

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

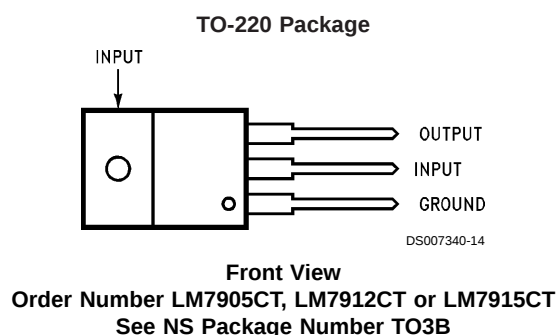
resistor divider. The low quiescent current drain of these devices with a specified maximum change with line and load ensures good regulation in the voltage boosted mode.

For applications requiring other voltages, see LM137 datasheet.

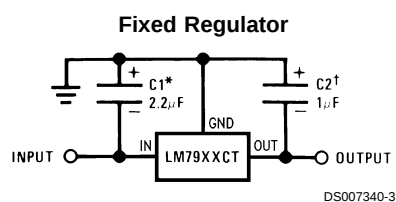
Features

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

Connection Diagrams



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

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

25V

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°C	-4.8	-5.0	-5.2	V	
		5mA ≤ I _{OUT} ≤ 1A,	-4.75		-5.25	V	
		P ≤ 15W	(-20 ≤ V _{IN} ≤ -7)			V	
ΔV _O	Line Regulation	T _J = 25°C, (Note 3)	8			mV	
			(-25 ≤ V _{IN} ≤ -7)			V	
			2			mV	
			(-12 ≤ V _{IN} ≤ -8)			V	
ΔV _O	Load Regulation	T _J = 25°C, (Note 3) 5mA ≤ I _{OUT} ≤ 1.5A 250mA ≤ I _{OUT} ≤ 750mA	15			mV	
			5			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	125				μV
	Ripple Rejection	f = 120Hz	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} = 5mA, 0 C ≤ T _J ≤ 100°C	0.4				mV/°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°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, (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
ΔV _O	Load Regulation	T _J = 25°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	Min	Typ	Max	
		5mA ≤ I _{OUT} ≤ 1.5A		15	200		15	200	mV
		250mA ≤ I _{OUT} ≤ 750mA		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
	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} = 5mA, 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.

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 :

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

Where:

$$\begin{aligned} T_J &= \text{Junction Temperature} \\ T_A &= \text{Ambient Temperature} \\ P_D &= \text{Power Dissipation} \end{aligned}$$

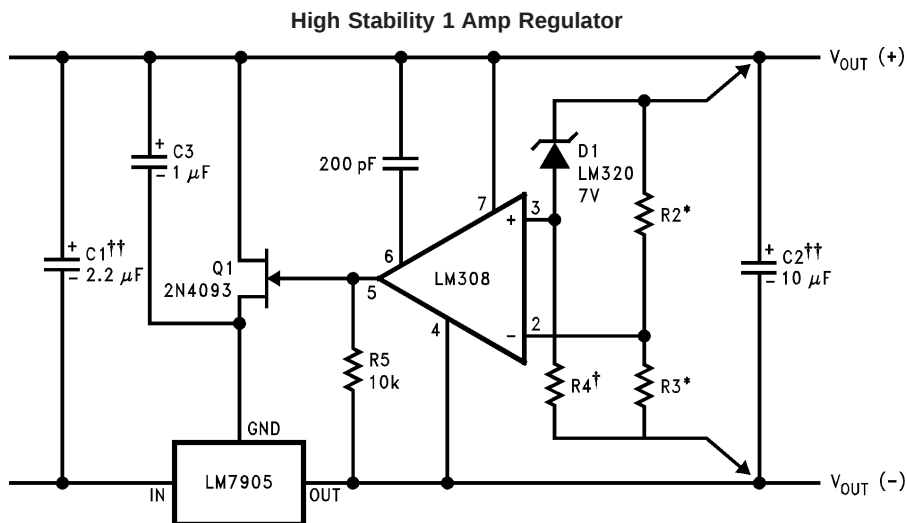
$$\begin{aligned} \theta_{JA} &= \text{Junction-to-Ambient Thermal Resistance} \\ \theta_{JC} &= \text{Junction-to-Case Thermal Resistance} \\ \theta_{CA} &= \text{Case-to-Ambient Thermal Resistance} \\ \theta_{CS} &= \text{Case-to-Heat Sink Thermal Resistance} \\ \theta_{SA} &= \text{Heat Sink-to-Ambient Thermal Resistance} \end{aligned}$$

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, (2.2 μ F on the input, 1.0 μ F 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 μ F or larger. The bypass capacitors should be mounted with the shortest leads, and if possible, directly across the regulator terminals.

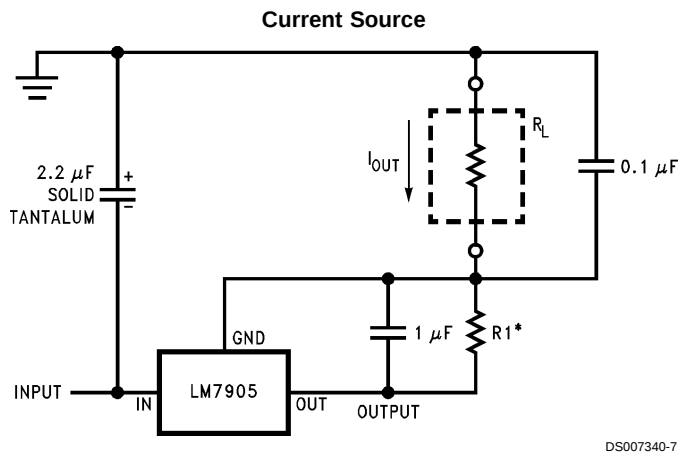


Load and line regulation < 0.01% temperature stability $\leq 0.2\%$

†Determine Zener current

††Solid tantalum

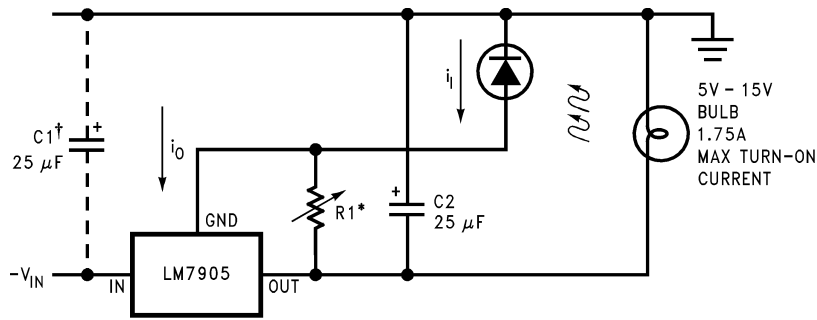
*Select resistors to set output voltage. 2 ppm/°C tracking suggested



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

Typical Applications (Continued)

Light Controller Using Silicon Photo Cell

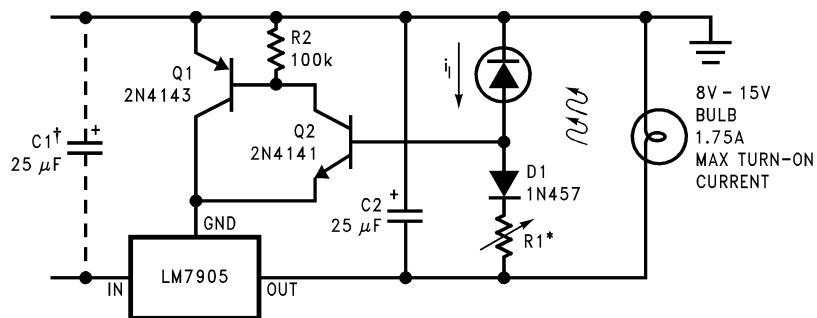


DS007340-8

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

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

High-Sensitivity Light Controller

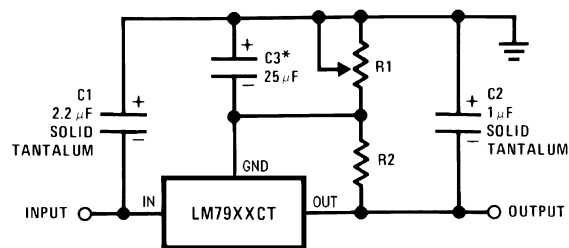


DS007340-9

*Lamp brightness increases until $i_l = 5V/R1$ (i_l 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 $50 \mu\text{F}$.

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

Select R2 as follows:

LM7905CT	300Ω
LM7912CT	750Ω
LM7915CT	1k

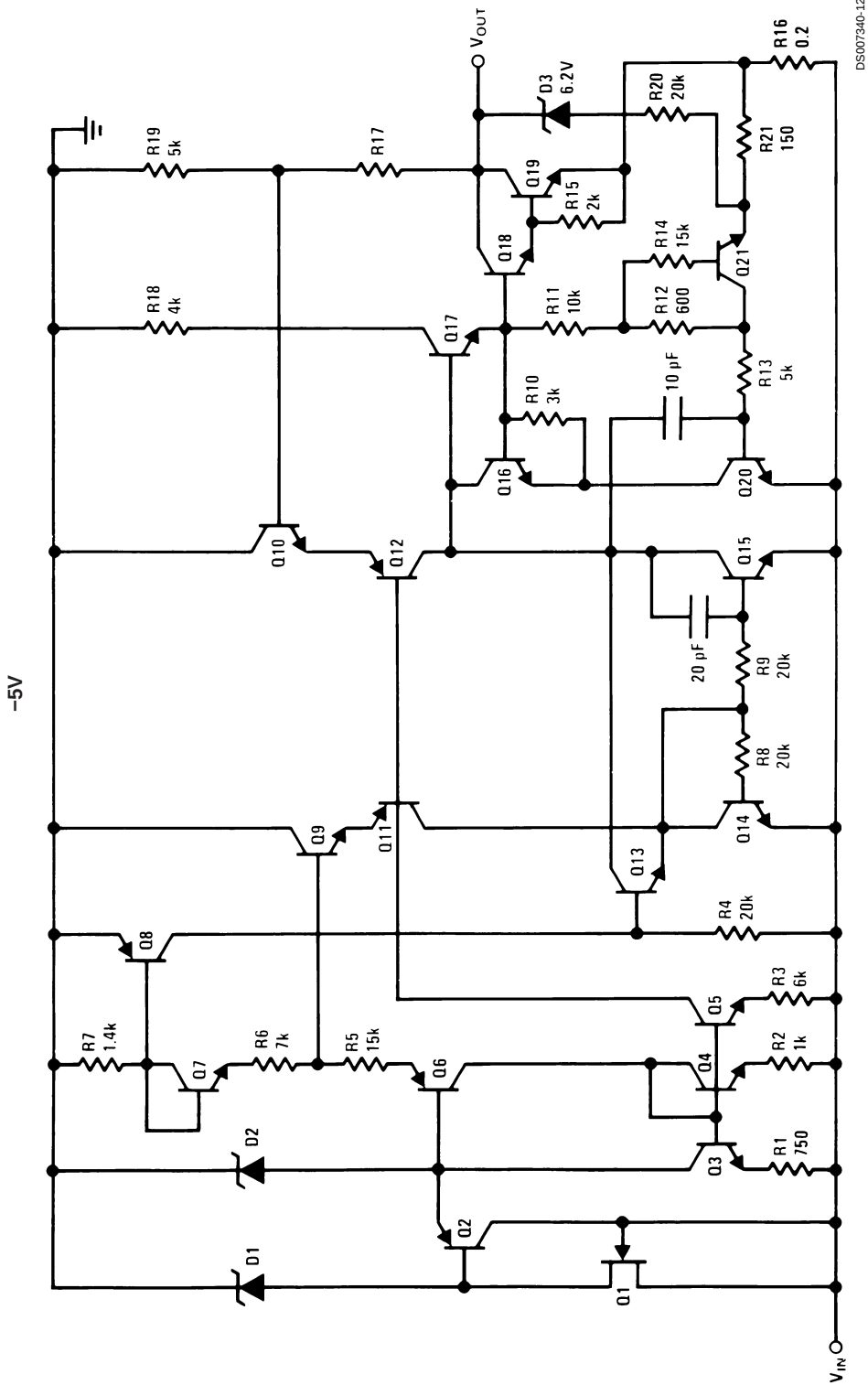
The circuit diagram shows a precision full-wave rectifier. It features an LM307 operational amplifier configured as a precision rectifier. The non-inverting input (pin 3) is connected to ground. The inverting input (pin 2) is connected to the output of the LM307 through a feedback network consisting of resistors R4* (10k, 1%) and R5* (10k, 1%). The output of the LM307 (pin 7) is connected to the positive output terminal V_{OUT} (+) 15V. The negative output terminal V_{OUT} (-) 15V is connected to the output of the LM307 through a diode D2 (1N4001). The output of the LM307 is also connected to the output of the LM340T regulator (pin 15) through a diode D1 (1N4001). The LM340T regulator is connected to the positive input terminal +V_{IN} (pin 1) and ground (pin 14). The LM7915CT regulator is connected to the negative input terminal -V_{IN} (pin 1) and ground (pin 14). The output of the LM7915CT is connected to the negative output terminal V_{OUT} (-) 15V. The circuit includes several capacitors: C1 (25 μF) at the positive input, C2 (25 μF) at the negative input, and C4** (25 μF) and C5** (25 μF) at the input terminals. Resistors R1 (50), R2 (1k), and R3 (5k) are used for output trimming, with R3 labeled "OUTPUT TRIM TO -15.0V".

	(-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

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

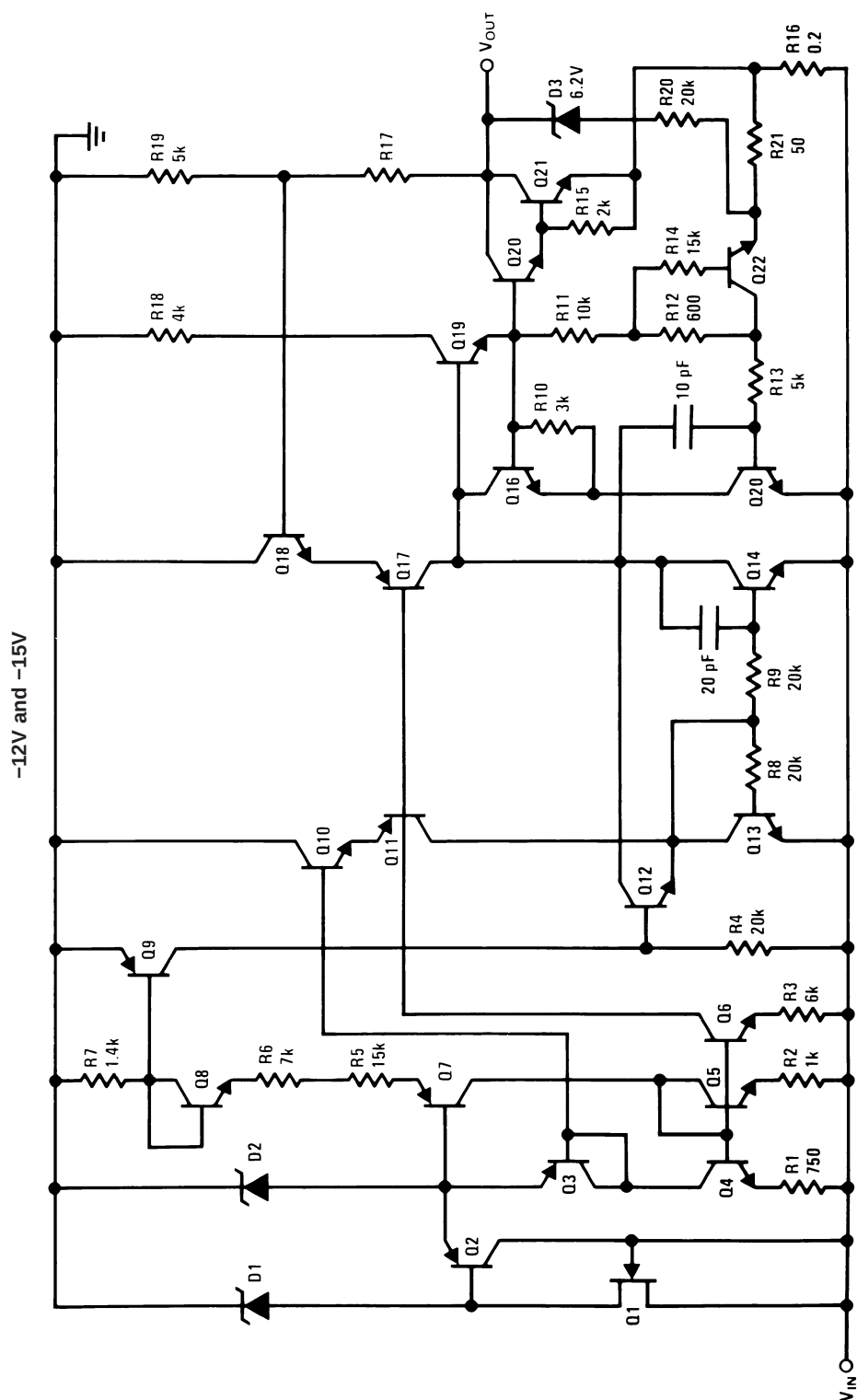
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Schematic Diagrams



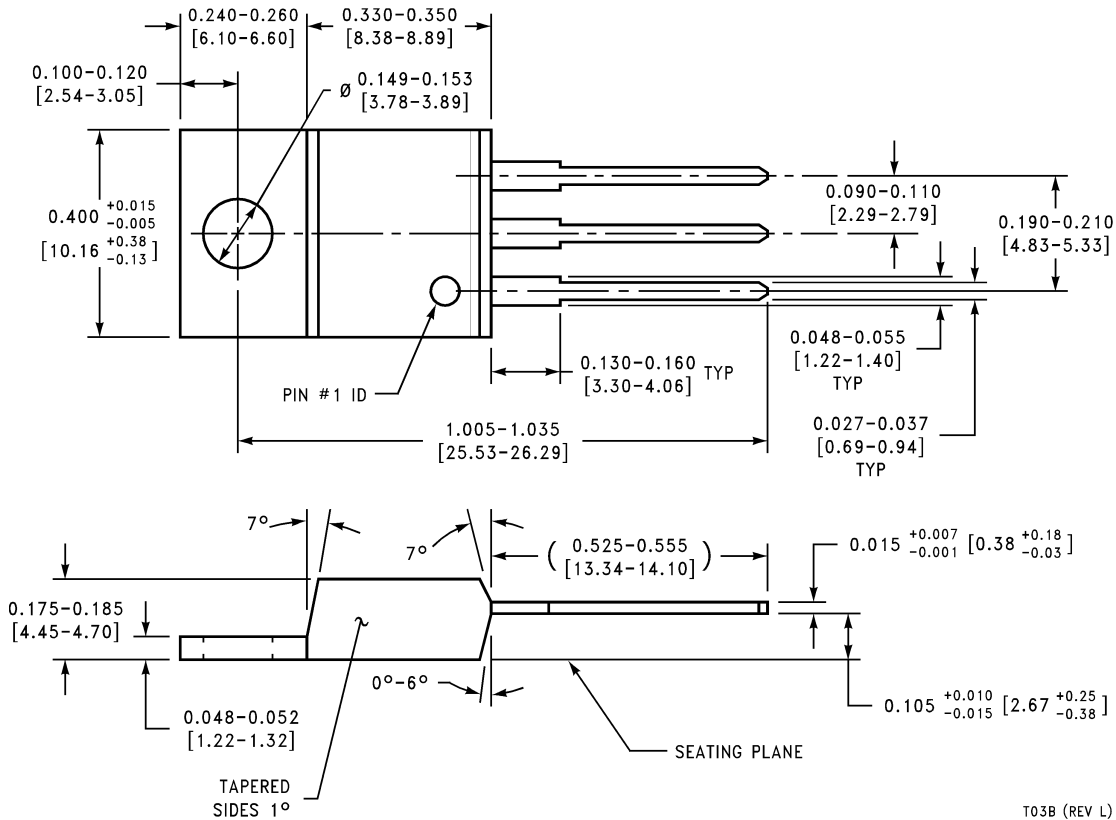
DS007340-12

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

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