

# LM120QML

## 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 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 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  $\pm 3\%$
- 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

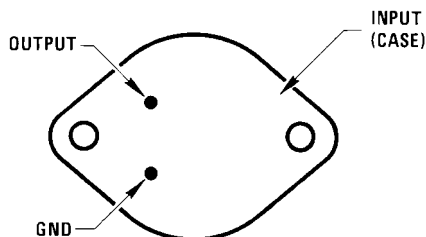
Package	Rated Power Dissipation	Design Load Current
TO-3 (K)	20W	1.5A
TO-39 (H)	2W	0.5A

### Ordering Information

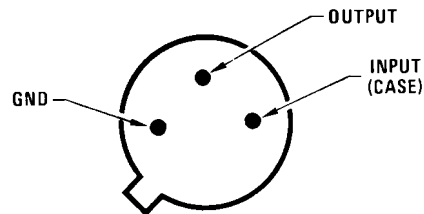
NS Part Number	SMD Part Number	NS Package Number	Package Description
LM120H-5.0/883		H03A	3LD TO-39 Metal Can
LM120H-12/883		H03A	3LD TO-39 Metal Can
LM120H-15/883		H03A	3LD TO-39 Metal Can
LM120K-12/883		K02C	2LD TO-3 Metal Can
LM120K-15/883		K02C	2LD TO-3 Metal Can
LM120KG-5 MD8		(Note 1)	Bare Die
LM120KG-12 MD8		(Note 1)	Bare Die
LM120KG-15 MD8		(Note 1)	Bare Die

Note 1: FOR ADDITIONAL DIE INFORMATION, PLEASE VISIT THE HI REL WEB SITE AT: [www.national.com/analog/space/level\\_die](http://www.national.com/analog/space/level_die)

### Connection Diagrams

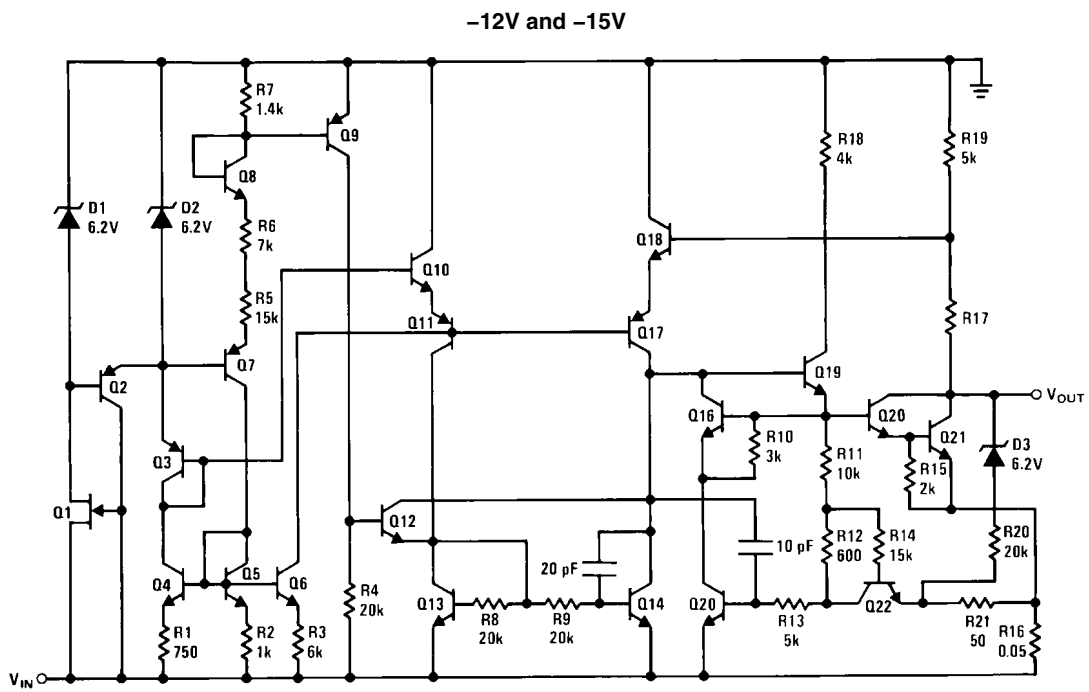
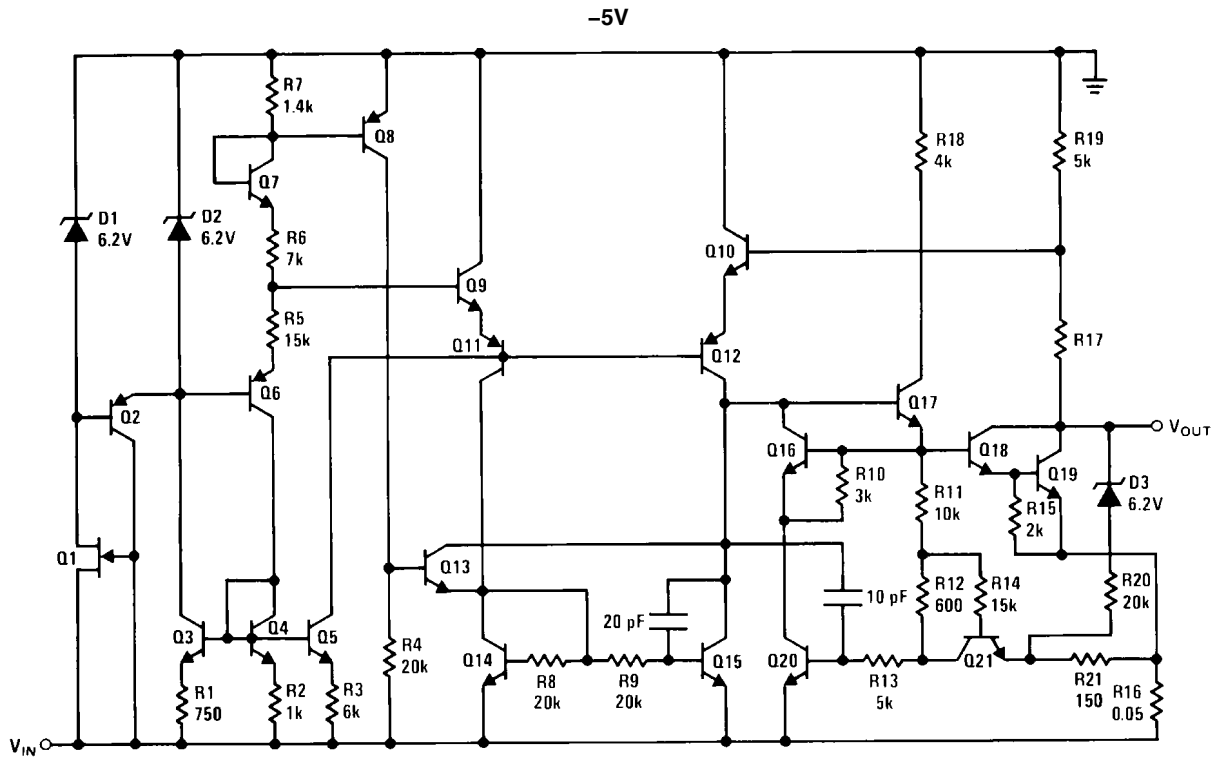


20150114  
**Bottom View**  
 Steel Metal Can Package TO-3 (K)  
 See NS Package Number K02C



20150113  
**Bottom View**  
 Metal Can Package TO-39 (H)  
 See NS Package Number H03A

# Schematic Diagrams



## Absolute Maximum Ratings *(Note 2)*

	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		$-65^{\circ}\text{C} \leq T_A \leq +150^{\circ}\text{C}$	
Operating Temperature Range		$-55^{\circ}\text{C} \leq T_A \leq +125^{\circ}\text{C}$	
Lead Temperature (Soldering, 10 sec.)		300°C	
Thermal Resistance			
$\theta_{JA}$			
H-Pkg (Still Air @ 0.5W)		191°C/W	
H-Pkg (500LF/Min Air flow @ 0.5W)		70°C/W	
K-Pkg (Still Air @ 0.5W)		35°C/W	
K-Pkg (500LF/Min Air flow @ 0.5W)		TBD	
$\theta_{JC}$			
H-Pkg		29°C/W	
K-Pkg		3°C/W	
ESD Tolerance <i>(Note 4)</i>		4000V	

## 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
$\Delta I_Q$	Quiescent Current Change	$5mA \leq I_L \leq 0.5A$		-0.4	0.4	mA	1
				-0.5	0.5	mA	2, 3
		$-25V \leq V_{IN} \leq -7V$		-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	$-25V \leq V_{IN} \leq -7V$		-25	25	mV	1
				-50	50	mV	2, 3
$R_{Load}$	Load Regulation	$5mA \leq I_L \leq 0.5A$		-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	$f = 120Hz, I_L = 125mA, e_1 = 1V_{RMS}$		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
$\Delta I_Q$	Quiescent Current Change	$5mA \leq I_L \leq 1.5A$		-0.4	0.4	mA	1
				-0.5	0.5	mA	2, 3
		$-25V \leq V_{IN} \leq -7V$		-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	$-25V \leq V_{IN} \leq -7V$		-25	25	mV	1
				-50	50	mV	2, 3
$R_{Load}$	Load Regulation	$5mA \leq I_L \leq 1.5A$		-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	$f = 120Hz, I_L = 350mA, e_1 = 1V_{RMS}$		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
$\Delta I_Q$	Quiescent Current Change	$V_{IN} = -17V$ , $5mA \leq I_L \leq 200mA$			0.4	mA	1
					0.5	mA	2, 3
		$-32V \leq V_{IN} \leq -14V$			0.4	mA	1
					0.5	mA	2, 3
$R_{Load}$	Load Regulation	$V_{IN} = -17V$ , $5mA \leq I_L \leq 200mA$		-25	25	mV	1
				-50	50		2, 3
$R_{Line}$	Line Regulation	$-32V \leq V_{IN} \leq -14V$		-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
$\Delta I_Q$	Quiescent Current Change	$V_{IN} = -17V$ , $5mA \leq I_L \leq 1A$			0.4	mA	1
					0.5	mA	2, 3
		$-32V \leq V_{IN} \leq -14V$			0.4	mA	1
					0.5	mA	2, 3
$R_{Load}$	Load Regulation	$V_{IN} = -17V$ , $5mA \leq I_L \leq 1A$		-80	80	mV	1, 2, 3
				-10	10	mV	1
$R_{Line}$	Line Regulation	$-32V \leq V_{IN} \leq -14V$		-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
$\Delta I_Q$	Quiescent Current Change	$V_{IN} = -17V$ , $5mA \leq I_L \leq 200mA$			0.4	mA	1
		$-35V \leq V_{IN} \leq -17V$			0.5	mA	2, 3
					0.4	mA	1
					0.5	mA	2, 3
$R_{Load}$	Load Regulation	$V_{IN} = -20V$ , $5mA \leq I_L \leq 200mA$		-25	25	mV	1
				-50	50	mV	2, 3
$R_{Line}$	Line Regulation	$-35V \leq V_{IN} \leq -17V$		-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.  $V_{IN} = 20V$ ,  $I_L = 5mA$

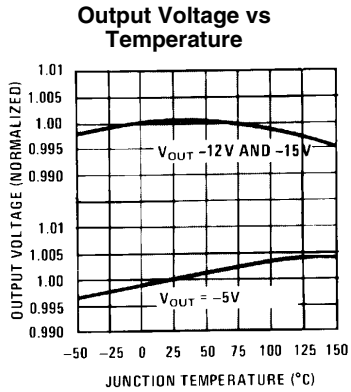
Symbol	Parameter	Conditions	Notes	Min	Max	Unit	Sub-groups
$I_Q$	Quiescent Current	$V_{IN} = -17V$			4.0	mA	1, 2, 3
		$V_{IN} = -35V$			4.0	mA	1, 2, 3
$\Delta I_Q$	Quiescent Current Change	$V_{IN} = -17V$ , $5mA \leq I_L \leq 1A$			0.4	mA	1
		$-35V \leq V_{IN} \leq -17V$			0.5	mA	2, 3
					0.4	mA	1
					0.5	mA	2, 3
$R_{Load}$	Load Regulation	$V_{IN} = -20V$ , $5mA \leq I_L \leq 1A$		-80	80	mV	1, 2, 3
				-10	10	mV	1
$R_{Line}$	Line Regulation	$-35V \leq V_{IN} \leq -17V$		-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
$\Delta V_O / \Delta t$	Long Term Stability		(Note 3)		150	mV	1
RR	Ripple Rejection	$f = 120Hz$ , $I_L = 350mA$ , $e_i = 1V_{RMS}$		56		dB	4

**Note 2:** 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 guarantee specific performance limits. For guaranteed specifications and test conditions, see the Electrical Characteristics. The guaranteed specifications apply only for the test conditions listed. Some performance characteristics may degrade when the device is not operated under the listed test conditions.

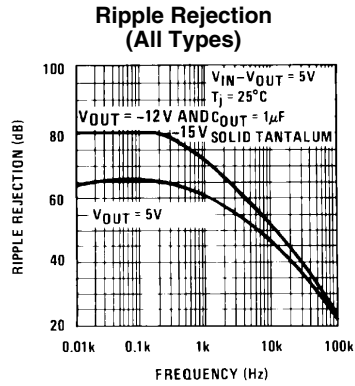
**Note 3:** Guaranteed parameter, not tested

**Note 4:** Human body model, 1.5 kΩ in series with 100 pF.

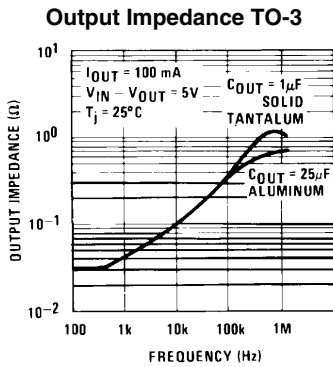
## Typical Performance Characteristics



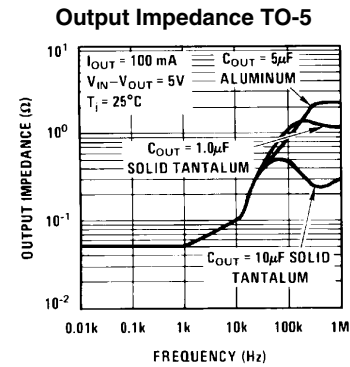
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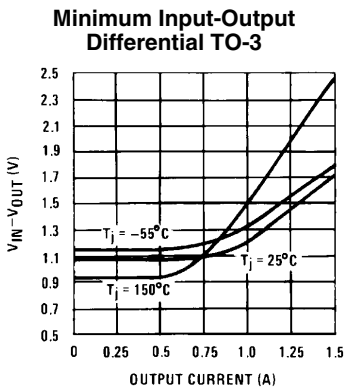
20150121



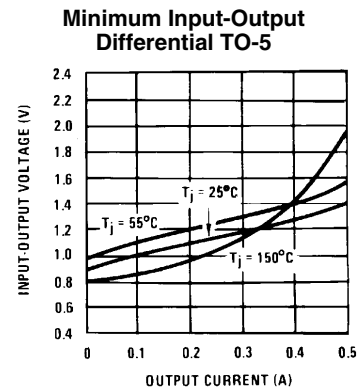
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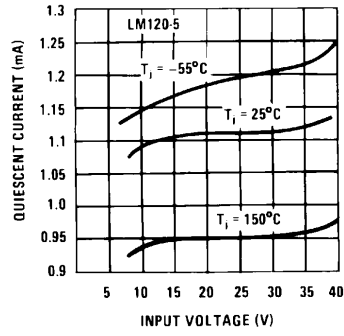


20150124



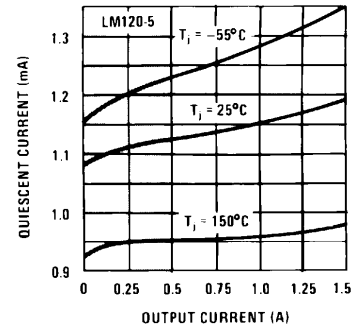
20150125

**Quiescent Current vs Input Voltage**



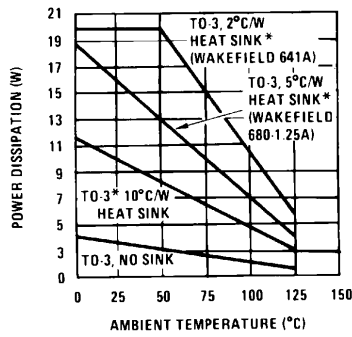
20150126

**Quiescent Current vs Load Current**



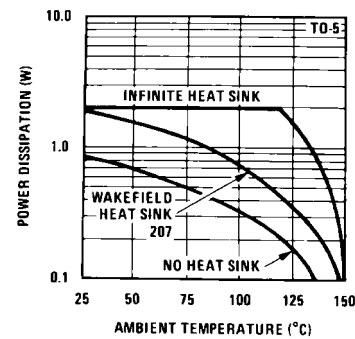
20150127

**Maximum Average Power Dissipation (TO-3)**



20150128

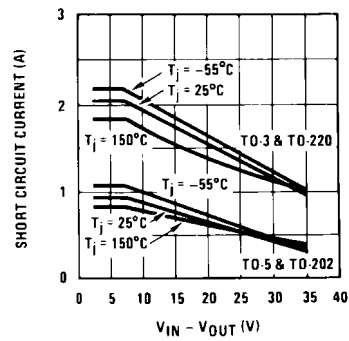
**Maximum Average Power Dissipation (TO-5)**



20150129

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

**Short Circuit Current**

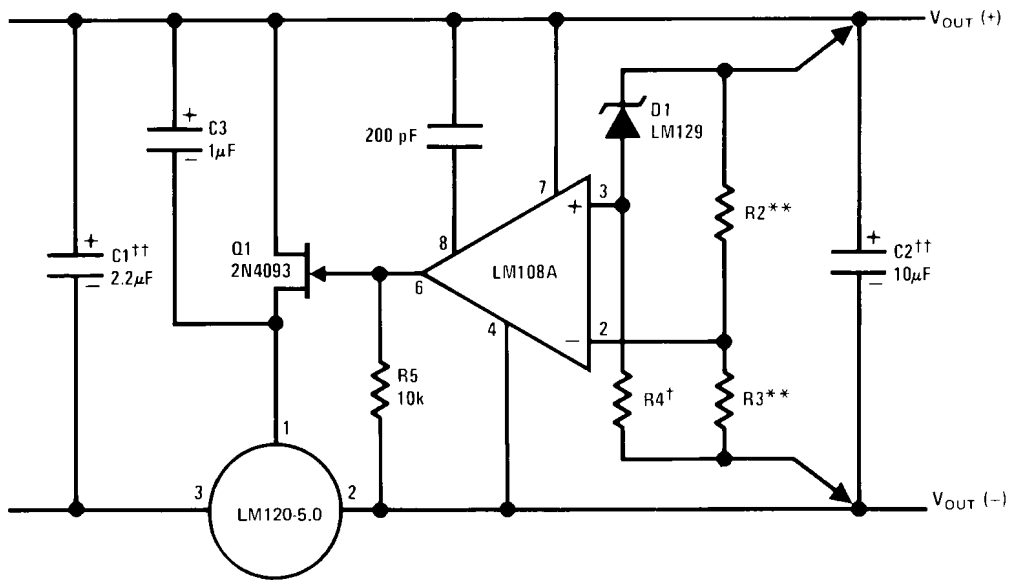


20150132



# Typical Applications

## High Stability 1 Amp Regulator



20150106

Lead and line regulation — 0.01% temperature stability — 0.2%

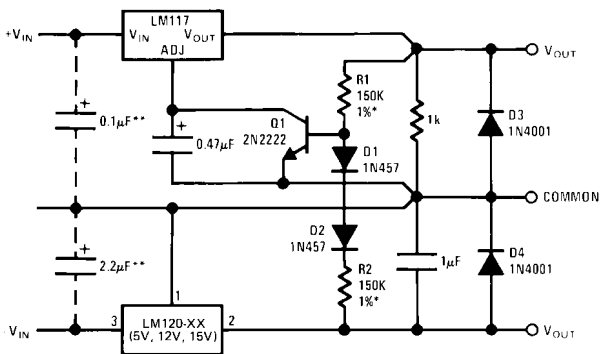
†Determines Zener current.

††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.

## Wide Range Tracking Regulator



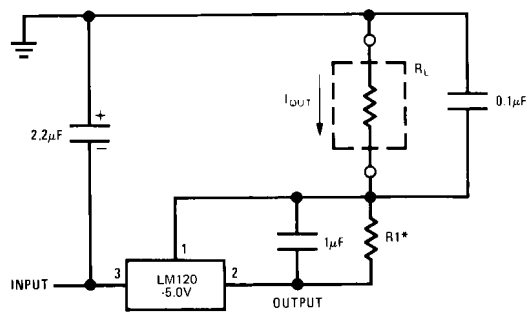
20150107

\* 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.

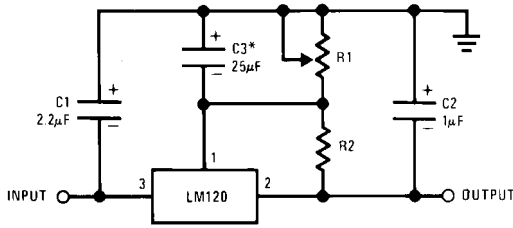
## Current Source



20150108

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

**Variable Output**



20150109

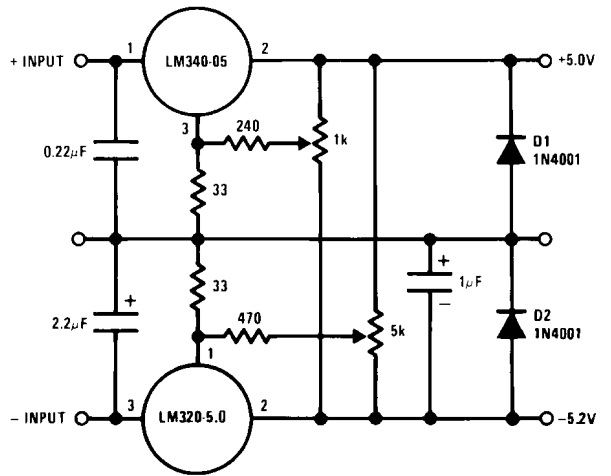
\*Optional. Improves transient response and ripple rejection.

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

SELECT R2 AS FOLLOWS:

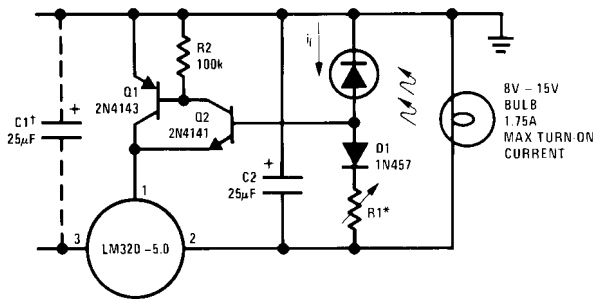
- LM120-5     -300Ω
- LM120-12   -750Ω
- LM120-15   -1k

**Dual Trimmed Supply**



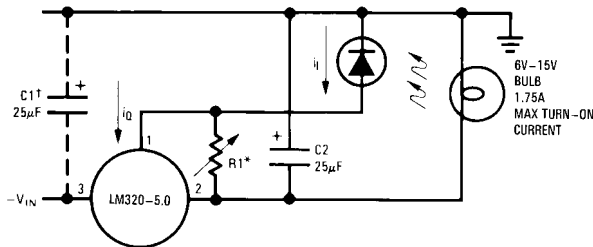
20150103

**Light Controllers Using Silicon Photo Cells**



20150110

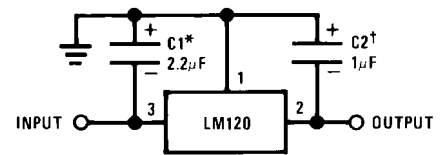
- \*Lamp brightness increases until  $i_i = 5V/R1$  ( $i_i$  can be set as low as 1 µA).
- †Necessary only if raw supply filter capacitor is more than 2 from LM320MP.



20150111

- \*Lamp brightness increases until  $i_i = i_O (1 \text{ mA}) + 5V/R1$ .
- †Necessary only if raw supply filter capacitor is more than 2 from LM320.

**Fixed Regulator**



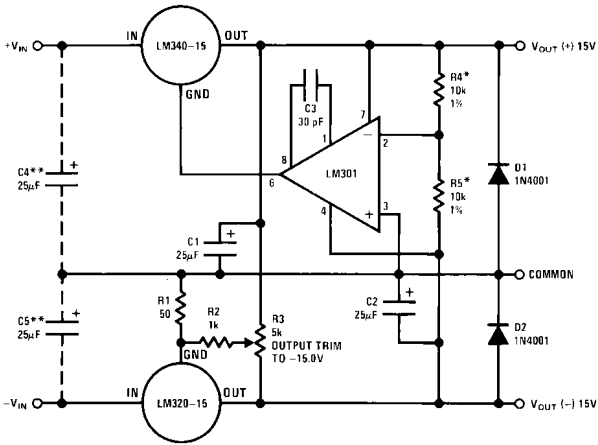
20150102

\*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.

**±15V, 1 Amp Tracking Regulators**



20150112

**Performance (Typical)**

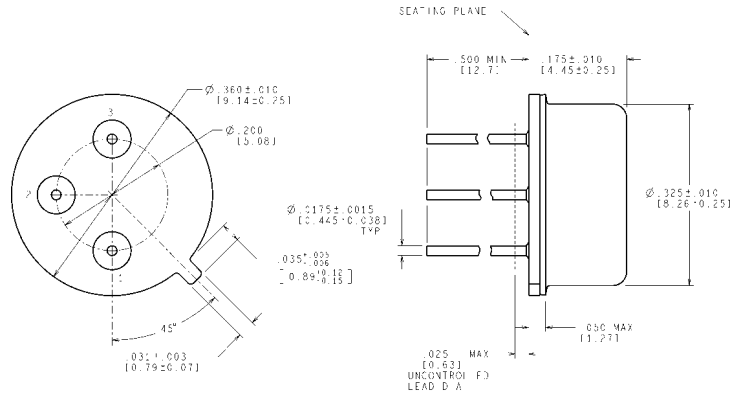
Load Regulation at $\Delta I_L = 1A$	10 mV	1 mV
Output Ripple, $C_{IN} = 3000 \mu F$ , $I_L = 1A$	100 $\mu VRMS$	100 $\mu VRMS$
Temperature Stability	+50 mV	+50 mV
Output Noise $10 Hz \leq f \leq 10 kHz$	150 $\mu VRMS$	150 $\mu VRMS$

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

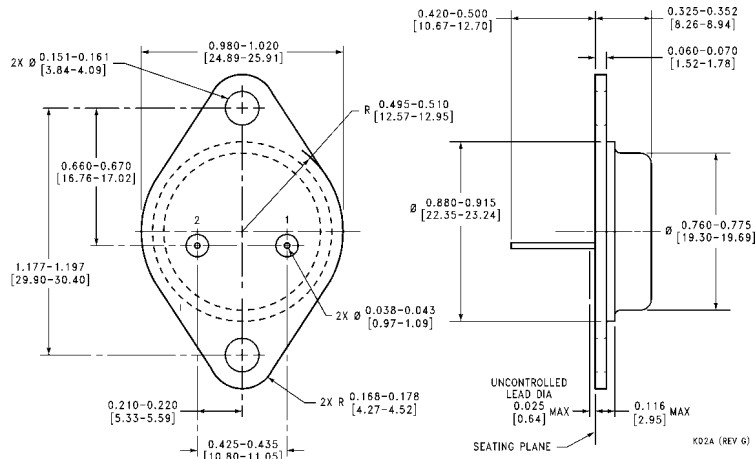
## Revision History

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 OBL, MNLM120-12-K Rev OBL, MNLM120-12-H Rev OBL, MNLM120-15-K Rev OBL, & MNLM120-15-H Rev OBL will be archived.

**Physical Dimensions** inches (millimeters) unless otherwise noted



**Metal Can Package (TO-39) (H)**  
NS Package Number H03A



**Steel Metal Can Package TO-3 (K)**  
NS Package Number K02C

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Power Management	<a href="http://www.national.com/power">www.national.com/power</a>	Green Compliance	<a href="http://www.national.com/quality/green">www.national.com/quality/green</a>
Switching Regulators	<a href="http://www.national.com/switchers">www.national.com/switchers</a>	Distributors	<a href="http://www.national.com/contacts">www.national.com/contacts</a>
LDOs	<a href="http://www.national.com/lido">www.national.com/lido</a>	Quality and Reliability	<a href="http://www.national.com/quality">www.national.com/quality</a>
LED Lighting	<a href="http://www.national.com/led">www.national.com/led</a>	Feedback/Support	<a href="http://www.national.com/feedback">www.national.com/feedback</a>
Voltage References	<a href="http://www.national.com/vref">www.national.com/vref</a>	Design Made Easy	<a href="http://www.national.com/easy">www.national.com/easy</a>
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Serial Digital Interface (SDI)	<a href="http://www.national.com/sdi">www.national.com/sdi</a>	Mil/Aero	<a href="http://www.national.com/milaero">www.national.com/milaero</a>
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