LM120QML Series 3-Terminal Negative Regulators

Check for Samples: LM120QML

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**

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 and LM137HV series provide an output voltage range of −1.2V to −47V.

The LM120 needs only one external component—a compensation capacitor at the output, making them easy to apply. Worst case specifies 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.

Table 1. LM120 Series Packages and Power Capability

Package	Rated Power Dissipation	Design Load Current
TO (K)	20W	1.5A
PFM (H)	2W	0.5A

Connection Diagram

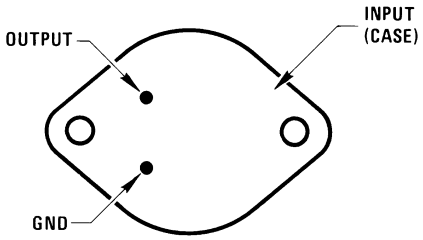


Figure 1. Bottom View
2-Pin TO Steel Metal Can
See K Package

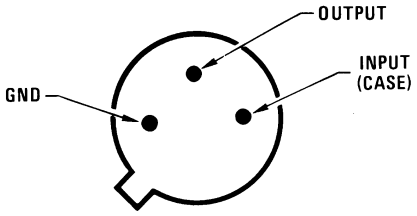


Figure 2. Bottom View
3-Pin PFM Metal Can
See NDT0003A Package

Schematic Diagrams

Figure 3. −5V

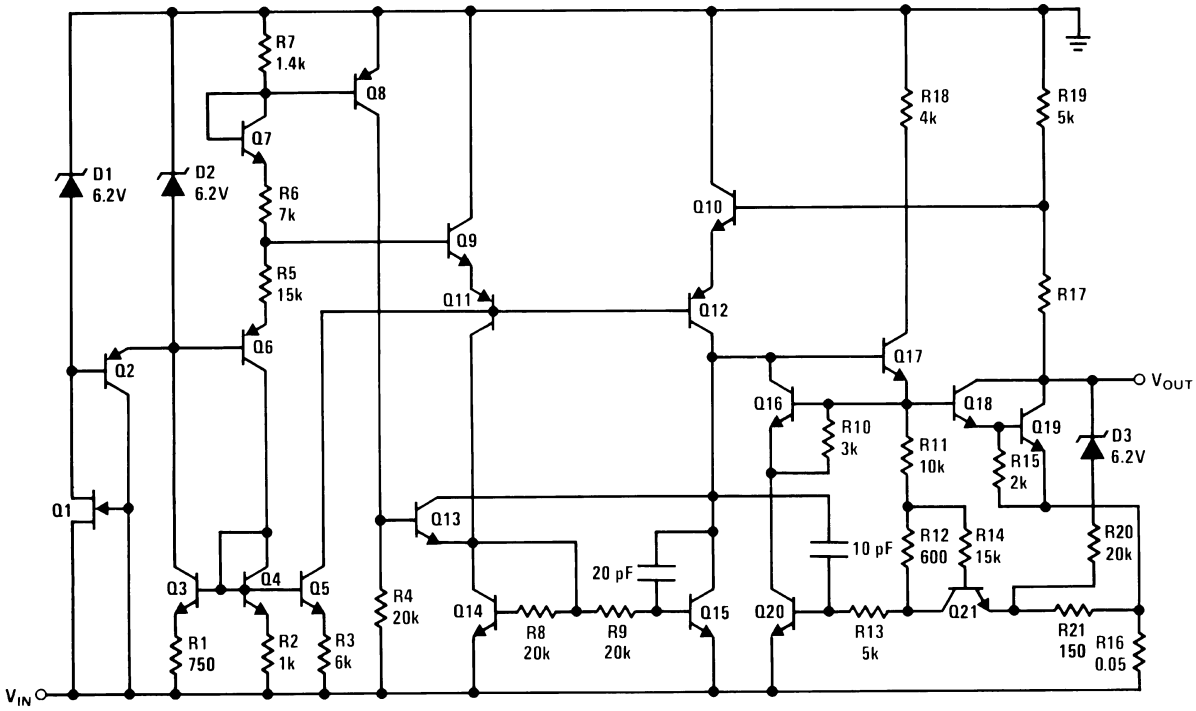
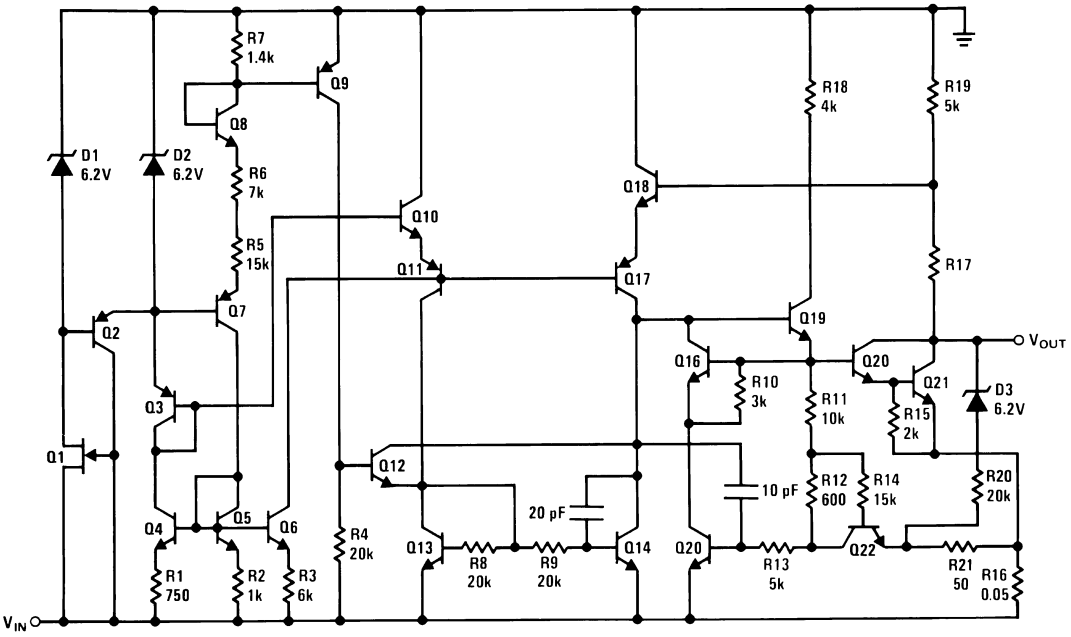


Figure 4. −12V and −15V



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)

			LM120−5	LM120−12	LM120−15
Power Dissipation			Internally Limited		
Input Voltage			−25V	−35V	−40V
Input-Output Voltage Differential			25V	30V	30V
Junction Temperatures			150°C		
Storage Temperature Range			−65°C ≤ T_A ≤ +150°C		
Operating Temperature Range			−55°C ≤ T_A ≤ +125°C		
Lead Temperature (Soldering, 10 sec.)			300°C		
Thermal Resistance	θ_{JA}	PFM-Pkg (Still Air @ 0.5W)	191°C/W		
		PFM-Pkg (500LF/Min Air flow @ 0.5W)	70°C/W		
		TO-Pkg (Still Air @ 0.5W)	35°C/W		
		TO-Pkg (500LF/Min Air flow @ 0.5W)	TBD		
	θ_{JC}	PFM-Pkg	29°C/W		
		TO-Pkg	3°C/W		
ESD Tolerance(2)			4000V		

(1) Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is functional, but do not ensure specific performance limits. For ensured specifications and test conditions, see the Electrical Characteristics. The ensured specifications apply only for the test conditions listed. Some performance characteristics may degrade when the device is not operated under the listed test conditions.

(2) Human body model, 1.5 kΩ in seriew with 100 pF.

Table 2. QUALITY CONFORMANCE INSPECTION

Mil-Std-883, Method 5005 - Group A		
Subgroup	**Description**	**Temp (°C)**
1	Static tests at	+25
2	Static tests at	+125
3	Static tests at	-55
4	Dynamic tests at	+25
5	Dynamic tests at	+125
6	Dynamic tests at	-55
7	Functional tests at	+25
8A	Functional tests at	+125
8B	Functional tests at	-55
9	Switching tests at	+25
10	Switching tests at	+125
11	Switching tests at	-55
12	Settling time at	+25
13	Settling time at	+125
14	Settling time at	-55

LM120H-5.0 DC PARAMETERS

The following conditions apply, unless otherwise specified. V_{IN} = −10V, I_L = 5mA

Symbol	Parameter	Conditions	Notes	Min	Max	Unit	Sub-groups
I_Q	Quiescent Current	V_{IN} = -7V			2.0	mA	1, 2, 3
		V_{IN} = -25V			2.0	mA	1, 2, 3
ΔI_Q	Quiescent Current Change	5mA ≤ I_L ≤ 0.5A		-0.4	0.4	mA	1
				-0.5	0.5	mA	2, 3
		-25V ≤ V_{IN} ≤ -7V		-0.4	0.4	mA	1
				-0.5	0.5	mA	2, 3
V_{OUT}	Output Voltage			-5.1	-4.9	V	1
		V_{IN} = -7.5V		-5.2	-4.8	V	1, 2, 3
		V_{IN} = -7.5V, I_L = 0.5A		-5.2	-4.8	V	1, 2, 3
		V_{IN} = -25V		-5.2	-4.8	V	1, 2, 3
		V_{IN} = -25V, I_L = 100mA		-5.2	-4.8	V	1, 2, 3
R_{Line}	Line Regulation	-25V ≤ V_{IN} ≤ -7V		-25	25	mV	1
				-50	50	mV	2, 3
R_{Load}	Load Regulation	5mA ≤ I_L ≤ 0.5A		-50	50	mV	1
				-100	100	mV	2, 3
I_{OS}	Short Circuit Current	V_{IN} = -25V		0.1	1.5	A	1
RR	Ripple Rejection	f = 120Hz, I_L = 125mA, e_I = $1V_{RMS}$		54		dB	4

LM120K-5.0 DC PARAMETERS

The following conditions apply, unless otherwise specified. V_{IN} = −10V, I_L = 5mA

Symbol	Parameter	Conditions	Notes	Min	Max	Unit	Sub-groups
I_Q	Quiescent Current	V_{IN} = -7V			2.0	mA	1, 2, 3
		V_{IN} = -25V			2.0	mA	1, 2, 3
ΔI_Q	Quiescent Current Change	5mA ≤ I_L ≤ 1.5A		-0.4	0.4	mA	1
				-0.5	0.5	mA	2, 3
		-25V ≤ V_{IN} ≤ -7V		-0.4	0.4	mA	1
				-0.5	0.5	mA	2, 3
V_{OUT}	Output Voltage			-5.1	-4.9	V	1
		V_{IN} = -7.5V		-5.2	-4.8	V	1, 2, 3
		V_{IN} = -7.5V, I_L = 1.5A		-5.2	-4.8	V	1, 2, 3
		V_{IN} = -25V		-5.2	-4.8	V	1, 2, 3
		V_{IN} = -25V, I_L = 1A		-5.2	-4.8	V	1, 2, 3
R_{Line}	Line Regulation	-25V ≤ V_{IN} ≤ -7V		-25	25	mV	1
				-50	50	mV	2, 3
R_{Load}	Load Regulation	5mA ≤ I_L ≤ 1.5A		-75	75	mV	1
				-100	100	mV	2, 3
I_{OS}	Short Circuit Current	V_{IN} = -25V		0.4	3.0	A	1
RR	Ripple Rejection	f = 120Hz, I_L = 350mA, e_I = $1V_{RMS}$		54		dB	4

LM120H-12 DC PARAMETERS

The following conditions apply, unless otherwise specified. V_{IN} = −17V, I_L = 5mA

Symbol	Parameter	Conditions	Notes	Min	Max	Unit	Sub-groups
I_Q	Quiescent Current	V_{IN} = -14V			4.0	mA	1, 2, 3
		V_{IN} = -32V			4.0	mA	1, 2, 3
ΔI_Q	Quiescent Current Change	V_{IN} = -17V, 5mA ≤ I_L ≤ 200mA			0.4	mA	1
					0.5	mA	2, 3
		-32V ≤ V_{IN} ≤ -14V			0.4	mA	1
					0.5	mA	2, 3
R_{Load}	Load Regulation	V_{IN} = -17V, 5mA ≤ I_L ≤ 200mA		-25	25	mV	1
				-50	50		2, 3
R_{Line}	Line Regulation	-32V ≤ V_{IN} ≤ -14V		-10	10	mV	1
				-20	20	mV	2, 3
I_{OS}	Short Circuit Current	V_{IN} = -32V		0.1	1.5	A	1
V_{OUT}	Output Voltage	V_{IN} = -17V		-12.3	-11.7	V	1
		V_{IN} = -32V		-12.5	-11.5	V	1, 2, 3
		V_{IN} = -32V, I_L = 100mA		-12.5	-11.5	V	1, 2, 3
		V_{IN} = -14.5V		-12.5	-11.5	V	1, 2, 3
		V_{IN} = -14.5V, I_L = 200mA		-12.5	-11.5	V	1, 2, 3
RR	Ripple Rejection	f = 120Hz, I_L = 125mA, e_i = $1V_{RMS}$		56		dB	4

LM120K-12 DC PARAMETERS

The following conditions apply to all the following parameters, unless otherwise specified. V_{IN} = −17V, I_L = 5mA

Symbol	Parameter	Conditions	Notes	Min	Max	Unit	Sub-groups
I_Q	Quiescent Current	V_{IN} = -14V			4.0	mA	1, 2, 3
		V_{IN} = -32V			4.0	mA	1, 2, 3
ΔI_Q	Quiescent Current Change	V_{IN} = -17V, 5mA ≤ I_L ≤ 1A			0.4	mA	1
					0.5	mA	2, 3
		-32V ≤ V_{IN} ≤ -14V			0.4	mA	1
					0.5	mA	2, 3
R_{Load}	Load Regulation	V_{IN} = -17V, 5mA ≤ I_L ≤ 1A		-80	80	mV	1, 2, 3
R_{Line}	Line Regulation	-32V ≤ V_{IN} ≤ -14V		-10	10	mV	1
				-20	20	mV	2, 3
I_{OS}	Short Circuit Current	V_{IN} = -32V		0.4	3.0	A	1
V_{OUT}	Output Voltage	V_{IN} = -17V		-12.3	-11.7	V	1
		V_{IN} = -32V		-12.5	-11.5	V	1, 2, 3
		V_{IN} = -32V, I_L = 1A		-12.5	-11.5	V	1, 2, 3
		V_{IN} = -14.5V		-12.5	-11.5	V	1, 2, 3
		V_{IN} = -14.5V, I_L = 1A		-12.5	-11.5	V	1, 2, 3
RR	Ripple Rejection	f = 120Hz, I_L = 350mA, e_i = $1V_{RMS}$		56		dB	4

LM120H-15 DC PARAMETERS

The following conditions apply to all the following parameters, unless otherwise specified. V_{IN} = 20V, I_L = 5mA

Symbol	Parameter	Conditions	Notes	Min	Max	Unit	Sub-groups
I_Q	Quiescent Current	V_{IN} = -17V			4.0	mA	1, 2, 3
		V_{IN} = -35V			4.0	mA	1, 2, 3
ΔI_Q	Quiescent Current Change	V_{IN} = -17V, 5mA ≤ I_L ≤ 200mA			0.4	mA	1
					0.5	mA	2, 3
		-35V ≤ V_{IN} ≤ -17V			0.4	mA	1
					0.5	mA	2, 3
R_{Load}	Load Regulation	V_{IN} = -20V, 5mA ≤ I_L ≤ 200mA		-25	25	mV	1
				−50	50	mV	2, 3
R_{Line}	Line Regulation	-35V ≤ V_{IN} ≤ -17V		-10	10	mV	1
				-20	20	mV	2, 3
I_{OS}	Short Circuit Current	V_{IN} = -35V		0.1	1.5	A	1
V_{OUT}	Output Voltage	V_{IN} = -20V		-15.3	-14.7	V	1
		V_{IN} = -35V		-15.5	-14.5	V	1, 2, 3
		V_{IN} = -35V, I_L = 100mA		-15.5	-14.5	V	1, 2, 3
		V_{IN} = -17.5V		-15.5	-14.5	V	1, 2, 3
		V_{IN} = -17.5V, I_L = 200mA		-15.5	-14.5	V	1, 2, 3
RR	Ripple Rejection	f = 120Hz, I_L = 125mA, e_i = $1V_{RMS}$		56		dB	4

LM120K-15 DC PARAMETERS

The following conditions apply, unless otherwise specified. V_{IN} = 20V, I_L = 5mA

Symbol	Parameter	Conditions	Notes	Min	Max	Unit	Sub-groups
I_Q	Quiescent Current	V_{IN} = -17V			4.0	mA	1, 2, 3
		V_{IN} = -35V			4.0	mA	1, 2, 3
ΔI_Q	Quiescent Current Change	V_{IN} = -17V, 5mA ≤ I_L ≤ 1A			0.4	mA	1
					0.5	mA	2, 3
		-35V ≤ V_{IN} ≤ -17V			0.4	mA	1
					0.5	mA	2, 3
R_{Load}	Load Regulation	V_{IN} = -20V, 5mA ≤ I_L ≤ 1A		-80	80	mV	1, 2, 3
R_{Line}	Line Regulation	-35V ≤ V_{IN} ≤ -17V		-10	10	mV	1
				-20	20	mV	2, 3
I_{OS}	Short Circuit Current	V_{IN} = -35V		0.4	3.0	A	1
V_{OUT}	Output Voltage	V_{IN} = -20V		-15.3	-14.7	V	1
		V_{IN} = -35V		-15.5	-14.5	V	1, 2, 3
		V_{IN} = -35V, I_L = 1A		-15.5	-14.5	V	1, 2, 3
		V_{IN} = -17.5V		-15.5	-14.5	V	1, 2, 3
		V_{IN} = -17.5V, I_L = 1.5A		-15.5	-14.5	V	1, 2, 3
ΔV_O / Δt	Long Term Stability		See (1)		150	mV	1
RR	Ripple Rejection	f = 120Hz, I_L = 350mA, e_I = 1V_{RMS}		56		dB	4

(1) Specified parameter, not tested

TYPICAL PERFORMANCE CHARACTERISTICS

Output Voltage vs Temperature

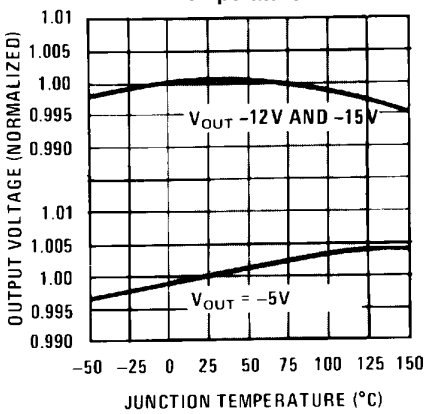


Figure 5.

Ripple Rejection (All Types)

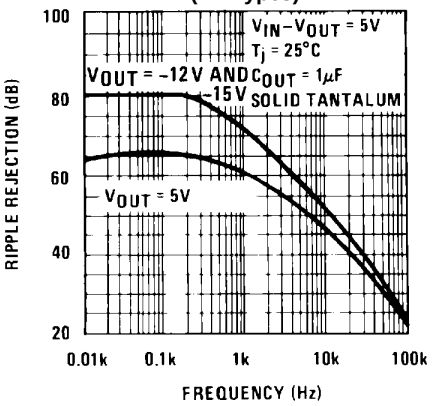


Figure 6.

Output Impedance TO-3

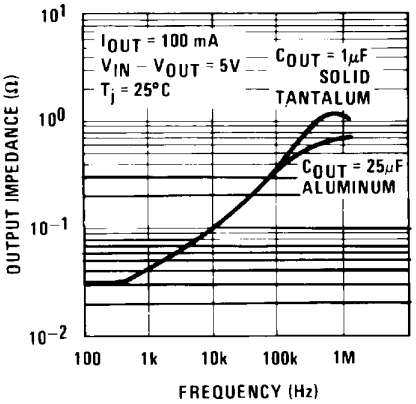


Figure 7.

Output Impedance TO-5

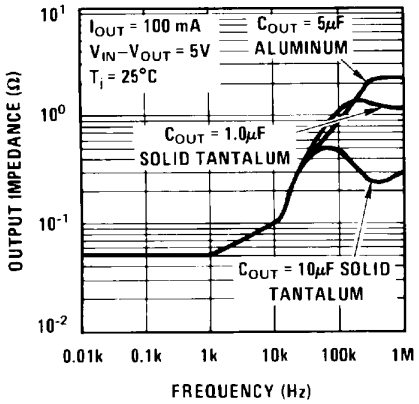


Figure 8.

Minimum Input-Output Differential TO-3

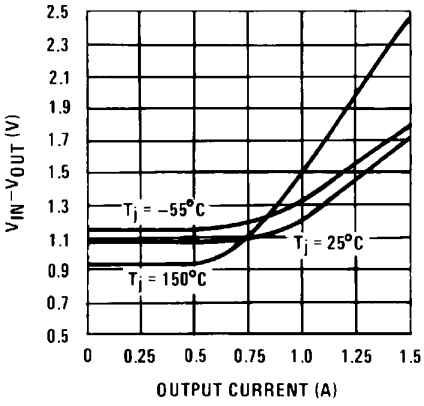


Figure 9.

Minimum Input-Output Differential TO-5

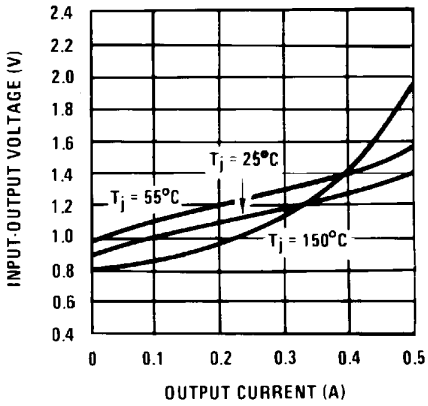


Figure 10.

TYPICAL PERFORMANCE CHARACTERISTICS (continued)

Quiescent Current vs Input Voltage

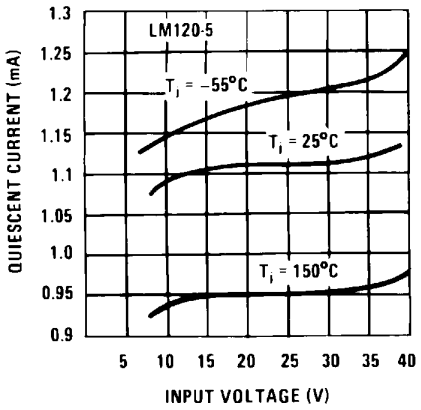


Figure 11.

Quiescent Current vs Load Current

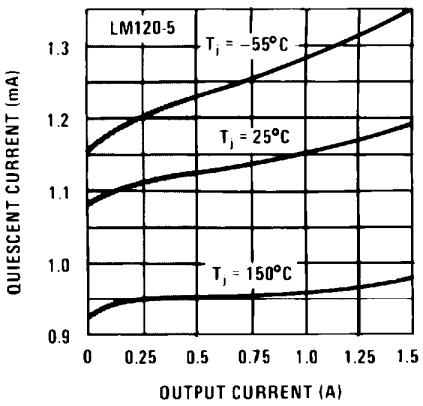
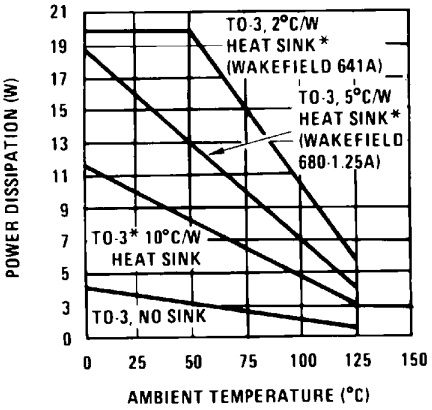


Figure 12.

Maximum Average Power Dissipation (TO-3)



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

Figure 13.

Maximum Average Power Dissipation (TO-5)

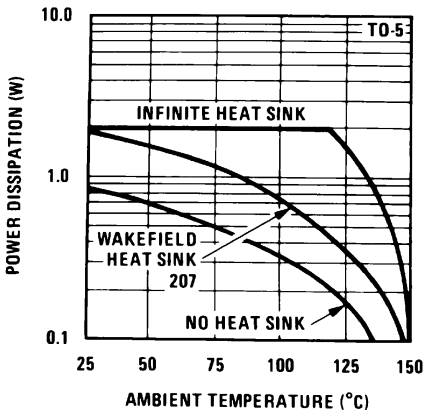


Figure 14.

Short Circuit Current

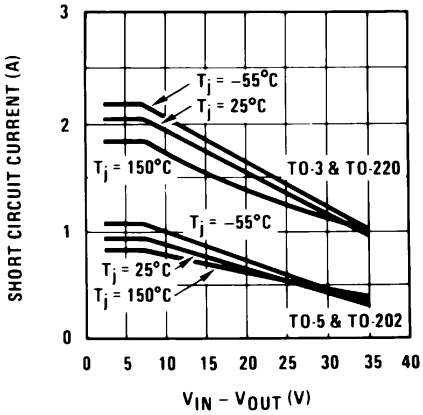
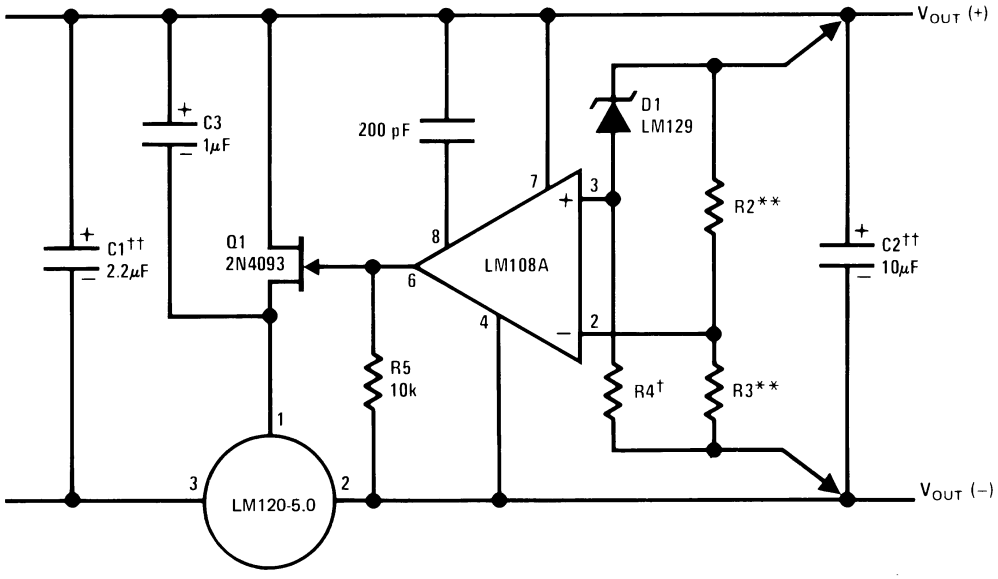


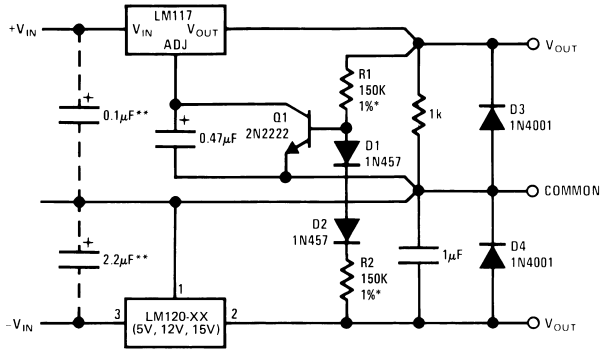
Figure 15.

TYPICAL APPLICATIONS



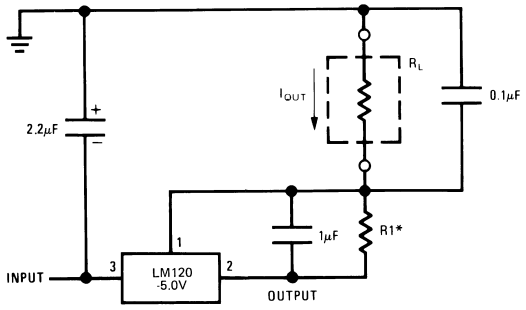
Lead and line regulation — 0.01% temperature stability — 0.2%
†Determines Zener current.
††Solid tantalum.
An LM120-12 or LM120-15 may be used to permit higher input voltages, but the regulated output voltage must be at least −15V when using the LM120-12 and −18V for the LM120-15.
**Select resistors to set output voltage. 2 ppm/°C tracking suggested.

Figure 16. High Stability 1 Amp Regulator



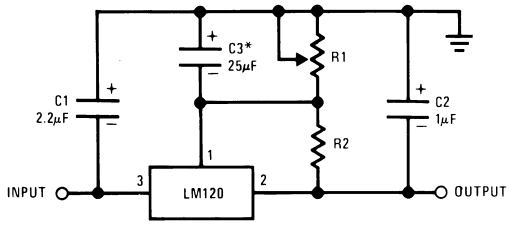
* Resistor tolerance of R1 and R2 determine matching of (+) and (−) inputs.
**Necessary only if raw supply capacitors are more than 3″ from regulators
An LM3086N array may substitute for Q1, D1 and D2 for better stability and tracking. In the array diode transistors Q5 and Q4 (in parallel) make up D2; similarly, Q1 and Q2 become D1 and Q3 replaces the 2N2222.

Figure 17. Wide Range Tracking Regulator



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

Figure 18. Current Source

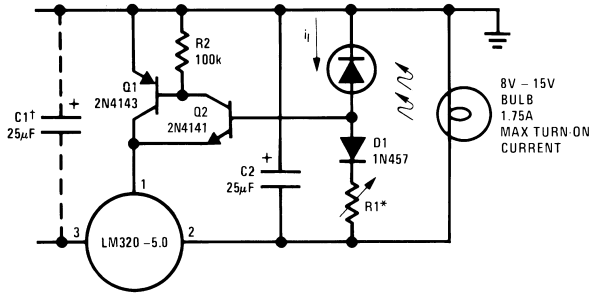


*Optional. Improves transient response and ripple rejection.

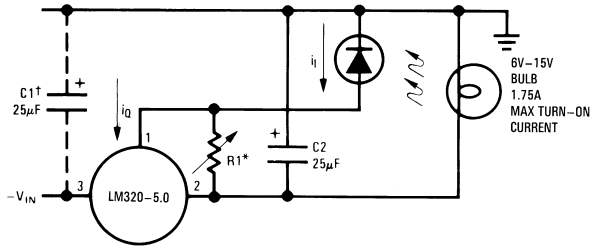
$$V_{OUT} = V_{SET}\frac{R1 + R2}{R2}$$

SELECT R2 AS FOLLOWS:
LM120-5 −300Ω
LM120-12 −750Ω
LM120-15 −1k

Figure 19. Variable Output



*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 LM320MP.



*Lamp brightness increases until $i_I = i_Q$ (1 mA) + 5V/R1.
†Necessary only if raw supply filter capacitor is more than 2″ from LM320.

Figure 20. Light Controllers Using Silicon Photo Cells

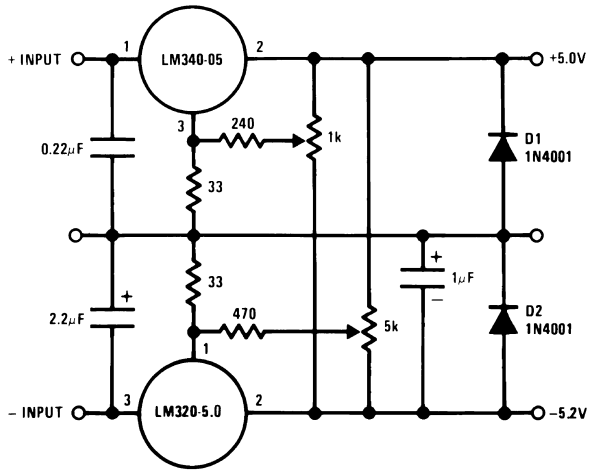
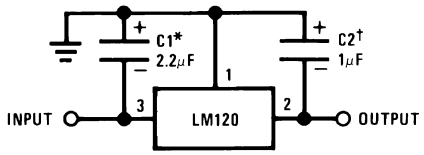


Figure 21. Dual Trimmed Supply



*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.

Figure 22. Fixed Regulator

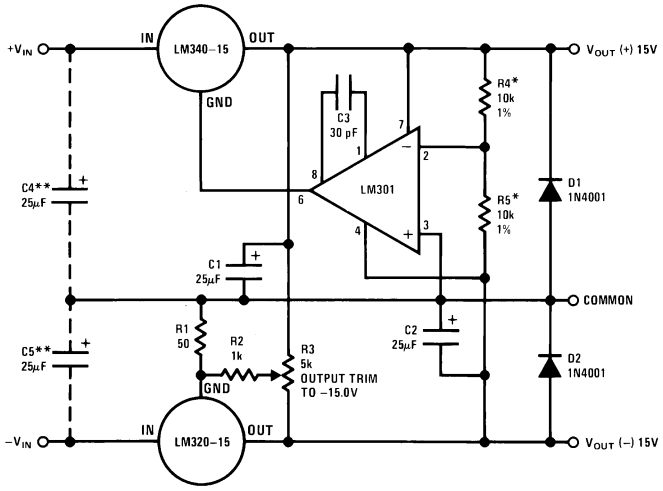


Figure 23. ±15V, 1 Amp Tracking Regulators

Table 3. Performance (Typical)(1)

Load Regulation at ΔI_L = 1A	10 mV	1 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

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

REVISION HISTORY

Date Released	Revision	Section	Changes
12/15/2010	A	New release to the corporate format	6 MDS datasheets were converted and merged into one datasheet compliant to corporate format. Drift endpoints removed since note used on 883 product. MDS MNLM120-5.0-K Rev OBL, MNLM120-5.0-H Rev 0BL, MNLM120-12-K Rev OBL, MNLM120-12-H Rev 0BL, MNLM120-15-K Rev OBL, & MNLM120-15-H Rev 0BL will be archived.

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)	Op Temp (°C)	Top-Side Markings (4)	Samples
LM120H-12/883	ACTIVE	TO	NDT	3	20	TBD	POST-PLATE	Level-1-NA-UNLIM	-55 to 150	LM120H-12/883 Q ACO LM120H-12/883 Q >T	Samples
LM120H-15/883	ACTIVE	TO	NDT	3	20	TBD	POST-PLATE	Level-1-NA-UNLIM	-55 to 150	LM120H-15/883 Q ACO LM120H-15/883 Q >T	Samples
LM120H-5.0/883	ACTIVE	TO	NDT	3	20	TBD	POST-PLATE	Level-1-NA-UNLIM	-55 to 150	LM120H-5.0/883 Q ACO LM120H-5.0/883 Q >T	Samples
LM120K-12/883	ACTIVE	TO	K	2	50	TBD	POST-PLATE	Level-1-NA-UNLIM	-55 to 150	LM120K-12 /883 Q ACO /883 Q >T	Samples
LM120K-15/883	ACTIVE	TO	K	2	50	TBD	POST-PLATE	Level-1-NA-UNLIM	-55 to 150	LM120K-15 /883 Q ACO /883 Q >T	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) Only one of markings shown within the brackets will appear on the physical device.

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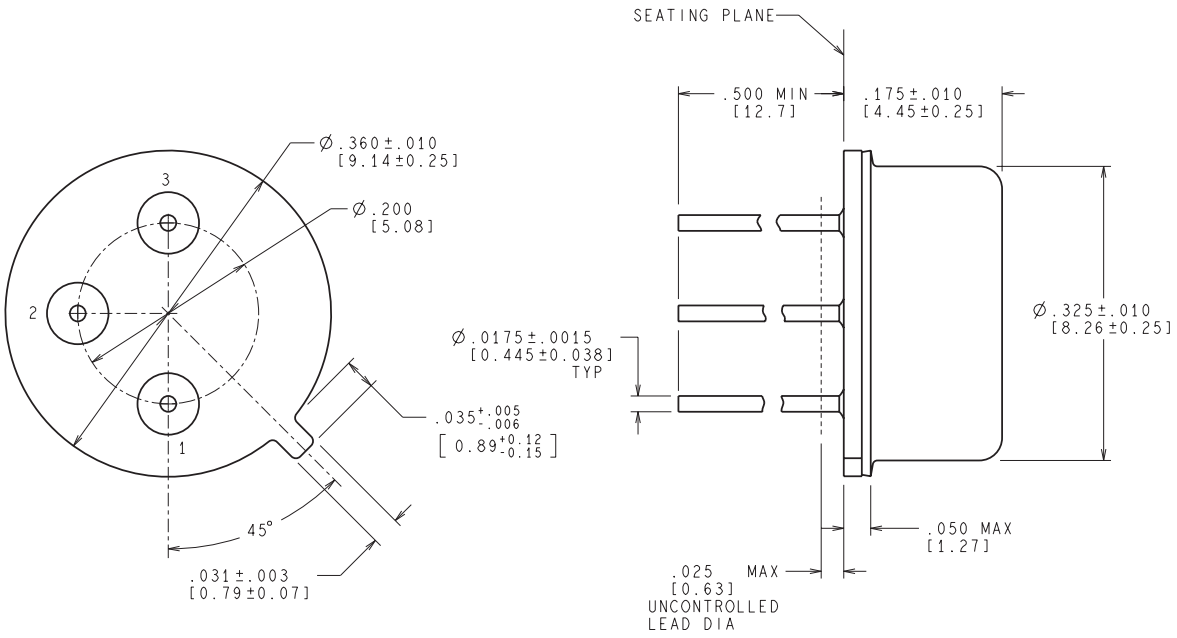

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