

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

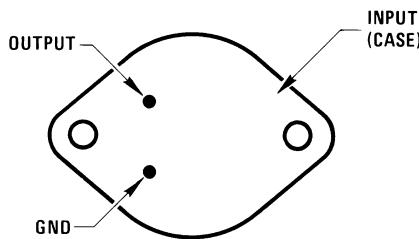


Figure 1. Bottom View
2-Pin TO Steel Metal Can
See K Package

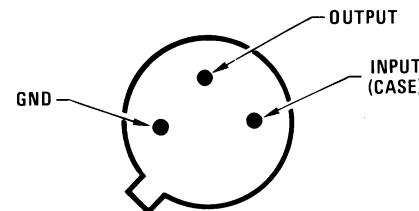


Figure 2. Bottom View
3-Pin PFM Metal Can
See NDT0003A Package

Schematic Diagrams

Figure 3. –5V

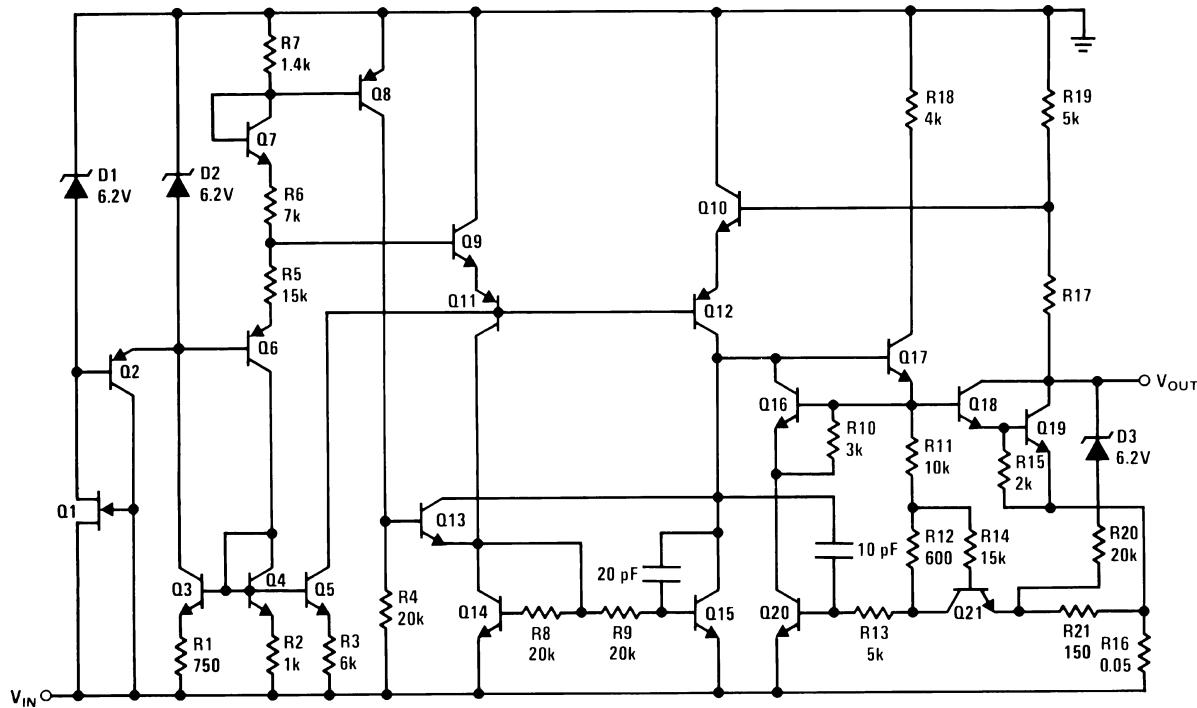
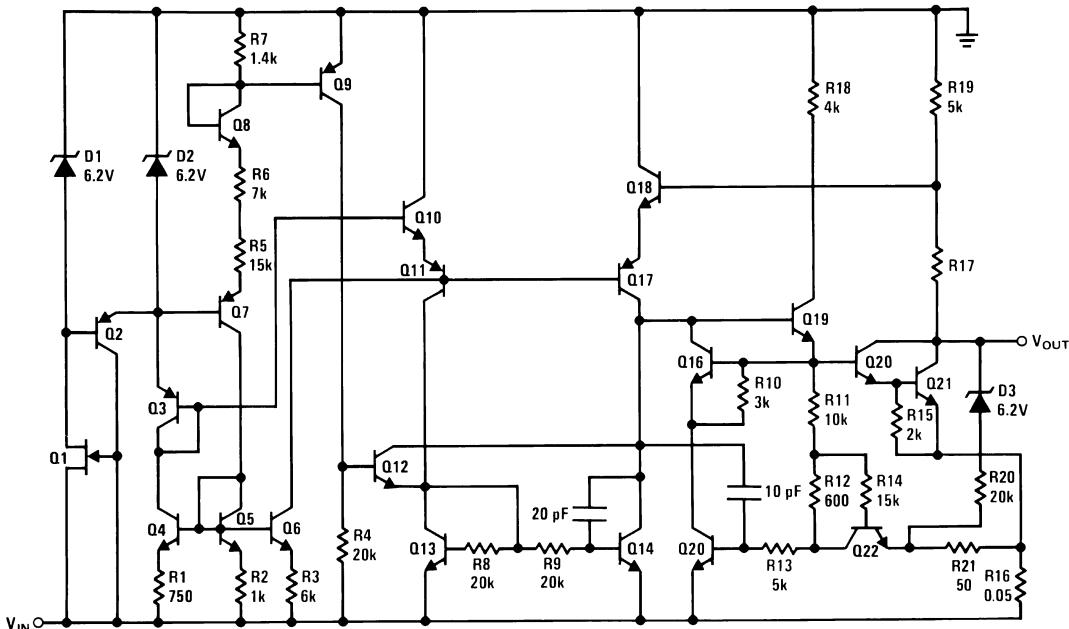


Figure 4. -12V and -15V



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, $1.5\text{ k}\Omega$ 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

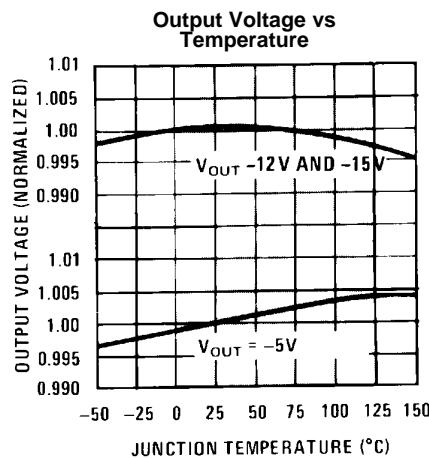


Figure 5.

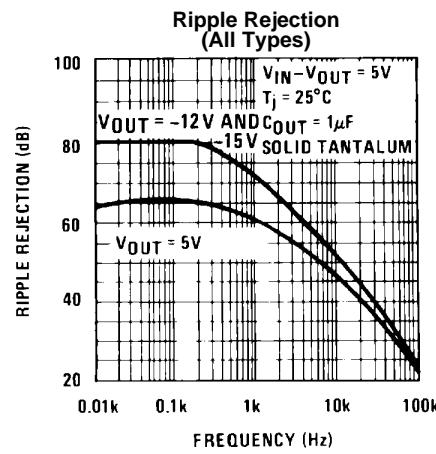


Figure 6.

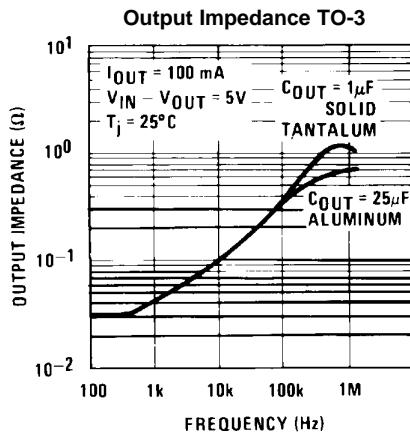


Figure 7.

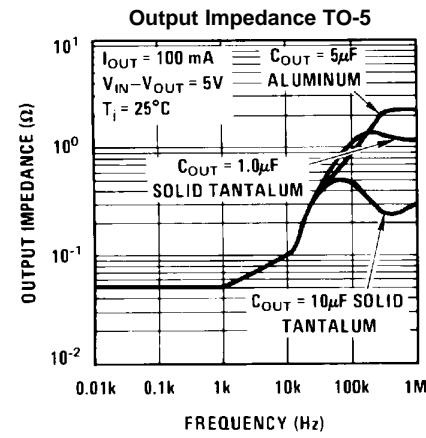


Figure 8.

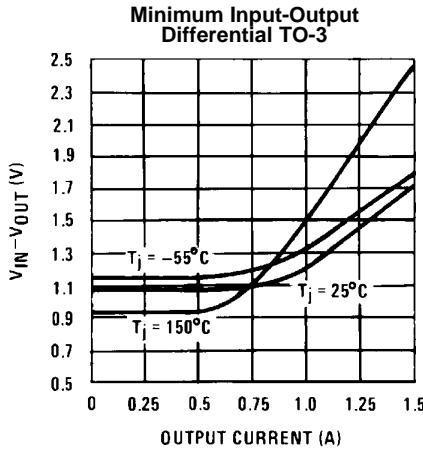


Figure 9.

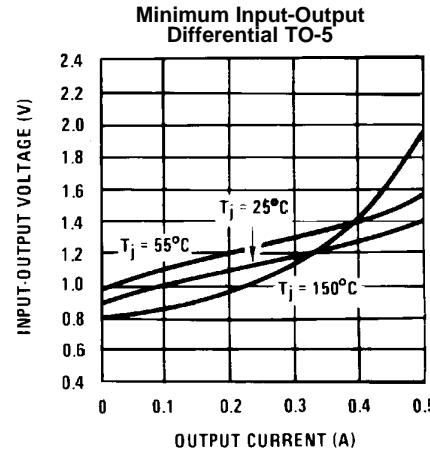


Figure 10.

TYPICAL PERFORMANCE CHARACTERISTICS (continued)

Quiescent Current vs Input Voltage

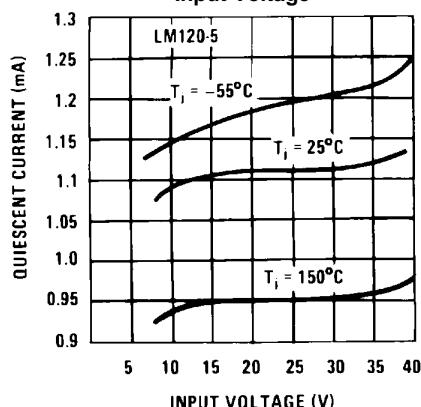


Figure 11.

Quiescent Current vs Load Current

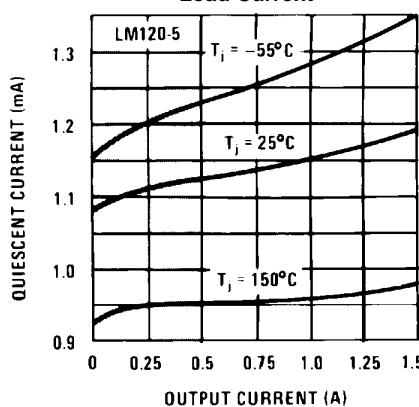
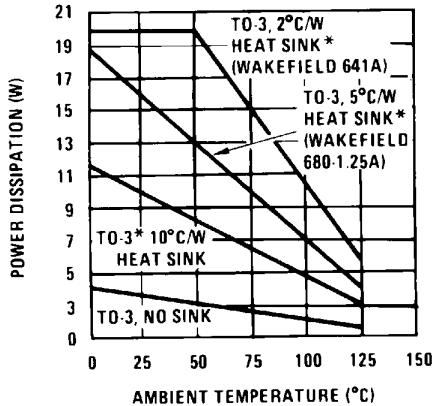


Figure 12.

Maximum Average Power Dissipation (TO-3)



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

Maximum Average Power Dissipation (TO-5)

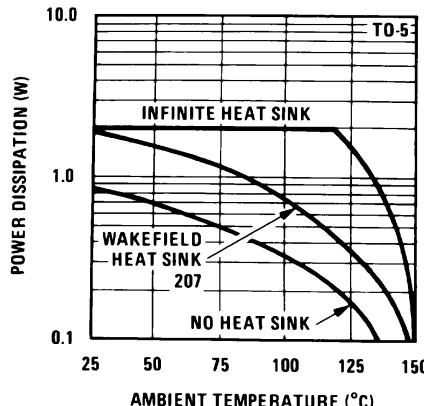


Figure 14.

Short Circuit Current

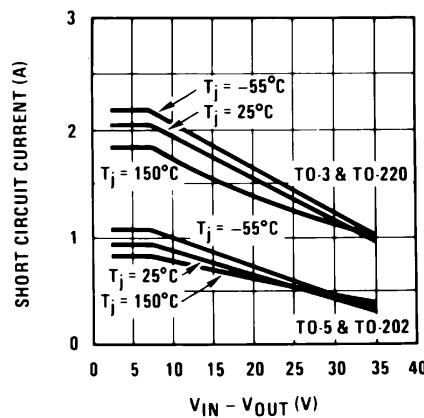
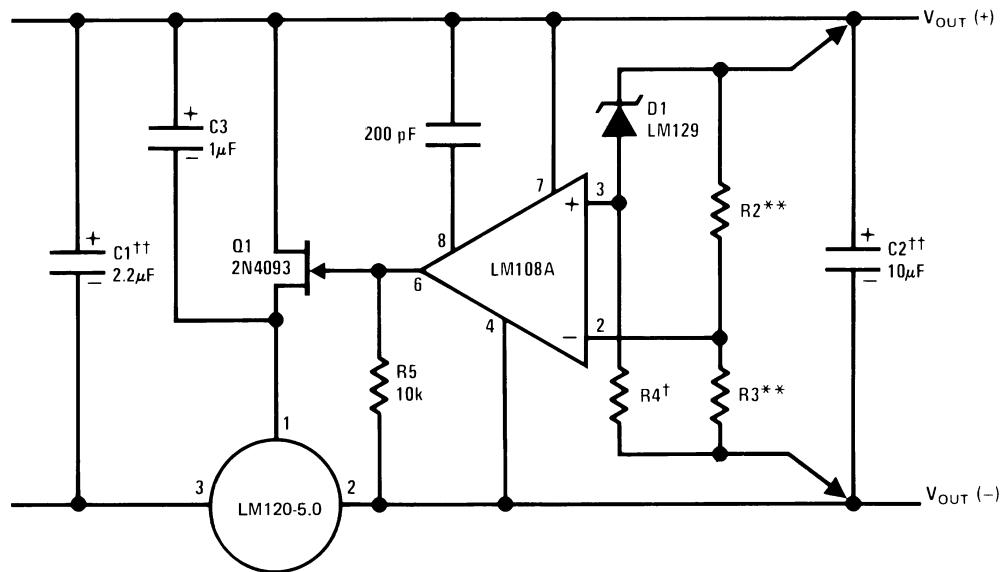


Figure 15.

TYPICAL APPLICATIONS



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

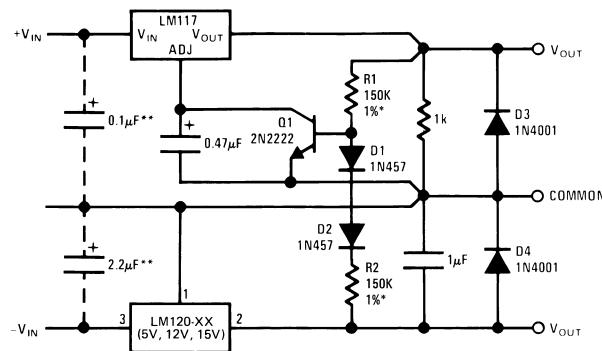
†Determines Zener current.

††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

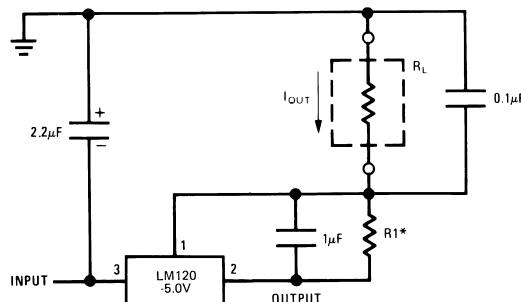


* Resistor tolerance of R1 and R2 determine matching of (+) and (-) inputs.

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

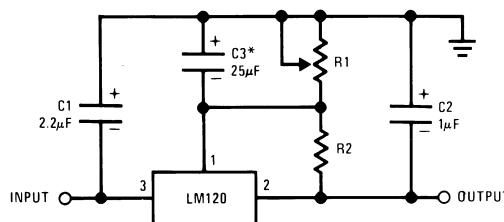
An LM3086N array may substitute for Q1, D1 and D2 for better stability and tracking. In the array diode transistors Q5 and Q4 (in parallel) make up D2; similarly, Q1 and Q2 become D1 and Q3 replaces the 2N2222.

Figure 17. Wide Range Tracking Regulator



$$*I_{OUT} = 1 \text{ mA} + \frac{5.0V}{R_1}$$

Figure 18. Current Source



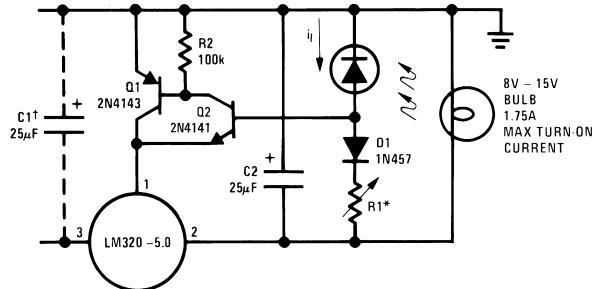
*Optional. Improves transient response and ripple rejection.

$$V_{OUT} = V_{SET} \frac{R_1 + R_2}{R_2}$$

SELECT R2 AS FOLLOWS:

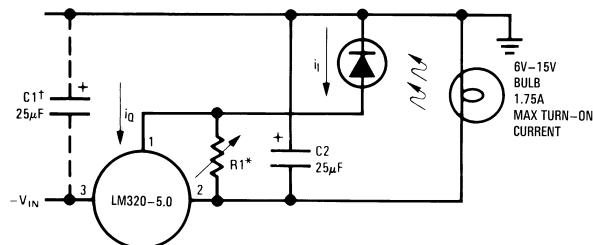
LM120-5	-300Ω
LM120-12	-750Ω
LM120-15	-1k

Figure 19. Variable Output



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

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



*Lamp brightness increases until $i_L = i_Q$ (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

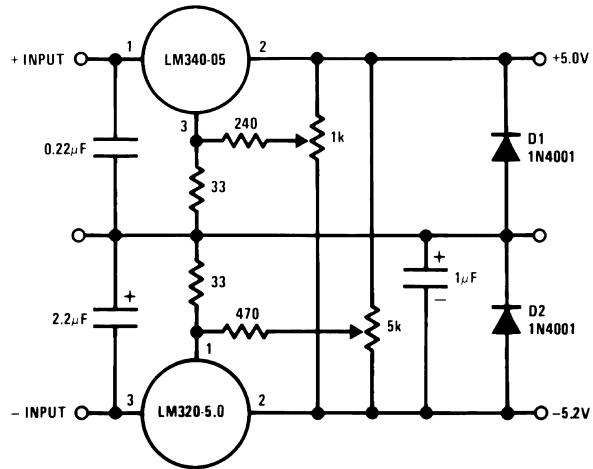
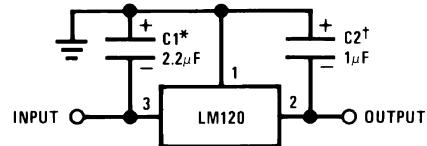


Figure 21. Dual Trimmed Supply

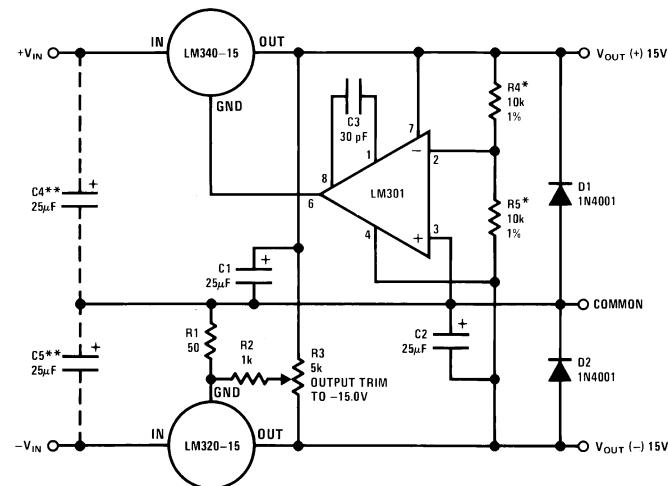


*Required if regulator is separated from filter capacitor by more than 3". For value given, capacitor must be solid tantalum. 25 μ F aluminum electrolytic may be substituted.

†Required for stability. For value given, capacitor must be solid tantalum. 25 μ F aluminum electrolytic may be substituted. Values given may be increased without limit.

For output capacitance in excess of 100 μ F, 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 $\Delta I_L = 1A$	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 part number	Status (1)	Material type (2)	Package Pins	Package qty Carrier	RoHS (3)	Lead finish/ Ball material (4)	MSL rating/ Peak reflow (5)	Op temp (°C)	Part marking (6)
LM120H-12/883	Active	Production	TO (NDT) 3	20 JEDEC TRAY (5+1)	No	Call TI	Level-1-NA-UNLIM	-55 to 150	LM120H-12/883 Q AC O LM120H-12/883 Q >T
LM120H-15/883	Active	Production	TO (NDT) 3	20 JEDEC TRAY (5+1)	No	Call TI	Level-1-NA-UNLIM	-55 to 150	LM120H-15P+ LM120H-15/883 Q AC O LM120H-15/883 Q >T
LM120H-5.0/883	Active	Production	TO (NDT) 3	20 JEDEC TRAY (5+1)	No	Call TI	Level-1-NA-UNLIM	-55 to 150	LM120H-5.0/883 Q A CO LM120H-5.0/883 Q > T
LM120K-12/883	Active	Production	TO (K) 2	50 TRAY NON-STD	Yes	Call TI	Level-1-NA-UNLIM	-55 to 150	LM120K-12 /883 Q ACO /883 Q >T
LM120K-15/883	Active	Production	TO (K) 2	50 TRAY NON-STD	Yes	Call TI	Level-1-NA-UNLIM	-55 to 150	(LM120H-15P+, LM12 0K-15) /883 Q ACO /883 Q >T
LM120KG-12 MD8	Active	Production	DIESALE (Y) 0	221 JEDEC TRAY (5+1)	Yes	Call TI	Level-1-NA-UNLIM	-55 to 125	
LM120KG-15 MD8	Active	Production	DIESALE (Y) 0	221 JEDEC TRAY (5+1)	Yes	Call TI	Level-1-NA-UNLIM	-55 to 125	
LM120KG-5 MD8	Active	Production	DIESALE (Y) 0	221 JEDEC TRAY (5+1)	Yes	Call TI	Level-1-NA-UNLIM	-55 to 125	

⁽¹⁾ **Status:** For more details on status, see our [product life cycle](#).

⁽²⁾ **Material type:** When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.

⁽³⁾ **RoHS values:** Yes, No, RoHS Exempt. See the [TI RoHS Statement](#) for additional information and value definition.

⁽⁴⁾ **Lead finish/Ball material:** Parts 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.

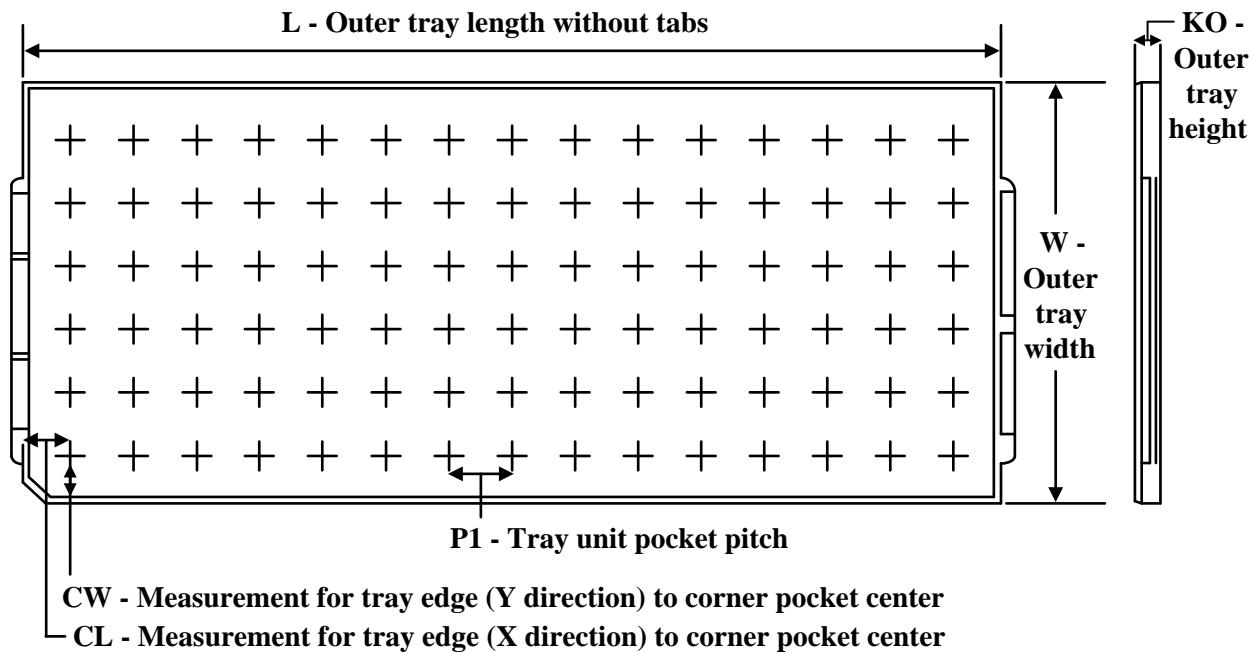
⁽⁵⁾ **MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.

⁽⁶⁾ **Part marking:** There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

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TRAY


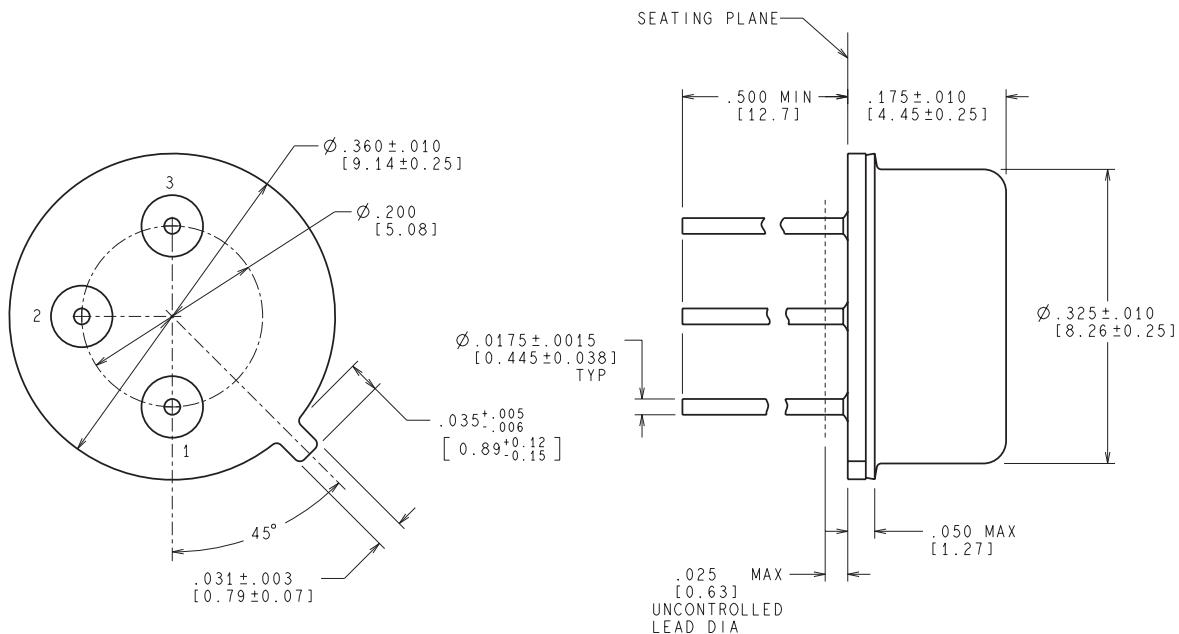
Chamfer on Tray corner indicates Pin 1 orientation of packed units.

*All dimensions are nominal

Device	Package Name	Package Type	Pins	SPQ	Unit array matrix	Max temperature (°C)	L (mm)	W (mm)	KO (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

MECHANICAL DATA

NDT0003A



CONTROLLING DIMENSION IS INCH
VALUES IN [] ARE MILLIMETERS

MIL-PRF-38535
CONFIGURATION CONTROL

H03A (Rev D)

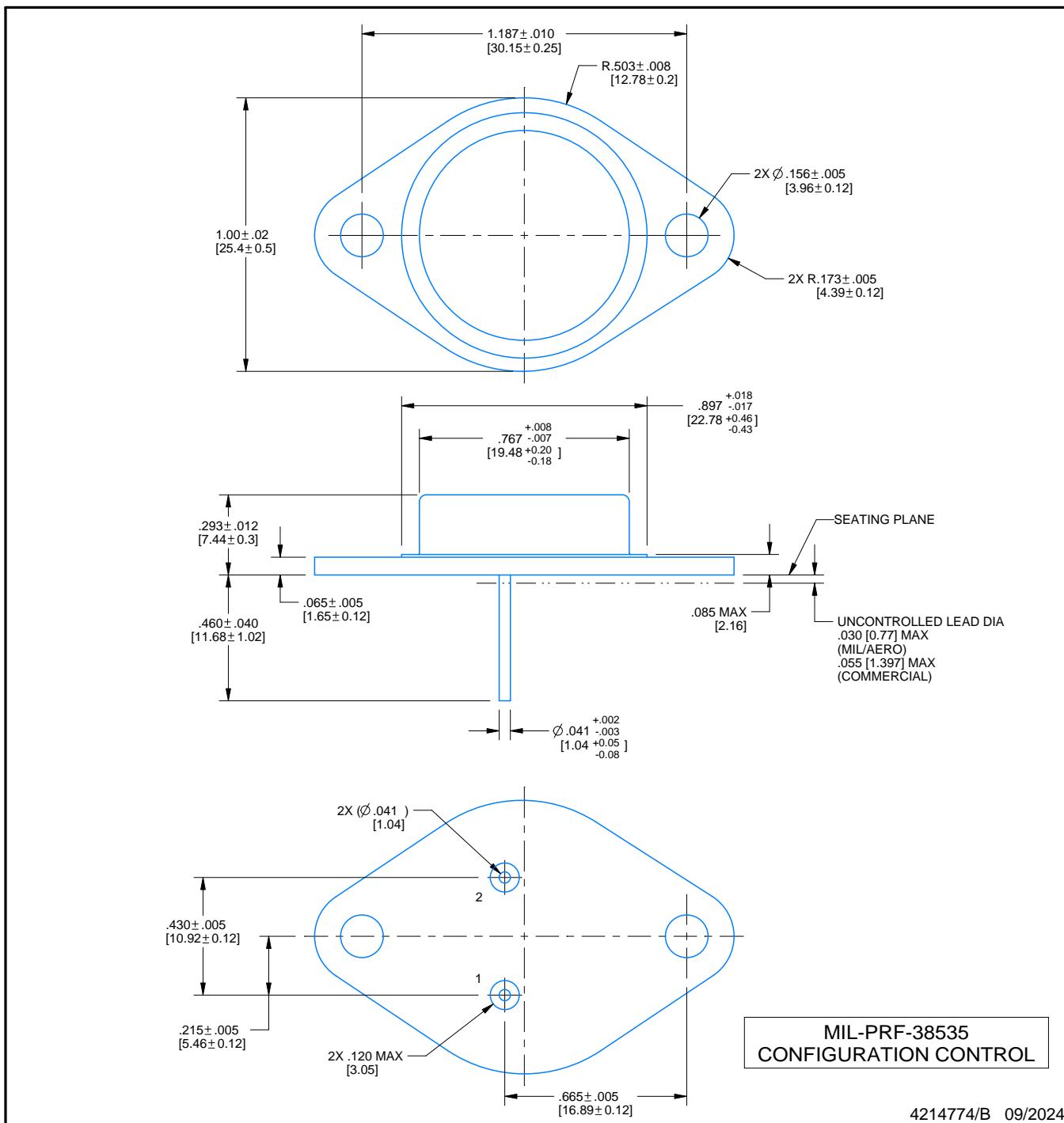
PACKAGE OUTLINE

K0002A



TO-CAN - 7.747 mm max height

TRANSISTOR OUTLINE



NOTES:

- Linear dimensions are in inches [millimeters]. Dimensions in parenthesis are for reference only. Controlling dimensions are in inches. Dimensioning and tolerancing per ASME Y14.5M.
- This drawing is subject to change without notice.
- Leads not to be bent greater than 15°.

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