

**JABIL Technology Services** **Design Services**

**Hat Trick CPLD**

**Specification**

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# Introduction

## Document Purpose

This document provides the information needed to implement the functionality required of the Hat Trick CPLD. The information contained in this document, along with information contained in the referenced documents, is intended to provide all the information needed to design and develop the CPLD code.

## Intended Audience

This document is primarily intended for the development team responsible for designing and implementing the CPLD code, and for the test team responsible for validating the operation of the CPLD’s operation. Additionally, this document provides the information necessary for those using the CPLD.

## Document Scope

The requirements contained in this document are limited to the code used to program the Lattice LCMX02 CPLD present on the Hat Trick.

# References, Definitions, Abbreviations, and Conventions

## References

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Document Name** | **Version/Date** | **Author/Issuer** |
| 1 | *Technical Note TN1204*  *MachX02 Programming and Configuration Usage Guide* | February 2012 | Lattice Semiconductor |
| 2 | *UM10204 - I2C-Bus Specification and User Manual* | Rev. 03  19 June 2007 | NXP |

## Definitions and Abbreviations

| Term | Meaning |
| --- | --- |
| CPLD | **C**omplex **P**rogrammable **L**ogic **D**evice |
| Drive Slot | The opening in a storage enclosure that accepts a drive with paddle. |
| SGPIO | **S**erial **G**eneral **P**urpose **I**nput/**O**utput |
| I2C | **I**nter **I**ntegrated **C**ircuit |
| HDD | **H**ard **D**isk **D**rive |
| HT CPLD | **H**at**T**rick **C**PLD |
| ISP | **I**n **S**ystem **P**rogramming |
| PCBA | **P**rinted **C**ircuit **B**oard **A**ssembly |
| SAS | **S**erial **A**ttach **S**CSI |
| SSD | **S**olid-**S**tate **D**rive |
| PCIe | **P**eripheral **C**omponent **I**nterconnect **E**xpress |
| NVMe | **N**on-**V**olatile **M**emory **E**xpress |

## Keywords

These keywords generally follow the definitions for such terms as outlined in IETF RFC-2119.

expected: A keyword used to describe the behavior of the hardware or software in the design models assumed by this specification.

invalid: A keyword used to describe an illegal or unsupported bit, byte, word, field or code value. Receipt of an invalid bit, byte, word, field or code value shall be reported as an error.

mandatory: A keyword indicating an item that is required to be implemented as defined in this specification.

may: A keyword that indicates flexibility of choice with no implied preference (equivalent to “may or may not”).

may not: Keywords that indicates flexibility of choice with no implied preference (equivalent to “may or may not”).

obsolete: A keyword indicating that an item was defined in prior specifications but has been removed from this specification.

optional: A keyword that describes features that are not required to be implemented to adhere to this specification. However, if an optional feature defined in this specification is implemented, it shall be implemented as defined in this specification.

reserved: A keyword referring to bits, bytes, words, fields or code values that are set aside for future use. Their use and interpretation may be defined by future revisions of this specification. A reserved bit, byte, word, field or code value shall be set to zero. Recipients are not required to check reserved bits, bytes, words, fields or code values. Receipt of reserved code values in defined fields shall be reported as an error.

shall: A keyword indication a mandatory requirement (equivalent to “is required to”).

should A keyword indicating flexibility of choice with a strongly preferred alternative; equivalent to the phrase “it is strongly recommended”.

## Editorial Conventions

Certain words and terms used in this specification had a specific meaning beyond the normal English meaning. These words or terms are defined in section 2.2 of this document or in the text where they first appear. Names of signals, phases, messages, commands, statuses, and other qualifiers are in all uppercase (e.g., REQUEST SENSE). Names of fields are in low uppercase (e.g., state or spare). Lower case is used for words having normal English meaning.

Fields that are only one bit are usually referred to as the name bit instead of the name field.

Numbers that are not immediately followed by a lower-case b or h are decimal values.

Numbers immediately followed by lower-case b (e.g., nnb) are binary values.

Numbers immediately followed by lower-case h (e.g., nnh) or are preceded with a 0x (e.g., 0xnn) are hexadecimal values.

Decimals are indicated with a period (e.g., two and one half is represented as 2.5)

Decimal numbers have a value exceeding 999 are represented with a space (e.g., 24 375)

An alphanumeric list (e.g., a,b,c or A,B,C) of items indicate that the items in the list are unordered, while a numeric list (e.g., 1,2,3) items indicate that the items in the list are ordered (i.e., item 1 must occur or complete before item 2)

In the event of conflicting information the precedence for requirements defined in this specification is:

1. text,
2. tables, then
3. figures.

# Overall Description

## Product Perspective

The HatTrick CPLDs provide I/O signal expansion for Jabil HatTrick product which is a high density storage enclosure for Open Compute Project. It can support 3.5” large form factor (LFF) SAS/SATA drives arranged 3 row x 5 column array.

## Product Functions

The HatTrick CPLDs provide support for increasing I/O capacity:

* 15 drive slots supporting SAS with SFF 8680 connectors contains:

HDDn\_INSERT\_L

PWR\_EN\_HDDn\_L

P5V\_GD\_HDDn

P12V\_GD\_HDDn

HDDn\_Health\_LED

HDDn\_FAULT\_LED

* 2 MiniSAS HD Module contains:

A/B\_MODPRESL

A/B\_INTL

A/B\_VMAN\_EN\_L

A/B\_VACT \_EN\_L

A/B\_VACT\_OC\_L

A/B\_Health\_LED\_L

A/B\_FAULT\_LED

* Enclosure and side plane signals

## Operating Environment

A Lattice Semiconductor MachXO2 FPGA family device shall be used as the CPLD packaged in a 256 BGA.

## Design and Implementation Constraints

There are no design or implementation constraints (such as corporate or regulatory policies, hardware limitations (timing requirements, memory requirements), interfaces to other applications, specific technologies, tools, and databases to be used, parallel operations, language requirements, communications protocols, security considerations, design conventions or programming standards, etc.) other than those imposed by other requirements specified in this document.

## User Documentation

There is no user documentation required to be developed in conjunction with the CPLD code.

## Assumptions and Dependencies

There are no specific assumed factors (as opposed to known facts) that could affect the requirements stated in this document.

# Interface Requirements

## Hardware Interfaces

The table below listing the signals is for the Hat Trick CPLD.

|  |  |  |  |
| --- | --- | --- | --- |
| Pin +B3:E42# | I/O Type | Function | Description |
|  | IN | HDD1\_INSERT\_L | L: Drive insert; H: No Drive Inserted |
|  | OD | PWR\_EN\_HDD1\_L | if HDD#\_INSERT\_L is Low,set it as Low to enable HDD 12V/5V |
|  | IN | P5V\_GD\_HDD1 | H: HDD 5V is ok |
|  | IN | P12V\_GD\_HDD1 | H: HDD 12V is ok |
|  | OUT | HDD1\_Health\_LED | H: Drive Online and Healthy; L: No Drive Inserted or Drive Failure |
|  | OUT | HDD1\_FAULT\_LED | H: Drive Failure; L: No Drive Inserted or Drive Online and Healthy |
|  |  |  |  |
|  | IN | HDD2\_INSERT\_L |  |
|  | OD | PWR\_EN\_HDD2\_L |  |
|  | IN | P5V\_GD\_HDD2 |  |
|  | IN | P12V\_GD\_HDD2 |  |
|  | OUT | HDD2\_Health\_LED |  |
|  | OUT | HDD2\_FAULT\_LED |  |
|  |  |  |  |
|  | IN | HDD3\_INSERT\_L |  |
|  | OD | PWR\_EN\_HDD3\_L |  |
|  | IN | P5V\_GD\_HDD3 |  |
|  | IN | P12V\_GD\_HDD3 |  |
|  | OUT | HDD3\_Health\_LED |  |
|  | OUT | HDD3\_FAULT\_LED |  |
|  |  |  |  |
|  | IN | HDD4\_INSERT\_L |  |
|  | OD | PWR\_EN\_HDD4\_L |  |
|  | IN | P5V\_GD\_HDD4 |  |
|  | IN | P12V\_GD\_HDD4 |  |
|  | OUT | HDD4\_Health\_LED |  |
|  | OUT | HDD4\_FAULT\_LED |  |
|  |  |  |  |
|  | IN | HDD5\_INSERT\_L |  |
|  | OD | PWR\_EN\_HDD5\_L |  |
|  | IN | P5V\_GD\_HDD5 |  |
|  | IN | P12V\_GD\_HDD5 |  |
|  | OUT | HDD5\_Health\_LED |  |
|  | OUT | HDD5\_FAULT\_LED |  |
|  |  |  |  |
|  | IN | HDD6\_INSERT\_L |  |
|  | OD | PWR\_EN\_HDD6\_L |  |
|  | IN | P5V\_GD\_HDD6 |  |
|  | IN | P12V\_GD\_HDD6 |  |
|  | OUT | HDD6\_Health\_LED |  |
|  | OUT | HDD6\_FAULT\_LED |  |
|  |  |  |  |
|  | IN | HDD7\_INSERT\_L |  |
|  | OD | PWR\_EN\_HDD7\_L |  |
|  | IN | P5V\_GD\_HDD7 |  |
|  | IN | P12V\_GD\_HDD7 |  |
|  | OUT | HDD7\_Health\_LED |  |
|  | OUT | HDD7\_FAULT\_LED |  |
|  |  |  |  |
|  | IN | HDD8\_INSERT\_L |  |
|  | OD | PWR\_EN\_HDD8\_L |  |
|  | IN | P5V\_GD\_HDD8 |  |
|  | IN | P12V\_GD\_HDD8 |  |
|  | OUT | HDD8\_Health\_LED |  |
|  | OUT | HDD8\_FAULT\_LED |  |
|  |  |  |  |
|  | IN | HDD9\_INSERT\_L |  |
|  | OD | PWR\_EN\_HDD9\_L |  |
|  | IN | P5V\_GD\_HDD9 |  |
|  | IN | P12V\_GD\_HDD9 |  |
|  | OUT | HDD9\_Health\_LED |  |
|  | OUT | HDD9\_FAULT\_LED |  |
|  |  |  |  |
|  | IN | HDD10\_INSERT\_L |  |
|  | OD | PWR\_EN\_HDD10\_L |  |
|  | IN | P5V\_GD\_HDD10 |  |
|  | IN | P12V\_GD\_HDD10 |  |
|  | OUT | HDD10\_Health\_LED |  |
|  | OUT | HDD10\_FAULT\_LED |  |
|  |  |  |  |
|  | IN | HDD11\_INSERT\_L |  |
|  | OD | PWR\_EN\_HDD11\_L |  |
|  | IN | P5V\_GD\_HDD11 |  |
|  | IN | P12V\_GD\_HDD11 |  |
|  | OUT | HDD11\_Health\_LED |  |
|  | OUT | HDD11\_FAULT\_LED |  |
|  |  |  |  |
|  | IN | HDD12\_INSERT\_L |  |
|  | OD | PWR\_EN\_HDD12\_L |  |
|  | IN | P5V\_GD\_HDD12 |  |
|  | IN | P12V\_GD\_HDD12 |  |
|  | OUT | HDD12\_Health\_LED |  |
|  | OUT | HDD12\_FAULT\_LED |  |
|  |  |  |  |
|  | IN | HDD13\_INSERT\_L |  |
|  | OD | PWR\_EN\_HDD13\_L |  |
|  | IN | P5V\_GD\_HDD13 |  |
|  | IN | P12V\_GD\_HDD13 |  |
|  | OUT | HDD13\_Health\_LED |  |
|  | OUT | HDD13\_FAULT\_LED |  |
|  |  |  |  |
|  | IN | HDD14\_INSERT\_L |  |
|  | OD | PWR\_EN\_HDD14\_L |  |
|  | IN | P5V\_GD\_HDD14 |  |
|  | IN | P12V\_GD\_HDD14 |  |
|  | OUT | HDD14\_Health\_LED |  |
|  | OUT | HDD14\_FAULT\_LED |  |
|  |  |  |  |
|  | IN | HDD15\_INSERT\_L |  |
|  | OD | PWR\_EN\_HDD15\_L |  |
|  | IN | P5V\_GD\_HDD15 |  |
|  | IN | P12V\_GD\_HDD15 |  |
|  | OUT | HDD15\_Health\_LED |  |
|  | OUT | HDD15\_FAULT\_LED |  |
|  |  |  |  |
|  | IN | A\_MODPRESL | L: MiniSAS HD cable module insert; H: No Inserted |
|  | IN | A\_INTL | L: An event has occurred that requires interrupt service; H: no interrupt |
|  | OD | A\_VMAN\_EN\_L | L: MiniSAS HD Module power enable for device management |
|  | OD | A\_VACT \_EN\_L | L: MiniSAS HD Module power enable for Active cable |
|  | IN | A\_VACT\_OC\_L | L: MiniSAS HD Module power enable for Active cable over current |
|  | OUT | A\_Health\_LED\_L | L: SAS links (x4) health, H: No link or Loss of SAS links (x1 ~x3) |
|  | OUT | A\_FAULT\_LED | H: Loss of SAS links (x1 ~x3), L: No SAS links or SAS links (x4) health |
|  |  |  |  |
|  | IN | B\_MODPRESL |  |
|  | IN | B\_INTL |  |
|  | OD | B\_VMAN\_EN\_L |  |
|  | OD | B\_VACT \_EN\_L |  |
|  | IN | B\_VACT\_OC\_L |  |
|  | OUT | B\_Health\_LED\_L |  |
|  | OUT | B\_FAULT\_LED |  |
|  |  |  |  |
|  | OUT | Enclosure\_Health\_LED\_L | L: Normal System Operation; PWM: Sled Identify; H: Others |
|  | OUT | Enclosure \_Fault\_LED | H: Any failure in whole enclosure; PWM: Reserved for future use; L: Others |
|  |  |  |  |
|  | IN | I2C\_CLK | connect to SAS3x24 Exp I2C bus1 |
|  | BI | I2C\_DATA | connect to SAS3x24 Exp I2C bus1 |
|  | OD | I2C\_ALERT\_L | connect to SAS3x24 Exp GPIO, L: An event has occurred required Exp to read CPLD status |
|  |  |  |  |
|  | IN | Sled\_in\_Chassis | H: Sled is inside the chassis; L: Sled is pulling out |
|  |  |  |  |
|  | IN | RST\_CPLD\_L | L: Reset CPLD |
|  | IN | sideplane HW reversion bit0 | sideplane HW reversion: P0(00)/P1(01)/P2(10) |
|  | IN | sideplane HW reversion bit1 | sideplane HW reversion: P0(00)/P1(01)/P2(10) |

## Communication Interfaces

### I2C Ports

The I2C ports on the CPLD shall provide an I2C-bus interface that is compliant with the *I2C-Bus Specification and User Manual* [REF 2] and operate under the following parameters:

* Only I2C Slave bus operations shall be supported.
* The I2C Slave address shall be:
  + I2C Ports C2/C3h
  + I2C programming Port: 80/81h
* The bus speed shall be Standard-mode (Sm), with a bit rate of 100kbits/s.
* Only 7-bit addressing shall be used. 10-bit addressing shall not be supported.
* General call address shall not be supported.
* Software reset shall not be supported.

## Software Interfaces

There are no software interface requirements for the CPLD.

# Other Requirements

## CPLD Programming

The CPLD shall support the following Lattice MachX02 programming and configuration modes (refer to *MachX02 Programming and Configuration Usage Guide* [REF 1]):

* JTAG (using the CPLD ispJTAG port)
* I2C (using the CPLD I2C Update Port)

## ISP (in-system programming) online mode with PC

Before starting to program the CPLD, the user must connect to the CPLD JTAG connector on the baseboard to a PC with ispDOWNLOAD Cable HW-USBN-2A. Power on main board, and enter standby mode or working mode for supply power to CPLD device.

User get ready for compiled JED format image, and programs JED file into HDDS CPLD device via Lattice ispVM system. For more information, refer to the document “UG48 ispDOWNLOAD Cable user’s Guide” about ispVM system in lattice website.

The standard JTAG header pin-out and description is shown in the table below.

|  |  |  |  |
| --- | --- | --- | --- |
| **ispDOWNLOAD Cable Pin Definitions** | **Name** | **Pin Type** | **Description** |
| VCC | Programming Voltage | Input | Connect to VCC plane of the target device. Typical ICC = 10mA. The board design supplies the power for VCC. |
| TDO | Test Data Output | Input | Used to shift data out via the IEEE1149.1 (JTAG) programming standard. |
| TDI | Test Data Input | Output | Used to shift data in via the IEEE1149.1 programming standard. |
| ispEN/PROG | Enable | Output | Enable device to be programmed. |
| TMS | Test Mode Select Input | Output | Used to control the IEEE1149.1 state machine. |
| GND | Ground | Input | Connect to ground plane of the target device |
| TCK | Test Clock Input | Output | Used to clock the IEEE1149.1 state machine |
| INIT | Initialize | Input | Indicates that ORCA device is ready for configuration. |
| DONE | Done | Input | An open-collector signal that indicates when configuration is complete. |

## ISP (in-system programming) online mode with SXP/SEP

The SXP/SEP on controller/IOM canister can upgrade the Baseboard CPLD using the I2C bus. The SXP/SEP will support this function only when System is on. To activate the fresh image downloaded into CPLD internal flash, SXP/SEP shall send the REFRESH command by using I2C, after complete to download the entire data into CPLD.

Refer to CPLD upgrade portion of the Controller/IOM SAS specification.