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.

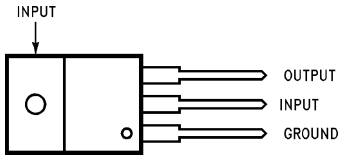
For applications requiring other voltages, see LM137 data sheet.

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



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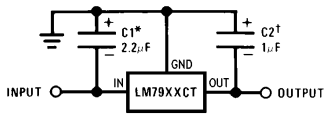
Front View

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

Typical Applications

Fixed Regulator



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*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

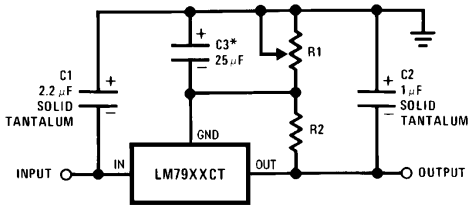
Electrical Characteristics

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, P ≤ 15W	−4.75		−5.25	V
				(−20 ≤ V_{IN} ≤ −7)		V
ΔV_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
ΔV_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
ΔI_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



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*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	300Ω
LM7912CT	750Ω
LM7915CT	1k

Electrical Characteristics (Continued) 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			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 5 mA ≤ I_{OUT} ≤ 1A, P ≤ 15W	−11.5 −11.4 (−27 ≤ V_{IN} ≤ −14.5)	−12.0	−12.5 −12.6	−14.4 −14.25 (−30 ≤ V_{IN} ≤ −17.5)	−15.0	−15.6 −15.75	V V V
ΔV_O	Line Regulation	T_J = 25°C, (Note 3)		5 (−30 ≤ V_{IN} ≤ −14.5) 3 (−22 ≤ V_{IN} ≤ −16)	80 30		5 (−30 ≤ V_{IN} ≤ −17.5) 3 (−26 ≤ V_{IN} ≤ −20)	100 50	mV V mV V
ΔV_O	Load Regulation	T_J = 25°C, (Note 3) 5 mA ≤ I_{OUT} ≤ 1.5A 250 mA ≤ I_{OUT} ≤ 750 mA		15 5	200 75		15 5	200 75	 mV mV
I_Q	Quiescent Current	T_J = 25°C		1.5	3		1.5	3	mA
ΔI_Q	Quiescent Current Change	With Line With Load, 5 mA ≤ I_{OUT} ≤ 1A		 (−30 ≤ V_{IN} ≤ −14.5)	0.5 0.5		 (−30 ≤ V_{IN} ≤ −17.5)	0.5 0.5	mA V mA
V_n	Output Noise Voltage	T_A = 25°C, 10 Hz ≤ f ≤ 100 Hz		300			375		µV
	Ripple Rejection	f = 120 Hz	54 (−25 ≤ V_{IN} ≤ −15)	70		54 (−30 ≤ V_{IN} ≤ −17.5)	70		dB 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

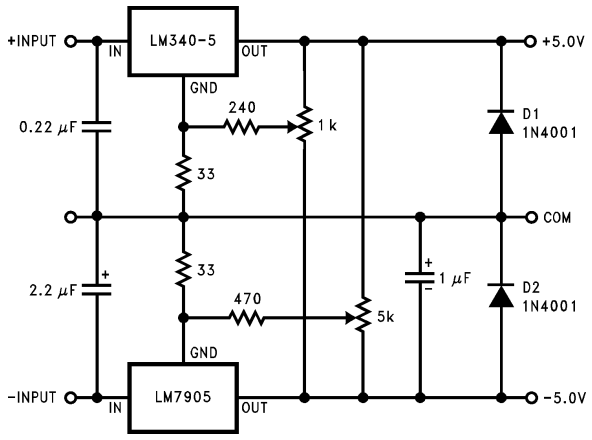
Note 1: Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is intended to be functional, but do not guarantee Specific Performance limits. For guaranteed specifications and test conditions, see the Electrical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



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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

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

$\theta_{CA} = \theta_{CS} + \theta_{SA}$ (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:

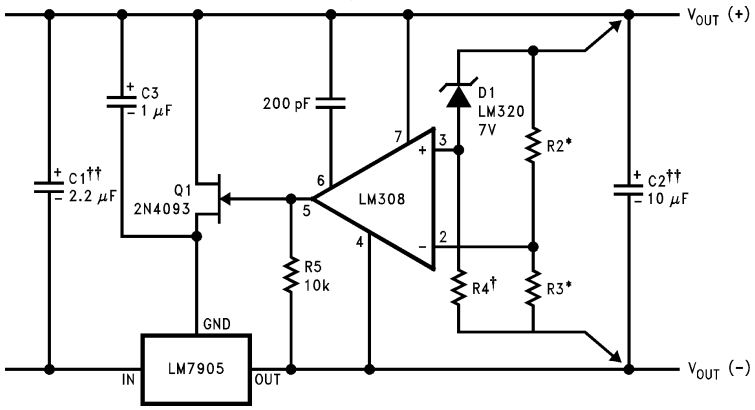
T_J = Junction Temperature
T_A = Ambient Temperature
P_D = Power Dissipation
θ_{JA} = Junction-to-Ambient Thermal Resistance
θ_{JC} = Junction-to-Case Thermal Resistance
θ_{CA} = Case-to-Ambient Thermal Resistance
θ_{CS} = Case-to-Heat Sink Thermal Resistance
θ_{SA} = Heat Sink-to-Ambient Thermal Resistance

Typical Applications (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



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

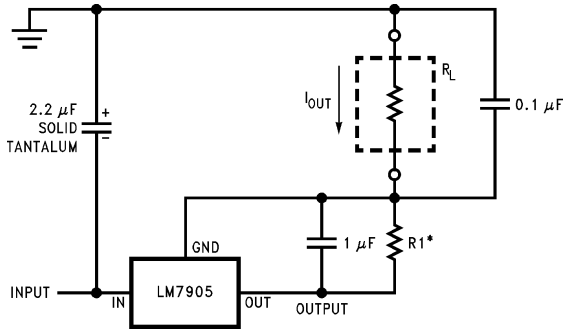
†Determine Zener current

††Solid tantalum

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

Typical Applications (Continued)

Current Source



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

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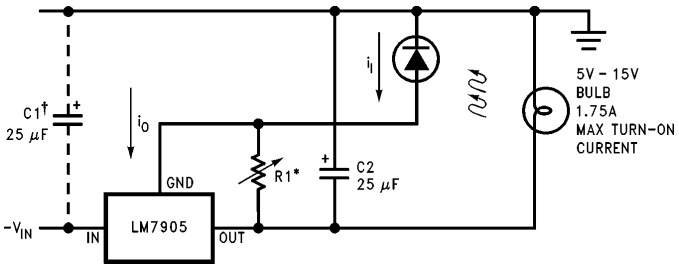
Light Controller Using Silicon Photo Cell



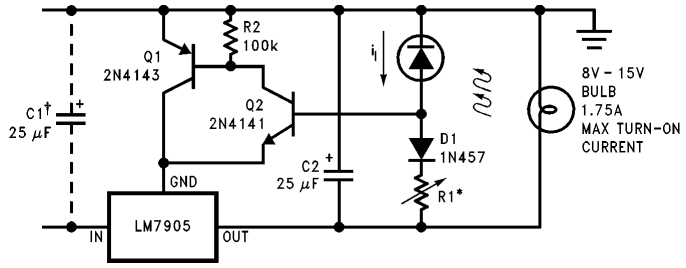
TL/H/7340–8

*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

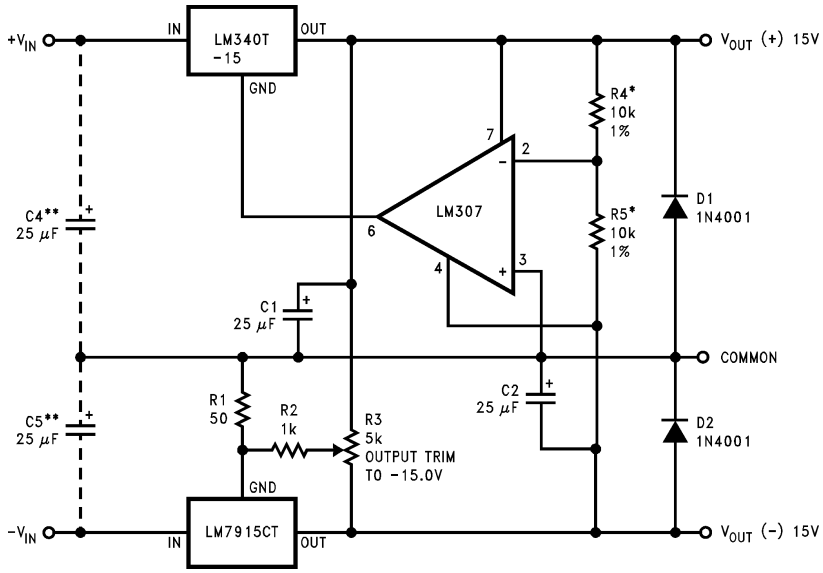


TL/H/7340–9

*Lamp brightness increases until i_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

±15V, 1 Amp Tracking Regulators



TL/H/7340–1

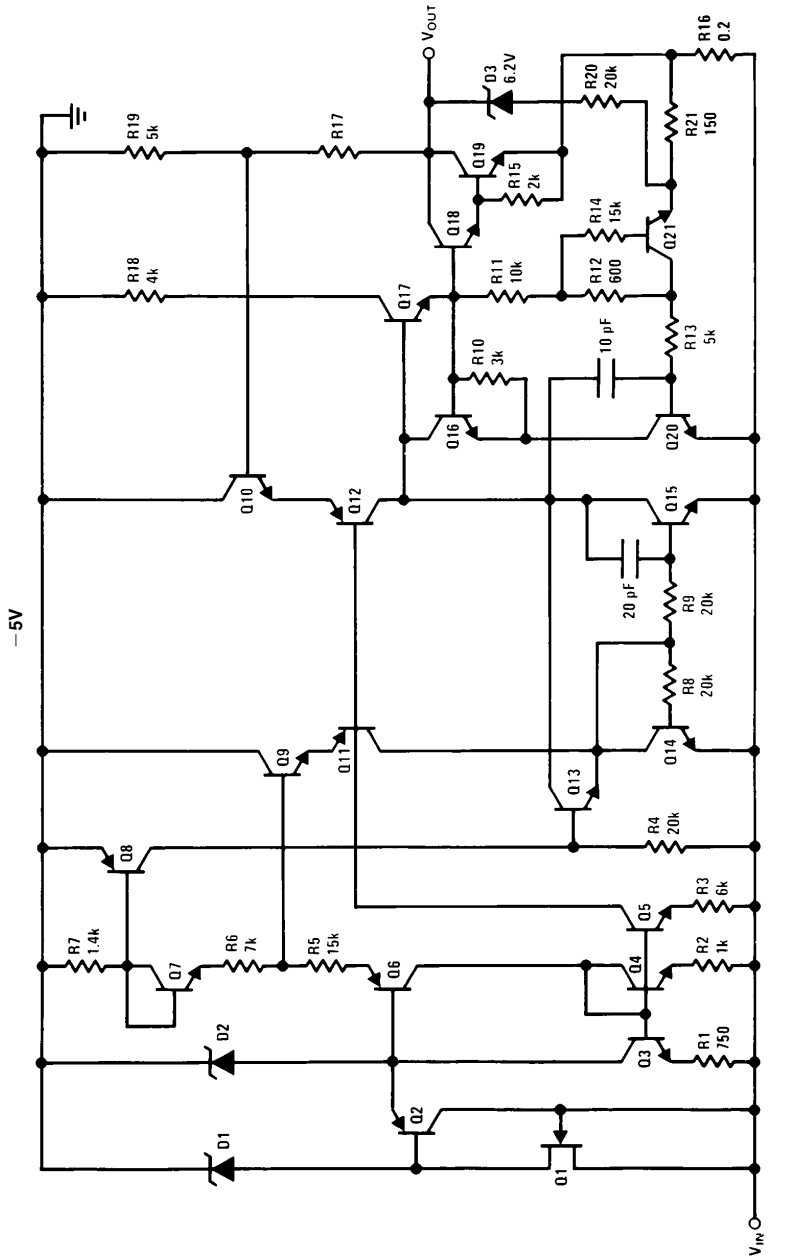
	(−15)	(+15)
Load Regulation at ΔI_L = 1A	40 mV	2 mV
Output Ripple, C_{IN} = 3000 μF, I_L = 1A	100 μVrms	100 μVrms
Temperature Stability	50 mV	50 mV
Output Noise 10 Hz ≤ f ≤ 10 kHz	150 μVrms	150 μVrms

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

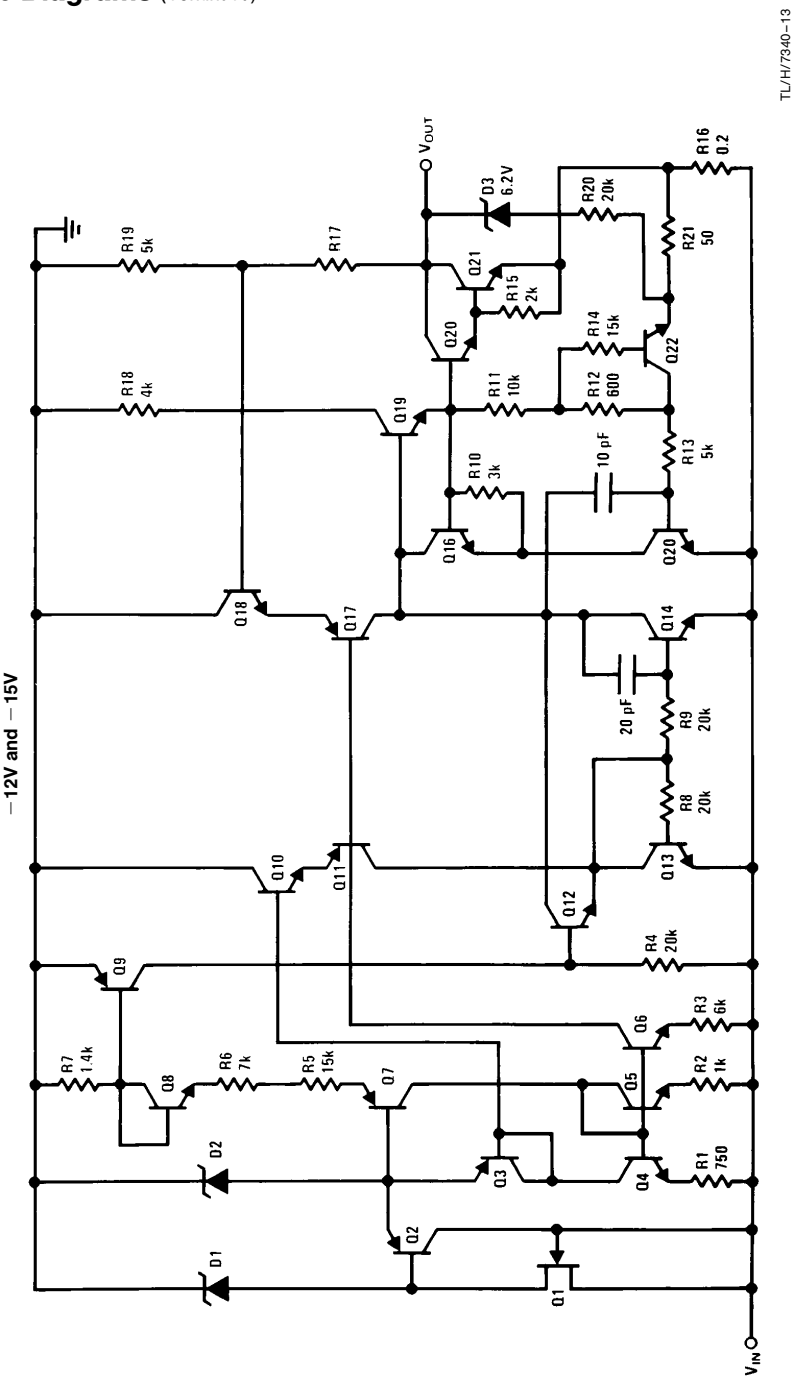
**Necessary only if raw supply filter capacitors are more than 3″ from regulators.

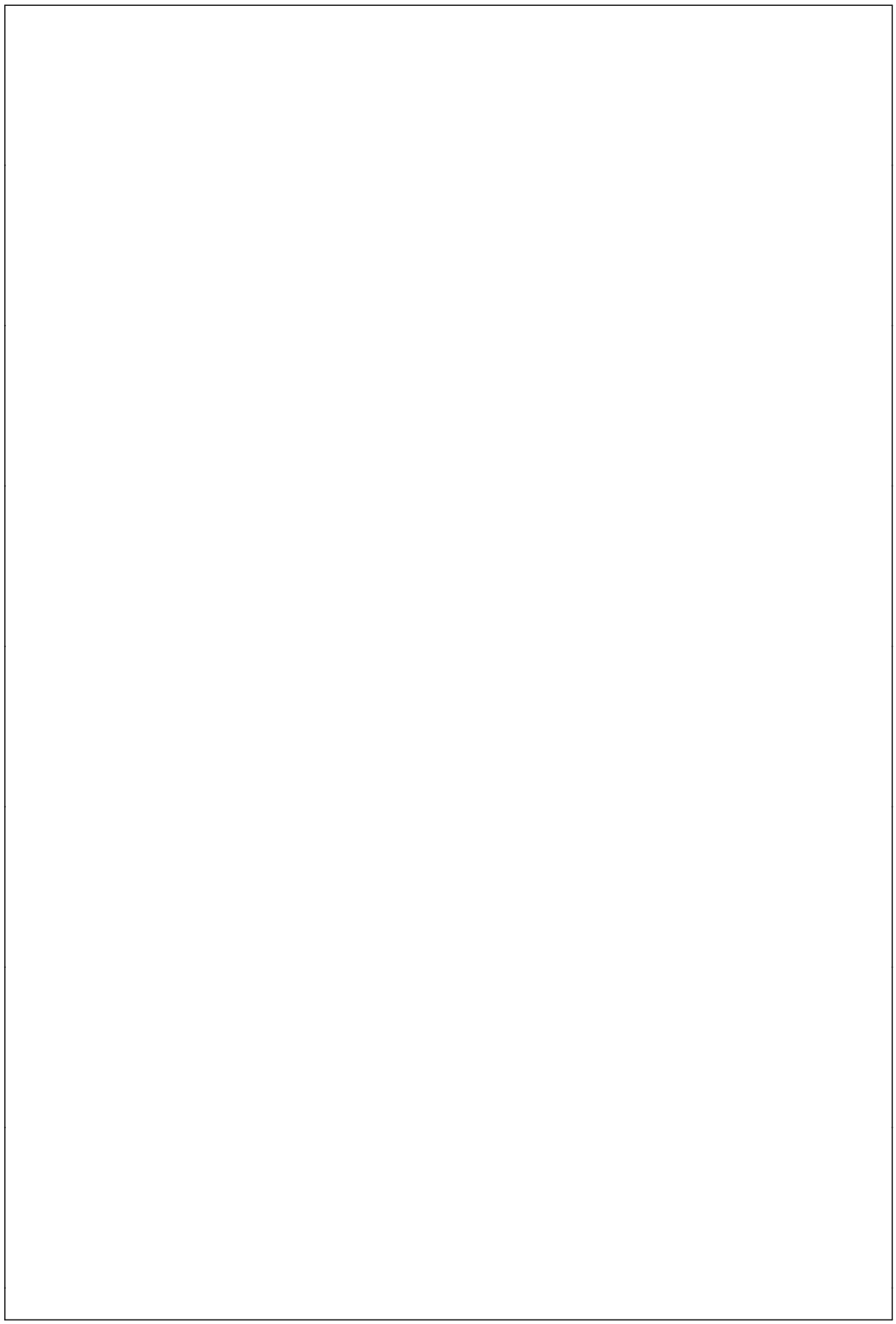
Schematic Diagrams

TL/H/7340–12

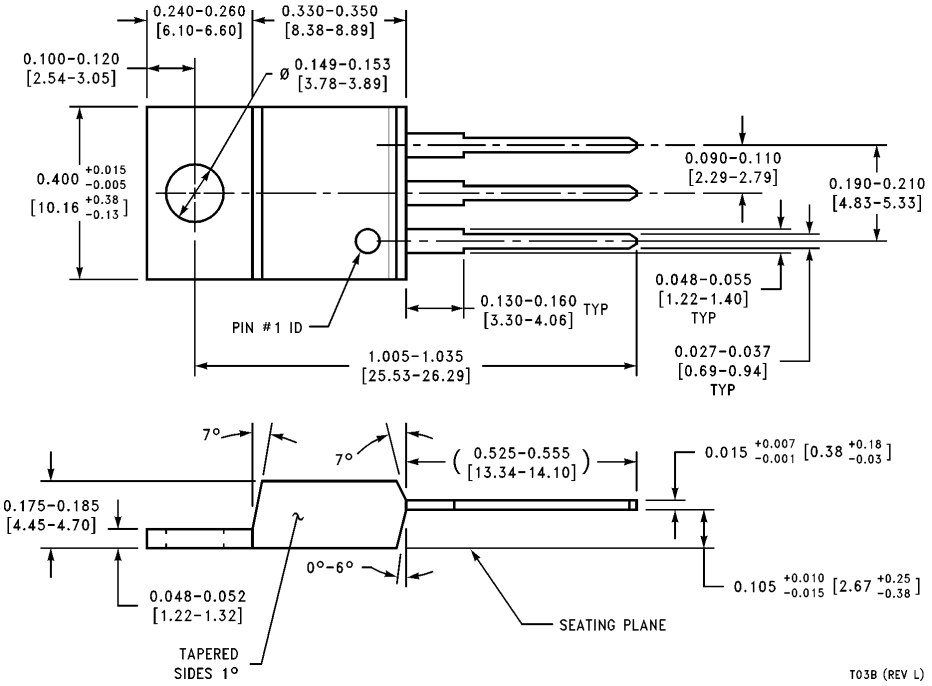


Schematic Diagrams (Continued)





Physical Dimensions inches (millimeters)



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

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