

Radiation Tolerant Multicell Battery Monitor

FEATURES

- 15kRad (SI) Total Ionizing Dose (TID) per MIL-STD-883 TM1019 Condition A
- Single Event Effect (LET) Threshold Linear Energy Transfer (LET) $\geq 21.17\text{MeV}\cdot\text{cm}^2/\text{mg}$
- Processed Using MIL-PRF-38535 Class N and PEM-INST-001 as a Guideline
- TID and SEE Reports Available
- Measures Up to 12 Battery Cells in Series
- Stackable Architecture Supports 100s of Cells
- Built-In isoSPI™ Interface:
 - 1Mbps Isolated Serial Communications
 - Uses a Single Twisted Pair, Up to 100 Meters
 - Low EMI Susceptibility and Emissions
- 1.2mV Maximum Total Measurement Error
- 290µs to Measure All Cells in a System
- Synchronized Voltage and Current Measurement
- 16-Bit Delta-Sigma ADC with Frequency Programmable 3rd Order Noise Filter
- Engineered for ISO26262 Compliant Systems
- Passive Cell Balancing with Programmable Timer

DESCRIPTION

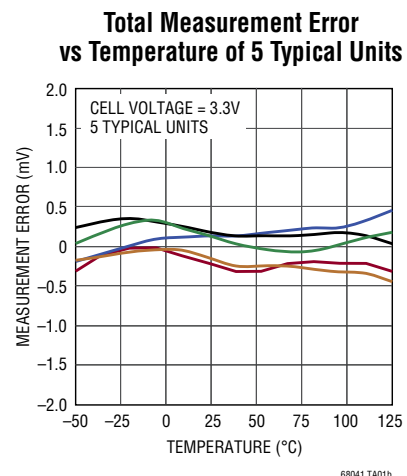
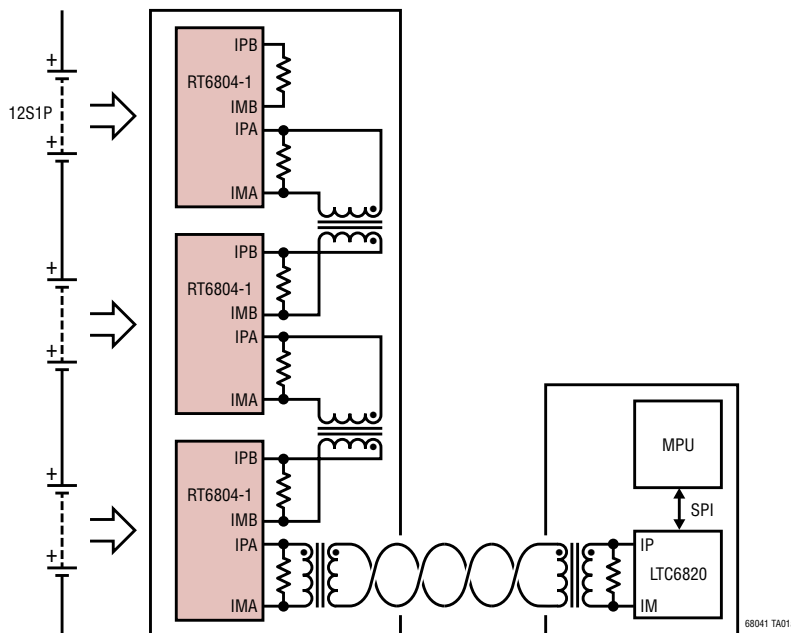
The RT[®]6804 is a 3rd generation multicell battery stack monitor that measures up to 12 series connected battery cells with a total measurement error of less than 1.2mV. The cell measurement range of 0V to 5V makes the RT6804 suitable for most battery chemistries. All 12 cell voltages can be captured in 290µs, and lower data acquisition rates can be selected for high noise reduction.

Multiple RT6804 devices can be connected in series, permitting simultaneous cell monitoring of long, high voltage battery strings. The RT6804 has an isoSPI interface for high speed, RF-immune, local area communications. Using the RT6804-1, multiple devices are connected in a daisy-chain with one host processor connection for all devices.

Additional features include passive balancing for each cell, an on-board 5V regulator, and 5 general purpose I/O lines. In sleep mode, current consumption is reduced to 4µA. The RT6804 can be powered directly from the battery, or from an isolated supply.

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TYPICAL APPLICATION



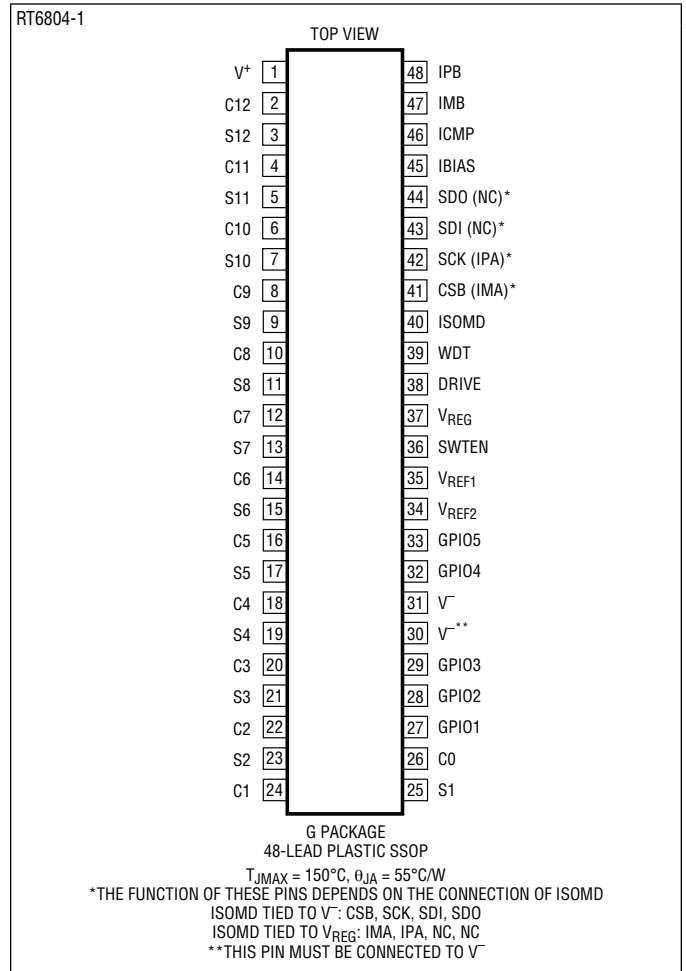
RT6804-1

ABSOLUTE MAXIMUM RATINGS

(Note 1)

| | |
|---|---------------------------|
| Total Supply Voltage V^+ to V^- | 75V |
| Input Voltage (Relative to V^-) | |
| C0..... | -0.3V to 0.3V |
| C12..... | -0.3V to 75V |
| C(n)..... | -0.3V to MIN (8 • n, 75V) |
| S(n)..... | -0.3V to MIN (8 • n, 75V) |
| IPA, IMA, IPB, IMB..... | -0.3V to $V_{REG} + 0.3V$ |
| DRIVE Pin..... | -0.3V to 7V |
| All Other Pins..... | -0.3V to 6V |
| Voltage Between Inputs | |
| V^+ to C12..... | -5.5V |
| C(n) to C(n - 1)..... | -0.3V to 8V |
| S(n) to C(n - 1)..... | -0.3V to 8V |
| C12 to C8..... | -0.3V to 25V |
| C8 to C4..... | -0.3V to 25V |
| C4 to C0..... | -0.3V to 25V |
| Current In/Out of Pins | |
| All Pins Except V_{REG} , IPA, IMA, IPB, IMB, S(n)..... | 10mA |
| IPA, IMA, IPB, IMB..... | 30mA |
| Operating Temperature Range | |
| RT6804H..... | -40°C to 125°C |
| Specified Temperature Range | |
| RT6804H..... | -40°C to 125°C |
| Junction Temperature..... | 150°C |
| Storage Temperature..... | -65°C to 150°C |
| Lead Temperature (Soldering, 10sec)..... | 300°C |

PIN CONFIGURATION



ORDER INFORMATION

| LEAD BASED FINISH | TAPE AND REEL | PART MARKING* | PACKAGE DESCRIPTION | SPECIFIED TEMPERATURE RANGE |
|-------------------|---------------|---------------|----------------------|-----------------------------|
| RT6804HG-1 | RT6804HG-1#TR | RT6804G-1 | 48-Lead Plastic SSOP | -40°C to 125°C |

Contact the factory for parts specified with wider operating temperature ranges. *The temperature grade is identified by a label on the shipping container.

[Tape and reel specifications](#). Some packages are available in 500 unit reels through designated sales channels with #TRMPBF suffix.

ELECTRICAL CHARACTERISTICS (Pre-Irradiation)Specifications are at $T_A = 25^\circ\text{C}$. The test conditions are $V^+ = 39.6\text{V}$, $V_{\text{REG}} = 5.0\text{V}$ unless otherwise noted.

| SYMBOL | PARAMETER | CONDITIONS | $T_A = 25^\circ\text{C}$ | | | SUB-GROUP | $-40^\circ\text{C} \leq T_A \leq 125^\circ\text{C}$ | | | SUB-GROUP | UNITS | |
|---|--|--|------------------------------|-----------|------|-----------|---|-----------|------|---------------|---------------|---------------|
| | | | MIN | TYP | MAX | | MIN | TYP | MAX | | | |
| ADC DC Specifications | | | | | | | | | | | | |
| | Total Measurement Error (TME) in Normal Mode | C(n) to C(n-1) = 2.0 | -0.8 | ± 0.1 | 0.8 | 1 | -1.4 | | 1.4 | 2, 3 | mV | |
| | | GPIO(n) to $V^- = 2.0$ | -1.4 | | 1.4 | 1 | -1.4 | | 1.4 | 2, 3 | mV | |
| | | C(n) to C(n-1) = 3.3 | -1.2 | ± 0.2 | 1.2 | 1 | -2.2 | | 2.2 | 2, 3 | mV | |
| | | GPIO(n) to $V^- = 3.3$ | -2.2 | | 2.2 | 1 | -2.2 | | 2.2 | 2, 3 | mV | |
| | | C(n) to C(n-1) = 4.2 | -1.6 | ± 0.3 | 1.6 | 1 | -2.8 | | 2.8 | 2, 3 | mV | |
| | | GPIO(n) to $V^- = 4.2$ | -2.8 | | 2.8 | 1 | -2.8 | | 2.8 | 2, 3 | mV | |
| | | VREG Pin | -0.25 | ± 0.1 | 0.25 | 1 | -0.25 | ± 0.1 | 0.25 | 2, 3 | % | |
| | Total Measurement Error (TME) in Filtered Mode | VREG Pin | -0.25 | ± 0.1 | 0.25 | 1 | -0.25 | ± 0.1 | 0.25 | 2, 3 | % | |
| I_L | Input Leakage Current When Inputs Are Not Being Measured | C(n), n = 0 to 12 | -250 | 10 | 250 | 1 | -250 | 10 | 250 | 2, 3 | nA | |
| | | GPIO(n), n = 1 to 5 | -250 | 10 | 250 | 1 | -250 | 10 | 250 | 2, 3 | nA | |
| Voltage Reference Specifications | | | | | | | | | | | | |
| V_{REF1} | 1st Reference Voltage | VREF1 Pin, No Load | 3.1 | 3.2 | 3.3 | 1 | 3.1 | 3.2 | 3.3 | 2, 3 | V | |
| V_{REF2} | 2nd Reference Voltage | VREF2 Pin, No Load | 2.99 | | 3.01 | 1 | 2.99 | | 3.01 | 2 | V | |
| General DC Specifications | | | | | | | | | | | | |
| I_{VP} | V^+ Supply Current | State: Core = SLEEP, isoSPI = IDLE | $V_{\text{REG}} = 0\text{V}$ | 3.8 | 6 | 1 | 3.8 | 10 | 2 | μA | | |
| | | | $V_{\text{REG}} = 5\text{V}$ | 1.6 | 3 | 1 | 1.6 | 5 | 2 | μA | | |
| | | State: Core = STANDBY | | 18 | 32 | 50 | 1 | 10 | 32 | 60 | 2, 3 | μA |
| | | State: Core = REFUP or MEASURE | | 0.4 | 0.55 | 0.7 | 1 | 0.375 | 0.55 | 0.725 | 2, 3 | mA |
| $I_{\text{REG(CORE)}}$ | V_{REG} Supply Current | State: Core = SLEEP, isoSPI = IDLE | $V_{\text{REG}} = 5\text{V}$ | 2.2 | 4 | 1 | 2.2 | 6 | 2 | μA | | |
| | | | State: Core = STANDBY | | 10 | 35 | 60 | 1 | 6 | 35 | 65 | 2, 3 |
| | | State: Core = REFUP | | 0.2 | 0.45 | 0.7 | 1 | 0.15 | 0.45 | 0.7 | 2, 3 | mA |
| | | State: Core = MEASURE | | 10.8 | 11.5 | 12.2 | 1 | 10.7 | 11.5 | 12.2 | 2, 3 | mA |
| | DRIVE output Voltage | Sourcing $1\mu\text{A}$ | 5.4 | 5.6 | 5.8 | 1 | 5.2 | 5.6 | 6.1 | 2, 3 | V | |
| | Discharge Switch ON Resistance | $V_{\text{CELL}} = 3.6\text{V}$ | | 10 | 25 | 1 | | 10 | 25 | 2 | Ω | |
| SPI Interface DC Specifications | | | | | | | | | | | | |
| $I_{\text{LEAK(DIG)}}$ | Digital Input Current | Pins CSB, SCK, SDI, ISOMD, SWTEN, A0 to A3 | -1 | | 1 | 1 | -1 | | 1 | 2, 3 | μA | |
| isoSPI DC Specifications | | | | | | | | | | | | |
| V_{BIAS} | Voltage on IBIAS Pin | READY/ACTIVE State | 1.9 | 2 | 2.1 | 1 | 1.9 | 2 | 2.1 | 2, 3 | V | |
| A_{IB} | Isolated Interface Current Gain | $V_A \leq 1.6\text{V}$ | $I_B = 1\text{mA}$ | 18 | 20 | 22 | 1 | 18 | 20 | 22 | 2, 3 | mA/mA |
| isoSPI Pulse Timing Specifications | | | | | | | | | | | | |
| $t_{1/2\text{PW(D)}}$ | Data Half-Pulse Width | | 40 | 50 | 60 | 4 | 40 | 50 | 60 | 5, 6 | ns | |

ELECTRICAL CHARACTERISTICS (Post-Irradiation)Specifications are at $T_A = 25^\circ\text{C}$. The test conditions are $V^+ = 39.6\text{V}$, $V_{\text{REG}} = 5.0\text{V}$ unless otherwise noted.

| SYMBOL | PARAMETER | CONDITIONS | 10kRad (SI) | | 15kRad (SI) | | UNITS | |
|---|--|--|------------------------------|------|-------------|------|---------------|---------------|
| | | | MIN | MAX | MIN | MAX | | |
| ADC DC Specifications | | | | | | | | |
| | Total Measurement Error (TME) in Normal Mode | C(n) to C(n-1) = 2.0 | -1.8 | 1.8 | -2.6 | 2.6 | mV | |
| | | GPIO(n) to $V^- = 2.0$ | -2.4 | 2.4 | -3.2 | 3.2 | mV | |
| | | C(n) to C(n-1) = 3.3 | -2.6 | 2.6 | -4.0 | 4.0 | mV | |
| | | GPIO(n) to $V^- = 3.3$ | -3.6 | 3.6 | -5.0 | 5.0 | mV | |
| | | C(n) to C(n-1) = 4.2 | -3.4 | 3.4 | -5.3 | 5.3 | mV | |
| | | GPIO(n) to $V^- = 4.2$ | -4.6 | 4.6 | -6.5 | 6.5 | mV | |
| | | VREG Pin | -17.5 | 17.5 | -31.5 | 31.5 | mV | |
| | Total Measurement Error (TME) in Filtered Mode | VREG Pin | -16.5 | 16.5 | -32.5 | 32.5 | mV | |
| I_L | Input Leakage Current When Inputs Are Not Being Measured | C(n), n = 0 to 12 | -360 | 360 | -360 | 360 | nA | |
| | | GPIO(n), n = 1 to 5 | -360 | 360 | -360 | 360 | nA | |
| Voltage Reference Specifications | | | | | | | | |
| V_{REF1} | 1st Reference Voltage | VREF1 Pin, No Load | 3.10 | 3.30 | 3.10 | 3.30 | V | |
| V_{REF2} | 2nd Reference Voltage | VREF2 Pin, No Load | 2.98 | 3.01 | 2.98 | 3.01 | V | |
| General DC Specifications | | | | | | | | |
| I_{VP} | V^+ Supply Current | State: Core = SLEEP, isoSPI = IDLE | $V_{\text{REG}} = 0\text{V}$ | 15 | 325 | | μA | |
| | | | $V_{\text{REG}} = 5\text{V}$ | 3.6 | 100 | | μA | |
| | | State: Core = STANDBY | | | 140 | 180 | | μA |
| | | State: Core = REFUP or MEASURE | | 0.3 | 0.8 | 0.3 | 0.8 | mA |
| $I_{\text{REG(CORE)}}$ | V_{REG} Supply Current | State: Core = SLEEP, isoSPI = IDLE | $V_{\text{REG}} = 5\text{V}$ | 425 | 2800 | | μA | |
| | | | | 475 | 3000 | | μA | |
| | | State: Core = REFUP | | 0.1 | 1.2 | 0.1 | 3.3 | mA |
| | | State: Core = MEASURE | | 10.4 | 12.6 | 8.6 | 14.4 | mA |
| | DRIVE Output Voltage | Sourcing $1\mu\text{A}$ | 5.3 | 5.9 | 5.3 | 5.9 | V | |
| | Discharge Switch ON Resistance | $V_{\text{CELL}} = 3.6\text{V}$ | | 27 | | 27 | Ω | |
| SPI Interface DC Specifications | | | | | | | | |
| $I_{\text{LEAK(DIG)}}$ | Digital Input Current | Pins GSB, SCK, SDI, ISOMD, SWTEN, A0 to A3 | -1.15 | 1.15 | -1.25 | 1.25 | μA | |
| isoSPI DC Specifications | | | | | | | | |
| V_{BIAS} | Voltage on IBIAS Pin | READY/ACTIVE State | 1.8 | 2.2 | 1.8 | 2.2 | V | |
| A_{IB} | Isolated Interface Current Gain | $V_A \leq 1.6\text{V}$ | $I_B = 1\text{mA}$ | 17 | 23 | 17 | 23 | mA/mA |
| isoSPI Pulse Timing Specifications | | | | | | | | |
| $t_{1/2\text{PW(D)}}$ | Data Half-Pulse Width | | 39 | 61 | 38 | 62 | ns | |

ELECTRICAL CHARACTERISTICS: BURN-IN DELTA PARAMETERS

Specifications are at $T_A = 25^\circ\text{C}$.

| SYMBOL | PARAMETER | CONDITIONS | DELTA LIMITS | | UNITS |
|------------|-----------------------|-----------------------|--------------|-----|---------------|
| | | | MIN | MAX | |
| V_{REF1} | 1st Reference Voltage | VREF1 Pin, No Load | -5 | 5 | mV |
| V_{REF2} | 2nd Reference Voltage | VREF2 Pin, No Load | -5 | 5 | mV |
| I_{VP} | V^+ Supply Current | State: Core = STANDBY | -0.5 | 0.5 | μA |

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: The ADC specifications are guaranteed by the Total Measurement Error specification.

Note 3: V^+ needs to be greater than or equal to the highest C(n) voltage for accurate measurements.

ELECTRICAL TEST REQUIREMENTS

| MIL-STD-883 TEST REQUIREMENTS | SUBGROUP |
|--|--------------|
| Final Electrical Test Requirements (Method 5004) | 1*,2,3,4,5,6 |
| Group A Test Requirements (Method 5005) | 1,2,3,4,5,6 |
| Group B and D for Class S, and End Point Electrical Parameters (Method 5005) | 1,2,3 |

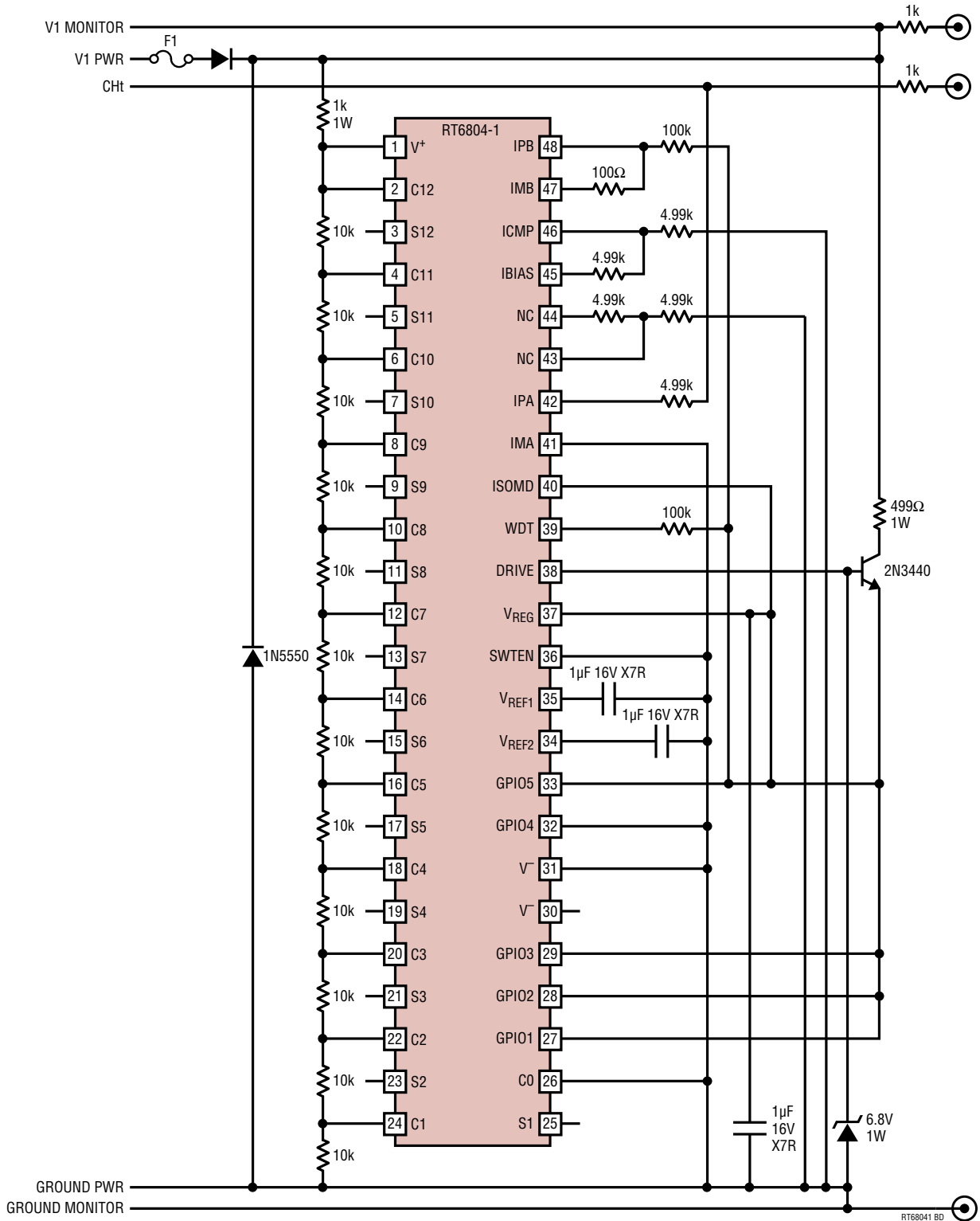
*PDA applies to subgroup 1. See PDA Test Notes.

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.

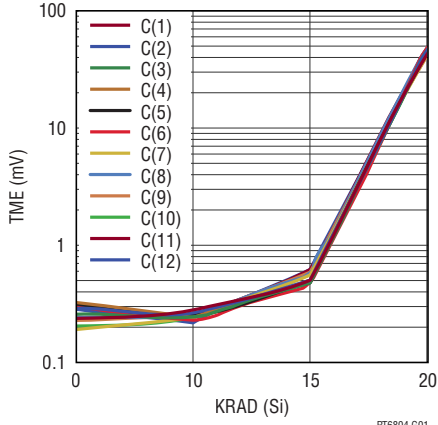
Analog Devices reserves the right to test to tighter limits than those given.

TOTAL DOSE BIAS CIRCUIT/BURN-IN CIRCUIT

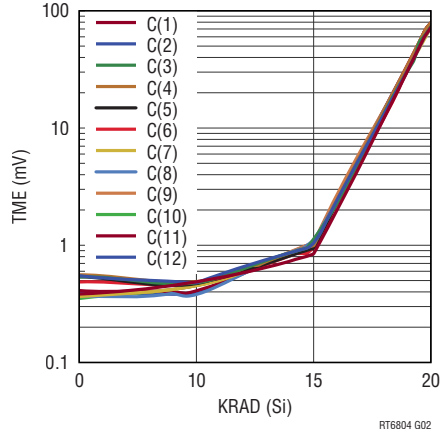


TYPICAL PERFORMANCE CHARACTERISTICS

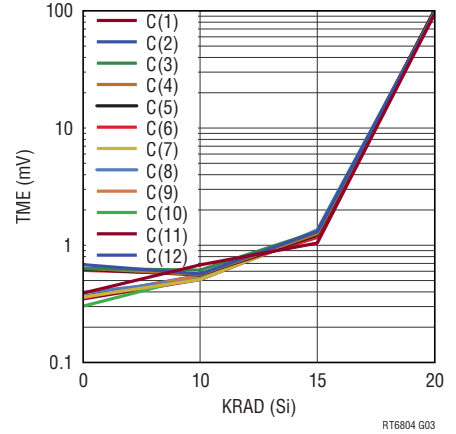
**TME in Normal Mode
C(n) to C(n-1) = 2V**



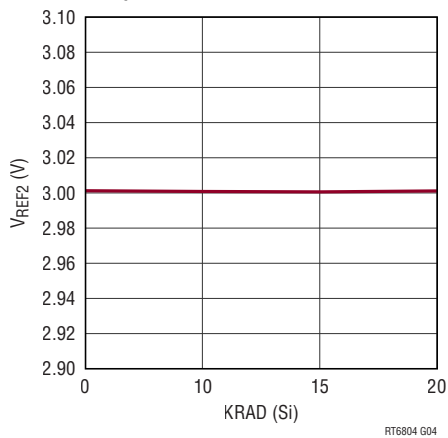
**TME in Normal Mode
C(n) to C(n-1) = 3.3V**



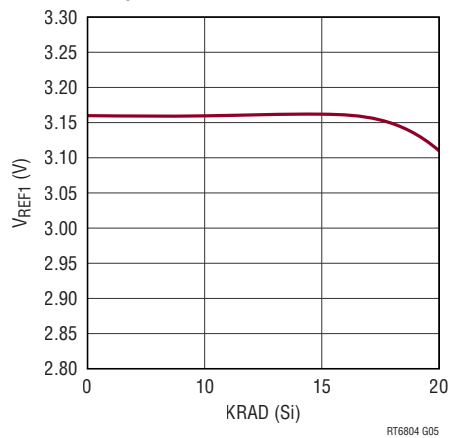
**TME in Normal Mode
C(n) to C(n-1) = 4.2V**



**Reference Voltage 2, V_{REF2},
V_{REG} = 5V**

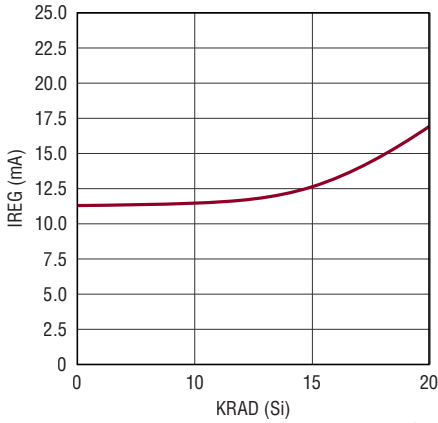


**Reference Voltage 1, V_{REF1},
V_{REG} = 5V**



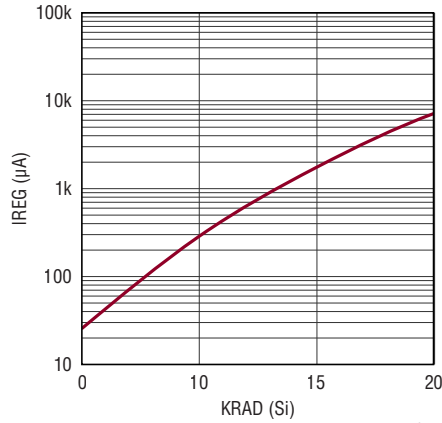
TYPICAL PERFORMANCE CHARACTERISTICS

IREG, Core = MEASURE



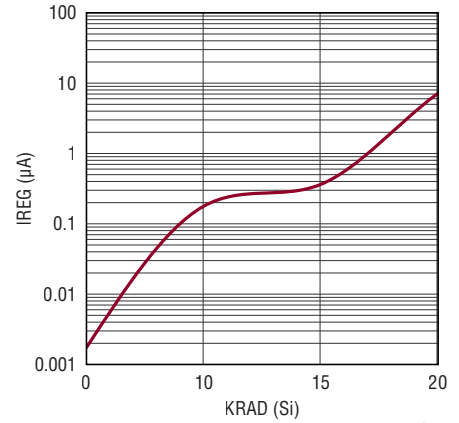
RT6804 G06

IREG, Core = STANDBY



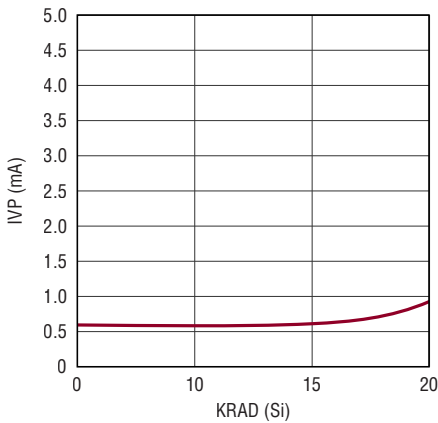
RT6804 G07

IREG Core = SLEEP, V_{REG} = 5V



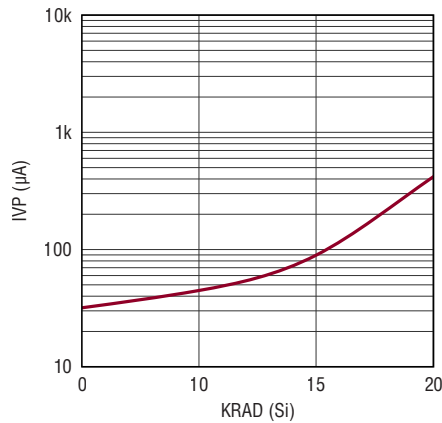
RT6804 G08

IVP, Core = MEASURE



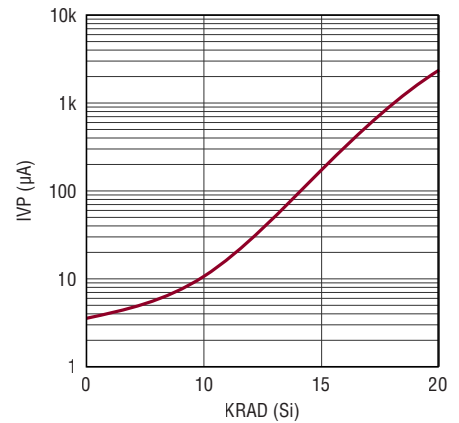
RT6804 G09

IVP, Core = STANDBY



RT6804 G10

IVP, Core = SLEEP, V_{REG} = 0V



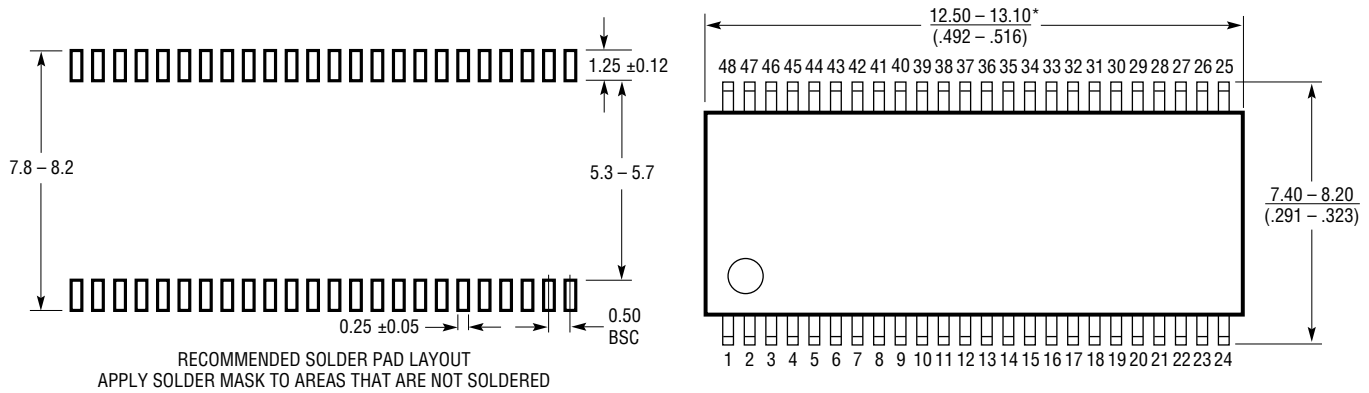
RT6804 G11

REVISION HISTORY

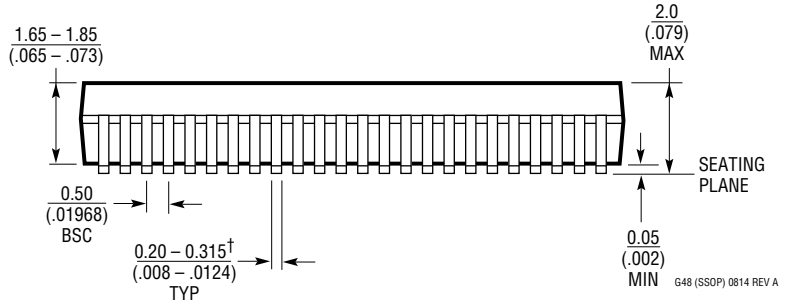
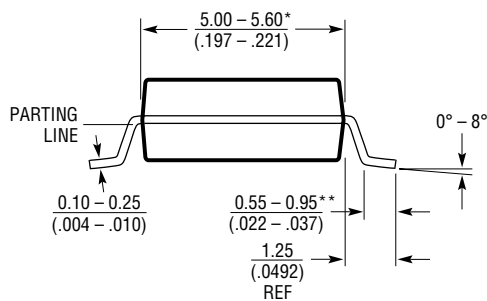
| REV | DATE | DESCRIPTION | PAGE NUMBER |
|-----|-------|--|-------------|
| A | 05/20 | Increased Post 15kRad (Si) V ⁺ Supply Current State: Core = SLEEP, isoSPI = IDLE V _{REG} = 5V to 100 μ A | 4 |

PACKAGE DESCRIPTION

G Package
48-Lead Plastic SSOP (5.3mm)
 (Reference LTC DWG # 05-08-1887 Rev A)



RECOMMENDED SOLDER PAD LAYOUT
 APPLY SOLDER MASK TO AREAS THAT ARE NOT SOLDERED



- NOTE:
1. DRAWING IS NOT A JEDEC OUTLINE
 2. CONTROLLING DIMENSION: MILLIMETERS
 3. DIMENSIONS ARE IN MILLIMETERS (INCHES)
 4. DRAWING NOT TO SCALE
 5. FORMED LEADS SHALL BE PLANAR WITH RESPECT TO ONE ANOTHER WITHIN 0.08mm AT SEATING PLANE

- * DIMENSIONS DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS, BUT DO INCLUDE MOLD MISMATCH AND ARE MEASURED AT THE PARTING LINE. MOLD FLASH SHALL NOT EXCEED .15mm PER SIDE
- ** LENGTH OF LEAD FOR SOLDERING TO A SUBSTRATE
- † THE MAXIMUM DIMENSION DOES NOT INCLUDE DAMBAR PROTRUSIONS. DAMBAR PROTRUSIONS DO NOT EXCEED 0.13mm PER SIDE