# National Semiconductor is now part of Texas Instruments.

Search <a href="http://www.ti.com/">http://www.ti.com/</a> for the latest technical information and details on our current products and services.



# 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 guiescent 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

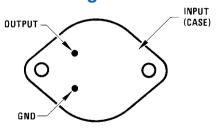
Package	Rated Power Dissipation	Design Load Current
TO-3 (K)	20W	1.5A
TO-39 (H)	2W	0.5A

### **Ordering Information**

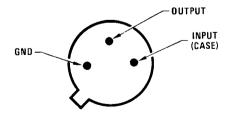
NS Part Number	SMD Part Number	NS Package Number	Package Description
LM120H-5.0/883		H03A	3LD T0-39 Metal Can
LM120H-12/883		H03A	3LD T0-39 Metal Can
LM120H-15/883		H03A	3LD T0-39 Metal Can
LM120K-12/883		K02C	2LD T0-3 Metal Can
LM120K-15/883		K02C	2LD T0-3 Metal Can
LM120KG-5 MD8		(Note 1)	Bare Die
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

# **Connection Diagrams**

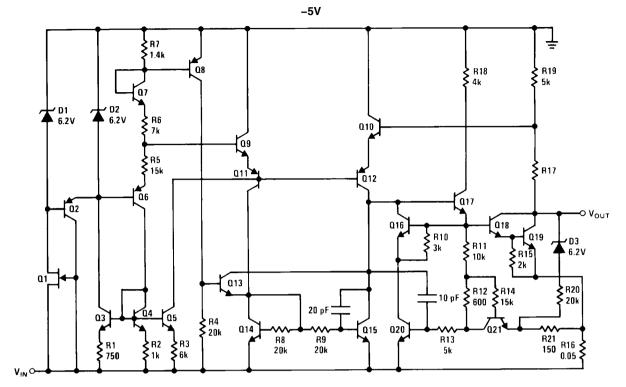


Bottom View
Steel Metal Can Package TO-3 (K)
See NS Package Number K02C

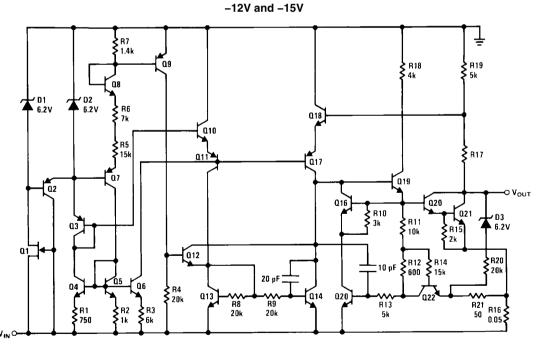


Bottom View
Metal Can Package TO-39 (H)
See NS Package Number H03A

# **Schematic Diagrams**



20150118



20150119

# 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°C ≤ T <sub>A</sub> ≤ $+150$ °C			
Operating Temperature Range		–55°C ≤ T <sub>A</sub> ≤ +125°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 (Note 4)	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
1	Outlessant Comment	$V_{IN} = -7V$			2.0	mA	1, 2, 3
l <sub>Q</sub>	Quiescent Current	V <sub>IN</sub> = -25V			2.0	mA	1, 2, 3
		Em 4 < 1 < 0 E 4		-0.4	0.4	mA	1
Δ1	Quiescent Current Change	$5mA \le I_L \le 0.5A$		-0.5	0.5	mA	2, 3
ΔI <sub>Q</sub>	Quiescent Current Change	25V < V < 7V		-0.4	0.4	mA	1
		-25V ≤ V <sub>IN</sub> ≤ -7V		-0.5	0.5	mA	2, 3
				-5.1	-4.9	٧	1
	Output Voltage	V <sub>IN</sub> = -7.5V		-5.2	-4.8	V	1, 2, 3
V <sub>OUT</sub>		$V_{IN} = -7.5V, I_{L} = 0.5A$		-5.2	-4.8	V	1, 2, 3
		V <sub>IN</sub> = -25V		-5.2	-4.8	V	1, 2, 3
		V <sub>IN</sub> = -25V, I <sub>L</sub> = 100mA		-5.2	-4.8	V	1, 2, 3
D	Line Degulation	051/61/67/		-25	25	mV	1
R <sub>Line</sub>	Line Regulation	-25V ≤ V <sub>IN</sub> ≤ -7V		-50	50	mV	2, 3
D	Load Degulation	5		-50	50	mV	1
R <sub>Load</sub>	Load Regulation	$5\text{mA} \le I_{L} \le 0.5\text{A}$		-100	100	mV	2, 3
I <sub>os</sub>	Short Circuit Current	V <sub>IN</sub> = -25V		0.1	1.5	Α	1
RR	Ripple Rejection	$f = 120$ Hz, $I_L = 125$ mA, $e_I = 1$ V <sub>RMS</sub>		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
1	Quiescent Current	V <sub>IN</sub> = -7V			2.0	mA	1, 2, 3
IQ	Quiescent Current	V <sub>IN</sub> = -25V			2.0	mA	1, 2, 3
		5mA ≤ I <sub>1</sub> ≤ 1.5A		-0.4	0.4	mA	1
٨١	Quiescent Current Change	SIIIA 3 I <sub>L</sub> 3 1:5A		-0.5	0.5	mA	2, 3
ΔI <sub>Q</sub>	Quiescent Current Change	-25V ≤ V <sub>IN</sub> ≤ -7V		-0.4	0.4	mA	1
		-25V 3 V <sub>IN</sub> 3 -7 V		-0.5	0.5	mA	2, 3
				-5.1	-4.9	V	1
	Output Voltage	V <sub>IN</sub> = -7.5V		-5.2	-4.8	V	1, 2, 3
V <sub>OUT</sub>		$V_{IN} = -7.5V, I_L = 1.5A$		-5.2	-4.8	V	1, 2, 3
		V <sub>IN</sub> = -25V		-5.2	-4.8	V	1, 2, 3
		V <sub>IN</sub> = -25V, I <sub>L</sub> = 1A		-5.2	-4.8	V	1, 2, 3
D	Line Regulation	251/51/57/		-25	25	mV	1
R <sub>Line</sub>	Line negulation	-25V ≤ V <sub>IN</sub> ≤ -7V		-50	50	mV	2, 3
D	Load Regulation	Em A < 1 < 1 = A		-75	75	mV	1
R <sub>Load</sub>	oad Load Regulation	5mA ≤ I <sub>L</sub> ≤ 1.5A		-100	100	mV	2, 3
Ios	Short Circuit Current	V <sub>IN</sub> = -25V		0.4	3.0	Α	1
RR	Ripple Rejection	$f = 120$ Hz, $I_L = 350$ mA, $e_I = 1$ V <sub>RMS</sub>		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	
1	Quiescent Current	V <sub>IN</sub> = -14V			4.0	mA	1, 2, 3	
l <sub>Q</sub>	Quiescent Current	V <sub>IN</sub> = -32V			4.0	mA	1, 2, 3	
		V <sub>IN</sub> = -17V,			0.4	mA	1	
Λ1	Quiescent Current Change	5mA ≤ I <sub>L</sub> ≤ 200mA			0.5	mA	2, 3	
Δl <sub>Q</sub>	Quiescent Current Change	201/51/5/141/			0.4	mA	1	
		-32V ≤ V <sub>IN</sub> ≤ -14V			0.5	mA	2, 3	
R	Load Regulation	$V_{IN} = -17V$ , 5mA $\leq I_L \leq 200$ mA	$V_{IN} = -17V$ , $5mA \le I_{I} \le 200mA$		-25	25	mV	1
R <sub>Load</sub>	Load negulation			-50	50		2, 3	
R <sub>Line</sub>	Line Regulation	-32V ≤ V <sub>IN</sub> ≤ -14V		-10	10	mV	1	
Line	Line Negulation	-32 V 3 V <sub>IN</sub> 3 - 14 V		-20	20	mV	2, 3	
I <sub>os</sub>	Short Circuit Current	V <sub>IN</sub> = -32V		0.1	1.5	Α	1	
		V <sub>IN</sub> = -17V		-12.3	-11.7	V	1	
		V <sub>IN</sub> = -32V		-12.5	-11.5	V	1, 2, 3	
V <sub>OUT</sub>	Output Voltage	V <sub>IN</sub> = -32V, I <sub>L</sub> = 100mA		-12.5	-11.5	V	1, 2, 3	
		V <sub>IN</sub> = -14.5V		-12.5	-11.5	V	1, 2, 3	
		V <sub>IN</sub> = -14.5V, I <sub>L</sub> = 200mA		-12.5	-11.5	V	1, 2, 3	
RR	Ripple Rejection	$f = 120$ Hz, $I_L = 125$ mA, $e_i = 1$ V <sub>RMS</sub>		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
1	Quiescent Current	V <sub>IN</sub> = -14V			4.0	mA	1, 2, 3
I <sub>Q</sub>	Quiescent Current	V <sub>IN</sub> = -32V			4.0	mA	1, 2, 3
		V = 17V 5mA < I < 1A			0.4	mA	1
٨١	Quiescent Current Change	$V_{IN} = -17V$ , $5mA \le I_L \le 1A$			0.5	mA	2, 3
ΔI <sub>Q</sub>	ų	-32V ≤ V <sub>IN</sub> ≤ -14V			0.4	mA	1
		-52 V = V <sub>IN</sub> = -14 V			0.5	mA	2, 3
R <sub>Load</sub>	Load Regulation	$V_{IN} = -17V$ , $5mA \le I_L \le 1A$		-80	80	mV	1, 2, 3
R <sub>Line</sub>	Line Regulation	001/51/51/11/		-10	10	mV	1
' 'Line	Line Regulation	-32V ≤ V <sub>IN</sub> ≤ -14V		-20	20	mV	2, 3
I <sub>os</sub>	Short Circuit Current	V <sub>IN</sub> = -32V		0.4	3.0	Α	1
		V <sub>IN</sub> = -17V		-12.3	-11.7	V	1
		V <sub>IN</sub> = -32V		-12.5	-11.5	V	1, 2, 3
$V_{OUT}$	Output Voltage	$V_{IN} = -32V$ , $I_L = 1A$		-12.5	-11.5	V	1, 2, 3
		V <sub>IN</sub> = -14.5V		-12.5	-11.5	V	1, 2, 3
		V <sub>IN</sub> = -14.5V, I <sub>L</sub> = 1A		-12.5	-11.5	V	1, 2, 3
RR	Ripple Rejection	$f = 120$ Hz, $I_L = 350$ mA, $e_i = 1$ V <sub>RMS</sub>		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
1	Quiescent Current	V <sub>IN</sub> = -17V			4.0	mA	1, 2, 3
l <sub>Q</sub>	Quiescent Current	V <sub>IN</sub> = -35V			4.0	mA	1, 2, 3
		V <sub>IN</sub> = -17V,			0.4	mA	1
Δ1	Ouissant Current Change	5mA ≤ I <sub>L</sub> ≤ 200mA			0.5	mA	2, 3
ΔI <sub>Q</sub>	Quiescent Current Change	25/16/1/16/17/1			0.4	mA	1
		-35V ≤ V <sub>IN</sub> ≤ -17V			0.5	mA	2, 3
Б	Load Degulation	V <sub>IN</sub> = -20V,		-25	25	mV	1
R <sub>Load</sub>	Load Regulation	5mA ≤ I <sub>L</sub> ≤ 200mA		-50	50	mV	2, 3
D	Line Deculation	25/16/1/16/17/1		-10	10	mV	1
R <sub>Line</sub>	Line Regulation	-35V ≤ V <sub>IN</sub> ≤ -17V		-20	20	mV	2, 3
I <sub>os</sub>	Short Circuit Current	V <sub>IN</sub> = -35V		0.1	1.5	Α	1
		V <sub>IN</sub> = -20V		-15.3	-14.7	V	1
		V <sub>IN</sub> = -35V		-15.5	-14.5	V	1, 2, 3
V <sub>OUT</sub>	Output Voltage	V <sub>IN</sub> = -35V, I <sub>L</sub> = 100mA		-15.5	-14.5	V	1, 2, 3
		V <sub>IN</sub> = -17.5V		-15.5	-14.5	V	1, 2, 3
		V <sub>IN</sub> = -17.5V, I <sub>L</sub> = 200mA		-15.5	-14.5	V	1, 2, 3
RR	Ripple Rejection	$f = 120$ Hz, $I_L = 125$ mA, $e_i = 1$ V <sub>RMS</sub>		56		dB	4

## LM120K-15

## **DC Parameters**

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

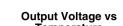
Symbol	Parameter	Conditions	Notes	Min	Max	Unit	Sub- groups
1	Ouissant Current	V <sub>IN</sub> = -17V			4.0	mA	1, 2, 3
I <sub>Q</sub>	Quiescent Current	V <sub>IN</sub> = -35V			4.0	mA	1, 2, 3
		V <sub>IN</sub> = -17V,			0.4	mA	1
٨١	Quioscont Current Change	$5mA \le I_L \le 1A$			0.5	mA	2, 3
ΔI <sub>Q</sub>	ΔI <sub>Q</sub> Quiescent Current Change	251/ < 1/ < 171/			0.4	mA	1
		-35V ≤ V <sub>IN</sub> ≤ -17V			0.5	mA	2, 3
R <sub>Load</sub>	Load Regulation	$V_{IN} = -20V$ , $5\text{mA} \le I_{L} \le 1\text{A}$		-80	80	mV	1, 2, 3
		051/451/4451/4		-10	10	mV	1
R <sub>Line</sub>	Line Regulation	-35V ≤ V <sub>IN</sub> ≤ -17V		-20	20	mV	2, 3
I <sub>os</sub>	Short Circuit Current	V <sub>IN</sub> = -35V		0.4	3.0	Α	1
		V <sub>IN</sub> = -20V		-15.3	-14.7	V	1
		V <sub>IN</sub> = -35V		-15.5	-14.5	V	1, 2, 3
V <sub>OUT</sub>	Output Voltage	$V_{IN} = -35V, I_{L} = 1A$		-15.5	-14.5	V	1, 2, 3
		V <sub>IN</sub> = -17.5V		-15.5	-14.5	V	1, 2, 3
		V <sub>IN</sub> = -17.5V, I <sub>L</sub> = 1.5A		-15.5	-14.5	V	1, 2, 3
ΔV <sub>O</sub> / Δt	Long Term Stability		(Note 3)		150	mV	1
RR	Ripple Rejection	$f = 120$ Hz, $I_L = 350$ mA, $e_I = 1$ V <sub>RMS</sub>		56		dB	4

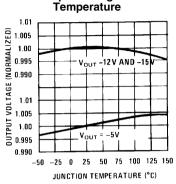
**Note 2:** Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is functional, but do not guarantee specific performance limits. For guaranteed specifications and test conditions, see the Electrical Characteristics. 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

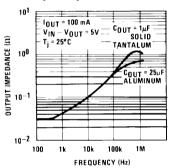
**Note 4:** Human body model, 1.5 k $\Omega$  in seriew with 100 pF.

### **Typical Performance Characteristics**



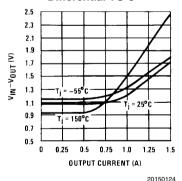


#### **Output Impedance TO-3**

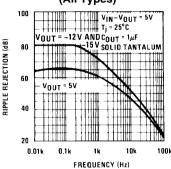


20150122

#### Minimum Input-Output Differential TO-3

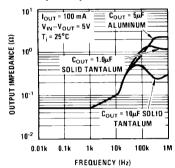


Ripple Rejection (All Types)



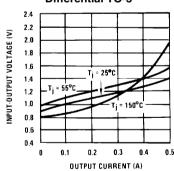
20150121

#### **Output Impedance TO-5**



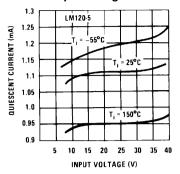
20150123

# Minimum Input-Output Differential TO-5



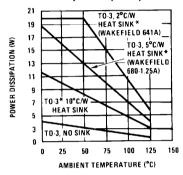
2015012

#### Quiescent Current vs Input Voltage



20150126

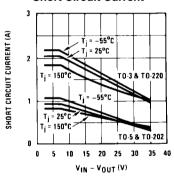
# Maximum Average Power Dissipation (TO-3)



20150128

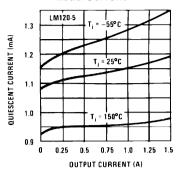
\*These curves for LM120. Derate 25°C further for LM320.

#### **Short Circuit Current**



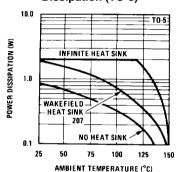
20150132

#### Quiescent Current vs Load Current



20150127

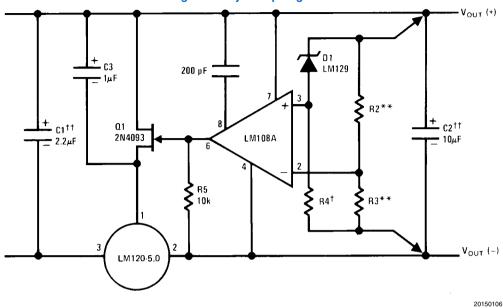
# Maximum Average Power Dissipation (TO-5)



20150129

# **Typical Applications**

#### **High Stability 1 Amp Regulator**



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

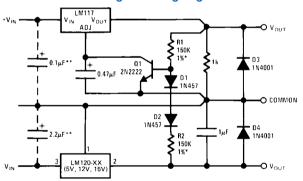
†Determines Zener current.

††Solid tantalum.

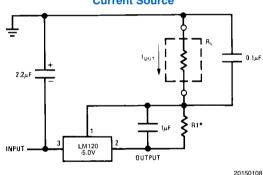
An LM120-12 or LM120-15 may be used to permit higher input voltages, but the regulated output voltage must be at least -15V when using the LM120-12 and -18V for the LM120-15.

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

#### Wide Range Tracking Regulator



#### **Current Source**



 $^{*}I_{OUT} = 1 mA +$ 

<sup>\*</sup> 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.

### 

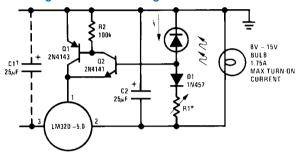
\*Optional. Improves transient response and ripple rejection.

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

#### **SELECT R2 AS FOLLOWS:**

LM120-5 -300ΩLM120-12 -750ΩLM120-15 -1k

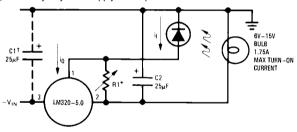
#### **Light Controllers Using Silicon Photo Cells**



2015011

20150109

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



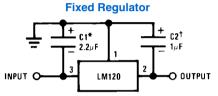
20150111

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

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

# 

20150103



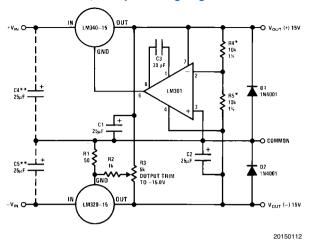
20150102

\*Required if regulator is separated from filter capacitor by more than 3 . For value given, capacitor must be solid tantalum. 25  $\mu\text{F}$  aluminum electrolytic may be substituted.

 $\dagger$ Required for stability. For value given, capacitor must be solid tantalum. 25  $\mu$ F aluminum electrolytic may be substituted. Values given may be increased without limit

For output capacitance in excess of 100  $\mu F,$  a high current diode from input to output (1N4001, etc.) will protect the regulator from momentary input shorts.

#### ±15V, 1 Amp Tracking Regulators



#### Performance (Typical)

Load Regulation at  $\Delta I_L = 1A$  10 mV 1 mV Output Ripple,  $C_{IN} = 3000~\mu F$ , 100  $\mu VRMS$  100  $\mu VRMS$   $I_L = 1A$ 

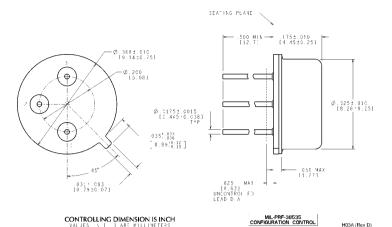
Temperature Stability +50 mV +50 mV Output Noise 10 Hz  $\leq$  f  $\leq$  10 kHz 150  $\mu$ VRMS 150  $\mu$ VRMS

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

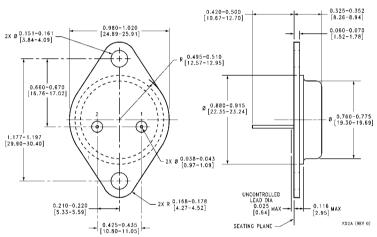
# **Revision History**

Date Released	Revision	Section	Changes
12/15/2010	Α	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.

# 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

H03A (Rev D)

### **Notes**

For more National Semiconductor product information and proven design tools, visit the following Web sites at: www.national.com

Pro	oducts	Design Support		
Amplifiers	www.national.com/amplifiers	WEBENCH® Tools	www.national.com/webench	
Audio	www.national.com/audio	App Notes	www.national.com/appnotes	
Clock and Timing	www.national.com/timing	Reference Designs	www.national.com/refdesigns	
Data Converters	www.national.com/adc	Samples	www.national.com/samples	
Interface	www.national.com/interface	Eval Boards	www.national.com/evalboards	
LVDS	www.national.com/lvds	Packaging	www.national.com/packaging	
Power Management	www.national.com/power	Green Compliance	www.national.com/quality/green	
Switching Regulators	www.national.com/switchers	Distributors	www.national.com/contacts	
LDOs	www.national.com/ldo	Quality and Reliability	www.national.com/quality	
LED Lighting	www.national.com/led	Feedback/Support	www.national.com/feedback	
Voltage References	www.national.com/vref	Design Made Easy	www.national.com/easy	
PowerWise® Solutions	www.national.com/powerwise	Applications & Markets	www.national.com/solutions	
Serial Digital Interface (SDI)	www.national.com/sdi	Mil/Aero	www.national.com/milaero	
Temperature Sensors	www.national.com/tempsensors	SolarMagic™	www.national.com/solarmagic	
PLL/VCO	www.national.com/wireless	PowerWise® Design University	www.national.com/training	

THE CONTENTS OF THIS DOCUMENT ARE PROVIDED IN CONNECTION WITH NATIONAL SEMICONDUCTOR CORPORATION ("NATIONAL") PRODUCTS. NATIONAL MAKES NO REPRESENTATIONS OR WARRANTIES WITH RESPECT TO THE ACCURACY OR COMPLETENESS OF THE CONTENTS OF THIS PUBLICATION AND RESERVES THE RIGHT TO MAKE CHANGES TO SPECIFICATIONS AND PRODUCT DESCRIPTIONS AT ANY TIME WITHOUT NOTICE. NO LICENSE, WHETHER EXPRESS, IMPLIED, ARISING BY ESTOPPEL OR OTHERWISE, TO ANY INTELLECTUAL PROPERTY RIGHTS IS GRANTED BY THIS DOCUMENT.

TESTING AND OTHER QUALITY CONTROLS ARE USED TO THE EXTENT NATIONAL DEEMS NECESSARY TO SUPPORT NATIONAL'S PRODUCT WARRANTY. EXCEPT WHERE MANDATED BY GOVERNMENT REQUIREMENTS, TESTING OF ALL PARAMETERS OF EACH PRODUCT IS NOT NECESSARILY PERFORMED. NATIONAL ASSUMES NO LIABILITY FOR APPLICATIONS ASSISTANCE OR BUYER PRODUCT DESIGN. BUYERS ARE RESPONSIBLE FOR THEIR PRODUCTS AND APPLICATIONS USING NATIONAL COMPONENTS. PRIOR TO USING OR DISTRIBUTING ANY PRODUCTS THAT INCLUDE NATIONAL COMPONENTS, BUYERS SHOULD PROVIDE ADEQUATE DESIGN, TESTING AND OPERATING SAFEGUARDS.

EXCEPT AS PROVIDED IN NATIONAL'S TERMS AND CONDITIONS OF SALE FOR SUCH PRODUCTS, NATIONAL ASSUMES NO LIABILITY WHATSOEVER, AND NATIONAL DISCLAIMS ANY EXPRESS OR IMPLIED WARRANTY RELATING TO THE SALE AND/OR USE OF NATIONAL PRODUCTS INCLUDING LIABILITY OR WARRANTIES RELATING TO FITNESS FOR A PARTICULAR PURPOSE, MERCHANTABILITY, OR INFRINGEMENT OF ANY PATENT, COPYRIGHT OR OTHER INTELLECTUAL PROPERTY RIGHT.

#### LIFE SUPPORT POLICY

NATIONAL'S PRODUCTS ARE NOT AUTHORIZED FOR USE AS CRITICAL COMPONENTS IN LIFE SUPPORT DEVICES OR SYSTEMS WITHOUT THE EXPRESS PRIOR WRITTEN APPROVAL OF THE CHIEF EXECUTIVE OFFICER AND GENERAL COUNSEL OF NATIONAL SEMICONDUCTOR CORPORATION. As used herein:

Life support devices or systems are devices which (a) are intended for surgical implant into the body, or (b) support or sustain life and whose failure to perform when properly used in accordance with instructions for use provided in the labeling can be reasonably expected to result in a significant injury to the user. A critical component is any component in a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system or to affect its safety or effectiveness.

National Semiconductor and the National Semiconductor logo are registered trademarks of National Semiconductor Corporation. All other brand or product names may be trademarks or registered trademarks of their respective holders.

Copyright© 2010 National Semiconductor Corporation

For the most current product information visit us at www.national.com



National Semiconductor Americas Technical Support Center Email: support@nsc.com Tel: 1-800-272-9959 National Semiconductor Europe Technical Support Center Email: europe.support@nsc.com National Semiconductor Asia Pacific Technical Support Center Email: ap.support@nsc.com

National Semiconductor Japan Technical Support Center Email: jpn.feedback@nsc.com