National Semiconductor

November 1994

# LM79XX Series 3-Terminal Negative Regulators

## General Description

The LM79XX series of 3-terminal regulators is available with fixed output voltages of −5V, −8V, −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.

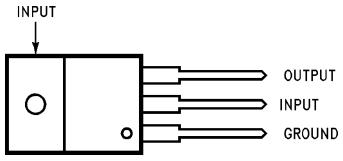
For applications requiring other voltages, see LM137 data sheet.

## Features

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

## Connection Diagrams

**TO-220 Package**



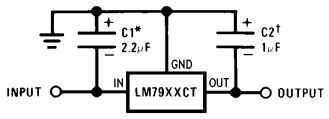

TL/H/7340 14

**Front View**

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

## Typical Applications

**Fixed Regulator**




TL/H/7340 3

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

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

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

RRD B30M115/Printed in U S A

## Absolute Maximum Ratings (Note 1)

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

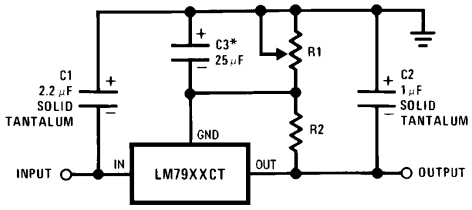
| | |
|---|---|
| Input Voltage | |
| ($V_o$ −5V) | −25V |
| ($V_o$ −12V and −15V) | −35V |
| Input-Output Differential | |
| ($V_o$ −5V) | 25V |
| ($V_o$ −12V and −15V) | 30V |
| Power Dissipation (Note 2) | Internally Limited |
| Operating Junction Temperature Range | 0°C to +125°C |
| Storage Temperature Range | −65°C to +150°C |
| Lead Temperature (Soldering, 10 sec.) | 230°C |

## Electrical Characteristics Conditions unless otherwise noted: $I_{OUT}$ 500 mA, $C_{IN}$ 2.2 μF, $C_{OUT}$ 1 μF, 0°C ≤ $T_J$ ≤ +125°C, Power Dissipation ≤ 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°C | −4.8 | −5.0 | −5.2 | V |
| | | 5 mA ≤ $I_{OUT}$ ≤ 1A, | −4.75 | | −5.25 | V |
| | | P ≤ 15W | | (−20 ≤ $V_{IN}$ ≤ −7) | | V |
| $\Delta V_O$ | Line Regulation | $T_J$ 25°C, (Note 3) | | 8 | 50 | mV |
| | | | | (−25 ≤ $V_{IN}$ ≤ −7) | | V |
| | | | | 2 | 15 | mV |
| | | | | (−12 ≤ $V_{IN}$ ≤ −8) | | V |
| $\Delta V_O$ | Load Regulation | $T_J$ 25°C, (Note 3) | | | | |
| | | 5 mA ≤ $I_{OUT}$ ≤ 1.5A | | 15 | 100 | mV |
| | | 250 mA ≤ $I_{OUT}$ ≤ 750 mA | | 5 | 50 | mV |
| $I_Q$ | Quiescent Current | $T_J$ 25°C | | 1 | 2 | mA |
| $\Delta I_Q$ | Quiescent Current Change | With Line | | | 0.5 | mA |
| | | | | (−25 ≤ $V_{IN}$ ≤ −7) | | V |
| | | With Load, 5 mA ≤ $I_{OUT}$ ≤ 1A | | | 0.5 | mA |
| $V_n$ | Output Noise Voltage | $T_A$ 25°C, 10 Hz ≤ f ≤ 100 Hz | | 125 | | μV |
| | Ripple Rejection | f 120 Hz | 54 | 66 | | dB |
| | | | | (−18 ≤ $V_{IN}$ ≤ −8) | | V |
| | Dropout Voltage | $T_J$ 25°C, $I_{OUT}$ 1A | | 1.1 | | V |
| $I_{OMAX}$ | Peak Output Current | $T_J$ 25°C | | 2.2 | | A |
| | Average Temperature Coefficient of Output Voltage | $I_{OUT}$ 5 mA, 0 C ≤ $T_J$ ≤ 100°C | | 0.4 | | mV/°C |

## Typical Applications (Continued)

**Variable Output**




TL/H/7340 2

*Improves transient response and ripple rejection. Do not increase beyond 50 μF.

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

Select R2 as follows:

| | |
|---|---|
| LM7905CT | 300Ω |
| LM7912CT | 750Ω |
| LM7915CT | 1k |

## Electrical Characteristics (Continued) Conditions unless otherwise noted: $I_{OUT}$ 500 mA, $C_{IN}$ 2.2 $\mu$F, $C_{OUT}$ 1 $\mu$F, 0°C ≤ $T_J$ ≤ +125°C, Power Dissipation 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°C | −11.5 | −12.0 | −12.5 | −14.4 | −15.0 | −15.6 | V |
| | | 5 mA ≤ $I_{OUT}$ ≤ 1A, | −11.4 | | −12.6 | −14.25 | | −15.75 | V |
| | | P ≤ 15W | (−27 ≤ $V_{IN}$ ≤ −14.5) | | | (−30 ≤ $V_{IN}$ ≤ −17.5) | | | V |
| $\Delta V_O$ | Line Regulation | $T_J$ 25°C, (Note 3) | | 5 | 80 | | 5 | 100 | mV |
| | | | (−30 ≤ $V_{IN}$ ≤ −14.5) | | | (−30 ≤ $V_{IN}$ ≤ −17.5) | | | V |
| | | | | 3 | 30 | | 3 | 50 | mV |
| | | | (−22 ≤ $V_{IN}$ ≤ −16) | | | (−26 ≤ $V_{IN}$ ≤ −20) | | | V |
| $\Delta V_O$ | Load Regulation | $T_J$ 25°C, (Note 3) | | | | | | | |
| | | 5 mA ≤ $I_{OUT}$ ≤ 1.5A | | 15 | 200 | | 15 | 200 | mV |
| | | 250 mA ≤ $I_{OUT}$ ≤ 750 mA | | 5 | 75 | | 5 | 75 | mV |
| $I_Q$ | Quiescent Current | $T_J$ 25°C | | 1.5 | 3 | | 1.5 | 3 | mA |
| $\Delta I_Q$ | Quiescent Current Change | With Line | | | 0.5 | | | 0.5 | mA |
| | | | (−30 ≤ $V_{IN}$ ≤ −14.5) | | | (−30 ≤ $V_{IN}$ ≤ −17.5) | | | V |
| | | With Load, 5 mA ≤ $I_{OUT}$ ≤ 1A | | | 0.5 | | | 0.5 | mA |
| $V_n$ | Output Noise Voltage | $T_A$ 25°C, 10 Hz ≤ f ≤ 100 Hz | | 300 | | | 375 | | $\mu$V |
| | Ripple Rejection | f 120 Hz | 54 | 70 | | 54 | 70 | | dB |
| | | | (−25 ≤ $V_{IN}$ ≤ −15) | | | (−30 ≤ $V_{IN}$ ≤ −17.5) | | | V |
| | Dropout Voltage | $T_J$ 25°C, $I_{OUT}$ 1A | | 1.1 | | | 1.1 | | V |
| $I_{OMAX}$ | Peak Output Current | $T_J$ 25°C | | 2.2 | | | 2.2 | | A |
| | Average Temperature Coefficient of Output Voltage | $I_{OUT}$ 5 mA, 0 C ≤ $T_J$ ≤ 100°C | | −0.8 | | | −1.0 | | mV/°C |

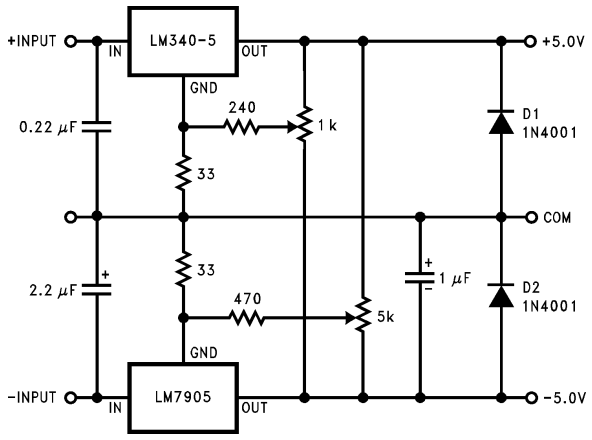
**Note 1:** Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is intended to be functional, but do not guarantee Specific Performance limits. For guaranteed specifications and test conditions, see the Electrical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

## Typical Applications (Continued)

**Dual Trimmed Supply**




TL/H/7340 4

## 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 $\theta_{JC}$ °C/W | Max $\theta_{JC}$ °C/W | Typ $\theta_{JA}$ °C/W | Max $\theta_{JA}$ °C/W |
|---|---|---|---|---|
| TO-220 | 3.0 | 5.0 | 60 | 40 |

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

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

Solving for $T_J$:

$T_J$ $T_A + P_D (\theta_{JC} + \theta_{CA})$ or

$T_A + P_D \theta_{JA}$ (without heat sink)

Where:

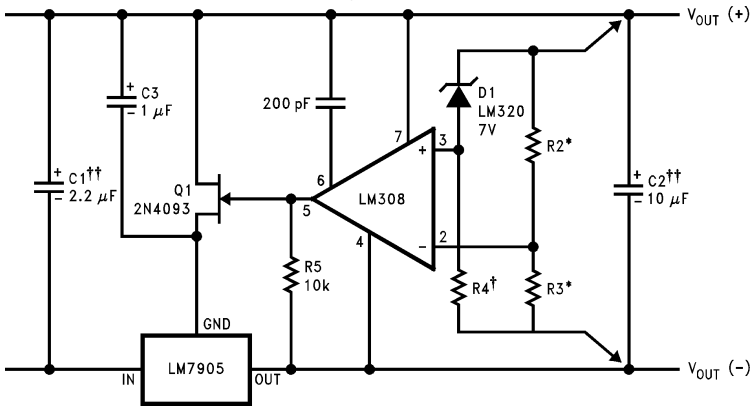
| | |
|---|---|
| $T_J$ | Junction Temperature |
| $T_A$ | Ambient Temperature |
| $P_D$ | Power Dissipation |
| $\theta_{JA}$ | Junction-to-Ambient Thermal Resistance |
| $\theta_{JC}$ | Junction-to-Case Thermal Resistance |
| $\theta_{CA}$ | Case-to-Ambient Thermal Resistance |
| $\theta_{CS}$ | Case-to-Heat Sink Thermal Resistance |
| $\theta_{SA}$ | Heat Sink-to-Ambient Thermal Resistance |

## Typical Applications (Continued)

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, (2.2 μF on the input, 1.0 μF on the output) should be ceramic or solid tantalum which have good high frequency characteristics. If aluminum electrolytics are used, their values should be 10 μF 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**




TL/H/7340 5

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

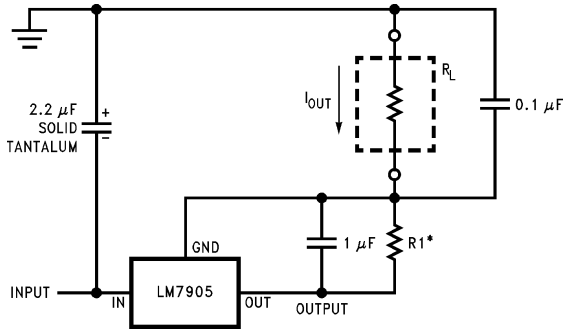
†Determine Zener current

††Solid tantalum

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

## Typical Applications (Continued)

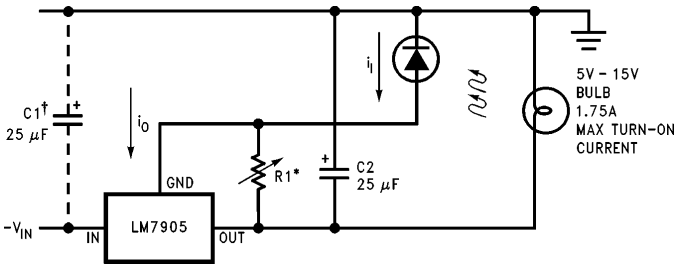
**Current Source**




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

TL/H/7340 7

**Light Controller Using Silicon Photo Cell**



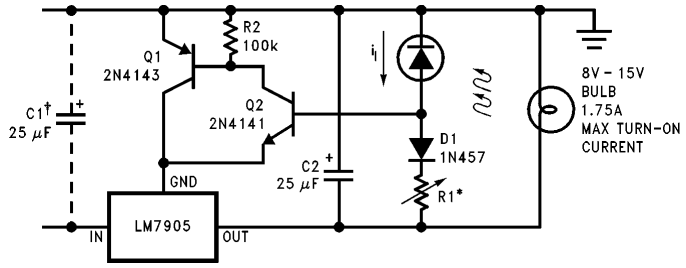

TL/H/7340 8

*Lamp brightness increase until $i_I$ $i_O$ (≈ 1 mA) + 5V/R1.

†Necessary only if raw supply filter capacitor is more than 2″ from LM7905CT

## Typical Applications (Continued)

**High-Sensitivity Light Controller**

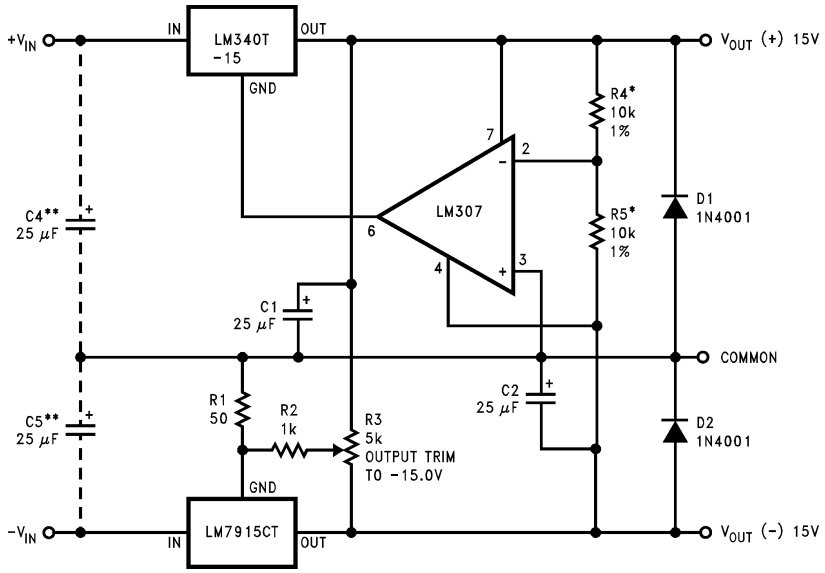



TL/H/7340 9

*Lamp brightness increases until $i_l$ 5V/R1 ($I_l$ can be set as low as 1 μA)

†Necessary only if raw supply filter capacitor is more than 2″ from LM7905

**±15V, 1 Amp Tracking Regulators**



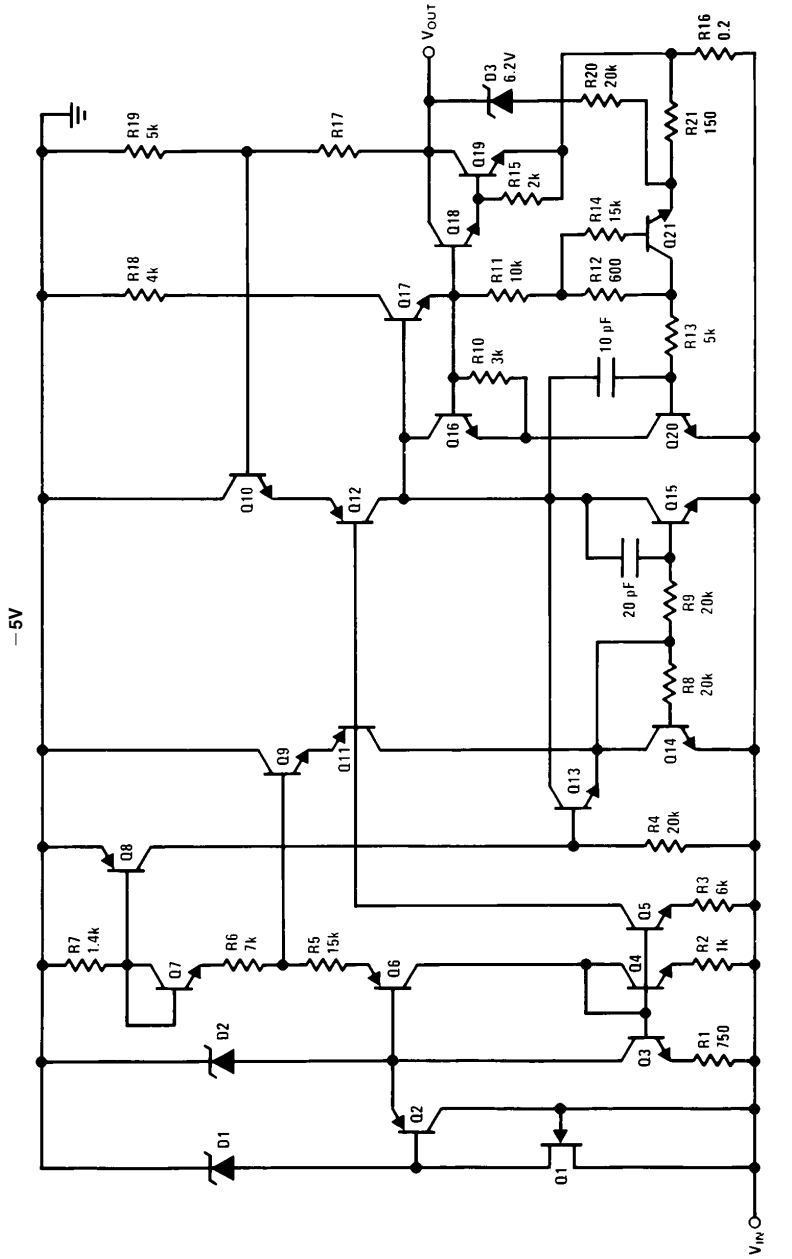

TL/H/7340 1

| | | ( 15) | (+ 15) |
|---|---|---|---|
| Load Regulation at $\Delta I_L$ | 1A | 40 mV | 2 mV |
| Output Ripple, $C_{IN}$ 3000 μF, $I_L$ | 1A | 100 μVrms | 100 μVrms |
| Temperature Stability | | 50 mV | 50 mV |
| Output Noise 10 Hz ≤ f ≤ 10 kHz | | 150 μVrms | 150 μVrms |

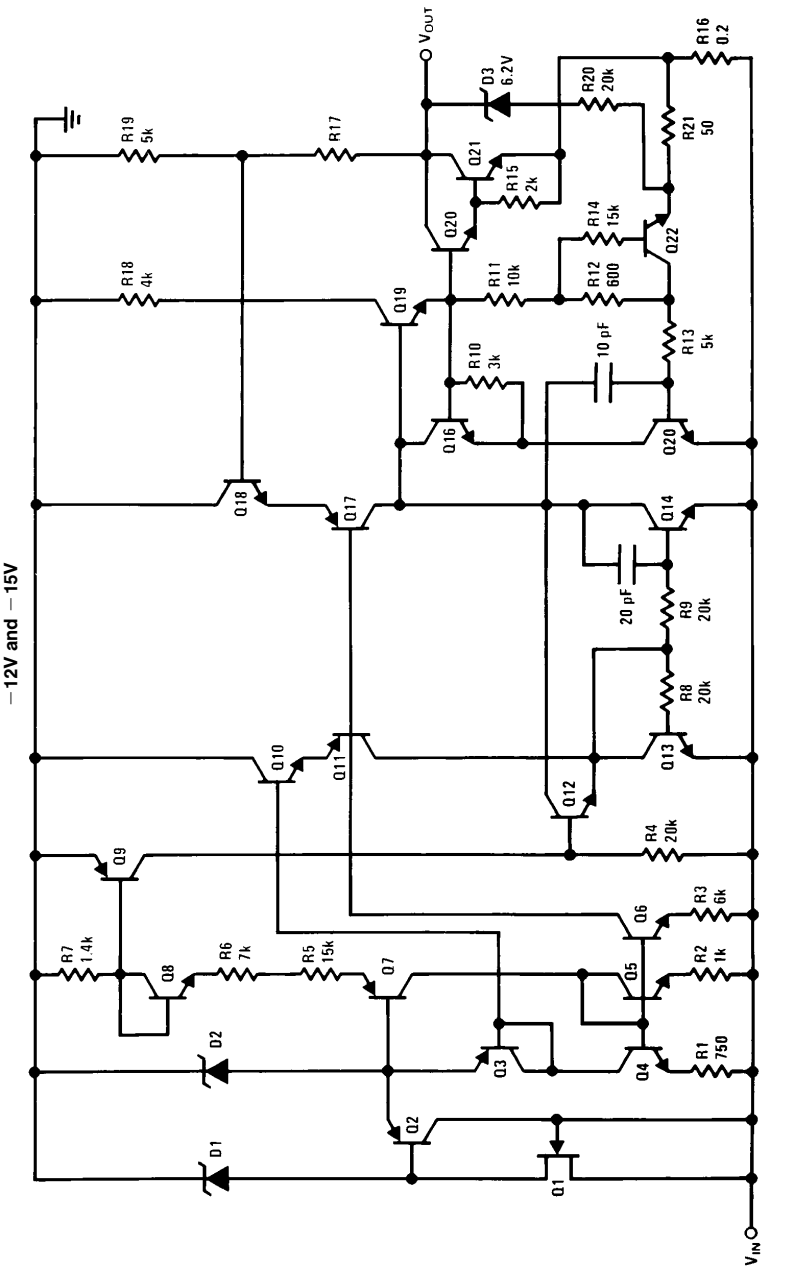
*Resistor tolerance of R4 and R5 determine matching of (+) and ( ) outputs.

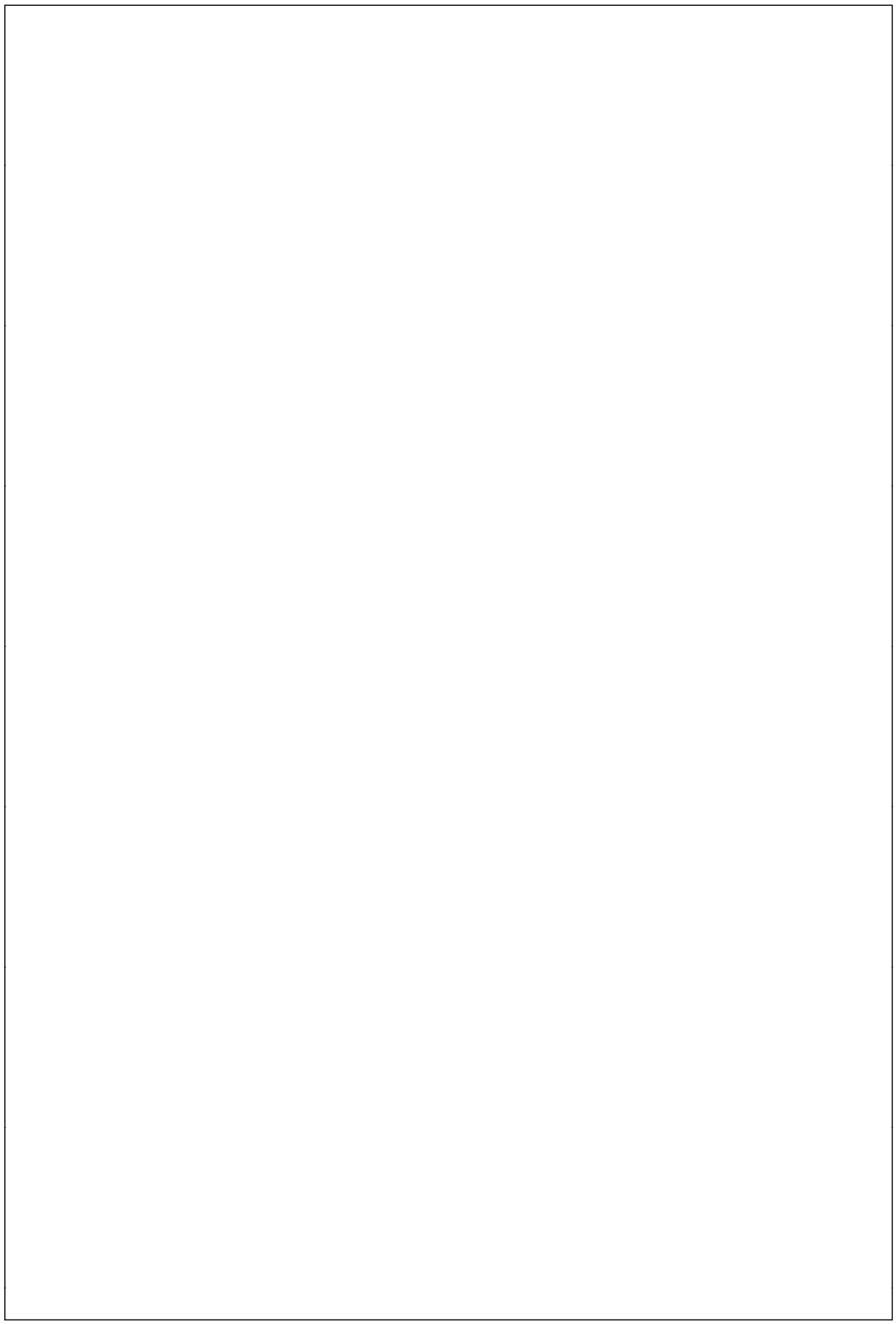
**Necessary only if raw supply filter capacitors are more than 3″ from regulators.

## Schematic Diagrams

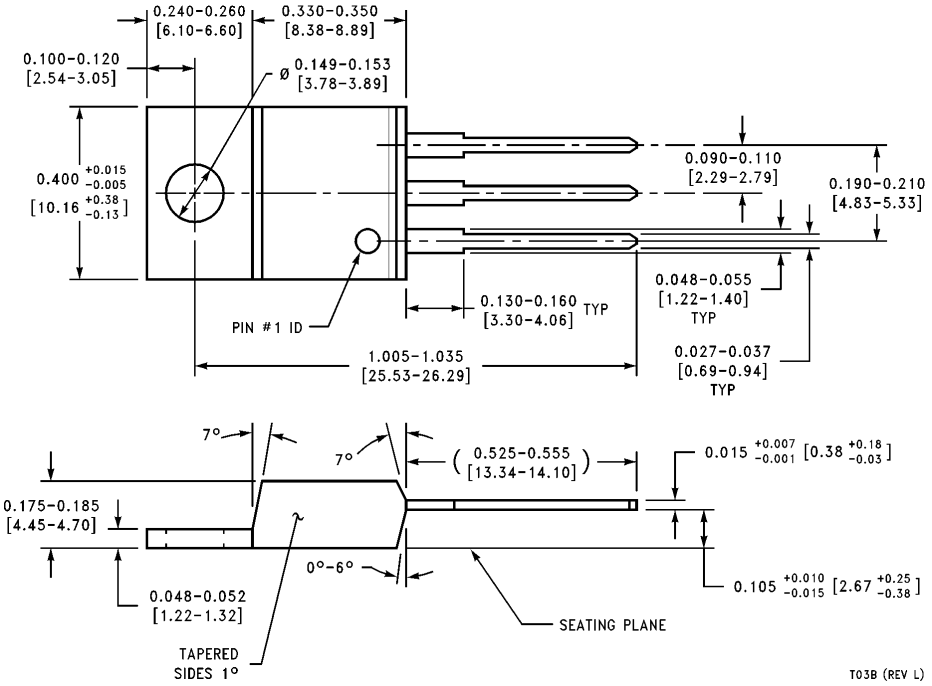


## Schematic Diagrams (Continued)





## Physical Dimensions inches (millimeters)




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

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**National Semiconductor Corporation**
1111 West Bardin Road
Arlington, TX 76017
Tel: 1(800) 272-9959
Fax: 1(800) 737-7018

**National Semiconductor Europe**
Fax: (+49) 0-180-530 85 86
Email: cnjwge@tevm2.nsc.com
Deutsch Tel: (+49) 0-180-530 85 85
English Tel: (+49) 0-180-532 78 32
Français Tel: (+49) 0-180-532 93 58
Italiano Tel: (+49) 0-180-534 16 80

**National Semiconductor Hong Kong Ltd.**
13th Floor, Straight Block,
Ocean Centre, 5 Canton Rd.
Tsimshatsui, Kowloon
Hong Kong
Tel: (852) 2737-1600
Fax: (852) 2736-9960

**National Semiconductor Japan Ltd.**
Tel: 81-043-299-2309
Fax: 81-043-299-2408