



Voltage Regulators

LM120 Series 3-Terminal Negative Regulators

General Description

The LM120 series are three-terminal negative regulators with a fixed output voltage of -5V, -12V, and -15V, and up to 1.5A load current capability. Where other voltages are required, the LM137 series provides an output voltage range of -1.2V to -47V.

The LM120 need only one external component—a compensation capacitor at the output, making them easy to apply. Worst case guarantees on output voltage deviation due to any combination of line, load or temperature variation assure satisfactory system operation.

Exceptional effort has been made to make the LM120 Series immune to overload conditions. The regulators have current limiting which is independent of temperature, combined with thermal overload protection. Internal current limiting protects against momentary faults while thermal shutdown prevents junction temperatures from exceeding safe limits during prolonged overloads.

Although primarily intended for fixed output voltage applications, the LM120 Series may be programmed for higher output voltages with a simple resistive divider. The low quiescent drain current of the devices allows this technique to be used with good regulation.

Features

- Preset output voltage error less than ±3%
- Preset current limit
- Internal thermal shutdown
- Operates with input-output voltage differential down to 1V
- Excellent ripple rejection
- Low temperature drift
- Easily adjustable to higher output voltage

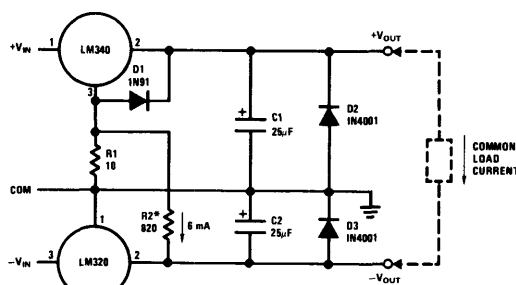
LM120 Series Packages and Power Capability

DEVICE	PACKAGE	RATED POWER DISSIPATION	DESIGN LOAD CURRENT
LM120	TO-3	20W	1.5A
LM320	TO-5	2W	0.5A
LM320T	TO-220	15W	1.5A
LM320M	TO-202	7.5W	0.5A
LM320ML*	TO-202	7.5W	0.25A
LM320L*	TO-92+	1.2W	0.1A

*Electrical specifications shown on separate data sheet

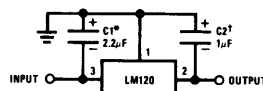
Typical Applications

Preventing Positive Regulator Latch-Up



R1 & D1 allow the positive regulator to "start-up" when V_{IN} is delayed relative to V_{OUT} and a heavy load is drawn between the outputs. Without R1 & D1, most three-terminal regulators will not start with heavy (0.1A-1A) load current flowing to the negative regulator, even though the positive output is clamped by D2.
*R2 is optional. Ground pin current from the positive regulator flowing through R1 will increase $+V_{OUT} = 60 \text{ mV}$ if R2 is omitted.

Fixed Regulator

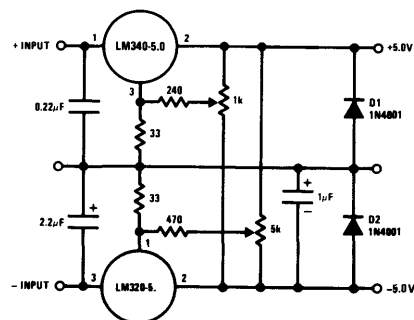


*Required if regulator is separated from filter capacitor by more than 3". For value given, capacitor must be solid tantalum. 25µF aluminum electrolytic may be substituted.

†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.

Dual Trimmed Supply



-5 VOLT REGULATORS (Note 3)

Absolute Maximum Ratings

Power Dissipation Internally Limited
 Input Voltage -25V
 Input-Output Voltage Differential 25V
 Junction Temperatures See Note 1
 Storage Temperature Range -65°C to +150°C
 Lead Temperature (Soldering, 10 seconds) 300°C

Electrical Characteristics

PARAMETER	ORDER NUMBERS	METAL CAN PACKAGE						POWER PLASTIC PACKAGE						UNITS	
		LM120K-5.0 (TO-3)		LM120H-5.0 (TO-5)		LM320K-5.0 (TO-3)		LM320H-5.0 (TO-5)		LM320T-5.0 (TO-220)		LM320MP-5.0 (TO-202)			
		MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX		
DESIGN OUTPUT CURRENT (I _D)		1.5A													
DEVICE DISSIPATION (P _D)		20W													
CONDITIONS (NOTE 1)		T _J = 25°C, V _{IN} = 10V, I _{LOAD} = 5 mA													
Output Voltage		-5.1	-6	-4.9	-5.1	-6.0	-4.9	-5.0	-4.8	-5.2	-6.0	-4.8	-5.0	-4.8	V
Line Regulation			10	25		10	25		10	40		10	40	mV	
Input Voltage		-25		-7	-25		-7		-25		-7.5		-7.5	V	
Ripple Rejection		54	64	54	54	64	54	64	54	64	54	64	64	dB	
Load Regulation (Note 2)			50	75		30	50		30	50		50	100	mV	
Output Voltage (Note 1)		-5.20		-4.80	-5.20		-4.80		-5.25		-4.75		-4.75	V	
Quiescent Current:		1	2	2	1	2	2	1	2	1	2	1	2	mA	
Quiescent Current: Change														mA	
		0.1	0.4	0.4	0.05	0.4	0.4	0.05	0.4	0.1	0.4	0.05	0.3	mA	
		0.1	0.4	0.4	0.04	0.4	0.4	0.04	0.4	0.1	0.4	0.04	0.25	mA	
Output Noise Voltage		150	150	150	150	150	150	150	150	150	150	150	150	μV	
Long Term Stability		5	5	50	5	50	5	50	5	50	5	50	10	mV	
Thermal Resistance														°C/W	
Junction to Case				3		15		15		4			12	°C/W	
Junction to Ambient				35		150		150		50			70	°C/W	

Note 1: This specification applies over -55°C ≤ T_J ≤ +150°C for the LM120 and 0°C ≤ T_J ≤ +125°C for the LM320.

Note 2: Regulation is measured at constant junction temperature. Changes in output voltage due to heating effects must be taken into account separately. To ensure constant junction temperature, low duty cycle, pulse testing is used. The LM120/LM320 series does have low thermal feedback, improving line and load regulation. On all other tests, even though power dissipation is internally limited, electrical specifications apply only up to P_D.

Note 3: For -5V 3 amp regulators, see LM145 data sheet.

LM120 Series

LM120 Series

-12 VOLT REGULATORS

Absolute Maximum Ratings

Power Dissipation Internally Limited
 Input Voltage -35V
 Input-Output Voltage Differential 30V
 Junction Temperatures See Note 1
 Storage Temperature Range -65°C to +150°C
 Lead Temperature (Soldering, 10 seconds) 300°C

Electrical Characteristics

PARAMETER	ORDER NUMBERS		METAL CAN PACKAGE						POWER PLASTIC PACKAGE						UNITS	
	DESIGN OUTPUT CURRENT (I _D) DEVICE DISSIPATION (P _D)		LM120K-12 (TO-3)		LM320K-12 (TO-3)		LM120H-12 (TO-5)		LM320H-12 (TO-5)		LM320T-12 (TO-220)		LM320MP-12 (TO-202)			
	MIN	TYP	MIN	TYP	MIN	TYP	MIN	TYP	MIN	TYP	MIN	TYP	MIN	TYP		MAX
Output Voltage	-12.3	-12	-11.7	-11.6	-12.3	-12	-11.7	-11.6	-12.4	-12	-11.6	-11.6	-12.4	-12	-11.5	V
Line Regulation	4	10	4	20	4	10	4	20	4	20	4	20	4	24	mV	
Input Voltage	-32	-14	-32	-14	-32	-14	-32	-14	-32	-14	-32	-14	-32	-14.5	V	
Ripple Rejection	56	80	56	80	56	80	56	80	56	80	56	80	56	80	dB	
Load Regulation, (Note 2)	30	80	30	80	30	80	30	80	30	80	30	80	30	80	mV	
Output Voltage, (Note 1)	-12.5	-11.5	-11.5	-11.4	-12.5	-11.5	-11.5	-11.4	-12.6	-12.6	-11.4	-11.4	-12.6	-11.4	V	
Quiescent Current:	2	4	2	4	2	4	2	4	2	4	2	4	2	4	mA	
Quiescent Current: Change	0.1	0.4	0.1	0.4	0.05	0.4	0.05	0.4	0.05	0.4	0.1	0.4	0.1	0.4	mA	
Output Noise Voltage	400	400	400	400	400	400	400	400	400	400	400	400	400	400	μV	
Long Term Stability	12	120	12	120	12	120	12	120	12	120	12	120	12	24	mV	
Thermal Resistance	3	3	3	3	3	3	3	3	3	3	3	3	3	4	°C/W	
Junction to Case	35	35	35	35	35	35	35	35	35	35	35	35	35	12	°C/W	
Junction to Ambient	35	35	35	35	35	35	35	35	35	35	35	35	35	70	°C/W	

Note 1: This specification applies over: -65°C ≤ T_J ≤ +150°C for the LM120 and 0°C ≤ T_J ≤ +125°C for the LM320.
Note 2: Regulation is measured at constant junction temperature. Changes in output voltage due to heating effects must be taken into account separately. To ensure constant junction temperature, low duty cycle, pulse testing is used. The LM120/LM320 series does have low thermal feedback, improving line and load regulation. On all other tests, even though power dissipation is internally limited, electrical specifications apply only up to P_D.

-15 VOLT REGULATORS

Absolute Maximum Ratings

Power Dissipation Internally Limited
 Input Voltage
 LM120/LM320 -40V
 LM320T/LM320MP -35V
 30V
 Input-Output Voltage Differential See Note 1
 Junction Temperature Range -65°C to +150°C
 Storage Temperature Range 300°C
 Lead Temperature (Soldering, 10 seconds)

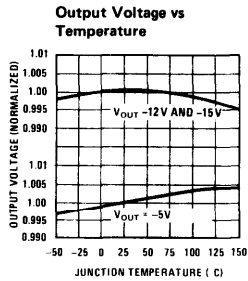
Electrical Characteristics

PARAMETER	ORDER NUMBERS	METAL CAN PACKAGE						POWER PLASTIC PACKAGE						UNITS		
		LM120K-15		LM320K-15		LM120H-15		LM320H-15		LM320T-15		LM320MP-15				
		MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX			
DESIGN OUTPUT CURRENT (I _D)		1A		1A		0.2A		0.2A		1A		0.5A		V		
DEVICE DISSIPATION (P _D)		20W		20W		2W		2W		15W		7.5W				
CONDITIONS (NOTE 1)		-15		-15		-15		-15		-15		-15				
Output Voltage	T _J = 25°C, V _{IN} = 20V, I _{LOAD} = 5 mA	15.3	-15	-14.7	-15.4	-15	-14.6	-15.3	-15	-14.7	-15.4	-15	-14.6	-15.6	-15	-14.4
Line Regulation	T _J = 25°C, I _{LOAD} = 5 mA, V _{MIN} ≤ V _{IN} < V _{MAX}		5	10		5	20		5	10		5	20		5	30
Input Voltage	f = 120 Hz															
Ripple Rejection	T _J = 25°C, V _{IN} = 20V, 5 mA ≤ I _{LOAD} ≤ I _D	-35		-17	-35		-17	-35		-17	-35		-17	-35		-17.5
Load Regulation, (Note 2)	T _J = 25°C, V _{IN} = 20V, 5 mA ≤ I _{LOAD} ≤ I _D , P < P _D	56	80	30	56	80	30	56	80	30	56	80	30	56	80	40
Output Voltage, (Note 1)	T _J = 25°C, V _{IN} = 20V, 5 mA ≤ I _{LOAD} ≤ I _D , P < P _D	-15.5		-14.5	-15.6		-14.4	15.5		14.5	-15.6		-14.4	-15.7		-14.3
Quiescent Current	V _{MIN} < V _{IN} ≤ V _{MAX}	2	4	2	4	2	4	2	4	2	4	2	4	2	4	2
Quiescent Current Change	T _J = 25°C															
Output Noise Voltage	V _{MIN} ≤ V _{IN} ≤ V _{MAX} 5 mA ≤ I _{LOAD} ≤ I _D	0.1	0.4	0.1	0.4	0.05	0.4	0.05	0.4	0.05	0.4	0.1	0.4	0.05	0.3	0.05
Long Term Stability	T _A = 25°C, C _L = 1μF, I _L = 5 mA, V _{IN} = 20V, 10 Hz ≤ f ≤ 100 kHz	400		400	400		400	400		400	400		400	400		400
Thermal Resistance Junction to Case		15	150	15	150	15	150	15	150	15	150	15	150	15	150	15
Junction to Ambient		3	35	3	35	15	150	15	150	15	150	15	150	15	150	15

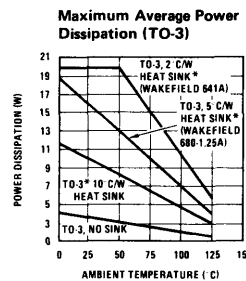
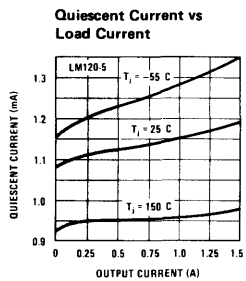
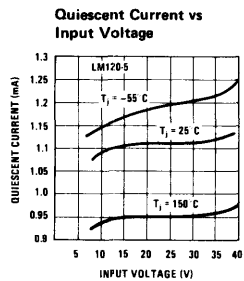
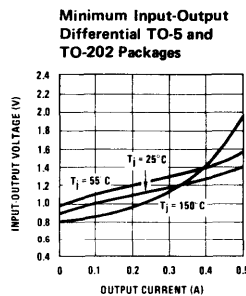
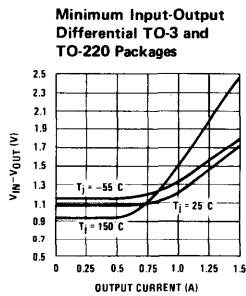
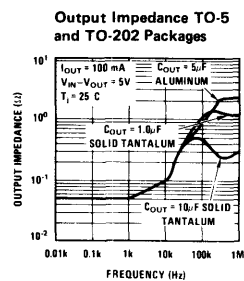
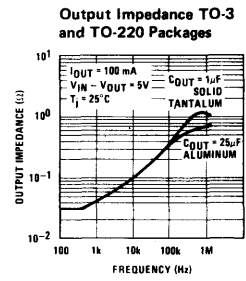
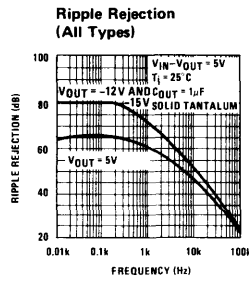
Note 1: This specification applies over -55°C ≤ T_J ≤ +150°C for the LM120 and 0°C ≤ T_J ≤ +125°C for the LM320.
Note 2: Regulation is measured at constant junction temperature. Changes in output voltage due to heating effects must be taken into account separately. To ensure constant junction temperature, low duty cycle, pulse testing is used. The LM120/LM320 series does have low thermal feedback, improving line and load regulation. On all other tests, even though power dissipation is internally limited, electrical specifications apply only up to P_D.

LM120 Series

Typical Performance Characteristics

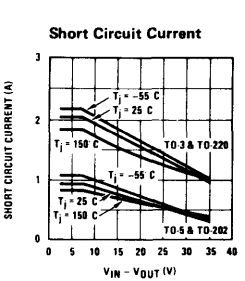
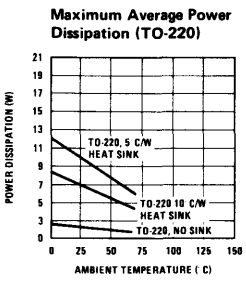
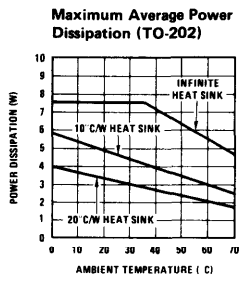
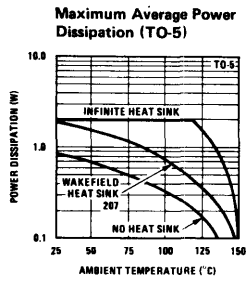


Note: Shaded portion refers to LM320 series regulators.



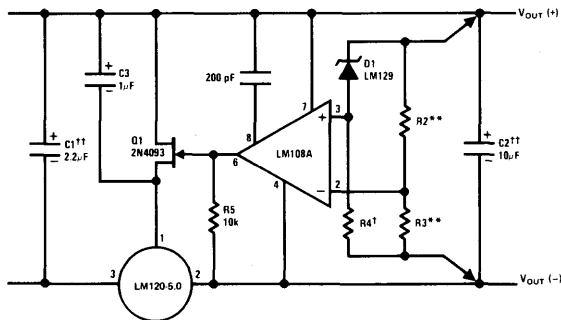
Note: Shaded area shows operating range of TO-5 and TO-202 packages.

*These curves for LM120 and LM220. Derate 25°C further for LM320.



Typical Applications (cont'd.)

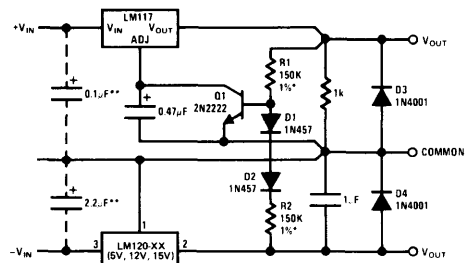
High Stability 1 Amp Regulator



Load and line regulation: 0.01% temperature stability < 0.2%
 †Determines Zener current.
 ††Solid tantalum.

An LM120-12 or LM120-15 may be used to permit higher input voltages, but the regulated output voltage must be at least -15V when using the LM120-12 and -18V for the LM120-15.
 **Select resistors to set output voltage. 2 ppm/°C tracking suggested.

Wide Range Tracking Regulator

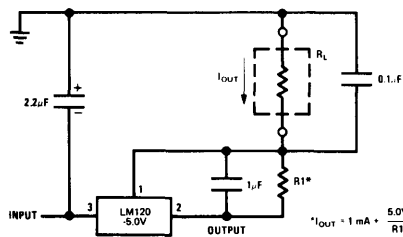


*Resistor tolerance of R1 and R2 determine matching of (+) and (-) inputs.

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

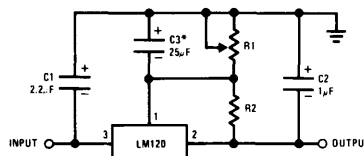
An LM3086N array may substitute for Q1, D1 and D2 for better stability and tracking. In the array diode transistors Q5 and Q4 (in parallel) make up D2, similarly, Q1 and Q2 become D1 and Q3 replaces the 2N2222.

Current Source



$$I_{OUT} = 1 \text{ mA} + \frac{5.0V}{R1}$$

Variable Output



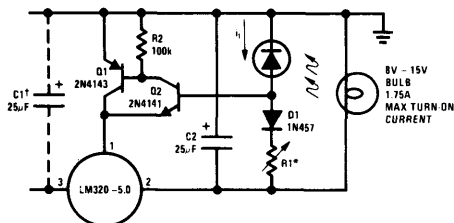
*Optional. Improves transient response and ripple rejection.

$$V_{OUT} = V_{SET} \frac{R1 + R2}{R2}$$

SELECT R2 AS FOLLOWS

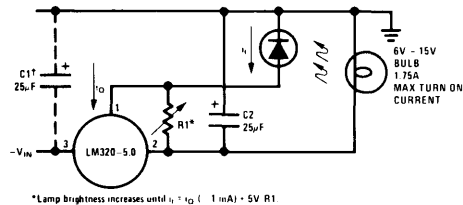
LM120-5	- 300 Ω
LM120-12	- 750 Ω
LM120-15	- 1K

Light Controllers Using Silicon Photo Cells



*Lamp brightness increases until $i_1 = 5V/R1$ (i_1 can be set as low as $1\mu A$).

†Necessary only if raw supply filter capacitor is more than 2" from LM320MP.

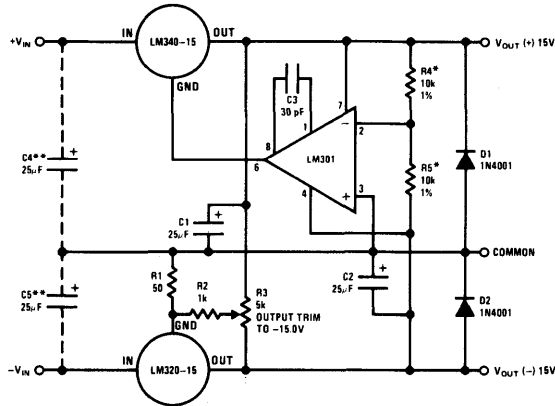


*Lamp brightness increases until $i_1 = i_2 = 1 \text{ mA} = 5V/R1$

†Necessary only if raw supply filter capacitor is more than 2" from LM320

Typical Applications (cont'd.)

±15V, 1 Amp Tracking Regulators

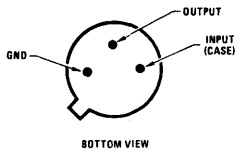


Performance (Typical)

Load Regulation at $\Delta I_L = 1A$	10 mV	1 mV
Output Ripple, $C_w = 3000\mu F, I_L = 1A$	100 μ Vrms	100 μ Vrms
Temperature Stability	+50 mV	+50 mV
Output Noise 10 Hz $\leq f \leq$ 10 kHz	150 μ Vrms	150 μ Vrms

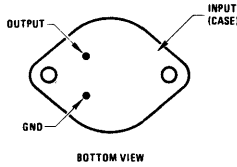
*Resistor tolerance of R4 and R5 determine matching of (+) and (-) outputs.
 **Necessary only if raw supply filter capacitors are more than 2" from regulators.

Connection Diagrams



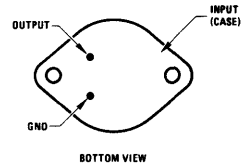
Metal Can Package (TO-39) (H)
 Order Numbers:

LM120H-5.0 LM120H-12 LM120H-15
 LM320H-5.0 LM320H-12 LM320H-15
 See Package H03A

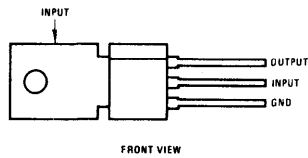


Steel Metal Can Package TO-3 (K)
 Order Numbers:

LM120K-5.0 LM120K-12 LM120K-15
 LM320K-5.0 LM320K-12 LM320K-15
 See Package K02A



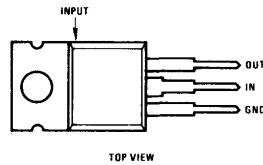
Aluminum Metal Can Package TO-3 (KC)
 Order Numbers:
 LM320KC-5.0 LM320KC-12
 LM320KC-15
 See Package KC02A



Power Package TO-202 (P)
 Order Numbers:

LM320MP-5.0 LM320MP-12 LM320MP-15
 See Package P03A

For Tab Formed TO-202
 Order Numbers:
 LM320MP-5.0TB
 LM320MP-12TB
 LM320MP-15TB
 See Package P03E

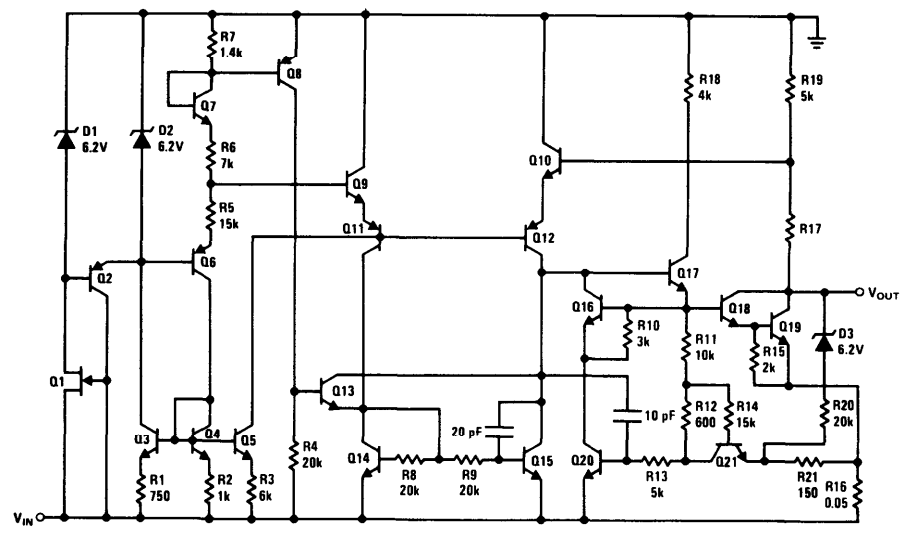


Power Package TO-220 (T)
 Order Numbers:

LM320T-5.0
 LM320T-12
 LM320T-15
 See Package T03B

Schematic Diagrams

-5V



-12V and -15V

