

Charger Detection Device with High Speed USB Switch Battery Charger Specification v1.2

Check for Samples: [bq24392](#)

FEATURES

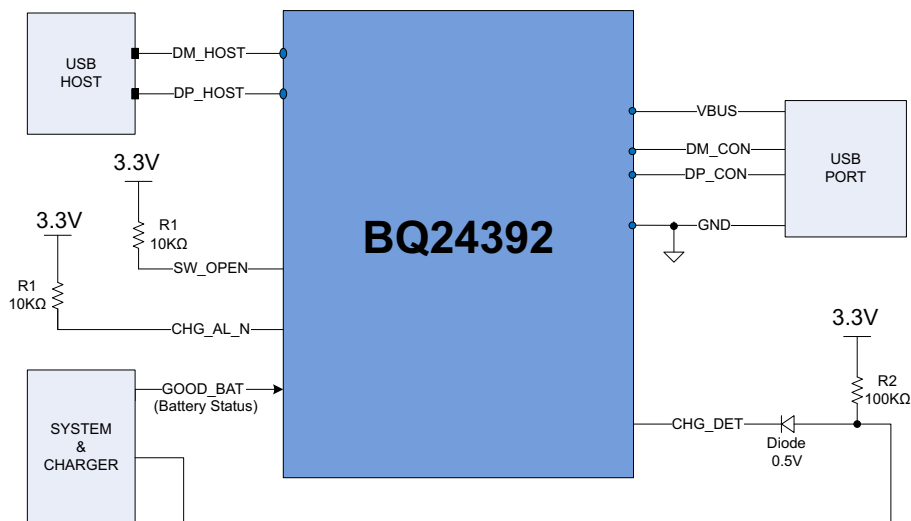
- **Charger Detection Device**
 - USB BCv1.2 Compliant
 - VBUS Detection
 - Data Contact Detection
 - Primary & Secondary Detection
 - Dead Battery Provision (DBP) 32-min Timer
- **Switch**
 - USB 2.0 High Speed Switch
- **Compatible Accessories**
 - Dedicated Charging Port
 - Standard Charging Port
 - Charging Port
- **Other Chargers Detected**
 - Apple™ Charger
 - TomTom™ Charger
 - Non Compliant USB Charger

- **VBUS Voltage Range**
 - –2V to 28V Tolerance on VBUS
- **ESD Performance Tested per JESD 22**
 - 4000-V Human-Body Model (A114-B, Class II)
 - 1500-V Charged-Device Model (C101)
- **ESD Performance DP_CON/DM_CON to GND**
 - ±8kV Contact Discharge (IEC 61000-4-2)

APPLICATIONS

- Cell Phones
- Smart-Phones
- Tablets
- Camera & GPS Systems

TYPICAL APPLICATION DIAGRAM



ORDERING INFORMATION⁽¹⁾

| T _A | PACKAGE ⁽²⁾ | ORDERABLE PART NUMBER | TOP-SIDE MARKING |
|----------------|--|-----------------------|------------------|
| –40°C to 85°C | μQFN 0.5-mm pitch – RSE Tape and Reel | BQ24392RSER | APH |

(1) For the most current package and ordering information, see the Package Option Addendum at the end of this document, or see the TI web site at www.ti.com.

(2) Package drawings, thermal data, and symbolization are available at www.ti.com/packaging.



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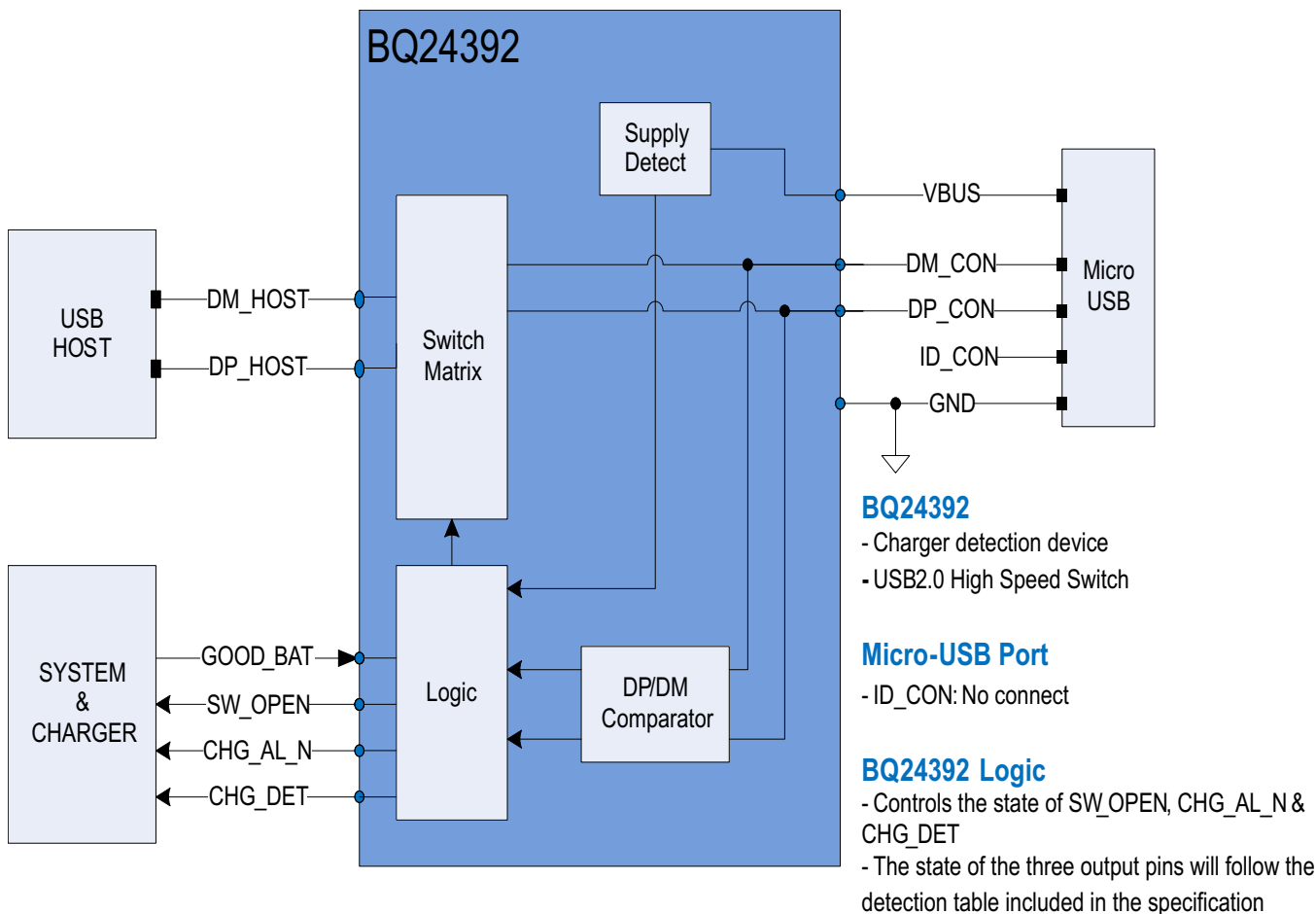
DESCRIPTION

The bq24392 is a charger detection device with an integrated isolation switch for use with a micro/mini USB port. The device is compliant with USB Battery Charging specification v1.2. This device allows cell phones and tablets to be charged from different adapters including USB BCv1.2 compliant and non-standard USB chargers. These non-standard chargers include Apple, TomTom, and non-compliant USB chargers. The bq24392 conforms to Dead Battery Provision (DBP) specified in BCv1.2. This includes a 32-min timer that cannot exceed 45 mins.

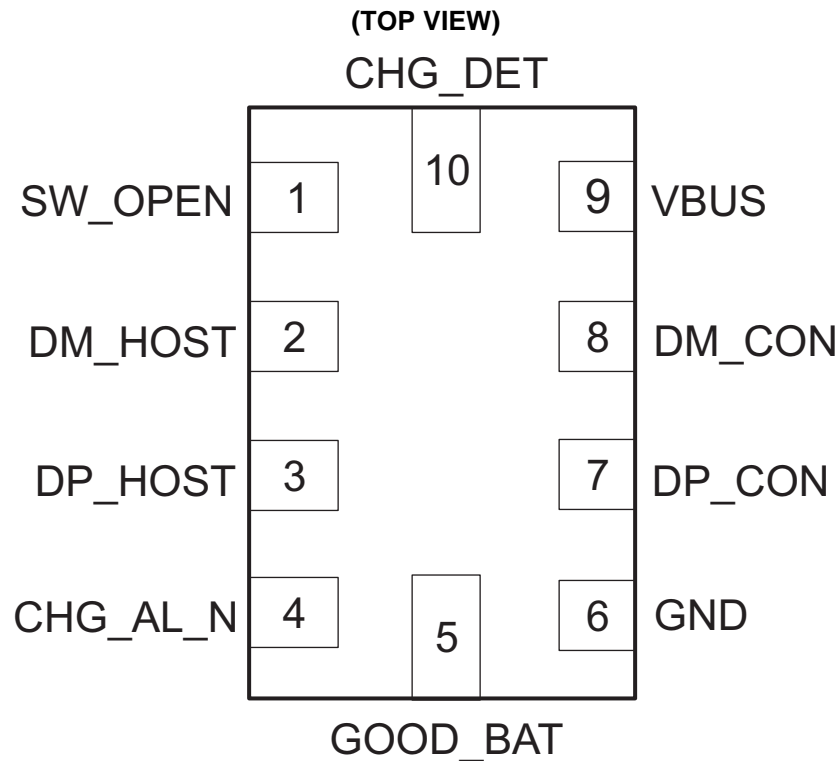
The bq24392 has a USB 2.0 switch that supports high speed. In addition to a USB connector and host pins, bq24392 has one input and three output pins. This results in a minimum software workload for the system to interact with the device.

V_{BUS} has 28V tolerance to avoid external protection. Power for this device is supplied through VBUS when accessory is attached.

BLOCK DIAGRAM



PINOUT DIAGRAM



PIN DESCRIPTION

| PIN | | I/O | DESCRIPTION |
|-----|----------|-----|--|
| NO. | NAME | | |
| 1 | SW_OPEN | O | Open-drain output. 10kΩ external pull-up resistor. This pin indicates the status of the USB switch. SW_OPEN = LOW then switch is connected SW_OPEN = HIGH-Z then switch is not connected |
| 2 | DM_HOST | I/O | D- signal to transceiver |
| 3 | DP_HOST | I/O | D+ signal to transceiver |
| 4 | CHG_AL_N | O | Open-drain output add 10kΩ external pull-up resistor. This pin indicates when charging is allowed. CHG_AL_N = LOW then charging allowed CHG_AL_N = HIGH-Z then no charging |
| 5 | GOOD_BAT | I | Input from the system This pin indicates the status of the battery GOOD_BAT = LOW indicates a dead battery GOOD_BAT = HIGH indicates a good battery |
| 6 | GND | | USB DM connected to USB receptacle |
| 7 | DP_CON | I/O | D+ signal from USB connector |
| 8 | DM_CON | I/O | D- signal from USB connector |
| 9 | VBUS | I | Supply pin from USB connector |
| 10 | CHG_DET | O | Push-pull output to the system This pin indicates if a charger is detected by the device CHG_DET = LOW indicates a charger is not detected CHG_DET = HIGH indicates a charger detected |

SUMMARY OF TYPICAL CHARACTERISTICS

| $T_A = 25^\circ\text{C}$ | USB Path (DP_CON and DM_CON) |
|---|------------------------------|
| ON-state resistance (r_{on}) | 8 Ω |
| ON-state resistance match (Δr_{on}) | 0.5 Ω |
| ON-state resistance flatness ($r_{on(flat)}$) | 0.5 Ω |
| Bandwidth (BW) | 920 MHz |
| OFF isolation (O_{ISO}) | -26 dB at 250 MHz |
| Crosstalk (X_{TALK}) | -32 dB at 250 MHz |
| Leakage current ($I_{IO(ON)}$) | 50 nA |

ABSOLUTE MAXIMUM RATINGS

over -40°C to 85°C temperature range (unless otherwise noted)

| | | ABSOLUTE MAX | UNIT |
|-------------------|--|--------------|------|
| Pin voltage range | VBUS | -2 to 28 | V |
| | CHG_AL_N | -2 to 28 | V |
| | All Others | -0.3 to 7 | V |
| ESD | HBM | 4000 | V |
| | CDM | 1500 | V |
| | IEC Contact Discharge (DP_CON, DM_CON to GND) | 8000 | V |

RECOMMENDED OPERATING CONDITIONS

| | | MIN | MAX | UNIT |
|------|--|------|------|------|
| VBUS | | 4.75 | 5.25 | V |

THERMAL IMPEDANCE RATINGS

| | | RSE PACKAGE | UNIT |
|---------------|---------------------------|-------------|---------------------------|
| θ_{JA} | Package thermal impedance | 184 | $^\circ\text{C}/\text{W}$ |

GENERAL ELECTRICAL SPECIFICATION

over -40°C to 85°C temperature range (unless otherwise noted)

| PARAMETER | | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|------------------|-------------------------------|--|-----|-----|--------------|---------------|
| V_{BUS_VALID} | VBUS Valid threshold | Rising VBUS threshold | | 3.5 | | V |
| V_{OH} | CHG_DET | $I_{OH} = -2\text{ mA}$ | 3.5 | | $VBUS^{(1)}$ | V |
| V_{OL} | CHG_DET, SW_OPEN, CHG_AL_N | $I_{OL} = 2\text{ mA}$ | | | 0.4 | V |
| V_{IH} | GOOD_BAT | | 1.1 | | | V |
| V_{IL} | | | | | 0.5 | V |
| R_{PD} | | Internal pull-down resistor | | 950 | | |
| I_{Q-SWON} | Current consumption | VBUS = 5V; USB Switch ON; GOOD_BAT VIH Min = 1.1 V | | 250 | | μA |
| I_{Q-SWON} | | VBUS = 5 V; USB Switch ON; GOOD_BAT VIH Min = 2.5 V | | 80 | | μA |
| $I_{Q-SWOFF}$ | | VBUS = 5 V; USB Switch OFF | | 45 | | μA |
| t_{DBP} | Dead battery provision timer | | 32 | 45 | | Mins |

(1) CHG_DET Max value will be clamped at 7V when VBUS > 7V.

USB SWITCHING ELECTRICAL CHARACTERISTICS

 $V_{BUS} = 4.5V \text{ to } 5.5V$, $T_A = -40^\circ C \text{ to } 85^\circ C$ (unless otherwise noted)⁽¹⁾

| PARAMETER | | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|------------------------------|--|---|-----|-------|-----|----------|
| VUSBIO | Analog signal range | | 0 | | 3.6 | V |
| r_{ON} | ON-state resistance | DM_CON, DP_CON, DM_HOST, DP_HOST $V_I = 0V \text{ to } 3.6V$, $I_O = -2mA$ | | 8 | | Ω |
| Δr_{ON} | ON-state resistance match between channels | DM_CON, DP_CON, DM_HOST, DP_HOST $V_I = 0.4V$, $I_O = -2mA$ | | 0.5 | | Ω |
| $r_{ON(Flat)}$ | ON-state resistance flatness | DM_CON, DP_CON, DM_HOST, DP_HOST $V_I = 0V \text{ to } 3.6V$, $I_O = -2mA$ | | 1.1 | | Ω |
| $I_{IO(OFF)}$ | V_I or V_O OFF leakage current | $V_I = 0.3V$, $V_O = 2.7V$ or $V_I = 2.7V$, $V_O = 0.3V$, Switch OFF | | 45 | | nA |
| $I_{IO(ON)}$ | V_O ON leakage current | $V_I = OPEN$, $V_O = 0.3V$ or $2.7V$, Switch ON | | 50 | | nA |
| DYNAMIC | | | | | | |
| $C_{I(OFF)}$ | V_I OFF capacitance | DC bias = $0V$ or $3.6V$, $f = 10MHz$, Switch OFF | | 2 | | pF |
| $C_{O(OFF)}$ | V_O OFF capacitance | DC bias = $0V$ or $3.6V$, $f = 10MHz$, Switch OFF | | 10 | | pF |
| $C_{I(ON)}$, $C_{O(ON)}$ | V_I , V_O ON capacitance | DC bias = $0V$ or $3.6V$, $f = 10MHz$, Switch ON | | 11 | | pF |
| BW | Bandwidth | $R_L = 50\Omega$, Switch ON | | 920 | | MHz |
| O_{ISO} | OFF Isolation | $f = 240MHz$, $R_L = 50\Omega$, Switch OFF | | -26 | | dB |
| X_{TALK} | Crosstalk | $f = 240MHz$, $R_L = 50\Omega$ | | -30.5 | | dB |

- (1) V_O is equal to the asserted voltage on DP_CON, DM_CON pins.
 V_I is equal to the asserted voltage on DP_HOST and DM_HOST pins.
 I_O is equal to the current on the DP_CON, DM_CON.
 I_I is equal to the current on the DP_HOST and DM_HOST pins.

GENERAL OPERATION

The bq24392 is designed to interface a micro/mini USB connector to external peripherals.

The device will automatically detect different types of chargers through the mini/micro USB pin connector. The bq24392 has a high speed USB 2.0 switch that can be automatically opened and closed based on the accessory detected.

DETECTION SEQUENCE

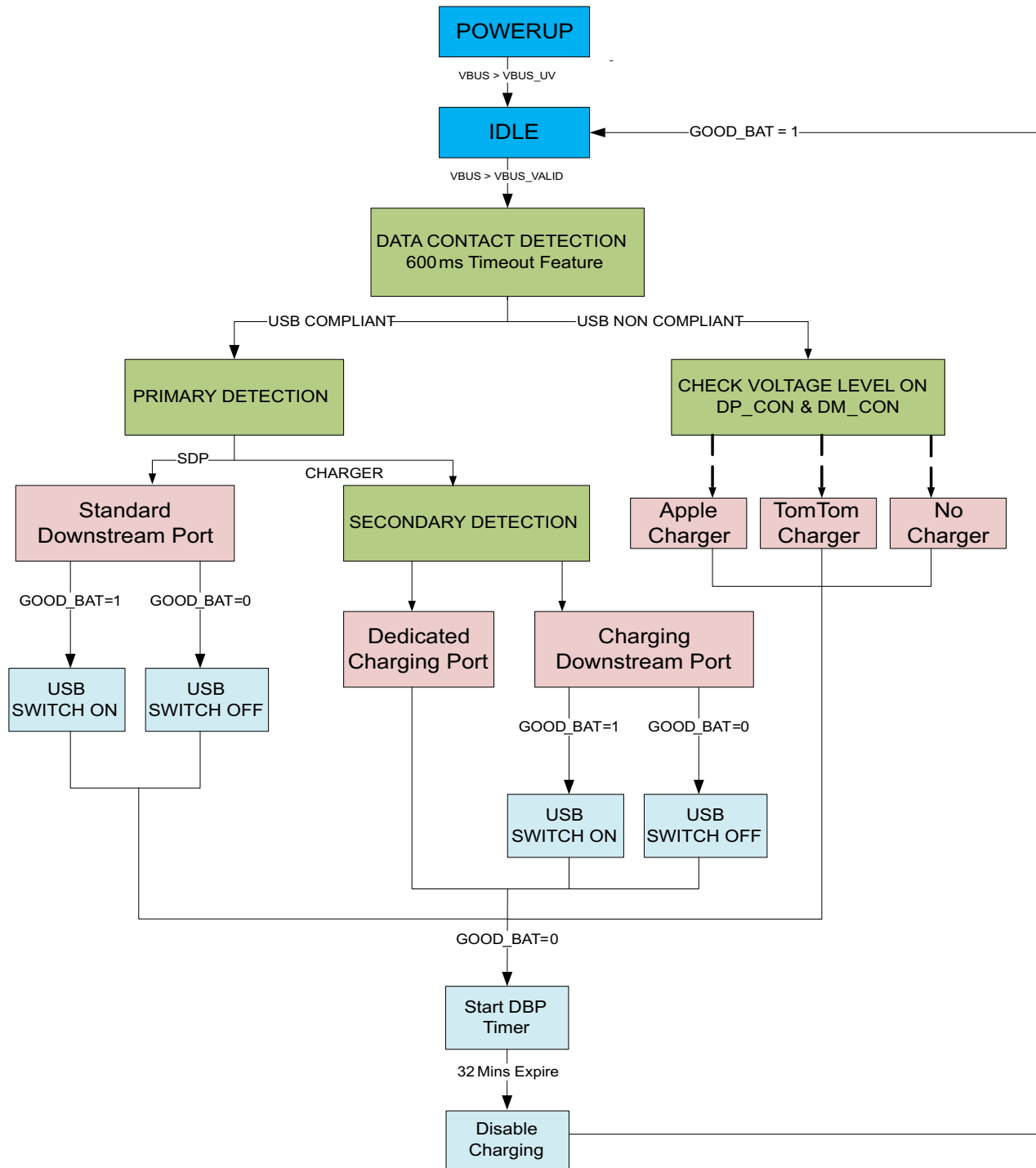
After accessory insertion, once VBUS voltage is greater than V_{BUS_VALID} threshold, the device proceeds onto data contact detection. This state has a 600ms timeout feature specified in BCDv1.2. Depending on the result, the next step is primary detection or non-compatible USB charger detection. In the case of former, the next step is detecting a Standard Downstream Port (SDP), Dedicated Charging Port (DCP), or Charging Downstream Port (CDP). In the case of latter, the next step is detecting an Apple, TomTom, or Non-compliant Charger.

The USB 2.0 switches are automatically closed to enable data transfer if either SDP or CDP is detected and the GOOD_BAT input is HIGH.

Once a charger has been detected, and if the GOOD_BAT input is LOW, a Dead Battery timer is initiated. If the GOOD_BAT continues to be LOW for 30 minutes (maximum of 45 minutes), charging is disabled. Toggling GOOD_BAT HIGH after DBP timer expires will re-start detection.

The following flow-chart shows the detection sequence used in the bq24392.

Flow Chart of Detection Sequence



Detection Table

The table below lists the configurations of the DP_CON (D+) and DM_CON (D–) that are internal to the various device types.

| Device Type | VBUS | DP_CON (D+) | DM_CON (D–) | GOOD_BAT (Input) | CHG_AL_N (Output) | CHG_DET (Output) | SW_OPEN (Output) | Switch Status |
|------------------------------|-------|-----------------------------|-----------------------------|------------------|-------------------|------------------|------------------|---------------|
| Standard Downstream Port | >3.5V | Pull-down R to GND | Pull-down R to GND | HIGH | LOW | LOW | LOW | Connected |
| | | | | LOW | LOW | LOW | Hi-Z | Not Connected |
| Charging Downstream Port | >3.5V | Pull-down R to GND | V _{DM_SRC} | HIGH | LOW | HIGH | LOW | Connected |
| | | | | LOW | LOW | HIGH | Hi-Z | Not Connected |
| Dedicated Charging Port | >3.5V | Short to D– | Short to D+ | HIGH | LOW | HIGH | Hi-Z | Not Connected |
| | | | | LOW | LOW | HIGH | Hi-Z | Not Connected |
| Apple Charger | >3.5V | 2.0 < V _{DP} < 2.8 | 2.0 < V _{DM} < 2.8 | HIGH | LOW | HIGH | Hi-Z | Not Connected |
| | | | | LOW | LOW | HIGH | Hi-Z | Not Connected |
| TomTom Charger | >3.5V | 2.0 < V _{DP} < 3.1 | 2.0 < V _{DM} < 3.1 | HIGH | LOW | HIGH | Hi-Z | Not Connected |
| | | | | LOW | LOW | HIGH | Hi-Z | Not Connected |
| PS/2 Charger | >3.5V | Pull-up R to VBUS | Pull-up R to VBUS | X | LOW | LOW | Hi-Z | Not Connected |
| Non-compliant USB Charger | >3.5V | Open | Open | X | LOW | LOW | Hi-Z | Not Connected |
| Any Device | <3.5V | Open | Open | X | Hi-Z | LOW | Hi-Z | Not Connected |
| Any Device DBP Timer Expired | >3.5V | X | X | LOW | Hi-Z | LOW | Hi-Z | Not Connected |

USB 2.0 EYE DIAGRAM

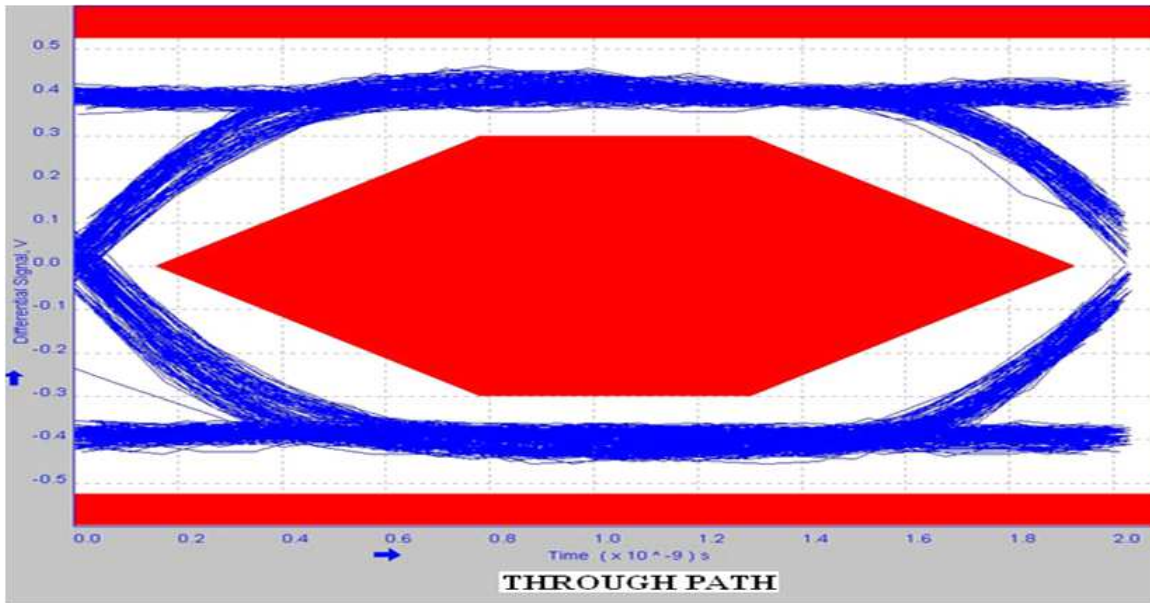


Figure 1. 480-Mbps USB 2.0 Eye Diagram with No Device

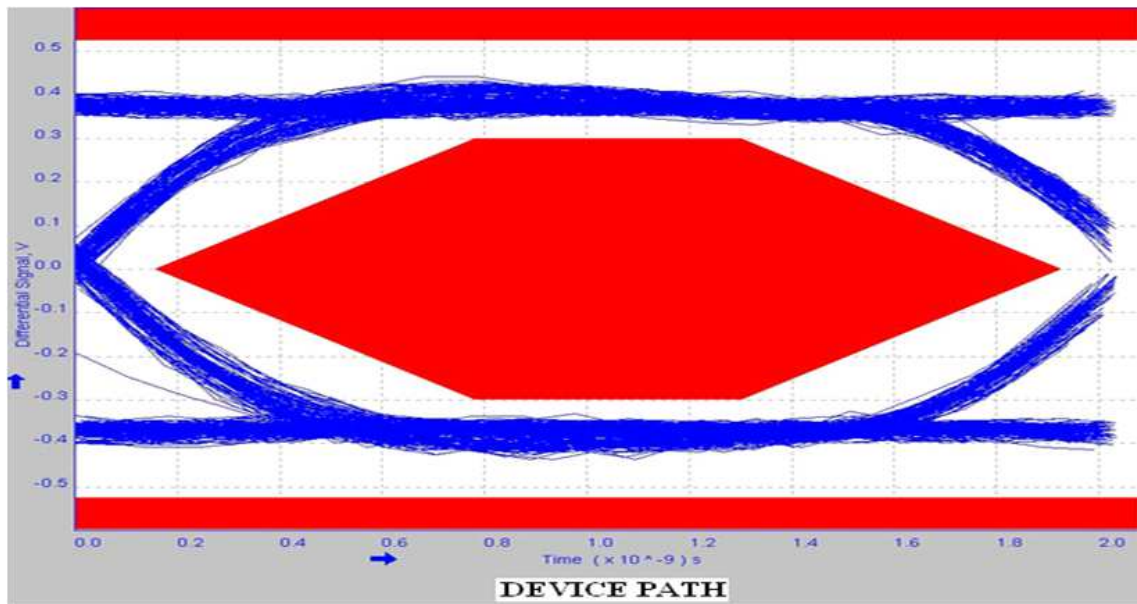


Figure 2. 480-Mbps USB 2.0 Eye Diagram with USB Switch

REFERENCE SCHEMATIC

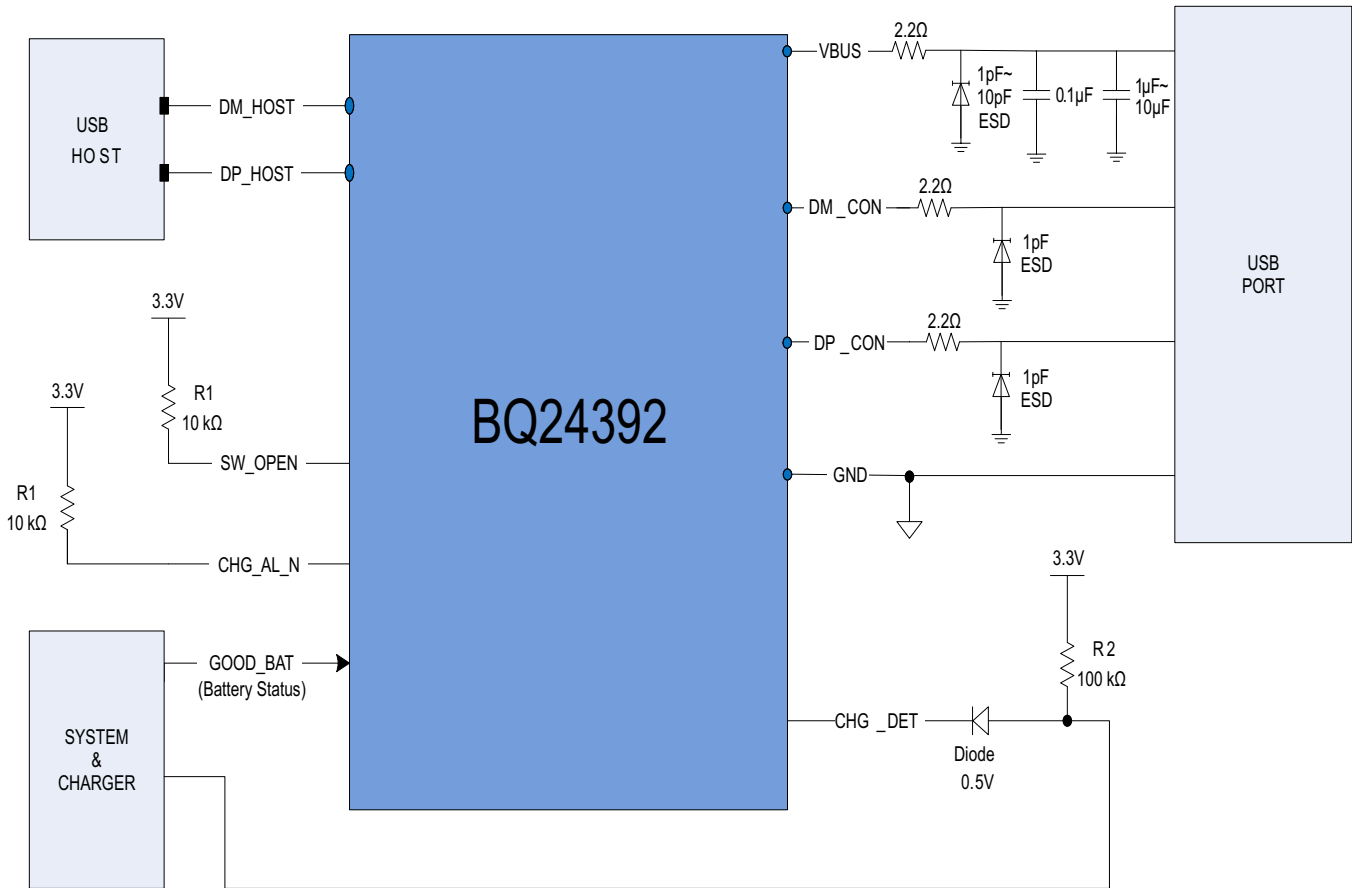


Table 1. Critical Components

| PIN | | |
|------------------|--------|----------------------|
| NAME | NUMBER | CRITICAL COMPONENT |
| V _{BUS} | 9 | 1μF~10μF |
| | | 2.2Ω |
| | | ESD Protection Diode |
| | | 0.1μF |
| SW_OPEN | 1 | 10kΩ |
| CHG_AL_N | 4 | 10kΩ |
| DM_CON | 14 | 2.2Ω |
| | | ESD Protection Diode |
| DP_CON | 15 | 2.2Ω |
| | | ESD Protection Diode |

Schematic Guidelines

1. V_{BUS} requires $1\mu\text{F}$ – $10\mu\text{F}$ and $0.1\mu\text{F}$ decoupling capacitors to reduce noise from circuit elements. The capacitors act as a shunt to block off the noise. The $0.1\mu\text{F}$ capacitor smooths out high frequencies and has a lower series inductance. The $1\mu\text{F}$ – $10\mu\text{F}$ capacitor smooths out the lower frequencies and has a much higher series inductance. Using both capacitors will provide better load regulation across the frequency spectrum.
2. SW_OPEN and CHG_AL_N are open-drain outputs that require a $10\text{k}\Omega$ pull-up resistor to VDDIO.
3. V_{BUS} , DM_CON, and DP_CON are recommended to have an external resistor of 2.2Ω to provide extra ballasting to protect the chip and internal circuitry.
4. DM_CON and DP_CON are recommended to have a 1pF external ESD Protection Diode rated for 8kV IEC protection to prevent failure in case of an 8kV IEC contact discharge.
5. V_{BUS_IN} is recommended to have a 1pF ~ 10pF external ESD Protection Diode rated for 8kV IEC protection to prevent failure in case of an 8kV IEC contact discharge.
6. CHG_DET is a push-pull output pin. An external pull-up and Diode are shown to depict a typical 3.3V system. The pull-up resistor and diode are optional. The pull-up range on the CHG_DET pin is from 3.5V to V_{BUS} . When $V_{BUS} > 7\text{V}$, CHG_DET will be clamped to 7V .

PACKAGING INFORMATION

| Orderable Device | Status ⁽¹⁾ | Package Type | Package Drawing | Pins | Package Qty | Eco Plan ⁽²⁾ | Lead/ Ball Finish | MSL Peak Temp ⁽³⁾ | Samples (Requires Login) |
|------------------|-----------------------|--------------|-----------------|------|-------------|----------------------------|----------------------|------------------------------|-----------------------------|
| BQ24392RSER | ACTIVE | UQFN | RSE | 10 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | |

⁽¹⁾ The marketing status values are defined as follows:

ACTIVE: Product device recommended for new designs.

LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

PREVIEW: Device has been announced but is not in production. Samples may or may not be available.

OBSOLETE: TI has discontinued the production of the device.

⁽²⁾ Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

TBD: The Pb-Free/Green conversion plan has not been defined.

Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

Pb-Free (RoHS Exempt): This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

⁽³⁾ MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

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TAPE AND REEL INFORMATION
REEL DIMENSIONS

TAPE DIMENSIONS


| | |
|----|---|
| A0 | Dimension designed to accommodate the component width |
| B0 | Dimension designed to accommodate the component length |
| K0 | Dimension designed to accommodate the component thickness |
| W | Overall width of the carrier tape |
| P1 | Pitch between successive cavity centers |

TAPE AND REEL INFORMATION

*All dimensions are nominal

| Device | Package Type | Package Drawing | Pins | SPQ | Reel Diameter (mm) | Reel Width W1 (mm) | A0 (mm) | B0 (mm) | K0 (mm) | P1 (mm) | W (mm) | Pin1 Quadrant |
|-------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| BQ24392RSER | UQFN | RSE | 10 | 3000 | 180.0 | 8.4 | 1.68 | 2.13 | 0.76 | 4.0 | 8.0 | Q1 |

TAPE AND REEL BOX DIMENSIONS

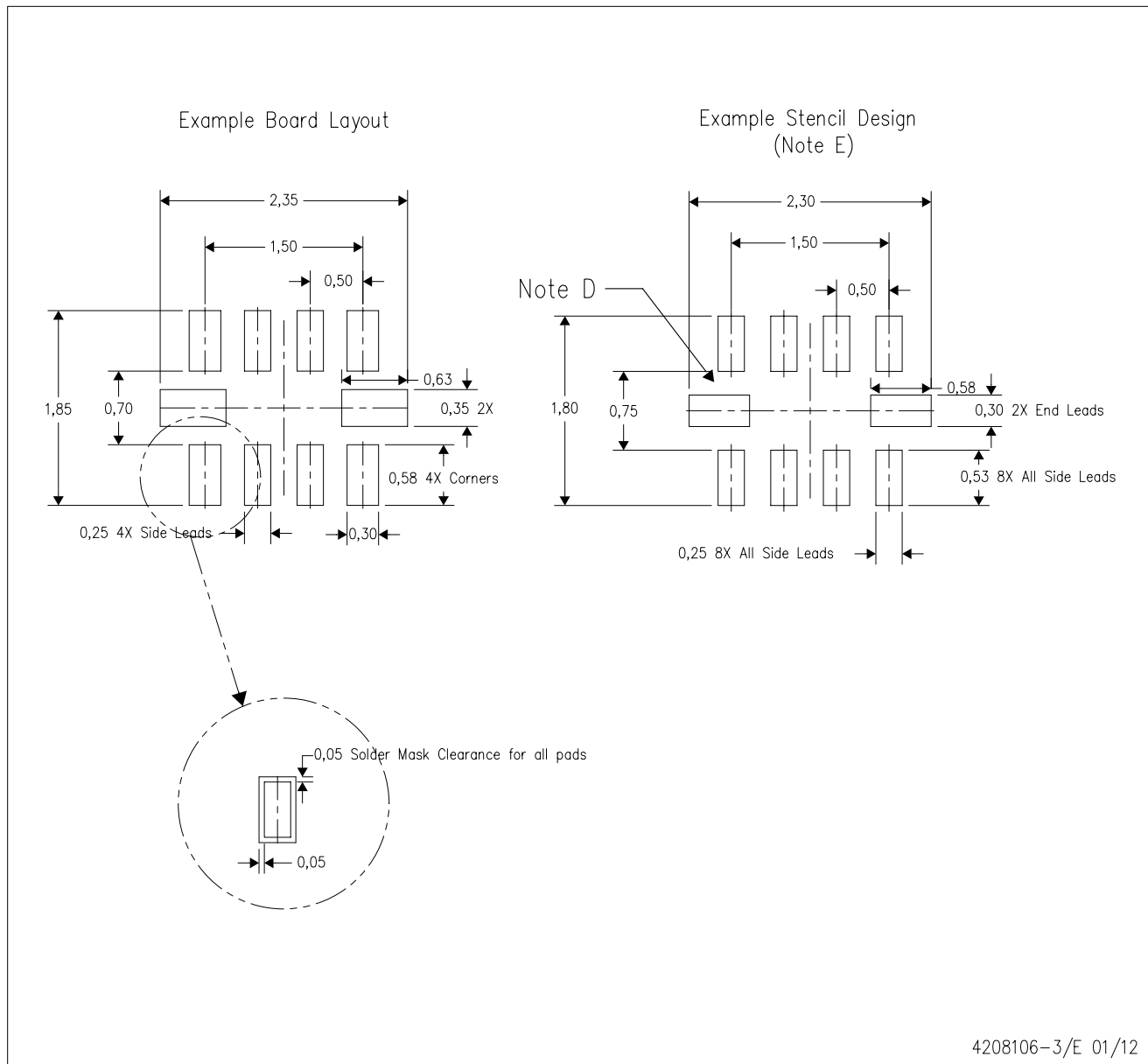


*All dimensions are nominal

| Device | Package Type | Package Drawing | Pins | SPQ | Length (mm) | Width (mm) | Height (mm) |
|-------------|--------------|-----------------|------|------|-------------|------------|-------------|
| BQ24392RSER | UQFN | RSE | 10 | 3000 | 202.0 | 201.0 | 28.0 |

RSE (R-PUQFN-N10)

PLASTIC QUAD FLATPACK NO-LEAD



- NOTES:
- A. All linear dimensions are in millimeters.
 - B. This drawing is subject to change without notice.
 - C. Publication IPC-7351 is recommended for alternate designs.
 - D. Customers should contact their board fabrication site for minimum solder mask web tolerances between signal pads.
 - E. Maximum stencil thickness 0,127 mm (5 mils). All linear dimensions are in millimeters.
 - F. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Refer to IPC 7525 for stencil design considerations.
 - G. Side aperture dimensions over-print land for acceptable area ratio > 0.66. Customer may reduce side aperture dimensions if stencil manufacturing process allows for sufficient release at smaller opening.

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