so that exact voltages are available for the most popular A/D and D/A converters. This avoids the necessity to perform adjustments in most cases, and reduces the problems with trim range and temperature coefficient loss in all others.

This series is divided into two basic groups, those with outputs less than the band-gap voltage (ICL8075/6), and those with higher outputs (ICL8077/8/9). The nominal reference voltage (cardinal value) is coded in the second part of the number, with two digits and a "D" for a decimal value or a "B" for a binary value, at the decimal point location.

Each device is packaged in a standard 8-pin TO-99 package, but the die is mounted on an insulating ceramic substrate to ensure a high thermal resistance from the die to the case. This usually undesirable condition is beneficial in this case, since it reduces the power consumption of the heater as far as possible, and facilitates maintaining the die temperature at about 85°C , even in cold ambient conditions.

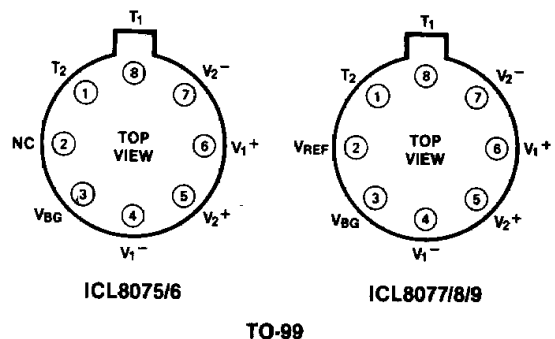
GENERAL DESCRIPTION

The ICL8075-9 are a family of precision laser-trimmed voltage references that incorporate a substrate heater to produce extremely low overall voltage temperature coefficients.

ORDERING INFORMATION

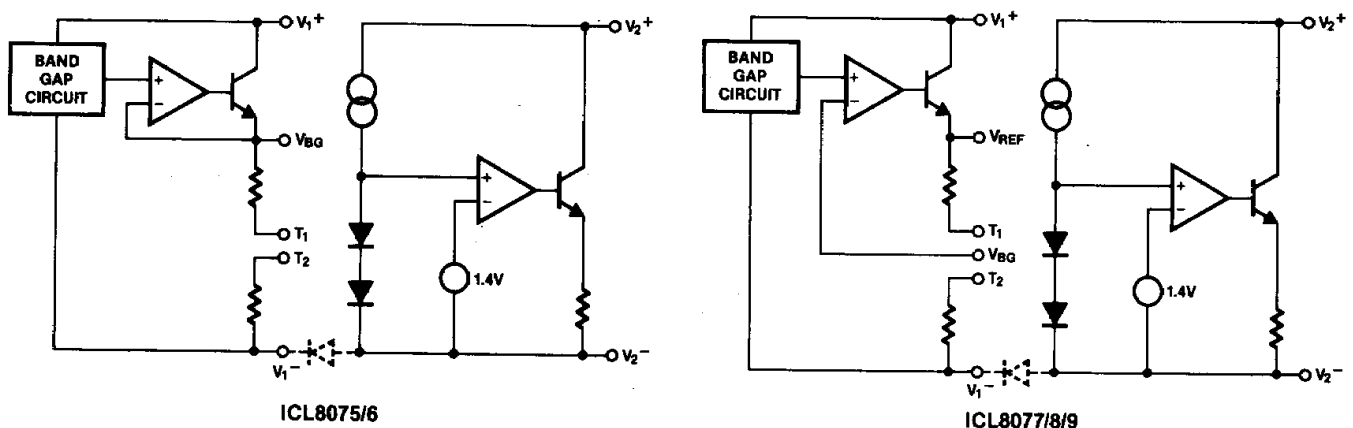
PART NUMBER	VOLTAGE	0.4% (8-BIT)	0.03% (12-BIT)
ICL8075-0D1	0.10	ICL8075-0D1JCTV	ICL8075-0D1LCTV
ICL8076-1D0	1.00	ICL8076-1D0JCTV	ICL8076-1D0LCTV
ICL8077-2D5	2.50	ICL8077-2D5JCTV	ICL8077-2D5LCTV
ICL8077-2B5	2.56	ICL8077-2B5JCTV	ICL8077-2B5LCTV
ICL8078-5D0	5.00	ICL8078-5D0JCTV	ICL8078-5D0LCTV
ICL8078-5B1	5.12	ICL8078-5B1JCTV	ICL8078-5B1LCTV
ICL8079-10D	10.00	ICL8079-10DJCTV	ICL8079-10DLCTV
ICL8079-10B	10.24	ICL8079-10BJCTV	ICL8079-10BLCTV

PIN CONFIGURATION (outline dwg TV)



TO-99

BLOCK DIAGRAMS



ICL8075-9

ABSOLUTE MAXIMUM RATINGS

Supply Voltage V_1^+ to V_1^-	36V
Heater Supply V_2^+ to V_2^-	36V
Supply Differential V_1^- to V_2^-	0V-36V
Operating Temperature	0°C to 70°C
Storage Temperature	-65°C to +160°C
Power Dissipation (@ 25°C)	150mW
derate @ other temperatures @ 4mW/°C	
Heater Current	150mA
Output Current	35mA
Lead Temperature (Soldering, 10 sec)	300°C

PRELIMINARY

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Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these or any other conditions above those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

DC ELECTRICAL CHARACTERISTICS

$V_1^+ = 15V$, $V_2^+ = 15V$, $V_1^- = V_2^- = 0V$, $T_A = 25^\circ C$ unless otherwise specified.

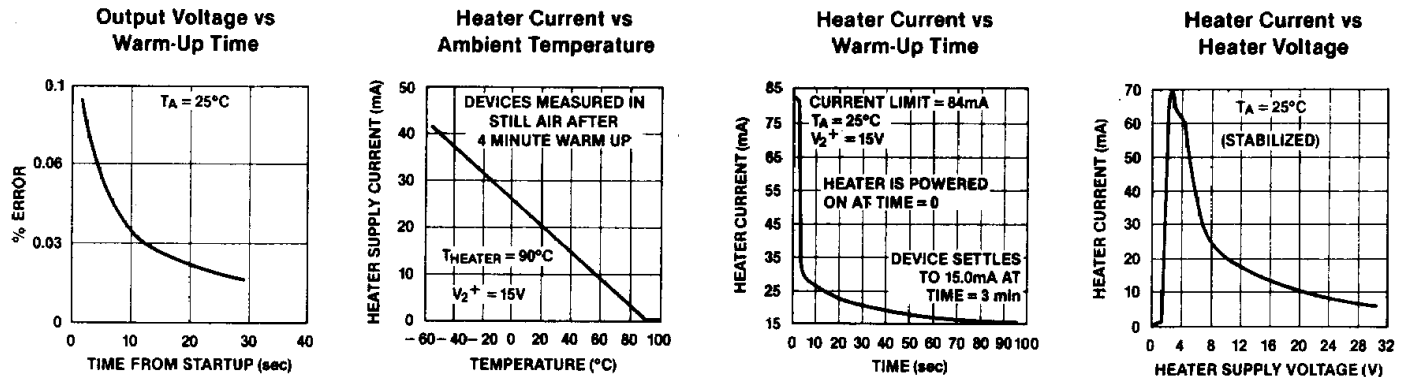
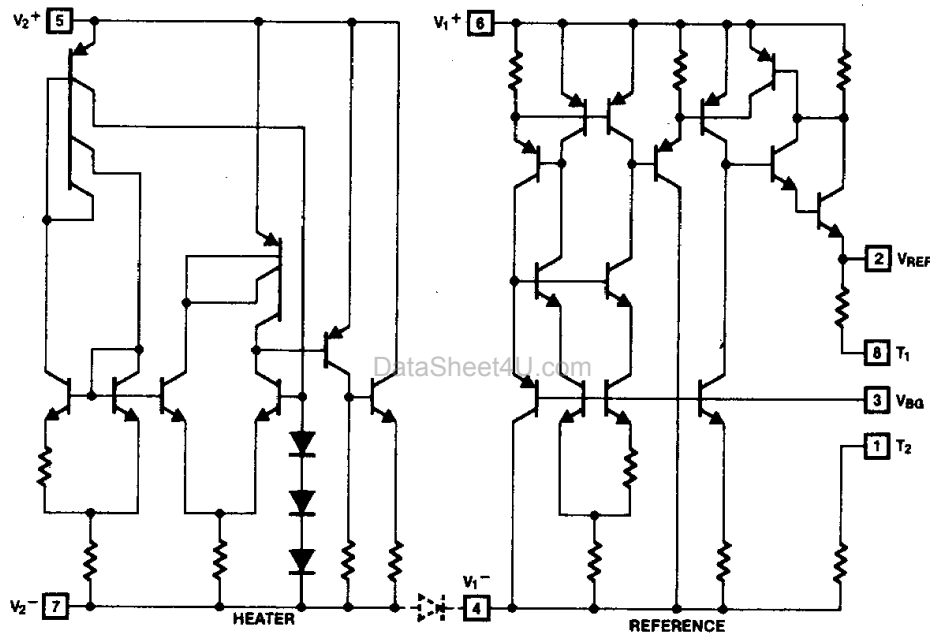
PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Supply Voltage Ranges Reference Supply	V_1^+	$(V_{REF} > 1.2)$	3.2		30	V
Heater Supply	V_2^+		$V_{OUT} + 2$		30	
Absolute Accuracy of V_{OUT}		Heater Settled J Grade L Grade		0.1 0.02	0.4 0.03	%
Line Regulation		V_1^+ to $V_1^- = 15V$ to 30V		0.002	0.005	%/V
Load Regulation of V_{OUT} (ICL8077/8/9 Only)		$I_{OUT} = 0mA$ to 5mA		0.03	0.05	%/mA
Short-Circuit Limits V_{OUT} (ICL8075/6) (ICL8077/8/9) V_{BG} (ICL8075/6) (ICL8077/8/9)	I_{SC}	(Note 1)		1 20 20 1	40 40	mA
Output Drive Capability V_{OUT} V_{BG}		ICL8077/8/9 Only (Note 2) ICL8075/6 Only	5 0	7		mA
Maximum Heater Current	I_{HTR}			90	130	mA
Supply Current Reference Section Heater Section	I_1^+ I_2^+	Device Warmed Up (Still Air)	10	250 15	450 20	μA mA
Temperature Coefficient of V_{OUT}		$V_2^+ > 8V$, $-55^\circ C < T_A < +85^\circ C$ $+85^\circ C < T_A < +125^\circ C$ (or $V_2^+ = 0$)		1 20		ppm/ $^\circ C$
Settling Time, Heater Power-Up		To 0.03% of Final Value		10	30	sec

Note 1. This will cause the output voltage to rise to approximately V_1^+ , potentially hazardous to the load.

Note 2. The output impedance of V_{OUT} on the ICL8075/6 and of V_{BG} on the ICL8077/8/9 is about 5k Ω . Loading either of these points can lead to serious errors.

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DataSheet

ICL8075-9**TYPICAL CHARACTERISTICS****EQUIVALENT SCHEMATIC DIAGRAM (ICL8077/8/9 Shown)****DETAILED DESCRIPTION**

The ICL8075-9 family consists of two semi-independent circuits within one die. One of these is a band-gap reference circuit with several possible mask options, each of which can be laser-trimmed to a specific value of output voltage. The circuit configuration depends on whether this voltage is less than or greater than the actual band-gap voltage (1.25V) itself. The laser-trimming is also used to reduce as far as possible the intrinsic temperature coefficient of the basic band-gap circuit. For devices whose output is lower than 1.2V, the band-gap voltage is divided by a pair of resistors to provide the required output, with the ratio of these resistors being adjusted to achieve the desired result. The higher output devices divide down the output of the internal amplifier to the band-gap value, again adjusting the resistor ratio to the requisite value.

The other section of the circuit is a constant temperature heater system, which takes another band-gap type voltage

and compares it to the voltage drop across a string of diodes. The result of the comparison is used to drive a pair of large heater transistor/resistor elements. The inherent feedback of this combination causes the die to be heated until the diode drop matches the band-gap-derived reference level, thus ensuring an almost constant temperature on the die. Care has been taken in the die layout to ensure that the large currents and temperature gradients associated with the heater do not degrade the accuracy and consistency of the band-gap reference output of the other section. Also, the die has been mounted on a thermally isolating substrate to reduce the required heater power and the temperature gradients across the die. The result is that the reference circuit sees only about 1/100 of the ambient temperature change, allowing a 1ppm/ $^\circ\text{C}$ temperature coefficient to be achieved in monolithic form.

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The coexistence of two circuits on one die has some implications; however. The high currents that flow in the heater section need to be isolated from the reference section, so separate supply pins are provided for the two sections. Although these are fairly independent, there is only one substrate for the die, which must be attached to one of the supplies, and therefore restrict the "freedom" of the other. In the ICL8075 family, the substrate is tied to the negative terminal of the heater supply (V_2^-), and the negative supply of the reference section (the V_1^- pin) must not be allowed to be negative with respect to this point.

The heater will take some time to heat the die up to its operating temperature. During this time, the output voltage will change at a rate determined by the intrinsic temperature coefficient of the reference, leading to some appreciable "warm-up" drift. The time required for this drift is given as the settling time for the heater, although the heater dissipation

settling time is substantially longer, owing to the longer thermal time constants of the package. Further, the choice of the die operating temperature leads to some compromises also. Clearly, the higher the operating temperature, the more power needed to sustain it at any given ambient temperature, and also the poorer the reliability of the device. On the other hand, if too low a temperature is chosen, the point at which temperature stabilization breaks down will be within the desirable operating range, leading to a degraded temperature coefficient. The ICL8075 family is laser-trimmed to stabilize at about $+85^\circ\text{C}$, so that the temperature coefficient break point is outside the commercial and industrial temperature ranges.

The trim pads on the ICL8075/6 and ICL8077/8/9 can be used to adjust the output voltage, in either direction, to finer precision than is available in the part itself. Figures 1 and 2 show two methods of adjustment, suitable for either type of device.

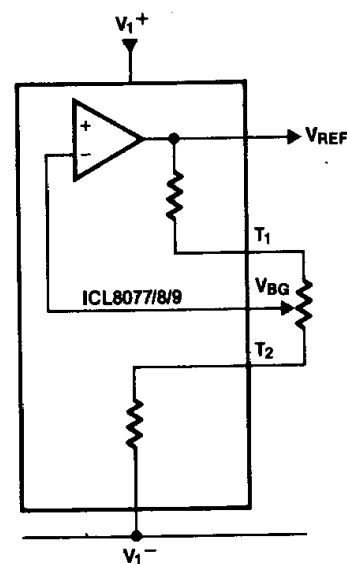
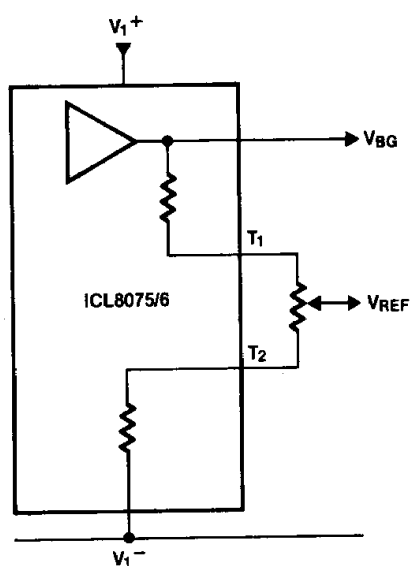


Figure 1. Fine Trim Circuit

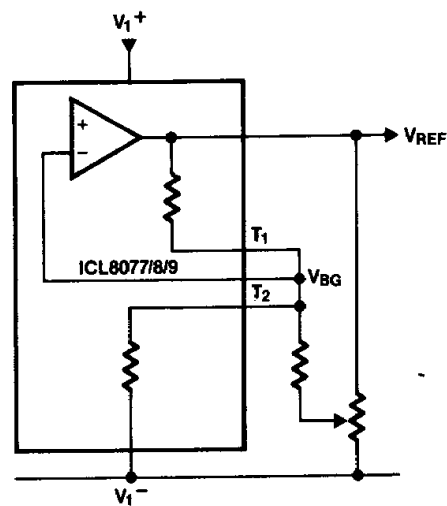
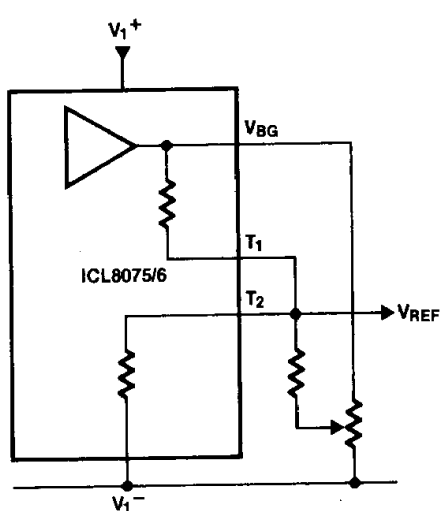


Figure 2. Alternative Trim Circuit

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APPLICATIONS

There are many possible applications of reference circuits, of course. One typical use is in A/D converters, such as the 4½-digit integrating converter shown in Figure 3. This schematic is roughly that of the ICL7135EV/Kit evaluation kit, on which provision has been made to accept an ICL8076-1D0 as a 1.000V reference. The PC board includes space for a potentiometer for fine adjustment of the voltage, since the accuracy of the ICL7135 is higher than that of the best grade of ICL8076.

Another common requirement is for references for D/A converters, such as the ICL7134 shown in Figure 4. This device offers 14-bit accuracy, without laser-trimming, by the expedient of using a CMOS PROM on the die to correct for the errors of the analog section. The circuit shown is that with a bipolar output, using a chopper-stabilized op amp, the ICL7650, to achieve high accuracy without adjustments and at low cost. A "binary" type of reference here will lead to a decimal value for the LSB; thus a 10.24V reference gives an LSB of 1/16mV.

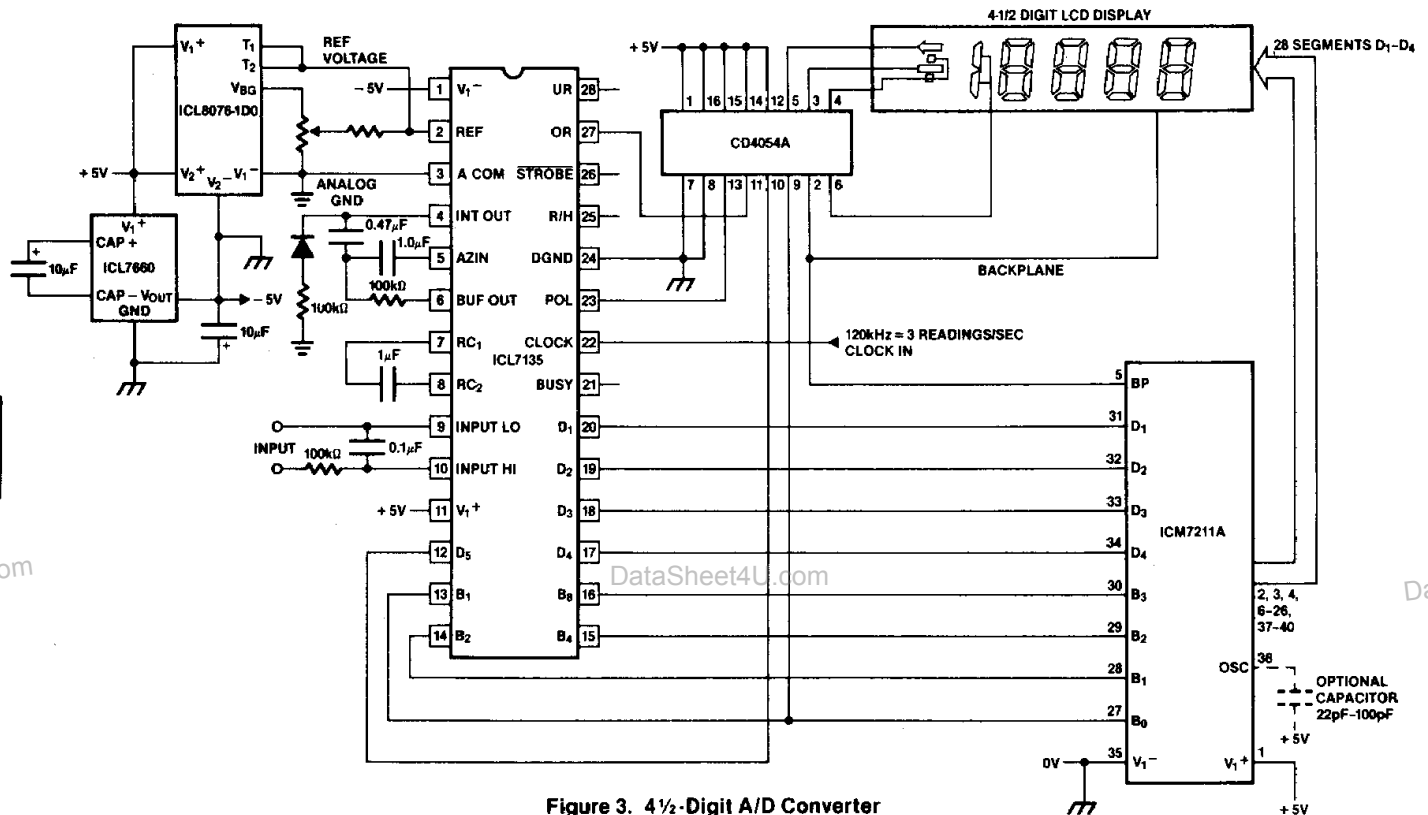


Figure 3. 4½-Digit A/D Converter

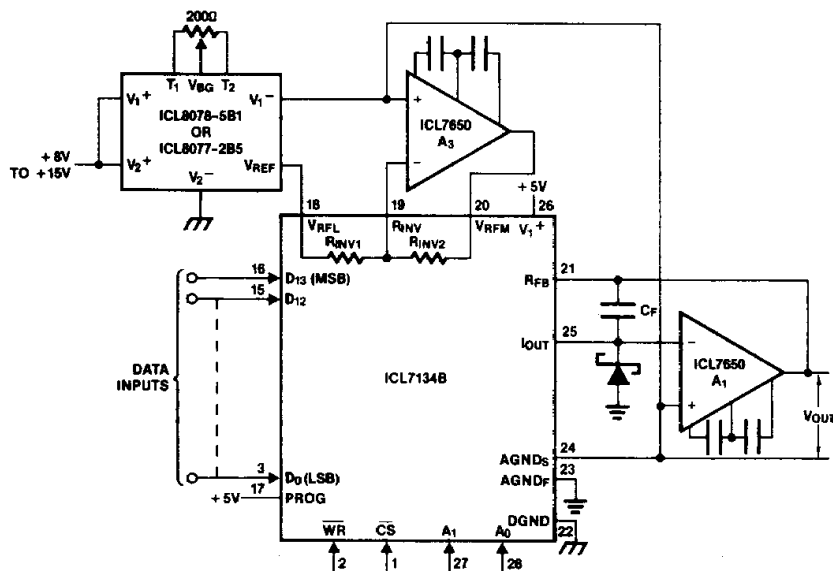


Figure 4. 14-Bit D/A Converter Without Adjustments

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APPLICATIONS (Continued)

Other applications are in accurate power supply circuits, such as that shown in Figure 5, which uses an ICH8530 power amplifier and a standard AD7541 DAC to set the output value.

Up to 3A at up to $\pm 30V$ can be controlled by this circuit, with errors well under 0.1%. The circuit is based on the same principle as Figure 4, but with a power output buffer.

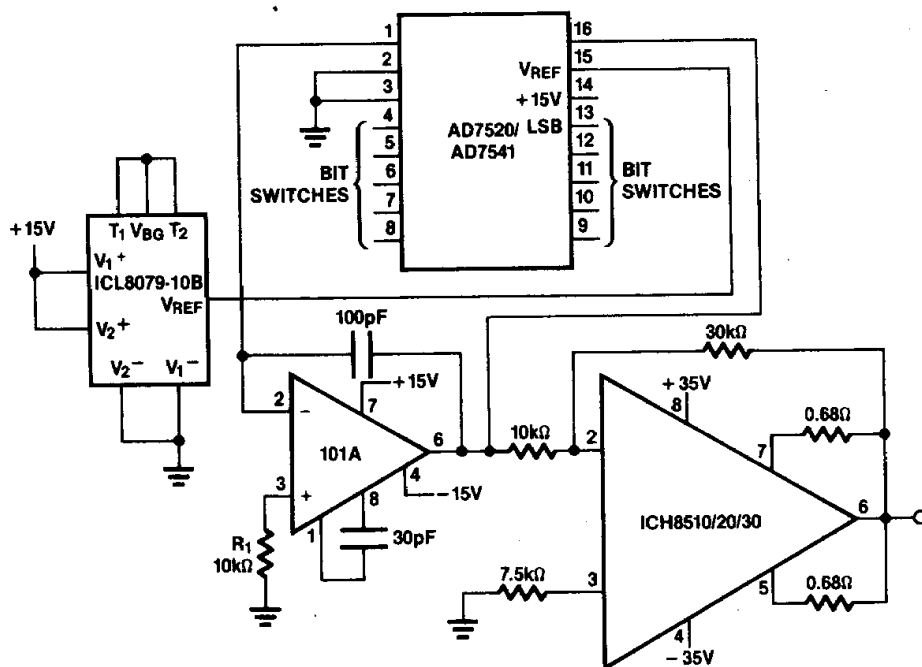


Figure 5. Accurate Power Supply Circuit

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