# SP2T SWITCH WITH IMPEDANCE DETECTION MICRO-USB SWITCH TO SUPPORT USB, UART

This application note describes the operation of TSU6111. This is a differential high performance automated SP2T switch that will automatically detect accessories plugged via the mini/micro USB 5 pin connector. This document contains an application diagram with external critical components as well as PCB routing guidelines.

For detailed pin configuration and register properties, consult the TSU6111 datasheet.

## Contents

# Introduction

TSU6111 is a differential high performance automated SP2T switch with Battery Charger Detection BCDv1.1. Each of the dual SP2T switches supports USB 2.0 High Speed. The device features impedance detection of accessories that are attached through DP, DM and ID. Accessory detection includes plug-in/un-plug detection, USB charger detection (BCDv1.1). The switch is controlled automatically via detection logic or manually through I2C. JIG and BOOT pins are available to support USB and UART JIG cable testing during development and manufacturing.

# Micro-USB Switch Flowchart

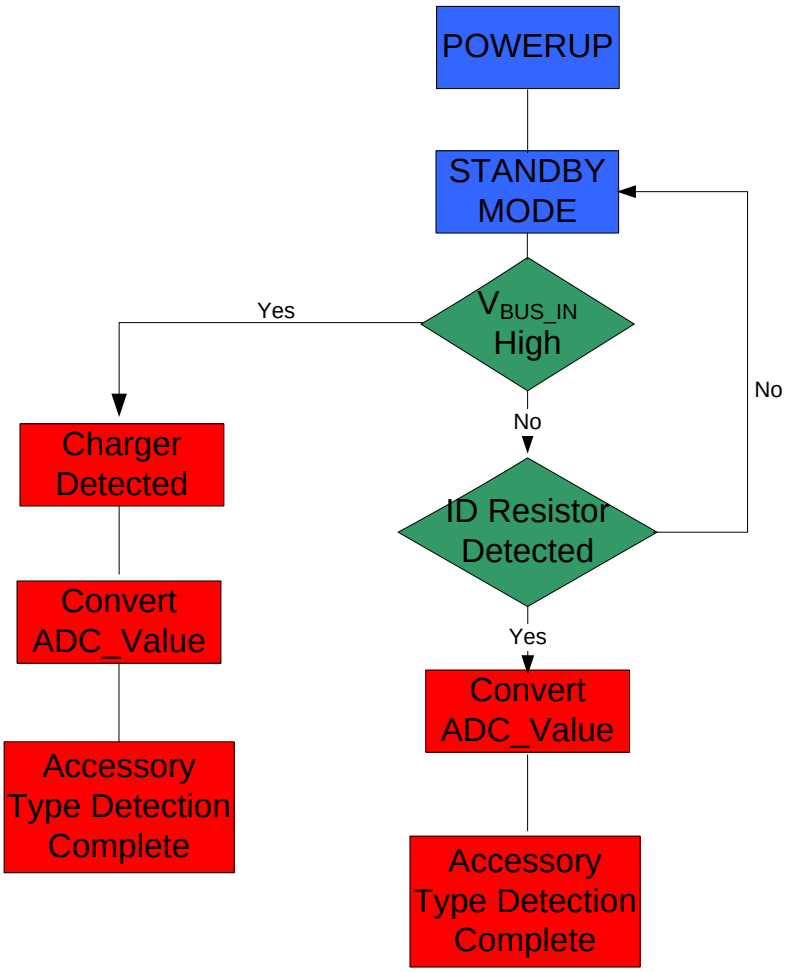



Figure 1: Micro-USB Switch Flow Diagram

# Application Schematic

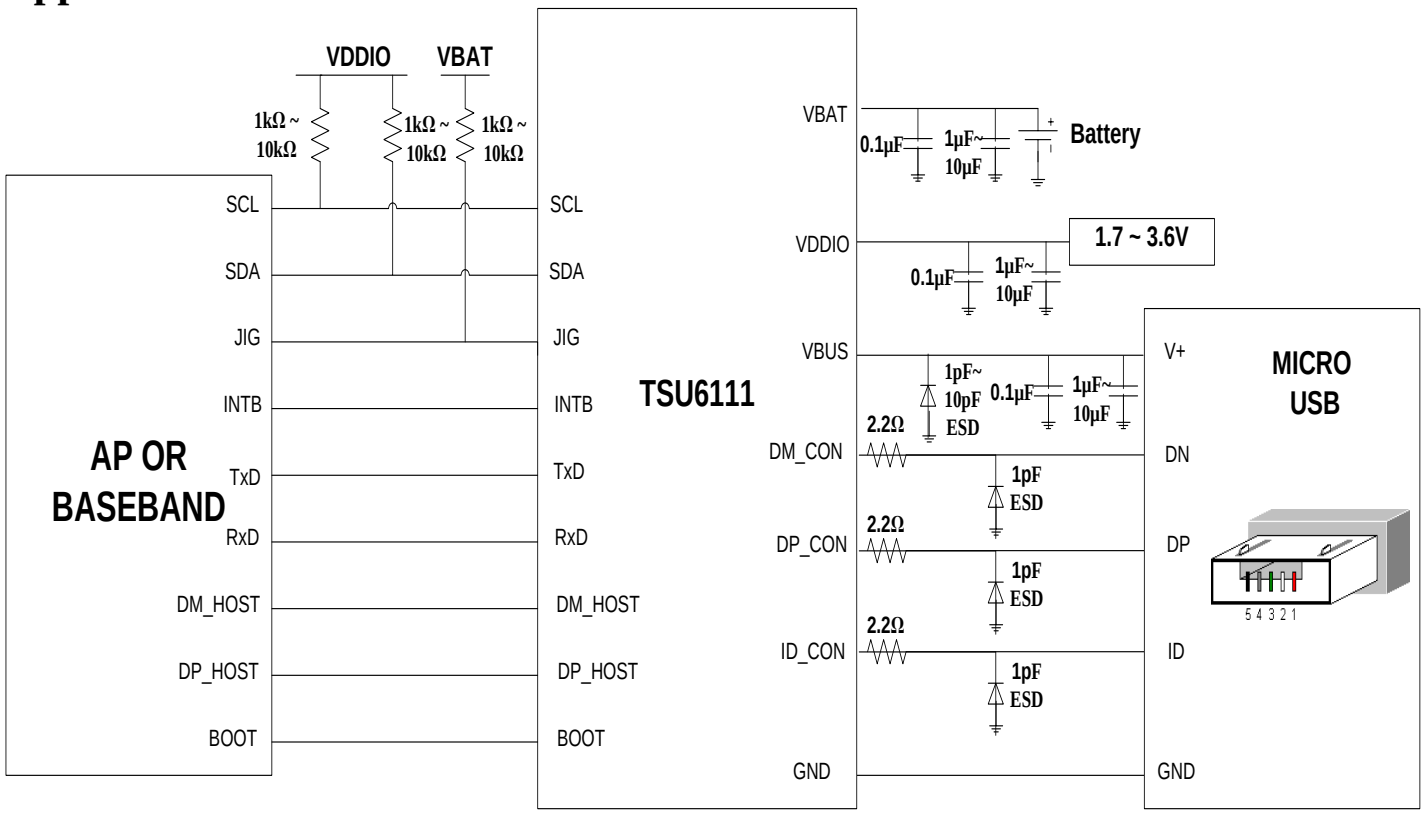



Figure 2: TSU6111 Application Schematic

Table 1: Critical Components

| Pin Name | Pin Number | Critical Component |
|---|---|---|
| $V_{BUS\_IN}$ | 13 | 1μF~10μF |
| | | ESD Protection Diode |
| | | 0.1μF |
| $V_{DDIO}$ | 8 | 1μF~10μF |
| | | 0.1μF |
| $V_{BAT}$ | 5 | 1μF~10μF |
| | | Battery |
| | | 0.1μF |
| Jig | 7 | 1kΩ |
| SCL | 10 | 1kΩ |
| SDA | 11 | 1kΩ |
| DM_CON | 14 | 2.2Ω |
| | | ESD Protection Diode |
| DP_CON | 15 | 2.2Ω |
| | | ESD Protection Diode |
| ID_CON | 16 | 2.2Ω* |
| | | ESD Protection Diode |

***Optional Components**

*Schematic Guidelines*

a) $V_{BUS\_IN}$, $V_{DDIO}$, & $V_{BAT}$ require 1µF~10µF and 0.1µF decoupling capacitors to reduce noise from circuit elements. The capacitors act as a shunt to block off the noise. The 0.1µF capacitor smoothes out high frequencies and has a lower series inductance. The 1µF~10µF capacitor smoothes out the lower frequencies and has a much higher series inductance. Placing both capacitors will provide better load regulation across the frequency spectrum.

b) JIG is an open-drain output and therefore requires a 1kΩ ~ 10kΩ pull-up resistor to VBAT

c) SCL and SDA require 1kΩ ~ 10kΩ pull-up resistors to VDDIO to prevent floating inputs

d) $V_{BUS\_IN}$ , DM_CON and DP_CON are recommended to have an external resistor 2.2Ω to provide extra ballasting to protect the chip and internal circuitry

   a. For ID_CON, if there is less stress on the ID pin then the external 2.2Ω resistor is optional

e) DM_CON, DP_CON, and ID_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

f) $V_{BUS\_IN}$ 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

# Recommended Operating Conditions

**Table 3: Recommended Operating Conditions**

| Condition | Min | Max | Units |
|---|---|---|---|
| $V_{BUS\_IN}$ | 4.5 | 6.5 | V |
| $V_{BAT}$ | 3.5 | 4.4 | V |
| $V_{DDIO}$ | 1.7 | 3.3 | V |
| Temperature | -40 | 85 | ˚C |

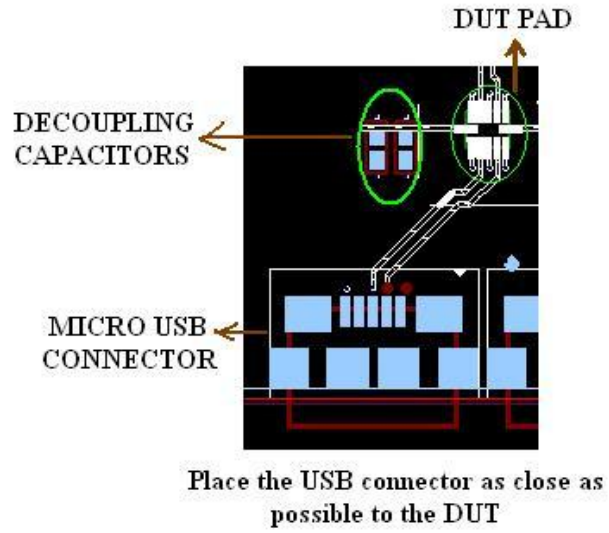
# PCB Routing Guidelines

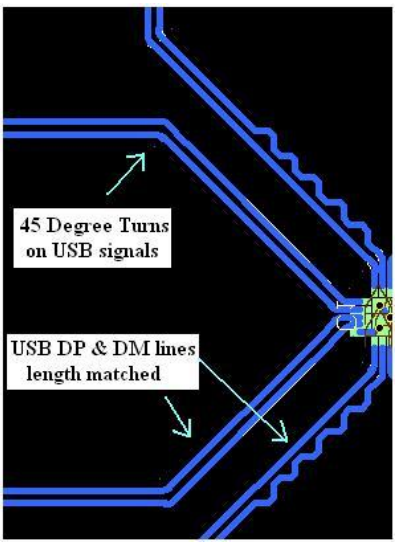
*Routing Guidelines for USB Signal Integrity*

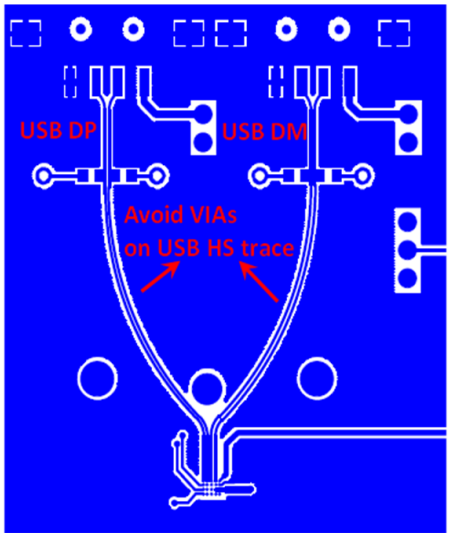
a) All the USB lines DP_CON, DM_CON, DP_HT, DM_HT, TxD & RxD
   - Must have 45Ω single ended characteristic impedance
   - Must have 90Ω differential ended impedance
   - To fulfill USB 2.0 requirements

b) TSU6111 location
   a. Close to the USB connector as possible
   b. The distance between the USB controller and the device less than 1 inch
   c. Shorter length of the trace will reduce effect of stray noise and radiate less EMI

c) Minimize use of VIAs for USB related signals
   a. Differential transmission lines should be matched as close as possible
   b. No VIAs for optimum USB2.0 performance



# Accessory ID Table

If $V_{BUS\_IN}$ is high and the attachment is not a charger, then determine the impedance on the ID pin. If $V_{BUS\_IN}$ is low and an accessory is attached, then use an ADC for impedance sensing on the ID pin to identify which accessory is attached.

**IMPEDANCE BUCKETS FOR EACH ACCESSORY**

In order to implement ID detection, each accessory should contain below ID impedance resistor value which is 5% tolerance accuracy.

**Table 2: Accessory ID Table**

| Accessory ID & Switch States | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Accessory** | **Detected Impedance on ID** | **Resistor Tolerance (%)** | **ADC Value** | **Switch State** | | **Factory Cable** | |
| | | | | **DP/DM** | | **JIG** | **BOOT** |
| | | | | **USB** | **UART** | | |
| OTG | 0 | - | 00000 | ON | OFF | OFF | OFF |
| Reserved Accessory #1 | 34K | 5% | 01111 | OFF | OFF | OFF | OFF |
| Reserved Accessory #2 | 40.2K | 5% | 10000 | OFF | OFF | OFF | OFF |
| Reserved Accessory #3 | 49.9K | 5% | 10001 | OFF | OFF | OFF | OFF |
| Reserved Accessory #4 | 64.9K | 5% | 10010 | OFF | OFF | OFF | OFF |
| Phone Powered Device | 102K | 5% | 10100 | OFF | ON | OFF | OFF |
| UART Cable | 150K | 5% | 10110 | OFF | ON | OFF | OFF |
| Factory Mode Cable - Boot Off USB | 255K | 5% | 11000 | ON | OFF | ON | OFF |
| Factory Mode Cable - Boot On USB | 301K | 5% | 11001 | ON | OFF | ON | ON |
| Factory Mode Cable - Boot Off UART | 523K | 5% | 11100 | OFF | ON | ON | OFF |
| Factory Mode Cable - Boot On UART | 619K | 5% | 11101 | OFF | ON | ON | ON |
| No ID | - | - | 11111 | OFF | OFF | OFF | OFF |
| USB Standard Downstream Port | - | - | 11111 | ON | OFF | OFF | OFF |
| USB Charging Downstream Port | - | - | 11111 | ON | OFF | OFF | OFF |
| Dedicated Charging Port | - | - | 11111 | OFF | OFF | OFF | OFF |

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