# AN 20.20

# Conversion from USB251x to USB251xB

## 1 Introduction

This application note provides information on how to convert an existing design from the SMSC USB2512/13/14 USB hubs to the new generation SMSC USB2512B/13B/14B USB hubs.

### 1.1 References

Datasheet: SMSC USB251x Hub Family

### 1.2 Objective

The goal of this document is to provide information about when an existing design can be adapted to the new generation of USB251xB products, what the benefits are for converting to the new generation and what needs to be modified in the design for a seamless transition.

### 1.3 Overview

In most cases of converting an existing USB251x design to the new generation of USB251xB products, PCB layout and bill of materials do not need to change. The new generation is both backward and pin compatible with the previous generation with regards to the 36-pin devices. Taking advantage of parametric enhancements such as lower power consumption does not require any changes. Taking advantage of new features available in the SMSC USB251xB requires PCB design changes.

## 2 Package and Pin Layout

The SMSC USB251x family is offered in both 36-pin QFN and 48-pin QFN packages. The new generation USB251xB is only offered in the 36-pin QFN package. A design using the 48-pin QFN version requires PCB layout changes and it loses LED functionality if converted to the new generation. When reducing the number of pins from 48 to 36 all the LED pins and a few of the configuration pins are removed.

SMSC does not anticipate customers to convert from 48-pin designs to 36-pin, as it is more complicated and expensive to perform this conversion. The focus of this application note is exclusively on 36-pin design conversions. SMSC will continue to manufacture the USB251x product family in 48-pin QFN package for all customers of the 48-pin devices who do not wish to switch to the new generation.

The pin assignments are identical between the USB251x and USB251xB families on the 36-pin devices. However, before the conversion, review the following differences in the pin functionality to prevent any unwanted results.

## 2.1 Pin Layout Consideration

With the exception of two differences discussed in the next two sections, each pin on the USB251x has an equivalent or corresponding pin with a similar function on the USB251xB.

### 2.1.1 Internal Power Pins

Internal power is 1.8 Volts for USB251x products and 1.2 Volts for USB251xB products. The pin labeled VDD18PLL on USB251x is labeled PLLFILT on USB251xB. The pin labeled VDD18 on USB251x is labeled CRFILT on USB251xB. An external decoupling capacitor is needed on both pins in both cases. The size of the decoupling capacitor has not changed. Only the voltage on the pins has changed from 1.8 V to 1.2 V. A board test, ICT or qualification procedure of the finished product must be adapted for the lower 1.2 V voltage.

### 2.1.2 PRTPWR[x]

The pins labeled PRTPWR[x] on the USB251x products are now labeled PRTPWR[x]/BC_EN[x] on the USB251xB products. The new function on these pins is a strapping option to enable USB Battery Charging. The strapping option is enabled if the pin is pulled high at the end of hardware reset, when RESET_N goes high.

A pull-up is not required for USB251x on its PRTPWR[x] pins as this device drives these pins at all times. If a pull-up was present it would not have any effect on the USB251x.

The PRTPWR[x]/BC_EN[x] pins on the USB251xB have a weak pull-down when the device is in hardware reset, that is when RESET_N is driven low. The weak pull-down can be overridden if an external pull-up is present. To retain identical behavior with the USB251x any pull-ups on PRTPWR[x] must be removed to convert to USB251xB.

#### 2.1.2.1 What happens if pull-ups on PRTPWR[x] are not removed for USB251xB?

In the event a design has a pull-up on PRTPWR[x] the difference in behavior is as follows:

1. USB251x drives PRTPWR[x] low until the host enables port power on the port. In typical designs VBUS on the port will be off until the host enables it.
2. USB251xB does not drive PRTPWR[x]. The external pull-up enables PRTPWR[x] immediately when the power is turned on. VBUS on the port will come on as soon as power is turned on.
3. USB251xB has Charging Downstream Port (CDP) signaling enabled for each port with a pull-up. A battery charging device can incorrectly assume that it may draw 1.5A of current on VBUS. Unless the port power controller, power supply and over-current protection are designed to handle the extra current the port may become unusable due to over-current condition.

# 3 Power Consumption

The active power consumption of the USB251xB is reduced by about 50% compared to the USB251x. The highest power consumption occurs when the hub itself is in hi-speed mode and all downstream ports are connected to hi-speed devices while the host sends traffic downstream.

The suspend current is somewhat higher on USB251xB products. The measurement is about 600 μA higher on USB251xB products compared to the USB251x hub controllers.

Table 3.1 summarizes the current consumption numbers. All current is drawn from 3.3 V of power.

**Table 3.1 Current Consumption Numbers**

| | **USB2512** | **USB2512B** | **UNITS** |
|---|---|---|---|
| Hi-speed operation | 155 | 65 | mA |
| For each additional active hi-speed port | 40 | 25 | mA |
| Suspend | 420 | 1000 | μA |
| | **USB2513** | **USB2513B** | **UNITS** |
| Hi-speed operation | 180 | 70 | mA |
| For each additional active hi-speed port | 40 | 25 | mA |
| Suspend | 420 | 1100 | μA |
| | **USB2514** | **USB2514B** | **UNITS** |
| Hi-speed operation | 200 | 80 | mA |
| For each additional active hi-speed port | 40 | 25 | mA |
| Suspend | 420 | 1200 | μA |

# 4 Battery Charging

A new feature called battery charging is available on the USB251xB products. The battery charging feature implements the Charging Downstream Port specification defined in the USB-IF Battery Charging Specification 1.1. The new feature can be enabled by strapping on the PRTPWR[x]/BC_EN[x] pins via a pull-up resistor, shown in Figure 4.1, or via SMBus/EEPROM setting.

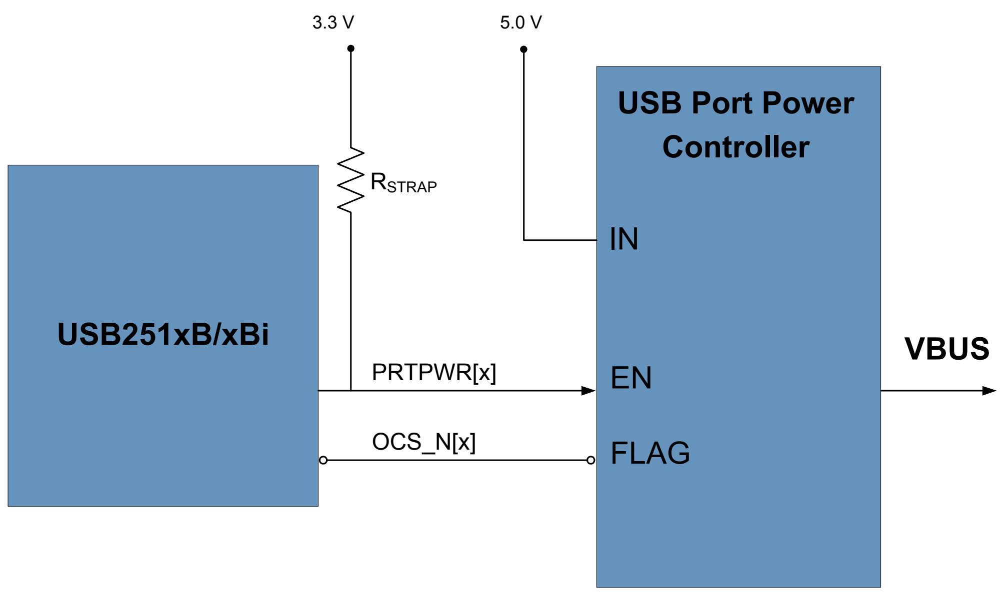
If an existing design has a pull-up resistor on the PRTPWR[x], it will inadvertently enable the battery charging function when switching from a USB251x product to the USB251xB product. The pull-up is ignored by the USB251x.

To fully support USB battery charging, each VBUS output on ports enabled for battery charging must be capable of delivering 1.5 Amps of current at 5 Volts. Typical port power controllers are set to generate an over-current event at 700 - 800 mA. The 5 Volt power supply must be capable of delivering the extra current. A typical four port hub design must be able to deliver a total of 2 Amps per the USB-IF requirement that each port can deliver at least 500 mA. The same design supporting four battery charging enabled ports must now be able to deliver 6 Amps.

The added current draw will cause larger IR-drops on the PCB. Consider and remedy this drop by increasing copper thickness or wire width on the PCB layout to keep the voltage drops under control and to meet the USB-IF requirements on VBUS voltage tolerance under load.

In summary, to enable battery charging consider these items:

1. Apply pull-ups on PRTPWR[x]/BC_EN[x] or via EEPROM/SMBus configuration.
2. Increase over-current limits from 500 mA to 1.5 A per downstream port.
3. Verify that the power supply delivers more VBUS current. [should we specify?]
4. Account for IR drops in the VBUS section that can increase by a factor of 3.




Note: $R_{STRAP}$ enables battery charging.

**Figure 4.1 Battery Charging Strapping**

# 5 EEPROM/SMBus

The EEPROM/SMBus register space shown in Table 5.1 is identical for USB251x and USB2515xB with two exceptions. The first difference is the Device ID in locations 04h and 05h. The Device ID is 0000 for the USB251x while it is 0BA0 for the USB251xB. This difference does not have a practical implication except when applied to test cases that may expect a specific Device ID. The second difference is in location D0h which is reserved for the USB251x and defined as the configuration for battery charging in the USB251xB.

**Table 5.1 Internal Default, EEPROM and SMBus Register Memory Map**

| ADDRESS | REGISTER NAME | DEFAULT ROM VALUES (HEXIDECIMAL) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | USB2512/12i | USB2512A/12Ai | USB2513/13i | USB2514/14i | USB2512B/12Bi | USB2513B/13Bi | USB2514B/14Bi | USB2517/17i |
| 00h | Vendor ID LSB | 24 | | | | | | | |
| 01h | Vendor ID MSB | 04 | | | | | | | |
| 02h | Product ID LSB | 12 | | 13 | 14 | 12 | 13 | 14 | 17 |
| 03h | Product ID MSB | 25 | | | | | | | |
| 04h | Device ID LSB | 00 | A0 | 00 | | A0 | | | 00 |
| 05h | Device ID MSB | 00 | 0A | 00 | | 0B | | | 00 |
| 06h | Configuration Data Byte 1 | 8B | | 9B | | | | | |
| 07h | Configuration Data Byte 2 | 20 | | | | | | | |
| 08h | Configuration Data Byte 3 | 02 | | | | | | | |
| 09h | Non-Removable Devices | 00 | | | | | | | |
| 0Ah | Port Disable (Self) | 08 | 00 | | | | | | |
| 0Bh | Port Disable (Bus) | 08 | 00 | | | | | | |
| 0Ch | Max Power (Self) | 01 | | | | | | | |
| 0Dh | Max Power (Bus) | 32 | | | | | | | |
| 0Eh | Hub Controller Max Current (Self) | 01 | | | | | | | |
| 0Fh | Hub Controller Max Current (Bus) | 32 | | | | | | | |
| 10h | Power-on Time | 32 | | | | | | | |
| 11h | Language ID High | 00 | | | | | | | |
| 12h | Language ID Low | R | | 00 | | | | | |
| 13h | Manufacturer String Length | R | | 00 | | | | | |
| 14h | Product String Length | R | | 00 | | | | | |
| 15h | Serial String Length | R | | 00 | | | | | |
| 16h-53h | Manufacturer String | R | | 00 | | | | | |

**Table 5.1 Internal Default, EEPROM and SMBus Register Memory Map (continued)**

<table>
<tr><th rowspan="2">ADDRESS</th><th rowspan="2">REGISTER NAME</th><th colspan="8">DEFAULT ROM VALUES (HEXIDECIMAL)</th></tr>
<tr><th>USB2512/12i</th><th>USB2512A/12Ai</th><th>USB2513/13i</th><th>USB2514/14i</th><th>USB2512B/12Bi</th><th>USB2513B/13Bi</th><th>USB2514B/14Bi</th><th>USB2517/17i</th></tr>
<tr><td>54h-91h</td><td>Product String</td><td colspan="2">R</td><td colspan="6">00</td></tr>
<tr><td>92h-CFh</td><td>Serial String</td><td colspan="2">R</td><td colspan="6">00</td></tr>
<tr><td>D0h</td><td>Battery Charging Enable</td><td colspan="4">R</td><td colspan="4">00</td></tr>
<tr><td>E0h</td><td>Reserved</td><td colspan="7">00</td><td>R</td></tr>
<tr><td>F5h</td><td>Reserved</td><td colspan="4">00</td><td colspan="3">R</td><td>00</td></tr>
<tr><td>F6h</td><td>Boost_Up</td><td colspan="8">00</td></tr>
<tr><td>F7h</td><td>Boost_7:5</td><td colspan="4">00</td><td colspan="3">R</td><td>00</td></tr>
<tr><td>F8h</td><td>Boost_x:0</td><td colspan="8">00</td></tr>
<tr><td>F9h</td><td>Reserved</td><td colspan="8">00</td></tr>
<tr><td>FAh</td><td>Port Swap</td><td colspan="8">00</td></tr>
<tr><td>FBh</td><td>Port Map 12</td><td colspan="8">00</td></tr>
<tr><td>FCh</td><td>Port Map 34</td><td colspan="2">R</td><td colspan="2">00</td><td>R</td><td colspan="3">00</td></tr>
<tr><td>FDh</td><td>Port Map 56</td><td colspan="7">R</td><td>00</td></tr>
<tr><td>FEh</td><td>Port Map 7</td><td colspan="7">R</td><td>00</td></tr>
<tr><td>FFh</td><td>Status/Command<br>Note: SMBus register only</td><td colspan="8">00</td></tr>
</table>

Battery charging can be enabled via strapping option, described earlier in Section 4, "Battery Charging". If the strapping option is not used in the design, battery charging can be enabled in register D0h when configuring via external EEPROM or via SMBus master. The register for configuring battery charging is shown in Figure 5.1. Each downstream port is individually controlled.

| BIT NUMBER | BIT NAME | DESCRIPTION |
|---|---|---|
| 7:0 | BC_EN | **Only available in USB251xB/xBi hub family products.**<br><br>Battery Charging Enable: Enables the battery charging feature for the corresponding port.<br><br>'0' = Battery Charging support is not enabled<br><br>'1' = Battery charging support is enabled<br><br>Bit 7= Reserved<br>Bit 6= Reserved<br>Bit 5= Reserved<br>Bit 4= Controls Port 4<br>Bit 3= Controls Port 3<br>Bit 2= Controls Port 2<br>Bit 1= Controls Port 1<br>Bit 0= Reserved |

**Figure 5.1 Register D0h: Battery Charging Enable**

# 6 USB-IF Certification

The USB-IF certification Test-ID or TID number can be retained for a product that has undergone conversion from USB251x to USB251xB if no other change has taken place. This certification compatibility saves expense and time when testing at an external test house. Changes made to non-USB related parts of a design such as the name, model, or revision number of the end product may not need a new certification. There is a procedure USB-IF has defined to handle non-USB related changes as described below.

## 6.1 USB Hub Device Change Only

A product that retains name, model, and revision numbers and only has the hub silicon replaced with the USB251xB/xBi silicon does not need a new certification. USB-IF does not need a new certification submission since the old TID remains valid.

## 6.2 Changes Unrelated to USB in Addition to USB Hub Change

A product that has the name, model, or revision number changed, or it has modifications to portions of the design that is unrelated to USB, not counting the USB hub change, must be qualified by USB-IF to retain a valid TID. The process to do this is called “Qualification by Similarity”. This change can be completed in the members area of the USB-IF website through this link:

http://www.usb.org/kcompliance/members/

A username and password may be required to authenticate access. The web page destination should appear as shown in Figure 6.1. The red arrow in Figure 6.1 points to the link for the form. The Qualification by Similarity Form has less than 20 questions related to the product and the related changes that have been made. Submit the completed form on-line. USB-IF usually responds within one week.

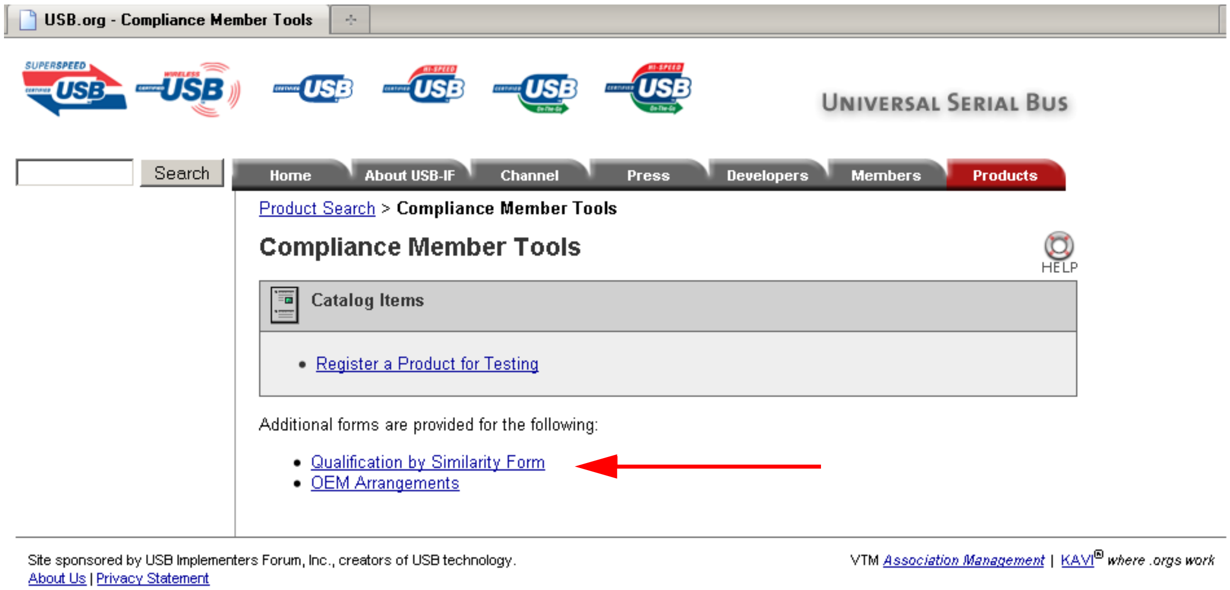



**Figure 6.1 USB-IF Website Qualification by Similarity Form**

## 6.3 Design Change or PCB Layout Change to USB Section

Products that are substantially changed in the USB section in addition to changing the USB hub device require a new USB-IF certification.

# 7 Testing

In-circuit testing, qualification, or validation must be adjusted for the following items if they are checked in the test itself:

1. Voltage tests on internal supplies should expect 1.2 V instead of 1.8 V.
2. Device ID, DID is 0xA00B instead of 0x0000.

# 8 Summary

To transition a design from USB251x to USB251xB is, in most instances or applications, straightforward and does not require PCB layout changes or bill of materials changes. Lower power consumption is one advantage that the transition provides. Non-USB related changes may retain the TID from USB-IF by requesting on-line Certification by Similarity without requiring a new test cycle saving both time and related expenses.

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