STCC50x1, STCC2540 demonstration board
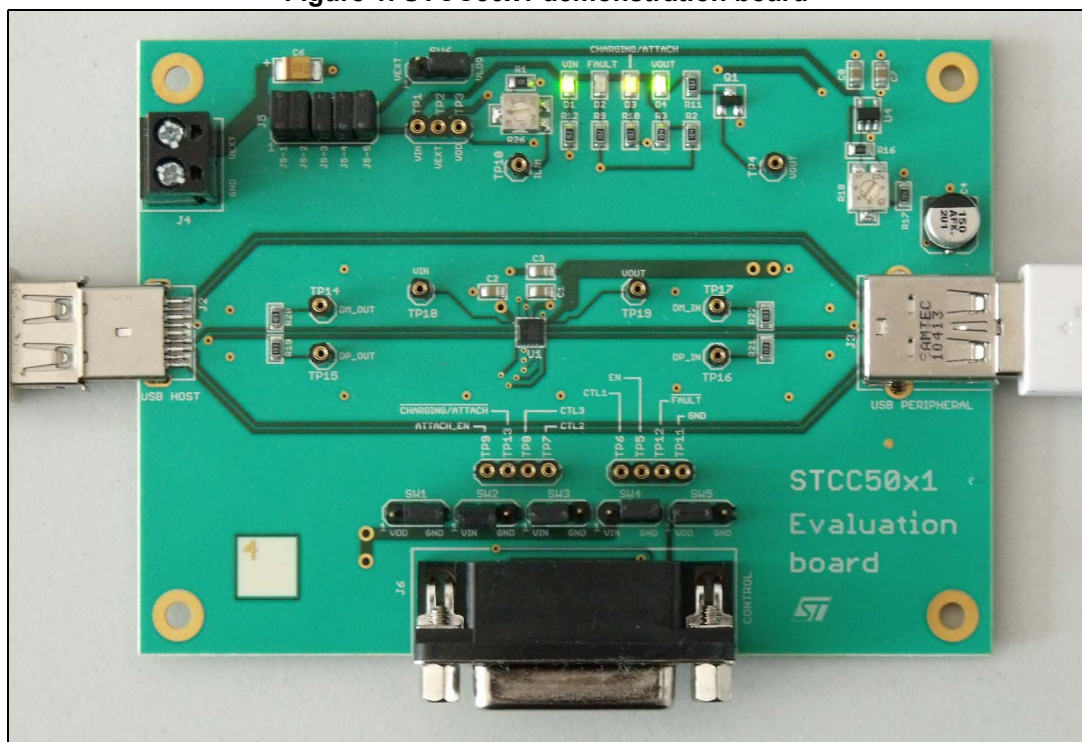
Introduction

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

Contents

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

$$V_{LDO} = \frac{1,2 \times R18 + 6,2 + 15}{15}(V, k\Omega)$$

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

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

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]

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

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

SW5 (EN)	SW1 (ATTACH_EN)	Attach detector	Continuous V_{OUT} discharge
0	0	Disabled	Yes
0	1	Enabled	No
1	X	Disabled	No

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 kΩ typ. is provided in the STCC50x1 device.

Table 3. J6 pinout

Pin number	Connection	Pin number	Connection
1	ATTACH_EN	9	V_{IN}
2	EN (internal pull-down resistor)	10	V_{IN}
3	CTL1	11	V_{IN}
4	CTL2	12	GND
5	CTL3	13	GND
6	GND	14	V_{DD}
7	$\overline{\text{CHARGING}}/\overline{\text{ATTACH}}$	15	V_{DD}
8	$\overline{\text{FAULT}}$	Shield	GND

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 (V_{IN} and V_{DD} are powered from the same supply)
- SW6 = V_{EXT} (V_{DD} = V_{IN})
- 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 V_{IN} 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 V_{IN} 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 V_{IN}) 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 $\overline{CHARGING/ATTACH}$ 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 kΩ 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}, $\overline{FAULT}$, $\overline{CHARGING/ATTACH}$, 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.

Appendix A   Schematic, BOM, and layers

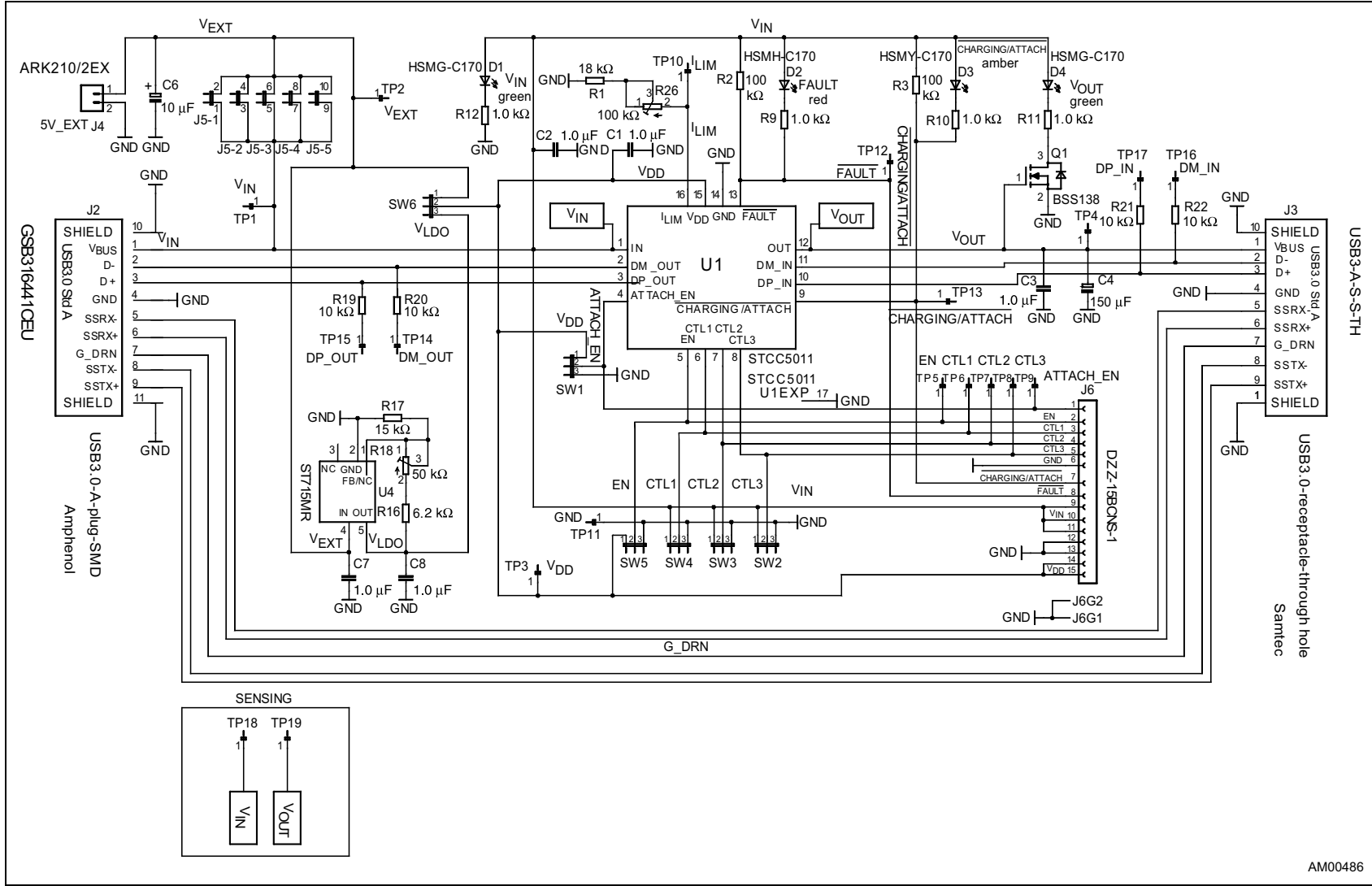**Figure 2. Schematic of STCC50x1 demonstration board**

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Table 4. Bill of material

Qty.	Component	Device	Value	Parts	Manufacturer/supplier
5	Ceramic capacitor	M/16V/X7R/0805[1]	1.0 µF	C1, C2, C3, C7, C8	Murata
1	Electrolytic capacitor	EEEFK1A151P	150 µF	C4	Panasonic
1	Tantalum capacitor	M/16V/B[2]	10 µF	C6	
2	LED	HSMG-C170		D1, D4	AVAGO Technologies
1	LED	HSMH-C170		D2	AVAGO Technologies
1	LED	HSMY-C170		D3	AVAGO Technologies
1	USB3.0 connector	GSB316441CEU	A type, plug	J2	Amphenol
1	USB3.0 connector	USB3-A-S-S-TH	A type, receptacle	J3	Samtec
1	Terminal block	ARK210/2EX		J4	GM® ELECTRONIC
1	Pin header 2r x 5p	PLD-10S	2.54 mm, straight, male	J5	GES® ELECTRONICS
1	Connector	DZZ-15BCNS-1	CANON, female	J6	HSUAN MAO TECHNOLOGY CO.,LTD
1	FET	BSS138	Q1		
1	Resistor	J/0805[3]	18 kΩ	R1	
1	Resistor	J/0805[3]	6.2 kΩ	R16	
1	Resistor	J/0805[3]	15 kΩ	R17	
1	Surface mount trimmer	3314G-1-503E	50 kΩ	R18	BOURNS®
4	Resistor	J/0805[3]	10 kΩ	R19, R20, R21, R22	
2	Resistor	J/0805[3]	100 kΩ	R2, R3	
1	Surface mount trimmer	3314G-1-104E	100 kΩ	R26	BOURNS
4	Resistor	J/0805[3]	1.0 kΩ	R9, R10, R11, R12	
6	Pin header 1r x 3p	PLS-03S	2.54 mm, straight, male	SW1, SW2, SW3, SW4, SW5, SW6	GES ELECTRONICS
6	Jumper	JUMPER/0	2.54 mm	Accessories (SW1, SW2, SW3, SW4, SW5, SW6)	GES ELECTRONICS
2	Pin header 1r x 4p	SIL40PZ / 4	2.54 mm, straight, female	(TP7-TP8-TP9-TP13), (TP5-TP6-TP11-TP12)	GM ELECTRONIC

Table 4. Bill of material (continued)

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

1. SMD … tolerance / voltage / size.

2. SMD … tolerance / size.

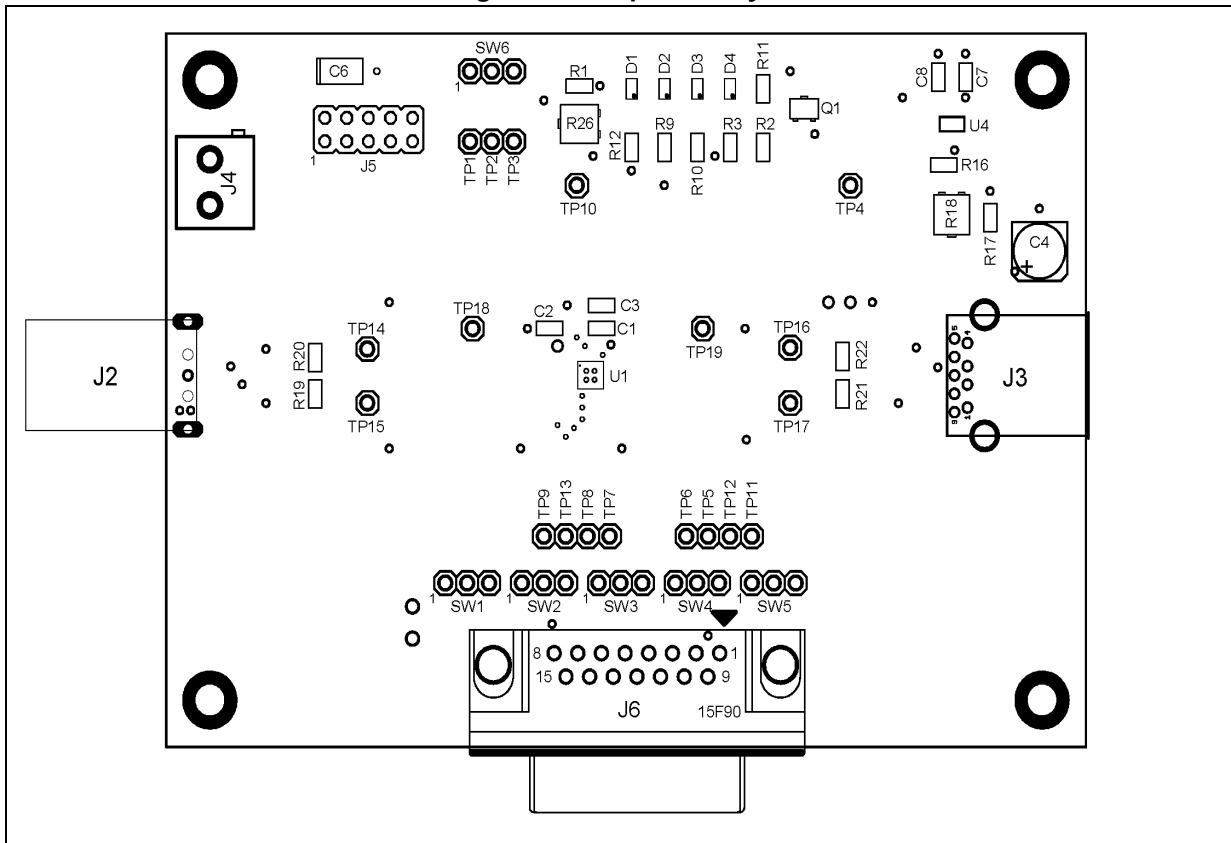3. SMD … tolerance / voltage / dielectric / size.

Figure 3. Component layer
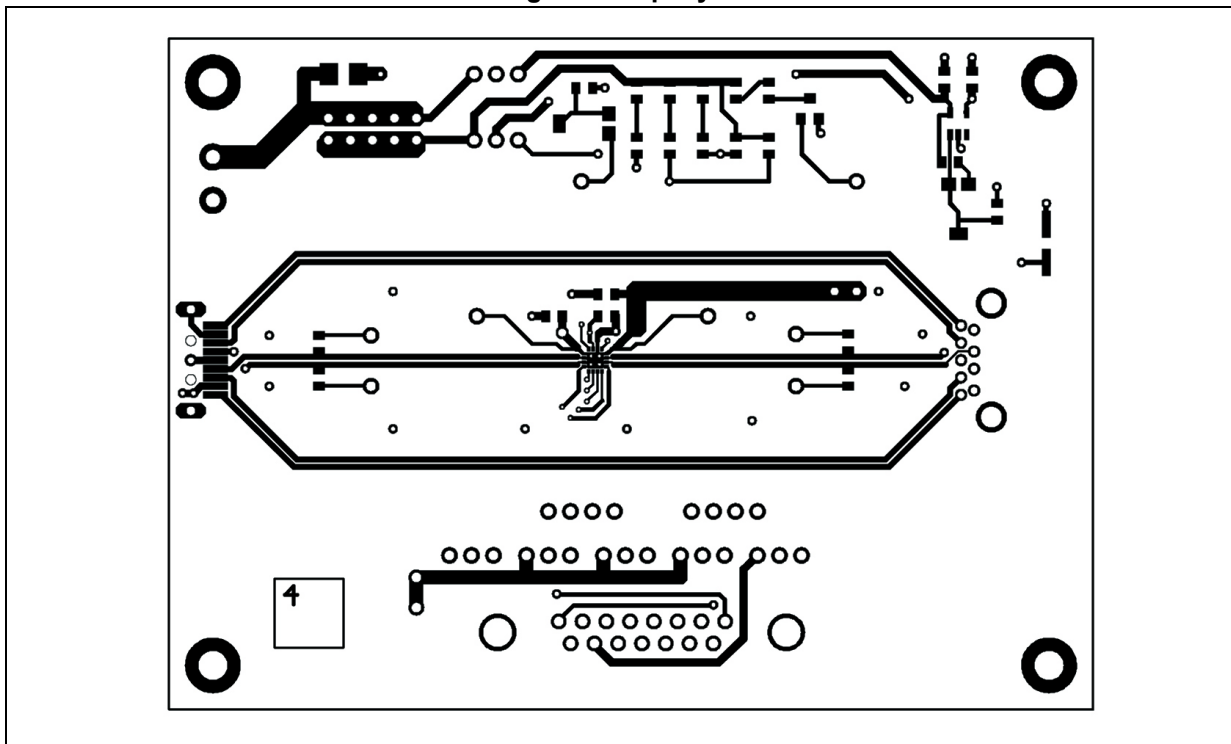

Figure 4. Top layer
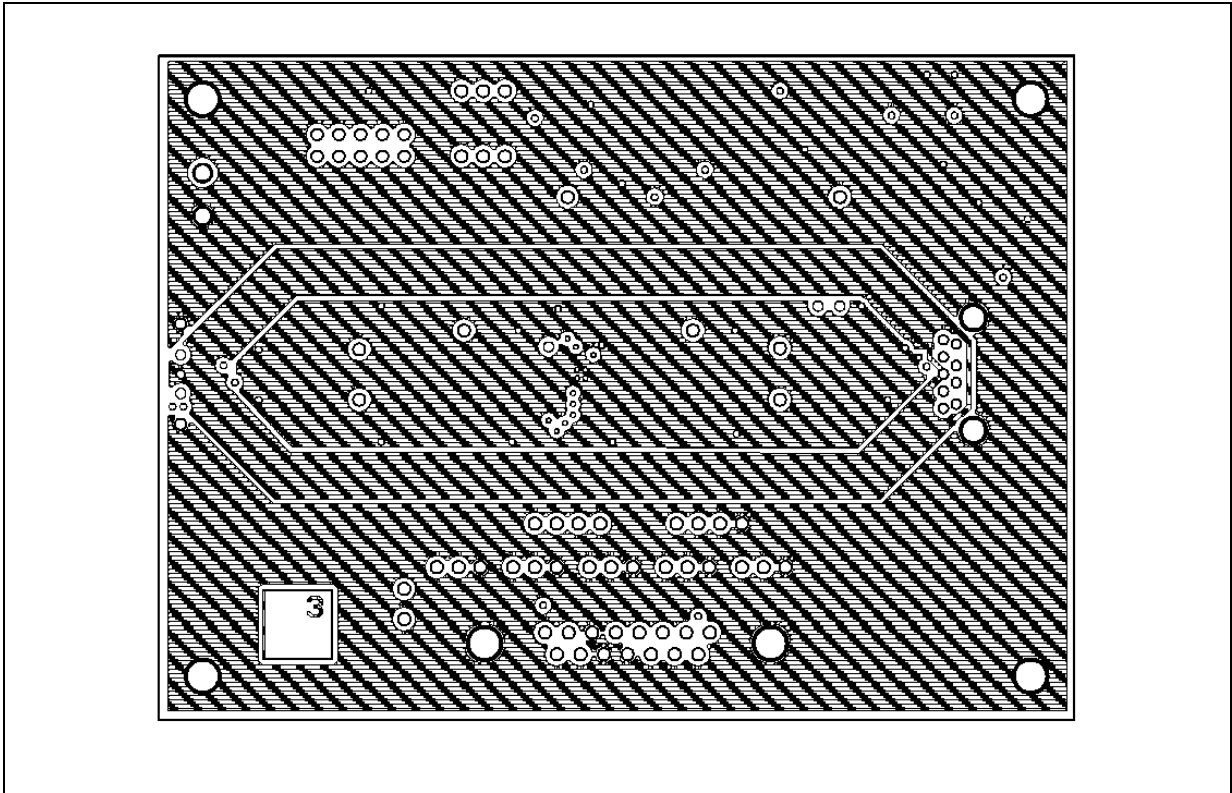
Figure 5. Inner layer 1
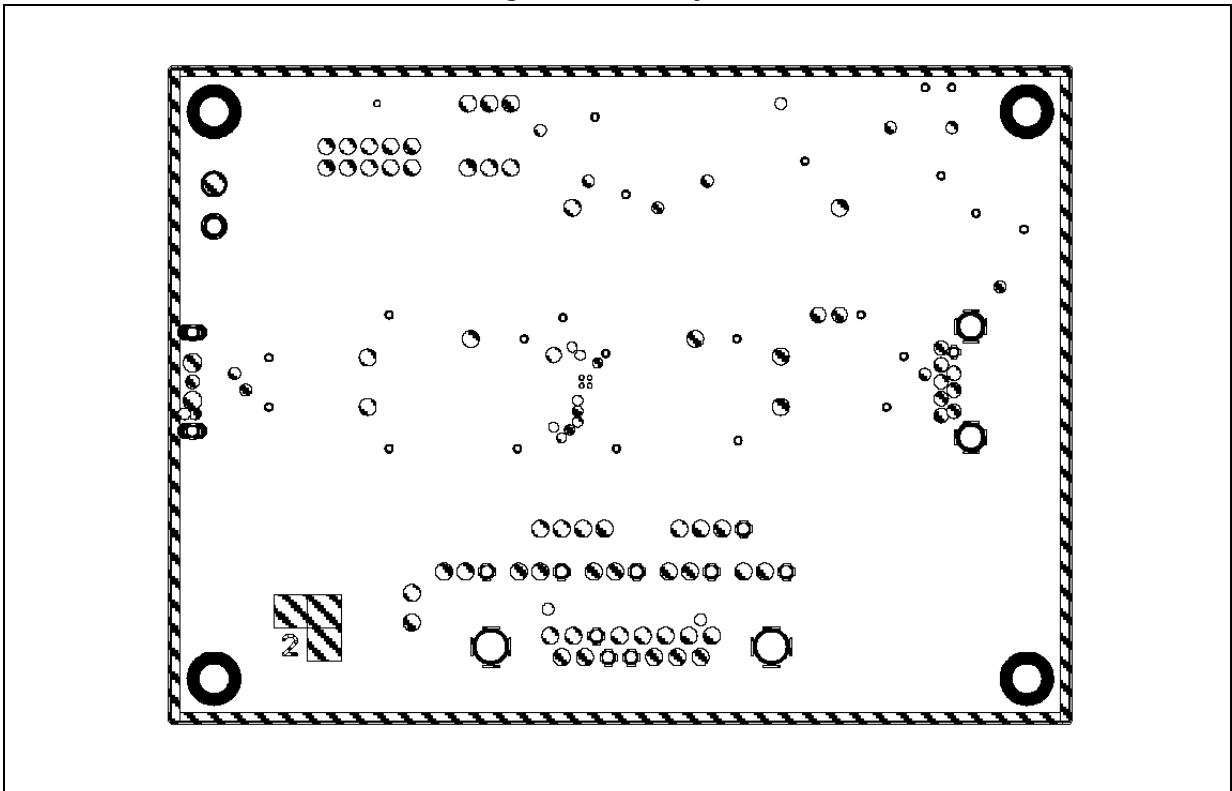

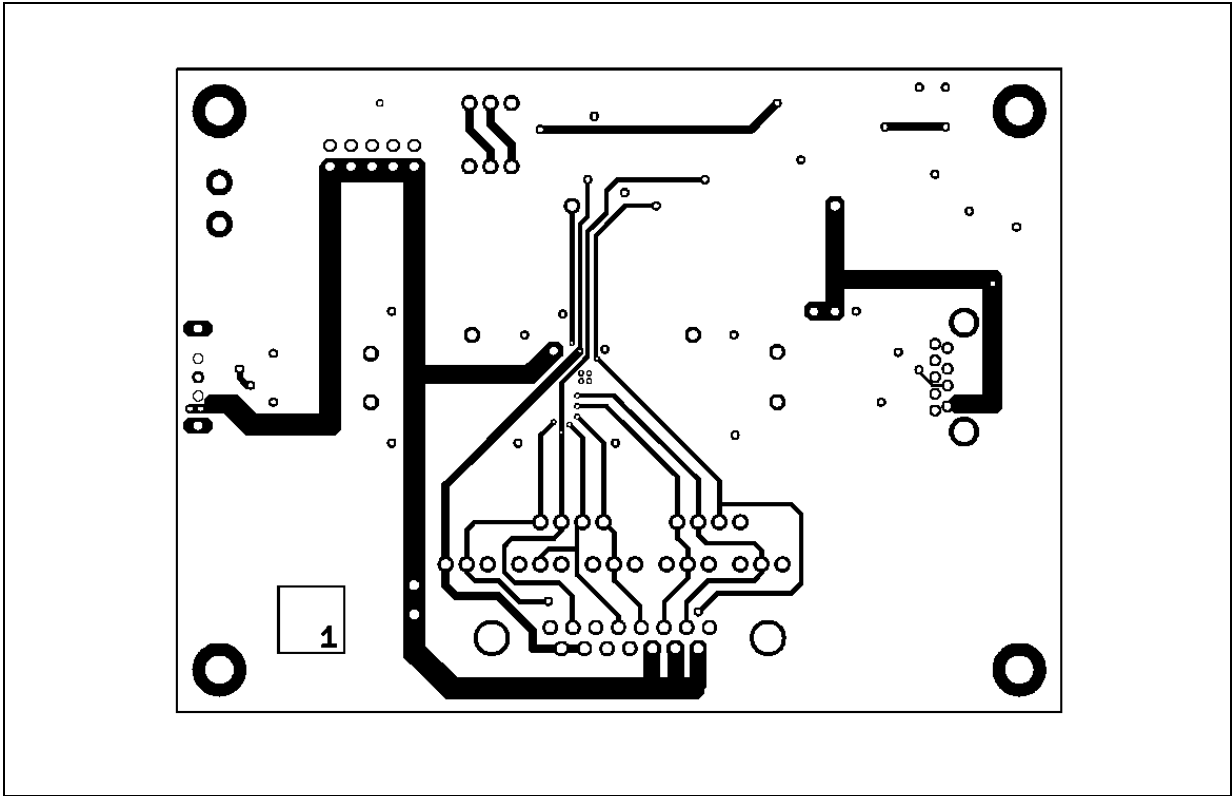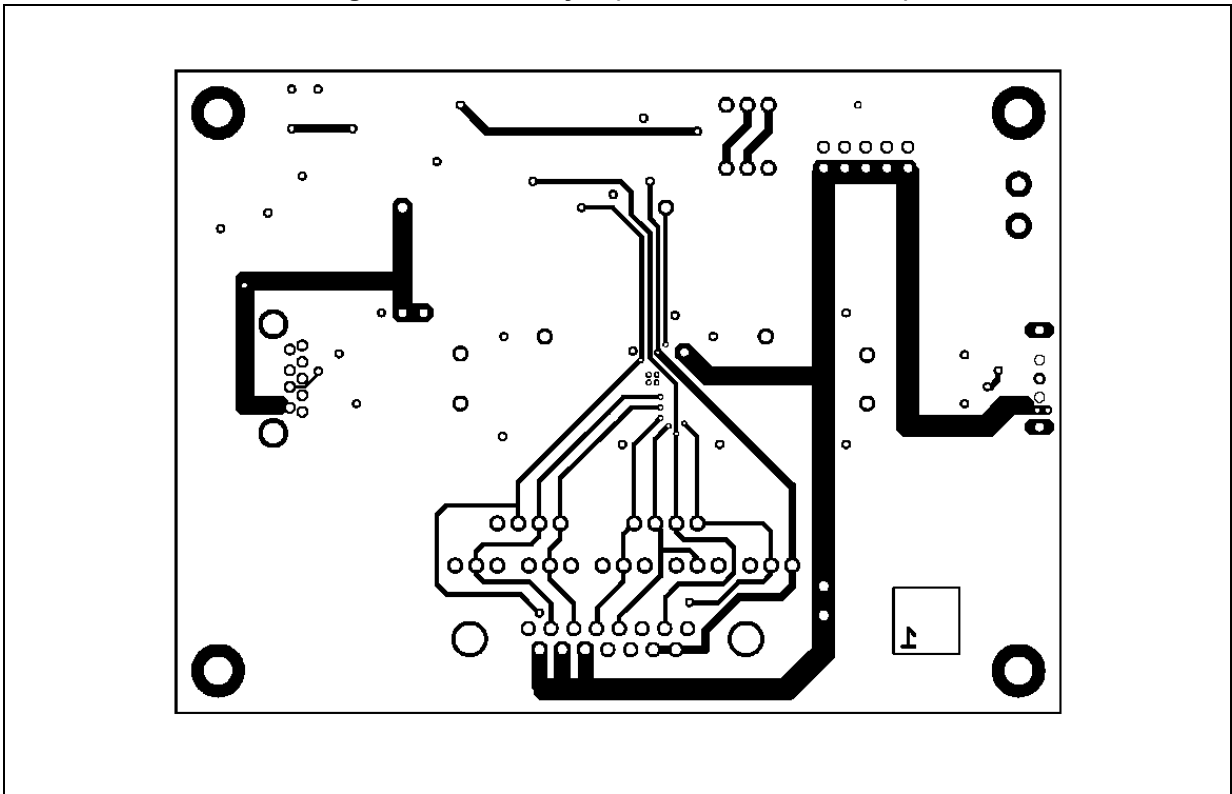**Figure 6. Inner layer 2**

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

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

Note: *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, continuous V_{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 **CTLx** inputs!*

Table 6. J6 pinout

Pin number	Connection	Pin number	Connection
1	Do not connect	9	V_{IN}
2	EN	10	V_{IN}
3	CTL1	11	V_{IN}
4	CTL2	12	GND
5	CTL3	13	GND
6	GND	14	Do not connect
7	$\overline{\text{CHARGING}}$	15	Do not connect
8	$\overline{\text{FAULT}}$	Shield	GND

Revision history

Table 7. Document revision history

Date	Revision	Changes
10-Jun-2013	1	Initial release.

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