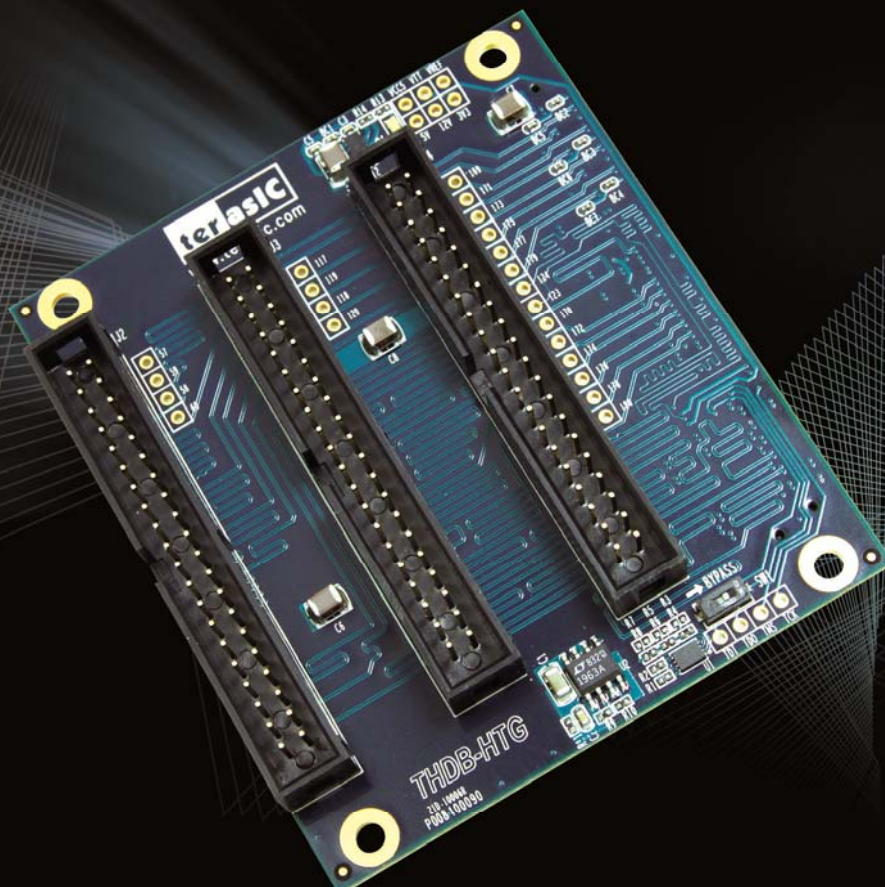


# THDB-HTG

## User Manual

### Terasic HSTC to GPIO Daughter Board



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The THDB-HTG board is designed to convert a High-Speed Terasic connector (HSTC) or a High-Speed Mezzanine connector (HSMC) I/Os to three 40-pin expansion prototype connectors, which are compatible with Altera DE2/DE1 expansion headers. Users can connect up to three Altera DE2/DE1 boards (or associated daughter cards) onto a HSTC/HSMC-interfaced host board via a THDB-HTG board.

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## Features

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Figure 1.1 shows the photo of a THDB-HTG board. The important functions of the THDB-HTG are listed below:

- Convert HSTC/HSMC-interfaced I/O to standard 40-pin expansion connectors.
- Allow users to connect Altera DE2/DE1 boards to a HSTC/HSMC-interfaced host board.
- Provide test points for signal measurement.



Figure 1.1. The picture of a THDB-HTG board

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## Getting Help

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Here are some places to get help if you encounter any problem:

- ✓ Email to [support@terasic.com](mailto:support@terasic.com)
- ✓ Taiwan & China: +886-3-550-8800
- ✓ Korea : +82-2-512-7661
- ✓ English Support Line: +1-408-512-12336

# 2 Architecture

This chapter describes the architecture of the THDB-HTG board, including block diagram and components.

## Layout and Componets

Figure 2.1, Figure 2.2, and Figure 2.3 depict the layout of the board and indicate the locations of the connectors and key components.

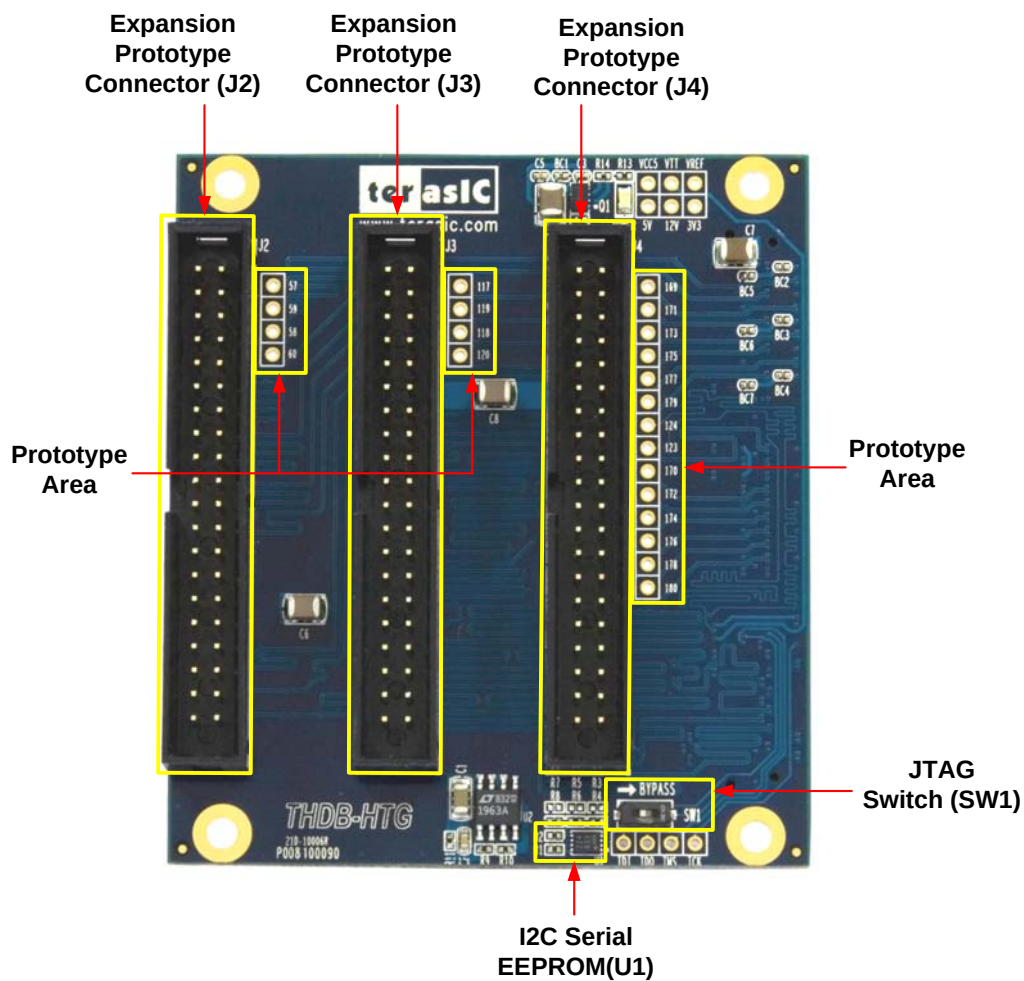


Figure 2.1 Top view of the TDRB-HTG board



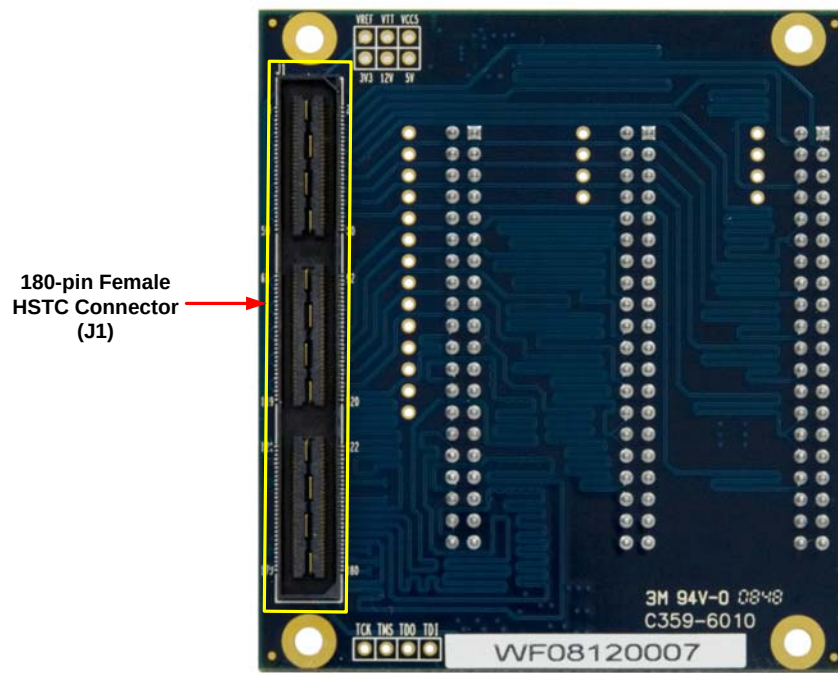


Figure 2.2 Back side of the TDRB-HTG board – HSTC version

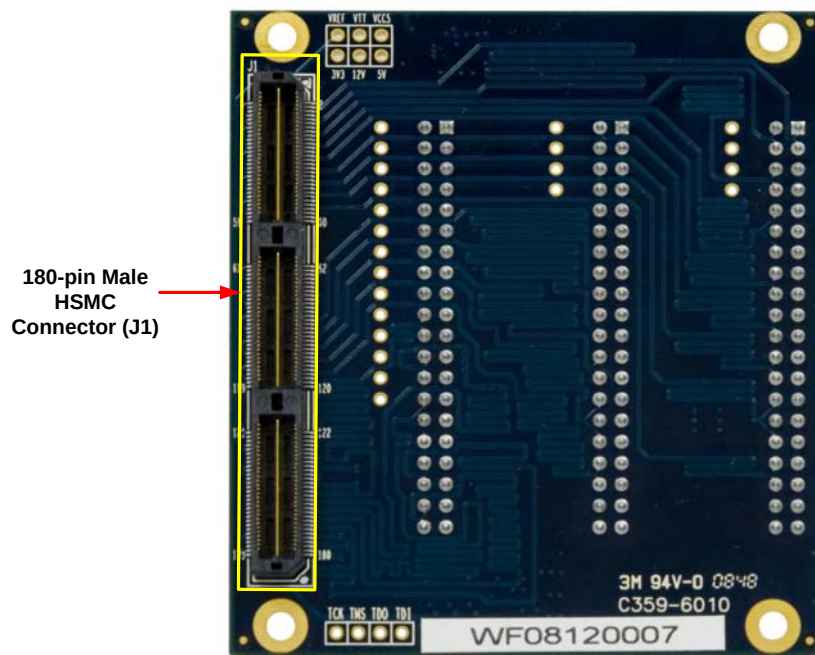


Figure 2.3 Back side of the TDRB-HTG board – HSMC version

The following components are provided on the THDB-HTG board :

- HSTC/HSMC expansion connector (J1)
- Expansion prototype connectors (J2,J3,J4)
- I2C serial EEPROM (U1)

## Block Diagram

Figure 2.4 shows the block diagram of the THDB-HTG board.

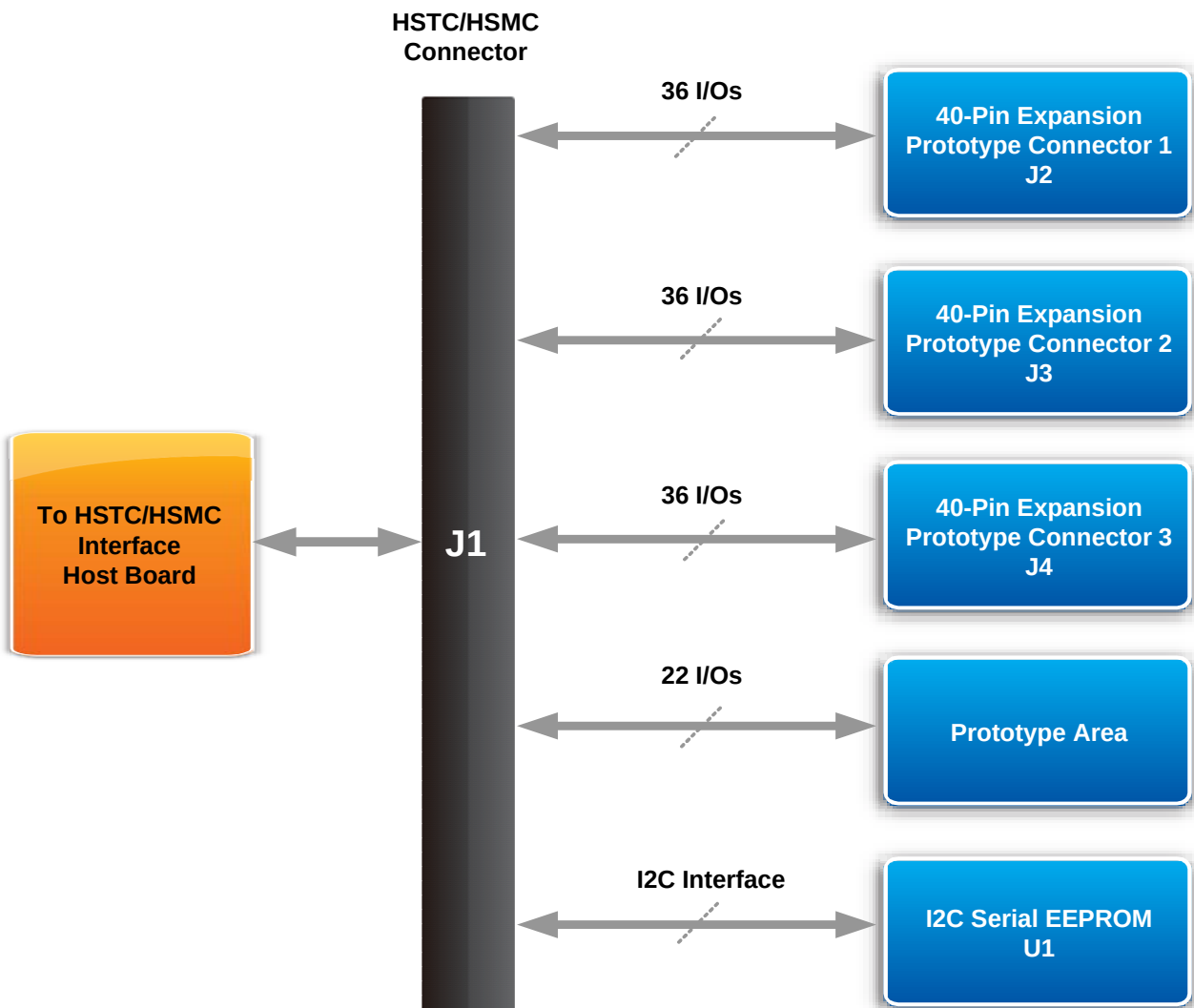


Figure 2.4. The block diagram of the THDB-HTG board

This section will describe the information of components, connector interfaces, and pin mappings on the THDB-HTG board in details.

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## HSTC/HSMC Expansion Connector

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This section describes the HSTC/HSMC connector on the THDB-HTG board

There are two options of high speed connector on the THDB-HTG board. One is a 180-pin female HSTC connector for HSTC-interfaced host board such as Altera DE3 board and Terasic PCI board. The other one is a 180-pin male connector for Altera HSMC-interfaced host board. All other interfaces on the THDB-HTG board are connected to the HSTC/HSMC connector. Figure 3.1 shows the pin-outs of the HSTC and HSMC connector.

## Board Components

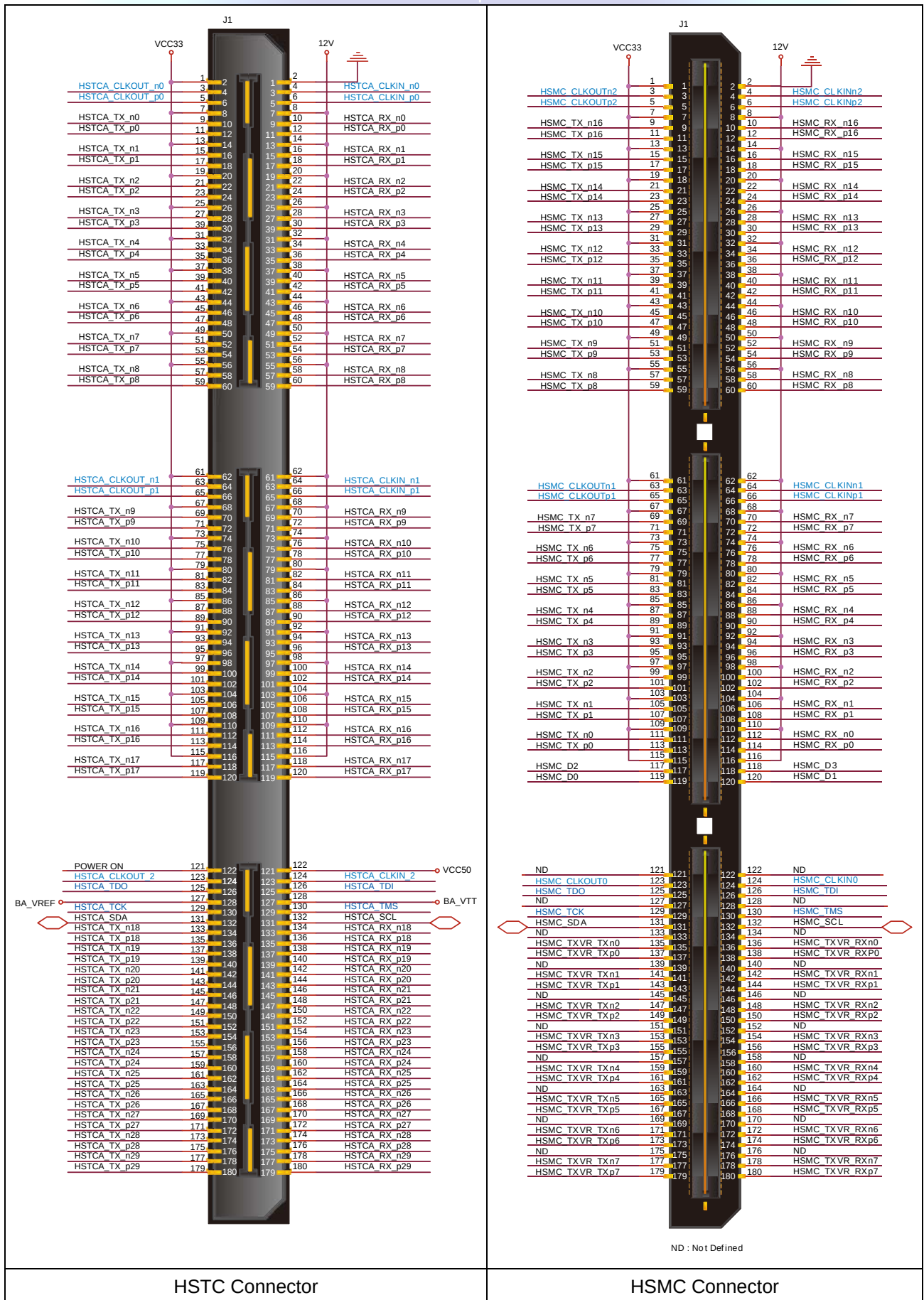


Figure 3.1 The pin-outs of the HSTC and HSMC connector.



## Expansion Prototype Connectors

This section describes the expansion prototype connectors on the THDB-HTG board.

The THDB-HTG board has three expansion prototype connectors (J2, J3, and J4) connected to the HSTC/HSMC connector directly. Each of the connectors has 36 prototyping I/Os and 3.3/5 volts power supply from the HSTC/HSMC interface and on-board regulator. In addition, the expansion connector is compatible with expansion headers of Altera DE1/DE2 board. Users can connect Altera DE2/DE1 development kits or custom daughter boards to a HSTC/HSMC-interfaced host board. Figure 3.2 and Figure 3.3 show the pin-outs of the expansion prototype connectors for HSTC and HSMC version, respectively. Detailed pin mappings to HSTC/HSMC connector are listed in Table 3.1, Table 3.2, and Table 3.3.

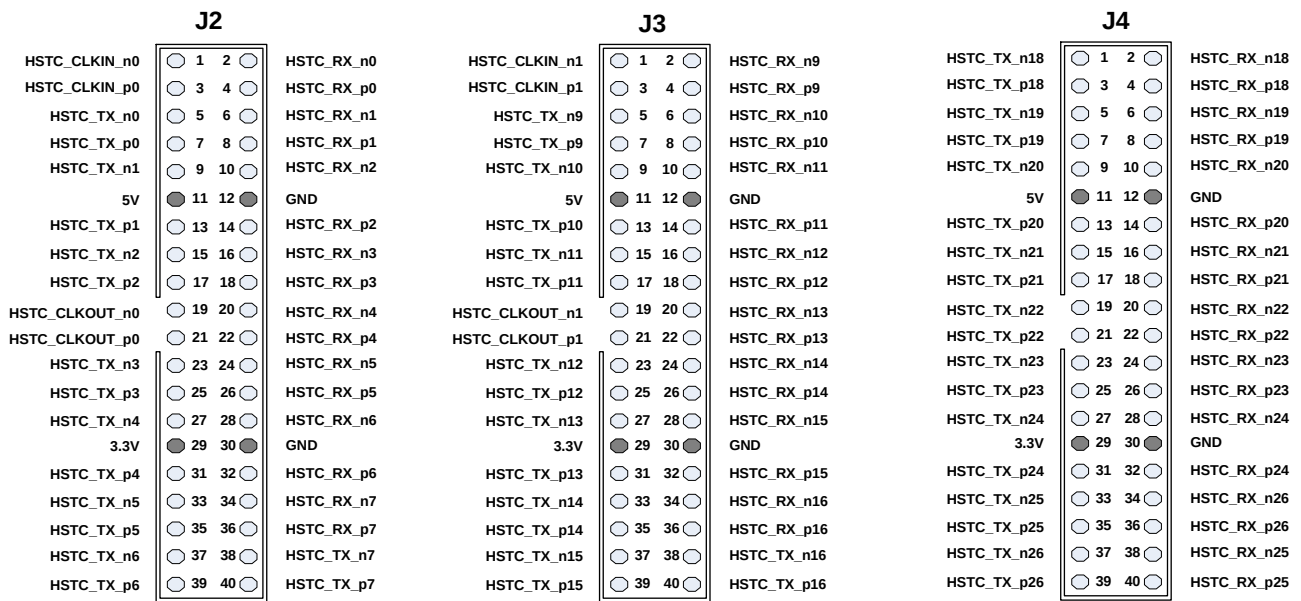


Figure 3.2 Pin-outs of the expansion prototype connectors for HSTC version

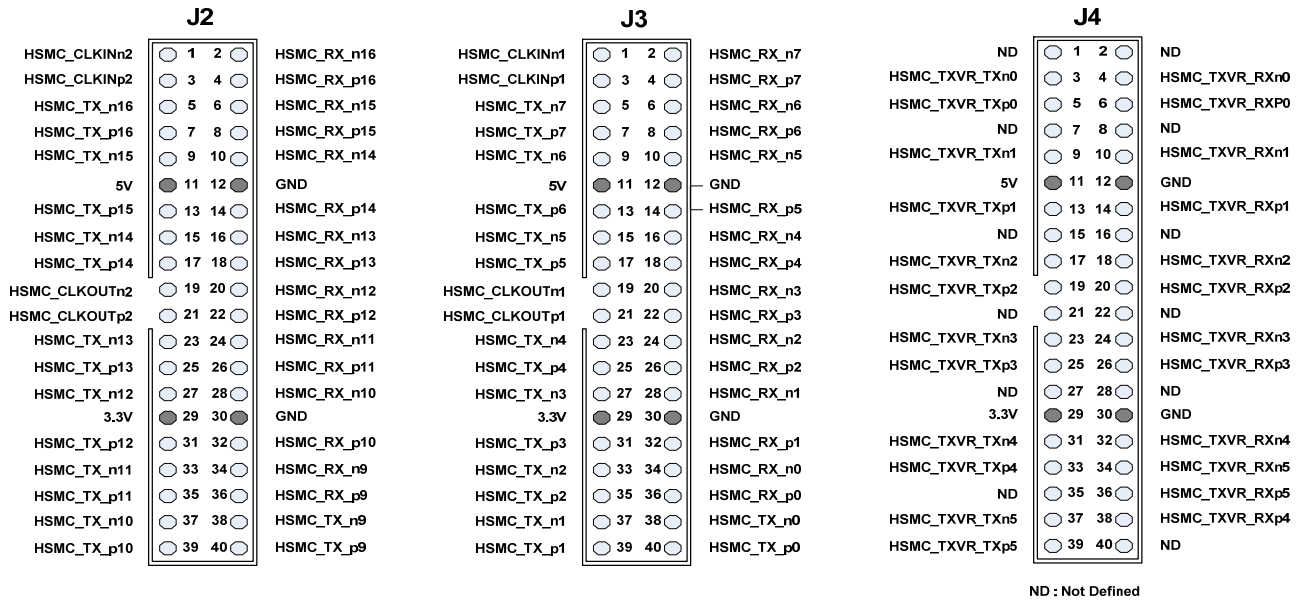


Figure 3.3 Pin-outs of the expansion prototype connectors for HSMC version

Table 3.1 Pin mappings of the expansion prototype connector J2

# Board Components

| Expansion Prototype Connector 1 – J2 |               |                               |                               |                          |
|--------------------------------------|---------------|-------------------------------|-------------------------------|--------------------------|
| J2 Pin Number                        | J1 Pin Number | J1 (HSTC Version) Signal Name | J1 (HSMC Version) Signal Name | DE2/DE1 GPIO Signal Name |
| 1                                    | 4             | HSTC_CLKIN_n0                 | HSMC_CLKIN_n2                 | GPIO0                    |
| 2                                    | 10            | HSTC_RX_n0                    | HSMC_RX_n16                   | GPIO1                    |
| 3                                    | 6             | HSTC_CLKIN_p0                 | HSMC_CLKIN_p2                 | GPIO2                    |
| 4                                    | 12            | HSTC_RX_p0                    | HSMC_RX_p16                   | GPIO3                    |
| 5                                    | 9             | HSTC_TX_n0                    | HSMC_TX_n16                   | GPIO4                    |
| 6                                    | 16            | HSTC_RX_n1                    | HSMC_RX_n15                   | GPIO5                    |
| 7                                    | 11            | HSTC_TX_p0                    | HSMC_TX_p16                   | GPIO6                    |
| 8                                    | 18            | HSTC_RX_p1                    | HSMC_RX_p15                   | GPIO7                    |
| 9                                    | 15            | HSTC_TX_n1                    | HSMC_TX_n15                   | GPIO8                    |
| 10                                   | 22            | HSTC_RX_n2                    | HSMC_RX_n14                   | GPIO9                    |
| 11                                   | N/A           | N/A                           | N/A                           | 5V                       |
| 12                                   | N/A           | N/A                           | N/A                           | GND                      |
| 13                                   | 17            | HSTC_TX_p1                    | HSMC_TX_p15                   | GPIO10                   |
| 14                                   | 24            | HSTC_RX_p2                    | HSMC_RX_p14                   | GPIO11                   |
| 15                                   | 21            | HSTC_TX_n2                    | HSMC_TX_n14                   | GPIO12                   |
| 16                                   | 28            | HSTC_RX_n3                    | HSMC_RX_n13                   | GPIO13                   |
| 17                                   | 23            | HSTC_TX_p2                    | HSMC_TX_p14                   | GPIO14                   |
| 18                                   | 30            | HSTC_RX_p3                    | HSMC_RX_p13                   | GPIO15                   |
| 19                                   | 3             | HSTC_CLKOUT_n0                | HSMC_CLKOUT_n2                | GPIO16                   |
| 20                                   | 34            | HSTC_RX_n4                    | HSMC_RX_n12                   | GPIO17                   |
| 21                                   | 5             | HSTC_CLKOUT_p0                | HSMC_CLKOUT_p2                | GPIO18                   |
| 22                                   | 36            | HSTC_RX_p4                    | HSMC_RX_p12                   | GPIO19                   |
| 23                                   | 27            | HSTC_TX_n3                    | HSMC_TX_n13                   | GPIO20                   |
| 24                                   | 40            | HSTC_RX_n5                    | HSMC_RX_n11                   | GPIO21                   |
| 25                                   | 29            | HSTC_TX_p3                    | HSMC_TX_p13                   | GPIO22                   |
| 26                                   | 42            | HSTC_RX_p5                    | HSMC_RX_p11                   | GPIO23                   |
| 27                                   | 33            | HSTC_TX_n4                    | HSMC_TX_n12                   | GPIO24                   |
| 28                                   | 46            | HSTC_RX_n6                    | HSMC_RX_n10                   | GPIO25                   |
| 29                                   | N/A           | N/A                           | N/A                           | 3.3V                     |
| 30                                   | N/A           | N/A                           | N/A                           | GND                      |
| 31                                   | 35            | HSTC_TX_p4                    | HSMC_TX_p12                   | GPIO26                   |
| 32                                   | 48            | HSTC_RX_p6                    | HSMC_RX_p10                   | GPIO27                   |
| 33                                   | 39            | HSTC_TX_n5                    | HSMC_TX_n11                   | GPIO28                   |
| 34                                   | 52            | HSTC_RX_n7                    | HSMC_RX_n9                    | GPIO29                   |
| 35                                   | 41            | HSTC_TX_p5                    | HSMC_TX_p11                   | GPIO30                   |
| 36                                   | 54            | HSTC_RX_p7                    | HSMC_RX_p9                    | GPIO31                   |
| 37                                   | 45            | HSTC_TX_n6                    | HSMC_TX_n10                   | GPIO32                   |
| 38                                   | 51            | HSTC_TX_n7                    | HSMC_TX_n9                    | GPIO33                   |
| 39                                   | 47            | HSTC_TX_p6                    | HSMC_TX_p10                   | GPIO34                   |
| 40                                   | 53            | HSTC_TX_p7                    | HSMC_TX_p9                    | GPIO35                   |

Table 3.2 Pin mappings of the expansion prototype connector J3

# Board Components

| Expansion Prototype Connector 1 – J3 |               |                               |                               |                          |
|--------------------------------------|---------------|-------------------------------|-------------------------------|--------------------------|
| J3 Pin Number                        | J1 Pin Number | J1 (HSTC Version) Signal Name | J1 (HSMC Version) Signal Name | DE2/DE1 GPIO Signal Name |
| 1                                    | 64            | HSTC_CLKIN_n1                 | HSMC_CLKIN_n1                 | GPIO0                    |
| 2                                    | 70            | HSTC_RX_n9                    | HSMC_RX_n7                    | GPIO1                    |
| 3                                    | 66            | HSTC_CLKIN_p1                 | HSMC_CLKIN_p1                 | GPIO2                    |
| 4                                    | 72            | HSTC_RX_p9                    | HSMC_RX_p7                    | GPIO3                    |
| 5                                    | 69            | HSTC_TX_n9                    | HSMC_TX_n7                    | GPIO4                    |
| 6                                    | 76            | HSTC_RX_n10                   | HSMC_RX_n6                    | GPIO5                    |
| 7                                    | 71            | HSTC_TX_p9                    | HSMC_TX_p7                    | GPIO6                    |
| 8                                    | 78            | HSTC_RX_p10                   | HSMC_RX_p6                    | GPIO7                    |
| 9                                    | 75            | HSTC_TX_n10                   | HSMC_TX_n6                    | GPIO8                    |
| 10                                   | 82            | HSTC_RX_n11                   | HSMC_RX_n5                    | GPIO9                    |
| 11                                   | N/A           | N/A                           | N/A                           | 5V                       |
| 12                                   | N/A           | N/A                           | N/A                           | GND                      |
| 13                                   | 77            | HSTC_TX_p10                   | HSMC_TX_p6                    | GPIO10                   |
| 14                                   | 84            | HSTC_RX_p11                   | HSMC_RX_p5                    | GPIO11                   |
| 15                                   | 81            | HSTC_TX_n11                   | HSMC_TX_n5                    | GPIO12                   |
| 16                                   | 88            | HSTC_RX_n12                   | HSMC_RX_n4                    | GPIO13                   |
| 17                                   | 83            | HSTC_TX_p11                   | HSMC_TX_p5                    | GPIO14                   |
| 18                                   | 90            | HSTC_RX_p12                   | HSMC_RX_p4                    | GPIO15                   |
| 19                                   | 63            | HSTC_CLKOUT_n1                | HSMC_CLKOUT_n1                | GPIO16                   |
| 20                                   | 94            | HSTC_RX_n13                   | HSMC_RX_n3                    | GPIO17                   |
| 21                                   | 65            | HSTC_CLKOUT_p1                | HSMC_CLKOUT_p1                | GPIO18                   |
| 22                                   | 96            | HSTC_RX_p13                   | HSMC_RX_p3                    | GPIO19                   |
| 23                                   | 87            | HSTC_TX_n12                   | HSMC_TX_n4                    | GPIO20                   |
| 24                                   | 100           | HSTC_RX_n14                   | HSMC_RX_n2                    | GPIO21                   |
| 25                                   | 89            | HSTC_TX_p12                   | HSMC_TX_p4                    | GPIO22                   |
| 26                                   | 102           | HSTC_RX_p14                   | HSMC_RX_p2                    | GPIO23                   |
| 27                                   | 93            | HSTC_TX_n13                   | HSMC_TX_n3                    | GPIO24                   |
| 28                                   | 106           | HSTC_RX_n15                   | HSMC_RX_n1                    | GPIO25                   |
| 29                                   | N/A           | N/A                           | N/A                           | 3.3V                     |
| 30                                   | N/A           | N/A                           | N/A                           | GND                      |
| 31                                   | 95            | HSTC_TX_p13                   | HSMC_TX_p3                    | GPIO26                   |
| 32                                   | 108           | HSTC_RX_p15                   | HSMC_RX_p1                    | GPIO27                   |
| 33                                   | 99            | HSTC_TX_n14                   | HSMC_TX_n2                    | GPIO28                   |
| 34                                   | 112           | HSTC_RX_n16                   | HSMC_RX_n0                    | GPIO29                   |
| 35                                   | 101           | HSTC_TX_p14                   | HSMC_TX_p2                    | GPIO30                   |
| 36                                   | 114           | HSTC_RX_p16                   | HSMC_RX_p0                    | GPIO31                   |
| 37                                   | 105           | HSTC_TX_n15                   | HSMC_TX_n1                    | GPIO32                   |
| 38                                   | 111           | HSTC_TX_n16                   | HSMC_TX_n0                    | GPIO33                   |
| 39                                   | 107           | HSTC_TX_p15                   | HSMC_TX_p1                    | GPIO34                   |
| 40                                   | 113           | HSTC_TX_p16                   | HSMC_TX_p0                    | GPIO35                   |

Table 3.3 Pin mappings of the expansion prototype connector J4

# Board Components

| Expansion Prototype Connector 1 – J4 |               |                               |                               |                          |
|--------------------------------------|---------------|-------------------------------|-------------------------------|--------------------------|
| J4 Pin Number                        | J1 Pin Number | J1 (HSTC Version) Signal Name | J1 (HSMC Version) Signal Name | DE2/DE1 GPIO Signal Name |
| 1                                    | 133           | HSTC_TX_n18                   | ND                            | GPIO0                    |
| 2                                    | 134           | HSTC_RX_n18                   | ND                            | GPIO1                    |
| 3                                    | 135           | HSTC_TX_p18                   | HSMC_TXVR_TXn0                | GPIO2                    |
| 4                                    | 136           | HSTC_RX_p18                   | HSMC_TXVR_RXn0                | GPIO3                    |
| 5                                    | 137           | HSTC_TX_n19                   | HSMC_TXVR_TXp0                | GPIO4                    |
| 6                                    | 138           | HSTC_RX_n19                   | HSMC_TXVR_RXp0                | GPIO5                    |
| 7                                    | 139           | HSTC_TX_p19                   | ND                            | GPIO6                    |
| 8                                    | 140           | HSTC_RX_p19                   | ND                            | GPIO7                    |
| 9                                    | 141           | HSTC_TX_n20                   | HSMC_TXVR_TXn1                | GPIO8                    |
| 10                                   | 142           | HSTC_RX_n20                   | HSMC_TXVR_RXn1                | GPIO9                    |
| 11                                   | N/A           | N/A                           | N/A                           | 5V                       |
| 12                                   | N/A           | N/A                           | N/A                           | GND                      |
| 13                                   | 143           | HSTC_TX_p20                   | HSMC_TXVR_TXp1                | GPIO10                   |
| 14                                   | 144           | HSTC_RX_p20                   | HSMC_TXVR_RXp1                | GPIO11                   |
| 15                                   | 145           | HSTC_TX_n21                   | ND                            | GPIO12                   |
| 16                                   | 146           | HSTC_RX_n21                   | ND                            | GPIO13                   |
| 17                                   | 147           | HSTC_TX_p21                   | HSMC_TXVR_TXn2                | GPIO14                   |
| 18                                   | 148           | HSTC_RX_p21                   | HSMC_TXVR_RXn2                | GPIO15                   |
| 19                                   | 149           | HSTC_TX_n22                   | HSMC_TXVR_TXp2                | GPIO16                   |
| 20                                   | 150           | HSTC_RX_n22                   | HSMC_TXVR_RXp2                | GPIO17                   |
| 21                                   | 151           | HSTC_TX_p22                   | ND                            | GPIO18                   |
| 22                                   | 152           | HSTC_RX_p22                   | ND                            | GPIO19                   |
| 23                                   | 153           | HSTC_TX_n23                   | HSMC_TXVR_TXn3                | GPIO20                   |
| 24                                   | 154           | HSTC_RX_n23                   | HSMC_TXVR_RXn3                | GPIO21                   |
| 25                                   | 155           | HSTC_TX_p23                   | HSMC_TXVR_TXp3                | GPIO22                   |
| 26                                   | 156           | HSTC_RX_p23                   | HSMC_TXVR_RXp3                | GPIO23                   |
| 27                                   | 157           | HSTC_TX_n24                   | ND                            | GPIO24                   |
| 28                                   | 158           | HSTC_RX_n24                   | ND                            | GPIO25                   |
| 29                                   | N/A           | N/A                           | N/A                           | 3.3V                     |
| 30                                   | N/A           | N/A                           | N/A                           | GND                      |
| 31                                   | 159           | HSTC_TX_p24                   | HSMC_TXVR_TXn4                | GPIO26                   |
| 32                                   | 160           | HSTC_RX_p24                   | HSMC_TXVR_RXn4                | GPIO27                   |
| 33                                   | 161           | HSTC_TX_n25                   | HSMC_TXVR_TXp4                | GPIO28                   |
| 34                                   | 166           | HSTC_RX_n26                   | HSMC_TXVR_RXn5                | GPIO29                   |
| 35                                   | 163           | HSTC_TX_p25                   | ND                            | GPIO30                   |
| 36                                   | 168           | HSTC_RX_p26                   | HSMC_TXVR_RXp5                | GPIO31                   |
| 37                                   | 165           | HSTC_TX_n26                   | HSMC_TXVR_TXn5                | GPIO32                   |
| 38                                   | 162           | HSTC_TX_n25                   | HSMC_TXVR_RXp4                | GPIO33                   |
| 39                                   | 167           | HSTC_TX_p26                   | HSMC_TXVR_TXp5                | GPIO34                   |
| 40                                   | 164           | HSTC_TX_p25                   | ND                            | GPIO35                   |



## Cyclone III Starter Board HSMC Connector

The naming convention used to assign the pin names for the HSMC connector is different for the Cyclone III Starter Board and the standard HSMC connector. Figure 3.4 shows the pin-outs of the expansion prototype connectors for Cyclone III Starter board HSMC version.

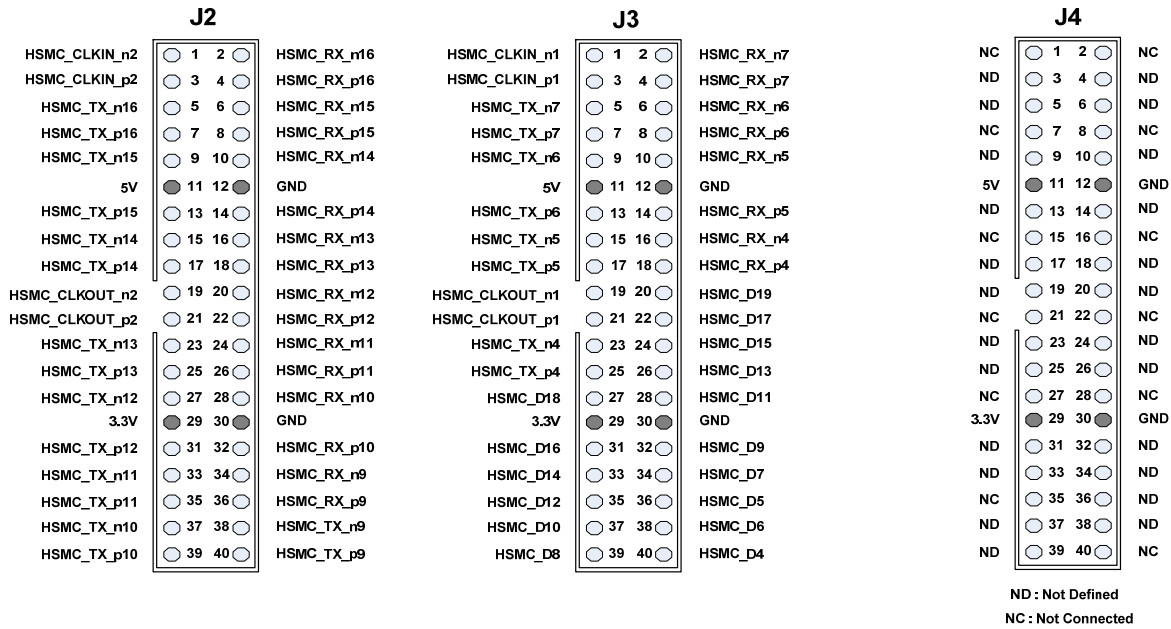


Figure 3.4 Pin-outs of the expansion prototype connectors for Cyclone III Starter board **HSMC** version

## Prototyping Area

The THDB-HTG board provides users a prototyping area for signal measurement or debug. These prototyping points are connected to the HSTC/HSMC connector directly. Detailed I/O maps for HSTC and HSMC version are provided to help users locate the corresponding prototyping points, as shown in Figure 3.4 and Figures 3.5, respectively.

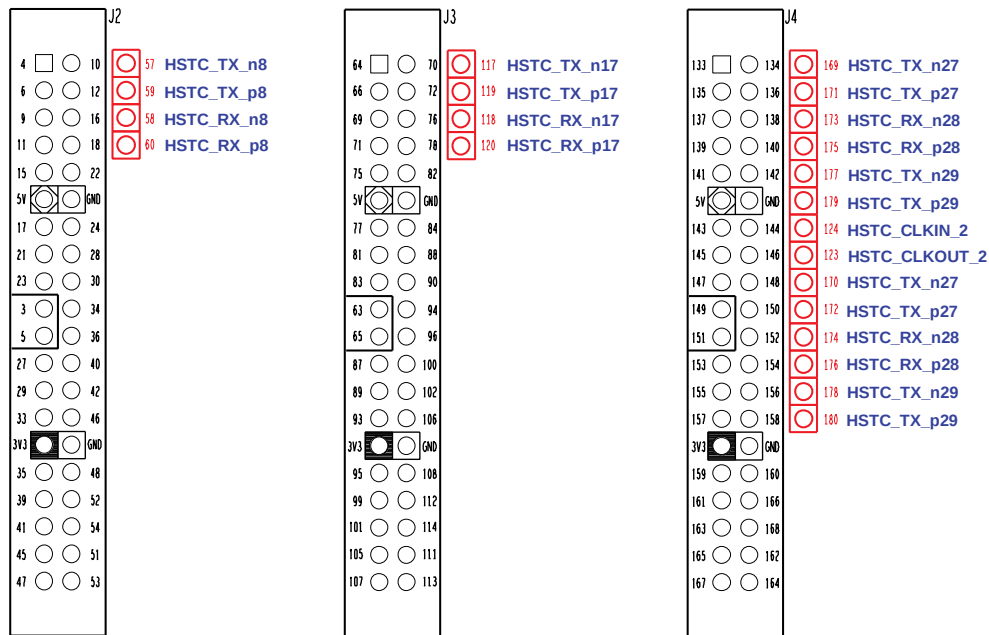


Figure 3.4 Pin distribution of the prototype area for TDHB-HTG **HSTC** version

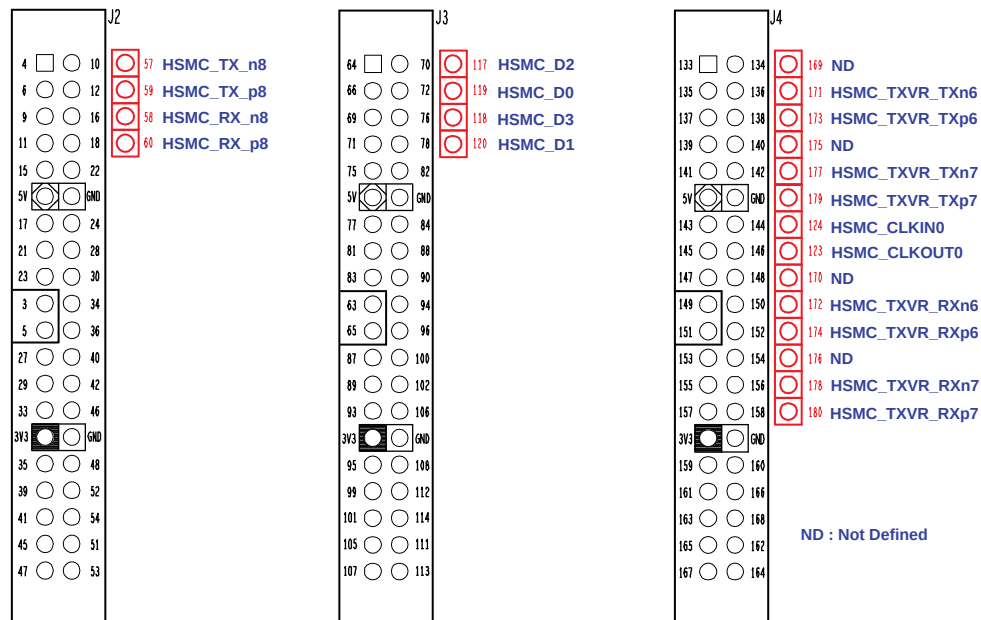


Figure 3.5 Pin distribution of the prototype area for TDHB-HTG **HSMC** version

## JTAG Switch

The THDB-HTG board provides a JTAG switch (SW1) to short the JTAG signal “HSTC\_TDI” and “HSTC\_TDO” together. When the THDB-HTG board is connected to a HSTC host board, this feature can bypass the JTAG signal from host board to form a close loop of JTAG chain. For example, if users connect a THDB-HTG with Altera DE3 board, this switch must be turned on, or the Stratix III FPGA device will not be detected because the JTGA chain is not a close loop on DE3 board. Figure 3.6 shows the JTAG switch being turned on.

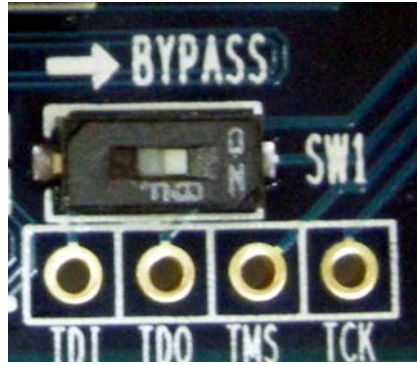


Figure 3.6 The JTAG Switch in “ON” position

## Power ON Control Pin

Pin 121 of the HSTC connector is defined as a “Power ON” control signal. This signal allows host board to turn on/off the power supply on THDB-HTG board. When the Power ON signal is in logic low level, the 3.3V and 5V on the expansion header will not supply any power. This feature is designed for THDB-HTG HSTC version only.

## I2C Serial EEPROM

This section describes the I2C Serial EEPROM on the THDB-HTG board

The THDB-HTG board provides a Microchip 24LC02BT EEPROM (U1) which can be configured by the I2C interface. The size of the EEPROM is 2K-bit that can store the board information or user’s data. The detailed pin description between EEPROM and HSMC connector is listed in the Table 3.4.

Table 3.4 The pin assignments of the I2C serial EEPROM

| EEPROM<br>Pin Number | EEPROM<br>Signal Name | HSMC Pin<br>Number |
|----------------------|-----------------------|--------------------|
| U1-1                 | A0                    | N/A                |
| U1-2                 | A1                    | N/A                |
| U1-3                 | A2                    | N/A                |
| U1-4                 | GND                   | N/A                |
| U1-5                 | HSTC_SDA              | J1-131             |
| U1-6                 | HSTC_SCL              | J1-132             |
| U1-7                 | WP                    | N/A                |
| U1-8                 | VCC33 (3.3 volts)     | N/A                |

## Power Supply

This section describes the power supply on the THDB-HTG board.

The power distribution on the THDB-HTG board is shown in Figure 3.7.

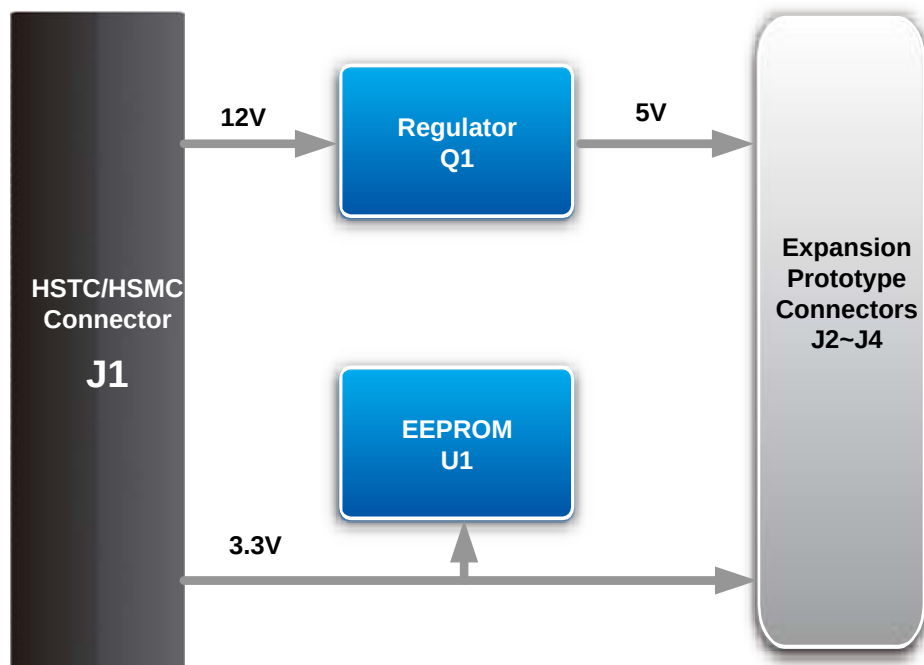


Figure 3.7 THDB-HTG board power distribution diagram.

# 4 Demonstration

This chapter illustrates how to use the THDB-HTG board to a HSMC-interfaced host board.

## Connecting THDB-HTG Board to a Cyclone III Starter Board

This section describes how to use the THDB-HTG board with a Cyclone III Starter Board.

Figure 4.1 illustrates how the THDB-HTG board is connected to the Cyclone III starter board. Users need to pay extra attention to the following two points:

1. Observe the orientation of the HSMC connector when connecting the THDB-HTG to the Cyclone III Starter Board.
2. Note that there are two LVDS pairs on the HSMC connector: the HSMC\_CLK\_p1/n1 (form a close loop via R3) and HSMC\_CLKIN\_p2/n2 (form a close loop via R4). Therefore, using any one of the signal in a LVDS pair under single-ended mode will prevent users from using the other signal in the same pair.

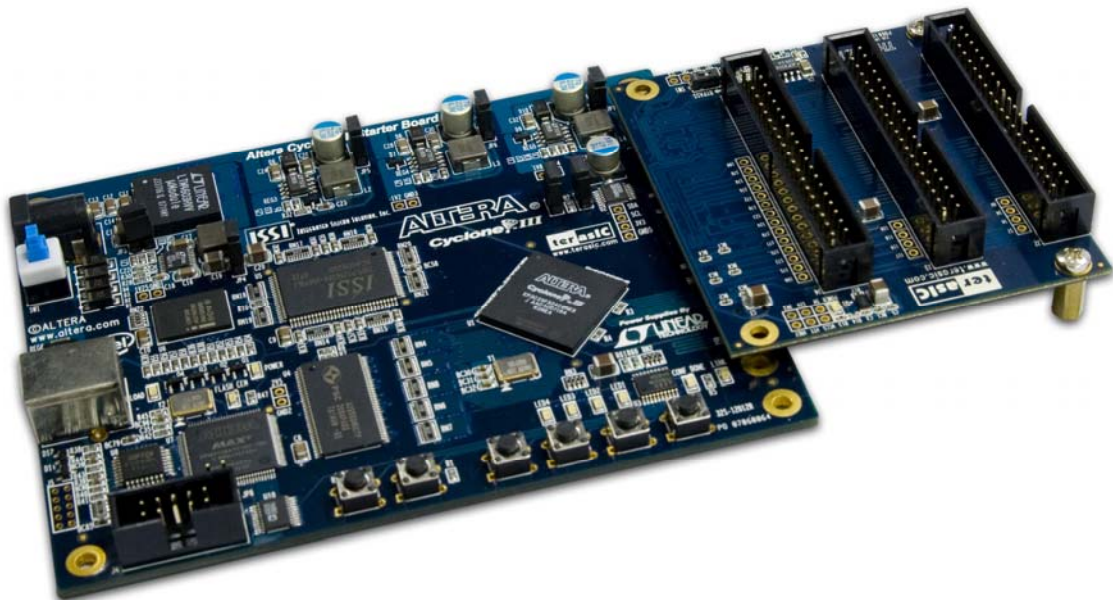


Figure 4.1 Connecting the THDB-HTG board to the Cyclone III starter board

## Connecting THDB-HTG Board to Altera DE3 Board

This section describes how to use the THDB-HTG board with Altera DE3 Board.

Figure 4.2 illustrates how the THDB-HTG board is connected to the Altera DE3 board. Users need to pay extra attention to the following three points:

1. THDB-HTG board can be connected to any of the HSTC connectors J1, J3, J5, and J7 on the DE3 board.
2. The JTAG Switch on the THDB-HTG board **MUST** be switched to “Bypass” position, or the FPGA device on DE3 board will not be detected.
3. Users can use DE3\_System\_builder to create Quartus II project. Please refer to Figure 3.2 for the corresponding signal names.

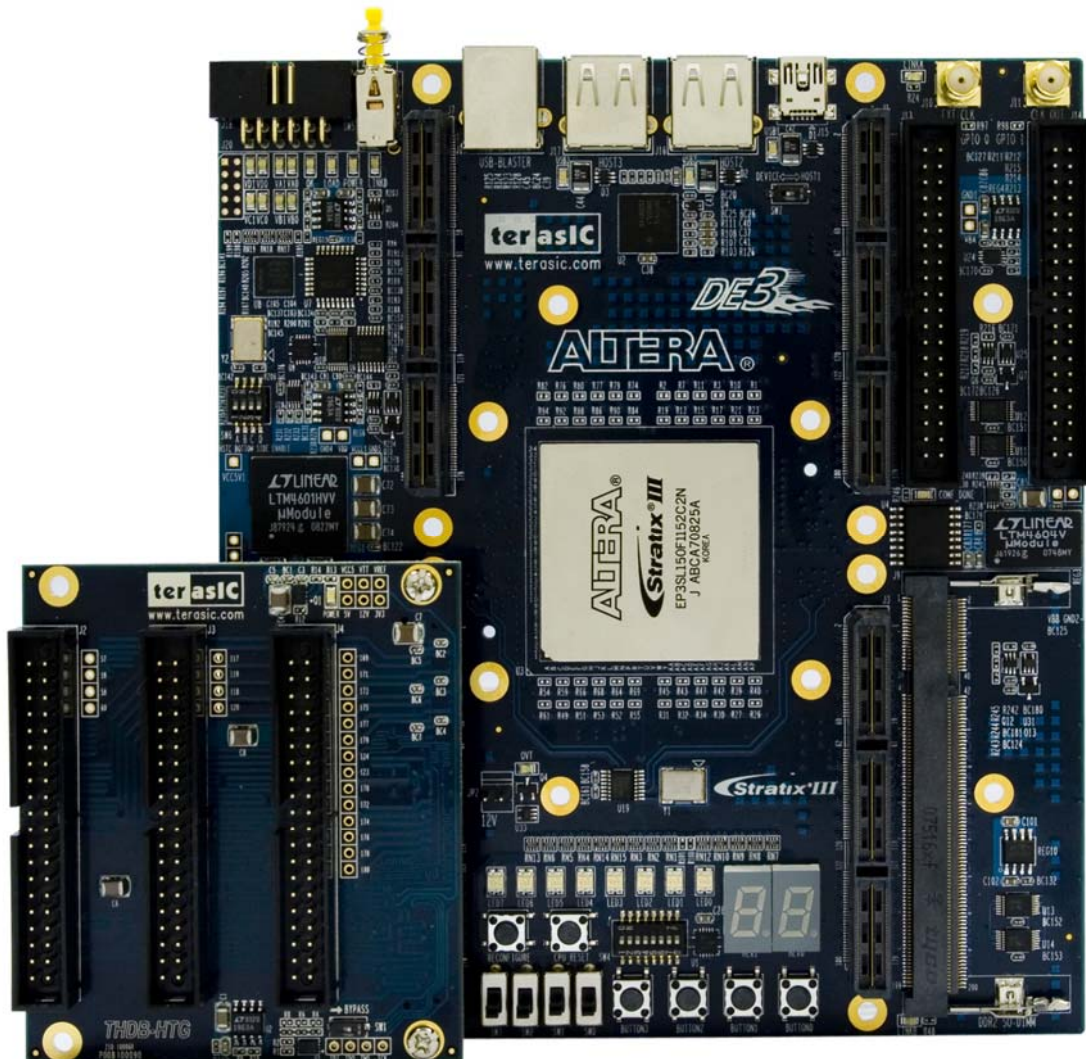


Figure 4.2 Connecting the THDB-HTG board to the Cyclone III starter board



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## Revision History

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| Date           | Change Log                                                              |
|----------------|-------------------------------------------------------------------------|
| JAN 04, 2009   | Initial Version                                                         |
| Oct 20, 2009   | Added Cyclone III Starter Board HSMC Connector section                  |
| April 08, 2010 | Modified pin names for Cyclone III Starter Board HSMC Connector section |
| Dec 24, 2010   | Corrected Table 3.1 Pin Mapping                                         |
| July 20, 2011  | Change cover page                                                       |

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## Always Visit THDB-HTG Webpage for New Main board

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We will be continuing providing interesting examples and labs on our THDB-HTG webpage. Please visit [www.altera.com](http://www.altera.com) or [HTG.terasic.com](http://HTG.terasic.com) for more information.