REVISION RECORD

REV	DESCRIPTION	DATE
0	INITIAL RELEASE	
A	PAGE 9, FIGURE 4, CHANGED 0JA	09/29/99
B	PAGE 3, PARAGRAPH 3. 8 CHANGED VERBIAGE ADDED "HEREIN " AFTER TABLE 1. PAGE 4, PARAGRAPH 5. 0 CHANGED VERBIAGE ADDED "HEREIN" AFTER TABLE 3. PARAGRAPH 5.2 ADDED "HEREIN" AFTER TABLE 2. PAGE 5, PARAGRAPH 6.2, 6.3, CHANGED VERBIAGE ADDED "HEREIN" AFTER TABLE 3.	01/04/00
C	• PAGE 3, PARAGRAPH 3.7.1, CHANGED THE DOSAGE RATE FROM "APPROXIMATELY 20 RADS PER SECOND" TO "LESS THAN OR EQUAL TO 10 RADS PER SECOND". • PAGE 4, PARAGRAPH 6.1 CHANGED QUALITY ASSURANCE PROVISIONS TO STATE THAT LTC IS QML CERTIFIED AND THAT RAD HARD CANDIDATES ARE ASSEMBLED ON QUALIFIED ON CLASS S MANUFACTURING LINES. • PAGES 6 THROUGH 10, ALL FIGURE TITLES CHANGED TO HAVE DEVICE OPTIONS AND PACKAGE TYPES AT TOP OF PAGE, AND HAVE ALL FIGURES AT BOTTOM OF PAGE. • PAGE 11, TABLES I AND II PUT ON ONE PAGE. • PAGE 12, NOTES FOR TABLE II PUT ON THIS PAGE. • CONVERSION OF SPECIFICATION FROM WORD PERFECT TO MICROSOFT WORD.	02/19/03
D	• PAGE 3, CHANGED INITIAL RATE OF RADS TO 240 RADS/SEC.	03/22/05
E	• PAGE 3, PARAGRAPH 3.7.1 CHANGED VERBIAGE.	05/05/08
F	• PAGE 13, CHANGED RH CANNED SAMPLE TABLE III FOR QUALIFYING DICE SALES ADDED TEMPERATURE CYCLE, CONSTANT ACCELERATION & REMOVED PIND TEST.	02/10/09
G	Page 2, amended section 3.3, Special Handling of Dice, to more accurately describe our current procedures and requirements.	04/05/12
H	**Page 13, Changed RH Canned Sample Table for Qualifying Dice Sales: Subgroup 6 Sample Size Series changed from 45 (3) to 65 (3). First note had the Sample Size Series from "15%" to "10%". Updated Die Sales table on pg 13.**	**03/24/15**

CAUTION: ELECTROSTATIC DISCHARGE SENSITIVE PART

REVISION	PAGE NO.	1	2	3	4	5	6	7	8	9	10	11	12	13			
INDEX	REVISION	H	H	H	H	H	H	H	H	H	H	H	H	H			
REVISION	PAGE NO.																
INDEX	REVISION																

				LINEAR TECHNOLOGY CORPORATION MILPITAS, CALIFORNIA			
	ORIG			TITLE:			
	DSGN			MICROCIRCUIT, LINEAR, RH27C LOW NOISE, HIGH SPEED PRECISION OP AMP DICE			
	ENGR						
	MFG						
	CM						
	QA			SIZE	CAGE CODE	DRAWING NUMBER	REV
	PROG				64155	05-08-5114	H
APPLICATION	FUNCT	SIGNOFFS	DATE	CONTRACT:			

FOR OFFICIAL USE ONLY

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 RH27C Precision Operational Amplifier Dice and Element Evaluation Test Samples, processed to space level manufacturing flow as specified herein.

3.2 Part Number: **RH27C Dice**

3.3 **Special Handling of Dice**: Rad Hard dice require special handling as compared to standard IC dice. Rad Hard dice are susceptible to surface damage due to the absence of silicon nitride passivation that is present on most standard dice. Silicon nitride protects the dice surface from scratches by its hard and dense properties. The passivation on Linear Technology's Rad Hard dice is silicon dioxide which is much "softer" than silicon nitride. During the visual and preparation for shipment, ESD safe Tweezers are used and only the edge of the die are touched.

LTC recommends that dice handling be performed with extreme care so as to protect the die surface from scratches. If the need arises to move the die in or out of the chip shipment tray (waffle pack), use an ESD-Safe-Plastic-tipped Bent Metal Vacuum Probe, preferably .020" OD x .010" ID (for use with tiny parts). The wand should be compatible with continuous air vacuums. The tip material should be static dissipative Delrin (or equivalent) plastic.

During die attach, care must be exercised to ensure no tweezers, or other equipment, touch the top of the dice.

3.4 The Absolute Maximum Ratings:

Supply Voltage	±22V
Internal Power Dissipation	500mW
Input Voltage	Equal to Supply Voltage
Output Short Circuit Duration	Indefinite
Differential Input Current 1/	±25mA
Operating Temperature Range	-55°C to 125°C
Junction Temperature Range	-55°C to 150°C
Storage Temperature Range	-65°C to 150°C
Lead Temperature (Soldering, 10 sec.)	300°C

1/ The RH27's inputs are protected by back-to-back diodes. Current Limiting resistors are not used in order to achieve low noise. If differential input voltage exceeds ±0.7V, the input current should be limited to 25mA.

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

3.6 Outline Dimensions and Pad Functions: Dice outline dimensions, pad functions, and locations shall be specified in Figure 1.

3.7 Radiation Hardness Assurance (RHA):

3.7.1 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.

3.7.2 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.

3.7.3 Total dose bias circuit is specified in Figure 2.

3.8 Wafer (or Dice) Probe: Dice shall be 100% probed at Ta = +25°C to the limits shown in Table I herein. All reject dice shall be removed from the lot. This testing is normally performed prior to dicing the wafer into chips. Final specifications after assembly are sample tested during the element evaluation.

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

3.10 Wafer Lot Acceptance Report: SEM is performed per MIL-STD-883, Method 2018. 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.

3.11 Traceability: Wafer Diffusion Lot and Wafer traceability shall be maintained through Quality Conformance Inspection.

4.0 QUALITY CONFORMANCE INSPECTION: Quality Conformance Inspection shall consist of the tests and inspections specified herein.

5.0 SAMPLE ELEMENT EVALUATION: A sample from **each wafer supplying dice** shall be assembled and subjected to element evaluation per Table III herein.

5.1 100 Percent Visual Inspection: All dice supplied to this specification shall be inspected in accordance with MIL-STD-883, Method 2010, Condition A. All reject dice shall be removed from the lot.

5.2 Electrical Performance Characteristics for Element Evaluation: The electrical performance characteristics shall be as specified in Table I and Table II herein.

5.3 Sample Testing: Each wafer supplying dice for delivery to this specification shall be subjected to element evaluation sample testing. No dice shall be delivered until all the lot sample testing has been performed and the results found to be acceptable unless the customer supplies a written approval for shipment prior to completion of wafer qualification as specified in this specification.

5.4 Part Marking of Element Evaluation Sample Includes**:**

5.4.1 LTC Logo

5.4.2 LTC Part Number

5.4.3 Date Code

5.4.4 Serial Number

5.4.5 ESD Identifier per MIL-PRF-38535, Appendix A

5.4.6 Diffusion Lot Number

5.4.7 Wafer Number

5.5 Burn-In Requirement: Burn-In circuit for TO5 package is specified in Figure 3.

5.6 Mechanical/Packaging Requirements: Case Outline and Dimensions are in accordance with Figure 4.

5.7 Terminal Connections: The terminal connections shall be as specified in Figure 5.

5.8 Lead Material and Finish: The lead material and finish shall be Kovar with hot solder dip (Finish letter A) in accordance with MIL-PRF-38535.

6.0 VERIFICATION (QUALITY ASSURANCE PROVISIONS)

6.1 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.

6.2 Sampling and Inspection: Sampling and Inspection shall be in accordance with Table III herein.

6.3 Screening: Screening requirements shall be in accordance with Table III herein.

6.4 Source Inspection:

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

6.4.2 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, die visual, and final data review.

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

6.5.1 Lot Serial Number Sheets identifying all Canned Sample devices accepted through final inspection by serial number.

6.5.2 100% attributes (completed element evaluation traveler).

6.5.3 Element Evaluation variables data, including Burn-In and Op Life

6.5.4 SEM photographs (3.10 herein)

6.5.5 Wafer Lot Acceptance Report (3.9 herein)

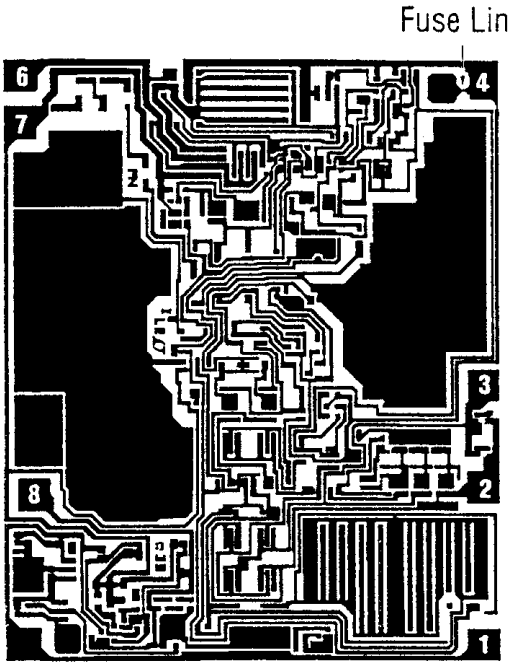
6.5.6 A copy of outside test laboratory radiation report if ordered

6.5.7 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 6.5.1 and 6.5.7 will be delivered as a minimum, with each shipment.

7.0 Packaging Requirements: Packaging shall be in accordance with Appendix A of MIL-PRF-38535. All dice shall be packaged in multicavity containers composed of conductive, anti-static, or static dissipative material with an external conductive field shielding barrier.

DICE OUTLINE DIMENSIONS AND PAD FUNCTIONS



PAD FUNCTION

1. V_{OS} Trim
2. −In
3. +In
4. V^-
5. No Connect
6. Out
7. V^+
8. V_{OS} Trim

Backside (substrate) is an alloyed gold layer. Connect to V^-.

FIGURE 1

TOTAL DOSE BIAS CIRCUIT

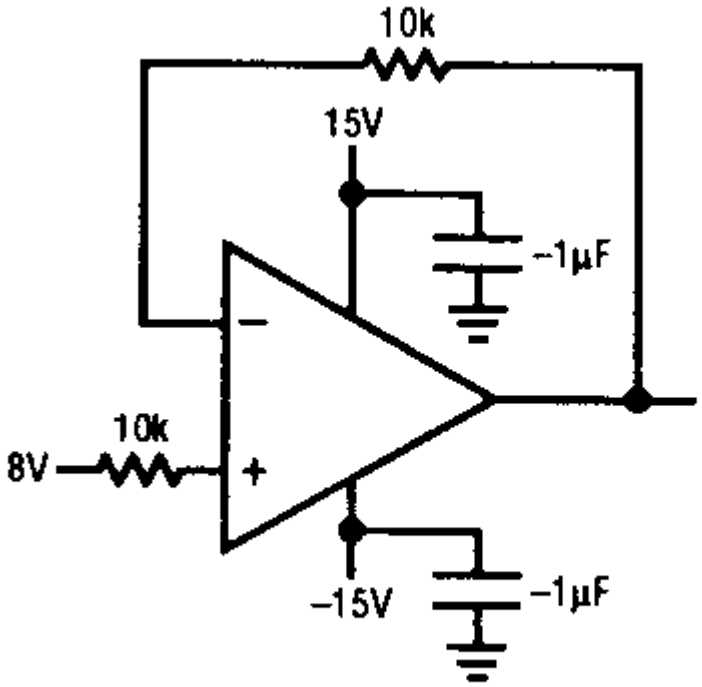
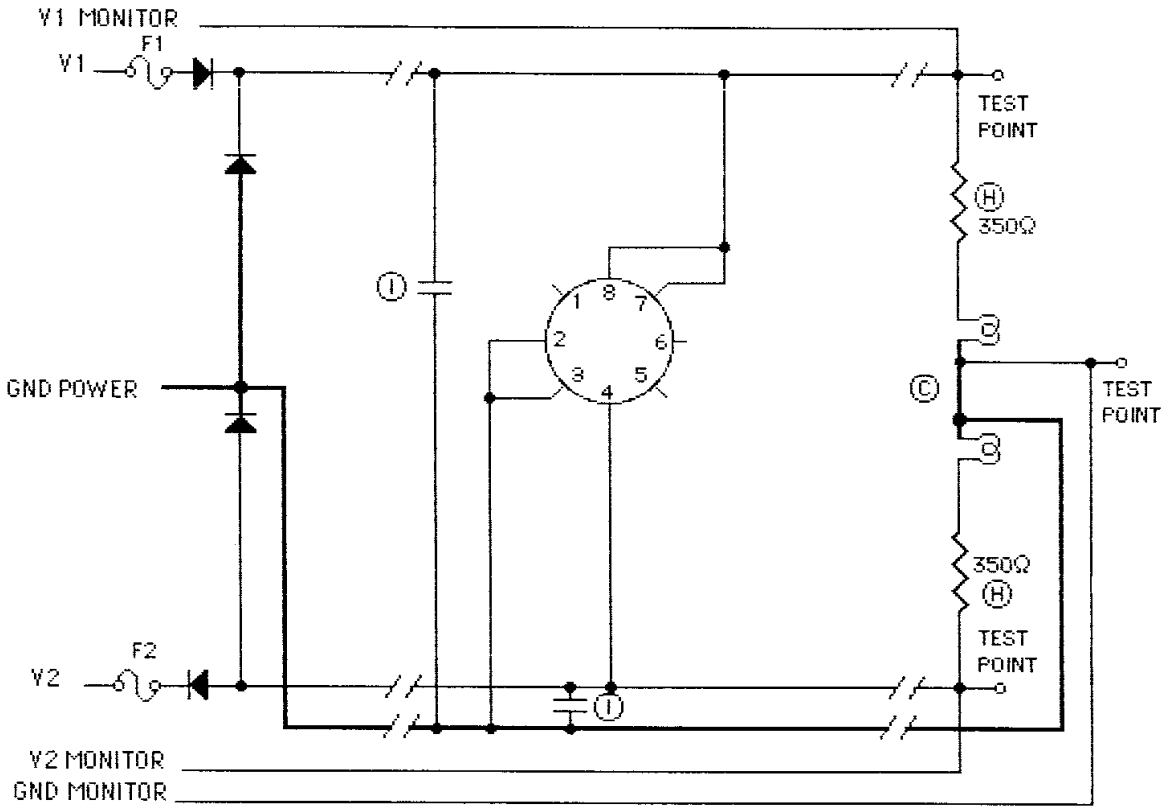


FIGURE 2

BURN-IN CIRCUIT

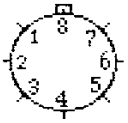


NOTES:

1. Unless otherwise specified, component tolerances shall be per military specification.
2. Tj = +181 °C maximum.
3. Ta = +150 °C to +158 °C maximum ambient.
4. Burn-in Voltages: V1 = + 18V to +19.8V
   V2 = - 18V to -19.8V

1. Vos Trim
2. -IN
3. +IN
4. V- (case)
5. N/C
6. Output
7. V+
8. Vos Trim

8 PIN TO-5

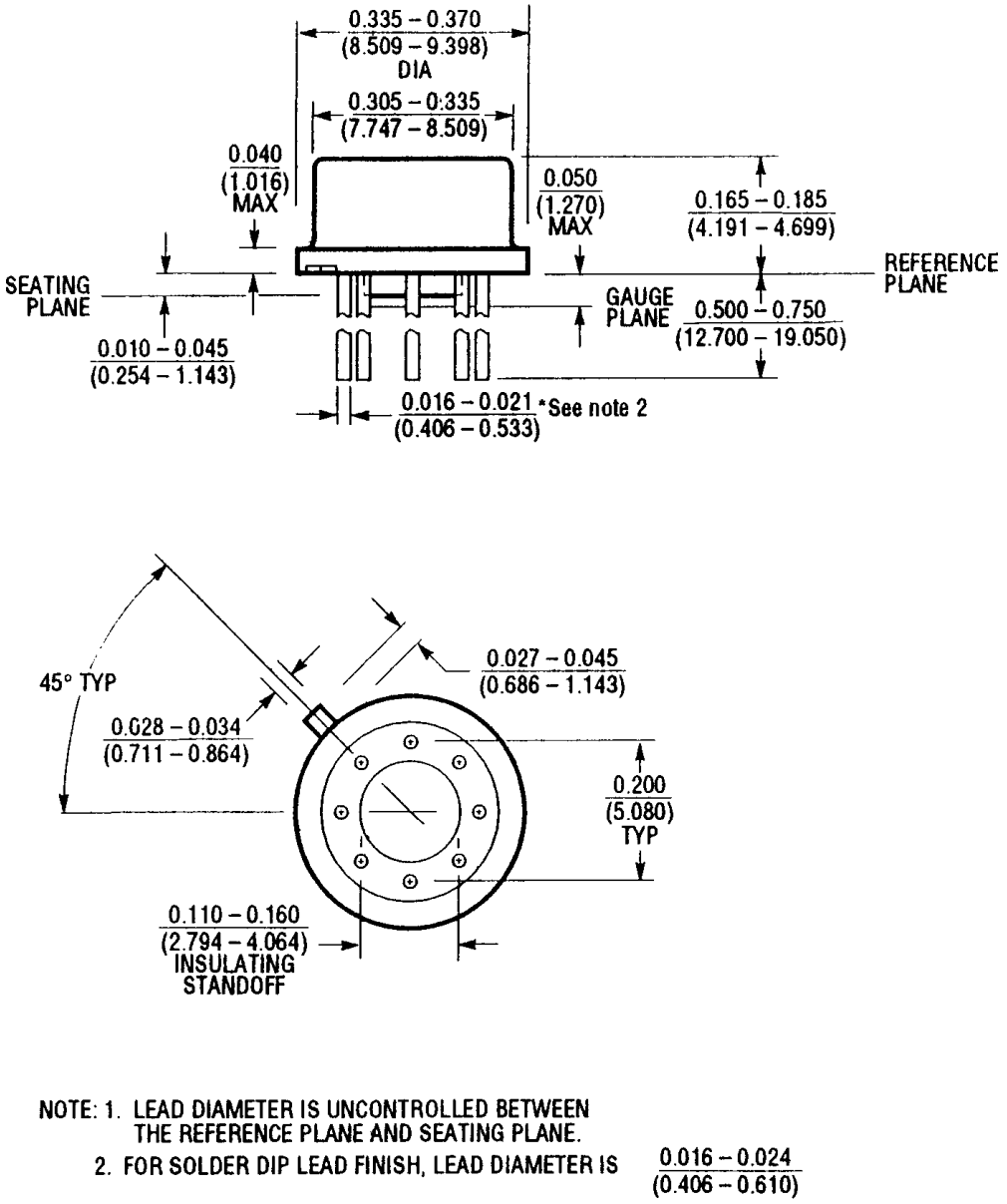


TOP VIEW

PACKAGE

FIGURE 3

TO5, 8 LEADS, CASE OUTLINE



NOTE: 1. LEAD DIAMETER IS UNCONTROLLED BETWEEN THE REFERENCE PLANE AND SEATING PLANE.

2. FOR SOLDER DIP LEAD FINISH, LEAD DIAMETER IS 0.016 – 0.024 (0.406 – 0.610)

FIGURE 4

$\theta ja = +150°C/W$
$\theta jc = +40°C/W$

TERMINAL CONNECTIONS

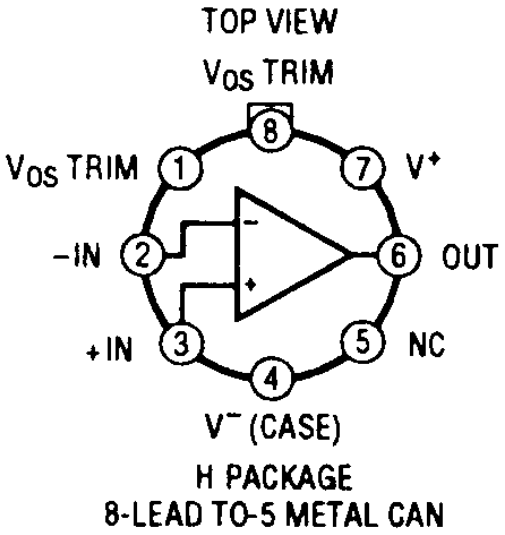


FIGURE 5

TABLE I DICE ELECTRICAL CHARACTERISTICS – Element Evaluation (Note 10)

SYMBOL	PARAMETER	CONDITIONS	RH27C MIN	RH27C MAX	UNITS
V_{OS}	Input Offset Voltage	(Note 1)		150	µV
I_{OS}	Input Offset Current			85	nA
I_B	Input Bias Current			90	nA
	Input Voltage Range		±11.0		V
CMRR	Common-Mode Rejection Ratio	V_{CM} = ±11	95		dB
PSRR	Power Supply Rejection Ratio	V_S = ±4V to ±18V	92		dB
A_{VOL}	Large-Signal Voltage Gain	$R_L \geq 2k$, V_O = ±10V	600		V/mV
V_{OUT}	Maximum Output Voltage Swing	$R_L \geq 2k$ $R_L \geq 600\Omega$	±11.4 ±10.0		V V
SR	Slew Rate	$R_L \geq 2k$	1.7		V/µs
P_D	Power Dissipation			170	mW

Note 1. Input offset voltage measurements are performed by automatic equipment, approximately 0.5 seconds after application of power.

TABLE II ELECTRICAL CHARACTERISTICS – Post-Irradiation (Note 10)

SYMBOL	PARAMETER	CONDITIONS	NOTES	10KRAD(Si) MIN	10KRAD(Si) MAX	20KRAD(Si) MIN	20KRAD(Si) MAX	50KRAD(Si) MIN	50KRAD(Si) MAX	100KRAD(Si) MIN	100KRAD(Si) MAX	200KRAD(Si) MIN	200KRAD(Si) MAX	UNITS
V_{OS}	Input Offset Voltage		1		100		130		180		280		400	µV
I_{OS}	Input Offset Current				75		75		90		120		180	nA
I_B	Input Bias Current				±80		±80		±125		±200		±400	nA
	Input Resistance Common Mode			2 (Typ)		2 (Typ)		2 (Typ)		2 (Typ)		2 (Typ)		GΩ
	Input Voltage Range		4	±11		±11		±11		±11		±11		V
CMRR	Common Mode Rejection Ratio	V_{CM} = ±11V		100		100		97		94		90		dB
PSRR	Power Supply Rejection Ratio	V_S = ±4V to ±18V		94		94		92		90		86		dB
A_{VOL}	Large-Signal Voltage Gain	$R_L \geq 2k$, V_O = ±10V		700		700		700		700		400		V/mV
V_{OUT}	Maximum Output Voltage Swing	$R_L \geq 10k$ $R_L \geq 600\Omega$		±11.5 ±10.0		±11.5 ±10.0		±11.5 ±10.0		±11.5 ±10.0		±11.5 ±10.0		V V
Z_O	Open-Loop Output Resistance	V_O = 0, I_O = 0		70 (Typ)		70 (Typ)		70 (Typ)		70 (Typ)		70 (Typ)		Ω
P_D	Power Dissipation			170		170		170		170		170		mW

NOTES FOR TABLE II ARE ON NEXT PAGE.

ONLY NOTES 1, 4, AND 10 PERTAIN TO TABLES I AND II ELECTRICAL CHARACTERISTICS. NOTES 2, 3, 5, 6, 7, 8, AND 9 PERTAIN TO THE ELECTRICAL CHARACTERISTICS FOR THE STANDARD RH27C PACKAGED DEVICE:

Note 1: Input offset voltage measurements are performed by automatic test equipment approximately 0.5 seconds after application of power.

Note 2: Long-term input offset voltage stability refers to the averaged trend line of offset voltage vs time over extended periods after the first 30 days of operation. Excluding the initial hour of operation, changes in V_{OS} during the first 30 days are typically 2.5μV. Refer to the typical performance curve.

Note 3: Sample tested to an LTPD of 15 on every lot. Contact factory for 100% testing of 10Hz voltage density noise.

Note 4: Parameter is guaranteed by design, characterization, or correlation to other tested parameters.

Note 5: See test circuit and frequency response curve for 0.1Hz to 10Hz tester on OP-27/OP-37 data sheet.

Note 6: See test circuit for current noise measurement on OP-27/OP-37 data sheet.

Note 7: The average input offset drift performance is within the specifications unnulled or when nulled with a pot having a range 8kΩ to 20kΩ.

Note 8: The RH27C's inputs are protected by back-to-back diodes. Current limiting resistors are not used in order to achieve low noise. If differential input voltage exceeds ±0.7V, the input current should be limited to 25mA.

Note 9: $V_S = \pm 15V$, $V_{CM} = 0V$ unless otherwise noted.

Note 10: $T_A = 25°C$, $V_S = \pm 15V$, $V_{CM} = 0V$, unless otherwise noted.

TABLE III RH ELEMENT EVALUATION TABLE QUALIFICATION OF DICE SALES

LINEAR TECHNOLOGY

RH CANNED SAMPLE TABLE FOR QUALIFYING DICE SALES

SUBGROUP	CLASS K/S	CLASS V	CLASS H/B	OPERATION	MIL-STD-883 METHOD	MIL-STD-883 CONDITION	QUANTITY (ACCEPT NUMBER)
1	X	X		SEM	2018	N/A	REF. METHOD 2018 FOR S/S
2	X	X	X	ELEMENT ELECTRICAL (WAFER SORT @ 25°C)			100%
3	X	X	X	ELEMENT VISUAL (2nd OP)	2010	A	100%
4	X	X	X	INTERNAL VISUAL (3rd OP)	2010	A	ASSEMBLED PARTS ONLY
	X	X		DIE SHEAR MONITOR	2019		
	X	X		BOND PULL MONITOR	2011		
5	X	X		STABILIZATION BAKE	1008	C	ASSEMBLED PARTS ONLY
	X	X		TEMPERATURE CYCLE	1010	C	
	X	X		CONSTANT ACCELERATION	2001	E	
	X	X		FINE LEAK	1014	A	
	X	X		GROSS LEAK	1014	C	
6	X	X		FIRST ROOM ELECTRICAL - READ & RECORD (REPLACE ANY ASSEMBLY-RELATED REJECTS)			45(0)
	X	X		PRE BURN-IN ELECT. READ & RECORD @ +125ºC or +150ºC, -55ºC			
	X	X		BURN-IN: +125°C/240 hrs. or +150°C/120 hrs.	1015	+ 125ºc MINIMUM 240 HOURS	
	X	X		POST BURN-IN ELECT. READ & RECORD @ 25ºC			
	X	X		POST BURN-IN ELECT. READ & RECORD @ +125ºC or +150ºC, -55ºC			
		X		TOTAL IRRADIATION DOSE	1019	A	
	X	X		PRE OP-LIFE ELECTRICAL @ 25°C READ & RECORD			
	X	X		OPERATING LIFE: +125°C/1000 hrs. or +150°C/500 hrs.	1005	+ 125ºc MINIMUM 1000 HOURS	
	X	X		POST OP-LIFE ELECT. (R & R @ 25ºC, +125ºC OR +150ºC, -55ºC			
7	X	X	X	WIRE BOND EVALUATION	2011		15(0) OR 25(1) - # of wires

NOTE: LTC is not qualified to process to MIL-PRF-38534. This is an LTC imposed element evaluation that follows MIL-STD-883 test methods and conditions. Please note the quantity and accept number from Sample Size Series of 5%, accept on 0, and note that the actual sample and accept number does not begin until Subgroup 6 OP-LIFE.

NOTE: Tests within Subgroup 5 may be performed in any sequence.

NOTE: LTC's radiation tolerance (RH) die has a topside glassivation thickness of 4KA minimum.

NOTE: Sample sizes on the travelers may be larger than that indicated in the above table; however, the larger sample size is to accommodate extra units for replacement devices in the event of equipment or operator error and for assembly related rejects in Subgroup 6, and for Wire Bond Evaluation, Surgroup 7. The larger sample size is at all times kept segregated and, if used for qualification, has all the required processing imposed.