

LM120QML Series 3-Terminal Negative Regulators

Check for Samples: [LM120QML](#)

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

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

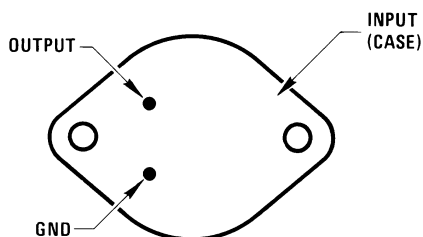
Package	Rated Power Dissipation	Design Load Current
TO (K)	20W	1.5A
PFM (H)	2W	0.5A



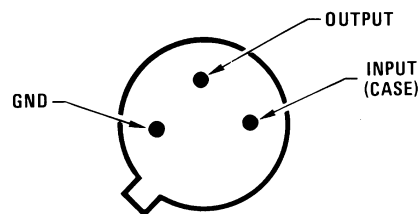
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Connection Diagram



**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

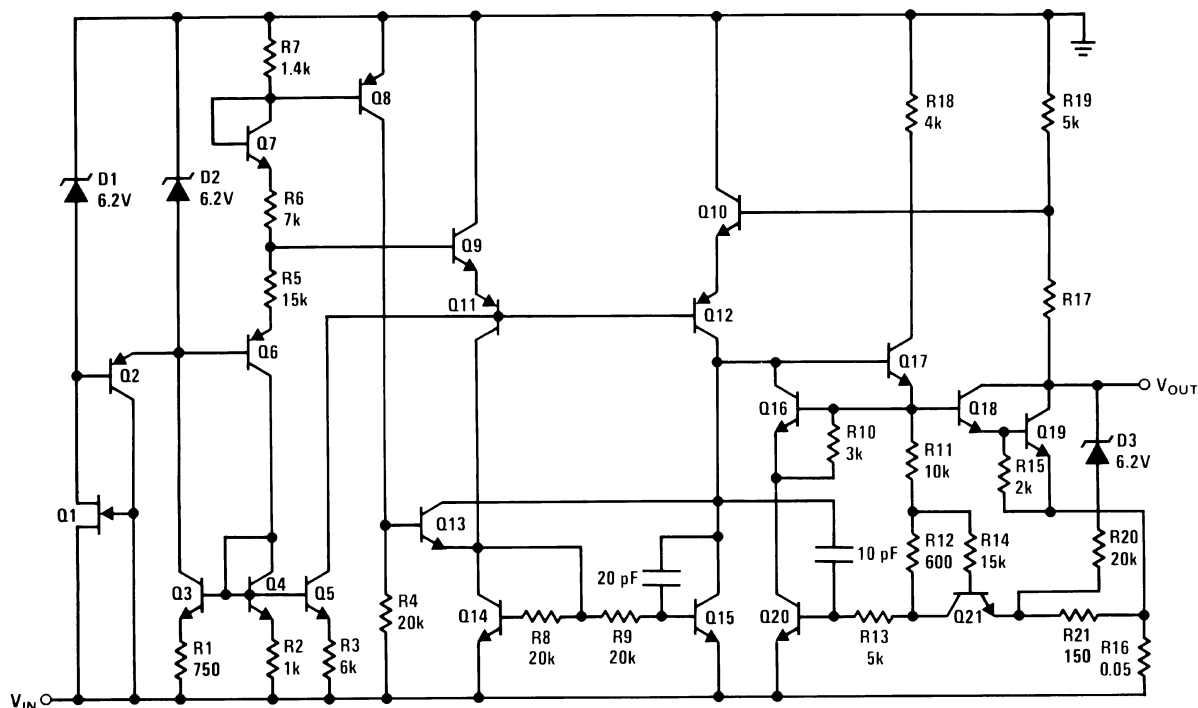
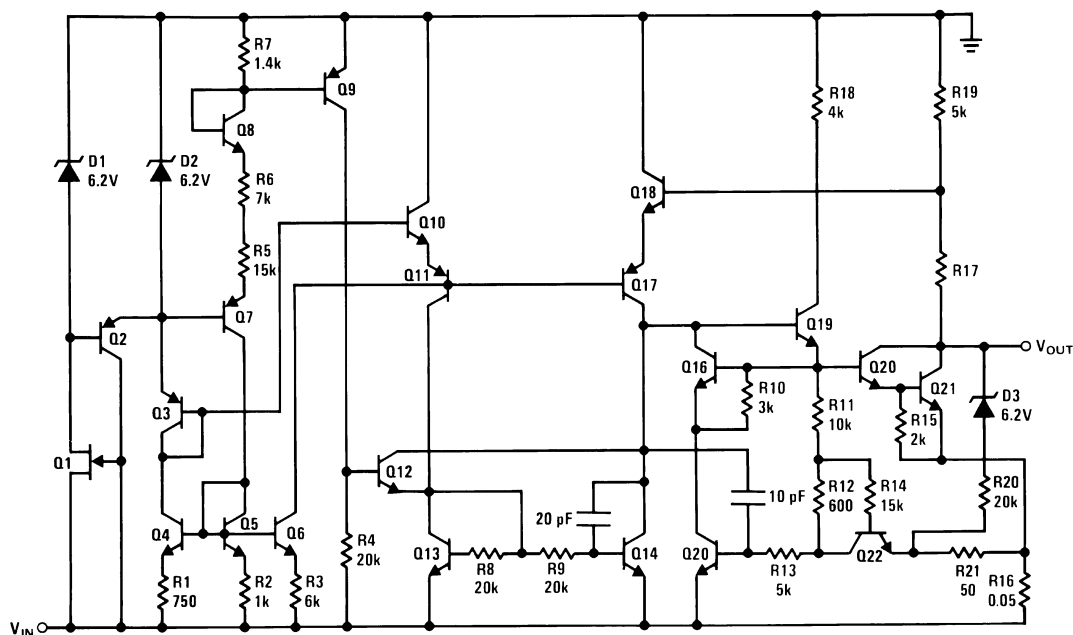


Figure 4. -12V and -15V



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 series 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	$5mA \leq I_L \leq 0.5A$		-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	$f = 120Hz$, $I_L = 125mA$, $e_i = 1V_{RMS}$		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	$5mA \leq I_L \leq 1.5A$		-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	$f = 120Hz$, $I_L = 350mA$, $e_i = 1V_{RMS}$		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	$V_{IN} = -17V$, $5mA \leq I_L \leq 200mA$			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
ΔI_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
R_{Line}	Line Regulation	$-32V \leq V_{IN} \leq -14V$		-10	10	mV	1
				-20	20	mV	2, 3
I_{OS}	Short Circuit Current	$V_{IN} = -32V$		0.4	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	$V_{IN} = -17V$, $5mA \leq I_L \leq 200mA$			0.4	mA	1
					0.5	mA	2, 3
		$-35V \leq V_{IN} \leq -17V$			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
ΔI_Q	Quiescent Current Change	$V_{IN} = -17V$, $5mA \leq I_L \leq 1A$			0.4	mA	1
					0.5	mA	2, 3
		$-35V \leq V_{IN} \leq -17V$			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
R_{Line}	Line Regulation	$-35V \leq V_{IN} \leq -17V$		-10	10	mV	1
				-20	20	mV	2, 3
I_{OS}	Short Circuit Current	$V_{IN} = -35V$		0.4	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		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

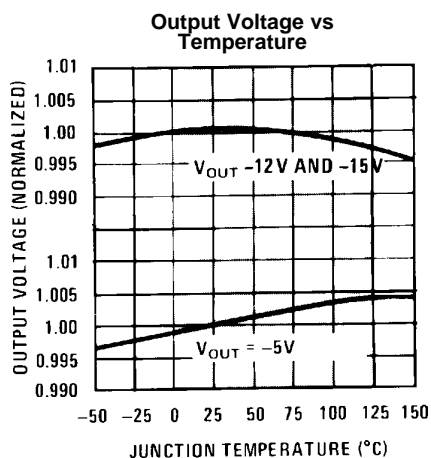


Figure 5.

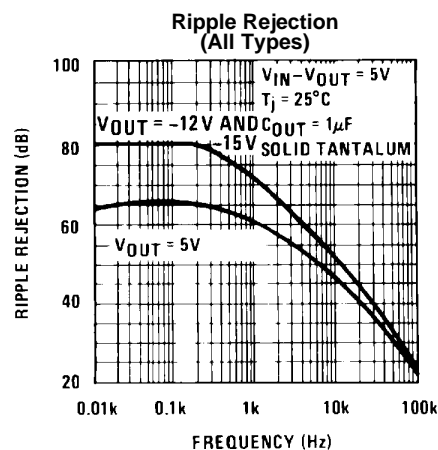


Figure 6.

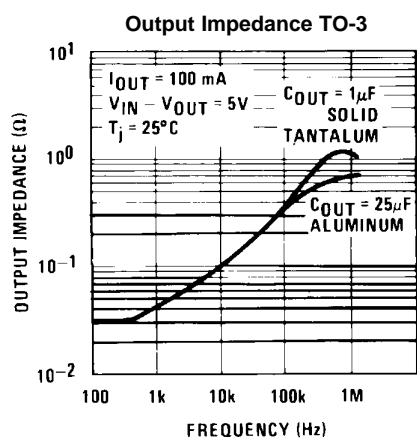


Figure 7.

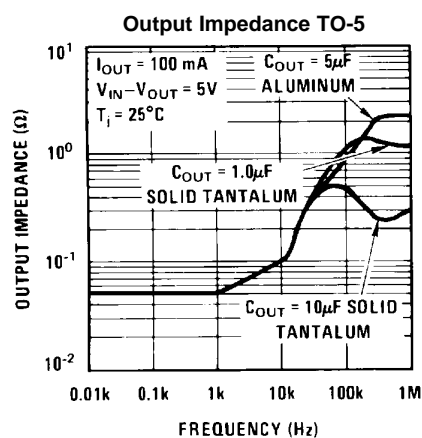


Figure 8.

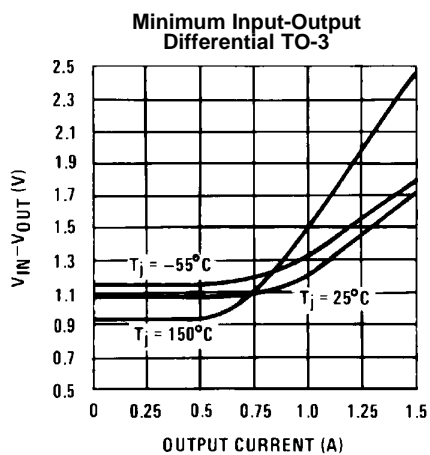


Figure 9.

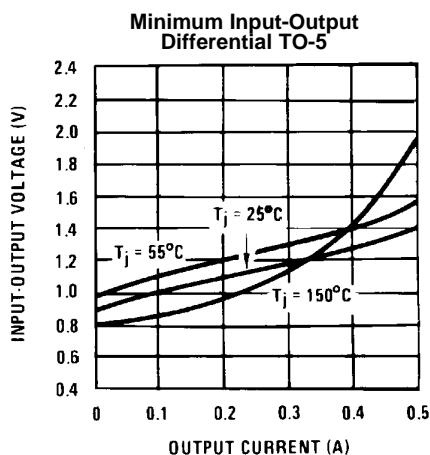


Figure 10.

TYPICAL PERFORMANCE CHARACTERISTICS (continued)

Quiescent Current vs
Input Voltage

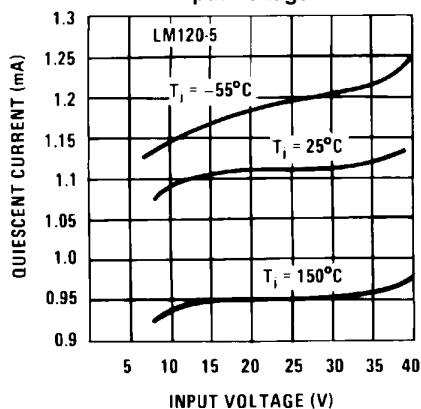


Figure 11.

Quiescent Current vs
Load Current

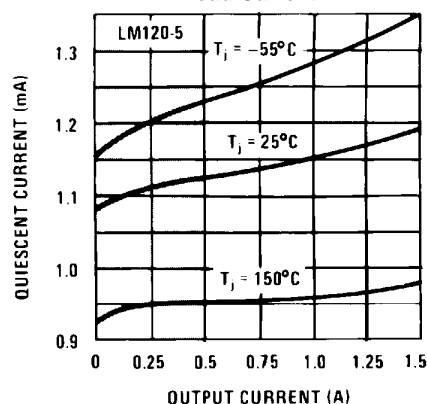
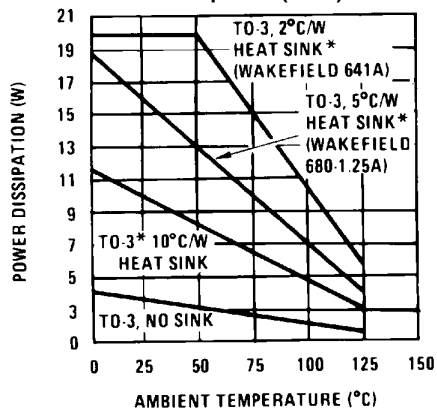


Figure 12.

Maximum Average Power
Dissipation (TO-3)



*These curves for LM120. Derate 25°C further for LM320.
Figure 13.

Maximum Average Power
Dissipation (TO-5)

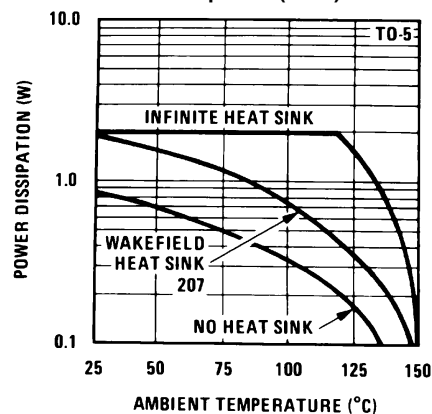


Figure 14.

Short Circuit Current

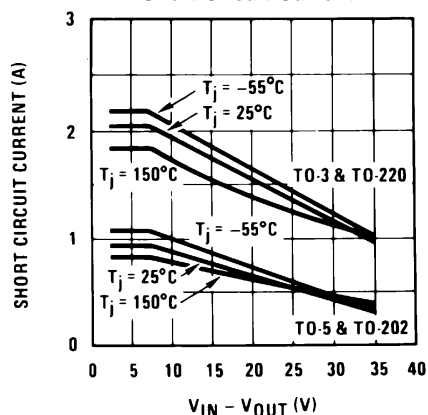
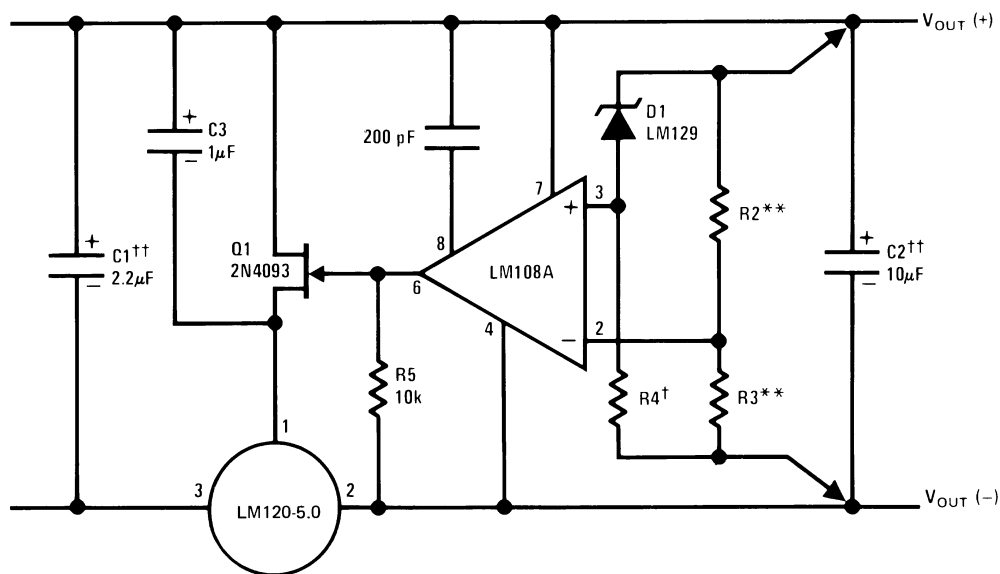


Figure 15.

TYPICAL APPLICATIONS



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

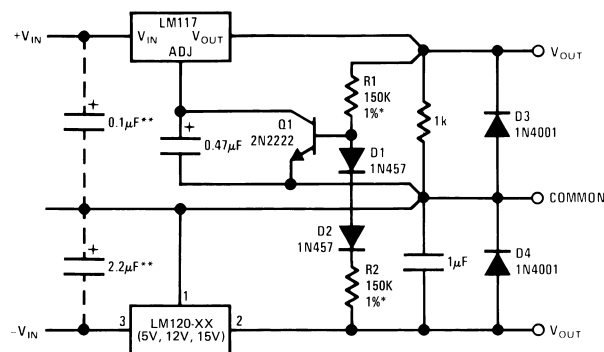
†Determines Zener current.

††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

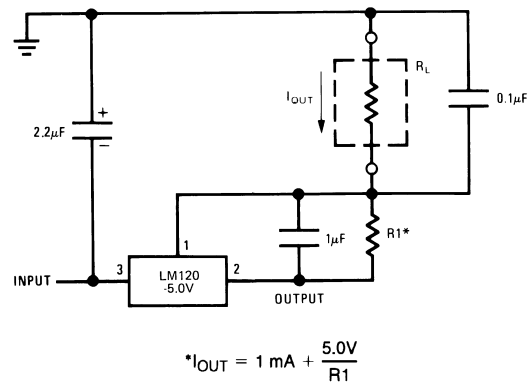
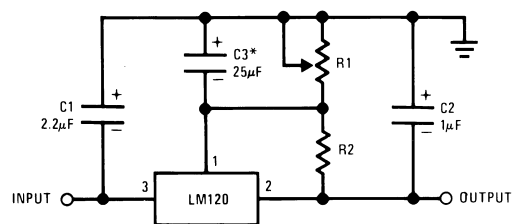


Figure 18. Current Source



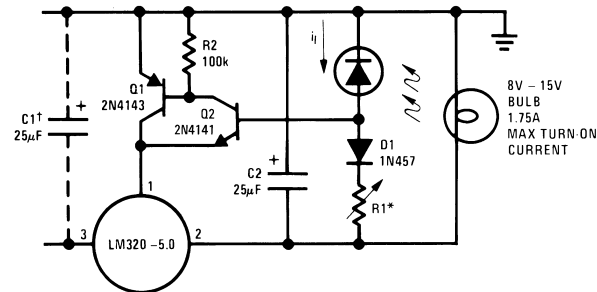
*Optional. Improves transient response and ripple rejection.

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

SELECT R2 AS FOLLOWS:

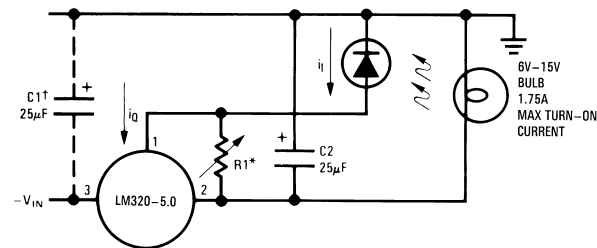
LM120-5	~300Ω
LM120-12	~750Ω
LM120-15	~1k

Figure 19. Variable Output



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

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

Figure 20. Light Controllers Using Silicon Photo Cells

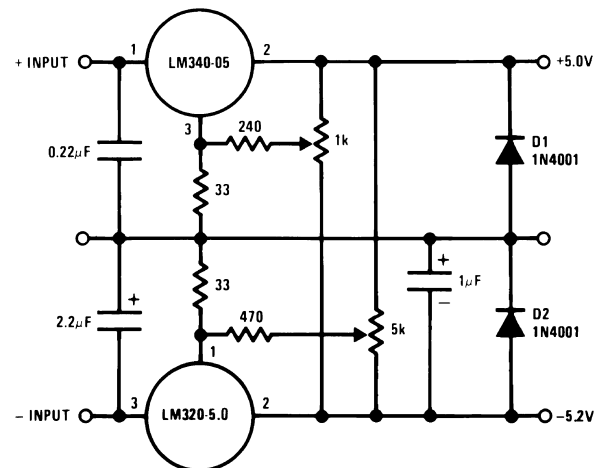
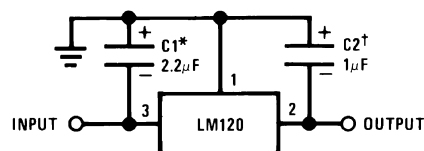


Figure 21. Dual Trimmed Supply



*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

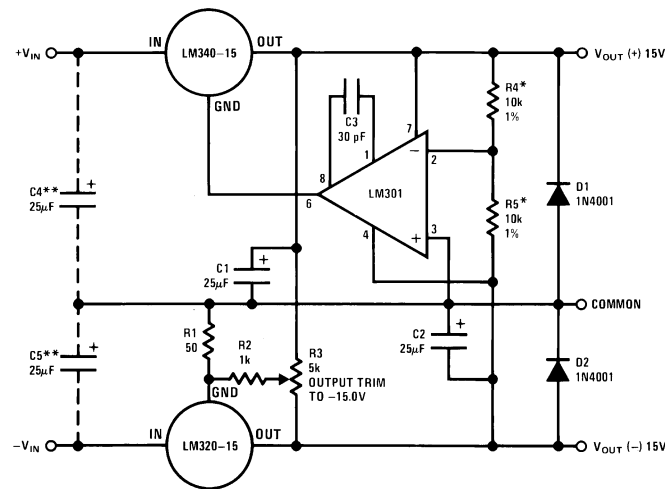


Figure 23. $\pm 15\text{V}$, 1 Amp Tracking Regulators

Table 3. Performance (Typical)⁽¹⁾

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 $\mu VRMS$

(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 OBL, MNLM120-12-K Rev OBL, MNLM120-12-H Rev OBL, MNLM120-15-K Rev OBL, & MNLM120-15-H Rev OBL will be archived.
4/22/2013	A	All	Changed layout of National Data Sheet to TI format.

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead finish/ Ball material (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
LM120H-12/883	ACTIVE	TO	NDT	3	20	Non-RoHS & Non-Green	Call TI	Call TI	-55 to 150	LM120H-12/883 Q AC O LM120H-12/883 Q >T	Samples
LM120H-15/883	ACTIVE	TO	NDT	3	20	Non-RoHS & Non-Green	Call TI	Call TI	-55 to 150	LM120H-15P+ LM120H-15/883 Q AC O LM120H-15/883 Q >T	Samples
LM120H-5.0/883	ACTIVE	TO	NDT	3	20	Non-RoHS & Non-Green	Call TI	Call TI	-55 to 150	LM120H-5.0/883 Q A CO LM120H-5.0/883 Q > T	Samples
LM120K-12/883	ACTIVE	TO	K	2	50	Non-RoHS & Non-Green	Call TI	Call TI	-55 to 150	LM120K-12 /883 Q ACO /883 Q >T	Samples
LM120K-15/883	ACTIVE	TO	K	2	50	Non-RoHS & Non-Green	Call TI	Call TI	-55 to 150	(LM120H-15P+, LM12 0K-15) /883 Q ACO /883 Q >T	Samples
LM120KG-12 MD8	ACTIVE	DIESALE	Y	0	221	RoHS & Green	Call TI	Level-1-NA-UNLIM	-55 to 125		Samples
LM120KG-15 MD8	ACTIVE	DIESALE	Y	0	221	RoHS & Green	Call TI	Level-1-NA-UNLIM	-55 to 125		Samples
LM120KG-5 MD8	ACTIVE	DIESALE	Y	0	221	RoHS & Green	Call TI	Level-1-NA-UNLIM	-55 to 125		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.

OBSELETE: TI has discontinued the production of the device.

(2) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".

RoHS Exempt: TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.

Green: TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of ≤ 1000 ppm threshold. Antimony trioxide based flame retardants must also meet the ≤ 1000 ppm threshold requirement.

(3) MSL, Peak Temp. - The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

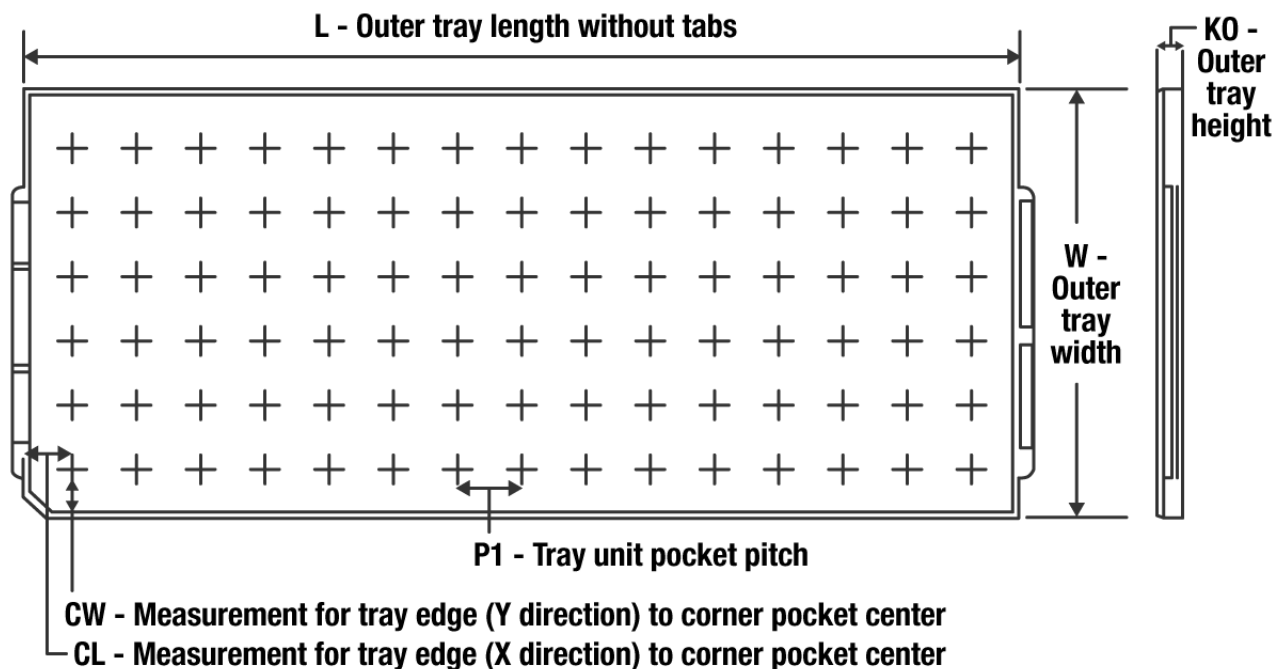
(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

(6) Lead finish/Ball material - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

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TRAY

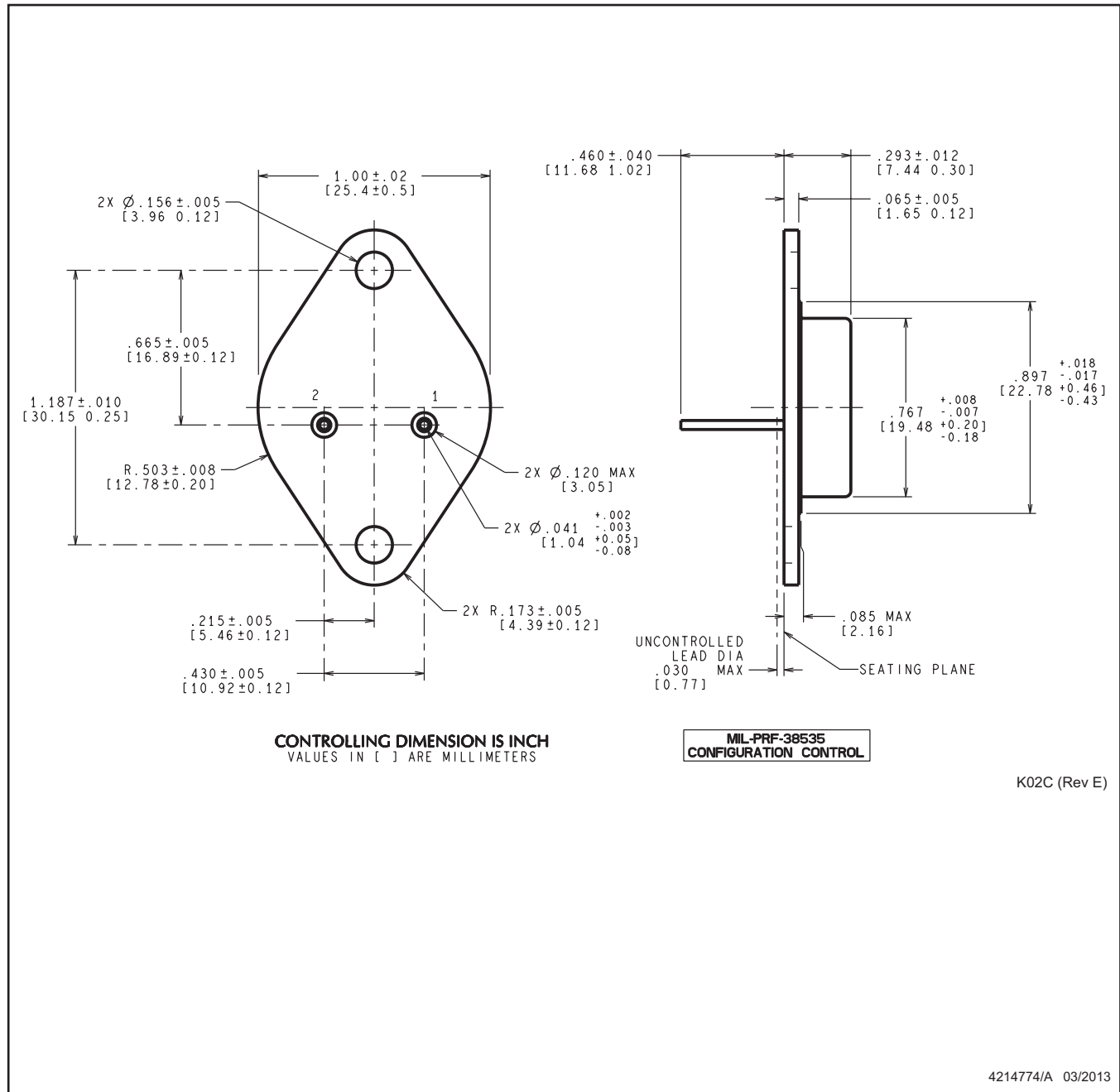


Chamfer on Tray corner indicates Pin 1 orientation of packed units.

*All dimensions are nominal

Device	Package Name	Package Type	Pins	SPQ	Unit array matrix	Max temperature (°C)	L (mm)	W (mm)	K0 (μm)	P1 (mm)	CL (mm)	CW (mm)
LM120H-12/883	NDT	TO-CAN	3	20	2 X 10	150	126.49	61.98	8890	11.18	12.95	18.54
LM120H-15/883	NDT	TO-CAN	3	20	2 X 10	150	126.49	61.98	8890	11.18	12.95	18.54
LM120H-5.0/883	NDT	TO-CAN	3	20	2 X 10	150	126.49	61.98	8890	11.18	12.95	18.54
LM120K-12/883	K	TO-CAN	2	50	9 X 6	NA	292.1	215.9	25654	3.87	22.3	25.4
LM120K-15/883	K	TO-CAN	2	50	9 X 6	NA	292.1	215.9	25654	3.87	22.3	25.4

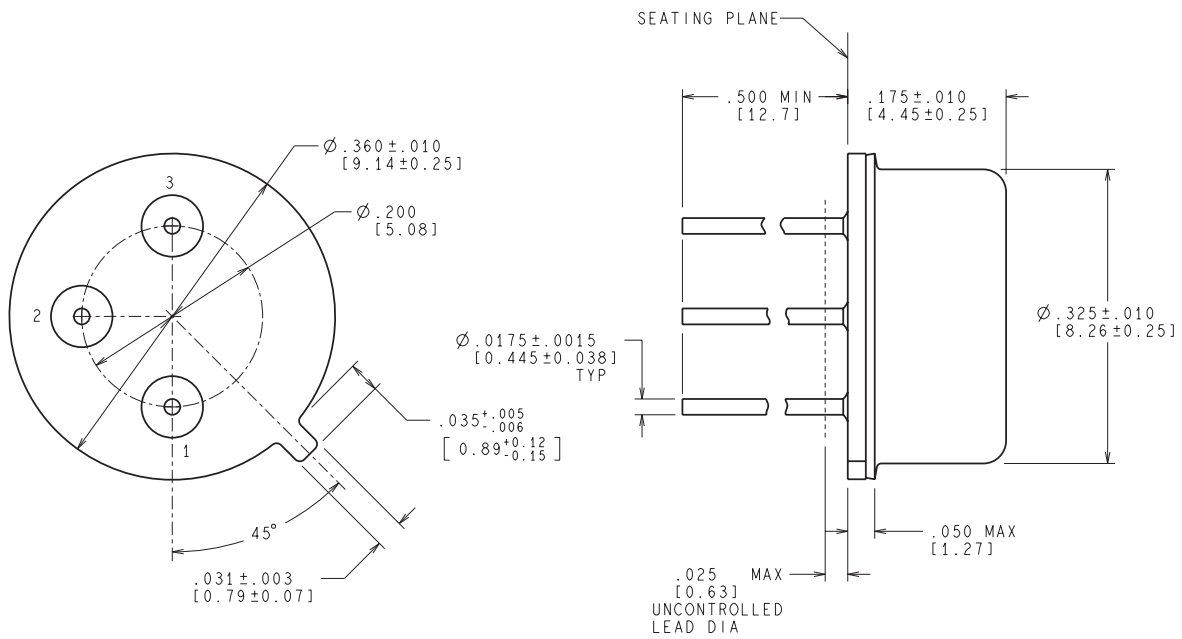
K0002C



NOTES:

1. All linear dimensions are in millimeters. Dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. Leads not to be bent greater than 15°

NDT0003A



CONTROLLING DIMENSION IS INCH
VALUES IN [] ARE MILLIMETERS

MIL-PRF-38535
CONFIGURATION CONTROL

H03A (Rev D)

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