

REVISION RECORD

REV	DESCRIPTION	DATE
0	INITIAL RELEASE	02/11/09
A	RH1185MK DICE/DWF DATA SHEET AMENDED. PAGE 11, PRE-IRRADIATION ELECTRICAL TEST LIMITS CHANGED REFERENCE VOLTAGE FROM -1.1V MIN, 1.1V MAX TO -2.344V MIN., -2.396V MAX, WITH A TYPICAL OF -2.37 V.	12/02/09
B	RH1185AMK DICE DATA SHEET CHANGED ON NOVEMBER 2011. THE FOLLOWING ARE THE COMPLETE AND CORRECT CHANGES. ALL PAGES: RH1185MK HAS BEEN CHANGED TO REFLECT RH1185AMK. PAGES 11 AND 12, REMOVED REF PIN SHUTDOWN CURRENT FROM TABLE I AND TABLE II ELECTRICAL CHARACTERISTICS.	01/19/12
C	Page 2, amended section 3.3, <u>Special Handling of Dice</u> , to more accurately describe our current procedures and requirements.	04/05/12
D	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%".	07/02/13
E	Updated Die Sales table on pg 13.	03/27/15
F	To Update spec, remove SI and to change Linear to Analog.	2/19/21

**CAUTION: ELECTROSTATIC DISCHARGE SENSITIVE PART**

REVISION	PAGE NO.	1	2	3	4	5	6	7	8	9	10	11	12	13			
INDEX	REVISION	F	F	F	F	F	F	F	F	F	F	F	F	F			
REVISION	PAGE NO.																
INDEX	REVISION																
										ANALOG DEVICES INC.							
		ORIG								TITLE: MICROCIRCUIT, LINEAR, RH1185AMK DICE NEGATIVE REGULATOR WITH ADJUSTABLE CURRENT LIMIT							
		DSGN															
		ENGR															
		MFG															
		CM															
		QA								SIZE	CAGE CODE	DRAWING NUMBER		REV			
		PROG									64155	05-08-5232		F			
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 RH1185AMK, DICE and Element Evaluation Test Samples, processed to space level manufacturing flow as specified herein.

3.2 Part Number: RH1185AMKDice

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 Analog Devices 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.

ADI 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:

Input Voltage	35V
Input - Output Differential	30V
FB Voltage	7V
REF Voltage	7V
Output Voltage	30V
Output Reverse Voltage	2V
Operating Ambient Temperature Range	-55°C to 125°C
Operating Junction Temperature Range	

Control Section . . . . .	-55°C to +150°C
Power Transistor Section . . . . .	-55°C to +175°C
Storage Temperature Range . . . . .	-65°C to +150°C
Lead Temperature (Soldering, 10 sec) . . . . .	+300°C

- 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 TO3 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 alloy 52 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. Analog Devices 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 Deliverable Data: Deliverable data that will ship with devices when a Space Data Pack is ordered:

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

6.4.2 100% attributes (completed element evaluation traveler).

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

6.4.4 SEM photographs (3.10 herein)

6.4.5 Wafer Lot Acceptance Report (3.9 herein)

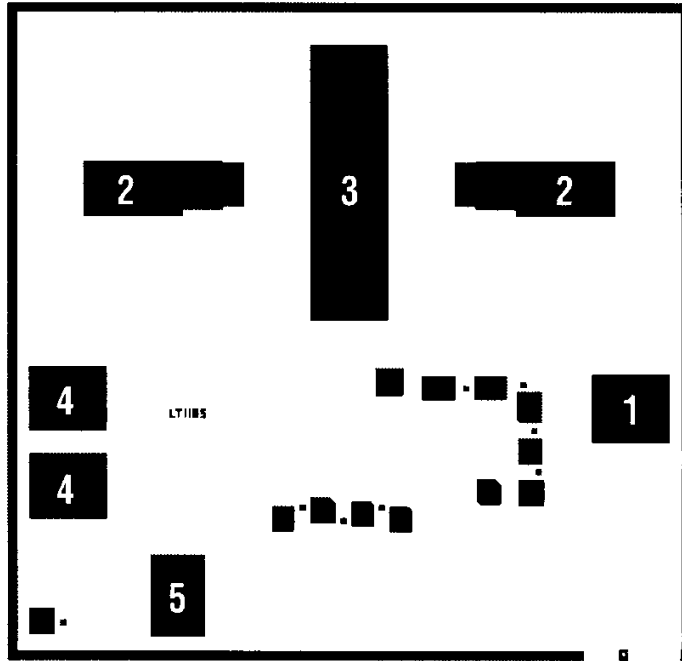
6.4.6 A copy of outside test laboratory radiation report if ordered

6.4.7 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. 4.1 and 6. 4.7 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. REF
- 2.  $V_{IN}$
- 3.  $V_{OUT}$
- 4. GND
- 5. FB

110mils × 116mils  
 Backside metal: Alloyed Gold Layer  
 Backside Potential:  $V_{IN}$  Pads 2

FIGURE 1

TOTAL DOSE BIAS CIRCUIT

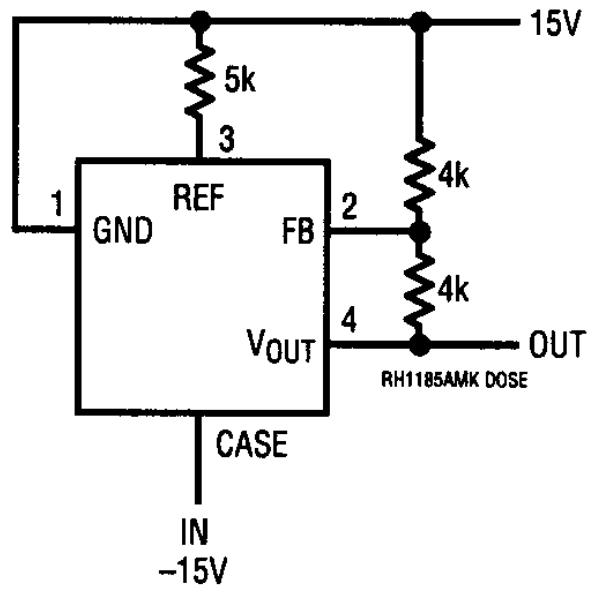
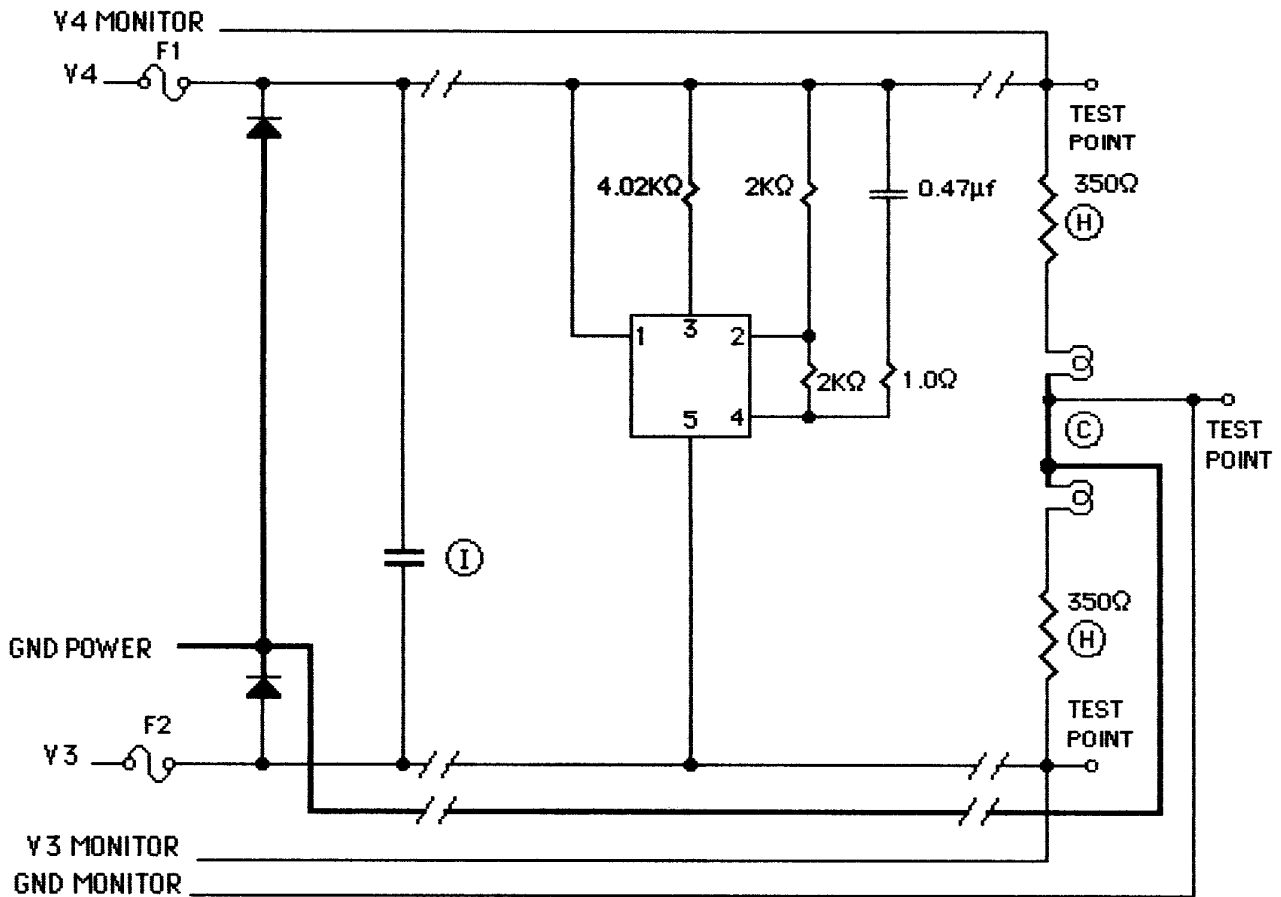


FIGURE 2

BURN-IN CIRCUIT



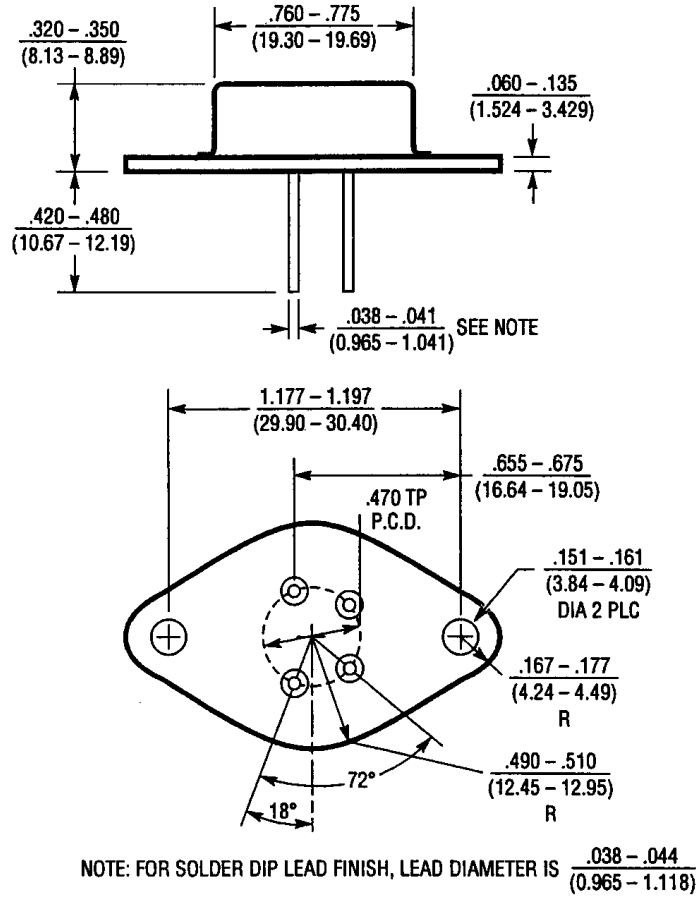
NOTES:

1. Unless otherwise specified, component tolerances shall be per military specification.
2.  $T_j = 163^\circ\text{C}$  maximum.
3.  $T_a = 150^\circ\text{C}$ .
4. Burn-in voltages: Y4 = +15V to +16.5V  
Y3 = -15V to -16.5V

FIGURE 3



TO3, 4 LEADS, CASE OUTLINE



$\theta_{ja} = +35^\circ\text{C/W}$   
 $\theta_{jc} = +3^\circ\text{C/W}$

FIGURE 4

TERMINAL CONNECTIONS

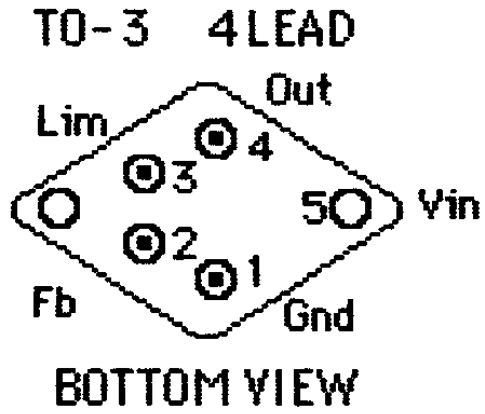


FIGURE 5

TABLE I DICE ELECTRICAL CHARACTERISTICS – Element Evaluation

 $V_{IN} = 7.4V$ ,  $V_{OUT} = 5V$ ,  $I_{OUT} = 1mA$ ,  $R_{LIM} = 4.02k$ , unless otherwise noted.

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Reference Voltage (at FB Pin, Note 2)	$V_{IN} - V_{OUT} = 5V$ , $V_{OUT} = V_{REF}$	-2.344	-2.37	-2.396	V
Feedback Pin Bias Current	$V_{OUT} = V_{REF}$			2	$\mu A$
Dropout Voltage (Note 3)	$I_{OUT} = 0.5A$ , $V_{OUT} = 5V$			0.4	V
	$I_{OUT} = 3A$ , $V_{OUT} = 5V$			1.05	V
Line Regulation (Note 6)	$V_{IN} - V_{OUT} = 1V$ to $20V$ , $V_{OUT} = 5V$			0.01	%/V
Minimum Input Voltage (Note 4)	$I_{OUT} = 1A$ , $V_{OUT} = V_{REF}$			4.5	V
Internal Current Limit (Note 8)	$V_{IN} - V_{OUT} = 1.5V$	3.3		4.2	A
	$V_{IN} - V_{OUT} = 20V$	1		2.6	A
	$V_{IN} - V_{OUT} = 30V$	0.2		1	A
External Current Limit (Note 7)	$R_{LIM} = 5k$ , $V_{OUT} = 1V$	2.7		3.3	A
	$R_{LIM} = 15k$ , $V_{OUT} = 1V$	0.9		1.1	A
Quiescent Supply Current (Note 5)	$I_{OUT} = 5mA$ , $V_{OUT} = V_{REF}$ , $4V \leq V_{IN} \leq 25V$			3.5	mA

**Note 1:** Dice are probe tested at 25°C to the limits shown except for high current tests. Dice are tested under low current conditions which assure full load current specifications when assembled in packaging systems approved by Linear Technology. For absolute maximum ratings, typical specifications, performance curves and finished product specifications, please refer to the standard product RH data sheet.

**Note 3:** Dropout voltage is tested by reducing input voltage until the output drops 1% below its nominal value. Tests are done at 0.5A and 3A. The power transistor looks basically like a pure resistance in this range so that minimum differential at any intermediate current can be calculated by interpolation;  $V_{DROPOUT} = 0.25V + 0.25\Omega \cdot I_{OUT}$ . For load current other than 0.5A and 3.0A, see the graph in the LT1185 data sheet.

**Note 4:** Minimum input voltage is limited by base emitter voltage drive of the power transistor section, not saturation as measured in Note 3. For output voltages below 4V, minimum input voltage specification may limit dropout voltage before transistor saturation limit.

**Note 2:** Testing is done using a pulsed low duty cycle technique. See thermal regulation specifications in the LT1185 data sheet for output changes due to heating effects.

**Note 5:** Supply current is measured on the ground pin, and does not include load current,  $R_{LIM}$ , or output divider current.

**Note 6:** Line regulation is measured on a pulse basis with a pulse width of  $\approx 2ms$  to minimize heating. DC regulation will be affected by thermal regulation and temperature coefficient of the reference. See the Applications Information section of the LT1185 data sheet for details.

**Note 7:** External current limit is programmed with a resistor from REF pin to GND pin. The value is  $15K \cdot A/LIMIT$ .

**Note 8:** For  $V_{IN} - V_{OUT} = 1.5V$ ,  $V_{IN} = 5V$  and  $V_{OUT} = 3.5V$ . For all other current limit tests  $V_{OUT} = 1V$ .

TABLE II ELECTRICAL CHARACTERISTICS – Post-Irradiation

PARAMETER AND CONDITIONS	10KRAD(Si)		20KRAD(Si)		50KRAD(Si)		100KRAD(Si)		200KRAD(Si)		UNITS
	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	
Reference Voltage Tolerance $V_{IN} - V_{OUT} = 5V, V_{OUT} = V_{REF}$	-1.2	1.2	-1.2	1.2	-1.5	1.5	-1.5	1.5	-2	2	%
Reference Voltage Tolerance $V_{IN} - V_{OUT} = 1.2V$ to $V_{IN} = 30V$ , $1mA \leq I_{OUT} \leq 3A$ , $P_D \leq 25W$ (Note 6), $V_{OUT} = 5V$ , $T_{MIN} \leq T_J \leq T_{MAX}$ (Note 9)	-3	3	-3	3	-3.2	3.2	-3.5	3.5	-4	4	%
Feedback Pin Bias Current, $V_{OUT} = V_{REF}$		2		2		2.5		3		3	$\mu A$
Dropout Voltage (Note 3) $I_{OUT} = 0.5A, V_{OUT} = 5V$ $I_{OUT} = 3A, V_{OUT} = 5V$		0.4 1		0.4 1		0.4 1		0.425 1.05		0.45 1.1	V V
Load Regulation (Note 7) $I_{OUT} = 5mA$ to $3A$ $V_{IN} - V_{OUT} = 1.5V$ to $10V, V_{OUT} = 5V$		0.3		0.4		0.5		0.8		1	%
Line Regulation, Absolute Value (Note 7) $V_{IN} - V_{OUT} = 1V$ to $20V, V_{OUT} = 5V$		0.01		0.01		0.01		0.02		0.05	%/V
Minimum Input Voltage (Note 4) $I_{OUT} = 1A, V_{OUT} = V_{REF}$ $I_{OUT} = 3A, V_{OUT} = V_{REF}$		3.9 4.4		3.9 4.4		3.9 4.4		4 4.5		4 4.5	V V
Internal Current Limit (Note 12) $1.5V \leq V_{IN} - V_{OUT} \leq 10V$ $V_{IN} - V_{OUT} = 15V$ $V_{IN} - V_{OUT} = 20V$ $V_{IN} - V_{OUT} = 30V$	3.3 2 1 0.2	4.3 4.3 2.7 1	3.3 2 1 0.2	4.3 4.3 2.75 1.15	3.3 2 1 0.2	4.4 4.35 2.85 1.3	3.3 2 1 0.2	4.55 4.5 3.1 1.6	3.3 2 1 0.2	4.75 4.7 3.3 2	A A A A
External Current Limit (Note 11) $R_{LIM} = 5k$ $R_{LIM} = 15k$	2.7 0.9	3.3 1.1	2.7 0.9	3.4 1.25	2.7 0.9	3.5 1.4	2.7 0.9	3.7 1.6	2.7 0.9	3.9 1.9	A A
Quiescent Supply Current $I_{OUT} = 5mA, V_{OUT} = V_{REF}, 4V \leq V_{IN} \leq 25V$		3.5		3.5		3.5		3.5		3.5	mA
Supply Current Change With Load $V_{IN} - V_{OUT} = V_{SAT}$ $V_{IN} - V_{OUT} \geq 2V$		25 15		27 16		30 18		35 21		45 27	mA/A mA/A

**Note 1:** Stresses beyond those listed under Absolute Maximum Ratings may cause permanent damage to the device. Exposure to any Absolute Maximum Rating condition for extended periods may affect device reliability and lifetime.

**Note 2:** Reference voltage is guaranteed both at nominal conditions (no load, 25°C) and at worst-case conditions of load, line, power and temperature.

**Note 3:** Dropout voltage is tested by reducing input voltage until the output drops 1% below its nominal value. Tests are done at 0.5A and 3A. The power transistor looks basically like a pure resistance in this range so that minimum differential at any intermediate current can be calculated by interpolation;  $V_{DROPOUT} = 0.25V + 0.25\Omega \cdot I_{OUT}$ . For load current other than 0.5A and 3.0A, see graph in LT1185 data sheet.

**Note 4:** "Minimum input voltage" is limited by base emitter voltage drive of the power transistor section, not saturation as measured in Note 3. For output voltages below 4V, "minimum input voltage" specification may limit dropout voltage before transistor saturation limitation.

**Note 5:** Supply current is measured on the ground pin, and does not include load current,  $R_{LIM}$ , or output divider current.

**Note 6:** The 25W power level is guaranteed for an input-output voltage of 8.3V to 17V. At lower voltages the 3A limit applies, and at higher voltages the internal power limiting may restrict regulator power below 25W. See graph of Internal Current Limit in LT1185 data sheet.

**Note 7:** Line and load regulation are measured on a pulse basis with a pulse width of  $\approx 2ms$ , to minimize heating. DC regulation will be affected by thermal regulation and temperature coefficient of the reference. See the Applications Information section of LT1185 data sheet for details.

**Note 8:** Guaranteed by design and correlation to other tests, but not tested.

**Note 9:**  $T_{JMIN} = -55^\circ C$  for the RH1185AMK. Power transistor area and control circuit area have different maximum junction temperatures. Control area limit is  $T_{JMAX} = 150^\circ C$  for the RH1185AMK. Power area limit is  $175^\circ C$  for RH1185AMK.

**Note 10:**  $V_{SAT}$  is the maximum specified dropout voltage;  $0.25V + 0.25\Omega \cdot I_{OUT}$ .

**Note 11:** Current limit is programmed with a resistor from REF pin to GND pin. The value is  $15k \cdot A/I$ -limit.

**Note 12:** For  $V_{IN} - V_{OUT} = 1.5V, V_{IN} = 5V$  and  $V_{OUT} = 3.5V$ . For all other current limit tests,  $V_{OUT} = 1.0V$

**TABLE III RH ELEMENT EVALUATION TABLE QUALIFICATION OF DICE SALES**



**RH CANNED SAMPLE TABLE FOR QUALIFYING DICE SALES**

SUBGROUP	CLASS			OPERATION	MIL-STD-883		QUANTITY (ACCEPT NUMBER)  REF. METHOD 2018 FOR S/S
	K/S	V	H/B		METHOD	CONDITION	
1	X	X		SEM	2018	N/A	100%
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		
5	X	X		BOND PULL MONITOR	2011		ASSEMBLED PARTS ONLY
	X	X		STABILIZATION BAKE	1008	C	
	X	X		TEMPERATURE CYCLE	1010	C	
	X	X		CONSTANT ACCELERATION	2001	E	
	X	X		FINE LEAK	1014	A	
	X	X		GROSS LEAK	1014	C	
	X	X		FIRST ROOM ELECTRICAL - READ & RECORD (REPLACE ANY ASSEMBLY-RELATED REJECTS)			
6	X	X		PRE BUR-IN ELECT. READ & RECORD @ +125°C or +150°C, -55°C			
	X	X		BUR-IN: +125°C/240 hrs. or +150°C/120 hrs.	1015	+125°C MINIMUM 240 HOURS	
	X	X		POST BUR-IN ELECT. READ & RECORD @ 25°C			
	X	X		POST BUR-IN ELECT. READ & RECORD @ +125°C or +150°C, -55°C			
	X	X		TOTAL IRRADIATION DOSE	1019	A	
7	X	X		PRE OP-LIFE ELECTRICAL @ 25°C READ & RECORD			
	X	X		OPERATING LIFE: +125°C/1000 hrs. or +150°C/500 hrs.	1005	+125°C MINIMUM 1000 HOURS	
7	X	X	X	POST OP-LIFE ELECT. IR & R @ 25°C, +125°C DR +150°C, -55°C 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, Subgroup 7. The larger sample size is at all times kept segregated and, if used for qualification, has all the required processing imposed.