

CONTINUED ON NEXT PAGE.....

CAUTION: ELECTROSTATIC DISCHARGE SENSITIVE PART

REVISION	PAGE NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14			
INDEX	REVISION	J	J	J	J	J	J	J	J	J	J	J	J	J	J			
											LINEAR TECHNOLOGY CORPORATION MILPITAS, CALIFORNIA							
	ORIG																	
	DSGN										TITLE: MICROCIRCUIT, LINEAR, RH137, NEGATIVE ADJUSTABLE REGULATOR							
	ENGR																	
	MFG																	
	CM																	
	QA																	
	PROG										SIZE	CAGE CODE		DRAWING NUMBER		REV		
												64155		05-08-5028		J		
APPLICATION	FUNCT	SIGNOFFS			DATE			CONTRACT:										

FOR OFFICIAL USE ONLY

REVISION RECORD		
REV	DESCRIPTION	DATE
	<ul style="list-style-type: none"> PAGE 4: PARAGRAPH 3.4 , MOVED PARAGRAPH AND NOTES FROM PAGE 3. CHANGED INPUT TO OUTPUT VOLTAGE DIFFERENTIAL FROM 40V TO 30V. PARAGRAPH 3.6, TABLE IA CHANGED TO TABLE II. PARAGRAPH 3.7, TABLE III CHANGED TO TABLE IV. PARAGRAPH 3.9, TABLE II CHANGED TO TABLE III. PARAGRAPH 3.11.1 WAS CHANGED FROM "...dosage rate of approximately 20 Rads per second" TO "...dosage rate of less than or equal to 10 Rads per second". PAGE 5: PARAGRAPHS 4.1 THROUGH 4.4.2 CHANGES WERE DONE TO CLARIFY GROUP SAMPLING. PARAGRAPHS 4.4.2.1 THROUGH 4.4.3.1 CHANGES WERE DONE TO CLARIFY GROUP SAMPLING. PAGE 6: PARAGRAPHS 4.6.2 THROUGH 4.6.4 WERE RE-WRITTEN TO CLARIFY DATA PROVIDED AND DATA AVAILABLE. PAGES 7 THROUGH 12: ALL FIGURE TITLES CHANGED TO HAVE DEVICE OPTIONS AND PACKAGE TYPES AT TOP OF PAGE, AND HAVE ALL FIGURES AT BOTTOM OF PAGE. PAGE 10: STATIC BURN-IN CIRCUIT NOTES CHANGED. Tj CHANGED FROM +148°C MAX TO +170°C MAX. Ta CHANGED FROM +125°C TO +150°C. BURN-IN VOLTAGES CHANGED FROM ±20V - ±22V TO ±15V - ±16.5V. PAGE 11: STATIC BURN-IN CIRCUIT NOTES CHANGED. Tj CHANGED FROM +137°C MAX TO +161°C MAX. Ta CHANGED FROM +125°C TO +150°C. BURN-IN VOLTAGES CHANGED FROM ±20V - ±22V TO ±15V - ±16.5V. PAGES 13 AND 14: TABLE IA WAS CHANGED TO TABLE II. Vin MAX CHANGED FROM 40V TO 30V AND MAX RAD DOSE CHANGED FROM 200 KRADS TO 100 KRADS. PAGE 14: TABLE II CHANGED TO TABLE III. TABLE III CHANGED TO TABLE IV. TABLE NOTES NOW REFLECTS TABLE I AND TABLE II BECAUSE OF CHANGE ON PAGE 14. 	05/30/02
F	<ul style="list-style-type: none"> PAGE 4: CHANGED INITIAL RATE OF RADDS TO 240 RADDS/SEC. 	03/15/05
G	PAGE 5, CHANGED IN BOTH PARAGRAPHS 4.2, 4.3 IN CONJUNCTION TO 3.3 CHANGED TO 3.4 AND PARAGRAPH 4.3 CHANGED 3.1.1 TO 3.1 AND 3.2.1 TO 3.1.1. AND ADDED UPDATED DATA SHEET CHANGES TO TABLE I & II AND TOTAL DOSE BIAS CIRCUIT.	12/03/07
H	<ul style="list-style-type: none"> PAGE 4, PARAGRAPH 3.11.1 CHANGED VERBIAGE AND PARAGRAPH 3.10.3 CHANGED "ALLOY 42" TO "ALLOY 52" REQUIREMENT ON TO3 PACKAGE. 	04/30/08
J	<ul style="list-style-type: none"> PAGE 5, PARAGRAPH 4.4.2 CHANGED VERBIAGE. PAGE 8, FIGURE 2 NOTE 2 ADDED TO LEAD THICKNESS. 	07/11/08

1.0 SCOPE:

- 1.1 This specification defines the performance and test requirements for a microcircuit processed to a space level manufacturing flow.

2.0 APPLICABLE DOCUMENTS:

- 2.1 Government Specifications and Standards: the following documents listed in the Department of Defense Index of Specifications and Standards, of the issue in effect on the date of solicitation, form a part of this specification to the extent specified herein.

SPECIFICATIONS:

MIL-PRF-38535 Integrated Circuits (Microcircuits) Manufacturing, General Specification for

MIL-STD-883 Test Method and Procedures for Microcircuits

MIL-STD-1835 Microcircuits Case Outlines

- 2.2 Order of Precedence: In the event of a conflict between the documents referenced herein and the contents of this specification, the order of precedence shall be this specification, MIL-PRF-38535 and other referenced specifications.

3.0 REQUIREMENTS:

- 3.1 General Description: This specification details the requirements for the RH137, Negative Adjustable Regulator, processed to space level manufacturing flow.

3.2 Part Number:

3.2.1 Option 1 – RH137H (TO39 METAL CAN, 3 LEADS)

3.2.2 Option 2 – RH137K (TO3 METAL CAN, 2 LEADS)

3.3 Part Marking Includes:

- a. LTC Logo
- b. LTC Part Number (See Paragraph 3.2)
- c. Date Code
- d. Serial Number
- e. ESD Identifier per MIL-PRF-38535, Appendix A

3.4 The Absolute Maximum Ratings:

Power Dissipation	Internally Limited
Input to Output Voltage Differential	30V
Operating Junction Temperature Range	-55°C to +150°C
Storage Temperature Range	-65°C to +150°C
Lead Temperature (Soldering, 10 Sec)	+300°C

3.5 Electrostatic discharge sensitivity, ESDS, shall be Class 2.

3.6 Electrical Performance Characteristics: The electrical performance characteristics shall be as specified in Table I and Table II.

3.7 Electrical Test Requirements: Screening requirements shall be in accordance with 4.1 herein, MIL-STD-883, Method 5004, and as specified in Table IV herein.

3.8 Burn-In Requirement:

3.8.1 Option 1 (TO39): Static Burn-In, Figure 5

3.8.2 Option 2 (TO3): Static Burn-In, Figure 6

3.9 Delta Limit Requirement: Delta limit parameters are specified in Table III herein, are calculated after each burn-in, and the delta rejects are included in the PDA calculation.

3.10 Design, Construction, and Physical Dimensions: Detail design, construction, physical dimensions, and electrical requirements shall be specified herein.

3.10.1 Mechanical / Packaging Requirements: Case outlines and dimensions are in accordance with Figure 1 and Figure 2.

3.10.2 Terminal Connections: The terminal connections shall be as specified in Figure 3 and Figure 4.

3.10.3 Lead Material and Finish: The lead material and finish shall be Kovar for device option 1 and Alloy 52 for device option 2, with hot solder dip (Finish letter A) in accordance with MIL-PRF-38535.

3.11 Radiation Hardness Assurance (RHA):

3.11.1 The manufacturer shall perform a lot sample test as an internal process monitor for total dose radiation tolerance. The sample test is performed with MIL-STD-883 TM1019 Condition A as a guideline.

3.11.2 For guaranteed radiation performance to MIL-STD-883, Method 1019, total dose irradiation, the manufacturer will provide certified RAD testing and report through an independent test laboratory when required as a customer purchase order line item.

3.11.3 Total dose bias circuit is specified in Figure 7.

3.12 Wafer Lot Acceptance: Wafer lot acceptance shall be in accordance with MIL-PRF-38535, Appendix A, except for the following: Topside glassivation thickness shall be a minimum of 4KÅ.

- 3.13 Wafer Lot Acceptance Report: SEM is performed per MIL-STD-883, Method 2018 and copies of SEM photographs shall be supplied with the Wafer Lot Acceptance Report as part of a Space Data Pack when specified as a customer purchase order line item.

4.0 VERIFICATION (QUALITY ASSURANCE PROVISIONS)

- 4.1 Quality Assurance Provisions: Quality Assurance provisions shall be in accordance with MIL-PRF-38535. Linear Technology is a QML certified company and all Rad Hard candidates are assembled on qualified Class S manufacturing lines.

- 4.2 Sampling and Inspection: Sampling and Inspection shall be in accordance with MIL-STD-883, Method 5005 with QML allowed and TRB approved deviations in conjunction with paragraphs 3.1.1, 3.2.1, and 3.4 of the test method.

- 4.3 Screening: Screening requirements shall be in accordance with MIL-STD-883, Method 5004 with QML allowed and TRB approved deviations in conjunction with paragraphs 3.1, 3.1.1, and 3.4 of the test method. Electrical testing shall be as specified in Table IV herein.

- 4.3.1 Analysis of catastrophic (open/short) failures from burn-in will be conducted only when a lot fails the burn-in or re-burn-in PDA requirements.

- 4.4 Quality Conformance Inspection: Quality conformance inspection shall be in accordance with 4.2 and 4.3 herein and as follows:

- 4.4.1 Group A Inspection: Group A inspection shall be performed in accordance with 4.1 herein, per MIL-STD-883, Method 5005, and specified in Table IV herein.

- 4.4.2 Group B Inspection: When purchased, a full Group B is performed on an inspection lot. As a minimum, Subgroups 1-4 plus 6 are performed on every assembly lot, and Subgroup B2 (Resistance to Solvents / Mark Permanency) and Subgroup B3 (Solderability) are performed prior to the first shipment from any inspection lot and Attributes provided when a Full Space Data Pack is ordered. Subgroup B5 (Operating Life) is performed on each wafer lot. This subgroup may or may not be from devices built in the same package style as the current inspection lot. Attributes and variables data for this subgroup will be provided upon request at no charge.

4.4.2.1 Group B, Subgroup 2c = 10%

Group B, Subgroup 3 = 10%

Group B, Subgroup 4 = 5%

Group B, Subgroup 5 = *5%

(*per wafer or inspection lot
whichever is the larger quantity)

Group B, Subgroup 6 = 15%

4.4.2.2 All footnotes pertaining to Table IIa in MIL-STD-883, Method 5005 apply. The quantity (accept number) of all other subgroups are per MIL-STD-883, Method 5005, Table IIa.

- 4.4.3 Group D Inspection: When purchased, a full Group D is performed on an inspection lot. As a minimum, periodic full Group D sampling is performed on each package family for each assembly location every 26 weeks. A generic Group D Summary is provided when a full Space Data Pack is ordered.

4.4.3.1 Group D, Subgroups 3, 4 and 5 = 15% each (Sample Size Series).

4.4.3.2 All footnotes pertaining to Table IV in MIL-STD-883, Method 5005 apply. The quantity (accept number) or sample number and accept number of all other subgroups are per MIL-STD-883, Method 5005, Table IV.

4.5 Source Inspection:

4.5.1 The manufacturer will coordinate Source Inspection at wafer lot acceptance and pre-seal internal visual.

4.5.2 The procuring activity has the right to perform source inspection at the supplier's facility prior to shipment for each lot of deliverables when specified as a customer purchase order line item. This may include wafer lot acceptance and final data review.

4.6 Deliverable Data: Deliverable data that will ship with devices when a Space Data Pack is ordered:

4.6.1 Lot Serial Number Sheets identifying all devices accepted through final inspection by serial number.

4.6.2 100% attributes (completed lot specific traveler; includes Group A Summary)

4.6.3 Burn-In Variables Data and Deltas (if applicable)

4.6.4 Group B2, B3, and B5 Attributes (Variables data, if performed on lot shipping)

4.6.5 Generic Group D data (4.4.3 herein)

4.6.6 SEM photographs (3.13 herein)

4.6.7 Wafer Lot Acceptance Report (3.13 herein)

4.6.8 X-Ray Negatives and Radiographic Report

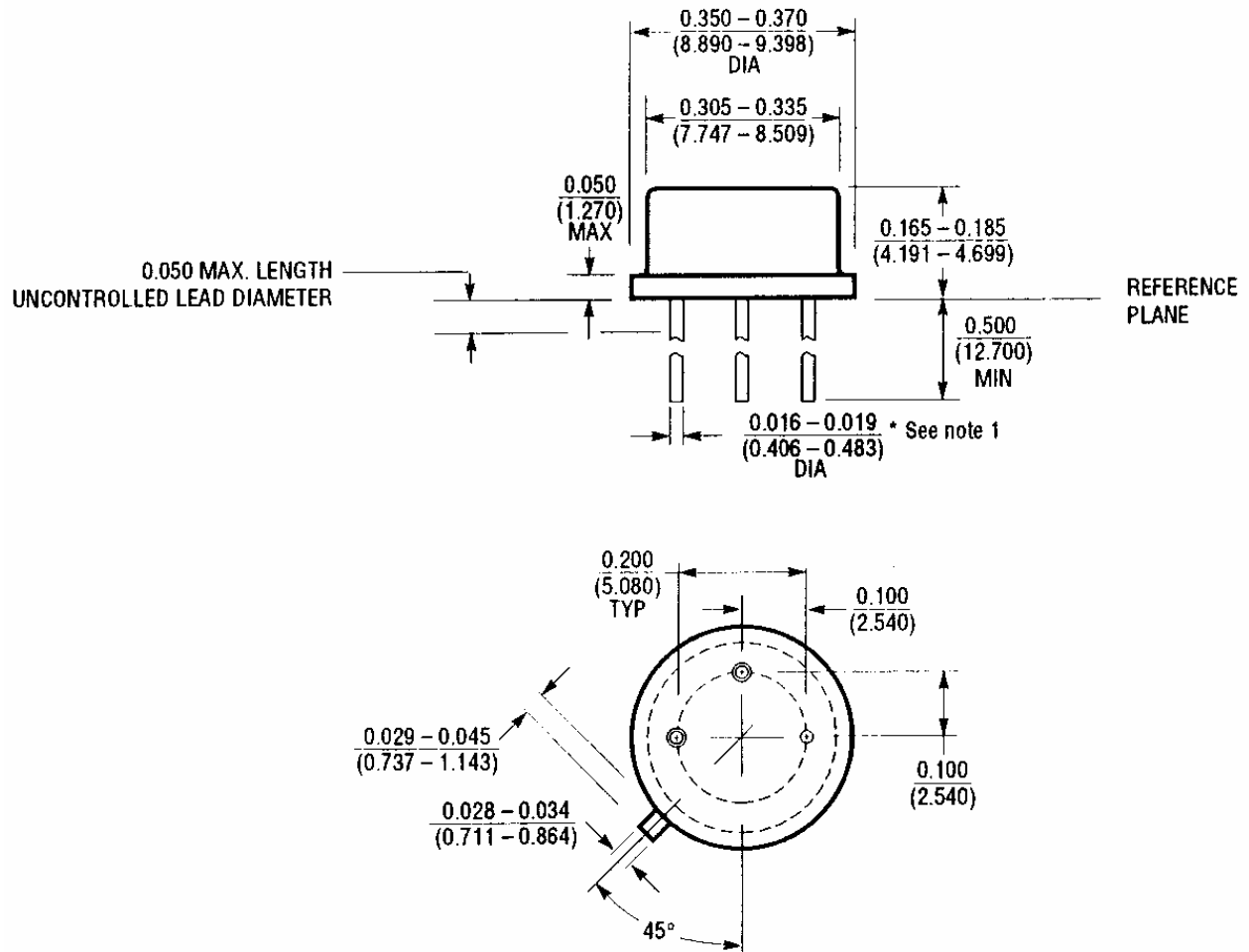
4.6.9 A copy of outside test laboratory radiation report if ordered

4.6.10 Certificate of Conformance certifying that the devices meet all the requirements of this specification and have successfully completed the mandatory tests and inspections herein.

Note: Items 4.6.1 and 4.6.10 will be delivered as a minimum, with each shipment. This is noted on the Purchase Order Review Form as "No Charge Data".

5.0 Packaging Requirements: Packaging shall be in accordance with Appendix A of MIL-PRF-38535. All devices shall be packaged in conductive material or packaged in anti-static material with an external conductive field shielding barrier.

DEVICE OPTION # 1
(H) TO39 METAL CAN / 3 LEADS CASE OUTLINE

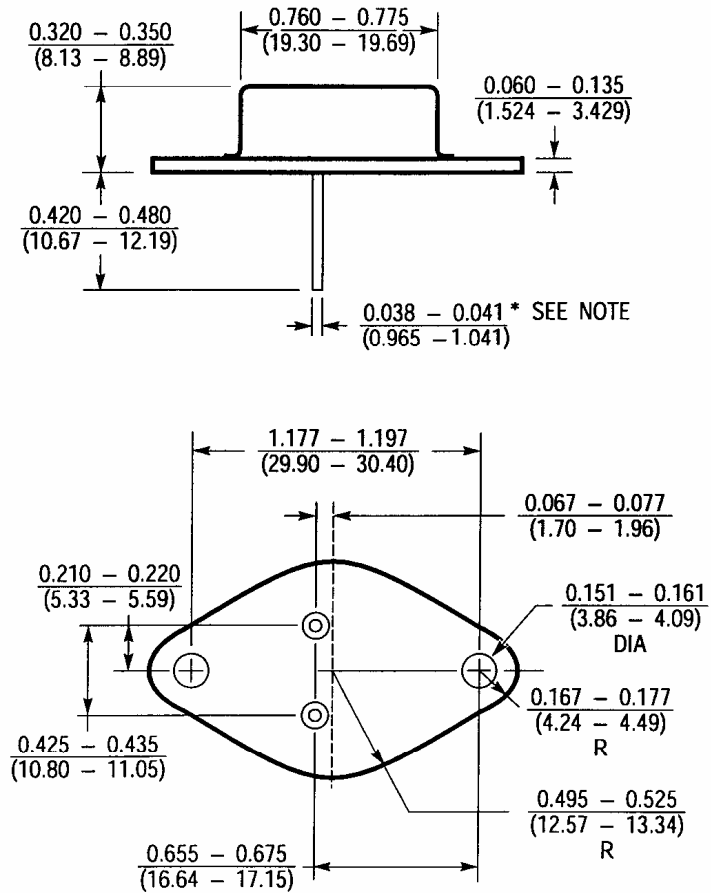


NOTE: 1. FOR SOLDER DIP LEAD FINISH, LEAD DIAMETER IS $\frac{0.016 - 0.024}{(0.406 - 0.610)}$

$\theta_{ja} = +150^{\circ}\text{C/W}$
 $\theta_{jc} = +15^{\circ}\text{C/W}$

FIGURE 1

DEVICE OPTION # 2
(K) TO3 METAL CAN / 2 LEADS CASE OUTLINE

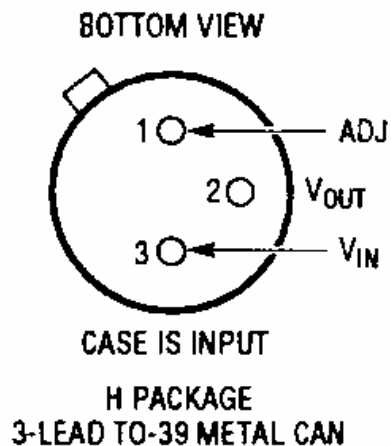
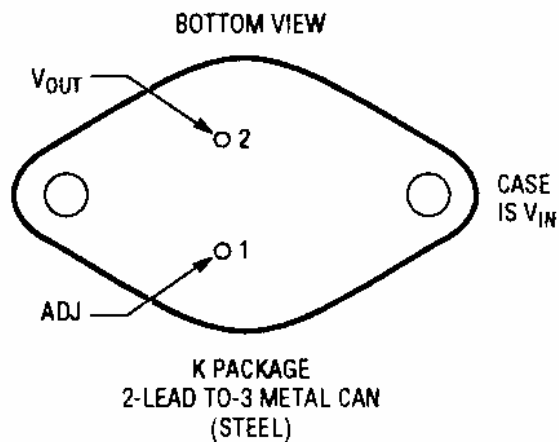


NOTE: FOR SOLDER DIP LEAD FINISH, LEAD DIAMETER IS $\frac{0.038 - 0.044}{(0.965 - 1.118)}$

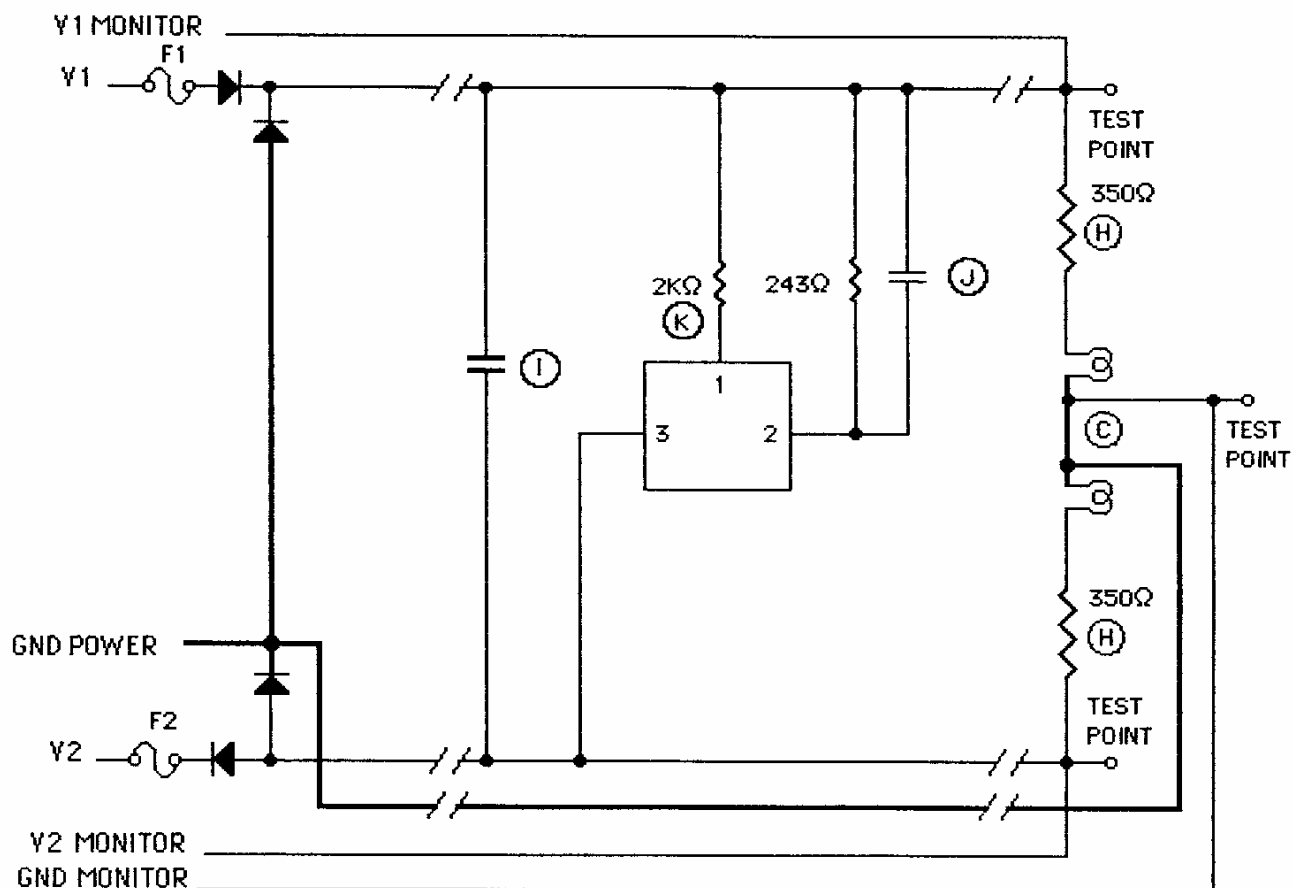
$\theta_{ja} = +35^{\circ}\text{C/W}$

$\theta_{jc} = +3^{\circ}\text{C/W}$

FIGURE 2

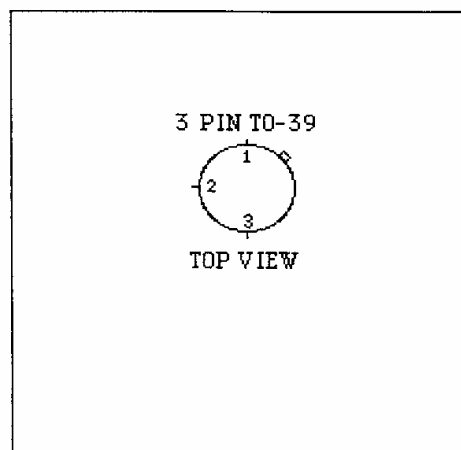
TERMINAL CONNECTIONS**DEVICE OPTION #1, TO39 / 3 LEAD METAL CAN****FIGURE 3****DEVICE OPTION #2, TO3 / 2 LEADS****FIGURE 4**

STATIC BURN-IN CIRCUIT
OPTION 1, T039 METAL CAN / 3 LEADS

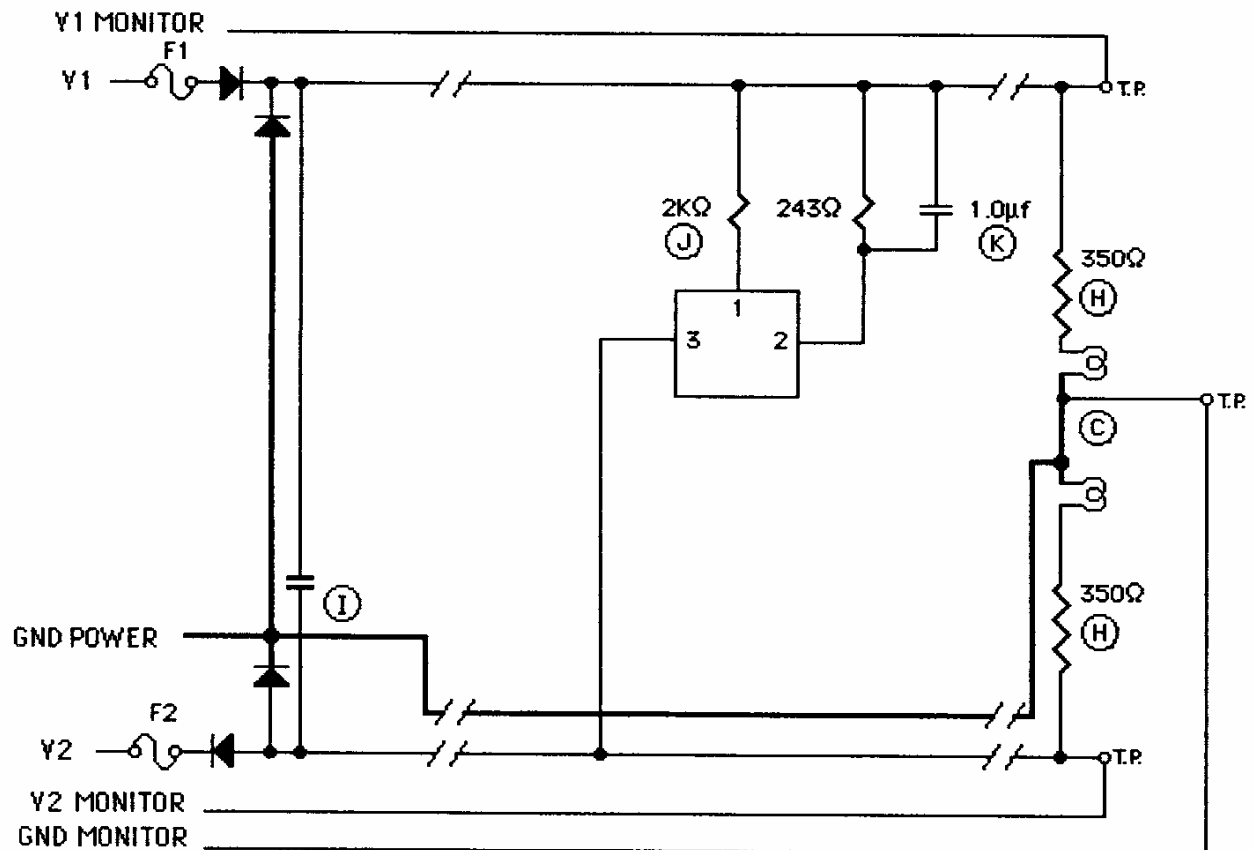


NOTES:

1. Unless otherwise specified, component tolerances shall be per military specification.
2. $T_j = +170^\circ \text{C}$ maximum.
3. $T_a = +150^\circ \text{C}$.
4. Burn-in Voltages: $V_1 = +15\text{V}$ to $+16.5\text{V}$
 $V_2 = -15\text{V}$ to -16.5V
5. USE ALL OTHER INFORMATION ON # 04-06-0010

**FIGURE 5**

STATIC BURN-IN CIRCUIT
OPTION #2, TO3 / 2 LEADS



NOTES:

1. Unless otherwise specified, component tolerances shall be per military specification.
2. $T_j = +161^\circ\text{C}$ maximum.
3. $T_a = +150^\circ\text{C}$.
4. Burn-in Voltages: $V_1 = +15\text{V}$ to $+16.5\text{V}$
 $V_2 = -15\text{V}$ to -16.5V
5. USE ALL OTHER INFORMATION ON # 04-06-0008

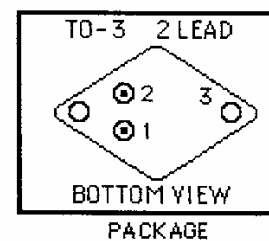


FIGURE 6

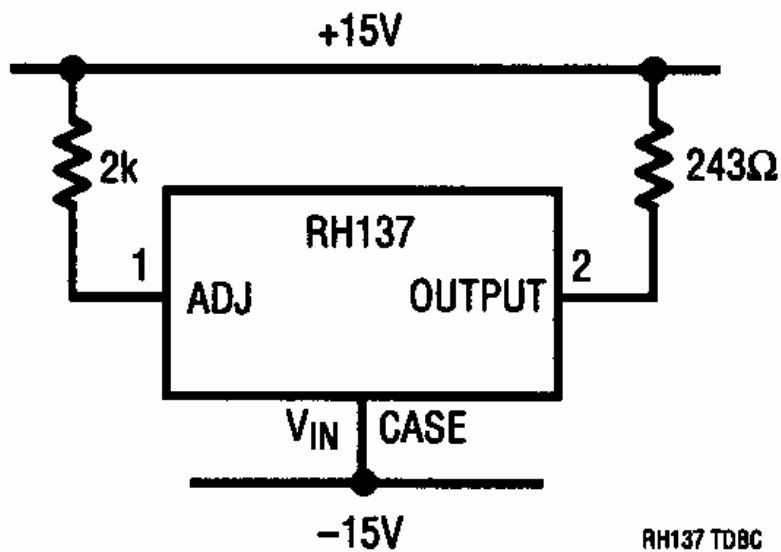
TOTAL DOSE BIAS CIRCUITFIGURE 7

TABLE I: ELECTRICAL CHARACTERISTICS (PRE-IRRADIATION) NOTE 1

SYMBOL	PARAMETER	CONDITIONS	NOTES	T _A = 25°C			SUB-GROUP	-55°C ≤ T _A ≤ 150°C			SUB-GROUP	UNITS
				MIN	TYP	MAX		MIN	TYP	MAX		
V _{REF}	Reference Voltage	V _{IN} - V _{OUT} = 5V, I _{OUT} = 10mA		-1.225	-1.275		1					V
		3V ≤ V _{IN} - V _{OUT} ≤ 30V, 10mA ≤ I _{OUT} ≤ I _{MAX} , P ≤ P _{MAX}		-1.200	-1.300		1	-1.200		-1.300	2, 3	V
$\frac{\Delta V_{OUT}}{\Delta V_{IN}}$	Line Regulation	3V ≤ V _{IN} - V _{OUT} ≤ 30V	2		0.02		1			0.05	2, 3	%/V
$\frac{\Delta V_{OUT}}{\Delta I_{OUT}}$	Load Regulation	10mA ≤ I _{OUT} ≤ I _{MAX} , V _{OUT} ≤ 5V	2		25		1			50	2, 3	mV
		10mA ≤ I _{OUT} ≤ I _{MAX} , V _{OUT} ≥ 5V	2		0.5		1			1	2, 3	%
	Thermal Regulation	10ms Pulse			0.02		1					%/W
	Ripple Rejection	V _{OUT} = -10V, f = 120Hz, C _{ADJ} = 0			60							dB
		V _{OUT} = -10V, f = 120Hz, C _{ADJ} = 10μF	3		66					66		dB
I _{ADJ}	Adjust Pin Current					100	1			100	2, 3	μA
ΔI _{ADJ}	Adjust Pin Current Change	10mA ≤ I _{OUT} ≤ I _{MAX} 3V ≤ V _{IN} - V _{OUT} ≤ 30V			5		1			5	2, 3	μA
					5		1			5	2, 3	μA
I _{MIN}	Minimum Load Current	V _{IN} - V _{OUT} = 30V V _{IN} - V _{OUT} ≤ 10V			5		1			5	2, 3	mA
					3		1			3	2, 3	mA
	Current Limit	V _{IN} - V _{OUT} ≤ 15V	H Package K Package	5 5	0.5 1.5		1 1	0.5 1.5			2, 3 2, 3	A A
		V _{IN} - V _{OUT} = 30V	H Package K Package	5 5	0.15 0.24		1 1					A A
$\frac{\Delta V_{OUT}}{\Delta T_{temp}}$	Temperature Stability	-55°C ≤ T _J ≤ 125°C	3							0.6		%
$\frac{\Delta V_{OUT}}{\Delta T_{time}}$	Long Term Stability	T _A = 125°C	3							1		%
e _n	RMS Output Noise	10Hz ≤ f ≤ 10kHz			0.003							%
θ _{JC}	Thermal Resistance (Junction to Case)	H Package K Package	3 3			15 3						°C/W °C/W

TABLE II ELECTRICAL CHARACTERISTICS (POST-IRRADIATION)T_A = 25°C unless otherwise noted.

SYMBOL	PARAMETER	CONDITIONS	NOTES	10KRAD(Si)		20KRAD(Si)		50KRAD(Si)		100KRAD(Si)		200KRAD(Si)		UNITS
				MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	
V _{REF}	Reference Voltage	V _{IN} - V _{OUT} ≤ 5V, I _{OUT} = 10mA		-1.225	-1.275	-1.225	-1.275	-1.225	-1.275	-1.225	-1.275	-1.22	-1.28	V
		3V ≤ V _{IN} - V _{OUT} ≤ 30V, 10mA ≤ I _{OUT} ≤ I _{MAX} , P ≤ P _{MAX}		-1.2	-1.3	-1.2	-1.3	-1.2	-1.3	-1.2	-1.3	-1.2	-1.3	V
$\frac{\Delta V_{OUT}}{\Delta V_{IN}}$	Line Regulation	3V ≤ V _{IN} - V _{OUT} ≤ 30V,	2		0.02		0.02		0.02		0.02		0.02	%/V
$\frac{\Delta V_{OUT}}{\Delta I_{OUT}}$	Load Regulation	10mA ≤ I _{OUT} ≤ I _{MAX} , V _{OUT} ≤ 5V	2		25		25		25		25		25	mV
		10mA ≤ I _{OUT} ≤ I _{MAX} , V _{OUT} ≥ 5V	2		0.5		0.5		0.5		0.5		0.5	%

NOTES:

- REMAINDER OF THE TABLE II ELECTRICAL CHARACTERISTICS (POST-IRRADIATION) IS ON PAGE 14.
- ELECTRICAL CHARACTERISTICS NOTES FOR PRE-IRRADIATION AND POST-IRRADIATION ARE ON PAGE 14.

TABLE II ELECTRICAL CHARACTERISTICS (POST-IRRADIATION)(Noted 4)
(Continued)

SYMBOL	PARAMETER	CONDITIONS	NOTES	10KRAD(Si)		20KRAD(Si)		50KRAD(Si)		100KRAD(Si)		200KRAD(Si)		UNITS
				MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	
I_{ADJ}	Adjust Pin Current				100		100		100		100		100	μA
ΔI_{ADJ}	Adjust Pin Current Change	$10mA \leq I_{OUT} \leq I_{MAX}$ $3V \leq V_{IN} - V_{OUT} \leq 30V$			5		5		5		5		5	μA
I_{MIN}	Minimum Load Current	$ V_{IN} - V_{OUT} = 30V$ $ V_{IN} - V_{OUT} \leq 10V$			5		5		5		5		5	mA
	Current Limit H Package	$ V_{IN} - V_{OUT} \leq 15V$ $ V_{IN} - V_{OUT} = 30V$			0.5		0.5		0.5		0.5		0.5	A
					0.15		0.15		0.15		0.15		0.15	A
	K Package	$ V_{IN} - V_{OUT} \leq 15V$ $ V_{IN} - V_{OUT} = 30V$			1.5		1.5		1.5		1.5		1.5	A
					0.24		0.24		0.24		0.24		0.24	A

Note 1: Unless otherwise specified, these specifications apply for $|V_{IN} - V_{OUT}| = 5V$; and $I_{OUT} = 0.1A$ for the H package (TO-39) and $I_{OUT} = 0.5A$ for the K package (TO-3) package. Although power dissipation is internally limited, these specifications are applicable for power dissipations of 2W for the TO-39 and 20W for the TO-3. I_{MAX} is 0.2A for the TO-39 and 1.5A for the TO-3 package.

Note 2: Regulation is measured at a constant junction temperature using pulse testing with a low duty cycle. Changes in output voltage due to heating effects are covered under the specification for thermal regulation.

Note 3: Guaranteed by design, characterization or correlation to other tested parameters.

Note 4: $T_J = 25^\circ C$ unless otherwise noted.

Note 5: I_{SC} is tested at the ambient temperatures of $25^\circ C$ and $-55^\circ C$. I_{SC} cannot be tested at the maximum ambient temperature of $150^\circ C$ due to the high power level required. I_{SC} specification at $150^\circ C$ ambient is guaranteed by characterization and correlation to $25^\circ C$ testing.

TABLE III: POST BURN-IN ENDPOINTS AND DELTA LIMIT REQUIREMENTS

$T_J = 25^\circ C$

PARAMETER	ENDPOINT LIMIT		DELTA		UNITS
	MIN	MAX	MIN	MAX	
V_{REF}	-1.200	-1.300	-0.010	0.010	V
I_{ADJ}		100	-10	10	μA
$\frac{\Delta V_{OUT}}{\Delta V_{IN}}$	-9.44	9.44	-4.0	4.0	mV

TABLE IV: ELECTRICAL TEST REQUIREMENTS

MIL-STD-883 TEST REQUIREMENTS	SUBGROUP
FINAL ELECTRICAL TEST REQUIREMENTS (METHOD 5004)	1*, 2, 3
GROUP A TEST REQUIREMENTS (METHOD 5005)	1, 2, 3
GROUP B AND D FOR CLASS S ENDPOINT ELECTRICAL PARAMETERS (METHOD 5005)	1, 2, 3

*PDA APPLIES TO SUBGROUP 1.

PDA TEST NOTE: The PDA is specified as 5% based on failures from Group A, Subgroup 1, tests after cooldown as the final electrical test in accordance with method 5004 of MIL-STD-883. The verified failures of Group A, Subgroup 1 and delta rejects after burn-in divided by the total number of devices submitted for burn-in in that lot shall be used to determine the percent for the lot.