



# Le79R79

## Ringing Subscriber Line Interface Circuit VE580 Series

### APPLICATIONS

- Ideal for short-loop applications
- Ideal for ISDN-TA and fixed radio access applications
- Integrated Access Devices (IADs)
- Network Interface Units (NIUs)
- Cable Modems
- DSL Modems
- Set Top / House Side Boxes
- Intelligent PBX
- Pain Gain
- FXS Cards
- Voice over ISDN or T1/E1
- Smart Residential Gateways
- WLL, APON, FITL, NGN, and all other short-loop CPE/Enterprise telephony applications

### FEATURES

- Through trapezoidal ringing
- On-chip ring-trip detector
- Low standby state power
- Battery operation:
  - $V_{BAT1}$ : -40.5 to -75 V
  - $V_{BAT2}$ : -19 V to  $V_{BAT1}$
- On-chip battery switching and feed selection
- On-hook transmission
- Two-wire impedance set by single external impedance
- Programmable constant-current feed
- Programmable Open Circuit voltage
- Programmable loop-detect threshold
- Current gain = 1000
- Ground-key detector
- Polarity reversal option available
- Internal  $V_{EE}$  regulator (no external -5 V power supply required)

### RELATED LITERATURE

- 080917 Ve790 Series RSLIC Device Product Brief
- 080158 Le79R70/79/100/101 Technical Overview
- 080914 Le79R79 RSLIC Device User's Guide
- 080810 Le71HR0021 Reference Design User's Guide
- 080255 Le71HE0040J Evaluation Board User's Guide
- 080458 Le79R100/101 v. Le79R79 Comparison Brief
- 080753 Le58QL02/021/031 QLSLAC™ Data Sheet

### ORDERING INFORMATION

| Device <sup>1</sup> | Package Type <sup>2, 3</sup>   | Packing <sup>4</sup> |
|---------------------|--------------------------------|----------------------|
| Le79R79-1DJC        | 32-pin PLCC<br>(Green package) | Tube                 |
| Le79R79-2DJC        |                                |                      |
| Le79R79-3DJC        |                                |                      |
| Le79R79-1FQC        | 32-pin QFN<br>(Green package)  | Tray                 |
| Le79R79-2FQC        |                                |                      |

-1: 52 dB Longitudinal Balance, Polarity Reversal

-2: 63 dB Longitudinal Balance, Polarity Reversal

-3: 52 dB Longitudinal Balance, No Polarity Reversal

1. Legerity reserves the right to fulfill all orders for this device with parts marked with the "Am" part number prefix, until such time as all inventory bearing this mark has been depleted. It should be noted that parts marked with either the "Am" or the "Le" part number prefix are equivalent devices in terms of form, fit, and function.
2. Due to size constraints, QFN devices are marked by omitting the "Le" prefix and the performance grade dash character. For example, Le79R79-1FQC is marked 79R791FQC.
3. The green package meets RoHS Directive 2002/95/EC of the European Council to minimize the environmental impact of electrical equipment.
4. For delivery using a tape and reel packing system, add a "T" suffix to the OPN (Ordering Part Number) when placing an order.

### DESCRIPTION

The Le79R79 Ringing SLIC device is a bipolar monolithic SLIC that offers on-chip ringing. Designers can achieve significant cost reductions at the system level for short-loop applications by integrating the ringing function on chip. Examples of such applications would be ISDN terminal adaptors, fiber-in-the-loop, radio-in-the-loop, hybrid fiber/coax and video telephony (home-side) boxes. The Le79R79 Ringing SLIC device can provide sufficient voltage to meet the stringent LSSGR five-ringer equivalent specification. Using a CMOS-compatible input waveform and wave shaping R-C network, the Le79R79 Ringing SLIC device can provide trapezoidal wave ringing to meet various design requirements.

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## PRODUCT DESCRIPTION

The Legerity family of subscriber line interface circuit (SLIC) products provide the telephone interface functions required throughout the worldwide market. Legerity SLIC devices address all major telephony markets including central office (CO), private branch exchange (PBX), digital loop carrier (DLC), fiber-in-the-loop (FITL), radio-in-the-loop (RITL), hybrid fiber coax (HFC), and video telephony applications.

The Legerity SLIC devices offer support of BORSHT (battery feed, overvoltage protection, ringing, supervision, hybrid, and test) functions with features including current limiting, on-hook transmission, polarity reversal, Tip Open, and loop-current detection. These features allow reduction of linecard cost by minimizing component count, conserving board space, and supporting automated manufacturing.

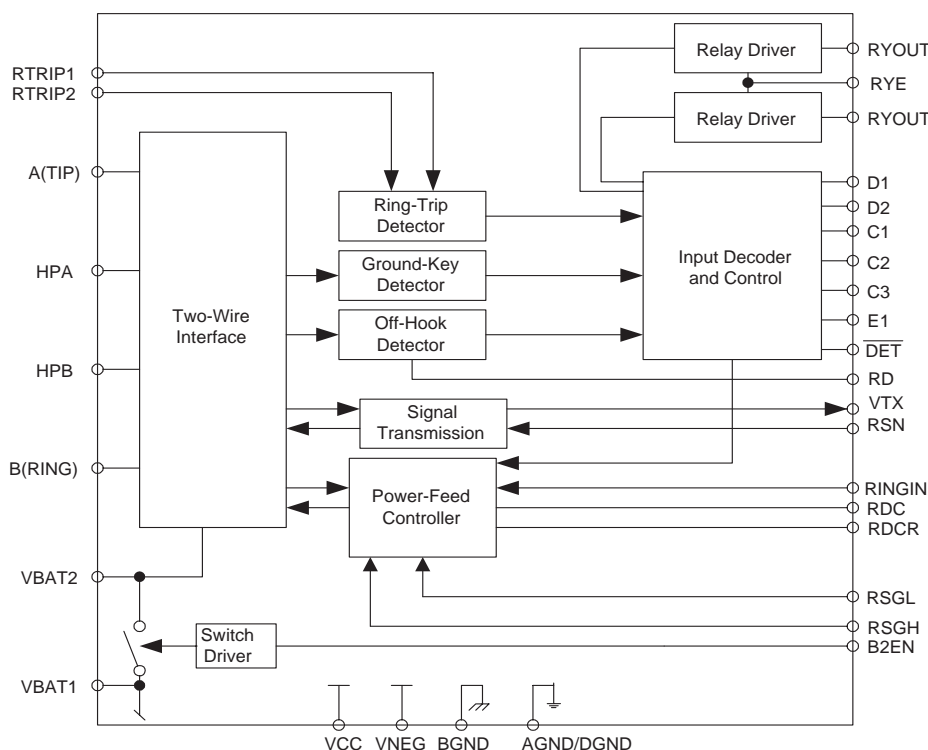
The Legerity SLIC devices provide the two- to four-wire hybrid function, DC-loop feed, and two-wire supervision. Two-wire termination is programmed by a scaled impedance network. Transhybrid balance can be achieved with an external balance circuit or simply programmed using a companion Legerity codec device, the Am79C02/03/031 DSLAC™ device, the Am79Q02/021/03 Programmable Quad SLAC (QSLAC™) device, or the Am79Q5457/4457 Nonprogrammable QSLAC device.

The Le79R79 Ringing SLIC device is a bipolar monolithic SLIC that offers on-chip ringing. Now designers can achieve significant cost reductions at the system level for short-loop applications by integrating the ringing function on chip. Examples of such applications would be ISDN terminal adaptors, fiber-in-the-loop, radio-in-the-loop, hybrid fiber/coax and video telephony (home-side) boxes. The Le79R79 Ringing SLIC can provide sufficient voltage to meet the stringent LSSGR five-ringer equivalent specification. Using a CMOS-compatible input waveform and wave shaping R-C network, the Le79R79 Ringing SLIC can provide trapezoidal wave ringing to meet various design requirements.

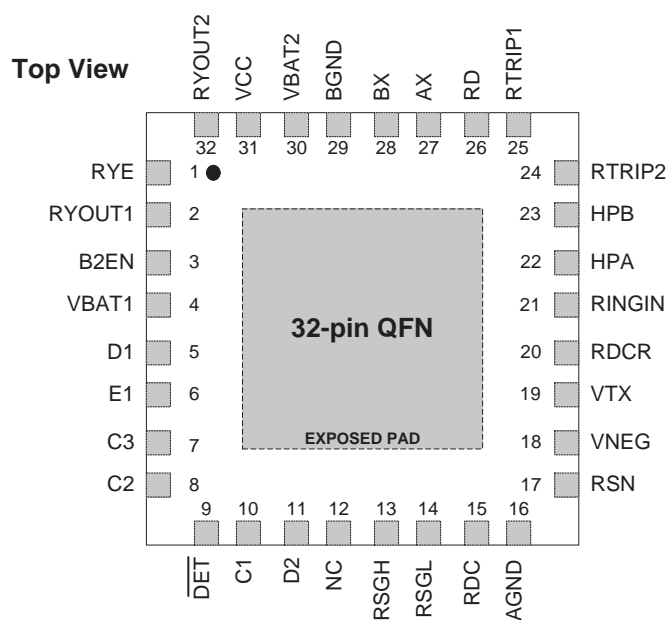
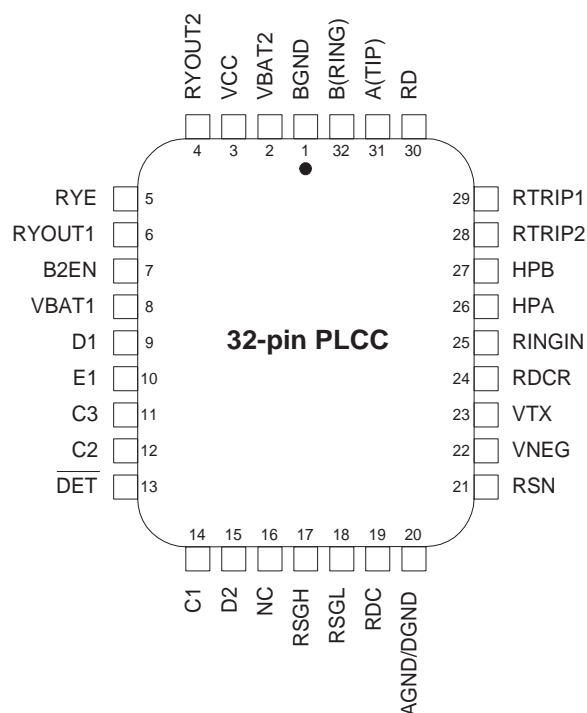
In order to further enhance the suitability of this device in short-loop, distributed switching applications, Legerity has maximized power savings by incorporating battery switching on chip. The Le79R79 Ringing SLIC device switches between two battery supplies such that in the off-hook (active) state, a low battery is used to save power. In order to meet the Open Circuit voltage requirements of fax machines and maintenance termination units (MTU), the SLIC device automatically switches to a higher voltage in the On-hook (Standby) state.

Like all of the Legerity SLIC devices, the Le79R79 Ringing SLIC device supports on-hook transmission, ring-trip detection, programmable loop-detect threshold, and is available with on-chip polarity reversal. The Le79R79 Ringing SLIC device is a programmable constant-current feed device with two on-chip relay drivers to operate external relays. Several performance grades are available to meet both CCITT and LSSGR requirements, including various longitudinal balance options.

**Figure 1. Le79R79 Block Diagram**



## CONNECTION DIAGRAMS



**Note:**

1. Pin 1 is marked for orientation.
2. NC = No connect.
3. The thermally enhanced QFN package features an exposed pad on the underside which must be electrically tied to VBAT1.

## PIN DESCRIPTIONS

| Pin Names               | Type      | Description   |
|-------------------------|-----------|---|
| AGND/DGND               | Ground    | Analog and digital ground   |
| A(TIP)                  | Output    | Output of A(TIP) power amplifier  |
| B2EN                    | Input     | V <sub>BAT2</sub> Enable. Logic Low enables operation from V <sub>BAT2</sub> . Logic High enables operation from V <sub>BAT1</sub> . TTL compatible.  |
| BGND                    | Ground    | Battery (power) ground  |
| B(RING)                 | Output    | Output of B(RING) power amplifier   |
| C3–C1                   | Input     | Decoder. SLIC control pins. C3 is MSB and C1 is LSB. TTL compatible.  |
| D1                      | Input     | Relay1 Control. TTL compatible. Logic Low activates the Relay1 relay driver.  |
| D2                      | Input     | Relay2 Control. (Option) TTL compatible. Logic Low activates the Relay2 relay driver.   |
| $\overline{\text{DET}}$ | Output    | Hook switch detector. When enabled, a logic Low indicates that the selected detector is tripped. The logic inputs C3–C1 and E1 select the detector. The output is open collector with a built-in 15 k $\Omega$ pull-up resistor.                          |
| E1                      | Input     | Ground-Key Enable. (Option) A logic High selects the off-hook detector. A logic Low selects the ground-key detector. TTL compatible.  |
| HPA                     | Capacitor | High-Pass Filter. A(TIP) side of high-pass filter capacitor.  |
| HPB                     | Capacitor | High-Pass Filter. B(RING) side of high-pass filter capacitor.   |
| NC                      | —         | Not internally connected.   |
| RD                      | Resistor  | Detect Resistor. Detector threshold set and filter pin.   |
| RDC                     | Output    | DC Feed Resistor. Connection point for the DC-feed current programming network. The other end of the network connects to the receiver summing node (RSN). The sign of V <sub>RDC</sub> is negative for normal polarity and positive for reverse polarity. |
| RDCR                    | —         | Connection point for feedback during ringing.   |
| RINGIN                  | Input     | Ring Signal. Pin for ring signal input. Square-wave shaped by external RC filter. Requires 50% duty cycle. CMOS-compatible input.   |
| RSGH                    | Input     | Saturation Guard High. Pin for resistor to adjust Open Circuit voltage when operating from V <sub>BAT1</sub> .  |
| RSGL                    | Input     | Saturation Guard Low. Pin for resistor to adjust the anti-saturation cut-in voltage when operating from both V <sub>BAT1</sub> and V <sub>BAT2</sub> .  |
| RSN                     | Input     | Receive Summing Node. The metallic current (both AC and DC) between A(TIP) and B(RING) is equal to 1000 x the current into this pin. The networks that program receive gain, two-wire impedance, and feed resistance all connect to this node.            |
| RTRIP1                  | Input     | Ring-Trip Detector. Ring-trip detector threshold set and filter pin.  |
| RTRIP2                  | Input     | Ring-Trip Detector. Ring-trip detector threshold offset (switch to V <sub>BAT1</sub> ). For power conservation in any nonringing state, this switch is open.  |
| RYE                     | Output    | Common Emitter of RYOUT1/RYOUT2. Emitter output of RYOUT1 and RYOUT2. Normally connected to relay ground.   |
| RYOUT1                  | Output    | Relay/Switch Driver. Open collector driver with emitter internally connected to RYE.  |
| RYOUT2                  | Output    | Relay/Switch Driver. (Option) Open collector driver with emitter internally connected to RYE.   |
| VBAT1                   | Battery   | Battery supply and connection to substrate.   |
| VBAT2                   | Battery   | Power supply to output amplifiers. Connect to off-hook battery through a diode.   |
| VCC                     | Power     | Positive analog power supply  |
| VNEG                    | Power     | Negative analog power supply. This pin is the return for the internal V <sub>EE</sub> regulator.  |
| VTX                     | Output    | Transmit Audio. This output is a 0.5066 gain version of the A(TIP) and B(RING) metallic AC voltage. VTX also sources the two-wire input impedance programming network.  |

## ELECTRICAL CHARACTERISTICS

### Absolute Maximum Ratings

Stresses greater than those listed under Absolute Maximum Ratings can cause permanent device failure. Functionality at or above these limits is not implied. Exposure to absolute maximum ratings for extended periods can affect device reliability.

|   |                                   |
|---|-----------------------------------|
| Storage Temperature   | –55 to +150° C                    |
| V <sub>CC</sub> with respect to AGND/DGND   | 0.4 to +7 V                       |
| V <sub>NEG</sub> with respect to AGND/DGND  | 0.4 V to V <sub>BAT2</sub>        |
| V <sub>BAT2</sub>   | V <sub>BAT1</sub> to GND          |
| V <sub>BAT1</sub> with respect to AGND/DGND:  |                                   |
| Continuous  | +0.4 to –80 V                     |
| 10 ms   | +0.4 to –85 V                     |
| BGND with respect to AGND/DGND:   | +3 to –3 V                        |
| A(TIP) or B(RING) to BGND:  |                                   |
| Continuous  | V <sub>BAT1</sub> –5 to +1 V      |
| 10 ms (F = 0.1 Hz)  | V <sub>BAT1</sub> –10 to +5 V     |
| 1 μs (F = 0.1 Hz)   | V <sub>BAT1</sub> –15 to +8 V     |
| 250 ns (F = 0.1 Hz)   | V <sub>BAT1</sub> –20 to +12 V    |
| Current from A(TIP) or B(RING)  | ±150 mA                           |
| RYOUT1, RYOUT2 current  | 75 mA                             |
| RYOUT1, RYOUT2 voltage  | RYE to +7 V                       |
| RYOUT1, RYOUT2 transient  | RYE to +10 V                      |
| RYE voltage   | BGND to V <sub>BAT1</sub>         |
| C3–C1, D2–D1, E1, B2EN, and RINGIN:   |                                   |
| Input voltage   | –0.4 V to V <sub>CC</sub> + 0.4 V |
| Maximum power dissipation, continuous,<br>T <sub>A</sub> = 70° C, No heat sink (see note) |                                   |
| In 32-pin PLCC package  | 1.67 W                            |
| In 32-pin QFN package   | 3.00 W                            |
| Thermal data:   | θ <sub>JA</sub>                   |
| In 32-pin PLCC package  | 45° C/W                           |
| In 32-pin QFN package   | 25° C/W                           |
| ESD Immunity (Human Body Model)   | JESD22 Class 1C compliant         |

**Note:**

1. Thermal limiting circuitry on the chip will shut down the circuit at a junction temperature of about 165°C. Continuous operation above 145°C junction temperature may degrade device reliability.
2. The thermal performance of a thermally enhanced package is assured through optimized printed circuit board layout. Specified performance requires that the exposed thermal pad be soldered to an equally sized exposed copper surface, which, in turn, conducts heat through multiple vias to a large internal copper plane.

### Package Assembly

The green package devices are assembled with enhanced, environmental compatible lead-free, halogen-free, and antimony-free materials. The leads possess a matte-tin plating which is compatible with conventional board assembly processes or newer lead-free board assembly processes. The peak soldering temperature should not exceed 245°C during printed circuit board assembly.

Refer to IPC/JEDEC J-Std-020B Table 5-2 for the recommended solder reflow temperature profile.

## OPERATING RANGES

Legerity guarantees the performance of this device over commercial (0 to 70° C) and industrial (-40 to 85°C) temperature ranges by conducting electrical characterization over each range and by conducting a production test with single insertion coupled to periodic sampling. These characterization and test procedures comply with section 4.6.2 of Bellcore GR-357-CORE Component Reliability Assurance Requirements for Telecommunications Equipment.

### Environmental Ranges

|                           |                                    |
|---------------------------|------------------------------------|
| Ambient Temperature       | 0 to 70°C Commercial               |
|                           | -40 to +85 °C extended temperature |
| Ambient Relative Humidity | 15 to 85%                          |

### Electrical Ranges

|                                  |                              |
|----------------------------------|------------------------------|
| V <sub>CC</sub>                  | 4.75 to 5.25 V               |
| V <sub>NEG</sub>                 | -4.75 V to V <sub>BAT2</sub> |
| V <sub>BAT1</sub>                | -40.5 to -75 V               |
| V <sub>BAT2</sub>                | -19 V to V <sub>BAT1</sub>   |
| AGND/DGND                        | 0 V                          |
| BGND with respect to AGND/DGND   | -100 to +100 mV              |
| Load resistance on VTX to ground | 20 kΩ minimum                |

## SPECIFICATIONS

### Transmission Performance

| Description                                     | Test Conditions (See Note 1)                   | Min  | Typ | Max | Unit             | Note    |
|---|--|------|-----|-----|------------------|---------|
| 2-wire return loss                              | 200 Hz to 3.4 kHz (See Figure 6.)              | 26   |     |     | dB               | 1, 4, 6 |
| Z <sub>VTX</sub> , analog output impedance      |  |      | 3   | 20  | Ω                | 4       |
| V <sub>VTX</sub> , analog output offset voltage | 0 to +70° C                                    | -35  |     | +35 | mV               | 4       |
|   | -40 to +85° C                                  | -40  |     | +40 |                  |         |
| Z <sub>RSN</sub> , analog input impedance       |  |      | 1   | 20  | Ω                |         |
| Overload level, 2-wire and 4-wire, Off hook     | Active state                                   | 2.5  |     |     | V <sub>pk</sub>  | 2a      |
| Overload level, 2-wire                          | On hook, R <sub>LAC</sub> = 600 Ω              | 0.88 |     |     | V <sub>rms</sub> | 2b      |
| THD (Total Harmonic Distortion)                 | +3 dBm, BAT 2 = -24 V                          |      | -64 | -50 | dB               | 5       |
| THD, On hook, OHT state                         | 0dBm, R <sub>LAC</sub> = 600 Ω<br>BAT1 = -75 V |      |     | -40 |                  |         |





## Line Characteristics

| Description                              | Test Conditions (See Note 1)   | Min        | Typ      | Max        | Unit    | Note |
|--|--|------------|----------|------------|---------|------|
| $I_L$ , Loop-current accuracy            | $I_L$ in constant-current region, B2EN=0   | $0.915I_L$ | $I_L$    | $1.085I_L$ | mA      |      |
| $I_L$ , Long Loops, Active state         | $R_{LDC} = 600 \Omega$ , RSGL = open   | 20         | 21.7     |            |         |      |
|  | $R_{LDC} = 750 \Omega$ , RSGL = short  | 20         |          |            |         |      |
| $I_L$ , Accuracy, Standby state          | $I_L = \frac{ V_{BAT1}  - 10 V}{R_L + 400}$<br>$I_L$ = constant-current region<br>$T_A = 25^\circ C$<br>$-40$ to $+85^\circ C$ | $0.8I_L$   | $I_L$    | $1.2I_L$   |         |      |
|  |  | 18         | 27       | 39         |         | 4    |
|  |  | 18         | 27       |            |         |      |
| $I_{LIM}$                                | Active, A and B to ground<br>OHT, A and B to ground  |            | 55<br>55 | 110        |         | 4    |
| $I_L$ , Loop current, Open Circuit state | $R_L = 0$  |            |          | 100        | $\mu A$ |      |
| $I_A$ , Pin A leakage, Tip Open state    | $R_L = 0$  |            |          | 100        |         |      |
| $I_B$ , Pin B current, Tip Open state    | B to ground  |            | 34       |            | mA      |      |
| VA, Standby, ground start signaling      | A to $-48 V = 7 k\Omega$ ,<br>B to ground = $100 \Omega$   | $-7.5$     | $-5$     |            | V       | 4    |
| $V_{AB}$ , Open Circuit voltage          |  | 42.8       |          |            |         | 8    |

## Power Supply Rejection Ratio

( $V_{RIPPLE} = 100$  mVrms), Active Normal State

| Description | Test Conditions (See Note 1) | Min | Typ | Max | Unit | Note |
|-------------|------------------------------|-----|-----|-----|------|------|
| $V_{CC}$    | 50 to 3400 Hz                | 33  | 50  |     | dB   | 5    |
| $V_{NEG}$   | 50 to 3400 Hz                | 30  | 40  |     |      |      |
| $V_{BAT1}$  | 50 to 3400 Hz                | 30  | 50  |     |      |      |
| $V_{BAT2}$  | 50 to 3400 Hz                | 30  | 50  |     |      |      |

## Power Dissipation

| Description                 | Test Conditions (See Note 1)                | Min | Typ  | Max  | Unit | Note |
|-----------------------------|---|-----|------|------|------|------|
| On hook, Open Circuit state | $V_{BAT1}$                                  |     | 48   | 100  | mW   |      |
| On hook, Standby state      | $V_{BAT2}$                                  |     | 55   | 80   |      | 10   |
| On hook, OHT state          | $V_{BAT1}$                                  |     | 200  | 300  |      |      |
| On hook, Active state       | $V_{BAT1}$                                  |     | 220  | 350  |      |      |
| Off hook, Standby state     | $V_{BAT1}$ or $V_{BAT2}$ $R_L = 300 \Omega$ |     | 2000 | 2800 |      | 10   |
| Off hook, OHT state         | $V_{BAT1}$ $R_L = 300 \Omega$               |     | 2000 | 2200 |      |      |
| Off hook, Active state      | $V_{BAT2}$ $R_L = 300 \Omega$               |     | 550  | 750  |      |      |

## Supply Currents

| Description                                     | Test Conditions (See Note 1) | Min | Typ  | Max | Unit | Note |
|---|------------------------------|-----|------|-----|------|------|
| $I_{CC}$ ,<br>On-hook $V_{CC}$ supply current   | Open Circuit state           |     | 3.0  | 4.5 | mA   |      |
|   | Standby state                |     | 3.2  | 5.5 |      |      |
|   | OHT state                    |     | 6.2  | 8.0 |      |      |
|   | Active state-normal          |     | 6.5  | 9.0 |      |      |
| $I_{NEG}$ ,<br>On-hook $V_{NEG}$ supply current | Open Circuit state           |     | 0.1  | 0.2 |      |      |
|   | Standby state                |     | 0.1  | 0.2 |      |      |
|   | OHT state                    |     | 0.7  | 1.1 |      |      |
|   | Active state-normal          |     | 0.7  | 1.1 |      |      |
| $I_{BAT}$ ,<br>On-hook $V_{BAT}$ supply current | Open Circuit state           |     | 0.45 | 1.0 |      |      |
|   | Standby state                |     | 0.6  | 1.5 |      |      |
|   | OHT state                    |     | 2.0  | 4.0 |      |      |
|   | Active state-normal          |     | 2.7  | 5.0 |      |      |

## Logic Inputs

(Applies to C3–C1, D2–D1, E1, and B2EN).

| Description                   | Test Conditions | Min  | Typ | Max | Unit    | Note |
|-------------------------------|-----------------|------|-----|-----|---------|------|
| $V_{IH}$ , Input High voltage |                 | 2.0  |     |     | V       |      |
| $V_{IL}$ , Input Low voltage  |                 |      |     | 0.8 |         |      |
| $I_{IH}$ , Input High current |                 | –75  |     | 40  | $\mu$ A |      |
| $I_{IL}$ , Input Low current  |                 | –400 |     |     |         |      |

## Logic Output

(DET)

| Description                    | Test Conditions (See Note 1)                   | Min | Typ | Max  | Unit | Note |
|--------------------------------|--|-----|-----|------|------|------|
| $V_{OL}$ , Output Low voltage  | $I_{OUT} = 0.8$ mA, 15 k $\Omega$ to $V_{CC}$  |     |     | 0.40 | V    |      |
| $V_{OH}$ , Output High voltage | $I_{OUT} = -0.1$ mA, 15 k $\Omega$ to $V_{CC}$ | 2.4 |     |      |      |      |

## Ring-Trip Detector Input

| Description          | Test Conditions (See Note 1)   | Min | Typ | Max | Unit | Note |
|----------------------|--|-----|-----|-----|------|------|
| Ring detect accuracy | $IRTD = \left( \frac{ BAT1  - 1}{RRT1} + 24 \mu A \right) \cdot 335$ |     | –10 |     | +10  | %    |

## Ring Signal

| Description                                       | Test Conditions (See Note 1)           | Min | Typ | Max | Unit | Note |
|---|--|-----|-----|-----|------|------|
| $V_{AB}$ , Ringing                                | BAT1 = –75 V, Ringload = 1570 $\Omega$ | 66  | 69  |     | Vpk  | 7    |
| $V_{AB}$ , Ringing offset                         | $V_{RINGIN} = 2.5$ V                   | –10 | 0   | 10  | V    |      |
| $\Delta V_{AB} / \Delta V_{RINGIN}$ (RINGIN gain) |  | 150 | 180 | 210 |      |      |

## Ground-Key Detector Thresholds

| Description                    | Test Conditions (See Note 1) | Min | Typ | Max | Unit       | Note |
|--------------------------------|------------------------------|-----|-----|-----|------------|------|
| Ground-key resistive threshold | B to ground                  | 2   | 5   | 10  | k $\Omega$ |      |
| Ground-key current threshold   | B to ground                  |     | 11  |     | mA         |      |

## Loop Detector

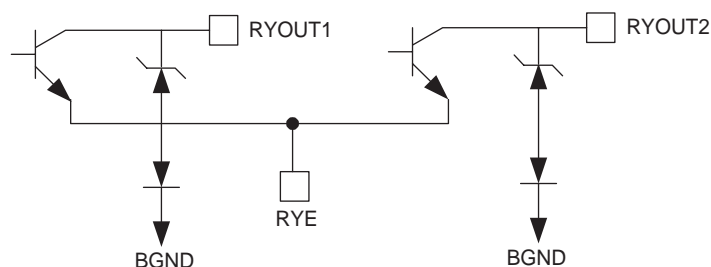
| Description                                  | Test Conditions (See Note 1) | Min | Typ | Max | Unit | Note |
|--|------------------------------|-----|-----|-----|------|------|
| $R_{LTH}$ , Loop-resistance detect threshold | Active, $V_{BAT1}$           | -20 |     | 20  | %    | 9    |
|  | Active, $V_{BAT2}$           | -20 |     | 20  |      |      |
|  | Standby                      | -15 |     | 15  |      |      |

## Relay Driver Output

(Relay 1 and 2)

| Description                          | Test Conditions (See Note 1) | Min | Typ   | Max  | Unit          | Note |
|--------------------------------------|------------------------------|-----|-------|------|---------------|------|
| $V_{OL}$ , On voltage (each output)  | $I_{OL} = 30 \text{ mA}$     |     | +0.25 | +0.4 | V             | 4    |
| $V_{OL}$ , On voltage (each output)  | $I_{OL} = 40 \text{ mA}$     |     | +0.30 | +0.8 |               |      |
| $I_{OH}$ , Off leakage (each output) | $V_{OH} = +5 \text{ V}$      |     |       | 100  | $\mu\text{A}$ |      |
| Zener breakover (each output)        | $I_Z = 100 \mu\text{A}$      | 6.6 | 7.9   |      | V             |      |
| Zener on voltage (each output)       | $I_Z = 30 \text{ mA}$        |     | 11    |      |               |      |

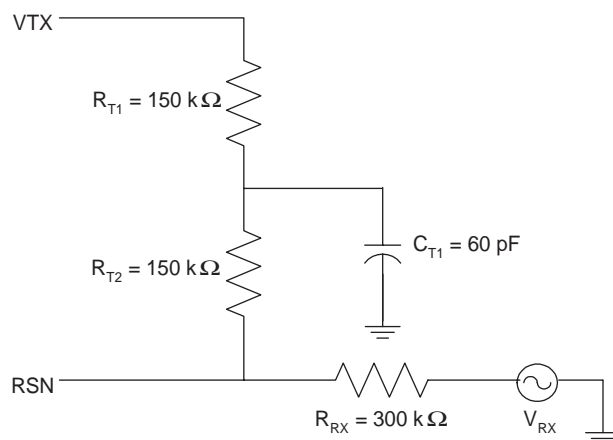
## RELAY DRIVER SCHEMATIC



### Note:

- Unless otherwise noted, test conditions are  $BAT1 = -75 \text{ V}$ ,  $BAT2 = -24 \text{ V}$ ,  $V_{CC} = +5 \text{ V}$ ,  $V_{NEG} = -5 \text{ V}$ ,  $R_L = 600 \Omega$ ,  $R_{DC1} = 80 \text{ k}\Omega$ ,  $R_{DC2} = 20 \text{ k}\Omega$ ,  $R_D = 75 \text{ k}\Omega$ , no fuse resistors,  $C_{HP} = 0.018 \mu\text{F}$ ,  $C_{DC} = 1.2 \mu\text{F}$ ,  $D_1 = D_2 = 1\text{N}400\text{x}$ , two-wire AC input impedance (ZSL) is a  $600 \Omega$  resistance synthesized by the programming network shown below.  $R_{SGL} = \text{open}$ ,  $R_{SGH} = \text{open}$ ,  $R_{DCR1} = 15 \text{ k}\Omega$ ,  $R_{DCR2} = 2 \text{ k}\Omega$ ,  $C_{DCR} = 10 \text{ nF}$ ,  $R_{RT1} = 430 \text{ k}\Omega$ ,  $R_{RT2} = 12 \text{ k}\Omega$ ,  $C_{RT} = 1.5 \mu\text{F}$ ,  $R_{SLEW} = 100 \text{ k}\Omega$ ,  $C_{SLEW} = 0.33 \mu\text{F}$ .

Figure 2. AC Input Impedance Programming Network



2. a. Overload level is defined when THD = 1%.  
b. Overload level is defined when THD = 1.5%.
3. Balance return signal is the signal generated at  $V_{TX}$  by  $V_{RX}$ . This specification assumes that the two-wire AC load impedance matches the programmed impedance.
4. Not tested in production. This parameter is guaranteed by characterization or correlation to other tests.
5. This parameter is tested at 1 kHz in production. Performance at other frequencies is guaranteed by characterization.
6. Group delay can be greatly reduced by using a  $Z_T$  network such as that shown in Note 1 above. The network reduces the group delay to less than 2  $\mu$ s and increases 2WRL. The effect of group delay on linecard performance may also be compensated for by synthesizing complex impedance with the QSLAC or DSLAC device.
7. 70 Vpk provides 50 Vrms with a crest factor of 1.25 to a load of 1400  $\Omega$  with  $2 \cdot R_f = 100$ , and  $R_{line} = 70 \Omega$  (1570  $\Omega$ ).
8. Open Circuit  $V_{AB}$  can be modified using  $R_{SGH}$ .
9.  $R_D$  must be greater than 56 k $\Omega$ . [See User-Programmable Components, on page 13](#), for typical value of  $R_{LTH}$ .
10. Lower power is achieved by switching into low-battery state in standby. Standby loop current is returned to  $V_{BAT1}$  regardless of the battery selected.

## SLIC Device Decoding

| State | C3 C2 C1 | Two-Wire Status          | (DET) Output  |            | Battery    |
|-------|----------|--------------------------|---------------|------------|------------|
|       |          |                          | E1 = 1        | E1 = 0     |            |
| 0     | 0 0 0    | Open Circuit             | Ring trip     | Ring trip  | B2EN       |
| 1     | 0 0 1    | Ringing                  | Ring trip     | Ring trip  |            |
| 2     | 0 1 0    | Active                   | Loop detector | Ground key |            |
| 3     | 0 1 1    | On-hook TX (OHT)         | Loop detector | Ground key |            |
| 4     | 1 0 0    | Reserved                 | Loop detector | Ground key | B2EN = 1** |
| 5     | 1 0 1    | Standby                  | Loop detector | Ground key | $V_{BAT1}$ |
| 6*    | 1 1 0    | Active Polarity Reversal | Loop detector | Ground key | B2EN       |
| 7*    | 1 1 1    | OHT Polarity Reversal    | Loop detector | Ground key |            |

### Note:

\* Only -1 and -2 performance grade device supports polarity reversal.

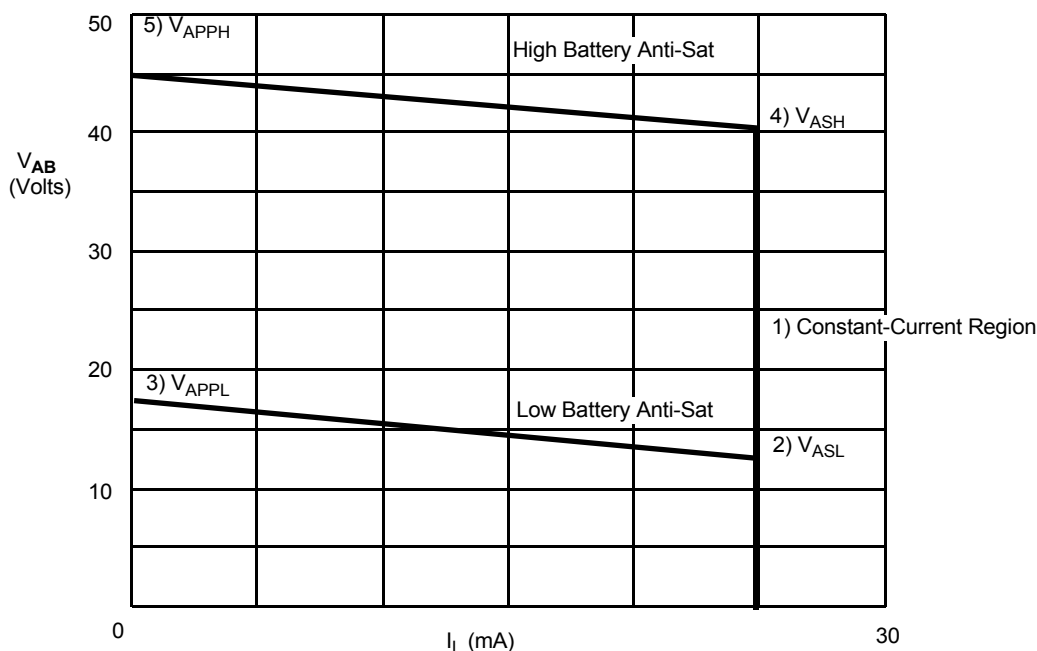
\*\* For correct ground-start operation using Tip Open,  $V_{BAT1}$  on-hook battery must be used.

## User-Programmable Components

|  |  |
|--|--|
| $Z_T = 500(Z_{2WIN} - 2R_F)$   | $Z_T$ is connected between the VTX and RSN pins. The fuse resistors are $R_F$ , and $Z_{2WIN}$ is the desired 2-wire AC input impedance. When computing $Z_T$ , the internal current amplifier pole and any external stray capacitance between VTX and RSN must be taken into account.   |
| $Z_{RX} = \frac{Z_L}{G_{42L}} \cdot \frac{1000 \cdot Z_T}{Z_T + 500(Z_L + 2R_F)}$  | $Z_{RX}$ is connected from $V_{RX}$ to $R_{SN}$ . $Z_T$ is defined above, and $G_{42L}$ is the desired receive gain.   |
| $R_{DC1} + R_{DC2} = \frac{2500}{I_{LOOP}}$<br>$R_{DCR1} + R_{DCR2} = \frac{3000}{I_{RINGLIM}}$<br>$C_{DC} = 19 \text{ ms} \cdot \frac{R_{DC1} + R_{DC2}}{R_{DC1}R_{DC2}}$<br>$C_{DCR} = \frac{R_{DCR1} + R_{DCR2}}{R_{DCR1}R_{DCR2}} \cdot 150 \mu s$ | $R_{DC1}$ , $R_{DC2}$ , and $C_{DC}$ form the network connected to the RDC pin. $I_{LOOP}$ is the desired loop current in the constant-current region.<br><br>$R_{DCR1}$ , $R_{DCR2}$ , and $C_{DCR}$ form the network connected to the RDCR pin.<br><a href="#">See Application Circuit, on page 20.</a> for these components.<br><br>$C_{DCR}$ sets the ringing time constant, which can be between 15 $\mu s$ and 150 $\mu s$ . |
| $R_D = R_{LTH} \cdot 12.67 \text{ for high battery state}$   | $R_D$ is the resistor connected from the RD pin to GND and $R_{LTH}$ is the loop-resistance threshold between on-hook and off-hook detection. $R_D$ should be greater than 56 k $\Omega$ to guarantee detection occurs in the Standby state. Choose the value of $R_D$ for high battery state; then use the equation for $R_{LTH}$ to find where the threshold is for low battery.   |
| <b>Loop-Threshold Detect Equations</b>   |  |
| $R_{LTH} = \frac{R_D}{12.67} \text{ for high battery state}$   | This is the same equation as for $R_D$ above, except solved for $R_{LTH}$ .  |
| $R_{LTH} = \frac{R_D}{11.37} \text{ for Active state}$   | For low battery, the detect threshold is slightly higher, which avoids oscillating between states.   |
| $R_{LTH} = \frac{ V_{BAT1}  - 10}{915} \cdot R_D - 400 - 2R_F$   | $R_{LTH} \text{ Standby} < R_{LTH} \text{ Active } V_{BAT1} < R_{LTH} \text{ Active } V_{BAT2}$ , which guarantees no unstable states under all operating conditions. This equation shows at what resistance the Standby threshold is; it is actually a current threshold rather than a resistance threshold, which is shown by the $V_{BAT}$ dependency.  |

## DC FEED CHARACTERISTICS

Figure 3. Typical  $V_{AB}$  vs.  $I_L$  DC Feed Characteristics



$$R_{DC} = R_{DC1} + R_{DC2} = 20 \text{ k}\Omega + 80 \text{ k}\Omega = 100 \text{ k}\Omega$$

$$(V_{BAT1} = -75 \text{ V}, V_{BAT2} = -24 \text{ V})$$

**Notes:**

1. Constant-current region:  $V_{AB} = I_L R_L = \frac{2500}{R_{DC}} R_L$ ; where  $R_L = R_L + 2R_F$ ,

2. Low battery  $V_{ASL} = \frac{1000 \cdot (104 \cdot 10^3 + R_{SGL})}{6720 \cdot 10^3 + (80 \cdot R_{SGL})}$ ; where  $R_{SGL}$  = resistor to GND, B2EN = logic Low.

Anti-sat region:  $V_{ASL} = \frac{1000 \cdot (R_{SGL} - 56 \cdot 10^3)}{6720 \cdot 10^3 + (80 \cdot R_{SGL})}$ ; where  $R_{SGL}$  = resistor to  $V_{CC}$ , B2EN = logic Low.  
 $R_{SGL}$  to  $V_{CC}$  must be greater than 100 k $\Omega$ .

3.  $V_{APPL} = 4.17 + V_{ASL}$

$$I_{LOOP} = \frac{V_{APPL}}{\frac{(R_{DC1} + R_{DC2})}{600} + 2R_F + R_{LOOP}}$$

4. High battery  $V_{ASH} = V_{ASHH} + V_{ASL}$

Anti-sat region:  $V_{ASHH} = \frac{1000 \cdot (70 \cdot 10^3 + R_{SGH})}{1934 \cdot 10^3 + (31.75 \cdot R_{SGH})}$ ; where  $R_{SGH}$  = resistor to GND, B2EN = logic High.

$$V_{ASHH} = \frac{1000 \cdot (R_{SGH} + 2.75 \cdot 10^3)}{1934 \cdot 10^3 + (31.75 \cdot R_{SGH})}$$
; where  $R_{SGH}$  = resistor to  $V_{CC}$ , B2EN = logic High.  
 $R_{SGH}$  to  $V_{CC}$  must be greater than 100 k $\Omega$ .

5.  $V_{APPH} = 4.17 + V_{ASH}$

$$I_{LOPH} = \frac{V_{APPH}}{\frac{(R_{DC1} + R_{DC2})}{600} + 2R_F + R_{LOPH}}$$

## RING-TRIP COMPONENTS

$$R_{RT2} = 12 \text{ k}\Omega$$

$$C_{RT} = 1.5 \text{ }\mu\text{F}$$

$$R_{RT1} = 300 \cdot CF \cdot \frac{V_{BAT1}}{V_{bat} - 3.5 - (15 \text{ }\mu\text{A} \cdot 300 \cdot CF \cdot (R_{LRT} + 150 + 2R_F))} \cdot (R_{LRT} + 150 + 2R_F)$$

where  $R_{LRT}$  = Loop-detection threshold resistance for ring trip and  $CF$  = Crest factor of ringing signal ( $\approx 1.25$ )

$$R_{SLEW}, C_{SLEW}$$

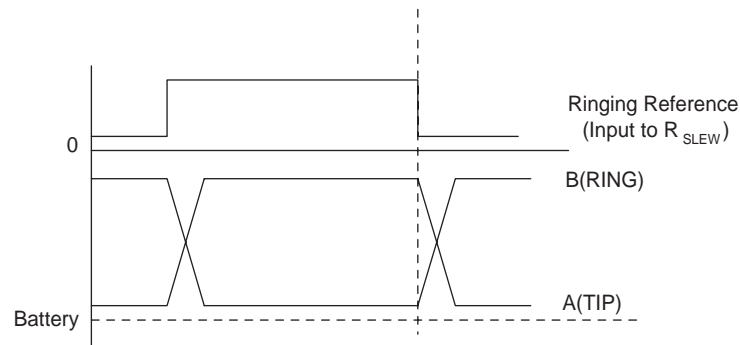
$$\text{Ring waveform rise time} \approx 0.214 \cdot (R_{SLEW} \cdot C_{SLEW}) \approx tr.$$

For a 1.25 crest factor @ 20 Hz,  $tr \approx 10 \text{ mS}$ .

$$\therefore (R_{SLEW} = 150 \text{ k}\Omega, C_{SLEW} = 0.33 \text{ }\mu\text{F})$$

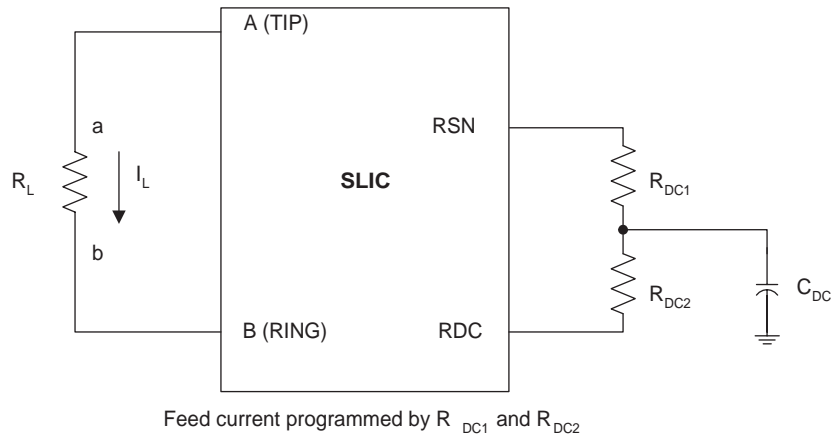
$C_{SLEW}$  should be changed if a different crest factor is desired.

**Figure 4. Ringing Waveforms**



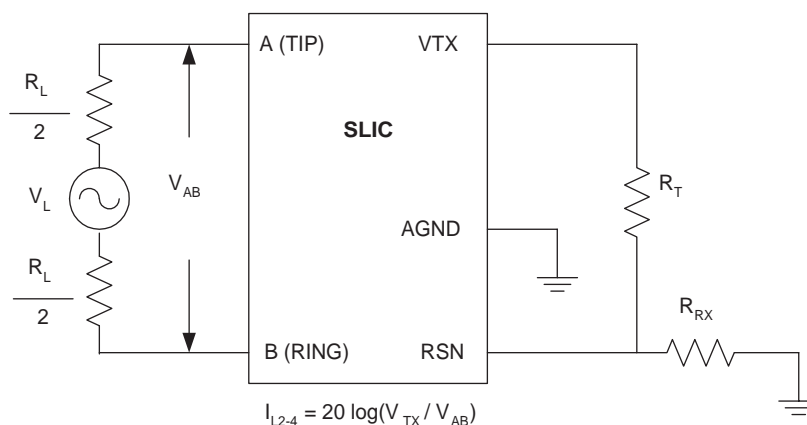
This is the best time for switching between Ringing and other states for minimizing detect switching transients.

**Figure 5. Feed Programming**

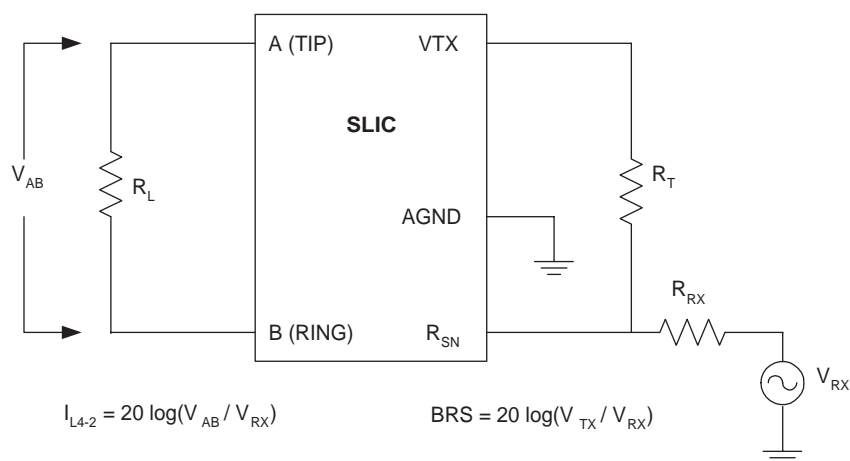


## TEST CIRCUITS

**Figure 6. Two-to-Four-Wire Insertion Loss**



**Figure 7. Four-to-Two-Wire Insertion Loss and Four-to-Four-Wire Balance Return Signal**



**Figure 8. Longitudinal Balance**

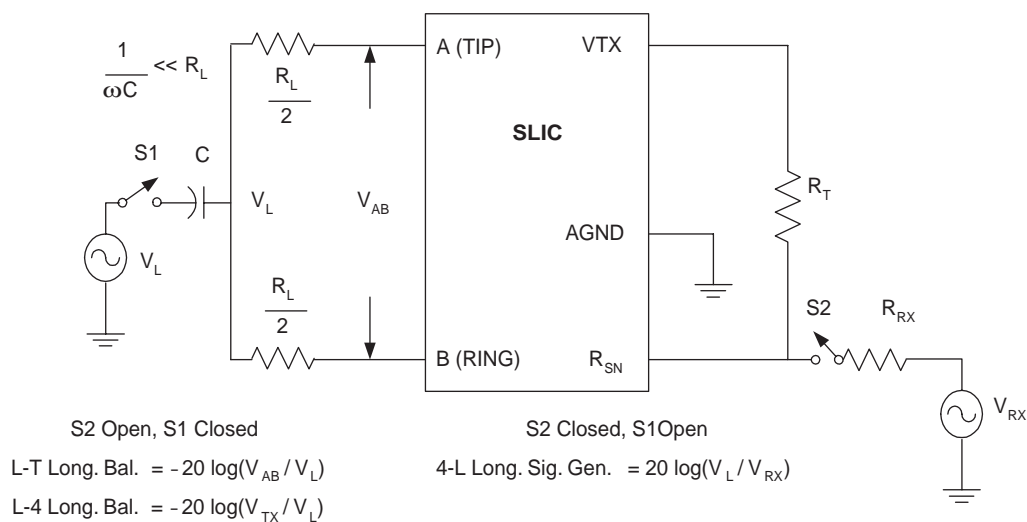




Figure 9. Two-Wire Return Loss Test Circuit

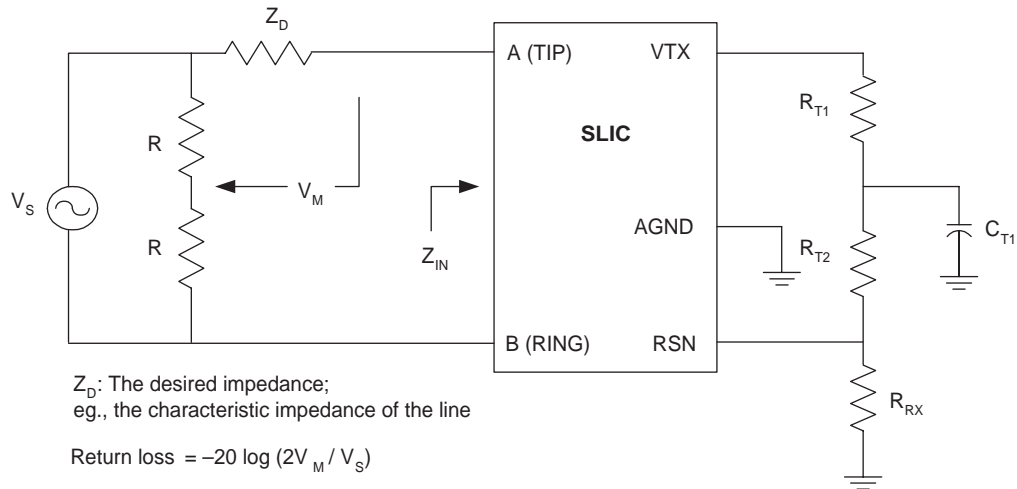


Figure 10. Loop-Detector Switching

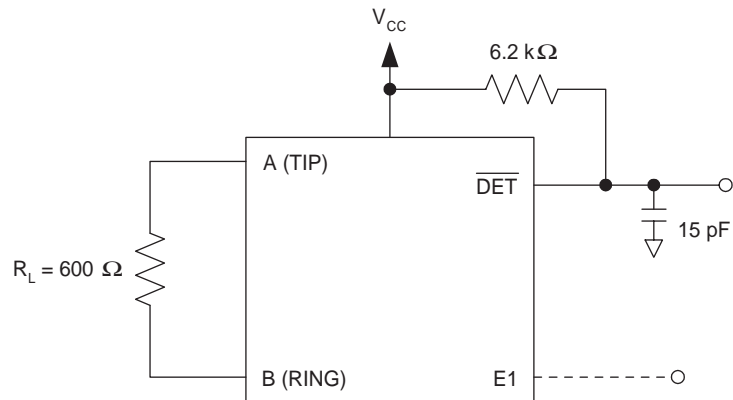
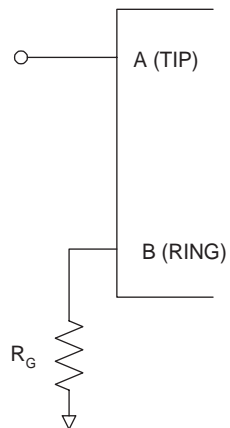
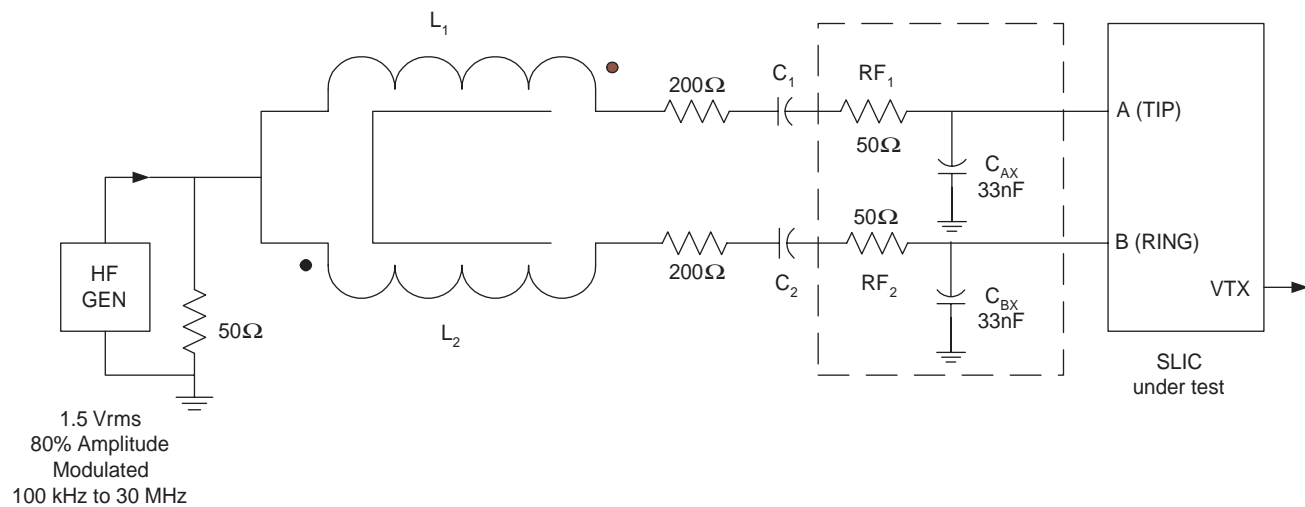


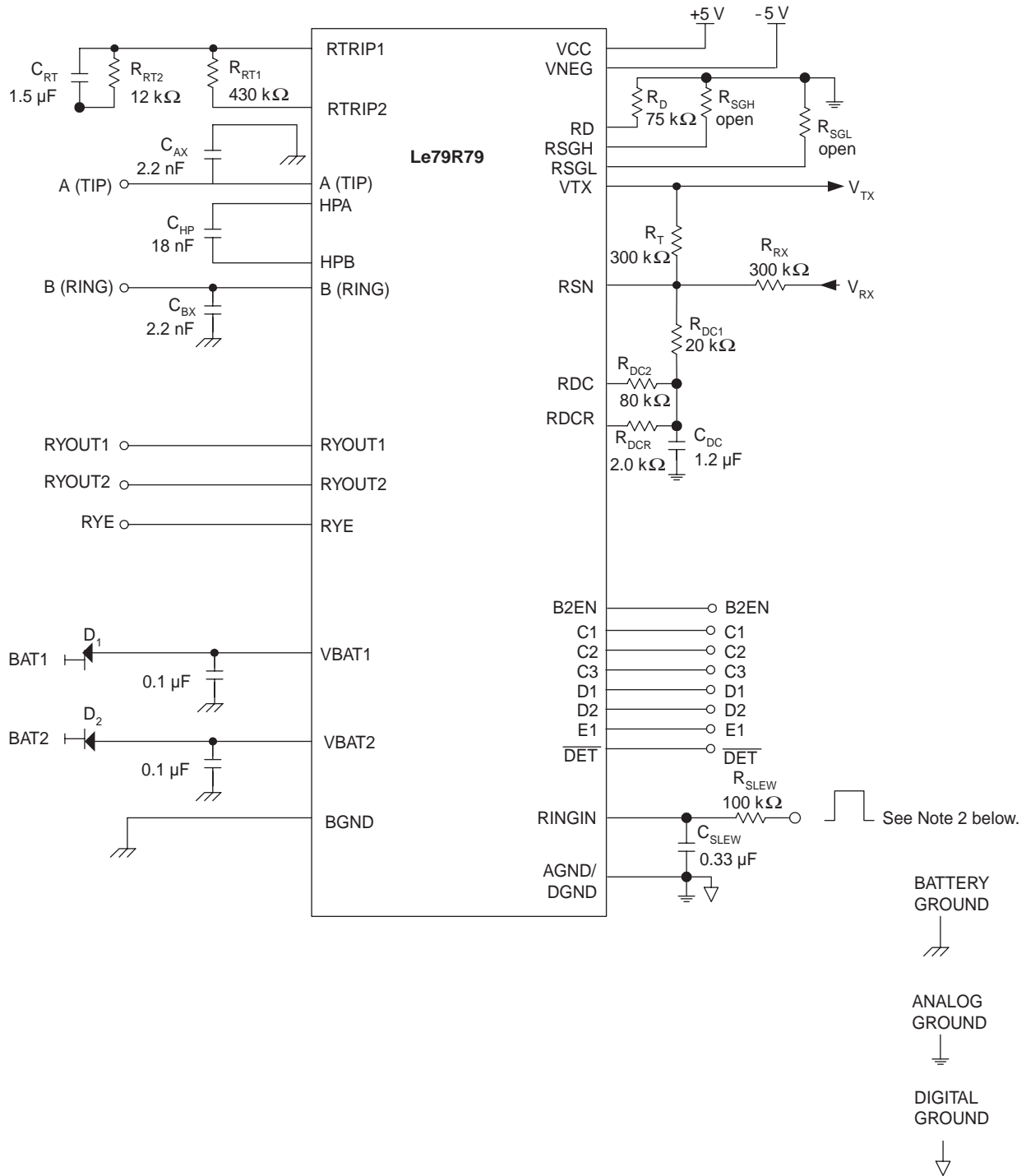
Figure 11. Ground-Key Switching



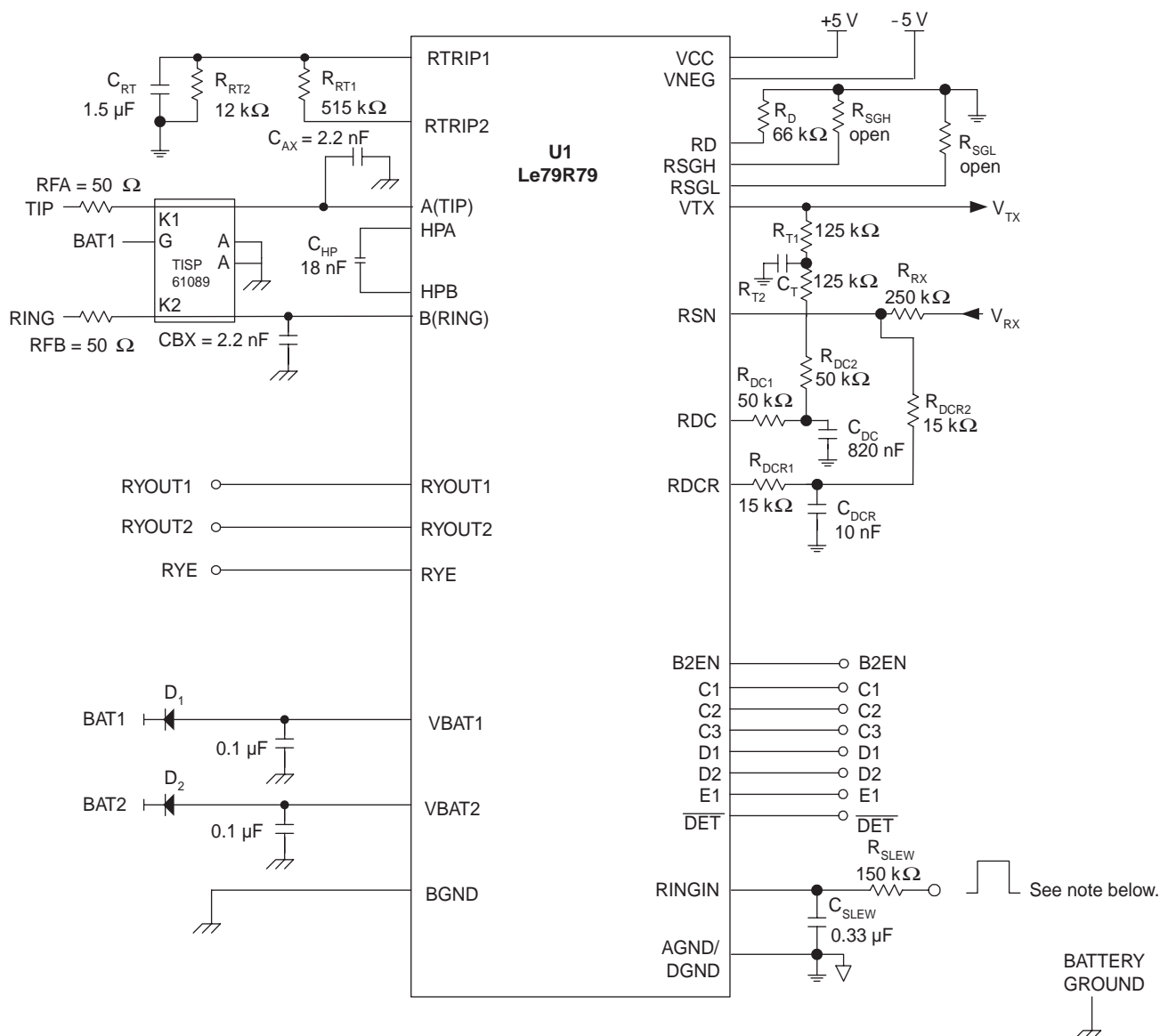
**Figure 12. RFI Test Circuit**



## Le79R79 TEST CIRCUIT



## APPLICATION CIRCUIT



### Assumptions:

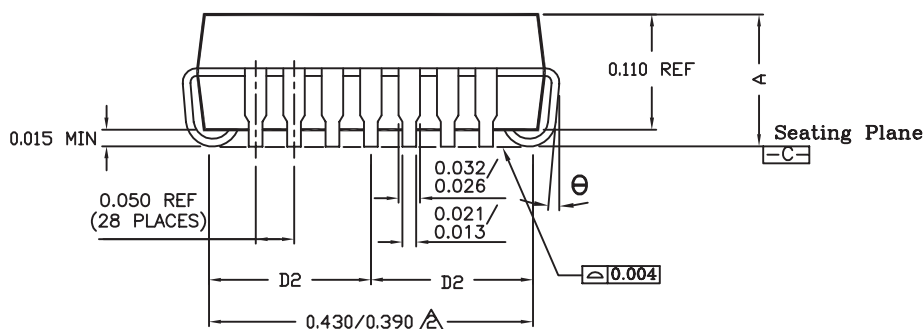
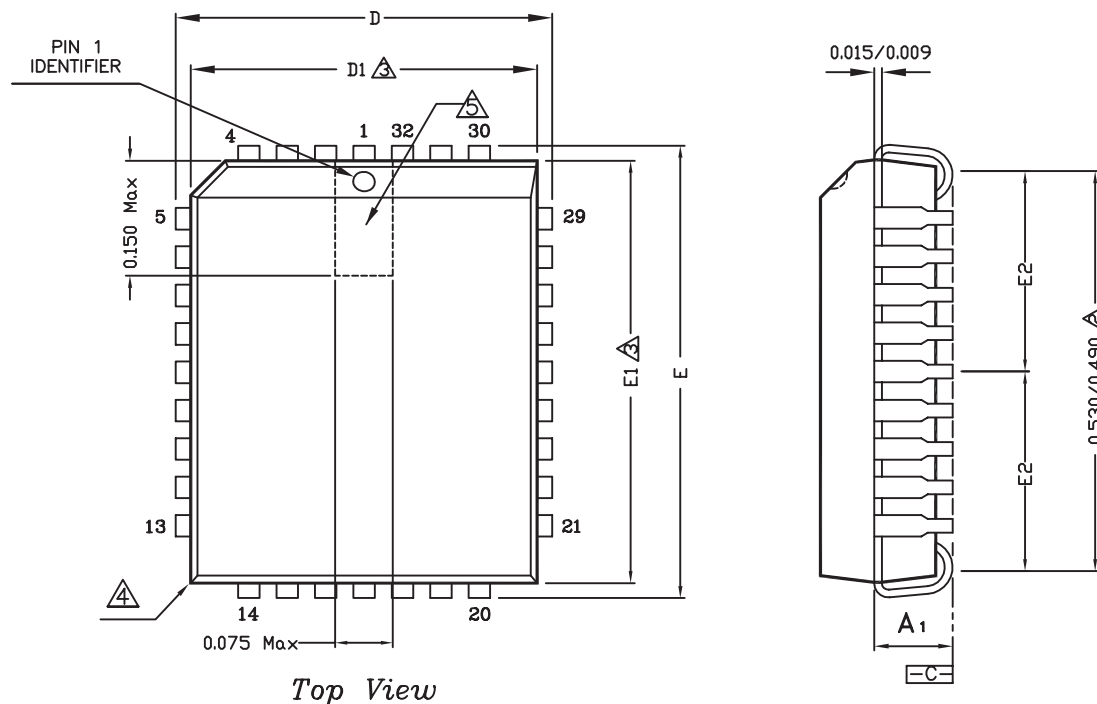
- |                                 |  |                               |
|---------------------------------|--|-------------------------------|
| 1. 1.25 CF                      | 4. 5.2 k $\Omega$ High Battery Loop Threshold          | 7. $G_{42L} = 1$              |
| 2. 25 mA $I_{LOOP}$             | 5. 925 $\Omega$ Ringing Loop Threshold                 | 8. -70 V V bat1, -24 V V bat2 |
| 3. 100 mA Ringing Current Limit | 6. 600 $\Omega$ Two-wire Impedance, 600 $\Omega$ $Z_L$ |                               |

### Note:

The input should be 50% duty cycle CMOS-compatible input.

## PHYSICAL DIMENSIONS

### 32-pin PLCC



#### NOTE :

1. DIMENSIONING AND TOLERANCING CONFORM TO ASME Y14.5M-1994.
- △ TO BE MEASURED AT SEATING PLANE  $\square C \square$  CONTACT POINT.
- △ DIMENSIONS D1 AND E1 DO NOT INCLUDE MOLD PROTRUSION. ALLOWABLE MOLD PROTRUSION IS 0.010 IN PER SIDE. DIMENSIONS D, AND E, INCLUDE MOLD MISMATCH AND DETERMINED AT THE PARTING LINE; THAT IS D1 AND E1 ARE MEASURED AT THE EXTREME MATERIAL CONDITION AT THE UPPER OR LOWER PARTING LINE.
- △ EXACT SHAPE OF THIS FEATURE IS OPTIONAL.
- △ DETAILS OF PIN 1 IDENTIFIER ARE OPTIONAL BUT MUST BE LOCATED WITHIN THE ZONE INDICATED.
6. SUM OF DAM BAR PROTRUSIONS TO BE 0.007 MAX PER LEAD.
7. CONTROLLING DIMENSION : INCH.
8. REFERENCE DOCUMENT : JEDEC MS-016

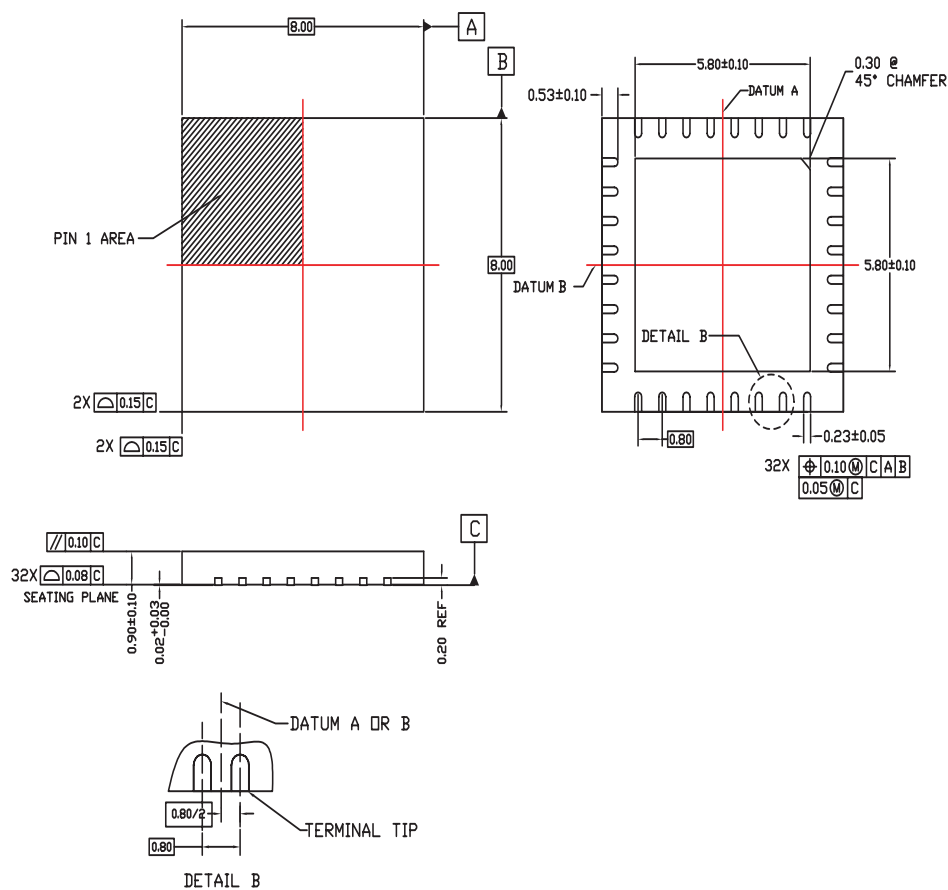
| Symbol | Dimension in inch |       |       |
|--------|-------------------|-------|-------|
|        | Min               | Nom   | Max   |
| A      | 0.125             | —     | 0.140 |
| A1     | 0.075             | 0.090 | 0.095 |
| D      | 0.485             | 0.490 | 0.495 |
| D1     | 0.447             | 0.450 | 0.453 |
| D2     | 0.205 REF         |       |       |
| E      | 0.585             | 0.590 | 0.595 |
| E1     | 0.547             | 0.550 | 0.553 |
| E2     | 0.255 REF         |       |       |
| θ      | 0°                | —     | 10°   |

#### Note:

Packages may have mold tooling markings on the surface. These markings have no impact on the form, fit or function of the device. Markings will vary with the mold tool used in manufacturing.

## 32-pin QFN

### 32 Lead QFN with Chamfer



| Symbol | 32 LEAD QFN |      |      |
|--------|-------------|------|------|
|        | Min         | Nom  | Max  |
| A      | 0.80        | 0.90 | 1.00 |
| A2     | 0.57 REF    |      |      |
| b      | 0.18        | 0.23 | 0.28 |
| D      | 8.00 BSC    |      |      |
| D2     | 5.70        | 5.80 | 5.90 |
| E      | 8.00 BSC    |      |      |
| E2     | 5.70        | 5.80 | 5.90 |
| e      | 0.80 BSC    |      |      |
| L      | 0.43        | 0.53 | 0.63 |
| N      | 32          |      |      |
| A1     | 0.00        | 0.02 | 0.05 |
| A3     | 0.20 REF    |      |      |
| aaa    | 0.20        |      |      |
| bbb    | 0.10        |      |      |
| ccc    | 0.10        |      |      |

#### NOTES:

1. Dimensioning and tolerancing conform to ASME Y14.5M-1994.
2. All dimensions are in millimeters.  $\phi$  is in degrees.
3. N is the total number of terminals.
4. The Terminal #1 identifier and terminal numbering convention shall conform to JEP 95-1 and SSP-012. Details of the Terminal #1 identifier are optional, but must be located within the zone indicated. The Terminal #1 identifier may be either a mold or marked feature.
5. Coplanarity applies to the exposed pad as well as the terminals.
6. Reference Document: JEDEC MO-220.
7. Lead width deviates from the JEDEC MO-220 standard.

#### Note:

Packages may have mold tooling markings on the surface. These markings have no impact on the form, fit or function of the device. Markings will vary with the mold tool used in manufacturing.

## REVISION HISTORY

### Revision B to C

- Minor changes were made to the data sheet style and format to conform to Legerity standards.
- Electrical Characteristics; Last row under Ring Signal, min changed from 130 to 150, typ changed from 160 to 180, and max changed from 190 to 210.
- SLIC Decoding Table; Added B2EN reference to the Battery Selection column and its corresponding note to the notes section.
- Applications Circuit; Revised

### Revision C to D

- Minor changes were made to the data sheet style and format to conform to Legerity standards.

### Revision D to E

- On pages 17 and 18, R<sub>DC1</sub> and R<sub>DC2</sub> were switched.

### Revision E to F

- The physical dimensions (PL032) were added to the Physical Dimensions section.
- Deleted the Ceramic DIP and Plastic DIP packages and references to them.
- Updated the Pin Description table to correct inconsistencies.

### Revision F to G

- The equation on page 13 was changed:

from: 
$$R_{RT1} = 300 \cdot CF \cdot \frac{V_{BAT1}}{V_{bat} - 3.5 - (15 \mu A \cdot 300 \cdot CF \cdot (R_{LRT} + 150 + 2R_F))} \cdot (R_{LRT} + 150 + 2R_F)$$

to: 
$$R_{RT1} = 320 \cdot CF \cdot \frac{V_{BAT1}}{V_{bat} - 5 - (24 \mu A \cdot 320 \cdot CF \cdot (R_{LRT} + 150 + 2R_F))} \cdot (R_{LRT} + 150 + 2R_F)$$

### Revision G to H

- In "Ordering Information" section, added description for wafer foundry facility optional character.

### Revision H to I

- Updated document format
- Added OPNs for QFN package to Ordering Information table
- Added physical dimensions for 8x8 QFN package

### Revision I to J1

- Added green package OPN to [Ordering Information, on page 1](#)
- Added [Package Assembly, on page 6](#)
- Updated document format

### Revision J1 to K1

- Added Note 3 to [Connection Diagrams, on page 4](#)

### Revision K1 to L1

- Added "Packing" column and Note 2 and 4 to [Ordering Information, on page 1](#)
- Updated 32QFN drawing in [Physical Dimensions, on page 21](#)

### Revision L1 to M1

- Added option for PLCC green package to [Ordering Information, on page 1](#)
- Added option for QFN green package for dash grades 2 through 4 in [Ordering Information, on page 1](#)
- Added note to [Physical Dimensions, on page 21](#)

## Revision M1 to N1

- Removed OPNs for all non-green packaged parts from [Ordering Information, on page 1](#)
- Removed 79R79-3QC, 79R79-4JC and 79R79-4QC from [Ordering Information, on page 1](#)

## Revision N1 to N2

- Removed reference to Le79R79-4 option from [Ordering Information, on page 1](#)



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