Introduction

This demonstration board allows the easy measurement of STCC50x1 parameters and the evaluation of all its functions and operating modes.

*Note:* The STCC2540 demonstration board is exactly the same, just assembled with the STCC2540 instead of the STCC50x1 device. For details, please see Appendix B.

Features

- USB 2.0 SDP or CDP data pass-through with S3 remote wakeup support or automatic charging
- Permanent USB 3.0 SuperSpeed data pass-through between input and output USB connector
- CDP mode with charging indication after CDP negotiation
- DCP modes with charging indication (BC1.2 mode, divider mode, auto-detect mode)
- Attach and charging/end-of-charging detection and indication
- Resistor-programmable precise current limiter and short-circuit protection

*Figure 1. STCC50x1 demonstration board*
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Description

Quick guide and default configuration

By default, the board is powered from a USB host (notebook, PC, docking station, etc.) through the J2 USB connector. No external power supply is necessary.

In this mode, evaluation of all STCC50x1 device features is possible with the following limitation:

Maximum charging current is limited by the USB host capabilities (typically 500 mA to 2000 mA).

Jumper and selector settings for default configuration

J5: ON (closed)
SW6: V_{EXT} (1 - 2)

Settings and connections

Variable resistors

Resistor R18

This resistor adjusts the $V_{LDO}$ voltage to verify proper functionality of the attach detector for the whole $V_{DD}$ operating range. The equation is as follows:

Equation 1

$$V_{LDO} = \frac{1.2 \times R18 + 6.2 \times 15}{15} (V, k\Omega)$$

Minimum adjustable voltage is approx. 1.7 V, maximum voltage is close to $V_{EXT}$. The $V_{LDO}$ increases in a counter-clockwise direction.

For externally set $V_{DD}$ voltage, the jumper selector SW6 can be placed in the $V_{EXT}$ position, connecting $V_{EXT}$ directly to $V_{DD}$.

Resistor R26

This resistor adjusts the current limiter threshold according to Equation 2:

Equation 2

$$ISC = \frac{48000}{R26 + 18} \text{ (mA, k\Omega)}$$

Minimum current is approx. 400 mA, maximum current is approx. 2700 mA. The current limit increases in a clockwise direction.

For minimum current, the accuracy is not defined. The host/power supply capability may be at least equal to the current limiter threshold set by R26.
Jumper selectors

**SW2 to SW4: operating mode (CTLx)**

1 - 2 = 1, 2 - 3 = 0 (see Table 1)

**Table 1. CTLx truth table(1)**

<table>
<thead>
<tr>
<th>SW4 (CTL1)</th>
<th>SW3 (CTL2)</th>
<th>SW2 (CTL3)</th>
<th>Mode</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>Power and data switch turned off</td>
<td>Continuous V OUT discharge</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>0</td>
<td>S0 SDP</td>
<td>No V OUT discharge pulse on transition 110 &lt;-&gt; 010</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>0</td>
<td>S3 SDP with remote wakeup</td>
<td>No V OUT discharge pulse on transition 111 &lt;-&gt; 011 for low speed devices</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
<td>S0 CDP</td>
<td>No V OUT discharge pulse on transition 111 &lt;-&gt; 011 for low speed devices</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>1</td>
<td>S3 CDP with remote wakeup for low speed devices / DCP auto-detect for full-speed and high-speed devices</td>
<td>Automatic switch to DCP auto-detect mode also after a device detach</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>1</td>
<td>DCP auto-detect</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>0</td>
<td>DCP BC1.2</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>1</td>
<td>DCP divider</td>
<td></td>
</tr>
</tbody>
</table>

1. The V OUT discharge pulse is also intentionally omitted for transitions 010 <-> 011, 110 <-> 011.

**SW5: power and data switch enable (EN)**

1 - 2 = 1, 2 - 3 = 0

1 = enabled, 0 = disabled, V OUT discharge when ATTACH_EN = 0 (see Table 2)

**SW1: attach detector enable (ATTACH_EN)**

1 - 2 = 1, 2 - 3 = 0

1 = enabled if EN = 0 (see Table 2), 0 = disabled

**Table 2. EN and ATTACH_EN truth table**

<table>
<thead>
<tr>
<th>SW5 (EN)</th>
<th>SW1 (ATTACH_EN)</th>
<th>Attach detector</th>
<th>Continuous V OUT discharge</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>Disabled</td>
<td>Yes</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>Enabled</td>
<td>No</td>
</tr>
<tr>
<td>1</td>
<td>X</td>
<td>Disabled</td>
<td>No</td>
</tr>
</tbody>
</table>

The control inputs (CTL1 - CTL3, EN, ATTACH_EN) are also available on control connector J6. If this connector is used, the jumper caps from SW1 to SW5 must be removed.
**SW6: attach detector power supply (V_DD) selector**

1 - 2 = V_{EXT} (J4), 2 - 3 = V_{LDO}

Default position: V_{EXT}

This selector allows to power the V_DD either from onboard adjustable LDO or from external voltage connected to J4 (V_{EXT}).

*If the V_DD is powered from V_{EXT} (no matter if directly or using onboard LDO), there should be an external pull-up resistor to V_{DD} connected to the CHARGING/ATTACH output to ensure its proper function in the case of V_IN turned off.*

**Jumper**

**J5: V_{BUS} to V_{EXT} connection**

Default position: ON

Set to OFF if the attach detector may be powered from an independent power supply.

**Connectors**

**Connector J2**

USB 3.0 (USB 2.0 compatible) standard A male (plug) connector to connect the demonstration board to the host (PC, notebook, docking station, etc.) USB port either directly or using any standard A male to standard A female USB expansion cable.

**Connector J3**

USB 3.0 (USB 2.0 compatible) standard A female (receptacle) connector to connect the peripheral device to the demonstration board.

**Connector J4**

Screw terminal to connect the demonstration board to high current power supply (4.75 - 5.25 V, 2.8 A or more) to evaluate highest current DCP charging modes (e.g. universal charger mode).

---

**Warning:** To prevent damage to the USB host and/or the external power supply, do NOT power the demonstration board from the USB host (through J2) and from external supply (through J4) simultaneously.

---

**Connector J6**

Control connector (CANON15) to set the STCC50x1 inputs remotely and also to remotely sense the status of its indication outputs.

If this connector is used, the jumper caps from SW1 to SW5 must be removed to allow remote setting of STCC50x1 inputs. No pull-up/pull-down resistors are provided on ATTACH_EN and CTLx inputs!

On EN, an internal pull-down resistor of 250 k\(\Omega\) typ. is provided in the STCC50x1 device.
STCC2540 emulation using the STCC50x1 device

This STCC50x1 device can be used also for evaluating the performance of the STCC2540 device using following settings:

- J5 = ON (VIN and VDD are powered from the same supply)
- SW6 = V_EXT (V_DD = VIN)
- SW1 = GND (attach detector disabled)

In this configuration the STCC50x1 device is functionally equivalent with the STCC2540 device with following remarks:

- There is an internal 250 kΩ pull-down resistor on EN input, which is not present in the STCC2540 device.
- The current consumption is slightly higher (because of the attach detector and EN pull-down resistor).
- For the STCC5011 device, the DCP divider mode is set to 1 A instead of 2 A.

Schematics diagram description

Power supply

The core of the board is the USB charging controller STCC50x1. Its VIN is powered from either V_BUS (power from USB host) through the J2 connector or from V_EXT (external 5 V supply) through J4. To evaluate the performance of dedicated charger mode, a direct supply path from V_EXT to VIN can be created by jumper J5.

To evaluate the performance of the STCC50x1 attach detector within the whole V_DD supply voltage range, an LDO U4 in typical configuration is used. Its output voltage, V_LDO, can be adjusted by R18 in the range of approx. 1.7 V to approx. 5 V.

For higher or external (independent on VIN) V_DD, the jumper selector SW6 may be set to the V_EXT position, the jumper J5 may be open (off) and the requested V_DD can then be connected to J4 (V_EXT).
If the \( V_{DD} \) is powered from \( V_{EXT} \) (no matter if directly or using onboard LDO), there should be an external pull-up resistor to \( V_{DD} \) connected to the CHARGING/ATTACH output to ensure its proper function in the case of \( V_{IN} \) turned off.

**Auxiliary and indication circuits**

**Test points**

All the important signals are available on test points.

The DP_IN, DM_IN, DP_OUT and DM_OUT signals are isolated from the high speed USB bus by 10 k\( \Omega \) resistors. The purpose of these test points is to verify DC values and various detection/negotiation processes only, not to evaluate the AC performance of the STCC50x1 device.

The AC performance of the USB data switch (eye-diagram tests for instance) can, of course, be evaluated using the demonstration board USB connectors J2 and J3 when the board is configured to SDP mode (CTLx = 110, EN = 1) and nothing connected to TP14 - TP17.

The sensing test points TP18 and TP19 allow measurements of RDS (on) using a Kelvin connection.

**LEDs**

The board is equipped with indication LEDs to allow easy visual verification of these vital signals: \( V_{IN} \), FAULT, CHARGING/ATTACH, \( V_{OUT} \).

The \( V_{OUT} \) LED is isolated from the \( V_{OUT} \) line by Q1 to prevent false attach detection caused by LED current.

**Decoupling components**

The capacitors C1, C2, C3 and C4 are recommended decoupling components for the STCC50x1 device. They are recommended values, types and placements and can be used as a guide for application design.
Figure 2. Schematic of STCC50x1 demonstration board
<table>
<thead>
<tr>
<th>Qty.</th>
<th>Component</th>
<th>Device</th>
<th>Value</th>
<th>Parts</th>
<th>Manufacturer/supplier</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Ceramic capacitor</td>
<td>M/16V/X7R/0805(1)</td>
<td>1.0 µF</td>
<td>C1, C2, C3, C7, C8</td>
<td>Murata</td>
</tr>
<tr>
<td>1</td>
<td>Electrolytic capacitor</td>
<td>EEEFK1A151P</td>
<td>150 µF</td>
<td>C4</td>
<td>Panasonic</td>
</tr>
<tr>
<td>1</td>
<td>Tantalum capacitor</td>
<td>M/16V/B(2)</td>
<td>10 µF</td>
<td>C6</td>
<td>AVAGO Technologies</td>
</tr>
<tr>
<td>2</td>
<td>LED</td>
<td>HSMG-C170</td>
<td></td>
<td>D1, D4</td>
<td>AVAGO Technologies</td>
</tr>
<tr>
<td>1</td>
<td>LED</td>
<td>HSMH-C170</td>
<td></td>
<td>D2</td>
<td>AVAGO Technologies</td>
</tr>
<tr>
<td>1</td>
<td>LED</td>
<td>HSMY-C170</td>
<td></td>
<td>D3</td>
<td>AVAGO Technologies</td>
</tr>
<tr>
<td>1</td>
<td>USB3.0 connector</td>
<td>GSB316441CEU</td>
<td></td>
<td></td>
<td>Amphenol</td>
</tr>
<tr>
<td></td>
<td>USB3.0 connector</td>
<td>USB3-A-S-S-TH</td>
<td></td>
<td></td>
<td>Samtec</td>
</tr>
<tr>
<td>1</td>
<td>Terminal block</td>
<td>ARK210/2EX</td>
<td></td>
<td></td>
<td>GM® ELECTRONIC</td>
</tr>
<tr>
<td>1</td>
<td>Pin header 2r x 5p</td>
<td>PLD-10S</td>
<td>2.54 mm, straight, male</td>
<td>J5</td>
<td>GES® ELECTRONICS</td>
</tr>
<tr>
<td>1</td>
<td>Connector</td>
<td>DZZ-15BCNS-1</td>
<td>CANON, female</td>
<td>J6</td>
<td>HSUAN MAO TECHNOLOGY CO.,LTD</td>
</tr>
<tr>
<td>1</td>
<td>FET</td>
<td>BSS138</td>
<td>Q1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Resistor</td>
<td>J/0805(3)</td>
<td>18 kΩ</td>
<td>R1</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Resistor</td>
<td>J/0805(3)</td>
<td>6.2 kΩ</td>
<td>R16</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Resistor</td>
<td>J/0805(3)</td>
<td>15 kΩ</td>
<td>R17</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Surface mount trimmer</td>
<td>3314G-1-503E</td>
<td>50 kΩ</td>
<td>R18</td>
<td>BOURNS®</td>
</tr>
<tr>
<td>4</td>
<td>Resistor</td>
<td>J/0805(3)</td>
<td>10 kΩ</td>
<td>R19, R20, R21, R22</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Resistor</td>
<td>J/0805(3)</td>
<td>100 kΩ</td>
<td>R2, R3</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Surface mount trimmer</td>
<td>3314G-1-104E</td>
<td>100 kΩ</td>
<td>R26</td>
<td>BOURNS</td>
</tr>
<tr>
<td>4</td>
<td>Resistor</td>
<td>J/0805(3)</td>
<td>1.0 kΩ</td>
<td>R9, R10, R11, R12</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Pin header 1r x 3p</td>
<td>PLS-03S</td>
<td>2.54 mm, straight, male</td>
<td>SW1, SW2, SW3, SW4, SW5, SW6</td>
<td>GES ELECTRONICS</td>
</tr>
<tr>
<td>6</td>
<td>Jumper</td>
<td>JUMPER/0</td>
<td>2.54 mm</td>
<td></td>
<td>Accessories (SW1, SW2, SW3, SW4, SW5, SW6)</td>
</tr>
<tr>
<td>2</td>
<td>Pin header 1r x 4p</td>
<td>SIL40PZ / 4</td>
<td>2.54 mm, straight, female</td>
<td>(TP7-TP8-TP9-TP13), (TP5-TP6-TP11-TP12)</td>
<td>GM ELECTRONIC</td>
</tr>
</tbody>
</table>
Table 4. Bill of material (continued)

<table>
<thead>
<tr>
<th>Qty.</th>
<th>Component</th>
<th>Device</th>
<th>Value</th>
<th>Parts</th>
<th>Manufacturer/supplier</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Pin header 1r x 3p</td>
<td>SIL40PZ / 3</td>
<td>2.54 mm, straight, female</td>
<td>TP1-TP2-TP3</td>
<td>GM ELECTRONIC</td>
</tr>
<tr>
<td>8</td>
<td>Pin header 1r x 1p</td>
<td>SIL40PZ /</td>
<td>1 straight, female</td>
<td>TP4, TP10, TP14, TP15, TP16, TP17, TP18, TP19</td>
<td>GM ELECTRONIC</td>
</tr>
<tr>
<td>1</td>
<td>IC</td>
<td>STCC5011, STCC5021 or</td>
<td>U1</td>
<td>STMicroelectronics™</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>STCC2540</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>IC</td>
<td>ST715MR</td>
<td>U4</td>
<td>STMicroelectronics</td>
<td></td>
</tr>
</tbody>
</table>

1. SMD ... tolerance / voltage / size.
2. SMD ... tolerance / size.
3. SMD ... tolerance / voltage / dielectric / size.
Figure 3. Component layer

Figure 4. Top layer
Figure 7. Bottom layer

Figure 8. Bottom layer (view from bottom side)
Appendix B  STCC2540 demonstration board

Introduction

This demonstration board allows easy measurement of STCC2540 parameters and evaluation of all its functions and operating modes. The STCC2540 device is simplified version of the STCC50x1 so the demonstration board is the same.

In this section, only the differences between the STCC2540 and STCC5021 are described. Please refer to Section: Introduction, Features, Description and Appendix A of this STCC50x1, STCC2540 demonstration board user manual for more information.

Features

- USB 2.0 SDP or CDP data passthrough with S3 remote wakeup support or automatic charging
- Permanent USB 3.0 superspeed data passthrough between input and output USB connector
- CDP mode with charging indication after CDP negotiation
- DCP modes with charging indication (BC1.2 mode, divider mode, autodetect mode)
- Charging/end of charging detection and indication
- Resistor-programmable precise current limiter and short-circuit protection

Quick guide and default configuration

Jumper and selector settings for default configuration

J5: ON (closed)

SW6: V_{EXT} (1 - 2)

Other settings make no sense for the STCC2540 device and are not recommended.

Board settings and connections

Variable resistor

Resistor R18

The STCC2540 device is not using the V_{DD} power supply so this resistor has no effect on device functionality.
Jumper selectors

**SW2 to SW4: operating mode (CTLx)**

1 - 2 = 1, 2 - 3 = 0 (See Table 5).

Table 5. Truth table

<table>
<thead>
<tr>
<th>SW4 (CTL1)</th>
<th>SW3 (CTL2)</th>
<th>SW2 (CTL3)</th>
<th>Mode</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>Power and data switch turned off</td>
<td>Continuous V\text{OUT} discharge</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>0</td>
<td>S0 SDP</td>
<td>No V\text{OUT} discharge pulse on transition 110 &lt;-&gt; 010</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>0</td>
<td>S3 SDP with remote wakeup</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
<td>S0 CDP</td>
<td>No V\text{OUT} discharge pulse on transition 111 &lt;-&gt; 011 for low-speed devices</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>1</td>
<td>S3 CDP with remote wakeup for low-speed devices / DCP autodetect for full-speed and high-speed devices</td>
<td>Automatic switch to DCP autodetect mode also after device detach</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>1</td>
<td>DCP Autodetect</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>0</td>
<td>DCP BC1.2</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>1</td>
<td>DCP divider</td>
<td></td>
</tr>
</tbody>
</table>

**Note:** The V\text{OUT} discharge pulse is also intentionally omitted for transitions 010 <-> 011, 110 <-> 011.

**SW5: power and data switch enable (EN)**

1 - 2 = 1, 2 - 3 = 0

1 = enabled, 0 = disabled, continuous V\text{OUT} discharge

**SW1: attach detector enable (ATTACH\_EN)**

This selector has no effect for the STCC2540 device.

Connector

**Connector J6**

Control connector (CANNON15) to set the STCC2540 inputs remotely and also to remotely sense the status of its indication outputs.

**Note:** If this connector is used, the jumper caps from SW1 to SW5 must be removed to allow remote setting of STCC2540 inputs. No pull-ups/pull-downs are provided on EN and CTL\text{x} inputs!
Table 6. J6 pinout

<table>
<thead>
<tr>
<th>Pin number</th>
<th>Connection</th>
<th>Pin number</th>
<th>Connection</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Do not connect</td>
<td>9</td>
<td>$V_{IN}$</td>
</tr>
<tr>
<td>2</td>
<td>EN</td>
<td>10</td>
<td>$V_{IN}$</td>
</tr>
<tr>
<td>3</td>
<td>CTL1</td>
<td>11</td>
<td>$V_{IN}$</td>
</tr>
<tr>
<td>4</td>
<td>CTL2</td>
<td>12</td>
<td>GND</td>
</tr>
<tr>
<td>5</td>
<td>CTL3</td>
<td>13</td>
<td>GND</td>
</tr>
<tr>
<td>6</td>
<td>GND</td>
<td>14</td>
<td>Do not connect</td>
</tr>
<tr>
<td>7</td>
<td>CHARGING</td>
<td>15</td>
<td>Do not connect</td>
</tr>
<tr>
<td>8</td>
<td>FAULT</td>
<td>Shield</td>
<td>GND</td>
</tr>
</tbody>
</table>

Revision history

Table 7. Document revision history

<table>
<thead>
<tr>
<th>Date</th>
<th>Revision</th>
<th>Changes</th>
</tr>
</thead>
<tbody>
<tr>
<td>10-Jun-2013</td>
<td>1</td>
<td>Initial release.</td>
</tr>
</tbody>
</table>