

## Adjustable 2.8A Single Resistor Low Dropout Regulator

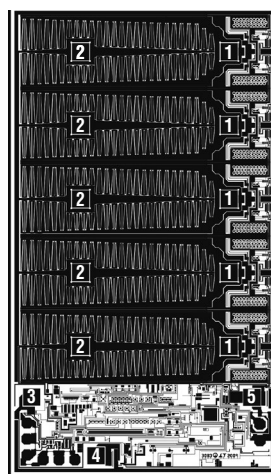
### FEATURES

- Outputs May Be Paralleled for Higher Current and Heat Spreading
- Single Resistor Sets Output Voltage
- Output Adjustable to 0V
- 50 $\mu$ A SET Pin Current: 1% Initial Accuracy
- Total Ionizing Dose (TID) Tolerance, per TM1019.8, MIL-STD-883 up to:
  - 200kRad (Si), per Condition A, at 50Rads(Si)/sec
  - 100kRad (Si), per Condition D, at 10mRads(Si)/sec
  - ELDRS Pass 100kRad(Si)
- Single Event Latchup (SEL) Threshold Linear Energy Transfer (LET)  $\geq 110\text{MeV} \cdot \text{cm}^2/\text{mg}$  at  $T_{\text{CASE}} = 100^\circ\text{C}$
- MIL-PRF-38535 Class V Compliant

### DESCRIPTION

The RH3083 is a 2.8A low dropout linear regulator with a unique architecture featuring a precision current source and voltage follower which allows the output to be programmed to any voltage between zero and 18V. Multiple regulators can be paralleled to increase total output current and spread heat over a system PC board with no need for heat sinking. The pass transistor collector can be brought out independently of the circuit supply voltage to allow dropout voltage to approach the saturation limit of the pass transistor. A small 10 $\mu$ F capacitor on the output with an ESR of less than 0.5 $\Omega$  is adequate to ensure stability. Applications with large output load transients require a larger output capacitor value to minimize output voltage change. Input circuitry ensures output safe operating area current limiting and thermal shutdown protection. The rated output current of an RH3083-based part is fixed by internal wire length/resistance. Analog Devices dice element evaluations are based on parts rated for 2.8A output current.

### DICE PINOUT



#### PAD FUNCTION

1. IN
2. OUT
3. SENSE
4. SET
5.  $V_{\text{CONTROL}}$

#### DIE CROSS REFERENCE

LTC® Finished Part Number	Order Part Number
RH3083MK RH3083MK	RH3083MK DICE RH3083MK DWF*

Please refer to [LT®3083](#) standard product data sheet for other applicable product information.

\*DWF = DICE in wafer form.

### ABSOLUTE MAXIMUM RATINGS

(Note 1) (All voltages relative to  $V_{\text{OUT}}$ )

$V_{\text{CONTROL}}$ Pin Voltage	$\pm 28\text{V}$
IN Pin Voltage	18V, $-0.3\text{V}$
No Overload or Short-Circuit	23V, $-0.3\text{V}$
SET Pin Current (Note 6)	$\pm 25\text{mA}$
SET Pin Voltage (Relative to OUT, Note 6)	$\pm 10\text{V}$
Output Short-Circuit Duration	Indefinite
Operating Junction Temperature Range (Notes 2, 10)	$-55^\circ\text{C}$ to $125^\circ\text{C}$
Storage Temperature Range	$-65^\circ\text{C}$ to $150^\circ\text{C}$

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66mils x 113mils  
Backside metal: Alloyed gold (K) layer  
Backside potential: OUT  
Tie SENSE to OUT

**TABLE 1. DICE/DWF ELECTRICAL TEST LIMITS**  $T_A = 25^\circ\text{C}$  (Notes 2, 5, 8, 9, 11)

Device is characterized at the TID levels below. Device is production tested at 100kRad(si).

PARAMETER	CONDITIONS	MIN	MAX	UNITS
SET Pin Current (Note 6)	$V_{IN} = 1\text{V}$ , $V_{CONTROL} = 2\text{V}$ , $I_{LOAD} = 1\text{mA}$	49.5	50.5	$\mu\text{A}$
Output Offset Voltage ( $V_{OUT} - V_{SET}$ )	$V_{IN} = 1\text{V}$ , $V_{CONTROL} = 2\text{V}$ , $I_{LOAD} = 1\text{mA}$	-2	2	mV
Load Regulation, $I_{SET}$	$I_{LOAD} = 1\text{mA}$ to 50mA	-30	30	nA
Load Regulation, $V_{OS}$	$I_{LOAD} = 1\text{mA}$ to 50mA	-0.5	0.5	mV
Line Regulation, $I_{SET}$	$V_{IN} = 1\text{V}$ to 23V, $V_{CONTROL} = 2\text{V}$ to 25V, $I_{LOAD} = 1\text{mA}$	-5	5	nA/V
Line Regulation, $V_{OS}$	$V_{IN} = 1\text{V}$ to 23V, $V_{CONTROL} = 2\text{V}$ to 25V, $I_{LOAD} = 1\text{mA}$	-0.008	0.008	mV/V
Minimum Load Current (Note 3)	$V_{IN} = 1\text{V}$ , $V_{CONTROL} = 2\text{V}$ $V_{IN} = 23\text{V}$ , $V_{CONTROL} = 25\text{V}$		0.5 1	mA mA
$V_{CONTROL}$ Dropout Voltage (Note 4)	$V_{IN} = 1\text{V}$ , $I_{LOAD} = 50\text{mA}$		1.4	V
$V_{IN}$ Dropout Voltage (Note 4)	$V_{CONTROL} = 2\text{V}$ , $I_{LOAD} = 50\text{mA}$		25	mV
$V_{CONTROL}$ Pin Current (Note 5)	$V_{IN} = 1\text{V}$ , $V_{CONTROL} = 2\text{V}$ , $I_{LOAD} = 50\text{mA}$		6.5	mA

**TABLE 2. ELECTRICAL CHARACTERISTICS** (Preirradiation) (Notes 2, 9, 11)

Device is characterized at the TID levels below. Device is production tested at 100kRad(si).

PARAMETER	CONDITIONS	T <sub>A</sub> = 25°C		SUB-GROUP	-55°C < T <sub>A</sub> < 125°C		SUB-GROUP	UNITS
		MIN	MAX		MIN	MAX		
SET Pin Current (Note 6)	V <sub>IN</sub> = 1V, V <sub>CONTROL</sub> = 2V, I <sub>LOAD</sub> = 1mA	49.5	50.5	1	49	51.5	2, 3	μA
Output Offset Voltage (V <sub>OUT</sub> - V <sub>SET</sub> )	V <sub>IN</sub> = 1V, V <sub>CONTROL</sub> = 2V, I <sub>LOAD</sub> = 1mA	-4	4	1	-6	6	2, 3	mV
Load Regulation, I <sub>SET</sub>	I <sub>LOAD</sub> = 1mA to 2.8A	-200	200	1	-300	300	2, 3	nA
Load Regulation, V <sub>OS</sub>	I <sub>LOAD</sub> = 5mA to 2.8A	-3	3	1	-4	4	2, 3	mV
Line Regulation, I <sub>SET</sub>	V <sub>IN</sub> = 1V to 23V, V <sub>CONTROL</sub> = 2V to 25V, I <sub>LOAD</sub> = 1mA V <sub>IN</sub> = 1V to 23V, V <sub>CONTROL</sub> = 2V to 25V, I <sub>LOAD</sub> = 5mA	-8	8	1	-10	10	2, 3	nA/V nA/V
Line Regulation, V <sub>OS</sub>	V <sub>IN</sub> = 1V to 23V, V <sub>CONTROL</sub> = 2V to 25V, I <sub>LOAD</sub> = 1mA V <sub>IN</sub> = 1V to 23V, V <sub>CONTROL</sub> = 2V to 25V, I <sub>LOAD</sub> = 5mA	-0.02	0.02	1	-0.05	0.05	2, 3	mV/V mV/V
Minimum Load Current (Note 3)	V <sub>IN</sub> = 1V, V <sub>CONTROL</sub> = 2V	0.5		1		5	2, 3	mA
	V <sub>IN</sub> = 23V, V <sub>CONTROL</sub> = 25V	1		1		5	2, 3	mA
V <sub>CONTROL</sub> Dropout Voltage (Note 4)	V <sub>IN</sub> = 1V, I <sub>LOAD</sub> = 0.1A	1.4		1		1.55	2, 3	V
	V <sub>IN</sub> = 1V, I <sub>LOAD</sub> = 1A	1.45		1		1.6	2, 3	V
	V <sub>IN</sub> = 1V, I <sub>LOAD</sub> = 2.8A	1.5		1		1.65	2, 3	V
V <sub>IN</sub> Dropout Voltage (Note 4)	V <sub>CONTROL</sub> = 2V, I <sub>LOAD</sub> = 0.1A	35		1		35	2, 3	mV
	V <sub>CONTROL</sub> = 2V, I <sub>LOAD</sub> = 1A	220		1		280	2, 3	mV
	V <sub>CONTROL</sub> = 2V, I <sub>LOAD</sub> = 2.8A	650		1		750	2, 3	mV
V <sub>CONTROL</sub> Pin Current (Note 5)	V <sub>IN</sub> = 1V, V <sub>CONTROL</sub> = 2V, I <sub>LOAD</sub> = 0.1A	10		1		10	2, 3	mA
	V <sub>IN</sub> = 1V, V <sub>CONTROL</sub> = 2V, I <sub>LOAD</sub> = 1A	35		1		40	2, 3	mA
	V <sub>IN</sub> = 1V, V <sub>CONTROL</sub> = 2V, I <sub>LOAD</sub> = 2.8A	80		1		90	2, 3	mA
Current Limit	V <sub>IN</sub> = 5V, V <sub>CONTROL</sub> = 5V, V <sub>SET</sub> = 0V, V <sub>OUT</sub> = -0.1V	2.8		1	2.8		2, 3	A
Error Amplifier RMS Output Noise (Note 7)	I <sub>LOAD</sub> = 500mA, 10Hz ≤ f ≤ 100kHz, C <sub>OUT</sub> = 10μF, C <sub>SET</sub> = 0.1μF	TYP = 40		1				μV <sub>RMS</sub>
Reference Current RMS Output Noise (Note 7)	10Hz ≤ f ≤ 100kHz	TYP = 1		1				nA <sub>RMS</sub>

**TABLE 3. ELECTRICAL CHARACTERISTICS** (Postirradiation) (Notes 2, 9, 11)

Device is characterized at the TID levels below. Device is production tested at 100kRad(si).

PARAMETER	CONDITIONS	10KRads(Si) MIN MAX		20KRads(Si) MIN MAX		50KRads(Si) MIN MAX		100KRads(Si) MIN MAX		200KRads(Si) MIN MAX		UNITS
SET Pin Current (Note 6)	$V_{IN} = 1V$ , $V_{CONTROL} = 2V$ , $I_{LOAD} = 1mA$	49	51	49	51	49	51	49	51	49	51	$\mu A$
Output Offset Voltage ( $V_{OUT} - V_{SET}$ )	$V_{IN} = 1V$ , $V_{CONTROL} = 2V$ , $I_{LOAD} = 1mA$	-4.5	4.5	-4.5	4.5	-4.5	4.5	-4.5	4.5	-4.5	4.5	mV
Load Regulation, $I_{SET}$	$I_{LOAD} = 1mA$ to 2.8A	-300	300	-300	300	-300	300	-300	300	-300	300	nA
Load Regulation, $V_{OS}$	$I_{LOAD} = 5mA$ to 2.8A	-3.5	3.5	-3.5	3.5	-3.5	3.5	-3.5	3.5	-3.5	3.5	mV
Line Regulation, $I_{SET}$	$V_{IN} = 1V$ to 23V, $V_{CONTROL} = 2V$ to 25V, $I_{LOAD} = 1mA$	-10	10	-10	10	-10	10	-10	10	-10	10	nA/V
Line Regulation, $V_{OS}$	$V_{IN} = 1V$ to 23V, $V_{CONTROL} = 2V$ to 25V, $I_{LOAD} = 1mA$	-0.025	0.025	-0.025	0.025	-0.025	0.025	-0.03	0.03	-0.04	0.04	mV/V
Minimum Load Current (Note 3)	$V_{IN} = 1V$ , $V_{CONTROL} = 2V$		0.5		0.5		0.5		0.5		0.5	mA
	$V_{IN} = 23V$ , $V_{CONTROL} = 25V$		1		1		1		1		1	mA
$V_{CONTROL}$ Dropout Voltage (Note 4)	$V_{IN} = 1V$ , $I_{LOAD} = 0.1A$		1.41		1.41		1.42		1.43		1.45	V
	$V_{IN} = 1V$ , $I_{LOAD} = 1A$		1.46		1.46		1.47		1.48		1.5	V
	$V_{IN} = 1V$ , $I_{LOAD} = 2.8V$		1.51		1.51		1.52		1.53		1.55	V
$V_{IN}$ Dropout Voltage (Note 4)	$V_{CONTROL} = 2V$ , $I_{LOAD} = 0.1A$		35		40		40		45		45	mV
	$V_{CONTROL} = 2V$ , $I_{LOAD} = 1A$		225		225		225		225		230	mV
	$V_{CONTROL} = 2V$ , $I_{LOAD} = 2.8A$		655		655		655		660		670	mV
$V_{CONTROL}$ Pin Current (Note 5)	$V_{IN} = 1V$ , $V_{CONTROL} = 2V$ , $I_{LOAD} = 0.1A$		10.1		10.1		10.2		10.5		11	mA
	$V_{IN} = 1V$ , $V_{CONTROL} = 2V$ , $I_{LOAD} = 1A$		36		37		38		40		45	mA
	$V_{IN} = 1V$ , $V_{CONTROL} = 2V$ , $I_{LOAD} = 2.8A$		82		83		85		90		100	mA
Current Limit	$V_{IN} = 5V$ , $V_{CONTROL} = 5V$ , $V_{SET} = 0V$ , $V_{OUT} = -0.1V$	2.8		2.8		2.8		2.8		2.8		A
Error Amplifier RMS Output Noise (Note 7)	$I_{LOAD} = 500mA$ , $10Hz \leq f \leq 100kHz$ , $C_{OUT} = 10\mu F$ , $C_{SET} = 0.1\mu F$	TYP = 40		TYP = 40		TYP = 40		TYP = 40		TYP = 40		$\mu V_{RMS}$
Reference Current RMS Output Noise (Note 7)	$10Hz \leq f \leq 100kHz$	TYP = 1		TYP = 1		TYP = 1		TYP = 1		TYP = 1		nA <sub>RMS</sub>

**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:** Unless otherwise specified, all voltages are with respect to  $V_{OUT}$ . The RH3083MK DICE is tested and specified under pulse load conditions such that  $T_J \equiv T_A$ .

**Note 3:** Minimum load current is equivalent to the quiescent current of the part. Since all quiescent and drive current is delivered to the output of the part, the minimum load current is the minimum current required to maintain regulation.

**Note 4:** Dropout results from either of minimum control voltage,  $V_{CONTROL}$ , or minimum input voltage,  $V_{IN}$ , both specified with respect to  $V_{OUT}$ . These specifications represent the minimum input-to-output differential voltage required to maintain regulation.

**Note 5:** The  $V_{CONTROL}$  pin current is the drive current required for the output transistor. This current tracks output current with roughly a 1:60 ratio. The minimum value is equal to the quiescent current of the device.

**Note 6:** The SET pin is clamped to the output with diodes through 1k resistors. These resistors and diodes only carry current under transient overloads.

**Note 7:** Adding a small capacitor across the reference current resistor lowers output noise. Adding this capacitor bypasses the resistor shot noise and reference current noise; output noise is then equal to error amplifier noise (see LT®3083 Data Sheet and Application Note 83).

**Note 8:** Dice are probe tested at 25°C to the limits shown in Table 1. Except for high current tests, dice are tested under low current conditions which assure full load current specifications when assembled.

**Note 9:** Dice that are not qualified by Analog Devices with a can sample are guaranteed to meet specifications of Table 1 only. Dice qualified by Analog Devices with a can sample meet specifications in all tables.

**Note 10:** This IC includes overtemperature protection that is intended to protect the device during momentary overload conditions. Junction temperature exceeds the maximum operating junction temperature when overtemperature protection is active. Continuous operation above the specified maximum operating junction temperature may impair device reliability.

**Note 11:** Please refer to LT3083 standard product data sheet for Typical Performance Characteristics, Pin Functions, Applications Information, and Typical Applications.

TABLE 4. 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, End Point Electrical Parameters (Method 5005)	1, 2, 3

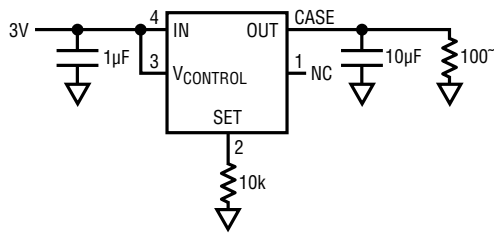
\*PDA applies to subgroup 1. See PDA Test Notes.

PDA Test Notes

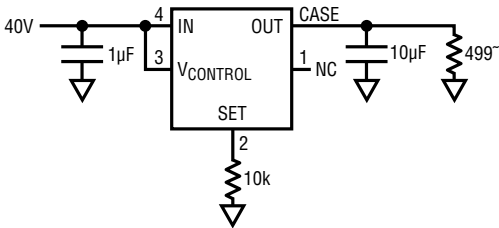
The PDA is specified as 5% based on failures from Group A, Subgroup 1, tests after cooldown as the final electrical test in accordance with method 5004 of MIL-STD-883. The verified failures of Group A, Subgroup 1, after burn-in divided by the total number of devices submitted for burn-in in that lot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

Analog Devices reserves the right to test to tighter limits than those given.

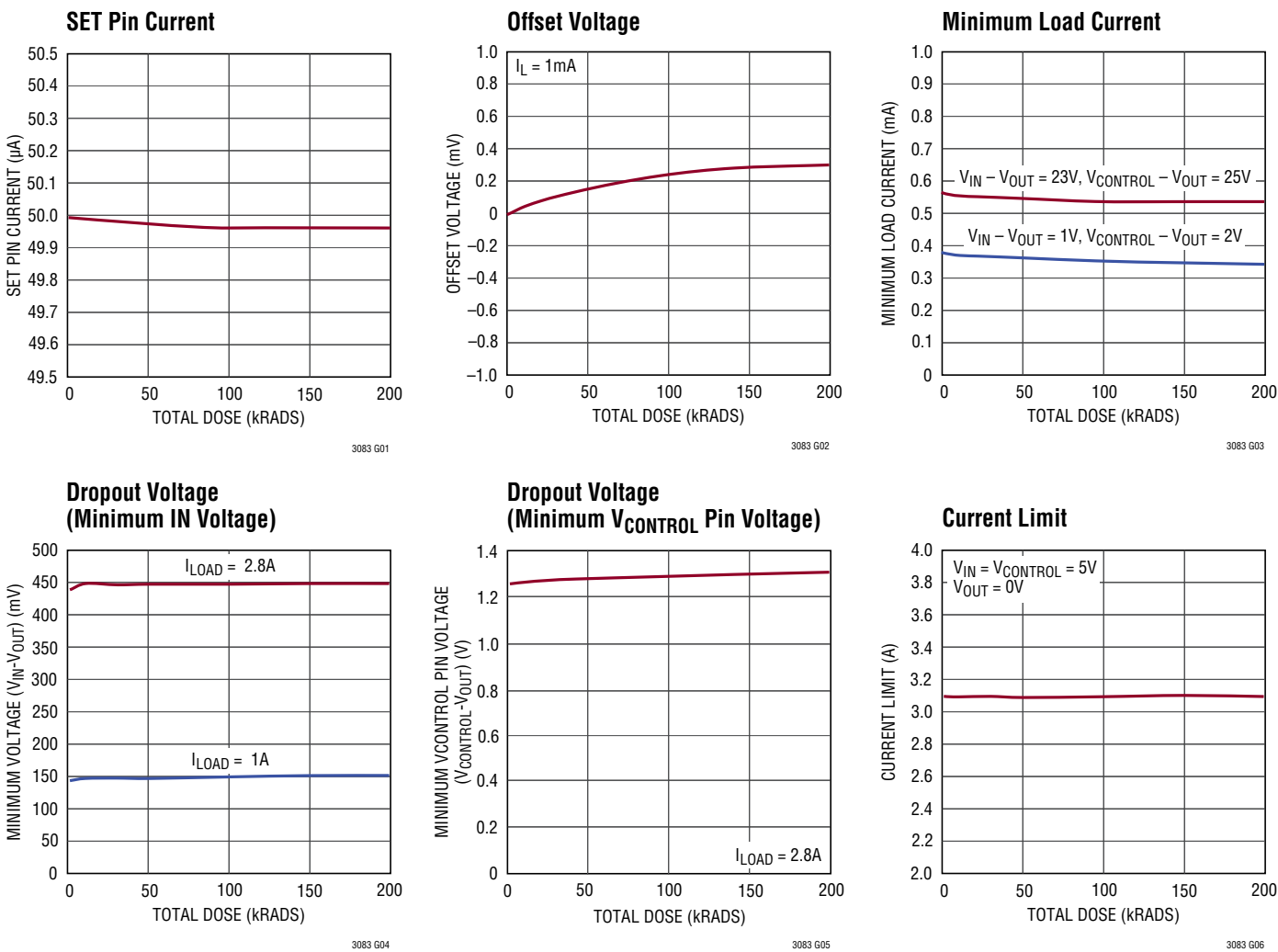
TOTAL DOSE BIAS CIRCUIT



BURN-IN CIRCUIT



TYPICAL PERFORMANCE CHARACTERISTICS



REVISION HISTORY

REV	DATE	DESCRIPTION	PAGE NUMBER
A	10/14	$I_L$ Min = 5mA; $V_{CONTROL} = 2V$ to 25V; Line Reg $I_{SET}$ and Line Reg, $V_{OS}$ update, added Note 11	2, 3, 4
B	7/23	Updated art title in the Electrical Characteristics section and updated the document to ADI format.	1–6