HSTCU, HSTCE High Speed Tool Connector

USB C-Type and Samtec ERF8 based tool connector

About this document

Scope and purpose

Infineon's AURIX™ TC3xx and TC4xx devices have a standardized set of tool interfaces (DAP, DAPE, trigger pins, AGBT, SGBT, SGMII). This document specifies a standardized pinning for all these interfaces for the cost effective and small USB Type-C connector. This pinning is not compatible to regular USB devices, but ensures that there is no damage for any combination of regular USB hardware, HSTCU (High Speed Tool Connector USB-C) boards and tool HW.

HSTCE (High Speed Tool Connector ERF8) defines a similar pinning for the Samtec ERF8 connector. HSTCE can be used for a tool cable adaptor board, but as well directly on the target board.

Intended audience

System designers, in particular PCB designers and tool vendors.

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1 Introduction

HSTCU Features

- Small size and footprint
- Designed for up to 10 Gbps high-speed signals
- Different variants offered by several manufacturers
- Cost effective
- Long term availability of USB Type-C connector parts
- Can be used also for a subset like DAP only
- No additional components needed
- Protection scheme for both sides if a regular USB device is plugged in
- Hot plug support due to GND first connection

Note: *The connector cannot be used with a regular USB cable. This avoids all kind of electrical issues and allows that a maximum number of the connector pins is usable for debug purposes.*

2   Connector pinning

Table 1   Connector pinning on target board

Pin	USB	AURIX™ TC3xx	AURIX™ TC4xx	Remark
A1	GND	GND		
A2	TX1+	AGBTTXP	SGBTTXP/SGMIITXP	
A3	TX1-	AGBTTXN	SGBTTXN/SGMIITXN	
A4	VBUS	Not connected		
A5	CC1	PORST		Pull-up on target board is assumed
A6	D+	DAP2/TGI3/TGO3 or TDO		TGO3 is recommended as trigger trace pin
A7	D-	(DAP3/TGI2/TGO2/DAPE1 or TDI)		Optional for 2nd trigger pin, DAPE or JTAG TGO2 is the alternative trigger trace pin
A8	SBU1	DAP0 or TCK		
A9	VBUS	Not connected		
A10	RX2-	Not connected	SGMIIRXN	Optional for Ethernet tool communication
A11	RX2+	Not connected	SGMIIRXP	
A12	GND	GND		
B1	GND	GND		
B2	TX2+	Not connected	Not connected	Future use for 2nd TX
B3	TX2-	Not connected	Not connected	Future use for 2nd TX
B4	VBUS	Not connected		
B5	CC2	VDDP of DAP/DAPE/JTAG pins		VREF for DAP/DAPE
B6	D+	(Auxiliary signal for e.g. WATCHDOG_DISABLE)		Optional signal with uncritical behavior. TESTMODE pin for Infineon internal boards.
B7	D-	DAPE0 or TRST	DAP4/DAPE0 or TRST	
B8	SBU2	DAP1 or TMS		
B9	VBUS	Not connected		
B10	RX1-	AGBTCLKN	SGBT_CLKN	SGBT: Most devices use an internal clock.
B11	RX1+	AGBTCLKP	SGBT_CLKP	AGBT: External clock is always needed.
B12	GND	Connected to PORST. (Not connected on tool side)		Enforce AURIX™ reset state (no pin driven) if a regular USB Type-C cable is connected. Enables also a straightforward connector orientation detection.

Uncritical behavior is a pin with input characteristics after reset and with optional a weak pull resistor. This state shall only be changed under control of the connected tool.

2.1 Protection for wrongly plugged tools or USB cables

Figure 1 shows the signals between the connector and AURIX™ which ensure the protection of a wrongly plugged tool or any other USB-C compliant cable or device. In case of a wrong plugging pin B12 will be forced to GND, which will force the low active reset (PORST) of AURIX™. In reset state all AURIX™ signals which are on the connector are in high impedance state.
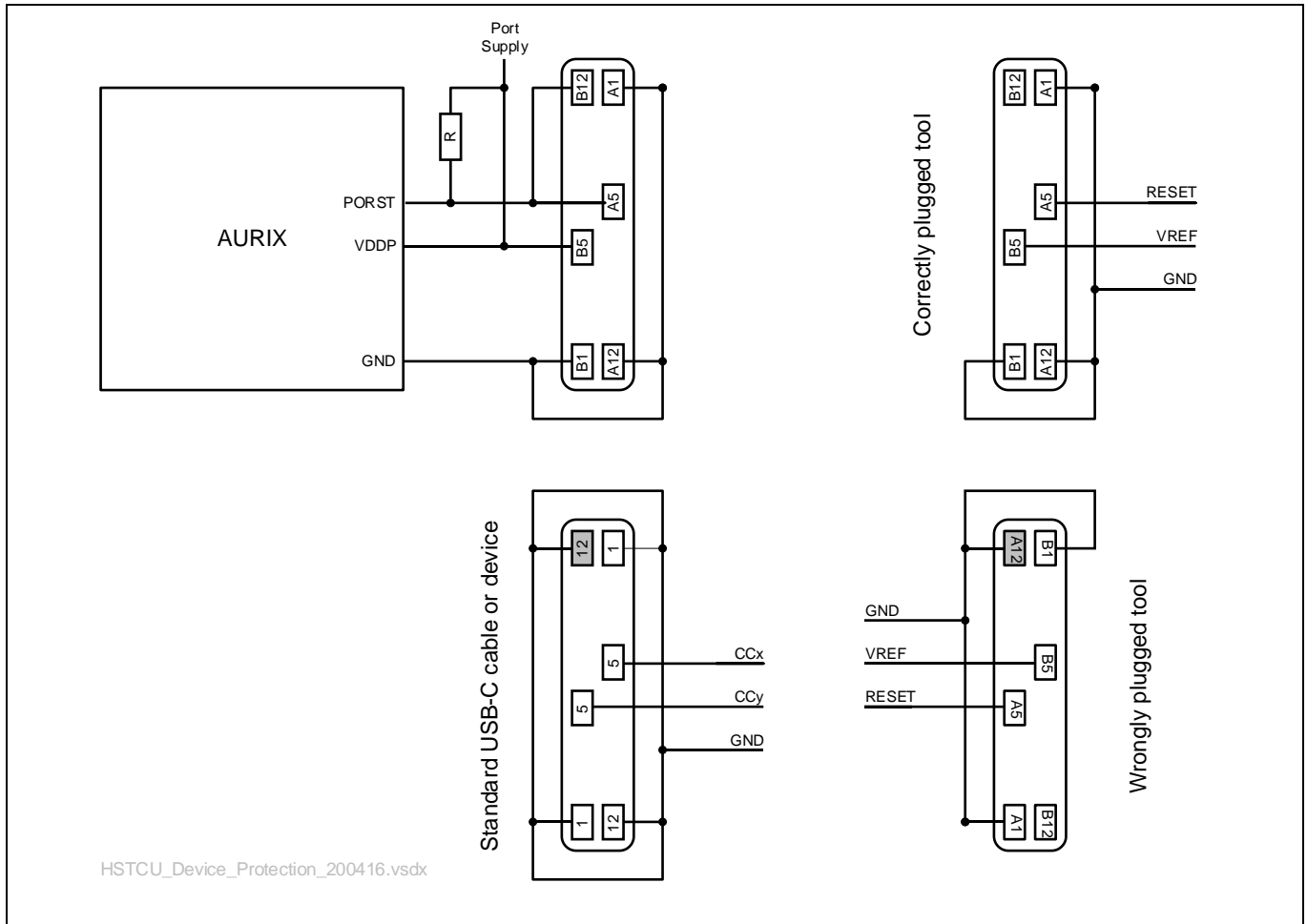
Figure 1   **Device protection scheme**

2.2 Connector orientation detection by the tool

Target presence is detectable by the tool with CC1/CC2. For a powered board at least VREF must be high. The PORST pin will be usually also high (PORST inactive). Excluding errors in the board design, the connector orientation is always detectable under these conditions:

- Board is powered (VREF is present)
- PORST on CC1 is forced low, when the orientation is wrong

The second condition is enforced by the described (Table 1, Figure 1) connection between B12 and and the AURIX™ PORST pin on the target board.

Table 2   Connector orientation detection by the tool

CC1	CC2	Orientation	Comment
L	L	Unknown	Target board is not powered
L	H	Correct	VREF on CC2, PORST active
H	H	Correct	VREF on CC2, PORST inactive. This is the normal operation mode.
H	L	Wrong	VREF on CC1, PORST active is forced because B12 is connected to GND.

2.3 Auxiliary power connector and mounting holes

There are two use cases for the power connector:

- Tool supplies the SBGT PHY of the target device
- Target board supplies tool frontend board

The first use case is described in section 3.3.

Table 3   Auxiliary power connector pinning on target board

Pin	Name	
1	GND	GND
2	VPHY	Supply from tool hardware for VDDPHPHYx on the target board.
3	VTHB	3.3V supply from the target board for the tool hardware board.
4	-	Reserved for Infineon internal usage. Do not connect.

Note: Do not connect VPHY on the target board, if VDDPHPHYx is supplied by the target board.

For a mechanical robust mounting of tool hardware to a target board two positions for 3 mm screws with spacing rollers are defined (Figure 2). A tool HW will always support the position between the two connectors. The second position is optional for larger tool HW boards.

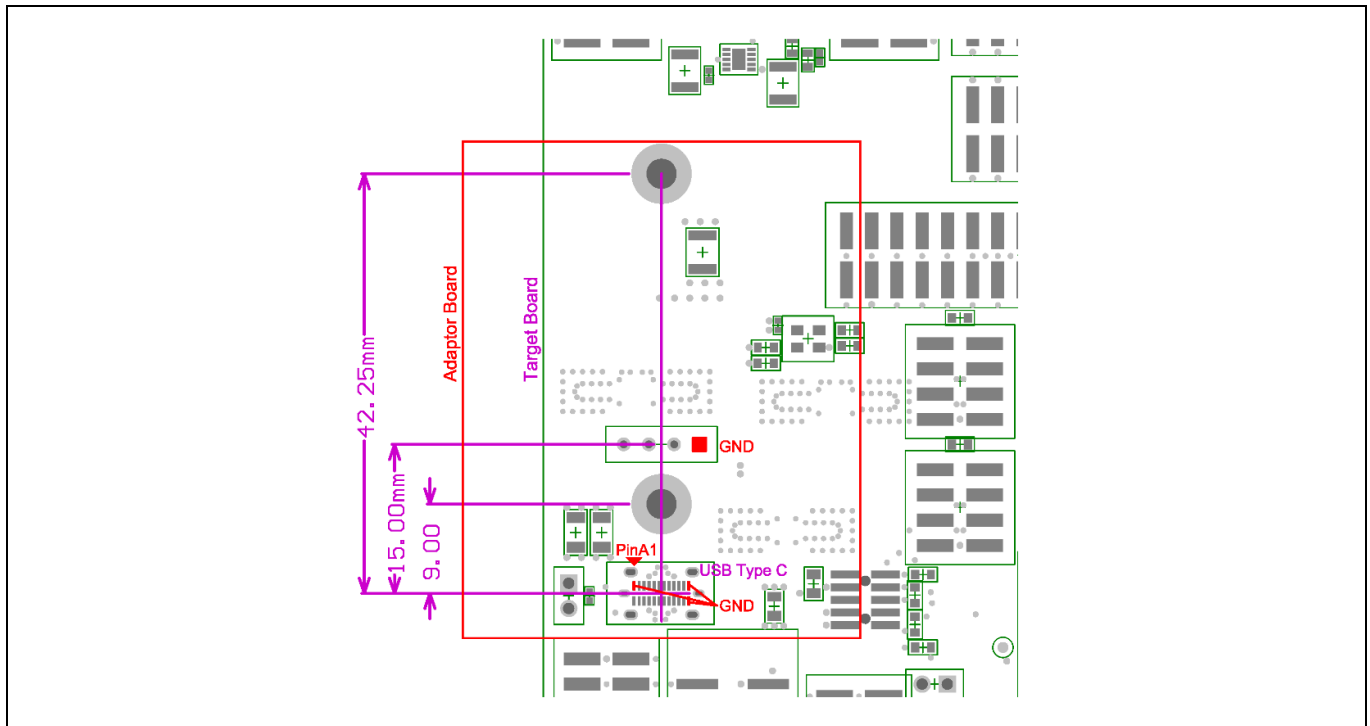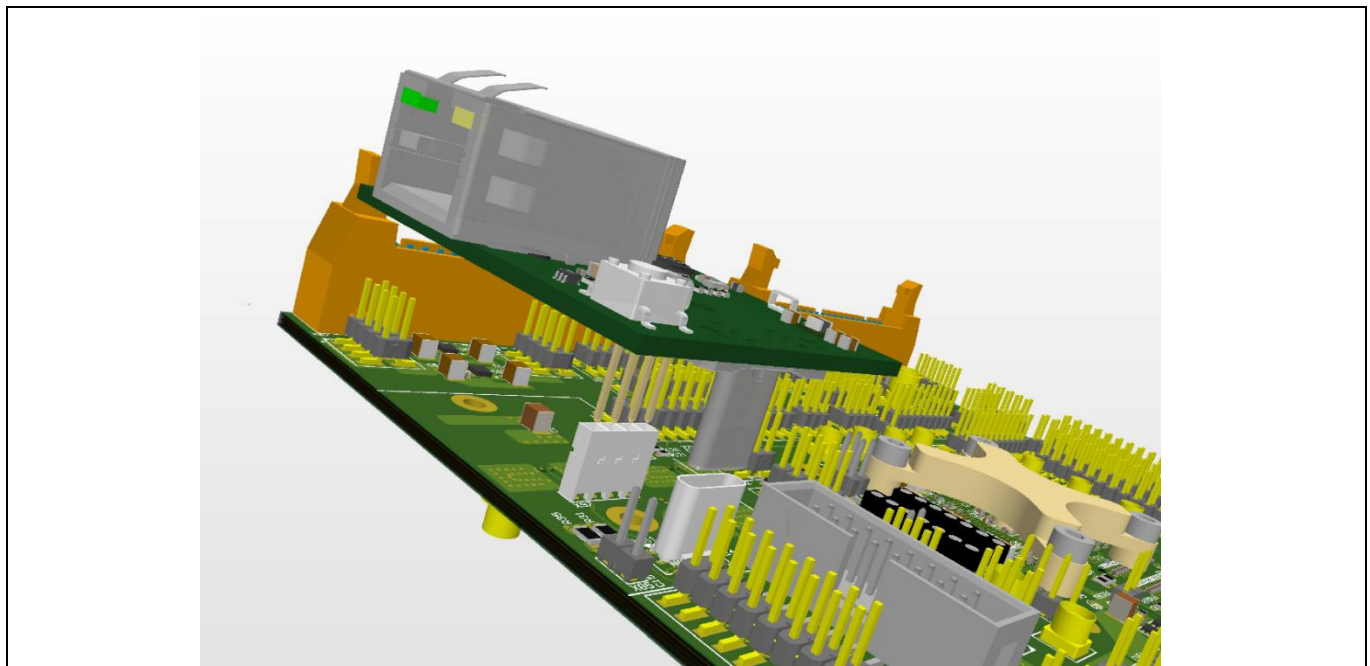**Figure 2**   **Connector and mounting hole geometry on the target board**

Figure 3   **Example for an adaptor board from SGMII to Ethernet**

3 Target board

3.1 TRST Pin circuitry

TRST must not have a strong pull-up on the target board. Otherwise an accidentally connected USB device will be damaged when the D- differential IO pin on A7/B7 is connected with a low resistive connection to 3.3 V or even 5 V. A board without an external pull-up fulfills this requirement since starting with the AURIX™ TC3xx generation the TRST pin has a chip internal pull-up.

3.2 PORST pin circuitry

A tool using DAPE must be able to sense the actual PORST pin level at the device to ensure that TRST is high at PORST release. The DAPE0 clock pin is overlaid to the TRST pin and, only by sensing the PORST pin, a DAPE tool can ensure that TRST is high at PORST release under all conditions. If TRST/DAPE0 is low at PORST release, JTAG will be enabled and no DAP/DAPE communication is possible.

A board with a direct connection between the connector PORST pin and the device PORST pin fulfills this requirement.

3.3 VDDPHPHYx supply for SGBT/SGMII by the tool

If there is no supply for VDDPHPHYx on the target board, this supply can be provided by the tool. It only needs to be ensured by a 1k resistor to GND on the target board, that this supply is not floating when e.g. the tool is unplugged. Also, a buffer capacitor on the target board is required.

Note: All VDDPHPHYx supplies of the device need to be connected to the same rail.

3.4 Labels Not4USB and A1

It is recommended to show the connector orientation by marking the connector side with the A1 pin on the board. This can be done with the label "A1" or a dot. For boards with many potentially unexperienced users it is recommended to label the connector with "Not4USB".

4 Standard adaptors

4.1 HSTCU to DAP connector adaptor

Please refer to appnote AP24003 for the definition of the DAP connector.

Table 4 HSTCU to DAP connector adaptor

DAP	Function	HSTCU	Comment
1	VREF	B5 (CC2)	
2	DAP1	B8 (SBU2)	
3, 5, 7, 9	GND	A1, A12, B1, (GND)	B12 is intentionally not connected
4	DAP0	A8 (SBU1)	
6	DAP2/TGI3/TGO3	A6 (D+)	
8	DAP3/TGI2/TGO2	A7 (D-)	Note not TRST (DAPEN)
10	RESET/PORST	A5 (CC1)	

The adaptor leaves all other HSTCU pins open, except B7 (TRST). This pin is connected to a 4k pull-up to VREF for ensuring DAP interface enabling for AURIX™ TC3xx devices. AURIX™ TC4xx devices have a TRST pin with an internal pull-up, which means the DAP interface is enabled per default if this pin is left open.

The GND pins are all connected together except B12. This enforces an active PORST, when the connector orientation is wrong and so this situation is safe and easily detectable even without a tool.

4.2 HSTCU to DAP+DAPE connector adaptor

This adapter allows to connect two regular DAP connector tools in parallel via the DAP and the DAPE interface.

Table 5 HSTCU to DAP+DAPE connector adaptor

DAP/DAPE	Function	HSTCU	Comment
1	VREF	B5 (CC2)	
2	DAP1 DAPE1	B8 (SBU2) A7 (D-)	
3, 5, 7, 9	GND	A1, A12, B1, (GND)	B12 is intentionally not connected
4	DAP0 DAPE0 (TRST)	A8 (SBU1) B7 (D-)	
6	DAP2/TGI3/TGO3 Not connected	A6 (D+) -	
8	Not connected Auxiliary signal	- B6 (D+)	Difference to DAP connector adaptor
10	RESET/PORST	A5 (CC1)	

The adaptor leaves all other HSTCU pins open. The GND pins are all connected together except B12. This enforces an active PORST, when the connector orientation is wrong and so this situation is safe and easily detectable even without a tool.

For mechanical stability it is recommended for this adaptor to use the standard mounting hole with a spacing roller and a screw.

V1.2
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Standard adaptors

For AURIX™ TC3xx devices it is strongly recommended to connect the dedicated DAPE0/1 pins from the center ball matrix to HSTCU and hardwire TRST to high for DAP enabling (without connecting it to HSTCU!). This ensures a robust tool behavior even if only one tool is connected.

4.3 HSTCU to HSTCE (ERF8) connector adaptor

The ERF8 connector was standardized as Aurora connector (according to Application Note AP32186) for AURIX™ TC2xx and TC3xx Emulation Devices.

For AURIX™ TC4xx devices with SGBT it can be used as well with minor changes. For instance, if the ERF8 connector is preferred over the USB C-type connector for temperature range reasons.

Table 6 defines the High-Speed Trace Connector with ERF8 (HSTCE) pinning. This HSTCE pinning is used for the adaptor but can be used on a target board as well.

Table 6   HSTCU to HSTCE (ERF8) connector adaptor

HSTCE	Function	HSTCU	Comment
1	SGBTTXP/SGMIITXP	A2	
3	SGBTTXN/SGMIITXN	A3	
5, 11, 17	GND	A1, A12, B1	B12 is intentionally not connected
7	TX+	B2	Future use for 2nd TX
9	TX-	B3	
13, 15, 20	-	-	Not connected on HSTCE
19, 21	(VPHY)	-	Optional VDDPHPHYx supply for target board
2	VDDP	B5	
4	DAP0 or TCK	A8	
6	DAP1 or TMS	B8	
8	DAP3 or TDI	A7	
10	DAP2 or TDO	A6	
12	DAP4 or TRST	B7	
14	SGBT_CLKP	B11	
16	SGBT_CLKN	B10	
18	(Auxiliary signal)	B6	
22	PORST	A5	
-	-	A4, A9, A10, A11, B4, B9, B12	Not connected on HSTCU

Note: VPHY is not connected to HSTCU. The use case is when the HSTCE connector is directly on a target board. Please consider the hints for VPHY from section 2.3 for the target board design.

Revision history

Document version	Date of release	Description of changes
V1.0	2021-04-26	Initial version
V1.1	2021-08-24	Added hint for WATCHDOG_DISABLE signal in Table 1
V1.2	2022-09-09	Changed document classification

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