

LM79XX Series 3-Terminal Negative Regulators

General Description

The LM79XX series of 3-terminal regulators is available with fixed output voltages of $-5V$, $-12V$, and $-15V$. These devices need only one external component—a compensation capacitor at the output. The LM79XX series is packaged in the TO-220 power package and is capable of supplying 1.5A of output current.

These regulators employ internal current limiting safe area protection and thermal shutdown for protection against virtually all overload conditions.

Low ground pin current of the LM79XX series allows output voltage to be easily boosted above the preset value with a

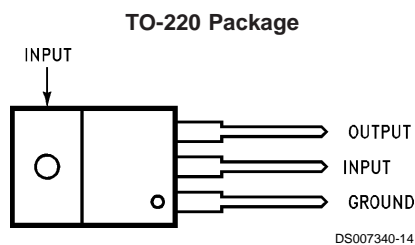
resistor divider. The low quiescent current drain of these devices with a specified maximum change with line and load ensures good regulation in the voltage boosted mode.

For applications requiring other voltages, see LM137 datasheet.

Features

- Thermal, short circuit and safe area protection
- High ripple rejection
- 1.5A output current
- 4% tolerance on preset output voltage

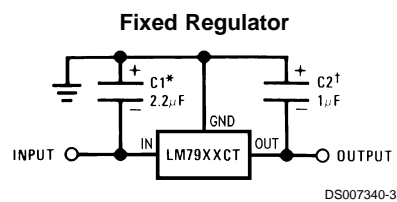
Connection Diagrams



Front View

**Order Number LM7905CT, LM7912CT or LM7915CT
See NS Package Number TO3B**

Typical Applications



*Required if regulator is separated from filter capacitor by more than 3". For value given, capacitor must be solid tantalum. 25µF aluminum electrolytic may be substituted.

†Required for stability. For value given, capacitor must be solid tantalum. 25µF aluminum electrolytic may be substituted. Values given may be increased without limit.

For output capacitance in excess of 100µF, a high current diode from input to output (1N4001, etc.) will protect the regulator from momentary input shorts.

Absolute Maximum Ratings (Note 1)

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/Distributors for availability and specifications.

Input Voltage

 $(V_o = -5V)$ $(V_o = -12V \text{ and } -15V)$

-25V

-35V

Input-Output Differential

 $(V_o = -5V)$

25V

 $(V_o = -12V \text{ and } -15V)$

30V

Power Dissipation (Note 2)

Internally Limited

Operating Junction Temperature Range

0°C to +125°C

Storage Temperature Range

-65°C to +150°C

Lead Temperature (Soldering, 10 sec.)

230°C

Electrical Characteristics

Conditions unless otherwise noted: $I_{OUT} = 500mA$, $C_{IN} = 2.2\mu F$, $C_{OUT} = 1\mu F$, $0^\circ C \leq T_J \leq +125^\circ C$, Power Dissipation $\leq 1.5W$.

Part Number			LM7905C			Units	
Output Voltage			-5V				
Input Voltage (unless otherwise specified)			-10V				
Symbol	Parameter	Conditions	Min	Typ	Max		
V_o	Output Voltage	$T_J = 25^\circ C$ $5mA \leq I_{OUT} \leq 1A$, $P \leq 15W$	-4.8	-5.0	-5.2	V	
			-4.75		-5.25	V	
				$(-20 \leq V_{IN} \leq -7)$		V	
ΔV_o	Line Regulation	$T_J = 25^\circ C$, (Note 3)		8	50	mV	
				$(-25 \leq V_{IN} \leq -7)$		V	
				2	15	mV	
				$(-12 \leq V_{IN} \leq -8)$		V	
ΔV_o	Load Regulation	$T_J = 25^\circ C$, (Note 3) $5mA \leq I_{OUT} \leq 1.5A$ $250mA \leq I_{OUT} \leq 750mA$		15	100	mV	
				5	50	mV	
I_Q	Quiescent Current	$T_J = 25^\circ C$		1	2	mA	
ΔI_Q	Quiescent Current Change	With Line With Load, $5mA \leq I_{OUT} \leq 1A$			0.5	mA	
				$(-25 \leq V_{IN} \leq -7)$		V	
					0.5	mA	
V_n	Output Noise Voltage	$T_A = 25^\circ C$, $10Hz \leq f \leq 100Hz$		125		μV	
			Ripple Rejection	$f = 120Hz$	54	66	dB
						$(-18 \leq V_{IN} \leq -8)$	
	Dropout Voltage	$T_J = 25^\circ C$, $I_{OUT} = 1A$		1.1		V	
I_{OMAX}	Peak Output Current	$T_J = 25^\circ C$		2.2		A	
	Average Temperature Coefficient of Output Voltage	$I_{OUT} = 5mA$, $0^\circ C \leq T_J \leq 100^\circ C$		0.4		$mV/^\circ C$	

Electrical Characteristics

Conditions unless otherwise noted: $I_{OUT} = 500mA$, $C_{IN} = 2.2\mu F$, $C_{OUT} = 1\mu F$, $0^\circ C \leq T_J \leq +125^\circ C$, Power Dissipation $\leq 1.5W$.

Part Number			LM7912C			LM7915C			Units
Output Voltage			-12V			-15V			
Input Voltage (unless otherwise specified)			-19V			-23V			
Symbol	Parameter	Conditions	Min	Typ	Max	Min	Typ	Max	
V_o	Output Voltage	$T_J = 25^\circ C$ $5mA \leq I_{OUT} \leq 1A$, $P \leq 15W$	-11.5	-12.0	-12.5	-14.4	-15.0	-15.6	V
			-11.4		-12.6	-14.25		-15.75	V
				$(-27 \leq V_{IN} \leq -14.5)$		$(-30 \leq V_{IN} \leq -17.5)$			V
ΔV_o	Line Regulation	$T_J = 25^\circ C$, (Note 3)		5	80		5	100	mV
				$(-30 \leq V_{IN} \leq -14.5)$		$(-30 \leq V_{IN} \leq -17.5)$			V
				3	30		3	50	mV
				$(-22 \leq V_{IN} \leq -16)$		$(-26 \leq V_{IN} \leq -20)$			V
ΔV_o	Load Regulation	$T_J = 25^\circ C$, (Note 3)							

Electrical Characteristics (Continued)

Conditions unless otherwise noted: $I_{OUT} = 500\text{mA}$, $C_{IN} = 2.2\mu\text{F}$, $C_{OUT} = 1\mu\text{F}$, $0^\circ\text{C} \leq T_J \leq +125^\circ\text{C}$, Power Dissipation $\leq 1.5\text{W}$.

Part Number		LM7912C			LM7915C			Units	
Output Voltage		-12V			-15V				
Input Voltage (unless otherwise specified)		-19V			-23V				
Symbol	Parameter	Conditions			Min	Typ	Max		
		$5\text{mA} \leq I_{OUT} \leq 1.5\text{A}$			15	200	15	200	mV
		$250\text{mA} \leq I_{OUT} \leq 750\text{mA}$			5	75	5	75	mV
I_Q	Quiescent Current	$T_J = 25^\circ\text{C}$			1.5	3	1.5	3	mA
ΔI_Q	Quiescent Current Change	With Line			0.5			0.5	mA
					$(-30 \leq V_{IN} \leq -14.5)$			$(-30 \leq V_{IN} \leq -17.5)$	V
		With Load, $5\text{mA} \leq I_{OUT} \leq 1\text{A}$			0.5			0.5	mA
V_n	Output Noise Voltage	$T_A = 25^\circ\text{C}$, $10\text{Hz} \leq f \leq 100\text{Hz}$			300			375	μV
	Ripple Rejection	$f = 120\text{Hz}$			54	70	54	70	dB
					$(-25 \leq V_{IN} \leq -15)$			$(-30 \leq V_{IN} \leq -17.5)$	V
	Dropout Voltage	$T_J = 25^\circ\text{C}$, $I_{OUT} = 1\text{A}$			1.1			1.1	V
I_{OMAX}	Peak Output Current	$T_J = 25^\circ\text{C}$			2.2			2.2	A
	Average Temperature Coefficient of Output Voltage	$I_{OUT} = 5\text{mA}$, $0^\circ\text{C} \leq T_J \leq 100^\circ\text{C}$			-0.8			-1.0	$\text{mV}/^\circ\text{C}$

Note 1: Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is intended to be functional, but do not guarantee Specific Performance limits. For guaranteed specifications and test conditions, see the Electrical Characteristics.

Note 2: Refer to Typical Performance Characteristics and Design Considerations for details.

Note 3: Regulation is measured at a constant junction temperature by pulse testing with a low duty cycle. Changes in output voltage due to heating effects must be taken into account.

Design Considerations

The LM79XX fixed voltage regulator series has thermal overload protection from excessive power dissipation, internal short circuit protection which limits the circuit's maximum current, and output transistor safe-area compensation for reducing the output current as the voltage across the pass transistor is increased.

Although the internal power dissipation is limited, the junction temperature must be kept below the maximum specified temperature (125°C) in order to meet data sheet specifications. To calculate the maximum junction temperature or heat sink required, the following thermal resistance values should be used:

Package	Typ θ_{JC} $^\circ\text{C}/\text{W}$	Max θ_{JC} $^\circ\text{C}/\text{W}$	Typ θ_{JA} $^\circ\text{C}/\text{W}$	Max θ_{JA} $^\circ\text{C}/\text{W}$
TO-220	3.0	5.0	60	40

$$P_{D\text{ MAX}} = \frac{T_{J\text{ Max}} - T_A}{\theta_{JC} + \theta_{CA}} \text{ or } \frac{T_{J\text{ Max}} - T_A}{\theta_{JA}}$$

$$\theta_{CA} = \theta_{CS} + \theta_{SA} \text{ (without heat sink)}$$

Solving for T_J :

$$T_J = T_A + P_D (\theta_{JC} + \theta_{CA}) \text{ or } \\ = T_A + P_D \theta_{JA} \text{ (without heat sink)}$$

Where:

$$T_J = \text{Junction Temperature} \\ T_A = \text{Ambient Temperature} \\ P_D = \text{Power Dissipation}$$

θ_{JA} = Junction-to-Ambient Thermal Resistance

θ_{JC} = Junction-to-Case Thermal Resistance

θ_{CA} = Case-to-Ambient Thermal Resistance

θ_{CS} = Case-to-Heat Sink Thermal Resistance

θ_{SA} = Heat Sink-to-Ambient Thermal Resistance

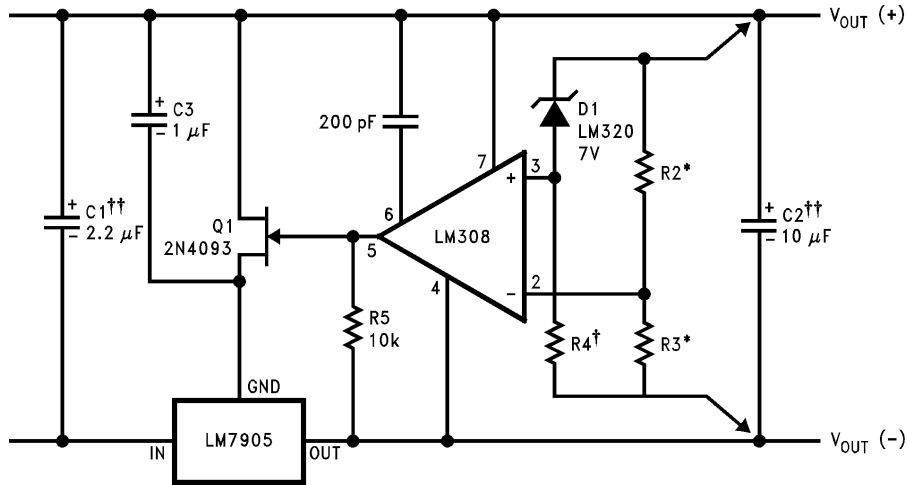
Typical Applications

Bypass capacitors are necessary for stable operation of the LM79XX series of regulators over the input voltage and output current ranges. Output bypass capacitors will improve the transient response by the regulator.

The bypass capacitors, (2.2μF on the input, 1.0μF on the output) should be ceramic or solid tantalum which have good

high frequency characteristics. If aluminum electrolytics are used, their values should be 10μF or larger. The bypass capacitors should be mounted with the shortest leads, and if possible, directly across the regulator terminals.

High Stability 1 Amp Regulator



DS007340-5

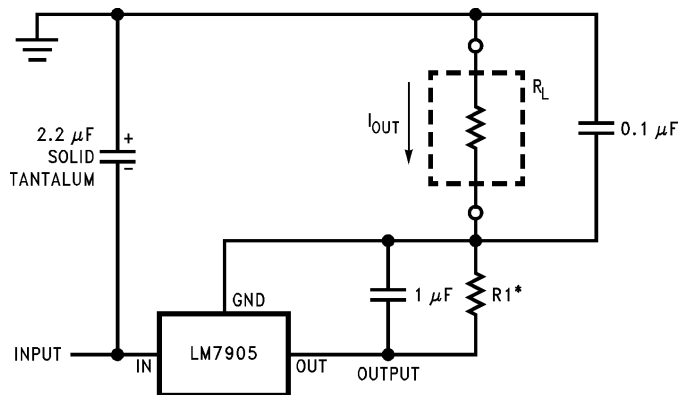
Load and line regulation < 0.01% temperature stability ≤ 0.2%

†Determine Zener current

††Solid tantalum

*Select resistors to set output voltage. 2 ppm/°C tracking suggested

Current Source

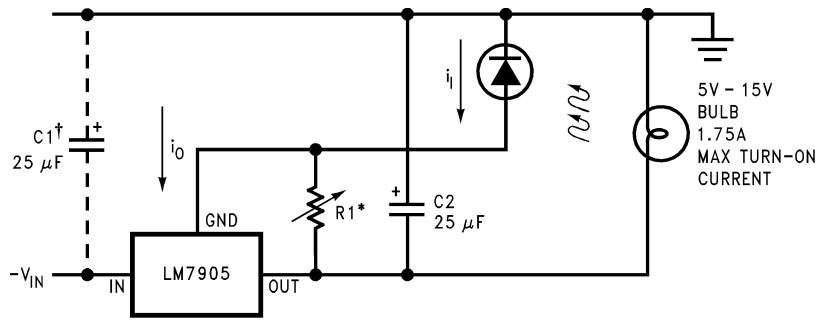


DS007340-7

$$*I_{OUT} = 1 \text{ mA} + \frac{5V}{R1}$$

Typical Applications (Continued)

Light Controller Using Silicon Photo Cell

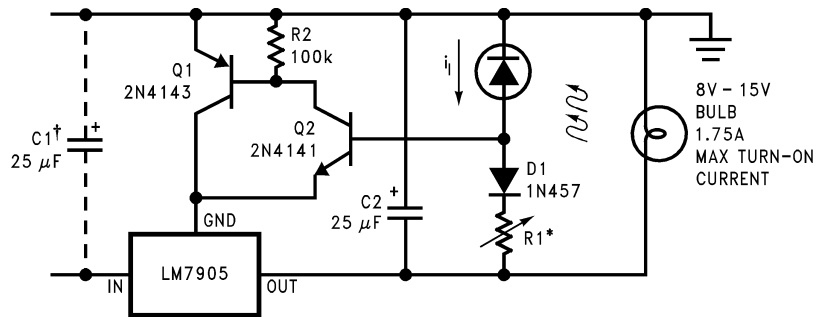


DS007340-8

*Lamp brightness increase until $i_i = i_Q (= 1 \text{ mA}) + 5V/R1$.

†Necessary only if raw supply filter capacitor is more that 2" from LM7905CT

High-Sensitivity Light Controller

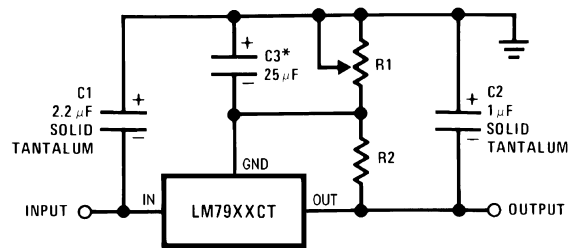


DS007340-9

*Lamp brightness increases until $i_i = 5V/R1$ (i_i can be set as low as $1 \mu\text{A}$)

†Necessary only if raw supply filter capacitor is more that 2" from LM7905

Variable Output



DS007340-2

*Improves transient response and ripple rejection. Do not increase beyond $50 \mu\text{F}$.

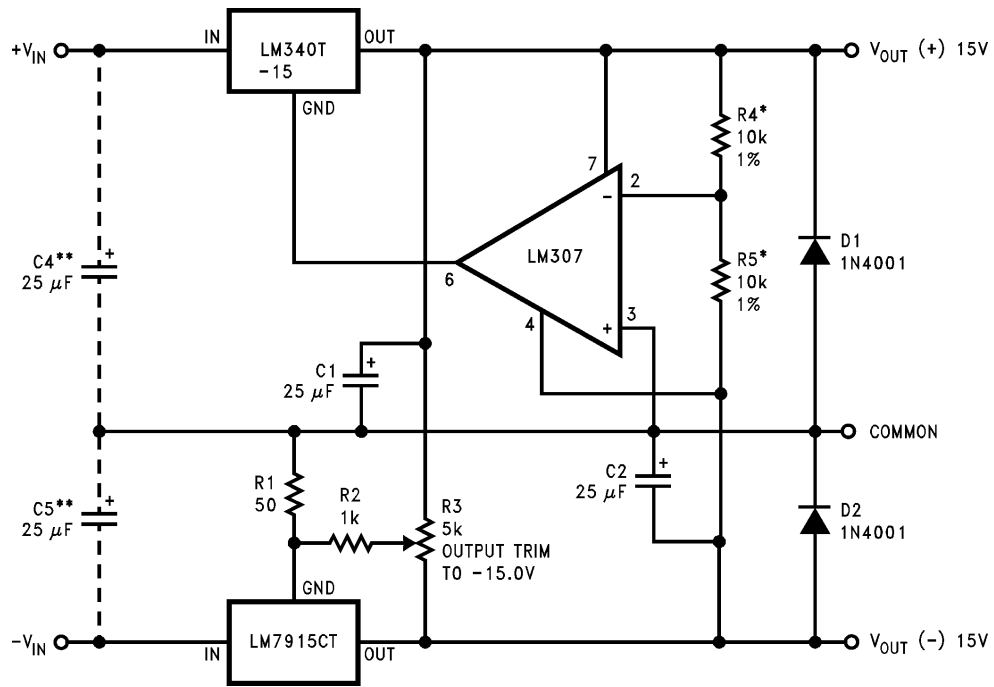
$$V_{\text{OUT}} = V_{\text{SET}} \left(\frac{R1 + R2}{R2} \right)$$

Select R2 as follows:

LM7905CT	300Ω
LM7912CT	750Ω
LM7915CT	1k

Typical Applications (Continued)

±15V, 1 Amp Tracking Regulators



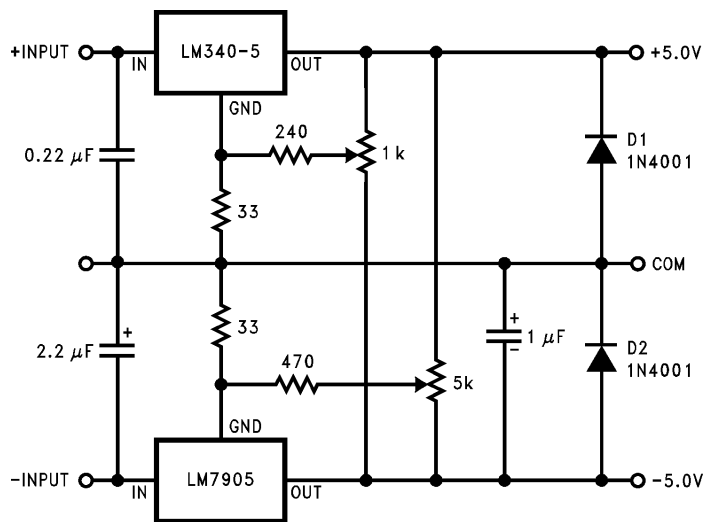
DS007340-1

	(-15)	(+15)
Load Regulation at $\Delta I_L = 1A$	40mV	2mV
Output Ripple, $C_{IN} = 3000\mu F$, $I_L = 1A$	100 μVms	100 μVms
Temperature Stability	50mV	50mV
Output Noise $10Hz \leq f \leq 10kHz$	150 μVms	150 μVms

*Resistor tolerance of R4 and R5 determine matching of (+) and (-) outputs.

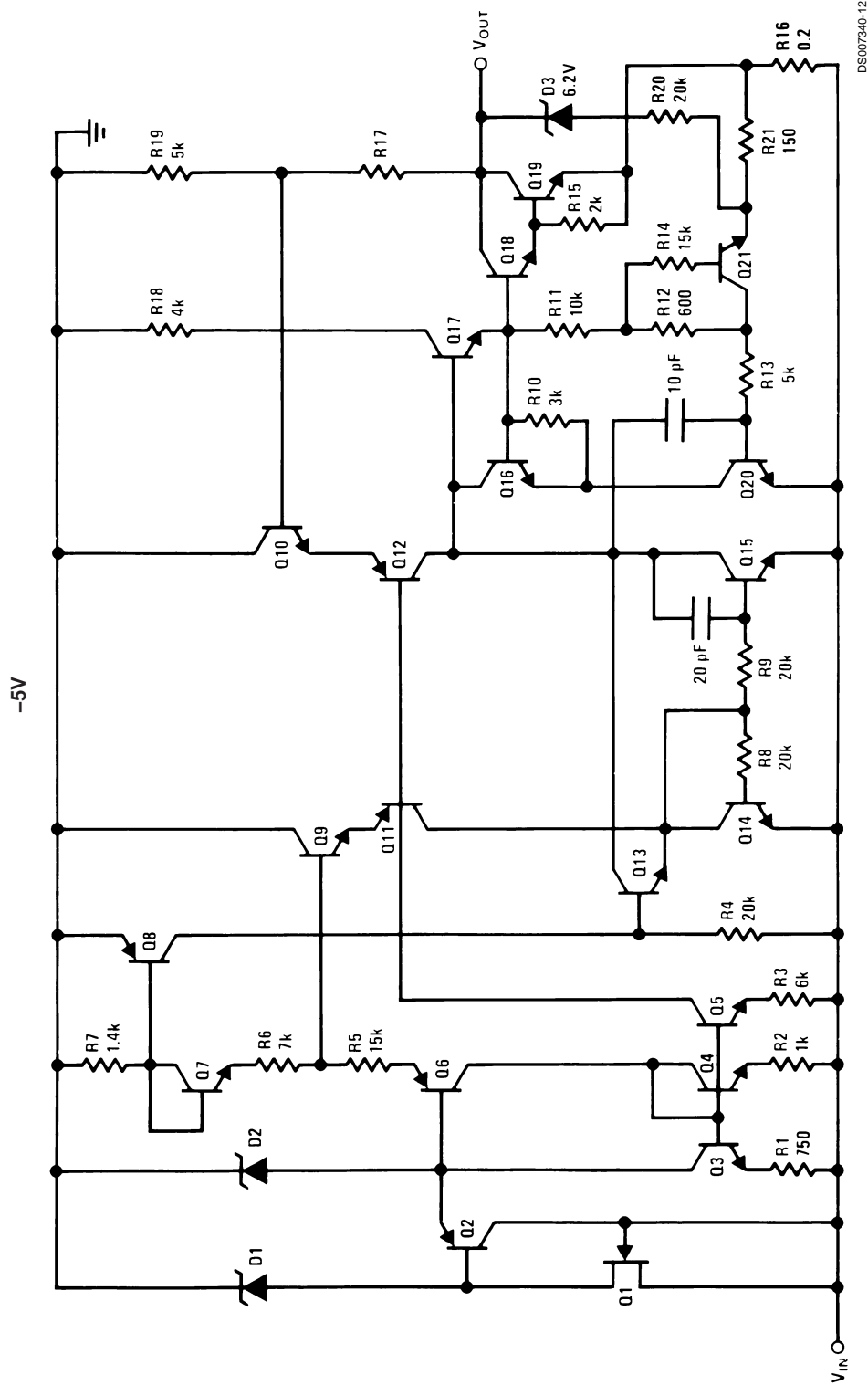
**Necessary only if raw supply filter capacitors are more than 3" from regulators.

Dual Trimmed Supply

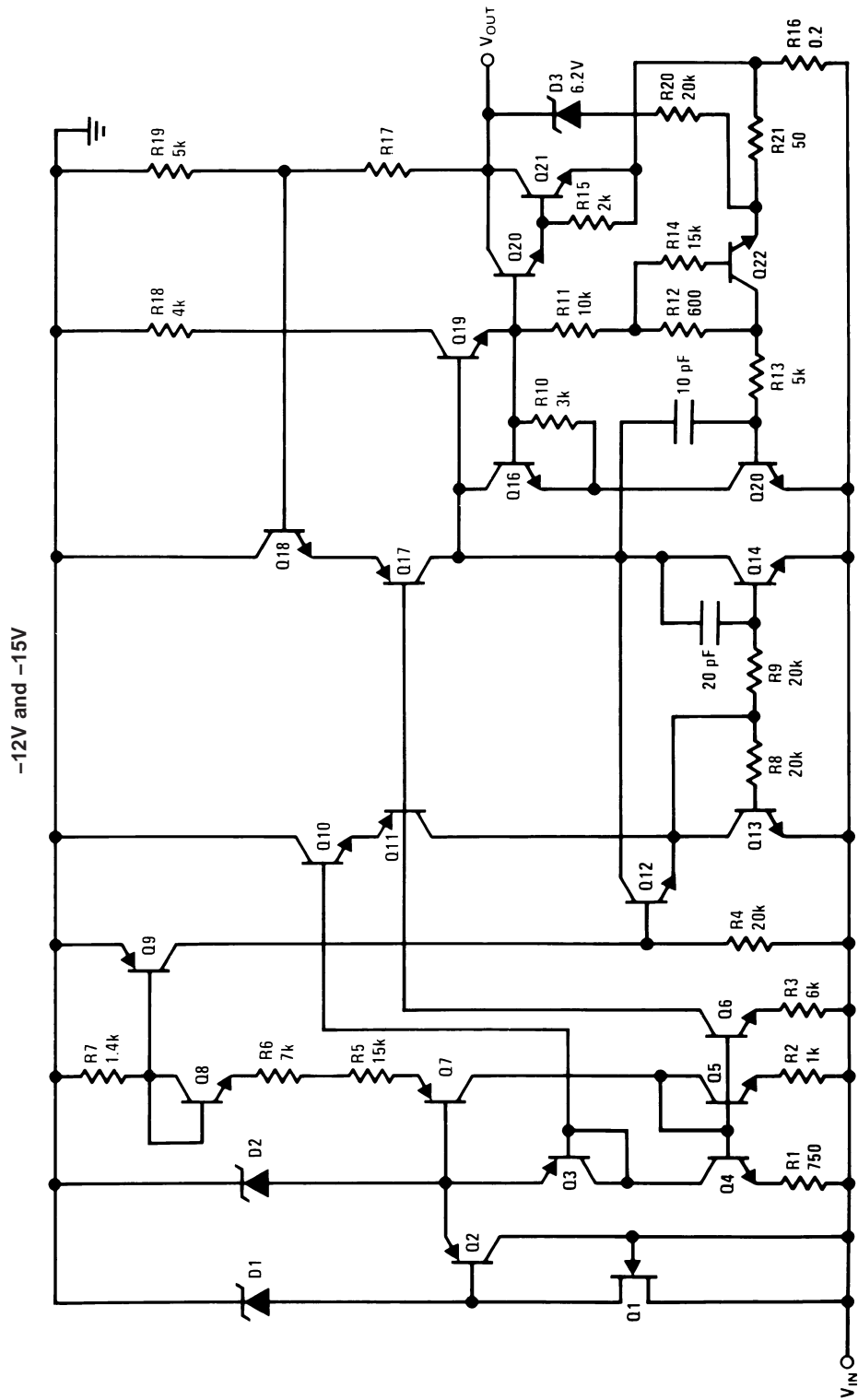


DS007340-4

Schematic Diagrams

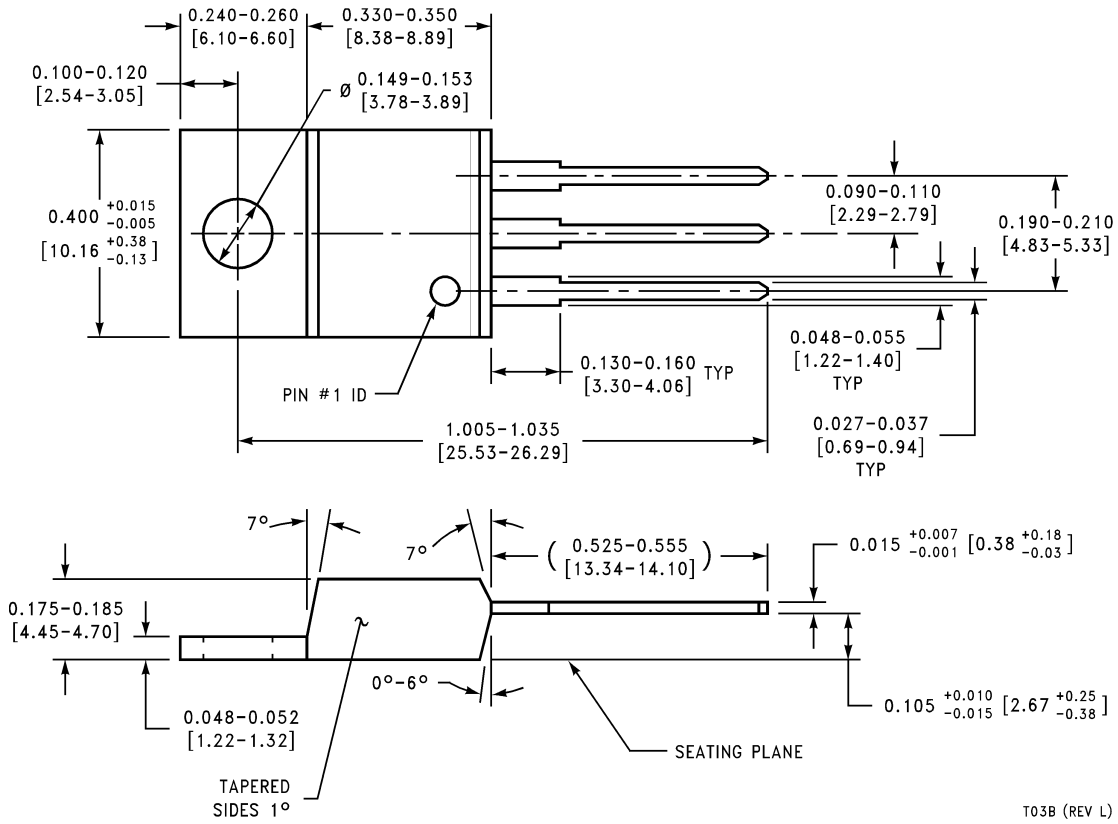


Schematic Diagrams (Continued)



DS007340-13

Physical Dimensions inches (millimeters) unless otherwise noted




TO-220 Outline Package (T)
Order Number LM7905CT, LM7912CT or LM7915CT
NS Package Number T03B

LIFE SUPPORT POLICY

NATIONAL'S PRODUCTS ARE NOT AUTHORIZED FOR USE AS CRITICAL COMPONENTS IN LIFE SUPPORT DEVICES OR SYSTEMS WITHOUT THE EXPRESS WRITTEN APPROVAL OF THE PRESIDENT AND GENERAL COUNSEL OF NATIONAL SEMICONDUCTOR CORPORATION. As used herein:

1. Life support devices or systems are devices or systems which, (a) are intended for surgical implant into the body, or (b) support or sustain life, and whose failure to perform when properly used in accordance with instructions for use provided in the labeling, can be reasonably expected to result in a significant injury to the user.
2. A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

 **National Semiconductor Corporation**
Americas
Email: support@nsc.com

National Semiconductor Europe
Fax: +49 (0) 180-530 85 86
Email: europe.support@nsc.com
Deutsch Tel: +49 (0) 69 9508 6208
English Tel: +44 (0) 870 24 0 2171
Français Tel: +33 (0) 1 41 91 8790

National Semiconductor Asia Pacific Customer Response Group
Tel: 65-2544466
Fax: 65-2504466
Email: ap.support@nsc.com

National Semiconductor Japan Ltd.
Tel: 81-3-5639-7560
Fax: 81-3-5639-7507

www.national.com