

## Absolute Maximum Ratings

(All voltages referenced to GND.)

|   |                                      |
|---|--------------------------------------|
| V <sub>BUS</sub> .....                      | -6V to +30V                          |
| CHG_AL_N .....                              | -0.3V to +30V                        |
| SW_OPEN, GOOD_BAT .....                     | -0.3V to +6V                         |
| CHG_DET (Note 1) .....                      | -0.3V to (V <sub>CCINT</sub> + 0.3V) |
| TDP, TDN .....                              | -0.3V to (V <sub>CCINT</sub> + 0.3V) |
| CDP, CDN .....                              | -0.3V to +6V                         |
| Continuous Current into All Terminals ..... | ±50mA                                |

Continuous Power Dissipation (T<sub>A</sub> = +70°C)

|   |                 |
|---|-----------------|
| UTQFN (derate 9mW/°C above +70°C) ..... | 722mW           |
| Operating Temperature Range .....       | 0°C to +70°C    |
| Maximum Junction Temperature .....      | +150°C          |
| Storage Temperature Range .....         | -65°C to +150°C |
| Lead Temperature (soldering, 10s) ..... | +300°C          |
| Soldering Temperature (reflow) .....    | +260°C          |

**Note 1:** V<sub>CCINT</sub> = min (V<sub>BUS</sub>, +4.2V).

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

## Package Information

| PACKAGE TYPE: 10 ULTRA QFN             |                         |
|--|-------------------------|
| Package Code                           | V101A2CN+1              |
| Outline Number                         | <a href="#">21-0610</a> |
| Land Pattern Number                    | <a href="#">90-0386</a> |
| THERMAL RESISTANCE, FOUR-LAYER BOARD   |                         |
| Junction to Ambient (θ <sub>JA</sub> ) | 110.8°C/W               |
| Junction to Case (θ <sub>JC</sub> )    | 62.1°C/W                |

Package thermal resistances were obtained using the method described in JEDEC specification JESD51-7, using a four-layer board. For detailed information on package thermal considerations, refer to [www.maximintegrated.com/thermal-tutorial](http://www.maximintegrated.com/thermal-tutorial).

For the latest package outline information and land patterns (footprints), go to [www.maximintegrated.com/packages](http://www.maximintegrated.com/packages). Note that a "+", "#", or "-" in the package code indicates RoHS status only. Package drawings may show a different suffix character, but the drawing pertains to the package regardless of RoHS status.

## Electrical Characteristics

( $V_{VBUS} = 3.5V$  to  $5.5V$ ,  $T_A = 0^{\circ}C$  to  $+70^{\circ}C$ , unless otherwise noted. Typical values are at  $V_{VBUS} = 5.0V$ ,  $T_A = +25^{\circ}C$ .) (Note 2)

| PARAMETER                             | SYMBOL                           | CONDITIONS   | MIN   | TYP | MAX         | UNITS      |
|---------------------------------------|----------------------------------|--|-------|-----|-------------|------------|
| <b>DC CHARACTERISTICS</b>             |                                  |  |       |     |             |            |
| Supply Voltage                        | $V_{VBUS}$                       |  | 0     |     | 28          | V          |
| VBUS POR                              | $V_{VBUSUVLO}$                   |  | 1.4   | 2.2 | 3.15        | V          |
| VBUS Supply Current                   | $I_{VBUS}$                       | $V_{VBUS} = 5.5V$ ,<br>GOOD_BAT = 1, charger de-<br>tection not running  |       | 150 | 300         | $\mu A$    |
| VBUS Supply Current                   | $I_{VBUS12}$                     | $V_{VBUS} = 12V$ , GOOD_BAT = 1,<br>charger detection not running  |       | 10  | 16          | mA         |
| <b>CHARGER DETECTION</b>              |                                  |  |       |     |             |            |
| $V_{DP\_SRC}$ Voltage                 | $V_{DP\_SRC}$                    | $I_{DP\_SRC} = 0$ to $250\mu A$  | 0.5   |     | 0.7         | V          |
| $V_{DAT\_REF}$ Voltage                | $V_{DAT\_REF}$                   |  | 0.25  |     | 0.4         | V          |
| $V_{LGC}$ Voltage                     | $V_{LGC}$                        |  | 0.8   |     | 2.0         | V          |
| $I_{DP\_SRC}$ Current                 | $I_{DP\_SRC}$                    |  | 7     |     | 10          | $\mu A$    |
| CDN Pulldown Resistor                 | $R_{DM\_DWN}$                    |  | 14.25 |     | 24.8        | k $\Omega$ |
| CDP Pulldown Resistor                 | $R_{DP\_DWN}$                    |  | 14.25 |     | 24.8        | k $\Omega$ |
| CDP and CDN Sink Current              | $I_{DP\_SINK}$<br>$I_{DM\_SINK}$ |  | 50    |     | 150         | $\mu A$    |
| CDP and CDN Weak Sink                 | $I_{WEAK}$                       | $V_{CDN} = 3.6V$   |       |     | 0.3         | $\mu A$    |
| VBUS Detection Ratio                  | $VBUS\_LOW$                      | $V_{VBUS} = 5V$  | 22.5  | 25  | 27.5        | %          |
|                                       | $VBUS\_MID$                      |  | 42.3  | 47  | 51.7        |            |
|                                       | $VBUS\_HIGH$                     |  | 76    | 80  | 89          |            |
| CDP and CDN Overvoltage Comparator    |                                  | $V_{VBUS} = 5V$ , no load on<br>CHG_DET  |       | 4.2 |             | V          |
| Primary Detection Voltage Source Time | $t_{VDP\_SRC\_ON}$               |  |       | 46  |             | ms         |
| VBUS Attach to CHG_DET                | $t_{VBUS\_CHG}$                  | From $V_{VBUS} > V_{VBDET}$ to<br>CHG_DET change, assuming<br>DCD delay = 0ms; Figure 1,<br>Figure 2, Figure 3 |       |     | 250         | ms         |
| GOOD_BAT to SW_OPEN                   | $t_{GOOD\_SW}$                   | Figure 2, Figure 3   |       | 15  | 20          | ms         |
| DCD Time Out                          | $t_{DCD\_TMO}$                   |  | 0.7   | 0.8 | 0.89        | s          |
| VBUS Detect Threshold Rising          | $V_{VBDET}$                      |  | 3.3   | 3.5 | 4           | V          |
| VBUS Detect Threshold Hysteresis      | $V_{VBDET\_HYST}$                |  |       | 50  |             | mV         |
| <b>USB ANALOG SWITCHES</b>            |                                  |  |       |     |             |            |
| Analog Signal Range                   |                                  | (Note 3, Note 4)   | 0     |     | $V_{CCINT}$ | V          |
| On-Resistance                         | $R_{ONUSB}$                      | $I_{CDP}, I_{CDN} = 10mA$ ,<br>$V_{CDP}, V_{CDN} = 0$ to $3V$  |       | 3   | 6           | $\Omega$   |
| On-Resistance Match Between Channels  | $\Delta R_{ONUSB}$               | $I_{CDP}, I_{CDN} = 10mA$ ,<br>$V_{CDP}, V_{CDN} = 0.4V$ (Note 4)  |       |     | 0.5         | $\Omega$   |

## Electrical Characteristics (continued)

( $V_{VBUS}$  = 3.5V to 5.5V,  $T_A$  = 0°C to +70°C, unless otherwise noted. Typical values are at  $V_{VBUS}$  = 5.0V,  $T_A$  = +25°C.) (Note 2)

| PARAMETER   | SYMBOL          | CONDITIONS   | MIN  | TYP      | MAX  | UNITS      |
|---|-----------------|--|------|----------|------|------------|
| On-Resistance Flatness  | $R_{FLATUSB}$   | $I_{CDP}$ , $I_{CDN}$ = 10mA, $V_{CDP}$ , $V_{CDN}$ = 0 to 3.3V (Note 4)                         |      | 0.06     | 0.2  | $\Omega$   |
| Off-Leakage Current   | $I_{LUSB(OFF)}$ | Switch open, $V_{TDN}$ or $V_{TDP}$ = 0.3V, 2.5V; $V_{CDN}$ or $V_{CDP}$ = 2.5V, 0.3V            | -360 |          | 360  | nA         |
| On-Leakage Current  | $I_{LUSB(ON)}$  | Switch closed, $V_{CDN}$ or $V_{CDP}$ = 0.3V, 2.5V   | -360 |          | 360  | nA         |
| <b>DIGITAL SIGNALS (GOOD_BAT, CHG_DET, SW_OPEN, CHG_AL_N)</b> |                 |  |      |          |      |            |
| GOOD_BAT Input Logic High                                     | $V_{IH}$        |  | 1.1  |          |      | V          |
| GOOD_BAT Input Logic Low                                      | $V_{IL}$        |  |      |          | 0.5  | V          |
| GOOD_BAT Pulldown   | $R_{PD}$        |  |      | 1        |      | M $\Omega$ |
| CHG_DET Output Logic High                                     | $V_{OH}$        | $I_{SOURCE}$ = -3mA  | 2    |          | 4.36 | V          |
| CHG_DET Output Logic Low                                      | $V_{OL}$        | $I_{SINK}$ = 3mA   |      |          | 0.4  | V          |
| SW_OPEN, CHG_AL_N Output Leakage                              | $I_{OUTLEAK}$   | $V_{IO}$ = 5V, output is in high-impedance   | -1   |          | +1   | $\mu$ A    |
| SW_OPEN, CHG_AL_N Output Logic Low                            | $V_{OL\_OD}$    | $I_{SINK}$ = 5mA   |      |          | 0.4  | V          |
| <b>DYNAMIC PERFORMANCE</b>                                    |                 |  |      |          |      |            |
| GOOD_BAT Debounce Time  | $t_{GBDEB}$     |  |      | 4        |      | ms         |
| VBUS Debounce Time  | $t_{CDEB}$      |  |      | 5        |      | ms         |
| Off-Capacitance   | COFF            | TDN, TDP applied voltage = 0.5V <sub>P-P</sub> , DC bias = 0V, f = 240MHz                        |      | 2        |      | pF         |
| On-Capacitance  | CONCOM          | CDN, CDP connected to TDN, TDP; applied voltage = 0.5V <sub>P-P</sub> , DC bias = 0V, f = 240MHz |      | 4.5      |      | pF         |
| Off-Isolation   |                 | $R_L$ = 50 $\Omega$ , f = 20kHz, $V_{CDN}$ , $V_{CDP}$ = 0.5V <sub>P-P</sub>                     |      | -60      |      | dB         |
| <b>ESD PROTECTION</b>   |                 |  |      |          |      |            |
| CDN, CDP  |                 | Human Body Model   |      | $\pm 15$ |      | kV         |
|   |                 | IEC61000-4-2 Air-Gap Discharge   |      | $\pm 15$ |      |            |
|   |                 | IEC61000-4-2 Contact   |      | $\pm 8$  |      |            |
| All Other Pins  |                 | Human Body Model   |      | $\pm 2$  |      | kV         |

**Note 2:** All devices are 100% production tested at  $T_A$  = +25°C. Specifications over the operating temperature range are guaranteed by design.

**Note 3:**  $V_{CCINT}$  = min ( $V_{VBUS}$ , +4.2V).

**Note 4:** Not production tested. Guaranteed by design.

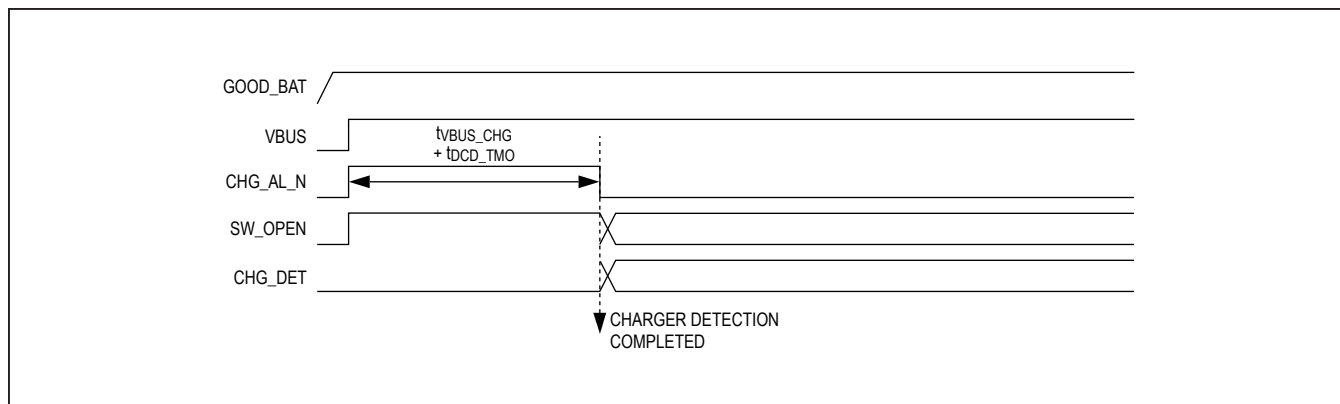


Figure 1. Normal Charger Detection (No Dead Battery)

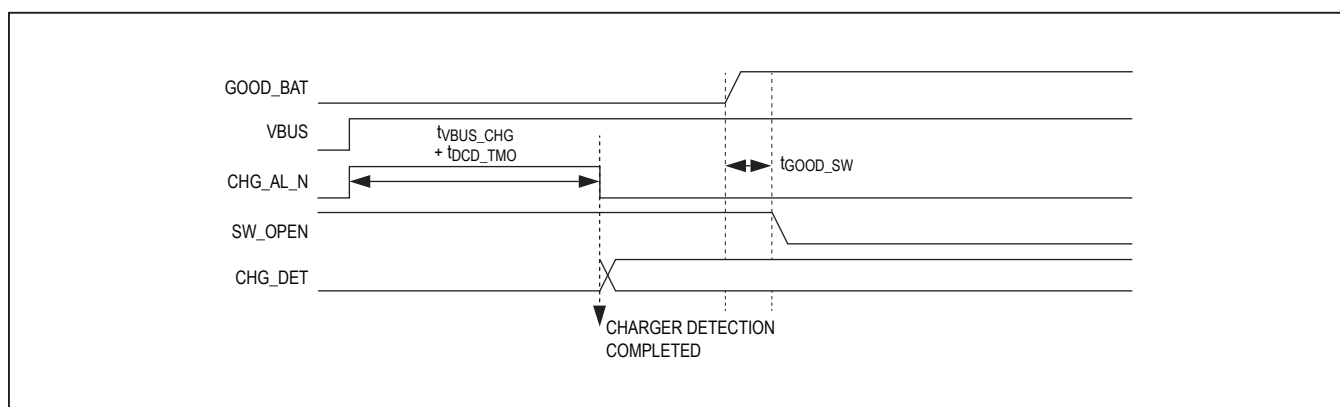


Figure 2. Charger Detection with Dead Battery

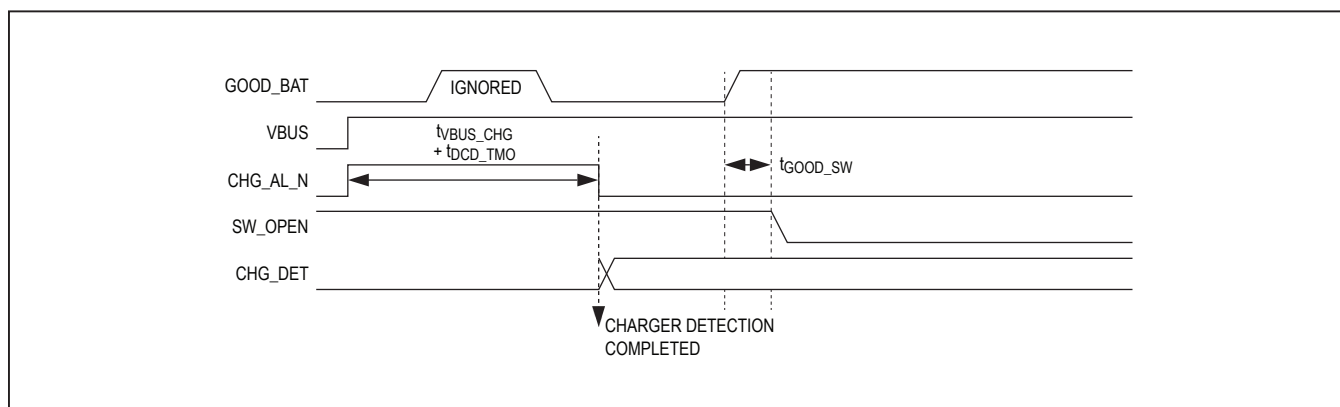
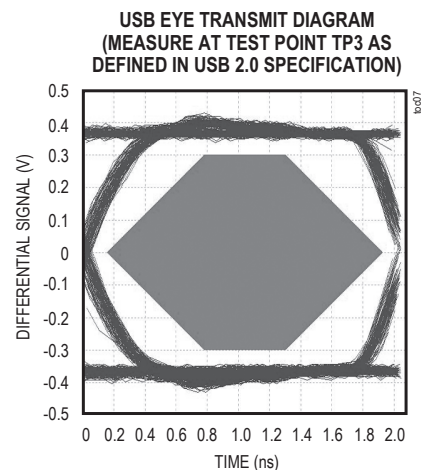
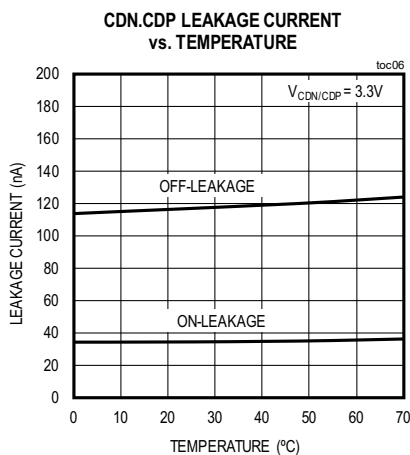
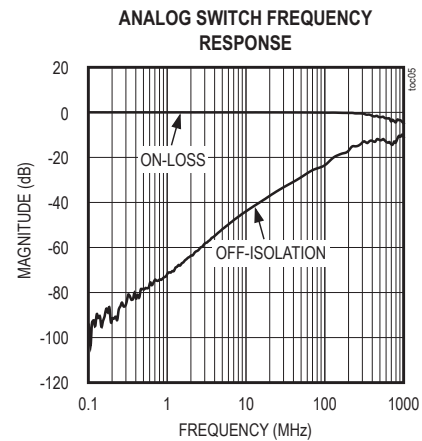
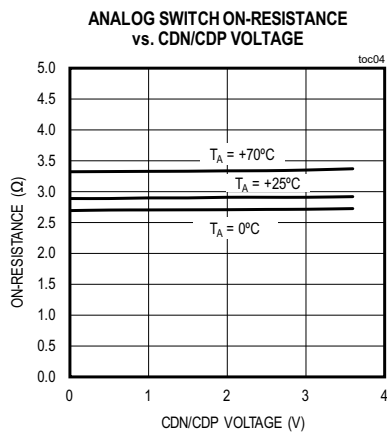
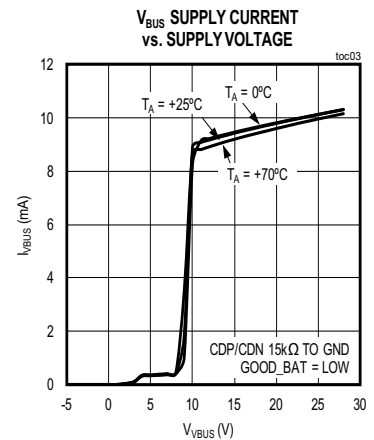
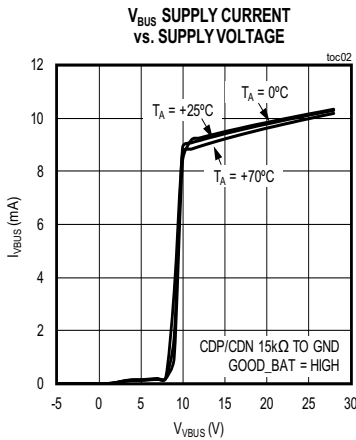
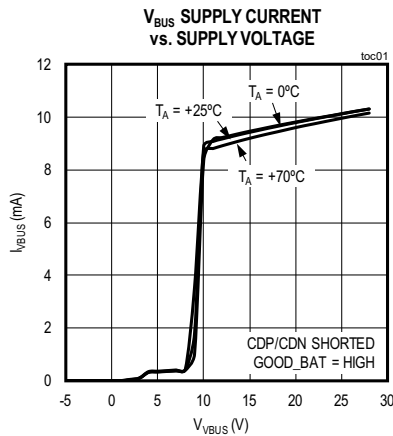


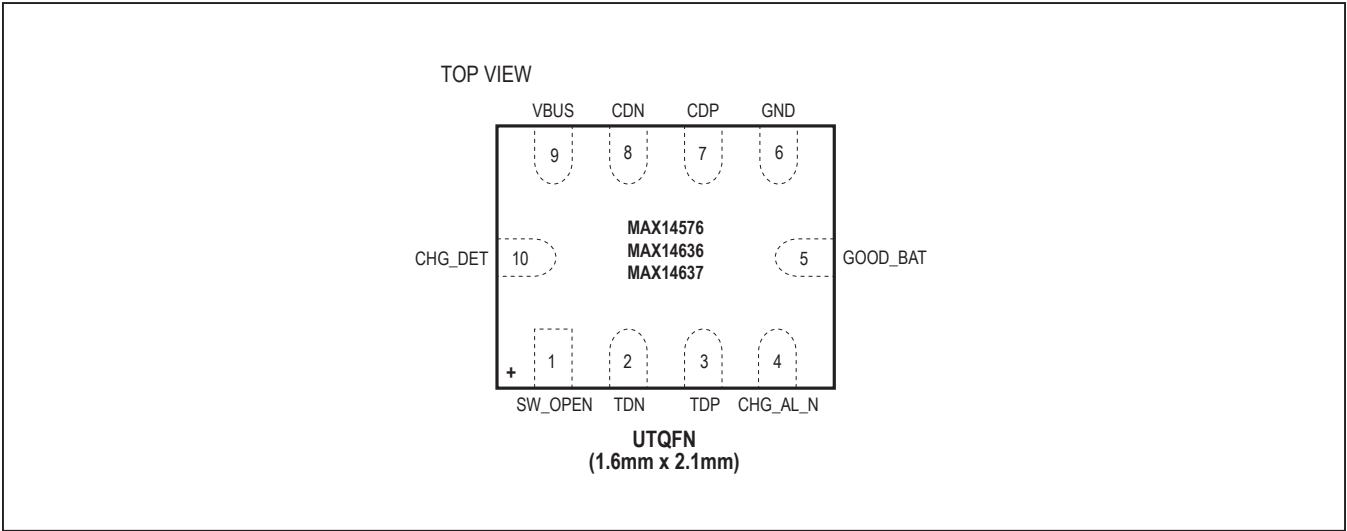
Figure 3. Charger Detection and Phone Flashing

## Typical Operating Characteristics

( $V_{BUS} = 5.0V$ ,  $T_A = +25^\circ C$ , unless otherwise noted)



Pin Configuration



Pin Description

| PIN | NAME     | FUNCTION   |
|-----|----------|--|
| 1   | SW_OPEN  | Data Switches Open Indicator. SW_OPEN is low when switches are closed. SW_OPEN is high impedance when switches are open. SW_OPEN is an open-drain output. Connect SW_OPEN to a pullup resistor externally. |
| 2   | TDN      | USB Transceiver D- Connection  |
| 3   | TDP      | USB Transceiver D+ Connection  |
| 4   | CHG_AL_N | Charging Allow Indicator. CHG_AL_N is low when VBUS is valid and charging is allowed. CHG_AL_N is an open-drain output. Connect CHG_AL_N to a pullup resistor externally.                                  |
| 5   | GOOD_BAT | Good Battery Digital Input. Set GOOD_BAT low for a dead battery and enable USB BC 1.2 compliant dead battery charging. Set GOOD_BAT high for a good battery.   |
| 6   | GND      | Ground   |
| 7   | CDP      | USB Connector D+ Connection  |
| 8   | CDN      | USB Connector D- Connection  |
| 9   | VBUS     | USB VBUS Input. Bypass VBUS to ground with a 0.1μF ceramic capacitor as close to the device as possible to achieve high ±15kV HBM ESD protection.  |
| 10  | CHG_DET  | Charger Detection Push-Pull Output. CHG_DET indicates the capability of the connected charger type (see Tables 1, 2, 3).   |

## Detailed Description

The MAX14576/MAX14636/MAX14637 detect battery charging sources as defined in USB Battery Charging Specification Rev 1.2 (USB BC 1.2). These devices are capable of detecting multiple USB battery charging methods including SDP, CDP, and DCP. The MAX14636/MAX14637 are also capable of detecting Apple chargers, and other nonstandard types (e.g., TomTom charger, and PC PS2 adapter). The devices also feature USB BC1.2 defined dead battery option support.

## USB Charger Detection

The charger detection starts when VBUS rises above the threshold. After the type of charger is determined, the MAX14576/MAX14636/MAX14637 set SW\_OPEN, CHG\_AL\_N, and CHG\_DET according to the charger type found ([Table 1](#), [Table 2](#), [Table 3](#)).

In case of SDP and CDP detection, dead battery mode (DB mode) is entered if GOOD\_BAT is low at the end of charger detection. After entering in DB mode, a 45 minute timer starts, VDP\_SRC is set on CDP and the device is allowed to charge at a 100mA rate. During DB mode, if GOOD\_BAT goes high, then DB mode ends, VDP\_SRC is removed and USB switches are closed. If GOOD\_BAT goes low again before the 45 minute timer expires, DB mode is entered again. If GOOD\_BAT is low when the 45 minute timer expires, DB mode ends and the device is not allowed to charge until VBUS is removed and reconnected. For GOOD\_BAT sensitivity in DB mode, the MAX14576/MAX14636 treat CDP as SDP and the MAX14637 treats CDP as DCP.

## USB Switches

The switches between CDP/CDN and TDP/TDN are low capacitance and low resistance, and capable of passing Hi-Speed USB signals. The switches are normally open when no valid VBUS is present. When valid VBUS is applied, the switches act according to the charger found ([Table 1](#), [Table 2](#), [Table 3](#)).

**Table 1. Charger Detection and Events (MAX14576)**

| ATTACHED CHARGING SOURCE                | INPUT    | OUTPUTS |          |         | USB SWITCHES | SYSTEM                   |
|---|----------|---------|----------|---------|--------------|--------------------------|
|   | GOOD_BAT | SW_OPEN | CHG_AL_N | CHG_DET |              |                          |
| DCP                                     | X        | Hi-Z    | Low      | High    | Open         | Charge with full current |
| CDP                                     | High     | Low     | Low      | High    | Closed       | Charge with full current |
|   | Low      | Hi-Z    | Low      | High    | Open         | Charge with full current |
| SDP/Apple® Charger/<br>TomTom® Charger* | High     | Low     | Low      | Low     | Closed       | Charge with 100mA        |
|   | Low      | Hi-Z    | Low      | Low     | Open         | Charge with 100mA        |
| PS2                                     | X        | Hi-Z    | Low      | Low     | Open         | Charge with 100mA        |
| No Valid VBUS                           | X        | Hi-Z    | Hi-Z     | Low     | Open         | X                        |

X = Don't care.

\*Detected as SDP after DCD timeout

Apple is a registered trademark of Apple, Inc.

TomTom is a registered trademark of TomTom International.

**Table 2. Charger Detection and Events (MAX14636)**

| ATTACHED CHARGING SOURCE               | INPUT    | OUTPUTS |          |         | USB SWITCHES | SYSTEM                   |
|--|----------|---------|----------|---------|--------------|--------------------------|
|  | GOOD_BAT | SW_OPEN | CHG_AL_N | CHG_DET |              |                          |
| DCP/Apple Charger/<br>TomTom Charger** | X        | Hi-Z    | Low      | High    | Open         | Charge with full current |
| CDP                                    | High     | Low     | Low      | High    | Closed       | Charge with full current |
|  | Low      | Hi-Z    | Low      | High    | Open         | Charge with full current |
| SDP                                    | High     | Low     | Low      | Low     | Closed       | Charge with 100mA        |
|  | Low      | Hi-Z    | Low      | Low     | Open         | Charge with 100mA        |
| PS2                                    | X        | Hi-Z    | Low      | Low     | Open         | Charge with 100mA        |
| No Valid VBUS                          | X        | Hi-Z    | Hi-Z     | Low     | Open         | X                        |

X = Don't care.

\*\*TomTom charger detected as DCP after DCD timeout.

**Table 3. Charger Detection and Events (MAX14637)**

| ATTACHED CHARGING SOURCE | INPUT    | OUTPUTS |          |         | USB SWITCHES | SYSTEM                   |
|--------------------------|----------|---------|----------|---------|--------------|--------------------------|
|                          | GOOD_BAT | SW_OPEN | CHG_AL_N | CHG_DET |              |                          |
| DCP/Apple Charger        | X        | Hi-Z    | Low      | High    | Open         | Charge with full current |
| CDP                      | X        | Low     | Low      | High    | Closed       | Charge with full current |
| SDP                      | High     | Low     | Low      | Low     | Closed       | Charge with 100mA        |
|                          | Low      | Hi-Z    | Low      | Low     | Open         | Charge with 100mA        |
| PS2                      | X        | Hi-Z    | Low      | Low     | Open         | Charge with 100mA        |
| No Valid VBUS            | X        | Hi-Z    | Hi-Z     | Low     | Open         | X                        |

X = Don't care.



## Applications Information

### Hi-Speed USB

Hi-Speed USB requires careful PCB layout with 45Ω single-ended/90Ω differential controlled-impedance matched traces of equal lengths.

### Extended ESD Protection

ESD protection structures are incorporated on all pins to protect against electrostatic discharges up to  $\pm 2\text{kV}$  (Human Body Model) encountered during handling and assembly. CDN and CDP are further protected against ESD up to  $\pm 15\text{kV}$  (HBM),  $\pm 15\text{kV}$  (Air-Gap Discharge method described in IEC 61000-4-2) and  $\pm 8\text{kV}$  (Contact Discharge Method described in IEC 61000-4-2) without damage. The VBUS input withstands up to  $\pm 15\text{kV}$  (HBM) if bypassed with a  $0.1\mu\text{F}$  ceramic capacitor close to the pin.

The ESD structures withstand high ESD both in normal operation and when the device is powered down. After an ESD event, the MAX14576/MAX14636/MAX14637 continue to function without latchup.

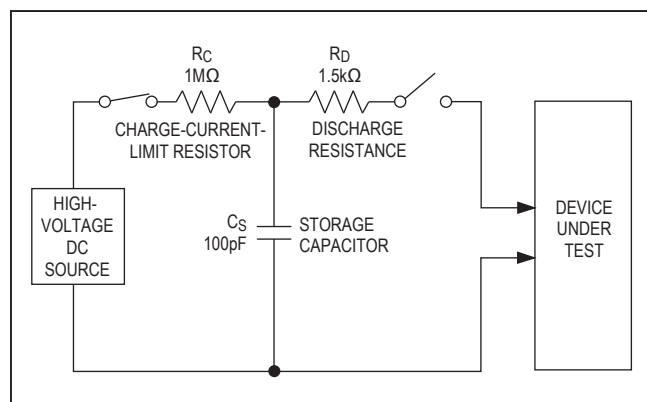


Figure 4. Human Body ESD Test Model

### ESD Test Conditions

ESD performance depends on a variety of conditions. Contact Maxim for a reliability report that documents test setup, test methodology, and test results.

### Human Body Model

Figure 4 shows the Human Body Model, and Figure 5 shows the current waveform it generates when discharged into a low impedance. This model consists of a  $100\text{pF}$  capacitor charged to the ESD voltage of interest that is then discharged into the device through a  $1.5\text{k}\Omega$  resistor.

### IEC 61000-4-2

The IEC 61000-4-2 standard covers ESD testing and performance of finished equipment. However, it does not specifically refer to integrated circuits. The major difference between tests done using the Human Body Model and IEC 61000-4-2 is higher peak current in IEC 61000-4-2 because series resistance is lower in the model. Hence, the ESD withstand voltage measured to IEC 61000-4-2 is generally lower than that measured using the Human Body Model. Figure 6 shows the IEC 61000-4-2 model, and Figure 7 shows the current waveform for the IEC 61000-4-2 ESD Contact Discharge test.

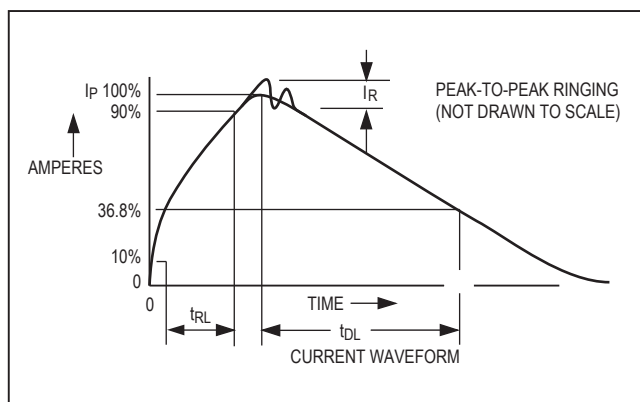


Figure 5. Human Body Current Waveform

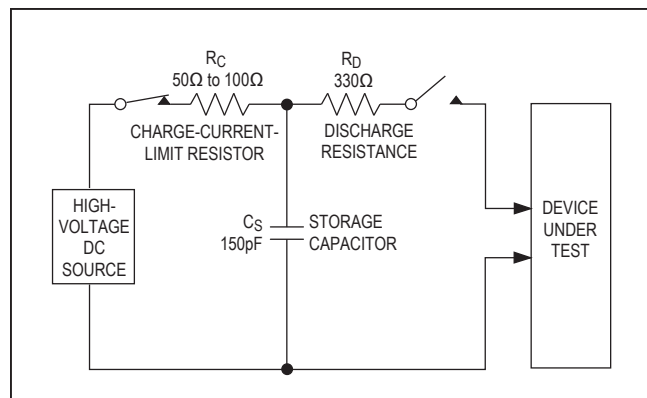


Figure 6. IEC 61000-4-2 ESD Test Model

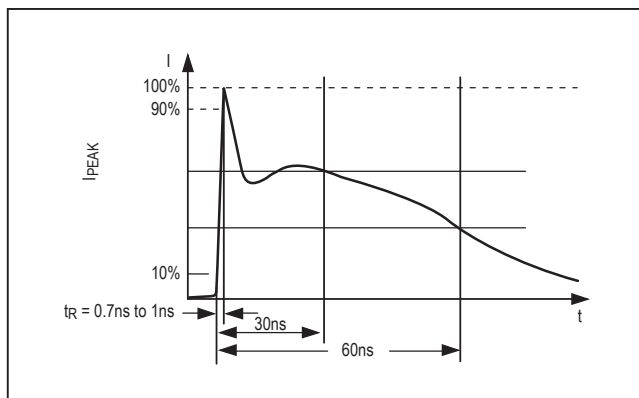


Figure 7. IEC 61000-4-2 ESD Generator Current Waveform

## Ordering Information/Selector Guide

| PART           | TEMP RANGE     | APPLE CHARGE CURRENT | TomTom CHARGE CURRENT | TOP MARK | PIN-PACKAGE |
|----------------|----------------|----------------------|-----------------------|----------|-------------|
| MAX14576CVB+T  | 0°C to +70°C   | 100mA                | 100mA                 | ABD      | 10 UTQFN    |
| MAX14636CVB+T  | 0°C to +70°C   | Full Current         | Full Current          | ABE      | 10 UTQFN    |
| MAX14637CVB+T  | 0°C to +70°C   | Full Current         | Not Supported         | ABG      | 10 UTQFN    |
| MAX14576EVB+T† | -40°C to +85°C | 100mA                | 100mA                 | ABD      | 10 UTQFN    |
| MAX14636EVB+T† | -40°C to +85°C | Full Current         | Full Current          | ABE      | 10 UTQFN    |
| MAX14637EVB+T† | -40°C to +85°C | Full Current         | Not Supported         | ABG      | 10 UTQFN    |

+ Denotes a lead(Pb)-free package/RoHS-compliant package.

T = Tape and reel

† Part no longer available. Replaced by MAX14xxxCVB+T

## Chip Information

PROCESS: BiCMOS

## Revision History

| REVISION<br>NUMBER | REVISION<br>DATE | DESCRIPTION   | PAGES<br>CHANGED |
|--------------------|------------------|---|------------------|
| 0                  | 9/12             | Initial release   | —                |
| 1                  | 1/13             | Removed future product asterisks from the MAX14636/MAX14637   | 11               |
| 2                  | 1/14             | Edited <i>Functional Diagram/Typical Application Circuit</i>  | 1                |
| 3                  | 6/18             | Updated temperature range, <i>Typical Operating Characteristics</i> , and <i>Ordering Information</i> table | 1–4, 6, 11       |
| 4                  | 8/18             | Updated <i>Ordering Information</i> table   | 11               |

For pricing, delivery, and ordering information, please visit Maxim Integrated's online storefront at <https://www.maximintegrated.com/en/storefront/storefront.html>.

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