

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

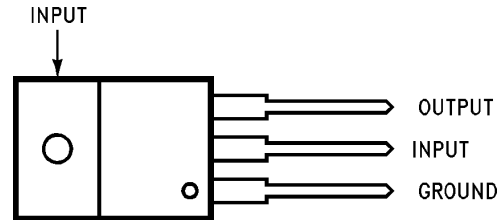
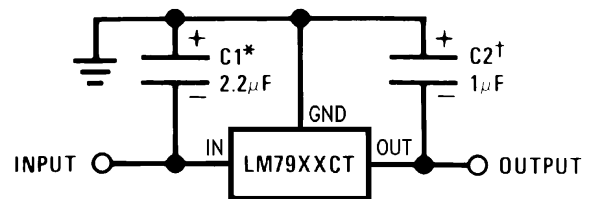


Figure 1. TO-220 Package Front View
See Package Number NDE0003B

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	$T_J = 25^\circ C$ $5mA \leq I_{OUT} \leq 1A$, $P \leq 15W$	-4.8	-5.0	-5.2	V
			-4.75		-5.25	V
				($-20 \leq V_{IN} \leq -7$)		V
ΔV_o	Line Regulation	$T_J = 25^\circ C$, ⁽¹⁾		8	50	mV
				($-25 \leq V_{IN} \leq -7$)		V
				2	15	mV
			($-12 \leq V_{IN} \leq -8$)		V	
ΔV_o	Load Regulation	$T_J = 25^\circ C$, ⁽¹⁾ $5mA \leq I_{OUT} \leq 1.5A$ $250mA \leq I_{OUT} \leq 750mA$		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			0.5	mA
		With Load, $5mA \leq I_{OUT} \leq 1A$			0.5	mA
V_n	Output Noise Voltage Ripple Rejection	$T_A = 25^\circ C$, $10Hz \leq f \leq 100Hz$ $f = 120Hz$		125		μV
			54	66		dB
	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/°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	$T_J = 25^\circ\text{C}$	-11.5	-12.0	-12.5	-14.4	-15.0	-15.6	V
		$5\text{mA} \leq I_{OUT} \leq 1\text{A}$,	-11.4		-12.6	-14.25		-15.75	V
		$P \leq 15\text{W}$	$(-27 \leq V_{IN} \leq -14.5)$			$(-30 \leq V_{IN} \leq -17.5)$			V
ΔV_O	Line Regulation	$T_J = 25^\circ\text{C}$, ⁽¹⁾	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	$T_J = 25^\circ\text{C}$, ⁽¹⁾			15	200			mV
			$5\text{mA} \leq I_{OUT} \leq 1.5\text{A}$				5	75	mV
			$250\text{mA} \leq I_{OUT} \leq 750\text{mA}$						
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
		With Load, $5\text{mA} \leq I_{OUT} \leq 1\text{A}$	$(-30 \leq V_{IN} \leq -14.5)$			$(-30 \leq V_{IN} \leq -17.5)$			V
V_n	Output Noise Voltage Ripple Rejection	$T_A = 25^\circ\text{C}$, $10\text{Hz} \leq f \leq 100\text{Hz}$ $f = 120\text{Hz}$	300			375			μV
			54		70	54		70	dB
	Dropout Voltage	$T_J = 25^\circ\text{C}$, $I_{OUT} = 1\text{A}$	$(-25 \leq V_{IN} \leq -15)$			$(-30 \leq V_{IN} \leq -17.5)$			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		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

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

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

Solving for T_J :

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

or

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

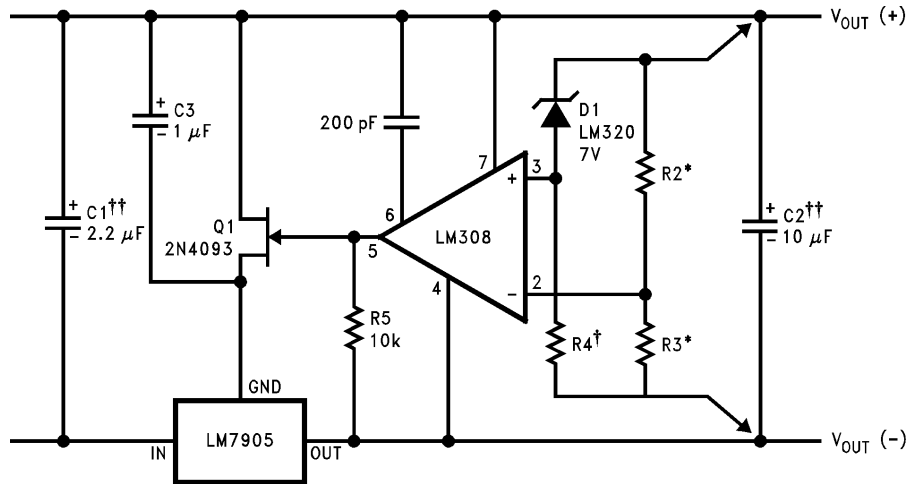
where

- 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.



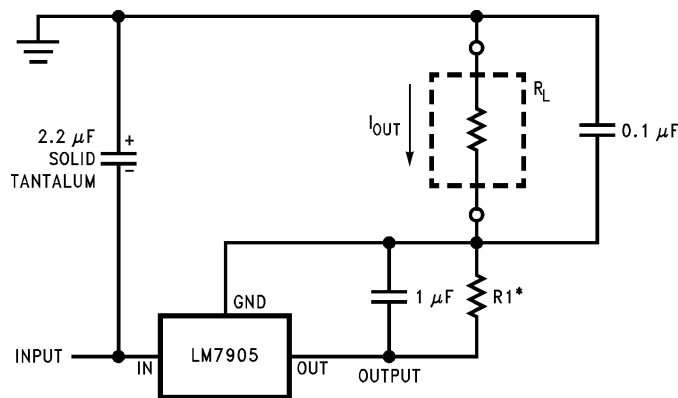
Load and line regulation < 0.01% temperature stability ≤ 0.2%

†Determine Zener current

††Solid tantalum

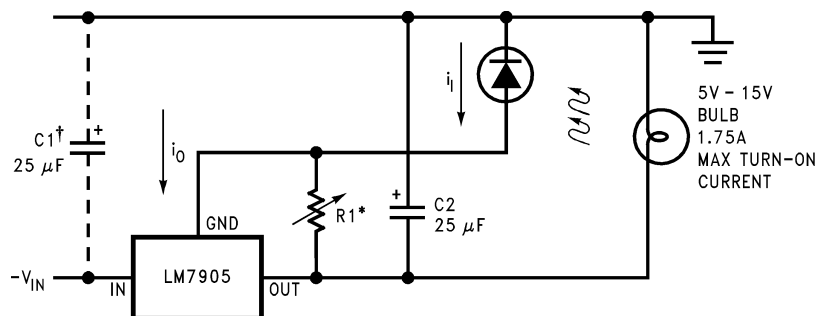
*Select resistors to set output voltage. 2 ppm/°C tracking suggested

Figure 3. High Stability 1 Amp Regulator



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

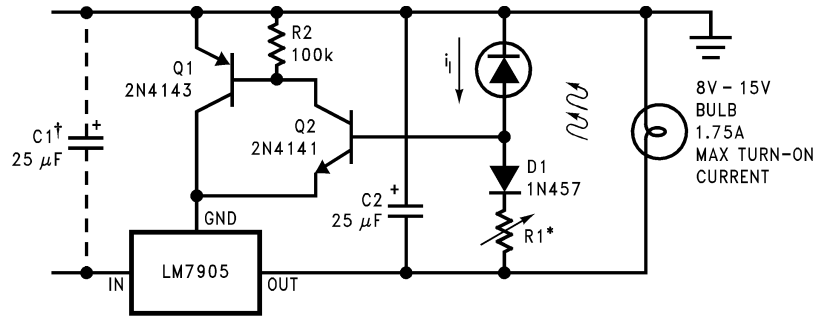
Figure 4. Current Source



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

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

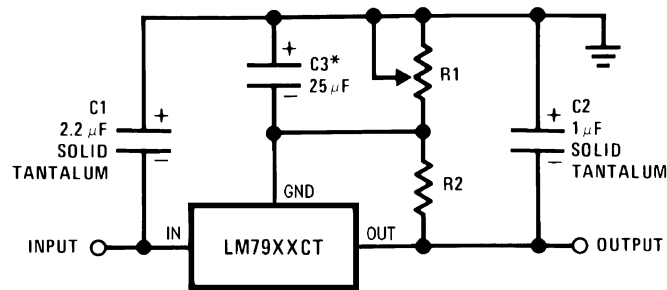
Figure 5. Light Controller Using Silicon Photo Cell



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

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

Figure 6. High-Sensitivity Light Controller



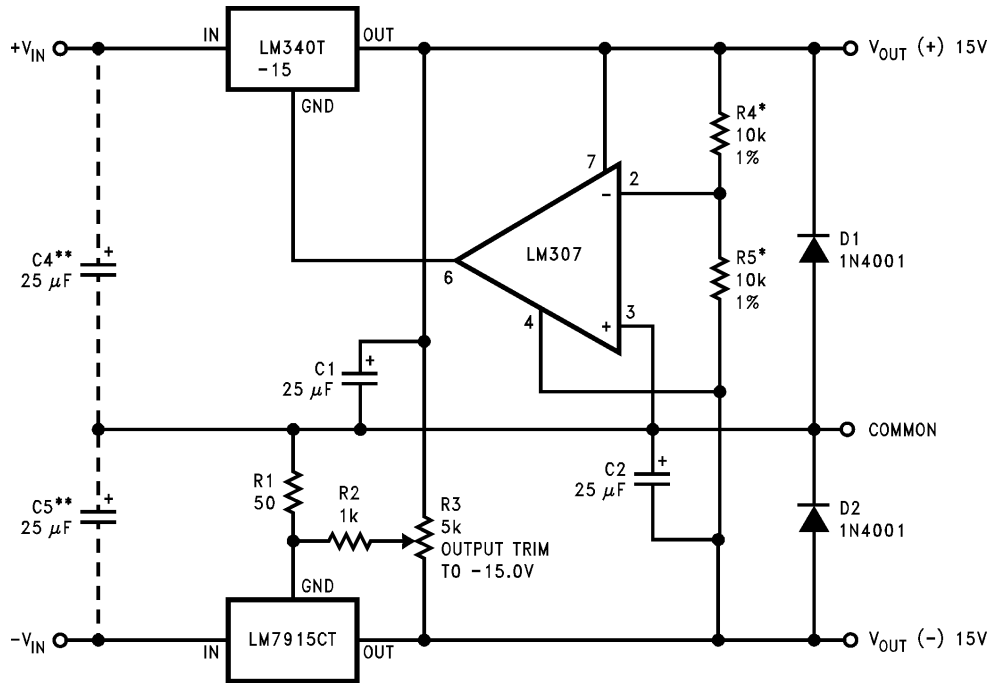
*Improves transient response and ripple rejection. Do not increase beyond $50 \mu F$.

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

Select R2 as follows:

LM7905CT	300Ω
LM7912CT	750Ω
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. ±15V, 1 Amp Tracking Regulators

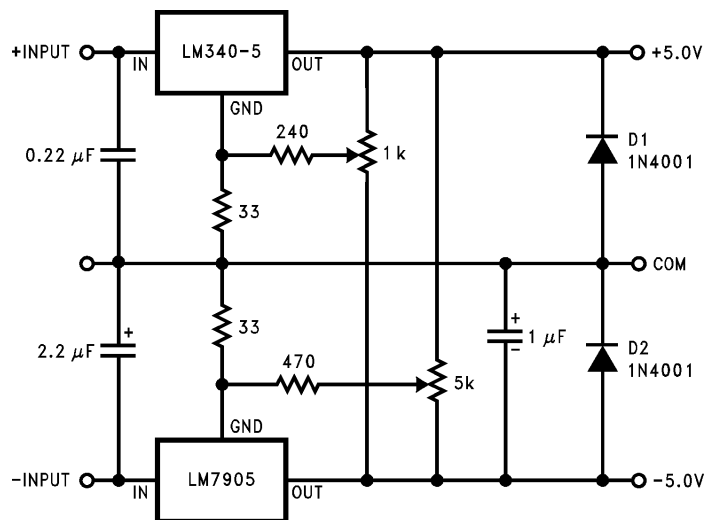


Figure 9. Dual Trimmed Supply

Schematic Diagrams

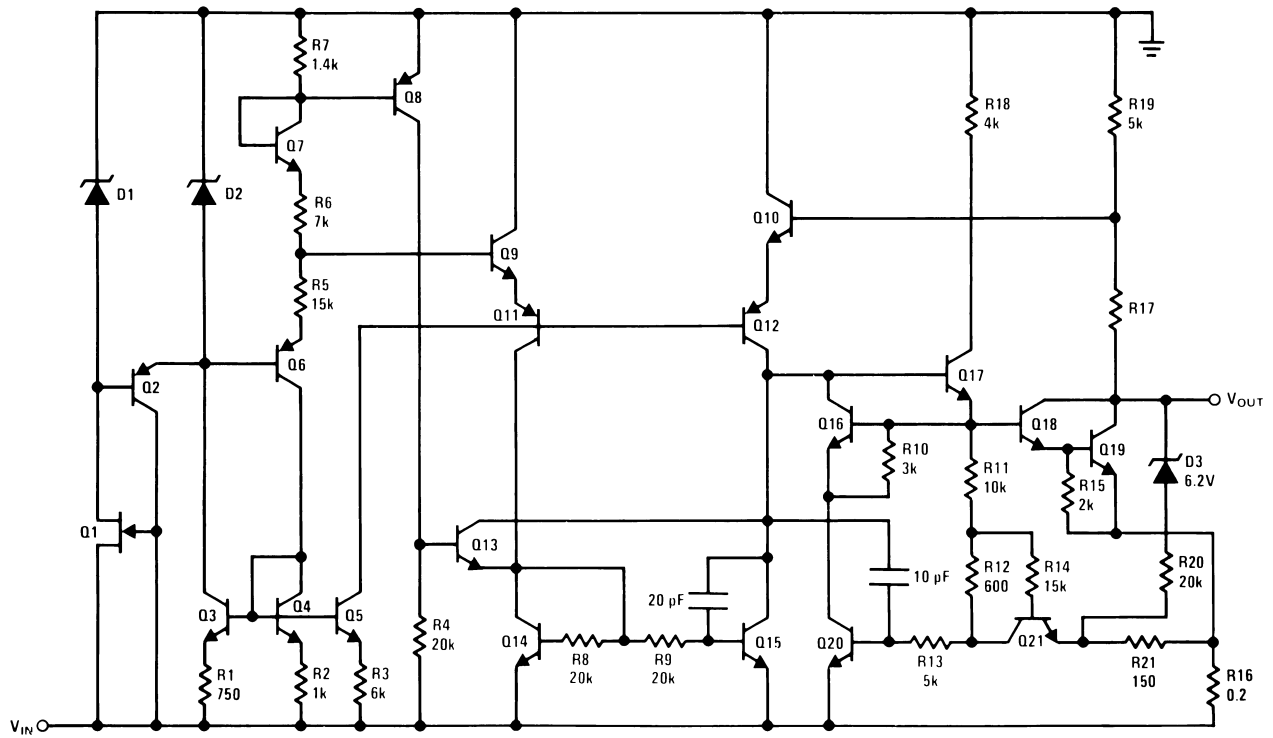


Figure 10. -5V

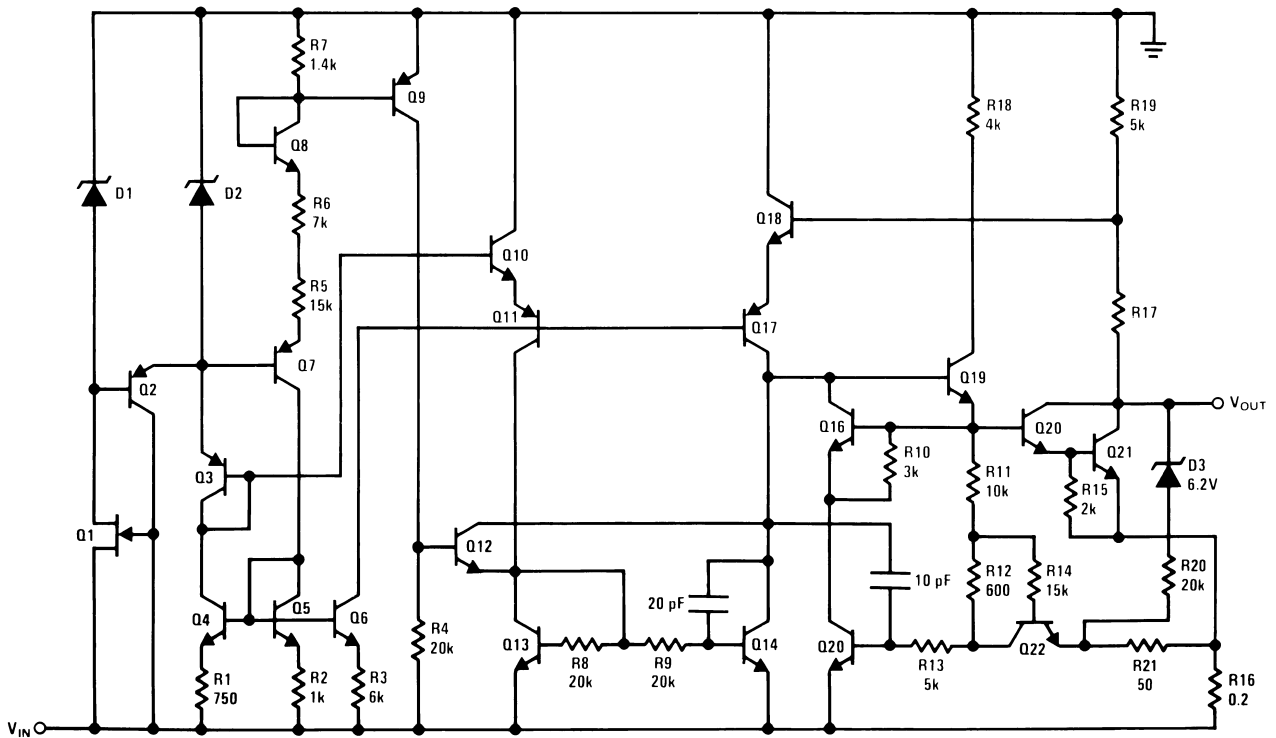


Figure 11. -12V and -15V

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 part number	Status (1)	Material type (2)	Package Pins	Package qty Carrier	RoHS (3)	Lead finish/ Ball material (4)	MSL rating/ Peak reflow (5)	Op temp (°C)	Part marking (6)
LM7905CT/NOPB	Active	Production	TO-220 (NDE) 3	45 TUBE	Yes	SN	Level-1-NA-UNLIM	0 to 125	LM7905CT
LM7905CT/NOPB.B	Active	Production	TO-220 (NDE) 3	45 TUBE	Yes	SN	Level-1-NA-UNLIM	0 to 125	LM7905CT
LM7912CT/NOPB	Active	Production	TO-220 (NDE) 3	45 TUBE	Yes	SN	Level-1-NA-UNLIM	0 to 125	LM7912CT
LM7912CT/NOPB.B	Active	Production	TO-220 (NDE) 3	45 TUBE	Yes	SN	Level-1-NA-UNLIM	0 to 125	LM7912CT
LM7915CT/NOPB	Active	Production	TO-220 (NDE) 3	45 TUBE	Yes	SN	Level-1-NA-UNLIM	0 to 125	LM7915CT
LM7915CT/NOPB.B	Active	Production	TO-220 (NDE) 3	45 TUBE	Yes	SN	Level-1-NA-UNLIM	0 to 125	LM7915CT

⁽¹⁾ **Status:** For more details on status, see our [product life cycle](#).

⁽²⁾ **Material type:** When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.

⁽³⁾ **RoHS values:** Yes, No, RoHS Exempt. See the [TI RoHS Statement](#) for additional information and value definition.

⁽⁴⁾ **Lead finish/Ball material:** Parts may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

⁽⁵⁾ **MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.

⁽⁶⁾ **Part marking:** There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

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TUBE


*All dimensions are nominal

Device	Package Name	Package Type	Pins	SPQ	L (mm)	W (mm)	T (μm)	B (mm)
LM7905CT/NOPB	NDE	TO-220	3	45	502	33	6985	4.06
LM7905CT/NOPB.B	NDE	TO-220	3	45	502	33	6985	4.06
LM7912CT/NOPB	NDE	TO-220	3	45	502	33	6985	4.06
LM7912CT/NOPB.B	NDE	TO-220	3	45	502	33	6985	4.06
LM7915CT/NOPB	NDE	TO-220	3	45	502	33	6985	4.06
LM7915CT/NOPB.B	NDE	TO-220	3	45	502	33	6985	4.06

NDE0003B



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