

LM79XX Series 3-Terminal Negative Regulators

Check for Samples: [LM7905](#), [LM7912](#), [LM7915](#)

FEATURES

- Thermal, Short Circuit and Safe Area Protection
- High Ripple Rejection
- 1.5A Output Current
- 4% Tolerance on Preset Output Voltage

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.

Connection Diagram

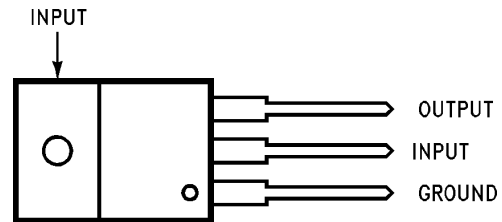
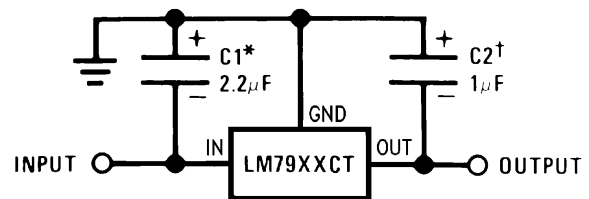


Figure 1. TO-220 Package Front View
See Package Number NDE0003B

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.

Figure 2. Fixed Regulator



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These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

ABSOLUTE MAXIMUM RATINGS⁽¹⁾

| | |
|---------------------------------------|--------------------|
| 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 ⁽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 |

(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 ensure Specific Performance limits. For ensured specifications and test conditions, see the Electrical Characteristics.

(2) Refer to [DESIGN CONSIDERATIONS](#) for details.

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°C | -4.8 | -5.0 | -5.2 | V |
| | | 5mA ≤ I _{OUT} ≤ 1A, P ≤ 15W | -4.75 | | -5.25 | V |
| | | | | (-20 ≤ V _{IN} ≤ -7) | | V |
| ΔV _O | Line Regulation | T _J = 25°C, ⁽¹⁾ | | 8 | 50 | mV |
| | | | | (-25 ≤ V _{IN} ≤ -7) | | V |
| | | | | 2 | 15 | mV |
| | | | | (-12 ≤ V _{IN} ≤ -8) | | V |
| ΔV _O | Load Regulation | T _J = 25°C, ⁽¹⁾ 5mA ≤ I _{OUT} ≤ 1.5A 250mA ≤ I _{OUT} ≤ 750mA | | | | |
| | | | | 15 | 100 | mV |
| | | | | 5 | 50 | mV |
| I _Q | Quiescent Current | T _J = 25°C | | 1 | 2 | mA |
| ΔI _Q | Quiescent Current Change | With Line | | | 0.5 | mA |
| | | | | (-25 ≤ V _{IN} ≤ -7) | | V |
| | | With Load, 5mA ≤ I _{OUT} ≤ 1A | | | 0.5 | mA |
| V _n | Output Noise Voltage | T _A = 25°C, 10Hz ≤ f ≤ 100Hz f = 120Hz | 54 | 125 | | μV |
| | | | | 66 | | dB |
| | Ripple Rejection | | (-18 ≤ V _{IN} ≤ -8) | | V | |
| | | Dropout Voltage | T _J = 25°C, I _{OUT} = 1A | | 1.1 | |
| I _{OMAX} | Peak Output Current | T _J = 25°C | | 2.2 | | A |
| | Average Temperature Coefficient of Output Voltage | I _{OUT} = 5mA, 0 C ≤ T _J ≤ 100°C | | 0.4 | | mV/°C |

(1) 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.

ELECTRICAL CHARACTERISTICS

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 | Min | Typ | Max | |
| V _O | Output Voltage | T _J = 25°C | -11.5 | -12.0 | -12.5 | -14.4 | -15.0 | -15.6 | V |
| | | 5mA ≤ 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 |
| ΔV _O | Line Regulation | T _J = 25°C, ⁽¹⁾ | 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 |
| ΔV _O | Load Regulation | T _J = 25°C, ⁽¹⁾ 5mA ≤ I _{OUT} ≤ 1.5A 250mA ≤ I _{OUT} ≤ 750mA | | | | | | | |
| | | | | 15 | 200 | | 15 | 200 | mV |
| | | | | 5 | 75 | | 5 | 75 | mV |
| I _Q | Quiescent Current | T _J = 25°C | | 1.5 | 3 | | 1.5 | 3 | mA |
| ΔI _Q | Quiescent Current Change | With Line | 0.5 | | | 0.5 | | | mA |
| | | | (-30 ≤ V _{IN} ≤ -14.5) | | | (-30 ≤ V _{IN} ≤ -17.5) | | | V |
| | | With Load, 5mA ≤ I _{OUT} ≤ 1A | 0.5 | | | 0.5 | | | mA |
| V _n | Output Noise Voltage | T _A = 25°C, 10Hz ≤ f ≤ 100Hz | 300 | | | 375 | | | μV |
| | | | 54 | 70 | | 54 | 70 | | dB |
| | Ripple Rejection | f = 120 Hz | (-25 ≤ V _{IN} ≤ -15) | | | (-30 ≤ V _{IN} ≤ -17.5) | | | V |
| | | | | | | | | | V |
| Dropout Voltage | 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} = 5mA, 0 C ≤ T _J ≤ 100°C | | -0.8 | | | -1.0 | | mV/°C |

(1) 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} °C/W | Max θ_{JC} °C/W | Typ θ_{JA} °C/W | Max θ_{JA} °C/W |
|---------|------------------------------|------------------------------|------------------------------|------------------------------|
| TO-220 | 3.0 | 5.0 | 60 | 40 |

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

$$\theta_{CA} = \theta_{CS} + \theta_{SA} \text{ (without heat sink)}$$
(1)

Solving for T_J :

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

or

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

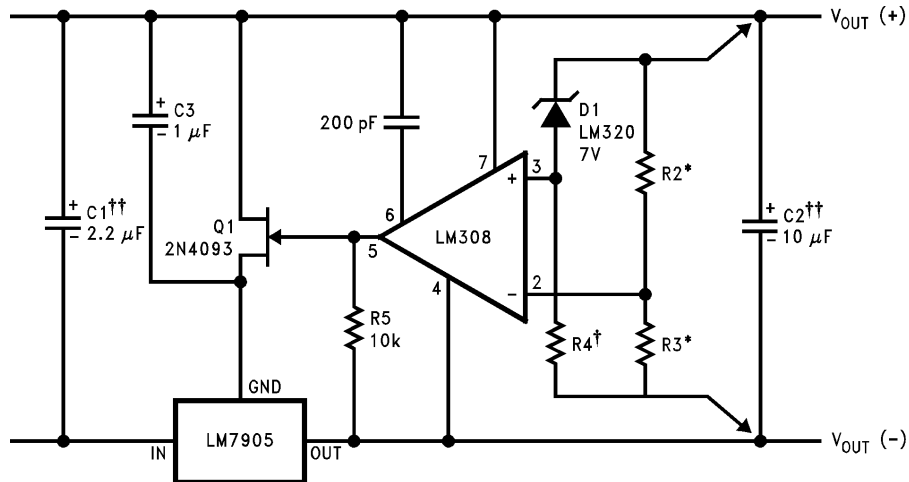
where

- T_J = Junction Temperature
- T_A = Ambient Temperature
- P_D = 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.



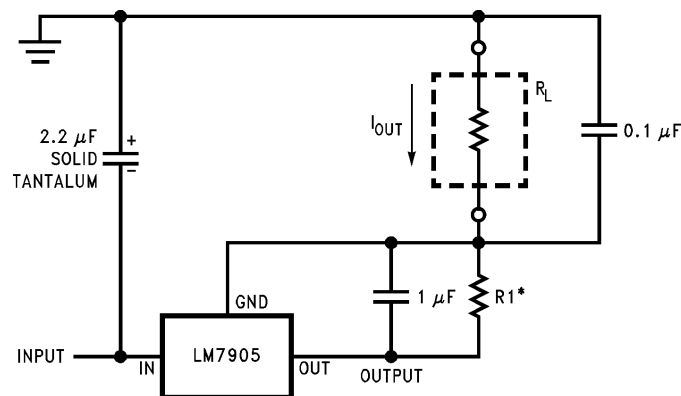
Load and line regulation $< 0.01\%$ temperature stability $\leq 0.2\%$

†Determine Zener current

††Solid tantalum

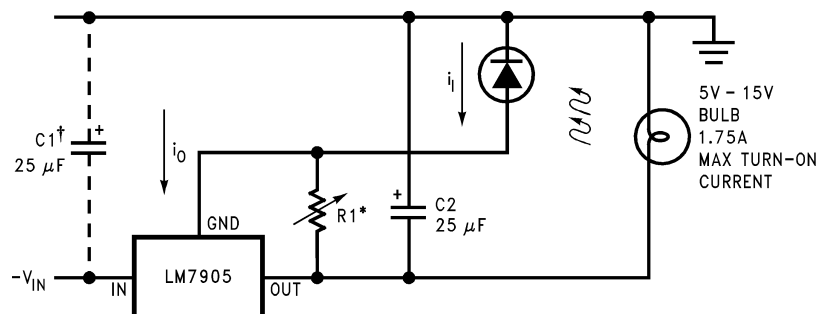
*Select resistors to set output voltage. 2 ppm/°C tracking suggested

Figure 3. High Stability 1 Amp Regulator



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

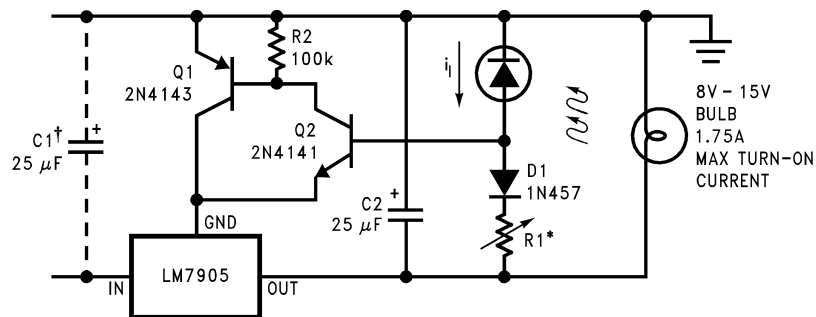
Figure 4. Current Source



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

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

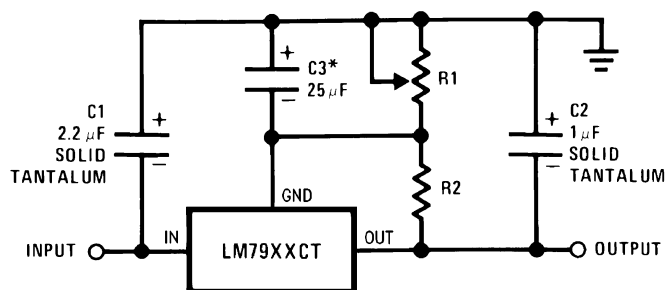
Figure 5. Light Controller Using Silicon Photo Cell



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

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

Figure 6. High-Sensitivity Light Controller



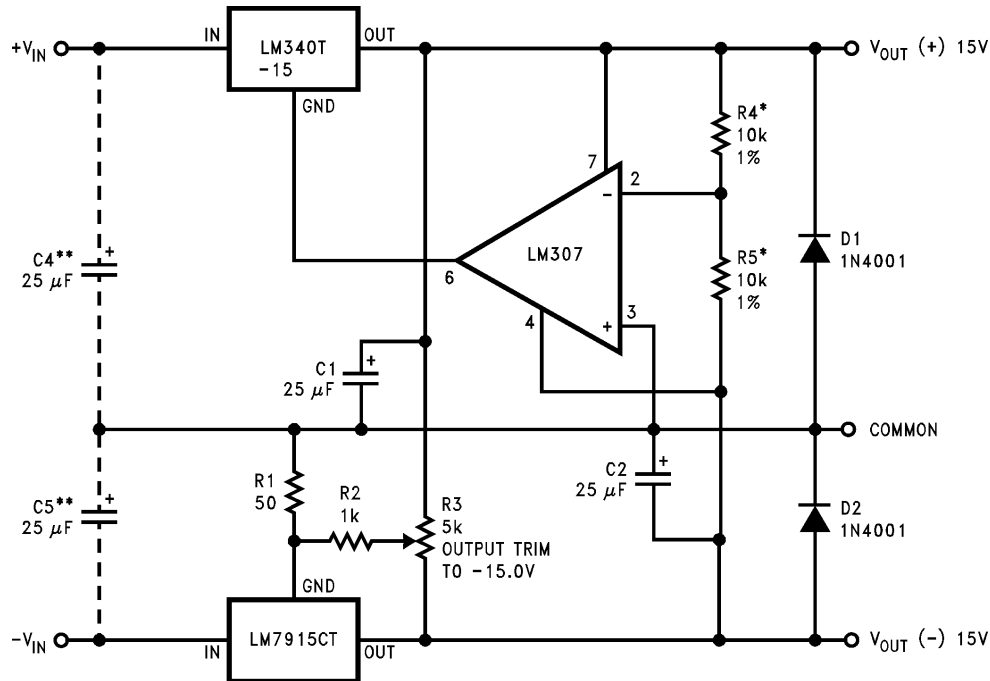
*Improves transient response and ripple rejection. Do not increase beyond 50 μF .

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

Select R2 as follows:

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

Figure 7. Variable Output



| | (-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.

Figure 8. $\pm 15V$, 1 Amp Tracking Regulators

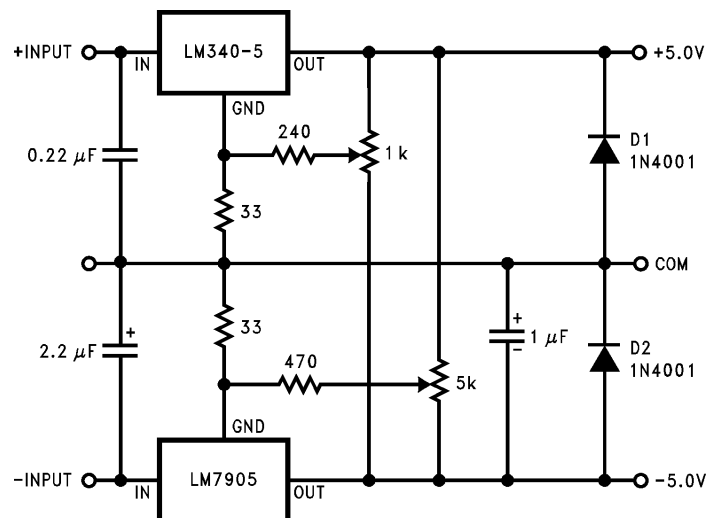


Figure 9. Dual Trimmed Supply

Schematic Diagrams

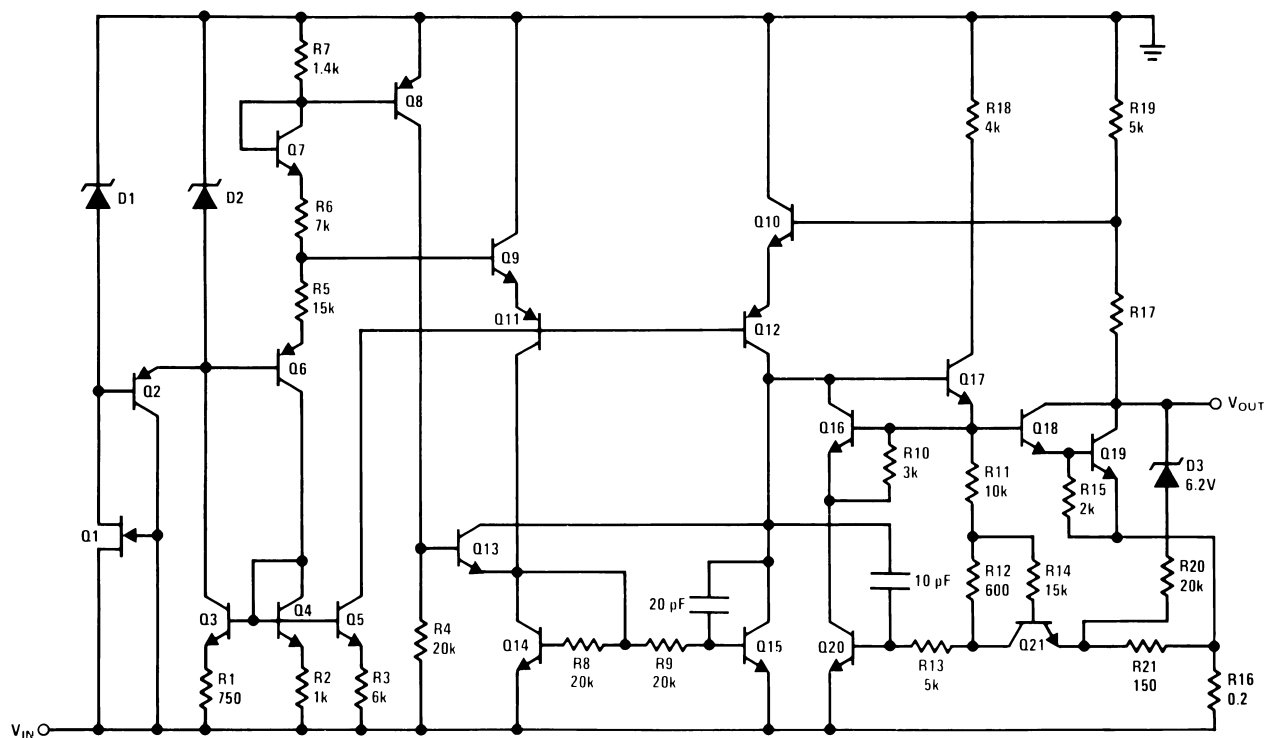


Figure 10. -5V

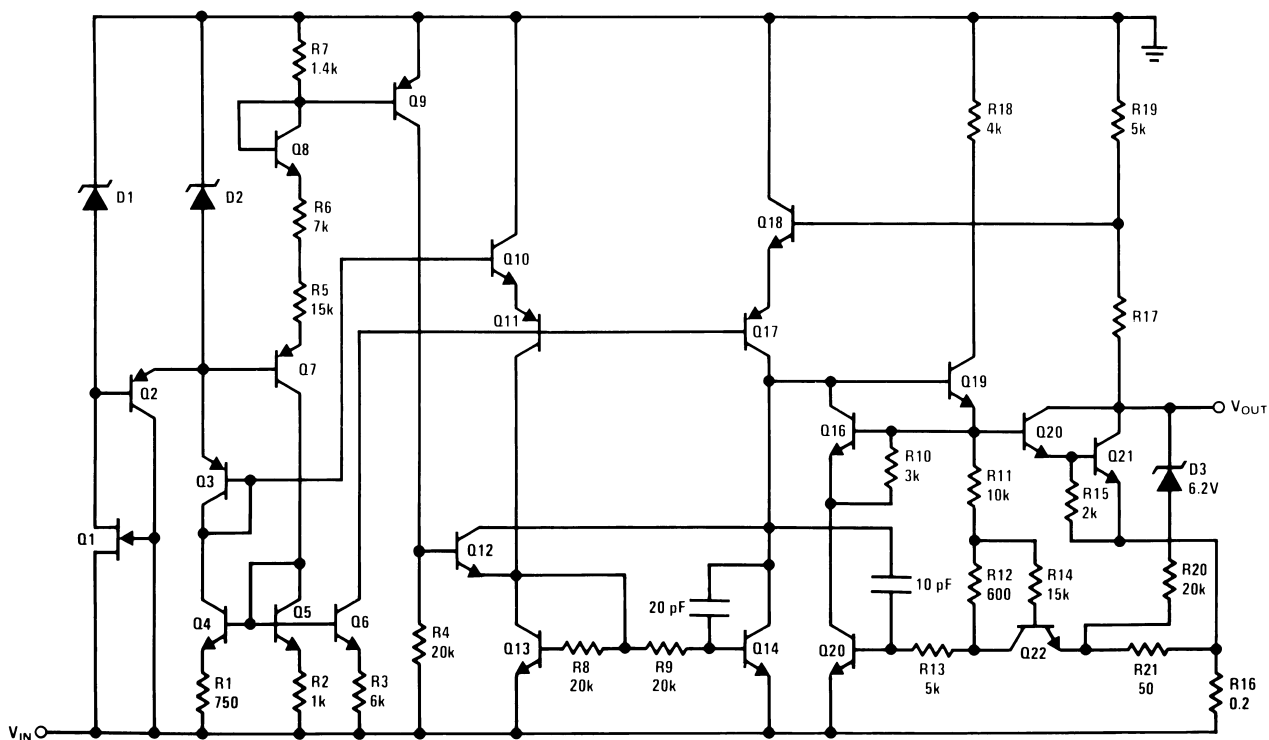


Figure 11. -12V and -15V

REVISION HISTORY

Changes from Revision B (May 2013) to Revision C

Page

- Changed layout of National Data Sheet to TI format. [8](#)

PACKAGING INFORMATION

| Orderable Device | Status (1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan (2) | Lead/Ball Finish (6) | MSL Peak Temp (3) | Op Temp (°C) | Device Marking (4/5) | Samples |
|------------------|---------------|--------------|--------------------|------|----------------|----------------------------|-------------------------|----------------------|--------------|-------------------------|-------------------------|
| LM7905CT | NRND | TO-220 | NDE | 3 | 45 | TBD | Call TI | Call TI | 0 to 125 | LM7905CT | |
| LM7905CT/NOPB | ACTIVE | TO-220 | NDE | 3 | 45 | Green (RoHS & no Sb/Br) | CU SN | Level-1-NA-UNLIM | 0 to 125 | LM7905CT | Samples |
| LM7912CT | NRND | TO-220 | NDE | 3 | 45 | TBD | Call TI | Call TI | 0 to 125 | LM7912CT | |
| LM7912CT/NOPB | ACTIVE | TO-220 | NDE | 3 | 45 | Green (RoHS & no Sb/Br) | CU SN | Level-1-NA-UNLIM | 0 to 125 | LM7912CT | Samples |
| LM7915CT | NRND | TO-220 | NDE | 3 | 45 | TBD | Call TI | Call TI | 0 to 125 | LM7915CT | |
| LM7915CT/NOPB | ACTIVE | TO-220 | NDE | 3 | 45 | Green (RoHS & no Sb/Br) | CU SN | Level-1-NA-UNLIM | 0 to 125 | LM7915CT | Samples |

(1) The marketing status values are defined as follows:

ACTIVE: Product device recommended for new designs.

LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

PREVIEW: Device has been announced but is not in production. Samples may or may not be available.

OBSOLETE: TI has discontinued the production of the device.

(2) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

TBD: The Pb-Free/Green conversion plan has not been defined.

Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

Pb-Free (RoHS Exempt): This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

(3) MSL, Peak Temp. - The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

⁽⁶⁾ Lead/Ball Finish - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead/Ball Finish values may wrap to two lines if the finish value exceeds the maximum column width.

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