RC4194

Dual Tracking Voltage Regulators

Features

- Simultaneously adjustable outputs with one resistor to ±35V
- Load current: ±200 mA with 0.04% load regulation
- Internal thermal shutdown at T_J = +175°C
- External balance for ±V_{OUT} unbalancing

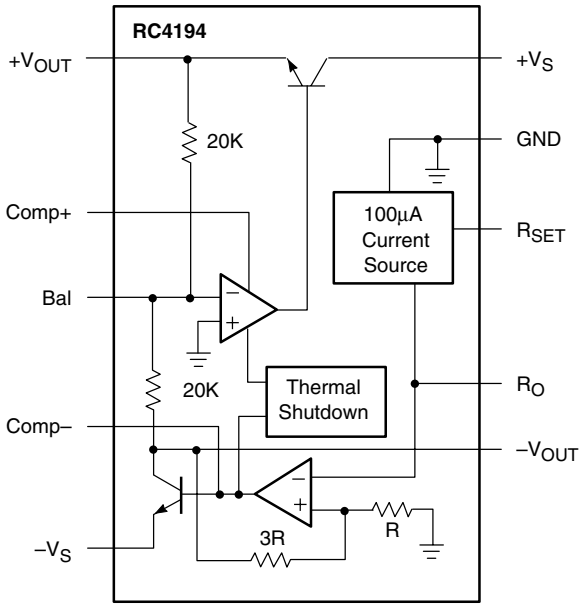
Description

The RC4194 is a dual polarity tracking regulator designed to provide balanced or unbalanced positive and negative output voltages at currents to 200 mA. A single external resistor adjustment can be used to change both outputs between the limits of ±50 mV and ±35V.

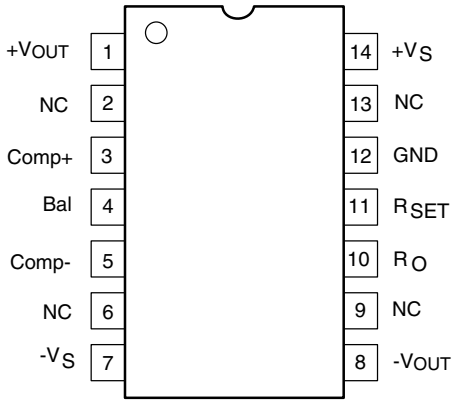
The device is designed for local "on-card" regulation, eliminating distribution problems associated with single-point regulation. To simplify applications the regulator requires a minimum number of external parts.

The device is available in the N package, 14-pin dual in-line, and will dissipate up to 625 mW.

Block Diagram



Pin Assignments



Absolute Maximum Ratings

(beyond which the device may be damaged)[1]

Parameter	Min	Typ	Max	Units
Supply Voltage			±35	V
Supply Input to Output Voltage Differential			±35	V
Load Current			100	mA
$P_D T_A$ < 50°C			468	mW
Operating Temperature (T_j)	0		70	°C
Storage Temperature	-65		150	°C
Junction Temperature			125	°C
Lead Soldering Temperature (60 seconds)			300	°C
For T_A > 50°C Derate at		6.25		mW/°C

Note:

1. Functional operation under any of these conditions is NOT implied.

Operating Conditions

Parameter		Min	Typ	Max	Units
θ_{JA}	Thermal Resistance		160		°C/W

Electrical Characteristics

($\pm 5 \le V_{OUT} \le V_{MAX}$; $-V_{IN} \le -8V$; $I_L = \pm 1mA$; $0°C \le T_j \le +70°C$ unless otherwise specified)

Parameters	Test Conditions	Min	Typ	Max	Units
Line Regulation	$\Delta V_S = 0.1\ V_{IN}$		0.04	0.1	$\%V_{OUT}$
Load Regulation[1]	$\pm V_S = \pm (V_{OUT} + 5)V$		0.002	0.004	$\%V_{OUT}/I_L$ (mA)
Output Voltage Drift With Temperature[2]					
Positive Output	$V_{OUT} = \pm 5V$		0.002	0.015	%/°C
Negative Output	$V_{OUT} = \pm 5V$		0.003	0.015	%/°C
Supply Current[3] (Positive)	$V_S = \pm V_{MAX}$, $V_{OUT} = 0V$, $I_L = 0$ mA		+0.8	+2.5	mA
Supply Current[4] (Negative)	$V_S = \pm V_{MAX}$, $V_{OUT} = 0V$, $I_L = 0$ mA		-1.8	-4.0	mA
Supply Voltage		±9.5		±35	V
Output Voltage Scale Factor	$R_{SET} = 71.5\ k\Omega$, $T_j = +25°C$, $V_S = \pm V_{MAX}$	2.38	2.5	2.62	kΩ/V
Output Voltage Range	$R_{SET} = 71.5\ k\Omega$, $I_L = 25$ mA	0.05		±35	V
Output Voltage Tracking			±0.4	±2.0	%
Ripple Rejection	F = 120 Hz, $T_j = +25°C$		70		dB
Input-Output Voltage Differential	$I_L = 50$ mA, $T_j = +25°C$	3.0			V
Short Circuit Current	$V_S = \pm 30V$, $T_j = +25°C$		300		mA
Output Noise Voltage	$C_L = 4.7\ \mu F$, $V_{OUT} = \pm 15V$, F = 10 Hz to 100 kHz		250		μV_{RMS}
Internal Thermal Shutdown			175		°C

Notes:

1. Measured as $\left(\frac{\Delta V_{OUT}}{V_{OUT}} \times 100\%\right) \S\ I_L$ (mA)
2. Output voltage temperature drift guaranteed by design.
3. The current drain will increase by $50\mu A/V_{OUT}$ on positive side and $100\mu A/V_{OUT}$ on negative side.
4. The specifications above apply for the given junction temperatures since pulse test conditions are used.

Typical Performance Characteristics

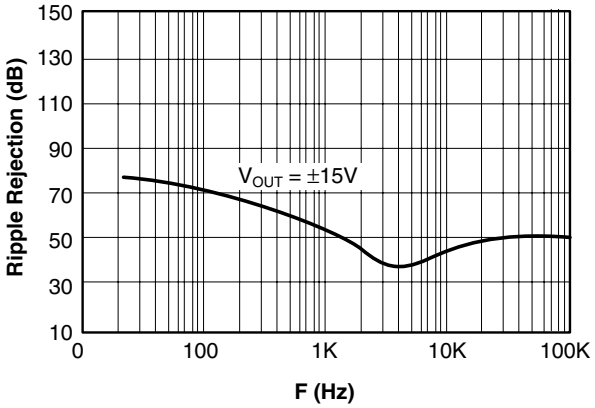


Figure 1. Ripple Rejection vs. Frequency

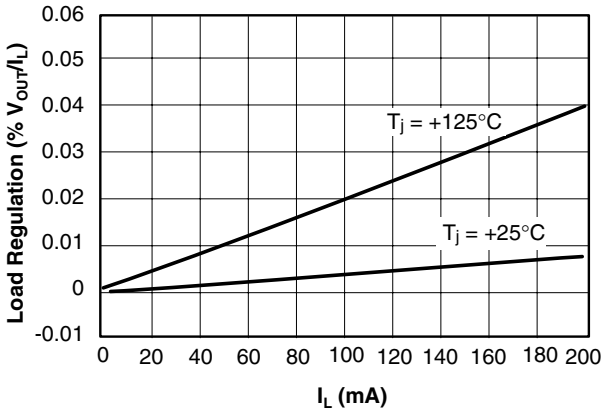
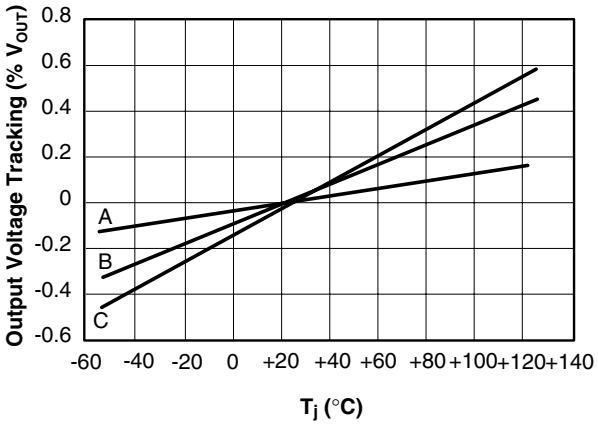


Figure 2. Load Regulation vs. Load Current



A = % Tracking of V_{OUT}
B = T.C. for Positive Regulator
C = T.C. for Negative Regulator

Figure 3. Output Voltage Tracking vs. Temperature

Typical Applications

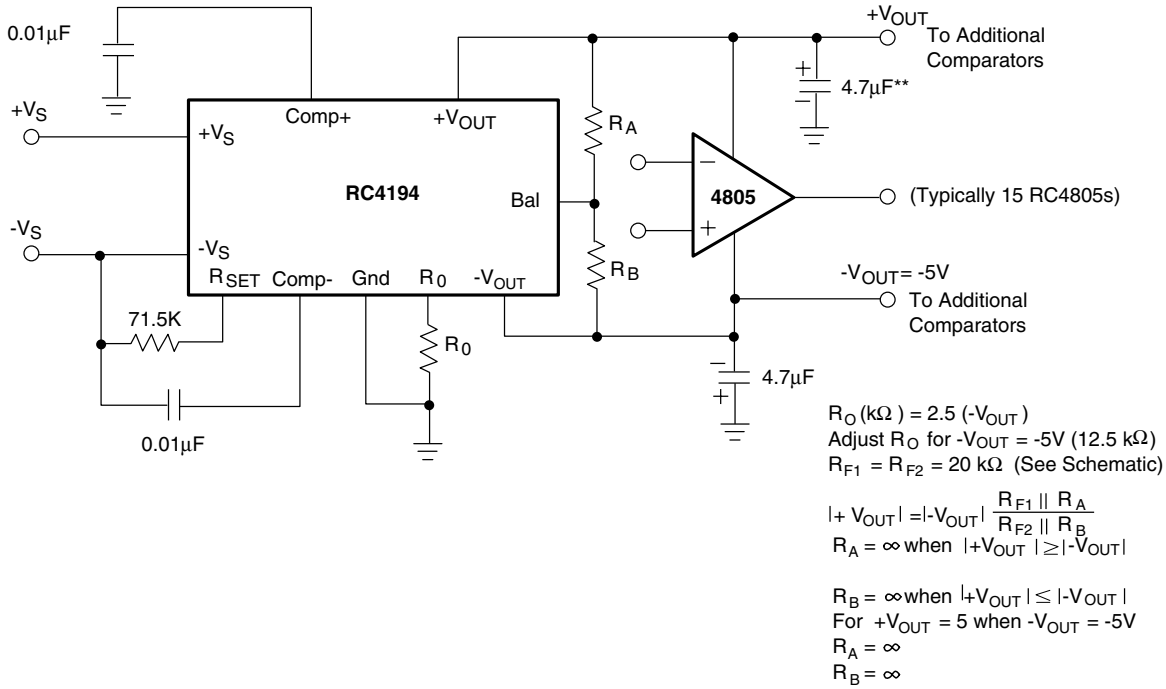
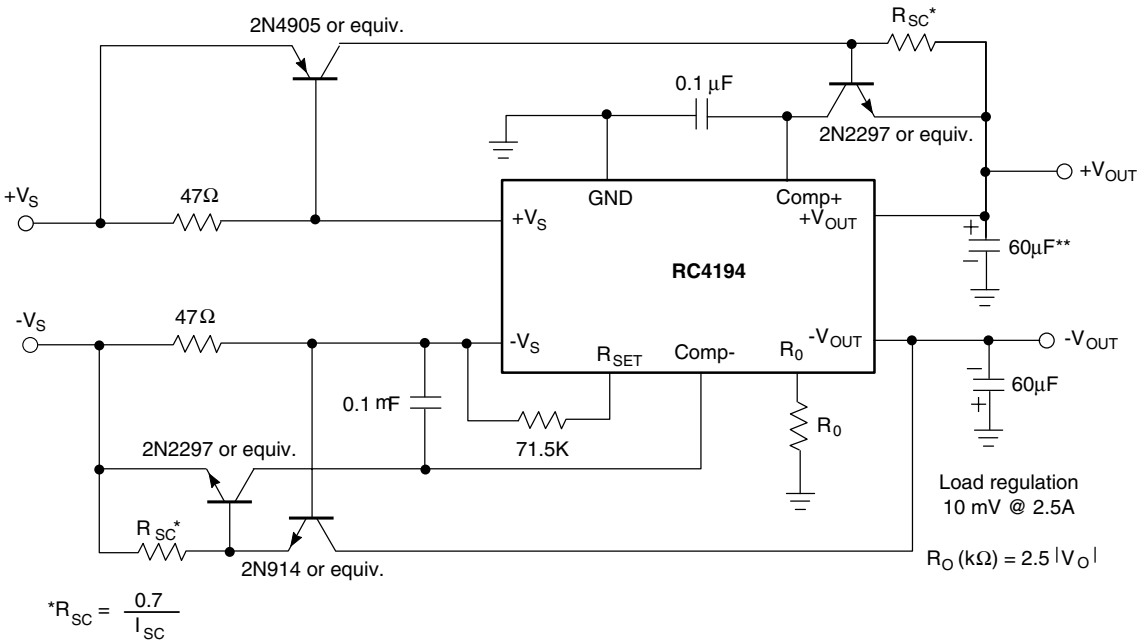


Figure 4. Unbalanced Output Voltage — Comparator Application



**Optional usage - Not as critical as $-V_O$ bypass capacitors.

Note: Compensation and bypass capacitor connections should be close as posibe to the RC4194

Figure 5. High Output Application

Typical Applications (continued)

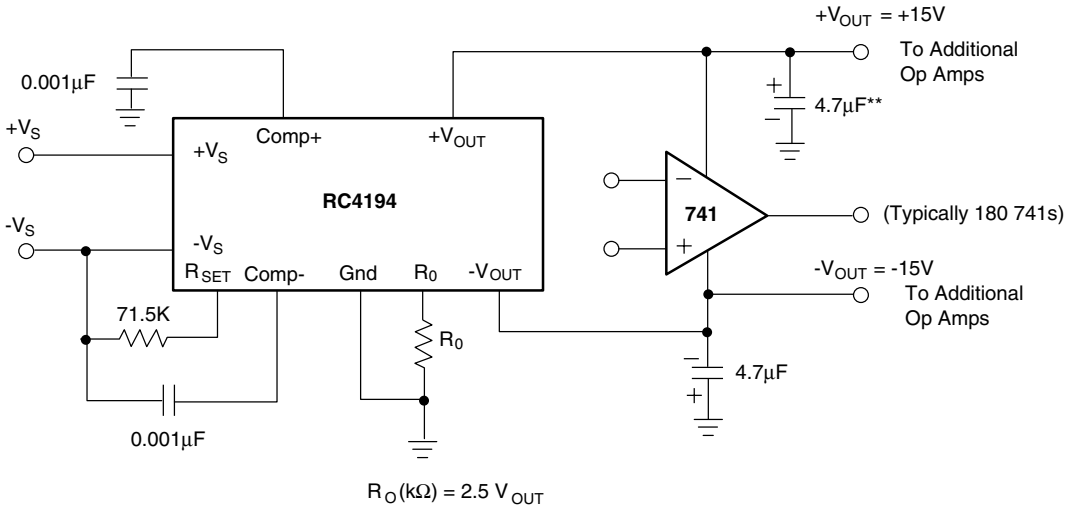


Figure 6. Balanced Output Voltage — Op Amp Application

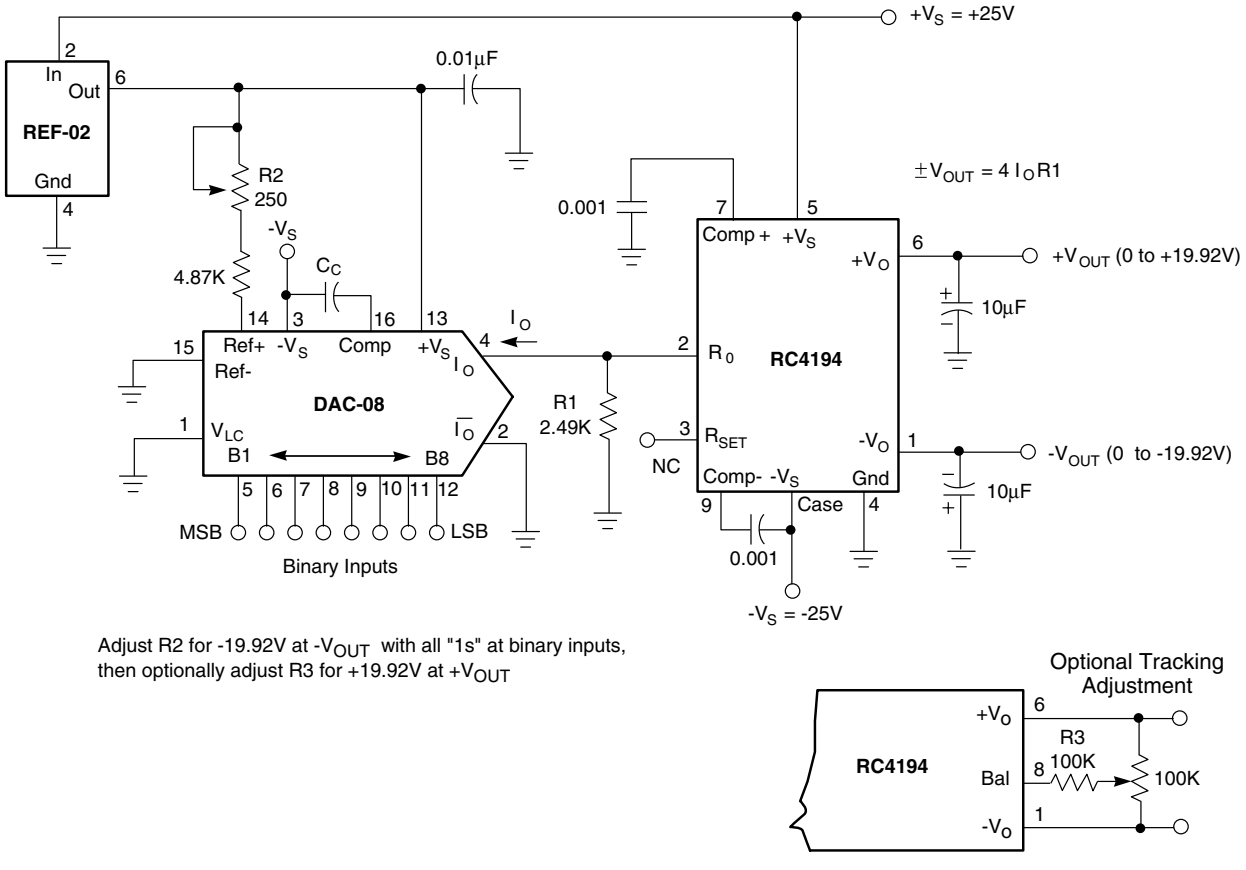


Figure 7. Digitally Controlled Dual 100 mA Voltage Regulator

RC4194 Switchable Power Supply

The outputs of the RC4194 can be simultaneously switched on or off under logic control as shown in Figure 8. In the "off" state, the outputs will be forced to a minimum voltage, or about ±20 mV, rather than becoming open-circuit. The turn-on time, with the outputs programmed to ±12V, is approximately 200 μs. This circuit works by forcing the R0 pin to ground with an analog switch.

Refer to the RC4194 internal schematic diagram. A reference voltage that regulates with respect to $-V_S$ is generated at the RSET pin by the zener diode Q12 and the buffer circuit of Q11 and Q13. When the external 71.5k RSET resistor is connected between the R_{SET} pin and $-V_S$, a precision current of 100 μA is generated which then flows into Q13's collector. Since Q13's collector is tied to the R0 pin, the 100 μA current will develop a ground-referenced voltage drop proportional to the value of R0, which is then amplified by the internal error amplifier. When the analog switch in Figure 8 turns on, it effectively shorts out R0 and causes 0V to be applied to the error amplifier. The output voltage in the off state will be approxi-mately ±20 mV. If a higher value (50 to 100 mV) is acceptable, then the DG201 analog switch can be replaced with a low-cost small signal transistor, as shown in the alternate switch configuration.

Compensation

For most applications, the following compensation technique is sufficient. The positive regulator section of the RC4194 is compensated by a 0.001 μF ceramic disc capacitor from the Comp+ terminal to ground. The negative regulator requires compensation at two points. The first is the Comp– pin, which should have 0.001 μF to the $-V_S$ pin, or case. A ceramic disc is ideal here. The second compen-sation point for the negative side is the $-V_{OUT}$ terminal, which ideally should be a 4.7 μF solid tantalum capacitor with enough reserve voltage capacity to avoid the momentary shorting and reforming which can occur with tantalum caps. For systems where the cost of a solid tantalum capacitor cannot be justified, it is usually sufficient to use an aluminum capacitor with a 0.03 μF ceramic disc in parallel to bypass high frequencies. In addition, if the rectifier filter capacitors have poor high frequency characteristics (like aluminum electrolytics) or if any impedance is in series with the $+V_S$ and $-V_S$ terminals, it is necessary to bypass these two points with 0.01 μF ceramic disc capacitors. Just as with monolithic op amps, some applications may not require these bypass caps, but if in doubt, be sure to include them.

All compensation and bypass caps should have short leads, solid grounds, and be located as close to the 4194 as possible. Refer to Figure 9 for recommended compensation circuitry.

Protection

In systems using monolithic voltage regulators, a number of conditions can exist which, left uncorrected, will destroy the regulator. Fortunately, regulators can easily be protected against these potentially destructive conditions. Monolithic regulators can be destroyed by any reversal of input or output voltage polarity, or if the input voltage drops below the

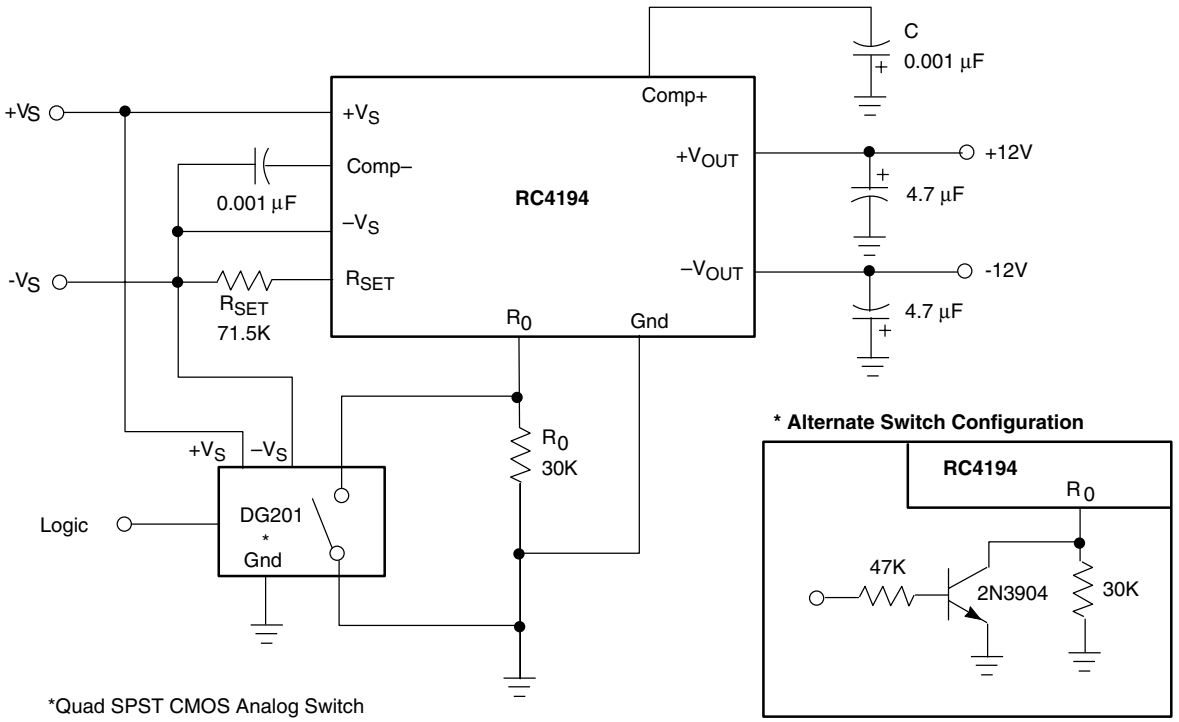


Figure 8. ±12V Switchable Power Supply

output voltage in magnitude. These conditions can be caused by inductive loads at the inputs or outputs of the regulator. Other problems are caused by heavy loads at the unregulated inputs to the regulator, which might cause the input voltage to drop below the output voltage at turn-off. If any of the preceding problem conditions are present in your system, it is recommended that you protect the regulator using diodes. These diodes should be high speed types capable of handling large current surges. Figure 10 shows all six of the possible protection diodes. The diodes at the inputs and outputs prevent voltages at those points from becoming reversed. Diodes from outputs to inputs prevent the output voltage from exceeding the input voltage. Chances are that the system under consideration will not require all six diodes, but if in doubt, be sure to include them.

Brownout Protection

The RC4194 is one of the most easily applied and trouble-free monolithic ICs available. When used within the data sheet ratings (package power dissipation, maximum output current, minimum and maximum input voltages) it provides the most cost-effective source of regulated ±15V for powering linear ICs.

Sometimes occasions arise in which the RC4194 ratings must be exceeded. One example is the "brownout." During a brownout, line voltages may be reduced to as low as 75 VRMS, causing the input voltage to the RC4194 to drop below the minimum dropout voltage. When this happens, the negative output voltage can go to positive. The maximum amount of current available is approximately 5 mA.

In general this is not enough current to damage most ICs which the RC4194 might be supplying, but it is a potentially destructive condition. Fortunately, it is easy to protect against. As shown in the typical application circuit in Figure 11, a diode, D, can be connected to the negative output.

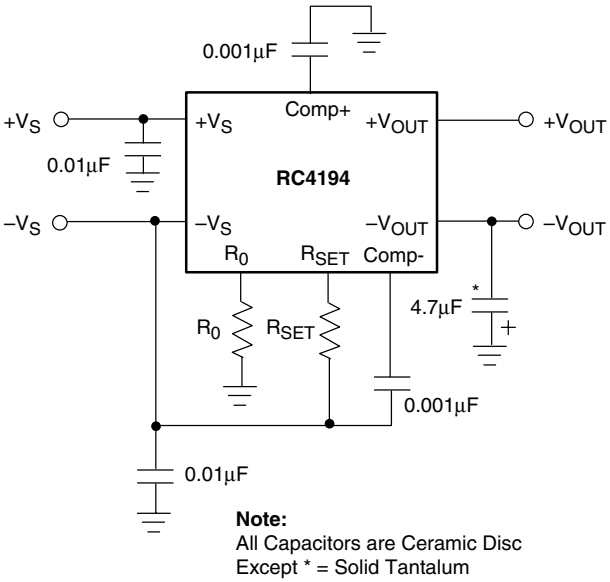


Figure 9. RC4194 Recommended Compensation

If a small signal silicon diode is used, it will clamp the negative output voltage at about +0.55V. A Schottky barrier or germanium device would clamp the voltage at about +0.3V. Another cure which will keep the negative output negative at all times is the 1 mΩ resistor connected between the +15V output and the Comp- terminal. This resistor will then supply drive to the negative output transistor, causing it to saturate to -1V during the brownout.

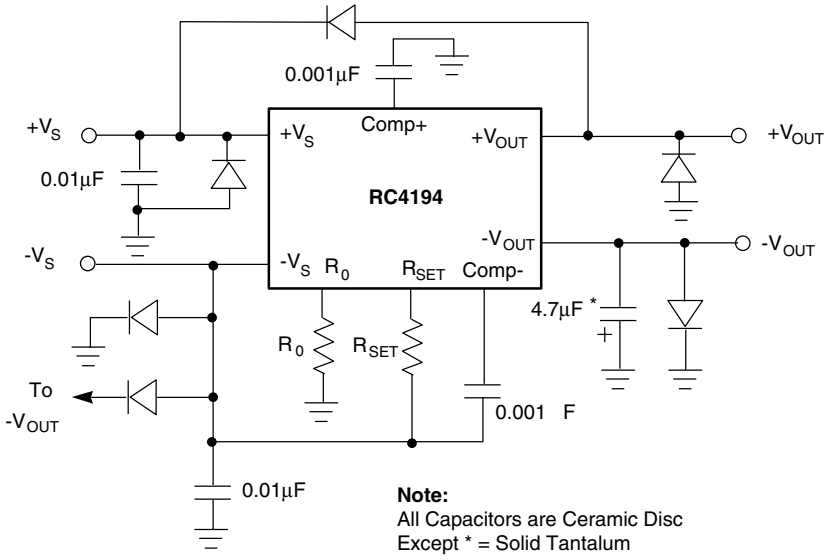
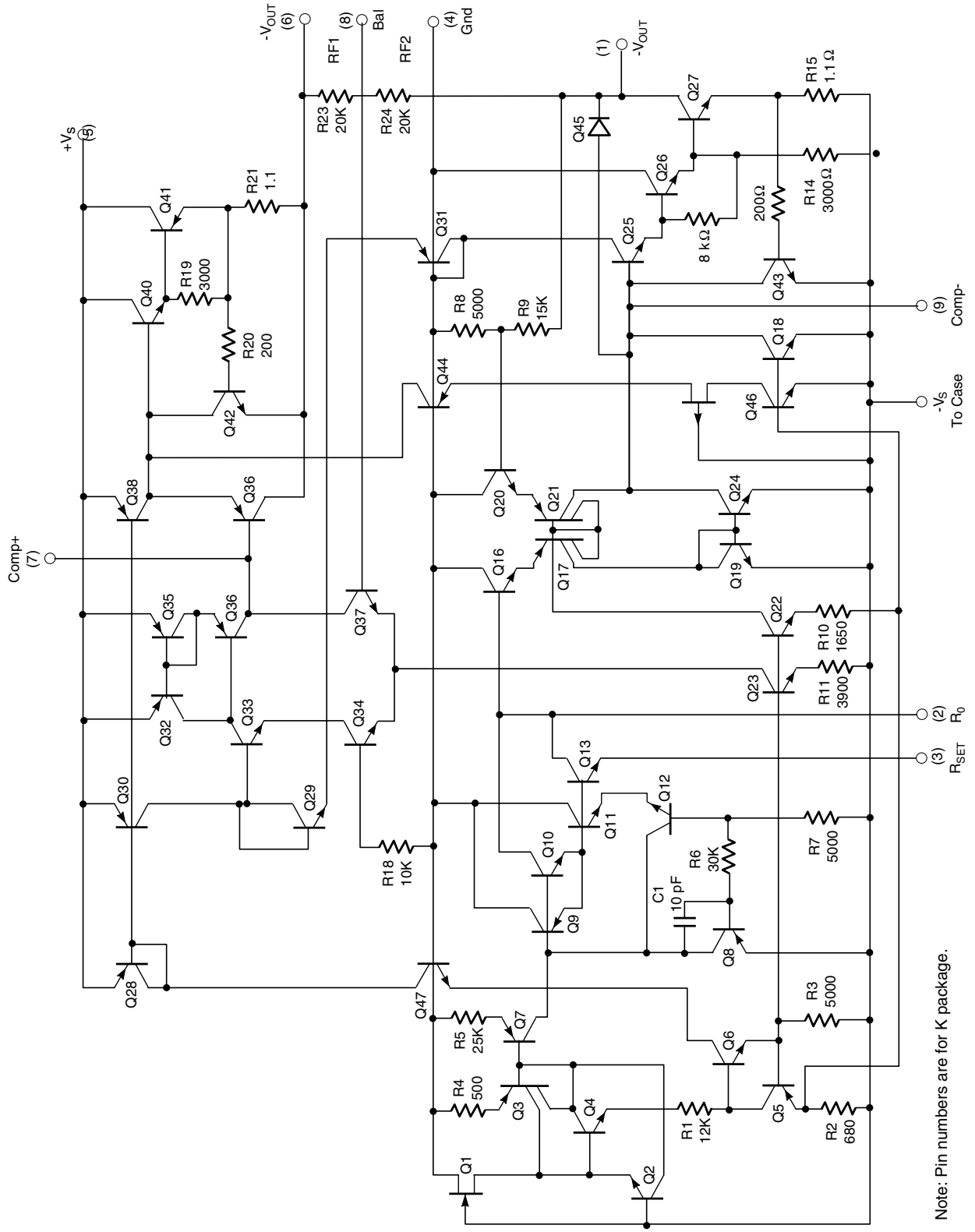


Figure 10. RC4194 Regulator Showing All Protective Diodes

Simplified Schematic Diagram



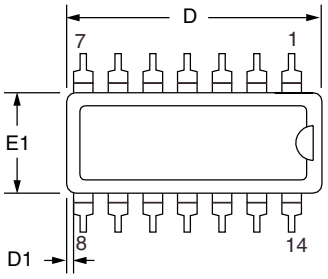
Mechanical Dimensions

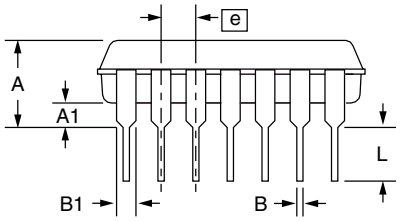
14-Lead Plastic DIP Package

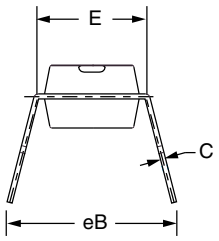
Symbol	Inches		Millimeters		Notes
	Min.	Max.	Min.	Max.	
A	—	.210	—	5.33	
A1	.015	—	.38	—	
A2	.115	.195	2.93	4.95	
B	.014	.022	.36	.56	
B1	.045	.070	1.14	1.78	
C	.008	.015	.20	.38	4
D	.725	.795	18.42	20.19	2
D1	.005	—	.13	—	
E	.300	.325	7.62	8.26	
E1	.240	.280	6.10	7.11	2
e	.100 BSC		2.54 BSC		
eB	—	.430	—	10.92	
L	.115	.200	2.92	5.08	
N	14		14		5

Notes:

1. Dimensioning and tolerancing per ANSI Y14.5M-1982.
2. "D" and "E1" do not include mold flashing. Mold flash or protrusions shall not exceed .010 inch (0.25mm).
3. Terminal numbers are shown for reference only.
4. "C" dimension does not include solder finish thickness.
5. Symbol "N" is the maximum number of terminals.







Ordering Information

Product Number	Temperature Range	Screening	Package
RC4194N	0° to +70°C	Commercial	14 pin Plastic DIP