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NTE923 & NTE923D
Integrated Circuit
Precision Voltage Regulator

Description:

The NTE923 and NTE923D are voltage regulators designed primarily for series regulator applications. By themselves, these devices will supply output currents up to 150mA; but, external transistors can be added to provide any desired load current. The circuits feature extremely low standby current drain, and provision is made for either linear or foldback current limiting.

These devices are also useful in a wide range of other applications such as shunt regulators, current regulators, and temperature controllers.

Features:

- 150mA Output Current without External Pass Transistor
- Output Currents in Excess of 10A Possible by Adding External Transistors
- Input Voltage: 40V Max
- Output Voltage Adjustable from 2V to 37V
- Can be Used as Either a Linear or a Switching Regulator

Absolute Maximum Ratings:

Pulse Voltage from V+ to V− (50ms) 50V
Continuous Voltage from V+ to V− 40V
Input−Output Voltage Differential 40V
Maximum Amplifier Input Voltage
Either Input 8.5V
Differential 5.0V
Current from V_Z 25mA
Current from V_{REF} 15mA
Internal Power Dissipation
NTE923 . . . . 800mW
NTE923D 660mW
Operating Temperature Range . . . . 0° to +70°C
Storage Temperature Range
NTE923 . . . . −65° to +150°C
NTE923D . . . . −55° to +150°C
Lead Temperature (During Soldering, 4sec max)
NTE923 . . . . +300°C
NTE923D . . . . +260°C

Electrical Characteristics: (Note 1)

Parameter	Test Conditions		Min	Typ	Max	Unit
Line Regulation	V_{IN} = 12V to 15V		–	0.01	0.1	% V_{OUT}
		0° ≤ T_A ≤ +70°C	–	–	0.3	% V_{OUT}
	V_{IN} = 12V to 40V		–	0.1	0.5	% V_{OUT}
Load Regulation	I_L = 1mA to 50mA		–	0.03	0.2	% V_{OUT}
		0° ≤ T_A ≤ +70°C	–	–	0.6	% V_{OUT}
Ripple Rejection	f = 50Hz to 10kHz	C_{REF} = 0	–	74	–	dB
		C_{REF} = 5μF	–	86	–	dB
Average Temperature Coefficient of Output Voltage	0° ≤ T_A ≤ +70°C, Note 2		–	0.003	0.015	%/°C
Short Circuit Current Limit	R_{SC} = 10Ω, V_{OUT} = 0		–	65	–	mA
Reference Voltage			6.80	7.15	7.50	V
Output Noise Voltage	BW = 100Hz to 10kHz	C_{REF} = 0	–	86	–	μV_{rms}
		C_{REF} = 5μF	–	2.5	–	μV_{rms}
Long Term Stability			–	0.05	–	%/1000Hrs
Standby Current Drain	I_L = 0, V_{IN} = 30V		–	1.7	4.0	mA
Input Voltage Range			9.5	–	40	V
Output Voltage Range			2.0	–	37	V
Input−Output Voltage Differential			3.0	–	38	V
Thermal Resistance, Junction to Ambient NTE923D			–	105	–	°C/W
NTE923	Board mount in still air		–	225	–	°C/W
	Board mount in 400LF/Min Air flow		–	90	–	°C/W
Thermal Resistance, Junction to Case			–	25	–	°C/W

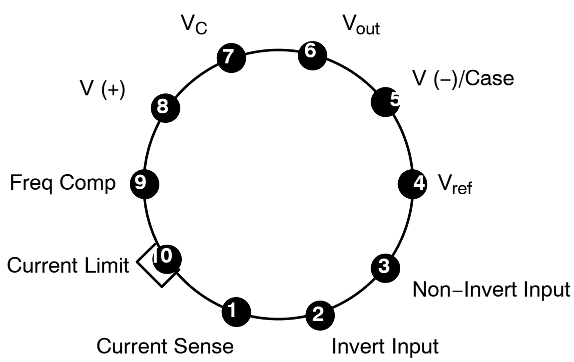
Note 1. Unless otherwise otherwise specified, T_A = +25°C, V_{IN} = V+ = V_C = 12V, V− = 0, V_{OUT} = 5V, I_L = 1mA, R_{SC} = 0, $C_!$ = 100pF, C_{REF} = 0 and divider impedance as seen by error amplifier ≤ 10kΩ. Line and load regulation specifications are given for the condition of constant chip temperature. Temperature drifts must be taken into account separately for high dissipation conditions.

Note 2. Guaranteed by correlation to other tests.

Note 3. For metal can applications where V_Z is required, an external 6.2V zener diode should be connected in series with V_{OUT}.

Pin Connection Diagram

NTE923
(Top View)



NTE923D

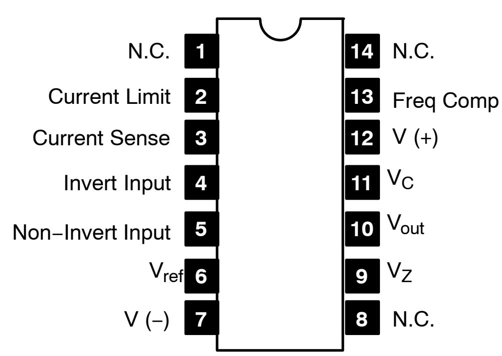


TABLE 1. Resistor Values (kΩ) for Standard Output Voltage:

Output Voltage	Applicable Figures	Fixed Output ±5%		Output Adjustable ±10% (Note 5)			Output Voltage	Applicable Figures	Fixed Output ±5%		Output Adjustable ±10% (Note 5)		
	(Note 4)	R1	R2	R1	P1	R2		(Note 4)	R1	R2	R1	P1	R2
+3.0	1, 5, 6, 9, 12 (4)	4.12	3.01	1.8	0.5	1.2	+100	7	3.57	102	2.2	10	91
+3.6	1, 5, 6, 9, 12 (4)	3.57	3.65	1.5	0.5	1.5	+250	7	3.57	255	2.2	10	240
+5.0	1, 5, 6, 9, 12 (4)	2.15	4.99	0.75	0.5	2.2	–6 (Note 6)	3, (10)	3.57	2.43	1.2	0.5	0.75
+6.0	1, 5, 6, 9, 12 (4)	1.15	6.04	0.5	0.5	2.7	–9	3, 10	3.48	5.36	1.2	0.5	2.0
+9.0	2, 4, (5, 6, 9, 12)	1.87	7.15	0.75	1.0	2.7	–12	3, 10	3.57	8.45	1.2	0.5	3.3
+12	2, 4, (5, 6, 9, 12)	4.87	7.15	2.0	1.0	3.0	–15	3, 10	3.65	11.5	1.2	0.5	4.3
+15	2, 4, (5, 6, 9, 12)	7.87	7.15	3.3	1.0	3.0	–28	3, 10	3.57	24.3	1.2	0.5	10
+28	2, 4, (5, 6, 9, 12)	21.0	7.15	5.6	1.0	2.0	–45	8	3.57	41.2	2.2	10	33
+45	7	3.57	48.7	2.2	10	39	–100	8	3.57	97.6	2.2	10	91
+75	7	3.57	78.7	2.2	10	68	–250	8	3.57	249	2.2	10	240

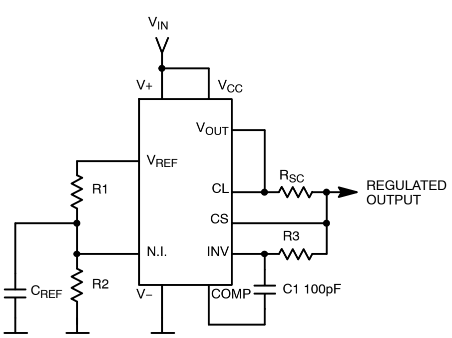
Note 4. Figures in parentheses may be used if R1/R2 divider is placed on opposite input of error amp.
Note 5. Replace R1/R2 in figures with divider shown in Figure .
Note 6. V+ and V_{CC} must be connected to a +3V or greater supply.

TABLE 2. Formulae for Intermediate Output Voltages:

Outputs from +2 to +7 Volts (Figures 1, 4, 5, 6, 9, 12)	Outputs from +4 to +250 Volts (Figure 7)	Current Limiting
$V_{OUT} = \left(V_{REF} \times \frac{R2}{R1 + R2}\right)$	$V_{OUT} = \left(\frac{V_{REF}}{2} \times \frac{R2 - R1}{R1}\right)$; R3 = R4	$I_{LIMIT} = \frac{V_{SENSE}}{R_{SC}}$
Outputs from +7 to +37 Volts (Figures 2, 4, 5, 6, 9, 12)	**Outputs from –6 to –250 Volts** (Figures 3, 8, 10)	**Foldback Current Limiting**
$V_{OUT} = \left(V_{REF} \times \frac{R1 + R2}{R2}\right)$	$V_{OUT} = \left(\frac{V_{REF}}{2} \times \frac{R1 + R2}{R1}\right)$; R3 = R4	$I_{KNEE} = \left(\frac{V_{OUT}\, R3}{R_{SC}\, R4} + \frac{V_{SENSE}\,(R3 + R4)}{R_{SC}\, R4}\right)$ $I_{SHORT\ CKT} = \left(\frac{V_{SENSE}}{R_{SC}} \times \frac{R3 + R4}{R4}\right)$

Typical Applications: (Pin numbers relative to the plastic package)

Figure 1. Basic Low Voltage Regultor
(V_{OUT} = 2 to 7 Volts)

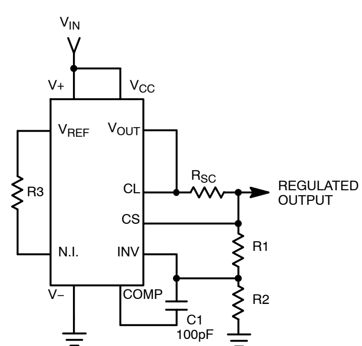


Note: $R3 = \frac{R1 \times R2}{R1 + R2}$
for minimum temperature drift.

Typical Performance

Regulated Output Voltage	5V
Line Regulation (ΔV_{IN} = 3V)	0.5mV
Load Regulation (ΔI_L = 50mA)	1.5mV

Figure 2. Basic High Voltage Regultor
(V_{OUT} = 27to 37 Volts)

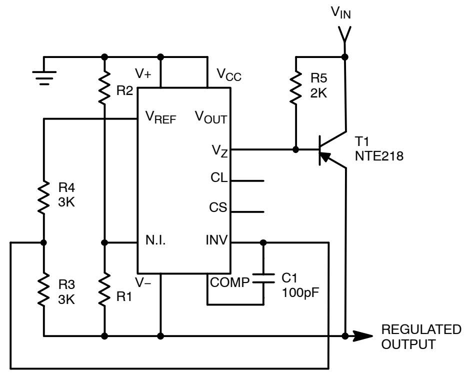


Note: $R3 = \frac{R1 \times R2}{R1 + R2}$
for minimum temperature drift.
R3 may be eliminated for
minimum component count.

Typical Performance

Regulated Output Voltage	15V
Line Regulation (ΔV_{IN} = 3V)	1.5mV
Load Regulation (ΔI_L = 50mA)	4.5mV

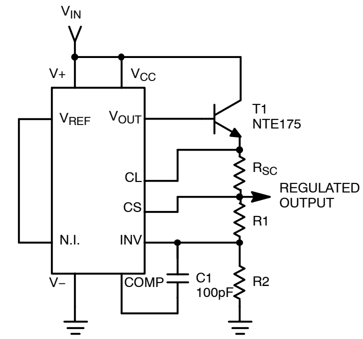
Figure 3. Negative Voltage Regultor



Typical Performance

Regulated Output Voltage	−15V
Line Regulation (ΔV_{IN} = 3V)	1mV
Load Regulation (ΔI_L = 100mA)	2mV

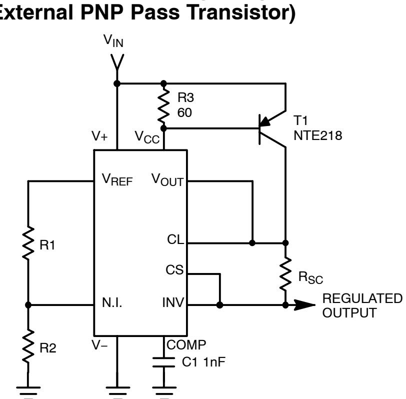
Figure 4. Positive Voltage Regultor (External NPN Pass Transistor)



Typical Performance

Regulated Output Voltage	+15V
Line Regulation (ΔV_{IN} = 3V)	1.5mV
Load Regulation (ΔI_L = 1A)	15mV

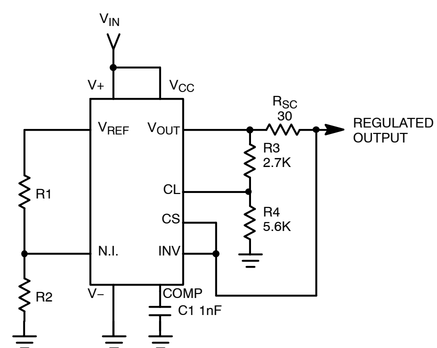
Figure 5. Positive Voltage Regultor (External PNP Pass Transistor)



Typical Performance

Regulated Output Voltage	+5V
Line Regulation (ΔV_{IN} = 3V)	0.5mV
Load Regulation (ΔI_L = 1A)	5mV

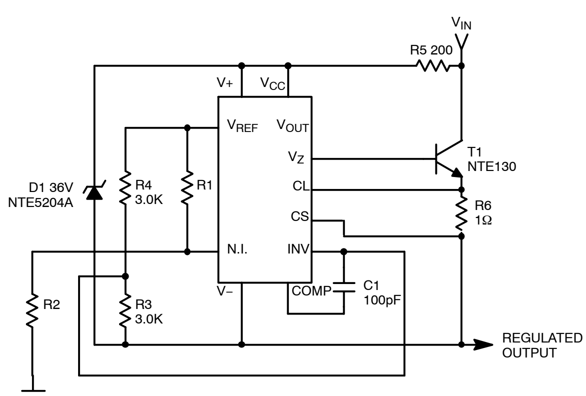
Figure 6. Foldback Current Limiting



Typical Performance

Regulated Output Voltage	+5V
Line Regulation (ΔV_{IN} = 3V)	0.5mV
Load Regulation (ΔI_L = 10mA)	1mV
Short Circuit Current	20mA

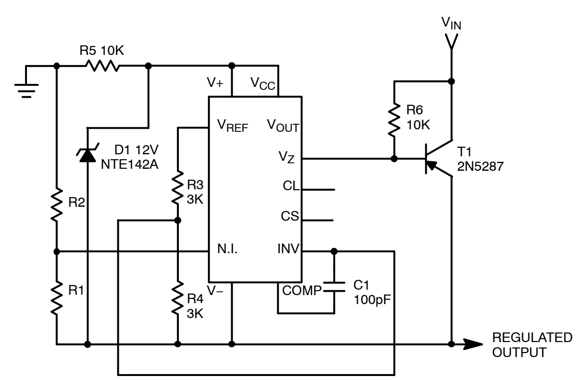
Figure 7. Positive Floating Regultor



Typical Performance

Regulated Output Voltage	+50V
Line Regulation (ΔV_{IN} = 20V)	30mV
Load Regulation (ΔI_L = 100mA)	20mV

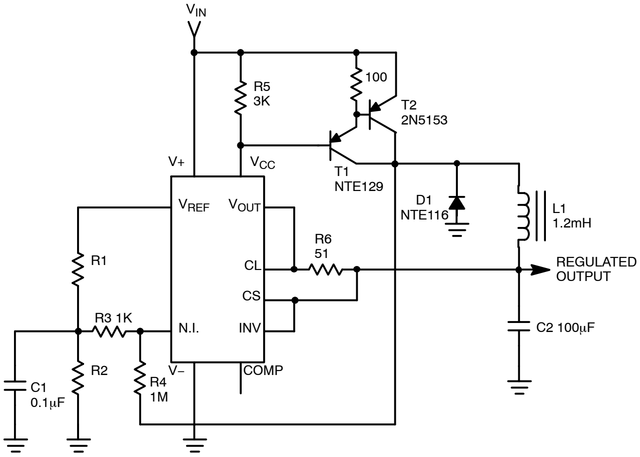
Figure 8. Negative Floating Regultor



Typical Performance

Regulated Output Voltage	−100V
Line Regulation (ΔV_{IN} = 20V)	30mV
Load Regulation (ΔI_L = 100mA)	20mV

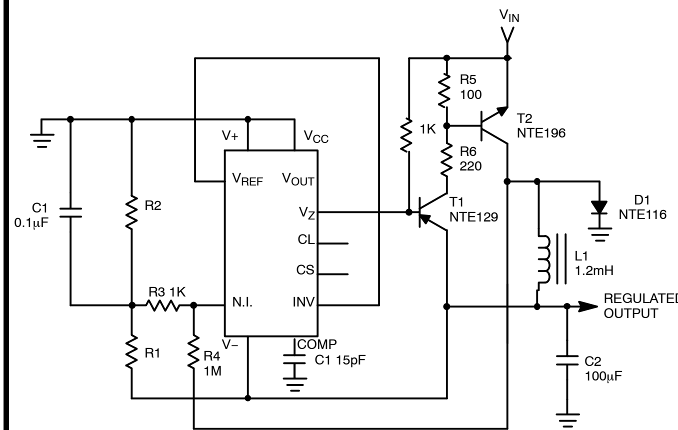
Figure 9. Positive Switching Regultor



Typical Performance

Regulated Output Voltage	+5V
Line Regulation (ΔV_{IN} = 30V)	10mV
Load Regulation (ΔI_L = 2A)	80mV

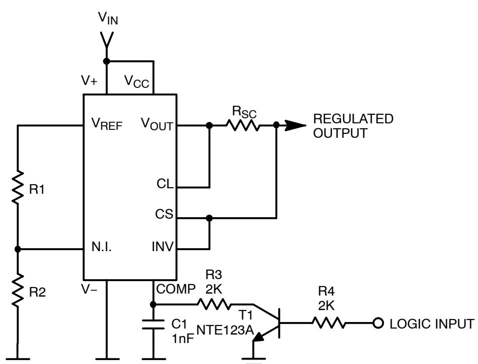
Figure 10. Negative Switching Regultor



Typical Performance

Regulated Output Voltage	−15V
Line Regulation (ΔV_{IN} = 20V)	8mV
Load Regulation (ΔI_L = 2A)	6mV

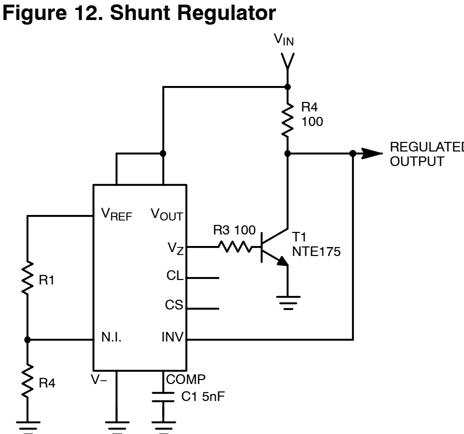
Figure 11. Remote Shutdown Regulator with Current Limiting



Typical Performance

Regulated Output Voltage	+5V
Line Regulation (ΔV_{IN} = 3V)	0.5mV
Load Regulation (ΔI_L = 50mA)	1.5mV

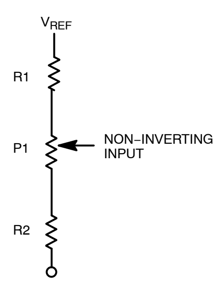
Figure 12. Shunt Regulator



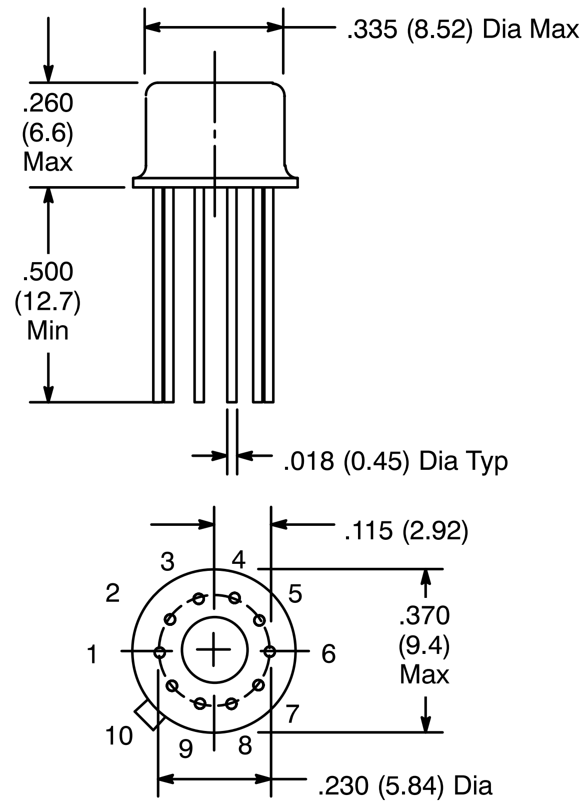
Typical Performance

Regulated Output Voltage	+5V
Line Regulation (ΔV_{IN} = 10V)	0.5mV
Load Regulation (ΔI_L = 100mA)	1.5mV

Figure 13. Output Voltage Adjust (Note 6)



NTE923



NTE923D