

SP3T SWITCH WITH IMPEDANCE DETECTION MICRO-USB SWITCH TO SUPPORT USB, UART, AUDIO, AND CHARGER

Check for Samples: [TS5USBA43402](#)

FEATURES

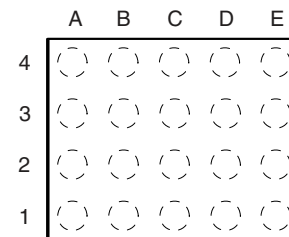
- **Compatible Accessories**
 - USB Data Cable
 - UART Cable
 - Charger (Dedicated Charger or Host/Hub Charger)
 - Stereo Headset With Mic
- **Integrated LDOs for V_{REF} and Mic Bias**
- **USB Path Supports USB 2.0 High Speed**
- **Audio Path Provides Negative Rail Support and Click/Pop Reduction**
- **Supports Factory Test Mode**
- **1.8-V Compatible I²C Interface**
- **ESD Performance Tested Per JESD 22**
 - 2000-V Human-Body Model (A114-B, Class II)
 - 1000-V Charged-Device Model (C101)

- **ESD Performance DP/DM/ID/ V_{BUS} to GND**
 - ± 8 -kV Contact Discharge (IEC 61000-4-2)
 - ± 15 -kV Air Gap Discharge (IEC 61000-4-2)

APPLICATIONS

- Cellular Telephones

**YZP PACKAGE
(LASER SCRIBE VIEW)**



PIN ASSIGNMENTS

| | A | B | C | D | E |
|----------|-------|-------------------------|---------|---------|-----------|
| 4 | MIC | ISET | UART_TX | USB_DM | USB_DP |
| 3 | R2.2K | $\overline{\text{INT}}$ | UART_RX | ID | DP |
| 2 | SDA | SCL | DSS | GND | DM |
| 1 | CLDO | V_{SUPPLY} | AUDIO_R | AUDIO_L | V_{BUS} |

DESCRIPTION

The TS5USBA43402 is designed to interface the cellphone UART, USB, and audio chips with external peripherals via a micro-USB connector. The switch features impedance detection for identification of various accessories that are attached through DP and DM of the micro-USB port. When an accessory is plugged into the micro-USB port, the switch uses a detection mechanism to identify the accessory (see [State Machine](#) for details). It will then switch to the appropriate channel—data, audio, or UART.

The TS5USBA43402 has an I²C interface for communication with the cellphone baseband or applications processor. An interrupt is generated when anything plugged into the micro-USB is detected. Another interrupt is generated when the device is unplugged.

Table 1. ORDERING INFORMATION

| T_A | PACKAGE ^{(1) (2)} | | ORDERABLE PART NUMBER | TOP-SIDE MARKING |
|---------------|------------------------------|---------------|-----------------------|------------------|
| –40°C to 85°C | WSCP – YZP (0.5-mm pitch) | Tape and reel | TS5USBA43402YZPR | 5F2 |

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

(2) 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.



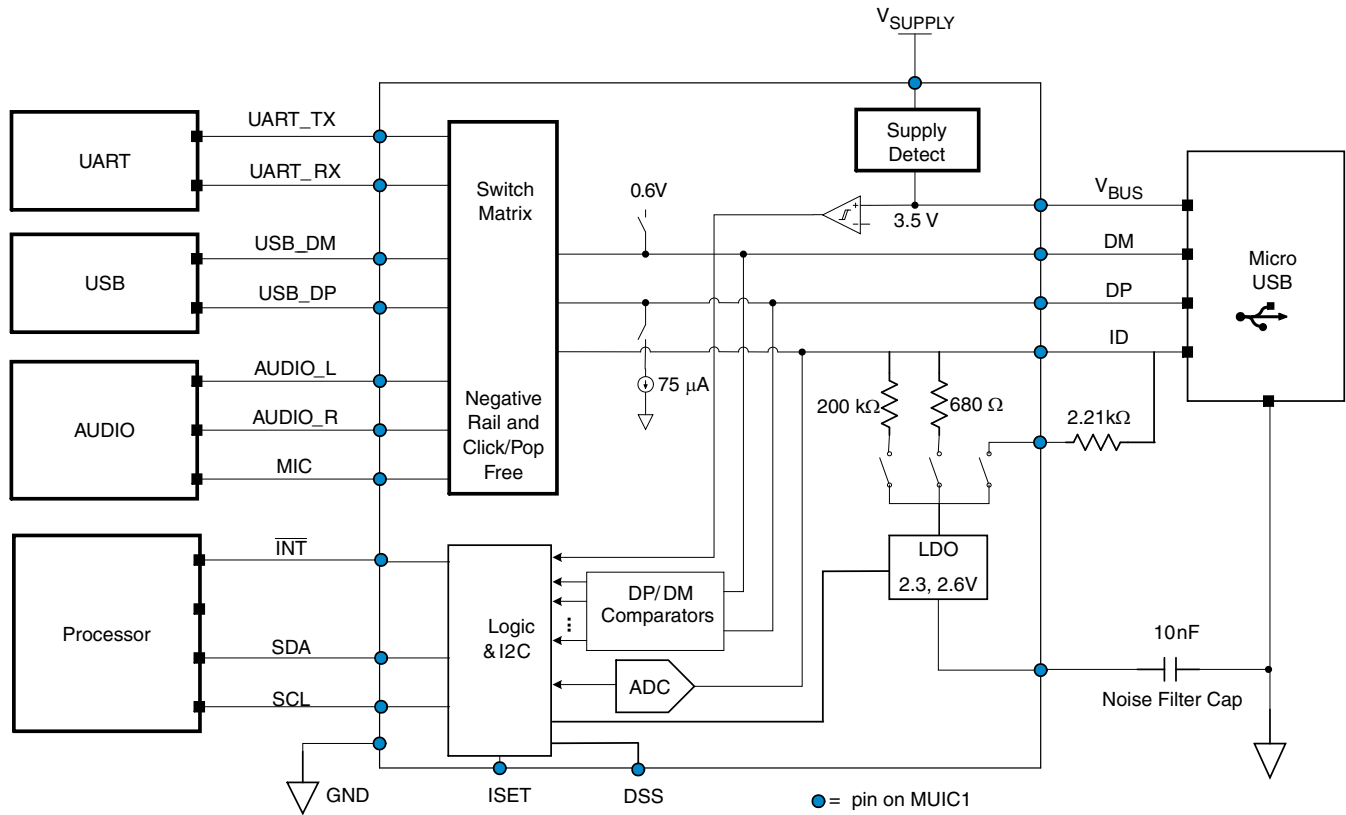
Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

Table 2. SUMMARY OF CHARACTERISTICS

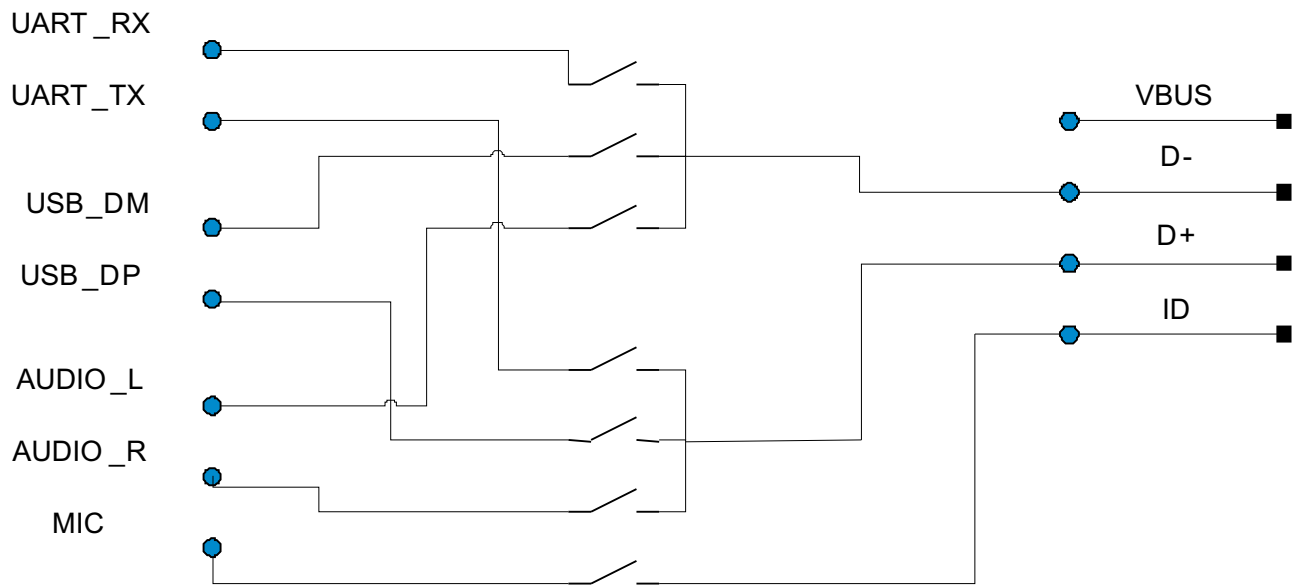
T_A = 25°C

| | USB PATH | UART PATH | AUDIO PATH | MIC PATH |
|---|---------------------------|-----------|------------|----------|
| Number of switches | 2 | 2 | 2 | 1 |
| ON-state resistance (r _{ON}) | 5 Ω | 37 Ω | 3 Ω | 8.8 Ω |
| ON-state resistance match (Δr _{ON}) | 1 Ω | 3 Ω | 1.1 Ω | N/A |
| ON-state resistance flatness (r _{ON(flat)}) | 0.24 Ω | 14 Ω | 0.1 Ω | 0.5 Ω |
| Turn-on/turn-off time (t _{ON} /t _{OFF}) | 1 ms | 1 ms | 1 ms | 1 ms |
| Bandwidth (BW) | >720 MHz | >300 MHz | >900 MHz | >67 MHz |
| OFF isolation (O _{ISO}) | -22 dB | -40 dB | -75 dB | -100 dB |
| Crosstalk (X _{TALK}) | -40 dB | -40 dB | -50 dB | -50 dB |
| Total harmonic distortion (THD) | N/A | N/A | 0.05% | 0.0017% |
| Leakage current (I _{NO(OFF)} /I _{NC(OFF)}) | 100 nA | 100 nA | 100 nA | 100 nA |
| Package options | YZP package, 0.5-mm pitch | | | |

BLOCK DIAGRAM



SWITCH MATRIX BLOCK DIAGRAM



TERMINAL FUNCTIONS

| TERMINAL | | TYPE | DESCRIPTION |
|-------------------------|-----|------|--|
| NAME | NO. | | |
| AUDIO_L | D1 | I/O | Stereo audio left channel |
| AUDIO_R | C1 | I/O | Stereo audio right channel |
| CLDO | A1 | O | Capacitor connection for LDO noise filtering |
| DM | E2 | I/O | Common I/O port for USB, UART, Audio. Connected to USB receptacle. |
| DP | E3 | I/O | Common I/O port for USB, UART, Audio. Connected to USB receptacle. |
| DSS | C2 | I | Pulldown or pullup resistor connection to determine default switch |
| GND | D2 | GND | Ground |
| ID | D3 | I/O | Common I/O port for microphone, ID detection |
| $\overline{\text{INT}}$ | B3 | O | Open-drain interrupt output. Connect an external pullup resistor. |
| ISSET | B4 | O | Output to charger for high-current charging mode. Open-drain output. |
| MIC | A4 | I/O | Microphone signal |
| R2.2K | A3 | I | 2.21 k Ω connection for microphone bias |
| SCL | B2 | I | I ² C clock input. Connect an external pullup resistor. |
| SDA | A2 | I/O | I ² C data. Connect an external pullup resistor. |
| UART_RX | C3 | I/O | UART receive data |
| UART_TX | C4 | I/O | UART transmit data |
| USB_DM | D4 | I/O | USB D– connected to host |
| USB_DP | E4 | I/O | USB D+ connected to host |
| V _{BUS} | E1 | I | V _{BUS} power supply from USB receptacle |
| V _{SUPPLY} | B1 | I | 2.8-V to 4.4-V battery supply voltage |

ABSOLUTE MAXIMUM RATINGS^{(1) (2)}

over operating free-air temperature range (unless otherwise noted)

| | | MIN | MAX | UNIT | |
|----------------------|--|--------------------|--------------------------|--------------------------|----|
| V _{BUS} | Supply voltage from USB connector | -0.5 | 28 | V | |
| V _{SUPPLY} | Supply voltage from battery | -0.5 | 6 | V | |
| V _{USBIO} | Switch I/O voltage range | USB switch | -0.5 | V _{SUPPLY} +0.5 | V |
| V _{UARTIO} | | UART switch | -0.5 | V _{SUPPLY} +0.5 | V |
| V _{AUDIO} | | Audio switch | -1.5 | V _{SUPPLY} +0.5 | V |
| V _{MICIO} | | Mic switch | -0.5 | V _{SUPPLY} +0.5 | |
| V _{LOGICIO} | Logic input, output and I/O voltage ranges | -0.5 | V _{SUPPLY} +0.5 | V | |
| I _{BUS} | Input current on V _{BUS} pin | | 100 | mA | |
| I _{SUPPLY} | Input current on V _{SUPPLY} pin | | 100 | mA | |
| I _{GND} | Continuous current through GND | | 100 | mA | |
| I _K | Analog port diode current | -50 | 50 | mA | |
| I _{SW-DC} | ON-state continuous switch current | -60 | 60 | mA | |
| I _{SW-PEAK} | ON-state peak switch current | -150 | 150 | mA | |
| I _{IK} | Digital logic input clamp current | V _L < 0 | | -50 | mA |
| I _{LOGIC_O} | Continuous current through logic output | | 50 | mA | |
| T _{stg} | Storage temperature range | -65 | 150 | °C | |

- (1) Stresses above these ratings may cause permanent damage. Exposure to absolute maximum conditions for extended periods may degrade device reliability. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those specified is not implied.
- (2) The algebraic convention, whereby the most negative value is a minimum and the most positive value is a maximum.

THERMAL IMPEDANCE RATINGS

| | | | UNIT |
|-----------------|---------------------------|-------------|-----------|
| θ _{JA} | Package thermal impedance | YZP package | 75.5 °C/W |

RECOMMENDED OPERATING CONDITIONS

| | | MIN | MAX | UNIT | |
|----------------------|--|--------------|---------------------|---------------------|---|
| V _{BUS} | Supply voltage from USB connector | 4.35 | 6.7 | V | |
| V _{SUPPLY} | Supply voltage from battery | 2.8 | 4.4 | V | |
| V _{USBIO} | Switch I/O voltage range | USB switch | 0 | 3.6 | V |
| V _{UARTIO} | | UART switch | 0 | V _{SUPPLY} | |
| V _{AUDIO} | | Audio switch | -1.3 | 1.3 | |
| V _{MICIO} | | Mic switch | 0 | 2.3 | |
| V _{LOGICIO} | Logic input, output and I/O voltage ranges | 0 | V _{SUPPLY} | V | |
| I _{SW-DC} | ON-state continuous switch current | | | mA | |
| I _{SWPEAK} | ON-state peak switch current | | | mA | |
| T _A | Ambient temperature | -40 | 85 | °C | |

ELECTRICAL CHARACTERISTICS

$T_A = -40^{\circ}\text{C}$ to 85°C , typical values are at $V_{\text{SUPPLY}} = 3.6\text{ V}$, $V_{\text{BUS}} = 5\text{ V}$, $T_A = 25^{\circ}\text{C}$ (unless otherwise noted)

| PARAMETER | SYMBOL | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|------------------------------------|----------------------|--|---|------|-----|------------------|
| V_{SUPPLY} supply current | I_{VSUPPLY} | $V_{\text{SUPPLY}} = 4.2\text{ V}$, $V_{\text{BUS}} = 0\text{ V}$, $\text{ADC_EN} = 0$, | $\text{CP_EN} = 0$, $\text{SEMREN} = 0$ | 6 | 10 | μA |
| | | | $\text{CP_EN} = 0$, $\text{SEMREN} = 1$ | 6 | 10 | |
| | | | $\text{CP_EN} = 1$, $\text{SEMREN} = 1$ | 60 | 70 | |
| V_{BUS} supply current | I_{VBUS} | $V_{\text{SUPPLY}} = 3.6\text{ V}$, $V_{\text{BUS}} = 5\text{ V}$, $\text{ADC_EN} = 0$, | $\text{CP_EN} = 0$, $\text{SEMREN} = 0$ | 45 | 60 | μA |
| | | | $\text{CP_EN} = 0$, $\text{SEMREN} = 1$ | 45 | 60 | |
| | | | $\text{CP_EN} = 1$, $\text{SEMREN} = 1$ | 80 | 98 | |
| V_{BUS} detect threshold | V_{BUSDET} | $V_{\text{BUS}} = 0$ to 5 V , read the INT | 3 | 3.5 | 4 | V |
| Microphone removal threshold | V_{MRCOMP} | Ramp ID down, read the INT | LDO voltage = 2.6 V | 2.2 | | V |
| | | | LDO voltage = 2.3 V | 1.95 | | |
| SEND/END threshold | V_{SECOMP} | LDO voltage = 2.3 or 2.6 V , ramp ID up from 0 V , read the INT | 0.15 | | | V |
| ID resistance 1 | R_{ID1} | $\text{ID_200} = 1$, $V_{\text{SUPPLY}} = 3.6\text{ V}$ | 160 | 200 | 240 | $\text{k}\Omega$ |
| ID resistance 2 | R_{ID2} | $\text{ID_620} = 1$, $V_{\text{SUPPLY}} = 3.6\text{ V}$ | 496 | 620 | 744 | Ω |

LDO ELECTRICAL CHARACTERISTICS

$T_A = -40^{\circ}\text{C}$ to 85°C , typical values are at $V_{\text{SUPPLY}} = 3.6\text{ V}$, $V_{\text{BUS}} = 5\text{ V}$, $T_A = 25^{\circ}\text{C}$ (unless otherwise noted)

| PARAMETER | SYMBOL | TEST CONDITIONS | MIN | TYP | MAX | UNIT | |
|-------------------------|---------------------|---|--|-----|------|---------------|---------------|
| Input voltage | V_{BUS} | | 4.35 | 5 | 6.7 | V | |
| | V_{SUPPLY} | | 2.8 | | 4.4 | | |
| Output voltage | $V_{\text{OUT-26}}$ | $I_{\text{O}} = 0\text{ mA}$ | 2.54 | 2.6 | 2.65 | V | |
| | $V_{\text{OUT-23}}$ | | 2.2 | 2.3 | 2.35 | | |
| Max output current | $I_{\text{O-26}}$ | Measured at R2.2K pin | | | 10 | μA | |
| | $I_{\text{O-23}}$ | | | | 500 | | |
| Power supply rejection | PSR_{217} | $V_{\text{OUT}} = 2.3\text{ V}$, $V_{\text{SUPPLY}} = 3.2\text{ V}$, $I_{\text{O}} = 150$ to $450\text{ }\mu\text{A}$, | $f = 217\text{ Hz}$ | -50 | | dB | |
| | PSR_{1k} | | $f = 1\text{ kHz}$ | -42 | | | |
| Integrated output noise | $e_{\text{n-OUT}}$ | $V_{\text{OUT}} = 2.3\text{ V}$, $V_{\text{SUPPLY}} = 3.2\text{ V}$, $I_{\text{O}} = 150$ to $450\text{ }\mu\text{A}$, | $f = 20\text{ Hz}$ to 20 kHz (A-weighted) | | 1 | 50 | μV |
| Rise time 1 | t_{r1} | $I_{\text{O}} = 20\text{ }\mu\text{A}$, R2.2K = 0 to 2.6 V | | | 178 | ms | |
| Rise time 2 | t_{r2} | $I_{\text{O}} = 20\text{ }\mu\text{A}$, R2.2K = 2.3 to 2.6 V | | | 260 | ms | |
| Fall time | t_{f} | $I_{\text{O}} = 0\text{ }\mu\text{A}$, R2.2K = 2.6 to 2.3 V | | | 2.5 | ms | |

USB SWITCH ELECTRICAL CHARACTERISTICS FOR 2.8 V to 4.4 V SUPPLY
 $T_A = -40^\circ\text{C}$ to 85°C , typical values are at $V_{\text{SUPPLY}} = 3.6\text{ V}$, $V_{\text{BUS}} = 5\text{ V}$, $T_A = 25^\circ\text{C}$ (unless otherwise noted)

| PARAMETER | SYMBOL | TEST CONDITIONS | | MIN | TYP | MAX | UNIT |
|---|--|--|---|-----|-----|-----|----------|
| Analog Switch | | | | | | | |
| Analog signal range | V_{USBIO} | | | 0 | | 3.6 | V |
| ON-state resistance | r_{ON} | $V_I = 0\text{ V to }3.6\text{ V}$, $I_O = -2\text{ mA}$, | $V_{\text{SUPPLY}} = 3.0\text{ V}$, $\text{CP_EN} = 1$, Switch ON | | 4.5 | 10 | Ω |
| ON-state resistance match between channels | Δr_{ON} | $V_I = 0.4\text{ V}$, $I_O = -2\text{ mA}$, | $V_{\text{SUPPLY}} = 3.0\text{ V}$, $\text{CP_EN} = 1$, Switch ON | | 1 | 1.5 | Ω |
| ON-state resistance flatness | $r_{\text{ON(flat)}}$ | $V_I = 0\text{ V to }3.6\text{ V}$, $I_O = -2\text{ mA}$, $V_{\text{SUPPLY}} = 3.0\text{ V}$ | $\text{CP_EN} = 1$, Switch ON | | 0.5 | 1 | Ω |
| V_I or V_O OFF leakage current ⁽¹⁾ | $I_{\text{IO(OFF)}}$ | $V_I = 0.3\text{ V}$, $V_O = 2.5\text{ V}$ or $V_I = 2.5\text{ V}$, $V_O = 0.3\text{ V}$, | $V_{\text{SUPPLY}} = 4.4\text{ V}$, Switch OFF | | 25 | 360 | nA |
| V_O ON leakage current ⁽¹⁾ | $I_{\text{IO(ON)}}$ | $V_I = \text{OPEN}$, $V_O = 0.3\text{ V}$ or 2.5 V , | $V_{\text{SUPPLY}} = 4.4\text{ V}$, $\text{CP_EN} = 1$, Switch ON | | 10 | 360 | nA |
| Dynamic | | | | | | | |
| Turn-ON time | t_{ON} | V_I or $V_O = V_{\text{SUPPLY}}$, $R_L = 50\ \Omega$, $C_L = 35\text{ pF}$ | $\text{CP_EN} = 1$ From receipt of I ² C ACK bit | | 1 | | ms |
| Turn-OFF time | t_{OFF} | V_I or $V_O = V_{\text{SUPPLY}}$, $R_L = 50\ \Omega$, $C_L = 35\text{ pF}$, | $\text{CP_EN} = 0$ From receipt of I ² C ACK bit | | 1 | | ms |
| V_I OFF capacitance ⁽¹⁾ | $C_{\text{I(OFF)}}$ | DC bias = 0 V or 3.6 V $f = 10\text{ MHz}$, | $\text{CP_EN} = 0$, Switch OFF | | 6.5 | | pF |
| V_O OFF capacitance ⁽¹⁾ | $C_{\text{O(OFF)}}$ | DC bias = 0 V or 3.6 V $f = 10\text{ MHz}$, | $\text{CP_EN} = 0$, Switch OFF | | 3 | | pF |
| V_I , V_O ON capacitance ⁽¹⁾ | $C_{\text{I(ON)}}$, $C_{\text{O(ON)}}$ | DC bias = 0 V or 3.6 V $f = 10\text{ MHz}$, | $\text{CP_EN} = 1$, Switch ON | | 9 | | pF |
| Bandwidth | BW | $R_L = 50\ \Omega$, | $\text{CP_EN} = 1$, Switch ON | | 830 | | MHz |
| OFF Isolation | O_{ISO} | $f = 240\text{ MHz}$, $R_L = 50\ \Omega$, $C_L = 20\text{ pF}$, | $\text{CP_EN} = 0$, Switch OFF | | -20 | | dB |
| Crosstalk | X_{TALK} | $f = 240\text{ MHz}$, $R_L = 50\ \Omega$, $C_L = 20\text{ pF}$, | $\text{CP_EN} = 1$, Switch ON | | -42 | | dB |

(1) V_I = voltage asserted on DP and DM pins. V_O = voltage asserted on USB_DP and USB_DM pins. I_O = current on the USB_DP or USB_DM pins.

UART SWITCH ELECTRICAL CHARACTERISTICS FOR 2.8 V to 4.4 V SUPPLY

$T_A = -40^\circ\text{C}$ to 85°C , typical values are at $V_{\text{SUPPLY}} = 3.6\text{ V}$, $V_{\text{BUS}} = 5\text{ V}$, $T_A = 25^\circ\text{C}$ (unless otherwise noted)

| PARAMETER | SYMBOL | TEST CONDITIONS | | MIN | TYP | MAX | UNIT |
|---|--|--|---|-----|------|---------------------|----------|
| Analog Switch | | | | | | | |
| Analog signal range | V_{UARTIO} | | | 0 | | V_{SUPPLY} | V |
| ON-state resistance | r_{ON} | $V_I = 0\text{ V to } 2.8\text{ V}$, $I_O = -2\text{ mA}$, | $V_{\text{SUPPLY}} = 2.8\text{ V}$, $\text{CP_EN} = 1$, Switch ON | | 37 | 61 | Ω |
| ON-state resistance match between channels | Δr_{ON} | $V_I = 0.4\text{ V}$, $I_O = -2\text{ mA}$, | $V_{\text{SUPPLY}} = 2.8\text{ V}$, Switch ON | | 2 | 3.5 | Ω |
| ON-state resistance flatness | $r_{\text{ON(flat)}}$ | $V_I = 0\text{ V to } 2.8\text{ V}$, $I_O = -2\text{ mA}$, $V_{\text{SUPPLY}} = 2.8\text{ V}$ | Switch ON | | 20 | 27 | Ω |
| V_I or V_O OFF leakage current ⁽¹⁾ | $I_{\text{IO(OFF)}}$ | $V_I = 0.3\text{ V}$, $V_O = 3.3\text{ V}$ or $V_I = 3.3\text{ V}$, $V_O = 0.3\text{ V}$, | $V_{\text{SUPPLY}} = 3.6\text{ V}$, Switch OFF | | 100 | 360 | nA |
| V_O ON leakage current ⁽¹⁾ | $I_{\text{IO(ON)}}$ | $V_I = \text{OPEN}$, $V_O = 0.3\text{ V}$ or 3.3 V , | $V_{\text{SUPPLY}} = 3.6\text{ V}$, $\text{CP_EN} = 1$, Switch ON | | 100 | 360 | nA |
| Dynamic | | | | | | | |
| Turn-ON time | t_{ON} | V_I or $V_O = V_{\text{SUPPLY}}$, $R_L = 50\ \Omega$, $C_L = 35\text{ pF}$ | From receipt of I ² C ACK bit | | 1 | | ms |
| Turn-OFF time | t_{OFF} | V_I or $V_O = V_{\text{SUPPLY}}$, $R_L = 50\ \Omega$, $C_L = 35\text{ pF}$ | From receipt of I ² C ACK bit | | 1 | | ms |
| V_I OFF capacitance ⁽¹⁾ | $C_{\text{I(OFF)}}$ | DC bias = 0 V or V_{SUPPLY} , $f = 10\text{ MHz}$, | Switch OFF | | 6.5 | | pF |
| V_O OFF capacitance ⁽¹⁾ | $C_{\text{O(OFF)}}$ | DC bias = 0 V or V_{SUPPLY} , $f = 10\text{ MHz}$, | Switch OFF | | 8 | | pF |
| V_I , V_O ON capacitance ⁽¹⁾ | $C_{\text{I(ON)}}$, $C_{\text{O(ON)}}$ | DC bias = 0 V or V_{SUPPLY} , $f = 10\text{ MHz}$, | Switch ON | | 22 | | pF |
| Bandwidth | BW | $R_L = 50\ \Omega$, | Switch ON | | 295 | | MHz |
| OFF Isolation | O_{ISO} | $f = 250\text{ kHz}$, $R_L = 50\ \Omega$, $C_L = 20\text{ pF}$, | Switch OFF | | -100 | | dB |
| Crosstalk | X_{TALK} | $f = 250\text{ kHz}$, $R_L = 50\ \Omega$, $C_L = 20\text{ pF}$, | Switch ON | | -98 | | dB |

(1) V_I = voltage asserted on DP and DM pins. V_O = voltage asserted on UART_RX and UART_TX pins. I_O = current on the UART_RX and UART_TX pins.

AUDIO SWITCH ELECTRICAL CHARACTERISTICS FOR 2.8 V to 4.4 V SUPPLY
 $T_A = -40^\circ\text{C}$ to 85°C , typical values are at $V_{\text{SUPPLY}} = 3.6\text{ V}$, $V_{\text{BUS}} = 5\text{ V}$, $T_A = 25^\circ\text{C}$ (unless otherwise noted)

| PARAMETER | SYMBOL | TEST CONDITIONS | | MIN | TYP | MAX | UNIT |
|---|--|--|--|------|-------|------|----------|
| Analog Switch | | | | | | | |
| Analog signal range | V_{AUDIOIO} | | | -1.3 | | 1.3 | V |
| ON-state resistance | r_{ON} | $V_I = \pm 1.3\text{ V}$, $I_O = -20\text{ mA}$, $V_{\text{SUPPLY}} = 2.8\text{ V}$, | AUDIO_L or AUDIO_R, DM or DP | | 3.8 | 6 | Ω |
| ON-state resistance match between channels | Δr_{ON} | $V_I = 1.3\text{ V}$, $I_O = -20\text{ mA}$, $V_{\text{SUPPLY}} = 2.8\text{ V}$, | AUDIO_L or AUDIO_R, DM or DP | | 1 | 1.3 | Ω |
| ON-state resistance flatness | $r_{\text{ON(flat)}}$ | $V_I = \pm 1.3\text{ V}$, $I_O = -20\text{ mA}$, $V_{\text{SUPPLY}} = 2.8\text{ V}$, | AUDIO_L or AUDIO_R, DM or DP | | 0.1 | 0.25 | Ω |
| V_I or V_O OFF leakage current ⁽¹⁾ | $I_{\text{IO(OFF)}}$ | $V_I = 0\text{ V}$, $V_O = 1.3\text{ V}$ or $V_I = 1.3\text{ V}$, $V_O = 0.3\text{ V}$, | Switch OFF | | 25 | 400 | nA |
| V_O ON leakage current ⁽¹⁾ | $I_{\text{IO(ON)}}$ | $V_I = \text{OPEN}$, $V_O = \pm 1.3\text{ V}$, $V_{\text{SUPPLY}} = 4.4\text{ V}$, | Switch ON | | 25 | 400 | nA |
| Dynamic | | | | | | | |
| Turn-ON time | t_{ON} | V_I or $V_O = V_{\text{SUPPLY}}$, $R_L = 50\ \Omega$, $C_L = 35\text{ pF}$ | From receipt of I ² C ACK bit | | 1 | | ms |
| Turn-OFF time | t_{OFF} | V_I or $V_O = V_{\text{SUPPLY}}$, $R_L = 50\ \Omega$, $C_L = 35\text{ pF}$ | From receipt of I ² C ACK bit | | 1 | | ms |
| V_I OFF capacitance ⁽¹⁾ | $C_{\text{I(OFF)}}$ | DC bias = 0 V or 2.6 V, $f = 10\text{ MHz}$, | Switch OFF | | 4.5 | | pF |
| V_O OFF capacitance ⁽¹⁾ | $C_{\text{O(OFF)}}$ | DC bias = 0 V or 2.6 V, $f = 10\text{ MHz}$, | Switch OFF | | 6.5 | | pF |
| V_I , V_O ON capacitance ⁽¹⁾ | $C_{\text{I(ON)}}$, $C_{\text{O(ON)}}$ | DC bias = 0 V or 2.6 V, $f = 10\text{ MHz}$, | Switch ON | | 9 | | pF |
| Bandwidth | BW | $R_L = 50\ \Omega$, | Switch ON | | 788 | | MHz |
| OFF Isolation | O_{ISO} | $f = 20\text{ kHz}$, $R_L = 50\ \Omega$, | Switch OFF | | -100 | | dB |
| Crosstalk | X_{TALK} | $f = 20\text{ kHz}$, $R_L = 50\ \Omega$, | Switch ON | | -120 | | dB |
| Total harmonic distortion | THD | $R_L = 16\ \Omega$, $C_L = 20\text{ pF}$, | $f = 20\text{ Hz}$ to 20 kHz , 2.6 Vpp | | 0.087 | 0.12 | % |

(1) V_O = voltage asserted on DP and DM pins. V_I = voltage asserted on AUDIO_R and AUDIO_L pins. I_O = current on the DP and DM pins.

MIC SWITCH ELECTRICAL CHARACTERISTICS FOR 2.8 V to 4.4 V SUPPLY

$T_A = -40^\circ\text{C}$ to 85°C , typical values are at $V_{\text{SUPPLY}} = 3.6\text{ V}$, $V_{\text{BUS}} = 5\text{ V}$, $T_A = 25^\circ\text{C}$ (unless otherwise noted)

| PARAMETER | SYMBOL | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---|--|---|-----|------|-------|----------|
| Analog Switch | | | | | | |
| Analog signal range | V_{MICIO} | | 0 | | 2.3 | V |
| ON-state resistance | r_{ON} | $V_I = 2.3\text{ V}$, $I_O = -2\text{ mA}$, $V_{\text{SUPPLY}} = 2.8\text{ V}$, MIC ID | | 9 | 12 | Ω |
| ON-state resistance flatness | $r_{\text{ON(flat)}}$ | $V_I = 2.3\text{ V}$, $I_O = -2\text{ mA}$, $V_{\text{SUPPLY}} = 2.8\text{ V}$ MIC ID | | 0.5 | 1 | Ω |
| V_I or V_O OFF leakage current ⁽¹⁾ | $I_{\text{O(OFF)}}$ | $V_I = 0.3\text{ V}$, $V_O = 2.3\text{ V}$ or $V_I = 2.3\text{ V}$, $V_O = 0.3\text{ V}$, $V_{\text{SUPPLY}} = 4.4\text{ V}$ Switch OFF | | 5 | 200 | nA |
| V_O ON leakage current ⁽¹⁾ | $I_{\text{O(ON)}}$ | $V_I = \text{OPEN}$ $V_O = 0.3\text{ V}$ or 2.5 V $V_{\text{SUPPLY}} = 4.4\text{ V}$ Switch ON | | 2 | 200 | nA |
| Dynamic | | | | | | |
| Turn-ON time | t_{ON} | V_I or $V_O = V_{\text{SUPPLY}}$, $R_L = 50\ \Omega$, $C_L = 35\text{ pF}$ From receipt of I ² C ACK bit | | 1 | | ms |
| Turn-OFF time | t_{OFF} | V_I or $V_O = V_{\text{SUPPLY}}$, $R_L = 50\ \Omega$, $C_L = 35\text{ pF}$ From receipt of I ² C ACK bit | | 1 | | ms |
| V_I OFF capacitance ⁽¹⁾ | $C_{\text{I(OFF)}}$ | DC bias = 0 V or 3.6 V , $f = 10\text{ MHz}$, Switch OFF | | 6 | | pF |
| V_O OFF capacitance ⁽¹⁾ | $C_{\text{O(OFF)}}$ | DC bias = 0 V or 3.6 V , $f = 10\text{ MHz}$, Switch OFF | | 6 | | pF |
| V_I , V_O ON capacitance ⁽¹⁾ | $C_{\text{I(ON)}}$, $C_{\text{O(ON)}}$ | DC bias = 0 V or 3.6 V , $f = 10\text{ MHz}$, Switch ON | | 12 | | pF |
| Bandwidth | BW | $R_L = 50\ \Omega$, Switch ON | | 573 | | MHz |
| OFF Isolation | O_{ISO} | $f = 20\text{ kHz}$, $R_L = 50\ \Omega$, Switch OFF | | -37 | | dB |
| Crosstalk | X_{TALK} | $f = 20\text{ kHz}$ to audio input, $R_L = 50\ \Omega$, Switch ON | | -125 | | dB |
| Total harmonic distortion | THD | $R_L = 600\ \Omega$, $C_L = 20\text{ pF}$, $f = 20\text{ Hz}$ to 20 kHz , 2.6 Vpp Switch ON | | 0.07 | 0.075 | % |

(1) V_I = voltage asserted on the ID pin. V_O = voltage asserted on MIC pin. I_O = current on the MIC pin.

DIGITAL SIGNALS
 $T_A = -40^\circ\text{C}$ to 85°C (unless otherwise noted), typical values are at $V_{\text{SUPPLY}} = 3.6\text{ V}$, $V_{\text{BUS}} = 5\text{ V}$, $T_A = 25^\circ\text{C}$

| PARAMETER | SYMBOL | TEST CONDITIONS | MIN | MAX | UNIT |
|------------------------|---------------------|--|--------------------------------|--------------------------------|---------------|
| DSS | | | | | |
| High-level input logic | V_{IH} | | $V_{\text{SUPPLY}} \times 0.7$ | V_{SUPPLY} | V |
| Low-level input logic | V_{IL} | | 0 | $V_{\text{SUPPLY}} \times 0.3$ | V |
| Input leakage current | I_{INLEAK} | $V_I = 0\text{ V to } V_{\text{SUPPLY}}$ | -1 | 1 | μA |
| SCL, SDA | | | | | |
| High-level input logic | V_{IH} | | 1.4 | | V |
| Low-level input logic | V_{IL} | | | 0.4 | V |
| Input leakage current | I_{INLEAK} | $V_I = 0\text{ V to } V_{\text{SUPPLY}}$ | -1 | 1 | μA |
| INT, ISET | | | | | |
| Open-drain low | V_{ODOL} | $I_{\text{ODL}} = 4\text{ mA}$ | | 0.4 | V |

APPLICATION INFORMATION

Default Switch Position

The default switch state (DSS) pin determines if the USB switches or UART switches are selected at startup. An internal pulldown resistor is present on the DSS pin, which selects the USB switches as the default at start-up. If the user wants to default to the UART switches at startup, the DSS pin must be pulled high. If the user wants to disable the switches, this must be done using an I²C write to the SW_Control register after initialization is complete.

The default configuration with V_{BAT} power disables the switches. If the user wants to use the switches, this must be done using an I²C write to the SW_Control register after initialization is complete.

| V _{BUS} PRESENT ON POWER UP | DSS | SWITCH STATES |
|--------------------------------------|-----------|---------------|
| Yes | OPEN / PD | USB |
| | PU | UART |
| No | x | Disable |

ID Impedance Detection

The TS5USBA43402 features impedance detection for identification of various accessories that are attached to the microUSB port. Each accessory is identified by a unique resistor value on the ID pin to ground. During ID detection, the device auto-calibrates an internal current source, using an external 2.21K ±1% resistor. The current source is then applied to the ID pin while an internal voltage reference is incremented until it matches the ID pin voltage. This produces a 4-bit ADC value corresponding to the ID resistance found.

| ID Resistor | Tolerance | ID No. | ADC Value |
|-------------|-----------|--------|-----------|
| 0 Ω | 1% | 0 | 0000 |
| 24 kΩ | 1% | 1 | 0001 |
| 56 kΩ | 1% or 20% | 2 | 0010 |
| 100 kΩ | 1% | 3 | 0011 |
| 130 kΩ | 1% | 4 | 0100 |
| 180 kΩ | 1% | 5 | 0101 |
| 240 kΩ | 1% | 6 | 0110 |
| 330 kΩ | 1% | 7 | 0111 |
| 430 kΩ | 1% | 8 | 1000 |
| 620 kΩ | 1% | 9 | 1001 |
| 910 kΩ | 1% | 10 | 1010 |
| Open | N/A | 11 | 1011 |

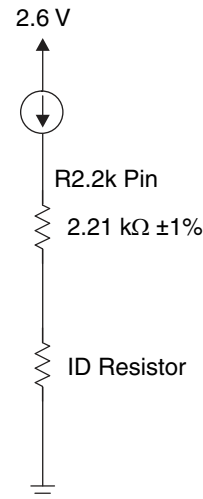


Figure 1. Figure 1. Impedance Detection Circuitry

Supply Detection

The TS5USBA43402 can be powered by either V_{SUPPLY} or V_{BUS} . The TS5USBA43402 will select V_{BUS} as the power source when present and otherwise will select V_{SUPPLY} as the power source when V_{SUPPLY} is present and V_{BUS} is not.

Supply Selection and Shutdown Sequence

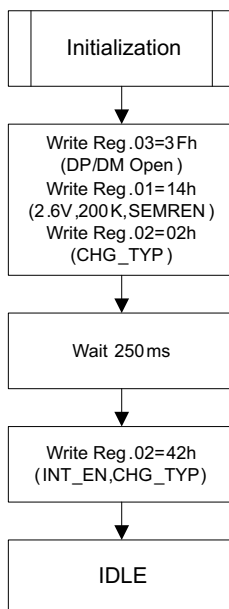
| | V_{SUPPLY} | HANDSET STATUS | MUIC STATUS | POWER SUPPLY |
|-------------------|----------------|------------------|-------------|--------------|
| NORMAL CASE | Yes | ON | Active | V_{SUPPLY} |
| | Yes | OFF (S/W off) | Shutdown | |
| SUDDEN POWER LOSS | Yes | ON | Active | V_{SUPPLY} |
| | No | OFF | Shutdown | |
| NO BATTERY | No | OFF | Shutdown | |
| | No | ON (V_{BUS}) | Active | V_{BUS} |
| USB CHARGING | Yes (charging) | ON (V_{BUS}) | Active | V_{BUS} |

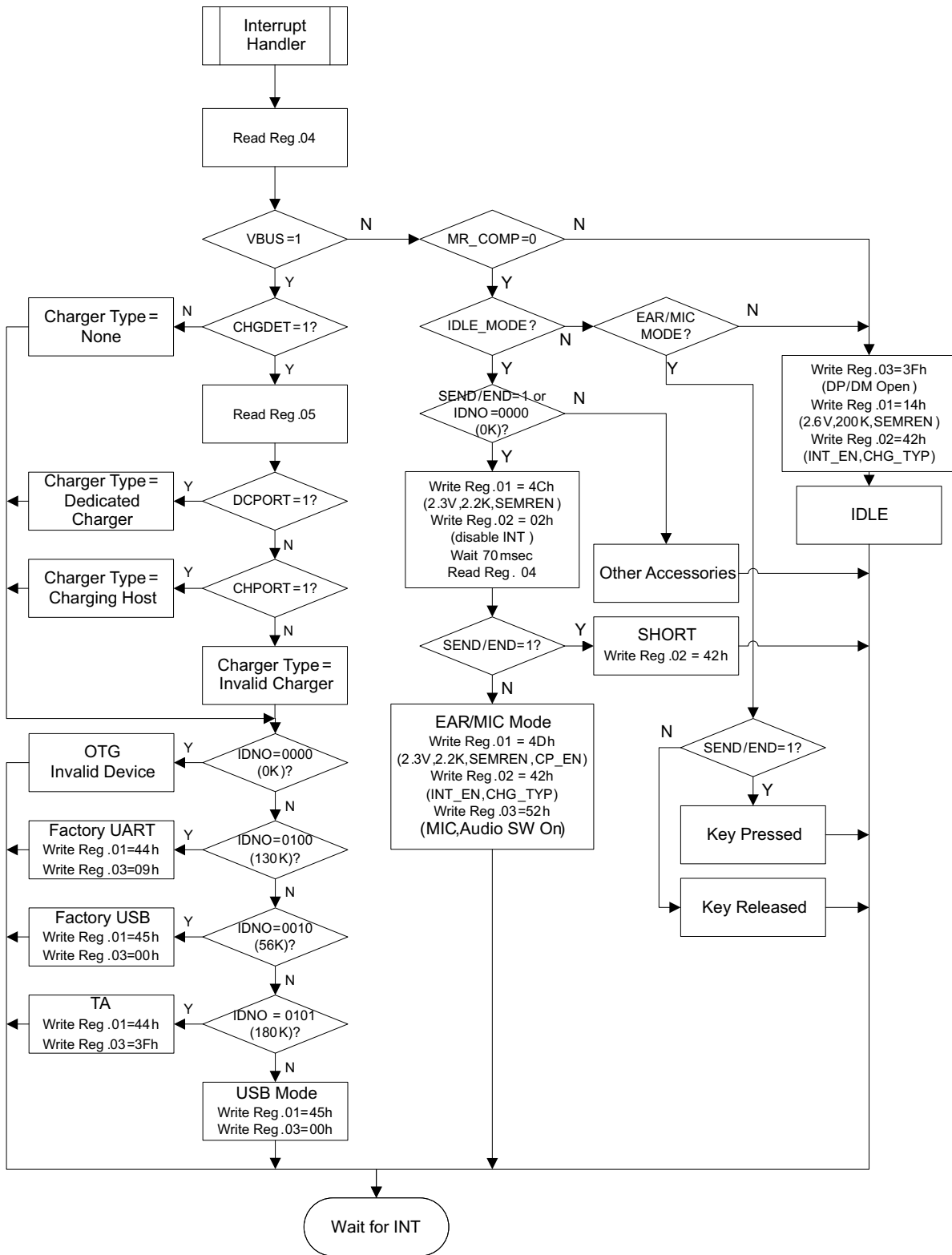
I²C Controlled Internal Comparator Operation

Internal Comparator Logic Table

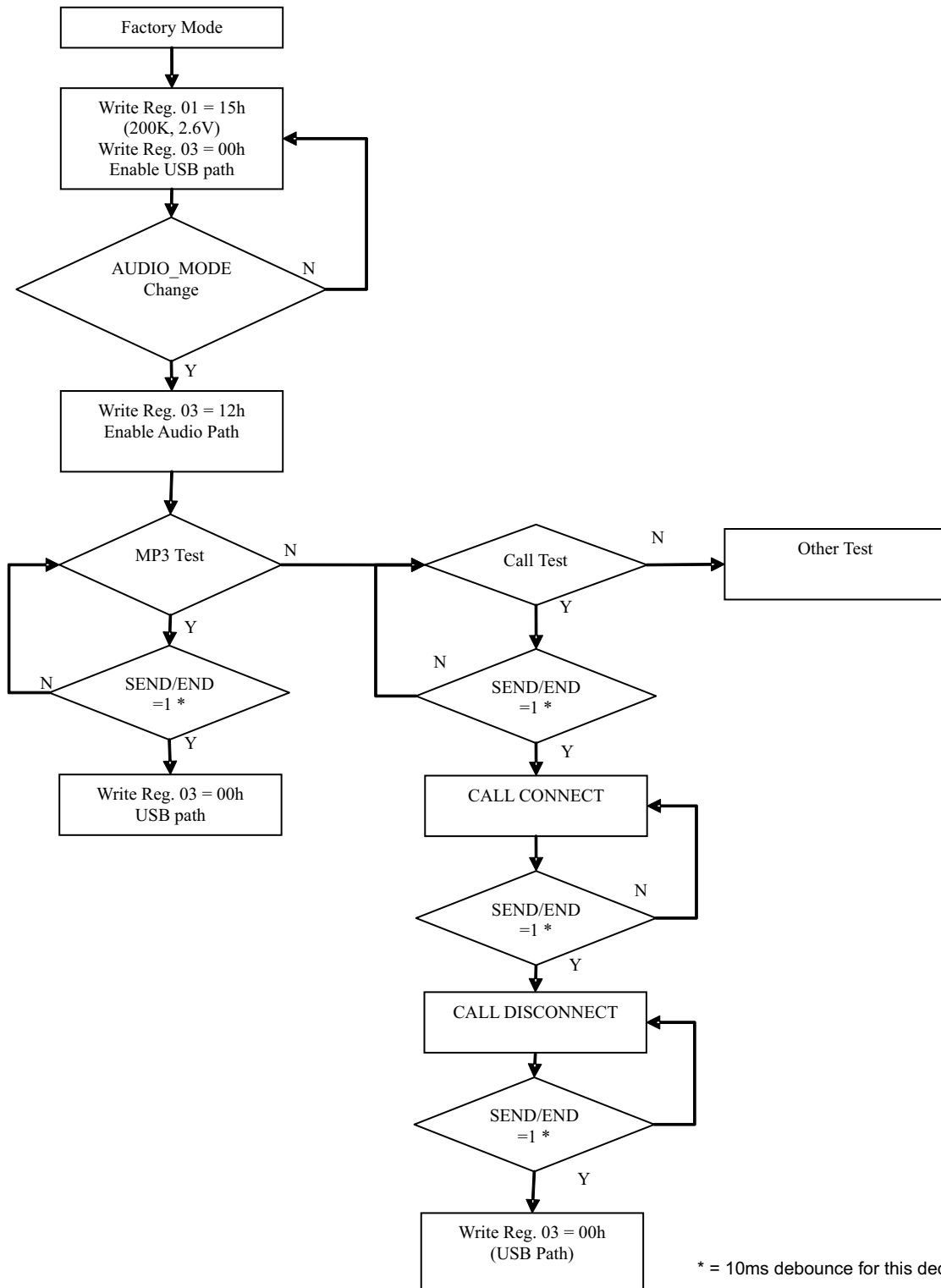
| I ² C CONTROL REGISTER BIT | | | COMPARATORS | | | |
|---------------------------------------|--------|--------|-------------|-----|-----|-----|
| USB_DET_DS | ADC_EN | SEMREN | V_{BUS} | SE | MR | LDO |
| 0 | 0 | 0 | ON | OFF | OFF | OFF |
| 0 | 0 | 1 | ON | ON | ON | ON |
| 0 | 1 | 0 | ON | OFF | ON | ON |
| 0 | 1 | 1 | ON | ON | ON | ON |
| 1 | 0 | 0 | OFF | OFF | OFF | OFF |
| 1 | 0 | 1 | ON | ON | ON | ON |
| 1 | 1 | 0 | ON | OFF | ON | ON |
| 1 | 1 | 1 | ON | ON | ON | ON |

Software Flowchart





FACTORY MODE FLOWCHART



I²C Register Map

| ADDRESS (xh) | NAME | TYPE | RESET VALUE | b7 | b6 | b5 | b4 | b3 | b2 | b1 | b0 |
|--------------|------------|------|-------------------------|--------------------------|---------|----------|--------|---------------|---------|---------|-------------|
| 0 | Device ID | R | TBD | VENDOR ID BITS (TI=0001) | | | | REVISION BITS | | | |
| 1 | Control 1 | R/W | X0000000 | RFU | ID_2P2 | ID_620 | ID_200 | VLDO | SEMREN | ADC_EN | CP_EN |
| 2 | Control 2 | R/W | 0000XX01 | INTPOL | INT_EN | MIC_LP | CP_AUD | RFU | RFU | CHG_TYP | USB_DET_DIS |
| 3 | SW Control | R/W | See ⁽¹⁾ | RFU | MIC_ON | DP[2:0] | | | DM[2:0] | | |
| 4 | INT_Status | R | 00000000 ⁽¹⁾ | CHGDET | MR_COMP | SEND/END | VBUS | IDNO[3: 0] | | | |
| 5 | Status | R | 00XXXXXX | DCPORT | CHPORT | RFU | RFU | RFU | RFU | RFU | RFU |

(1) Refer INT_Status

Slave Address

| NAME | SIZE (BITS) | DESCRIPTION | | | | | | | |
|---------------|-------------|-------------|-------|-------|-------|-------|-------|-------|-------|
| | | Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
| Slave address | 8 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | R/W |

Register Descriptions

Device ID

Address: 00H

Reset Value: N/A

Type: Read

| NAME | SIZE (BITS) | DESCRIPTION |
|-----------|-------------|--|
| Device ID | 8 | A unique number for chip version 00000000 bits 0–3 = chip revision, bits 4–7 = Vendor ID (TI = 1xh, Maxim = 2xh) |

Control 1

Address: 01H

Reset Value: x0000000

Type: Read/Write

| NAME | SIZE (BITS) | DESCRIPTION |
|--------|-------------|---|
| ID_2P2 | 1 | 0: 2.21 kΩ switch open 1: Connect LDO to ID through 2.21 kΩ external resistor |
| ID_620 | 1 | 0: 620 Ω switch open 1: Connect LDO to ID through 620 Ω internal resistor (used for video) |
| ID_200 | 1 | 0: 200 kΩ switch open 1: Connect LDO to ID through 200 kΩ internal resistor |
| VLDO | 1 | 0: LDO voltage = 2.6 V (if manual switching mode) 1: LDO voltage = 2.3 V (if manual switching mode) |
| SEMREN | 1 | 0: Disable send/end and MIC removal comparators and LDO 1: Enable send/end and MIC removal comparators and LDO |

| NAME | SIZE (BITS) | DESCRIPTION |
|--------|-------------|---|
| ADC_EN | 1 | 0: ADC and LDO disabled 1: ADC and LDO enabled |
| CP_EN | 1 | 0: charge pump disabled 1: charge pump enabled |

Control 2

Address: 02H

| ADDRESS (xxh) | NAME | TYPE | b7 | b6 | b5 | b4 | b3 | b2 | b1 | b0 |
|---------------|-----------|------|--------|--------|--------|--------|-----|-----|---------|-------------|
| 2 | Control 2 | R/W | INTPOL | INT_EN | MIC_LP | CP_AUD | RFU | RFU | CHG_TYP | USB_DET_DIS |
| Reset Value | | | 0 | 0 | 0 | 0 | X | X | 0 | 1 |

| NAME | SIZE (BITS) | DESCRIPTION |
|-------------|-------------|---|
| INT_POL | 1 | 0: Interrupt polarity = active low 1: interrupt polarity = active high |
| INT_EN | 1 | 0: All interrupts disabled (masked) 1: All interrupts enabled |
| MIC_LP | 1 | 0: Low power mode - MIC power pulsing disabled 1: Low power mode - MIC power pulsing enabled |
| CP_AUD | 1 | 0: Click/pop resistors on AUDIO_L and AUDIO_R disabled 1: Click/pop resistors on AUDIO_L and AUDIO_R enabled |
| CHG_TYP | 1 | 0: Charger type detection disabled 1: Charger type detection enabled |
| USB_DET_DIS | 1 | 0: USB detection enabled 1: USB detection disabled |

SW_Control

Address: 03H

| ADDRESS (xxh) | NAME | TYPE | b7 | b6 | b5 | b4 | b3 | b2 | b1 | b0 |
|---------------|------------|------|-----|--------|--------------------|----|----|--------------------|----|----|
| 03 | SW Control | R/W | RFU | MIC_ON | DP[2:0] | | | DM[2:0] | | |
| Reset Value | | | X | 0 | See ⁽¹⁾ | | | See ⁽¹⁾ | | |

(1) The reset value depends on V_{BUS} status at powerup. If V_{BUS} presents, the default value depends on DSS pin state (refer Default Switch Position session). If V_{BUS} does not present, the default value is 111b (DM/DP switch is open).

| NAME | SIZE (BITS) | DESCRIPTION |
|--------|-------------|--|
| MIC_ON | 1 | 0: MIC switching path open 1: MIC switching path connected to ID line |
| DP | 3 | 000: DP connected to USB_DP 001: DP connected to UART_TX 010: DP connected to AUDIO_R 011: Future Use (right Audio for Video) |

| NAME | SIZE (BITS) | DESCRIPTION |
|------|-------------|--|
| DM | 3 | 000: DM connected to USB_DM 001: DM connected to UART_RX 010: DM connected to AUDIO_L 011: Future Use (left Audio for Video) 100–111: DM switching path open |

INT_Status

Address: 04H

| ADDRESS (xxh) | NAME | TYPE | b7 | b6 | b5 | b4 | b3 | b2 | b1 | b0 |
|---------------|------------|------|--------|---------|----------|------|--------------------|----|----|----|
| 04 | INT_Status | R | CHGDET | MR_COMP | SEND/END | VBUS | IDNO[3:0] | | | |
| Reset Value | | | 0 | 0 | 0 | 0 | See ⁽¹⁾ | | | |

(1) ADC value of the ID pin

| NAME | SIZE (BITS) | DESCRIPTION |
|------------------|-------------|--|
| CHGDET | 1 | 0: High-current charger not detected 1: High-current charger detected |
| MR_COMP | 1 | 0: MIC removal comparator low 1: MIC removal comparator high |
| SEND/END | 1 | 0: ID line not grounded 1: ID line grounded (send/end button pressed) |
| V _{BUS} | 1 | 0: No power detected on V _{BUS} 1: Power detected on V _{BUS} |
| IDNO | 1 | 0000: ADC determined ID impedance = 0 Ω (grounded) 0001: ADC determined ID impedance = 24 kΩ 0010: ADC determined ID impedance = 56 kΩ 0011: ADC determined ID impedance = 100 kΩ 0100: ADC determined ID impedance = 130 kΩ 0101: ADC determined ID impedance = 180 kΩ 0110: ADC determined ID impedance = 240 kΩ 0111: ADC determined ID impedance = 330 kΩ 1000: ADC determined ID impedance = 430 kΩ 1001: ADC determined ID impedance = 620 kΩ 1010: ADC determined ID impedance = 910 kΩ 1011: ADC determined ID impedance = open |

Status

Address: 05H

| ADDRESS (xxh) | NAME | TYPE | b7 | b6 | b5 | b4 | b3 | b2 | b1 | b0 |
|---------------|--------|------|--------|--------|-----|-----|-----|-----|-----|-----|
| 5 | Status | R | DCPORT | CHPORT | RFU | RFU | RFU | RFU | RFU | RFU |
| Reset Value | | | 0 | 0 | X | X | X | X | X | X |

| NAME | SIZE (BITS) | DESCRIPTION |
|--------|-------------|--|
| DCPORT | 1 | 0: Dedicated charger not detected 1: Dedicated charger detected |
| CHPORT | 1 | 0: Charging host port not detected 1: Charging host port detected |

Power Consumption

Operating Modes Summary (with estimated power consumption)

| | BAND GAP | UVLO | I ² C | DETECTION PLUG | Z DETECTION | CHARGE PUMP | CHARGE PUMP (LOW CURRENT) | TOTAL I _{CC} (μA) |
|--------------------------|----------|------|------------------|----------------|-------------|-------------|---------------------------|----------------------------|
| Audio | ON | ON | ON | ON | ON | ON | OFF | 59 |
| Audio (no active signal) | ON | ON | ON | ON | ON | OFF | ON | 14 |
| UART | ON | ON | ON | ON | ON | OFF | OFF | 9 |
| USB | ON | ON | ON | ON | ON | ON | OFF | 59 |
| Travel Adapter | ON | ON | ON | ON | OFF | OFF | OFF | 8 |
| IDLE | ON | ON | ON | ON | OFF | OFF | OFF | 8 |
| Sleep | OFF | OFF | OFF | OFF | OFF | OFF | OFF | 0 |
| I _{CC} (μA) | 3 | 2 | 1 | 2 | 1 | 50 | 5 | |

PARAMETER MEASUREMENT INFORMATION

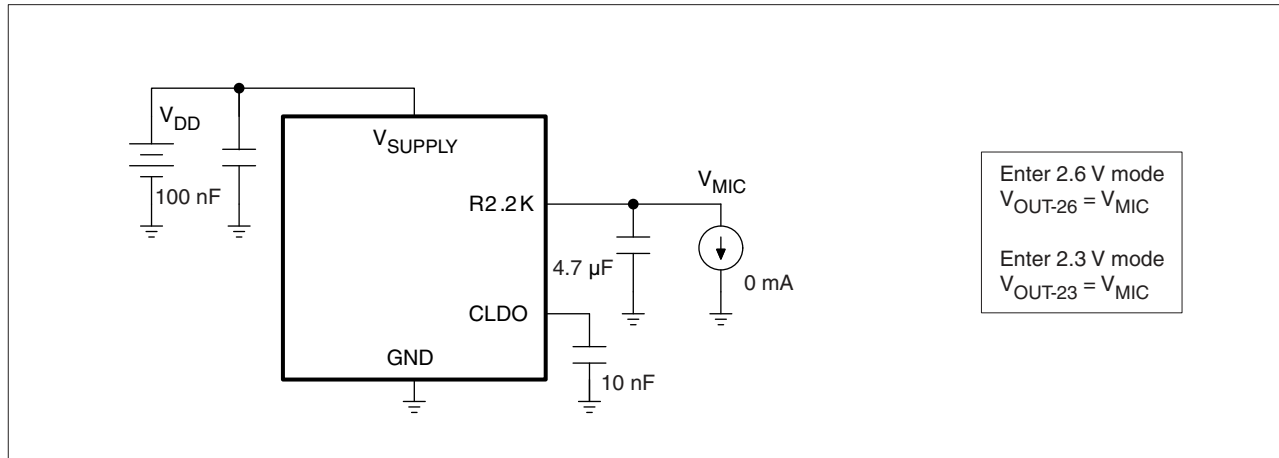


Figure 2. LDO Output Voltage

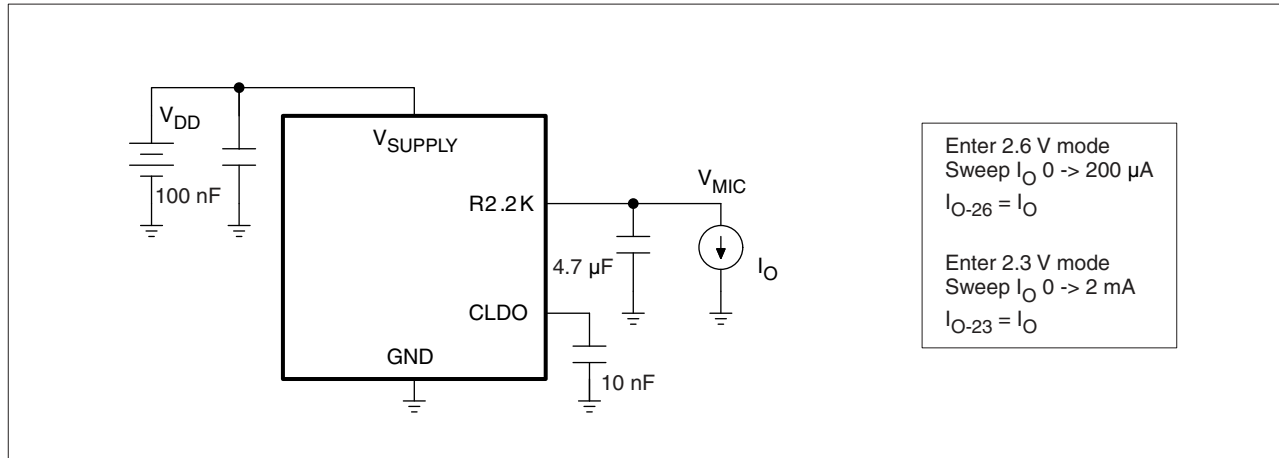


Figure 3. Max Output Current

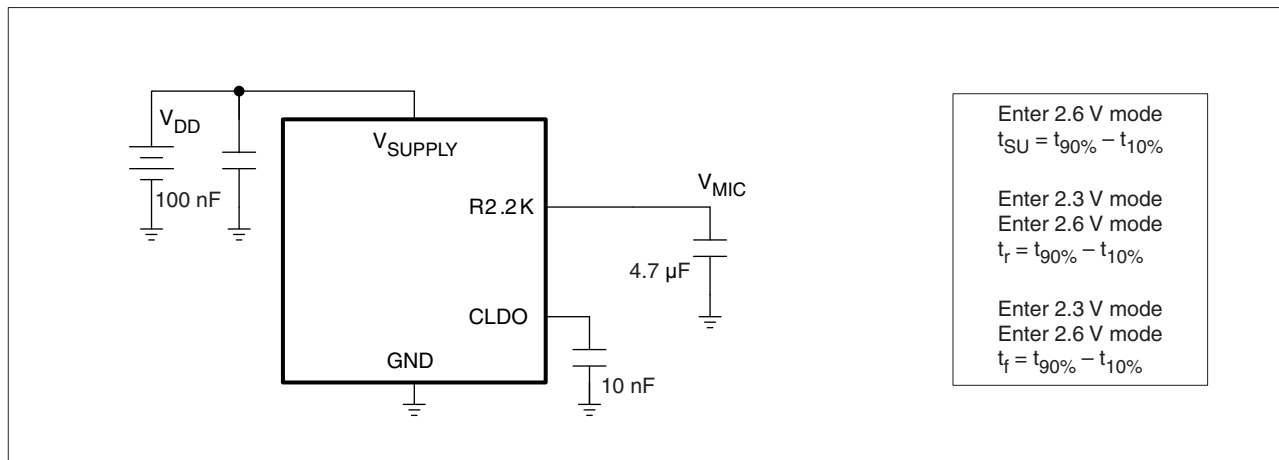


Figure 4. LDO Rise/Fall Time

A. I_O can be set with a resistor.

PARAMETER MEASUREMENT INFORMATION (continued)

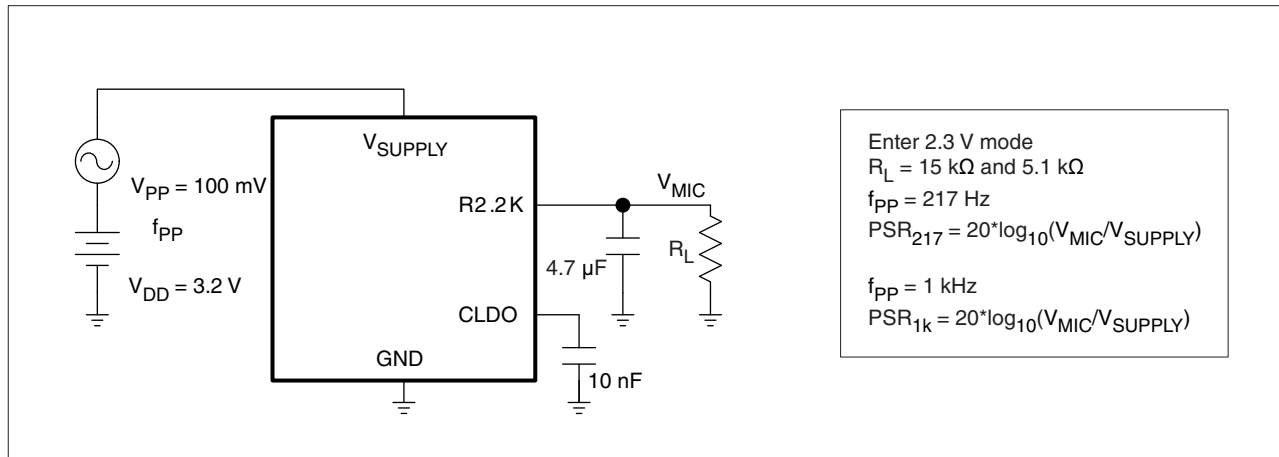


Figure 5. Power Supply Rejection

B. V_{MIC} should be $V_{2.2K}$; add 200 pF on V_{SUPPLY} in LDO output noise.

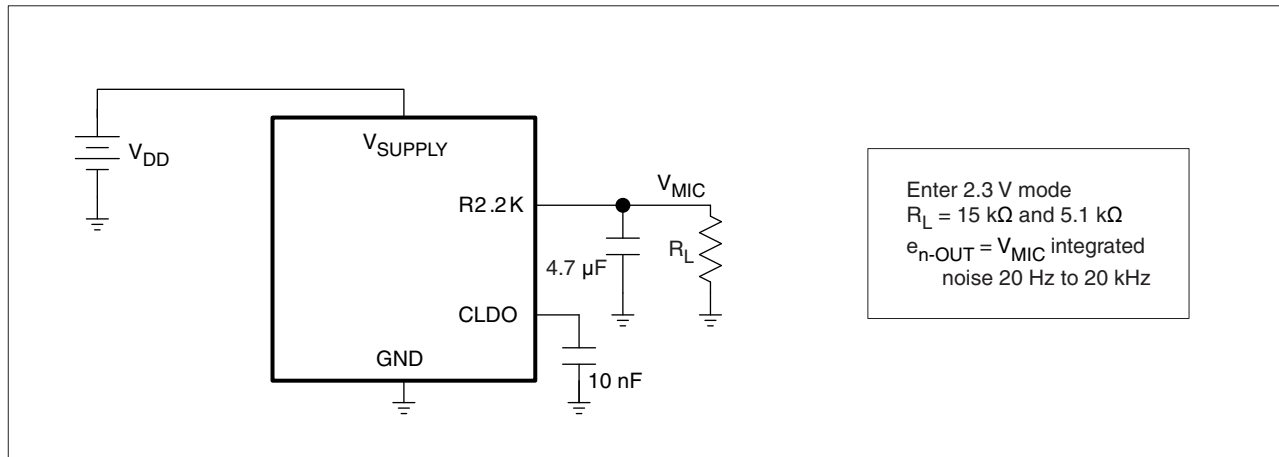


Figure 6. Integrated Output Noise

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) |
|------------------|-----------------------|--------------|-----------------|------|-------------|----------------------------|----------------------|------------------------------|--------------------------------------|
| TS5USBA43402YZPR | ACTIVE | DSBGA | YZP | 20 | 3000 | Green (RoHS & no Sb/Br) | Call TI | Level-1-260C-UNLIM | Request Free Samples |

⁽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.

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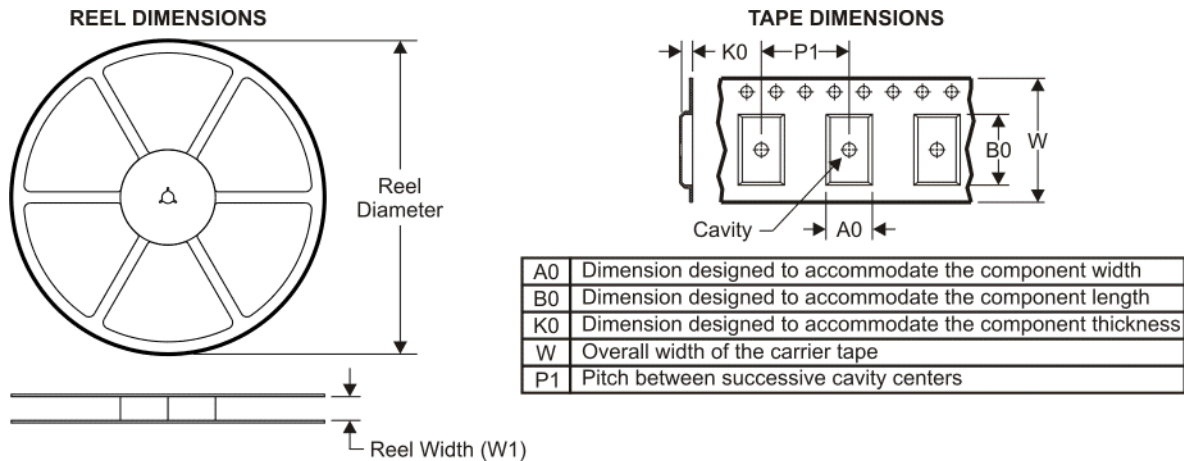
Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

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

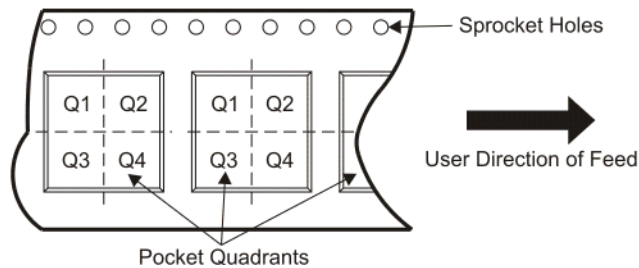
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TAPE AND REEL INFORMATION



QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*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 |
|------------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| TS5USBA43402YZPR | DSBGA | YZP | 20 | 3000 | 180.0 | 8.4 | 2.02 | 2.52 | 0.63 | 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) |
|------------------|--------------|-----------------|------|------|-------------|------------|-------------|
| TS5USBA43402YZPR | DSBGA | YZP | 20 | 3000 | 220.0 | 220.0 | 34.0 |

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