

## FEATURES

- Altera Cyclone V - U672 SoC
  - **Up To Dual ARM Cortex- A9 MPU**
  - 925MHz Max clock speed
  - Dual NEON SIMD Coprocessors
  - 32 KB L1 Program Cache (per core)
  - 32 KB L1 Data Cache (per core)
  - 512 KB L2 Cache (shared)
  - 64 KB on-chip RAM
  - ECC Support
  - **Up To 133 User FPGA I/O Pins**
  - **44 CPU I/O Pins**
  - **6 High speed transceivers (SX only)**
- **Cyclone V Processor Choices**
  - Cyclone V SX (3.125 Gbps transceivers)
  - Cyclone V SE
- **Memory**
  - Up To 2GB DDR3 CPU RAM  
x32 bits + ECC
  - Up To 512MB DDR3 FPGA RAM  
x8 bits (optional)
  - Up To 48MB QPSI NOR FLASH
- Integrated Power Management
- JTAG connector on-module
- **FPGA Fabric**
  - Up To 110K Logic Elements (LE)
  - 460Mhz Global Clock
  - Up To 5.1Mb M10K Memory
  - Up To 621Kb MLAB Memory
  - Up To 112 DSP Blocks
  - Up To 6 FPGA PLLs
  - Fractional PLL Outputs on each PLL
- Low Power Serial Transceivers (**SX only**)
  - 3.125Gbps Transceivers
  - PCIe Hard IP Block  
(Gen1.1 x1 or x4)
- Power, Reset and Clock Management



- **Mechanical**
  - 314-Pin Card Edge Connector
  - Small 82mm (3.2") x 39mm (1.5") size
- **Hard Processor System (HPS)**
  - Selection of boot sources
  - Up to 2 10/100/1000 Mbps RGMII
  - Up to 2 USB 2.0 OTG Ports
  - Up to 2 CAN Interfaces
  - Up to 2 UARTs
  - 1 MMC/SD/SDIO
  - Up to 4 I2C controllers
  - Up to 2 master/2 slave SPI
  - 3 HPS PLLs

## APPLICATIONS

- Machine Vision
- Test and Measurement
- Embedded Instrumentation
- Industrial Automation and Control
- Industrial Instrumentation
- Medical Instrumentation
- Closed Loop Motor Control

## BENEFITS

- Rapid Development / Deployment
- Multiple Connectivity and I/O Options
- Rich User Interfaces
- High System Integration
- High Level OS Support
  - Embedded Linux
  - Micrium uC/OS (via 3<sup>rd</sup> Party)
  - Android (via 3<sup>rd</sup> Party)
  - QNX (via 3<sup>rd</sup> Party)

## DESCRIPTION

The MitySOM-5CSx series of highly configurable, small form-factor System-on-Modules (SoM) feature an Altera Cyclone V System-on-Chip (SoC). Additionally the module includes on-board power supplies, NOR FLASH and DDR3 RAM memory subsystems. A MitySOM-5CSx provides a complete and flexible CPU infrastructure for highly integrated embedded systems.

The MitySOM-5CSX is available with either a Cyclone V SX or Cyclone V SE which provide up-to Dual-core Cortex-A9 32-bit RISC processors with dual NEON SIMD coprocessors. This MPU is capable of running a rich set of real-time operating systems containing software applications programming interfaces (APIs) expected by modern system designers. The ARM architecture supports several operating systems, including Linux, Micrium uC/OS, Android and QNX.

### MitySOM 5CSx System On Module Block Diagram

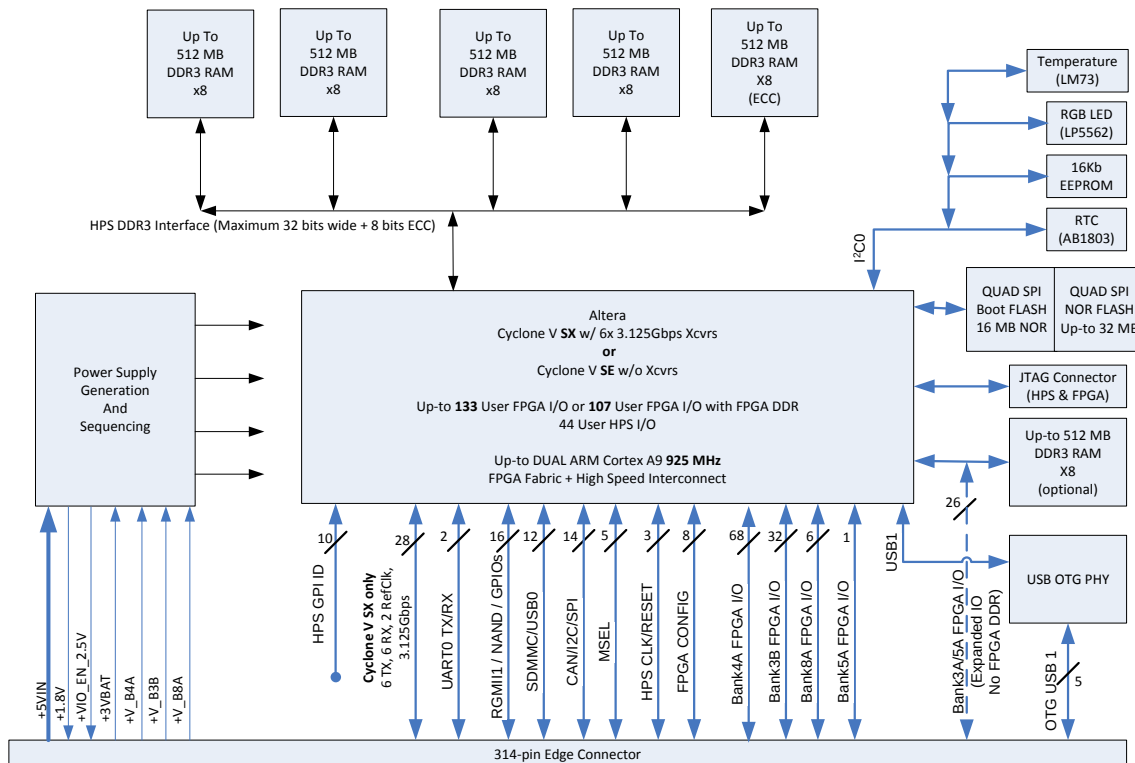


Figure 1 MitySOM-5CSx Block Diagram

Figure 1 provides a top level block diagram of the MitySOM-5CSx processor card. As shown in the figure, the primary interface to the MitySOM-5CSx is through a 314-Pin card edge interface. Details of the edge connector interface are included in the Card Edge Interface Description section.

## **MitySOM-5CSx Onboard Storage**

### **DDR3 Memory – HPS Memory**

The MitySOM-5CSx includes one dedicated 40-bit DDR3 memory interface. The memory interface can be up-to 40-bits wide including 8-bits for ECC. A maximum of 2GB of DDR3 RAM with ECC is supported by the MitySOM-5CSx module.

The standard MitySOM-5CSX includes 1GB of DDR3 RAM with ECC (40-bits wide) integrated on the module.

The standard MitySOM-5CSE includes 512MB of DDR3 RAM without ECC (16-bits wide) integrated on the module with options for additional memory configurations.

This HPS DDR3 memory is available for both the HPS (Cortex-A9 ARM core(s)) as well as the FPGA fabric through either the AXI or Avalon high speed interfaces internal to the Cyclone V.

See Table 9: Standard Model Numbers for additional details.

### **DDR3 Memory – FPGA Memory (Optional)**

The MitySOM-5CSx modules can also include up to 512MB of DDR3 connected directly to the Cyclone V FPGA fabric. This memory is exclusively for the use of the FPGA fabric for buffering and local storage and is available through a high speed, low latency direct connect.

A total of 26 additional FPGA I/O is available through the card edge connector in models that do not feature the FPGA DDR3 memory. See Table 9: Standard Model Numbers for additional details.

### **HPS-FPGA AXI**

The high bandwidth HPS-FPGA AXI bridges provided by Altera in the Cyclone V SoC allow masters in the FPGA fabric to communicate with slaves in the HPS logic and vice versa. These bridges can be configured for 32, 64, or 128 bit widths.

For example, designers can instantiate additional memories or peripherals in the FPGA fabric, and master interfaces belonging to components in the HPS logic can access them. Designers can also instantiate components such as a Nios® II processor in the FPGA fabric and their master interfaces can access memories or peripherals in the HPS logic, including DDR3 Memory – HPS Memory.

### **NOR FLASH**

A maximum of 48MB (1 x 16MB and 1 x 32MB) of on-board NOR FLASH memory is connected to the Cyclone V using a Quad Serial Peripheral Interface (QSPI SS0 and SS1). This is a reliable flash memory that can be used as a boot media for the module.

### **Configuration EEPROM**

MitySOM-5CSx modules contain a 2048 x 8-bit EEPROM that is used to hold configuration data for the module. The EEPROM is connected to the Cyclone V using the I2C0 interface. This EEPROM contains information such as the module type, Serial Number, and MAC addresses for the Ethernet interface(s).

## On-board Interfaces

The following on-board interfaces were chosen to provide the most flexibility for end user applications. As many HPS MUX options as possible were left available for the user. These interfaces should not be muxed external to the module on other pins.

### Console Serial port

The console serial port (UART0) is supported on pins 2 (RX) and 4 (TX) of the 314-Pin Card Edge Connector with a simple TX/RX interface. By default, the flow control signals are not enabled but can be added to the console serial interface if desired.

Please reference the Card Edge Pin-Out for specific Cyclone V pin-connections.

### I2C0 Interface

The I2C0 peripheral is consumed local to the module. It is used for the Real Time Clock, Temperature Sensor, Configuration EEPROM, and to control a PWM LED driver for status and debug.

**Table 1: I2C0 Peripherals**

| Address | Device     | Feature                                       |
|---------|------------|-----------------------------------------------|
| 1000010 | AS3668     | LED Driver for RGB Status LED and a Green LED |
| 1010XXX | FT24C16A   | 16Kbit EEPROM for factory config parameters   |
| 1101001 | AB1803-T3  | Real Time Clock                               |
| 1001100 | LM73CIMK-1 | Temperature sensor                            |

### QuadSPI Interface

The QUADSPI peripheral is wired to Bank 7B and is used for the NOR FLASH interface on the module. Both Slave select 0 and slave select 1 have been utilized for this NOR memory.

**Table 2: QSPI Slave Selects**

| Slave Select | Feature          | Memory Sizing                                                  |
|--------------|------------------|----------------------------------------------------------------|
| 0            | Boot flash       | 128Mb –x4 width - 16MB max                                     |
| 1            | Additional flash | 128Mb –x4 width (not populated on 16MB NOR modules) – 32MB max |

### USB-2.0 OTG Phy

The USB1 interface of the Cyclone V processor is connected directly to a USB 2.0 OTG phy on the module itself. Only the necessary USB ID, power and data pins are brought off the module.

Please see Table 7 for the specific pin locations.

### **Debug JTAG/TRACE Emulator**

The JTAG and TRACE interface signals for the Cyclone V processor have been brought out to a Hirose header, J2, which is intended for use with an available Critical Link breakout adapter. This header can be removed for production units; please contact your Critical Link representative for details.

The debug adapter is not included with individual modules but is included with each Critical Link MitySOM-5CSx Development Kit that is ordered. If an adapter is needed please contact your Critical Link representative.

## External Interfaces

The Cyclone V makes extensive use of functional pin multiplexing to provide a highly configurable device that can be tailored to a multitude of applications.

## HPS Interfaces

A list of the interfaces/functions that are available to the user from the HPS is provided below.

- Up to 2 Universal Serial Bus (USB) 2.0 High-Speed On-The-Go (OTG) port
- 2 Controller-Area Network (CAN) ports
- Up to 2 Gigabit Ethernet MAC's (10/100/1000 Mbps)
  - EMAC1 through HPS or FPGA fabric
  - EMAC0 through FPGA fabric
- 1 MMC/SD/SDIO ports
- 4 Serial Peripheral (SPI) ports
  - 2 Master
  - 2 Slave
- 2 Universal Asynchronous Receive/Transmit (UART) ports
- 4 Inter-Integrated Circuit (I2C) ports
  - I2C0 is connected to the on-board EEPROM, Temperature Sensor, RTC and LED Driver
- JTAG/Debugger port
- RTC Battery Input (+3VBAT)

Additionally, most of the pin multiplexed signals can be configured as general purpose I/O signals with interrupt capability.

## FPGA Interfaces

### ***GPIO***

Up to 133 FPGA Input/Output pins are available externally to a module that does not utilize FPGA memory and 107 FPGA Input/Output pins are available externally for modules that do utilize the FPGA memory.

### ***3.125 Gbps Transceivers (Cyclone V SX based modules only)***

A total of six (6) 3.125Gbps transceivers are available on the module for supporting high speed serial interfaces. This feature is only available on Cyclone V SX based modules.

## Configuration and Boot Modes

The Cyclone V has two groups of pins that are read during reset to determine which media to boot from for the HPS and one group of pins that is used to configure the FPGA.

Please see Table 7 for the specific pin locations.

### HPS Configuration pins

The BSEL and CSEL pins determine which memory interface has the bootloader and how to clock the interface. For booting the HPS, the BSEL and CSEL pins details are covered in [CV-5400A](#)<sup>[1]</sup>.

#### ***BSEL (HPS Boot Select at Reset)***

The MitySOM-5CSx module can boot from a number of devices and identified in Table 3 below. Pull-ups and pull-downs must be included in the base-board design to select the correct boot option; please consult the MitySOM-5CSx Carrier Board Design Guide for details.

Table 3 lists the BSEL values that could be used on a MitySOM-5CSx design. The necessary BSEL configuration pins are all exposed to the edge connector for their HPS peripheral functions, Table 7.

**Table 3: BSEL Values**

| BSEL Value | Boot device                                                    |
|------------|----------------------------------------------------------------|
| 0x0        | Reserved                                                       |
| 0x1        | FPGA (HPS-to-FPGA bridge)                                      |
| 0x2        | 1.8V NAND flash memory                                         |
| 0x5        | 3.0V SD/MMC flash memory with external transceiver             |
| 0x6        | 1.8V SPI or Quad SPI flash memory (48MB or less QSPI NOR)      |
| 0x7        | 3.0V SPI or Quad SPI flash memory (Greater than 48MB QSPI NOR) |

#### ***CSEL[0:1] (HPS Clock Select at Reset)***

The HPS signals that include the two CLKSEL boot configuration options are exposed on the module's edge connector pins. These need to be pulled to the desired clock select option for your design. The default is to use the MitySOM-5CSx module's included 25MHz clock source into the osc1\_clk pin. Please consult the MitySOM-5CSx Carrier Board Design Guide for details.

The CSEL settings allow some of the HPS peripherals to run from a different clock source than the main HPS reference. Refer to [CV-5400A](#)<sup>[1]</sup> for the CSEL setting details.

### **FPGA Configuration Pins**

The FPGA MSEL configuration input pins are dedicated inputs that should be connected directly to either power or ground. These define where the FPGA configuration boot stream will come from and the master that will clock the interface. Please see [CV-52007](#)<sup>[2]</sup> for details on what value to use for the MSEL connections and the MitySOM-5CSx Carrier Board Design Guide for further recommendations.

### ***MSEL (FPGA Configuration Mode Select at Power-On-Reset)***

The MSEL should be set to FPPx16 if the design is going to use the FPGA Manager. With MSEL set to FPP, the HPS will be able to load the FPGA using the FPGA manager. This works in both FPPx16 and FPPx32 modes, but partial reconfiguration only works if set to FPPx16. The MSEL may be internally adjusted in the future using the HPS when it is configured first, the initial devices are not able to exercise this functionality.

For modules that include the optional DDR memory connected to the FPGA fabric I/Os the FPP configuration modes are not supported because the Bank 3A pins are consumed by the DDR interface. If the FPGA needs to be loaded first, the serial configuration modes are available, but the HPS will not be able to use the FPGA Manager to reconfigure the logic.

When configuring the FPGA through the HPS, MSEL can be:

- FPPx16 or FPPx32 (required for FPGA Manager to function properly)
- FPPx16 mode required to support partial reconfiguration
- Set MSEL to boot peripheral image. Can be from a prom or from the HPS pre-loader.
- Using the internal HPS FPGA Manager

### **Supported MSEL Options**

- FPP – Fast Passive Parallel (Modules without FPGA DDR only)

FPP configuration is expected to work on the future module without FPGA DDR and FPPx16 is the default mode to use for booting from HPS.

- PS – Passive Serial

1bit @ 125MHz Max – 10000 and 10001

- AS – Active Serial

1bit or 4bit @ 100MHz Max – 10010 and 10011

- CVP – Config via Protocol (over the PCI Express bus)

This mode is supported for production Cyclone V silicon, but not for the modules shipped with early silicon. These early silicon modules are identified with a -X indicator at the end of their Critical Link model number, Table 9.

Because the MSEL connections are dedicated inputs that should be tied directly to a power supply or ground, they are arranged on the edge connector to help isolate clock signals from crosstalk. They are also used for return current paths to improve signal integrity. To get this benefit, there are 1000pF capacitors on each of these signals on the module. The baseboard design must also include these caps to get the additional return current path benefits if they are not directly connected to ground.

### **Debug LEDs**

There are 5 debug LEDs on the MitySOM-5CSx module. Three of them are on/off status LEDs tied to a specific condition and the other two are controlled by software through the LED controller on the I2C0 interface, Table 1.

The LEDs have been identified in Figure 2.

### ***General Status LED's***

#### **Trace Debug**

D3 indicates that the JTAG/TRACE adapter board has been inserted into J2 of the module and was detected.

#### **Power OK**

D4 indicates the MitySOM-5CSx on-module +3.3V supply is operating.

#### **Configuration Debug**

D2 indicates that FPGA configuration is not complete by lighting a yellow LED. This is only a warning rather than an error because the HPS can still boot and load the FPGA.

### ***I2C Controllable LED's***

#### **Status Feedback**

The first LED, D1, is an RGB LED which is controlled when using the UBoot image provided by Critical Link.

The second LED, D5, is a green LED that is also controlled by the LED controller on the I2C0 interface.

### Software and Application Development Support

Users of the MitySOM-5CSx are encouraged to develop applications using the MitySOM-5CSx software development kit provided by Critical Link LLC. The SDK is an expansion of the Altera platform support package for the Cyclone V and includes an implementation of a Yocto Project-compatible board support package providing an Angstrom based Linux root filesystem/distribution and compatible gcc compiler tool-chain with debugger. Additional embedded Linux support is available from TimeSys, Inc.

### Growth Options

The MitySOM-5CSx has been designed to support several upgrade options. These options include a range of speed grades, FPGA DDR memory, I/O, main DDR memory configurations, and operating temperature specifications including commercial and industrial temperature ranges. The available options are listed in the section below containing ordering information. For additional ordering information and details regarding these options, or to inquire about a particular configuration not listed below, please contact a Critical Link sales representative.

### Absolute Maximum Ratings

If Military/Aerospace specified cards are required, please contact the Critical Link Sales Office or unit Distributors for availability and specifications.

**Table 4: Absolute Maximum Ratings**

|                           |                |
|---------------------------|----------------|
| Maximum Supply Voltage    | 5.2V           |
| Storage Temperature Range | -55°C to 150°C |

### Operating Conditions

The following are the minimum temperature ratings for the components that are installed on a MitySOM-5CSx. For specifications not contained in this table please contact a Critical Link sales representative. Please see the Thermal Management section below concerning ambient/operating temperature recommendations.

**Table 5: Module Component Temperature Ratings (minimum)**

| Temperature Range | Component Ratings |
|-------------------|-------------------|
| Commercial (-RC)  | 0°C to 70°C       |
| Industrial (-RI)  | -40°C to 85°C     |

## Thermal Management

The MitySOM-5CSx module requires careful consideration of thermal management. Depending on processor load, thermal management may be required for operation at room temperatures and above. The primary thermal concern is with the Cyclone V SoC device. Even when idle, case temperature on this device rises significantly. Additional processing activity will require more power consumption and more heat dissipation.

Critical Link has operated the MitySOM-5CSx module without a heat sink or air flow on bench tops at room temperatures for long periods of time without issue.

Thermal management is a system level issue that must be addressed in conjunction with the overall system design. Some systems may have available airflow with limited space for a heat sink; others may have room for a heat sink with or without the possibility for additional airflow. As a result, the approach taken for thermal management is a design consideration that must be addressed by the overall system designers when integrating the MitySOM-5CSx into an end product.

Critical Link has developed a sample heat-spreader that is compatible with the MitySOM-5CSx. Please contact your Critical Link representative for further details.

Every end product is different and it is advisable to perform thorough testing to ensure that the product will meet desired performance and longevity specifications. We recommend that customers utilize Altera's Early Power Estimator (EPE) for the Cyclone V. This utility will assist in estimating the potential power usage of the processor for a given application. Details can be found on the [PowerPlay EPE<sup>\[4\]</sup>](#) page at Altera.com. In order to achieve reliable operation at the maximum specified operating temperatures it has been determined that heat dissipation will likely be required.

## Example Thermal Dissipation Scenarios

By utilizing the PowerPlay EPE for the Cyclone V SoC Critical Link has provided some example scenarios detailing the effects of different cooling fin and airflows. Please be advised these are only estimations based on the Altera modeling tool that are only being used to illustrate the effect of different heat dissipation techniques and are not tested conditions by Critical Link.

Table 6: Example EPE Based Scenarios

| Cyclone V Power | Fin Size | Airflow | Max Ambient |
|-----------------|----------|---------|-------------|
| 2.90W           | 23 mm    | 200 LFM | 71°C        |
| 4.25W           | 15 mm    | None    | 49°C        |
| 4.25W           | 15 mm    | 100 LFM | 55°C        |
| 4.25W           | 15 mm    | 400 LFM | 65°C        |
| 4.25W           | 23 mm    | 200 LFM | 65°C        |
| 4.25W           | 28 mm    | 400 LFM | 67°C        |

### Card-Edge Interface Description

The primary interface connector for the MitySOM-5CSx is the 314-pin card edge interface which contains 7 classes of signals:

- Power (**PWR**)
  - Input – Input power to the module
  - Output – Voltage supply from the module
  - Enable – Voltage enable signal from the module for sequencing on carrier boards
- Bank IO Power to the module (**PWR\_VIO**)
- FPGA Bank Power (**PWR\_FPGA**)
- Dedicated signals mapped to the Cyclone V SoC HPS / FPGA pins (5CSx\_D)
- Multi-function signals mapped to the Cyclone V SoC HPS pins (5CSx\_HPS)
- General purpose I/O pins mapped to the Cyclone V SoC FPGA pins (5CSx\_IO)
- General purpose I/O pins available on expanded IO modules; no FPGA DDR memory present on the module (5CSx\_EIO)
- Dedicated 3.125Gbps Transceiver signals mapped to the Cyclone V SoC (5CSX\_GXB). Only available on Cyclone V SX based modules.

Table 7 contains a summary of the MitySOM-5CSx pin-mapping.

### Card-Edge Mating Connector

The MitySOM-5CSx module mates with a single connector that contains all of the power and I/O for the module. The mating socket is a 314-pin MXM 3.0 type connector. An example connector is a JAE - MM70-314-310B1-1-R300 which is available from distributors such as DigiKey and Mouser.

More information is available in the MitySOM-5CSx Carrier Board Design guide from Critical Link.

Table 7: MitySOM-5CSx Edge Connector Pin-Out

| Module Pin Number | Class       | SCH NET Name                             | Bank Number | Cyclone V 5CSXFC6 U672 | HPS Pin Mux Select 3 | HPS Pin Mux Select 2 | HPS Pin Mux Select 1 | HPS Pin Mux Select 0 |
|-------------------|-------------|------------------------------------------|-------------|------------------------|----------------------|----------------------|----------------------|----------------------|
| 1                 | PWR - Input | +5VIN                                    |             |                        |                      |                      |                      |                      |
| 2                 | 5CSx_HPS    | UART0_RX                                 | 7A          | B19                    | CAN0_RX              | UART0_RX             | SPIM1_MISO           | HPS_GPIO65           |
| 3                 | PWR - Input | +5VIN                                    |             |                        |                      |                      |                      |                      |
| 4                 | 5CSx_HPS    | UART0_TX,CLKSEL0                         | 7A          | C16                    | CAN0_TX,CLKSEL0      | UART0_TX,CLKSEL0     | SPIM1_SS0            | HPS_GPIO66           |
| 5                 | PWR - Input | +5VIN                                    |             |                        |                      |                      |                      |                      |
| 6                 | 5CSx_HPS    | UART0_RTS/SPIM0_MOSI/I2C1_SCL/HPS_GPIO58 | 7A          | C17                    | SPIM0_MOSI           | I2C1_SCL             | UART0_RTS            | HPS_GPIO58           |
| 7                 | PWR - Input | +5VIN                                    |             |                        |                      |                      |                      |                      |
| 8                 | 5CSx_HPS    | UART0_CTS/SPIM0_CLK/I2C1_SDA/HPS_GPIO57  | 7A          | A18                    | SPIM0_CLK            | I2C1_SDA             | UART0_CTS            | HPS_GPIO57           |
| 9                 | PWR - Input | +5VIN                                    |             |                        |                      |                      |                      |                      |
| 10                | 5CSx_HPS    | CAN0_TX,CLKSEL1/HPS_GPIO62               | 7A          | H17                    | UART0_TX,CLKSEL1     | CAN0_TX,CLKSEL1      | SPIM1_SS1            | HPS_GPIO62           |
| 11                | PWR         | GND                                      |             |                        |                      |                      |                      |                      |
| 12                | 5CSx_HPS    | CAN0_RX/SPIM0_SS1/HPS_GPIO61             | 7A          | A17                    | UART0_RX             | CAN0_RX              | SPIM0_SS1            | HPS_GPIO61           |
| 13                | PWR         | GND                                      |             |                        |                      |                      |                      |                      |
| 14                | 5CSx_HPS    | CAN1_TX,BOOTSEL0/SPIM0_SS0/HPS_GPIO60    | 7A          | J17                    | SPIM0_SS0            | CAN1_TX,BOOTSEL0     | UART1_RTS,BOOTSEL0   | HPS_GPIO60           |
| 15                | PWR         | GND                                      |             |                        |                      |                      |                      |                      |
| 16                | 5CSx_HPS    | CAN1_RX/SPIM0_MISO/HPS_GPIO59            | 7A          | B18                    | SPIM0_MISO           | CAN1_RX              | UART1_CTS            | HPS_GPIO59           |
| 17                | PWR         | GND                                      |             |                        |                      |                      |                      |                      |
| 18                | PWR - Input | +3VBAT                                   |             |                        |                      |                      |                      |                      |
| 19                | 5CSx_D      | B7A_HPS_CLK2                             | 7A          | D20                    |                      |                      |                      |                      |
| 20                | 5CSx_HPS    | TRACE_D7/SPIS1_MISO/HPS_GPIO56           | 7A          | C18                    | TRACE_D7             | SPIS1_MISO           | I2C0_SCL             | HPS_GPIO56           |
| 21                | 5CSx_D      | nPERSTL1/B5A_RX_R6n                      | 5A          | W15                    |                      |                      |                      |                      |
| 22                | 5CSx_HPS    | TRACE_D6/SPIS1_SS0/HPS_GPIO55            | 7A          | A19                    | TRACE_D6             | SPIS1_SS0            | I2C0_SDA             | HPS_GPIO55           |
| 23                | 5CSx_D      | HPS_nRST                                 | 7A          | A23                    |                      |                      |                      |                      |
| 24                | 5CSx_HPS    | TRACE_D5/SPIS1_MOSI/CAN1_TX/HPS_GPIO54   | 7A          | J18                    | TRACE_D5             | SPIS1_MOSI           | CAN1_TX              | HPS_GPIO54           |
| 25                | 5CSx_D      | HPS_nPOR                                 | 7A          | H19                    |                      |                      |                      |                      |
| 26                | 5CSx_HPS    | TRACE_D4/SPIS1_CLK/CAN1_RX/HPS_GPIO53    | 7A          | A20                    | TRACE_D4             | SPIS1_CLK            | CAN1_RX              | HPS_GPIO53           |
| 27                |             | B3B_FPGA_DCLK                            | 3A          | AA8                    |                      |                      |                      |                      |
| 28                | 5CSx_HPS    | TRACE_D3/SPIS0_SS0/I2C1_SCL/HPS_GPIO52   | 7A          | K18                    | TRACE_D3             | SPIS0_SS0            | I2C1_SCL             | HPS_GPIO52           |
| 29                | 5CSx_D      | MSEL0                                    | 9A          | J10                    |                      |                      |                      |                      |
| 30                | 5CSx_HPS    | TRACE_D2/SPIS0_MISO/I2C1_SDA/HPS_GPIO51  | 7A          | A21                    | TRACE_D2             | SPIS0_MISO           | I2C1_SDA             | HPS_GPIO51           |
| 31                |             | B3B_FPGA_D3                              | 3A          | AB6                    |                      |                      |                      |                      |
| 32                | 5CSx_HPS    | TRACE_D1/SPIS0_MOSI/HPS_GPIO50           | 7A          | B21                    | TRACE_D1             | SPIS0_MOSI           | UART0_TX             | HPS_GPIO50           |
| 33                |             | B3B_FPGA_D2                              | 3A          | AC5                    |                      |                      |                      |                      |
| 34                | 5CSx_HPS    | TRACE_D0/SPIS0_CLK/HPS_GPIO49            | 7A          | A22                    | TRACE_D0             | SPIS0_CLK            | UART0_RX             | HPS_GPIO49           |
| 35                |             | B3B_FPGA_D1                              | 3A          | AC6                    |                      |                      |                      |                      |
| 36                | 5CSx_D      | MSEL4                                    | 9A          | K9                     |                      |                      |                      |                      |
| 37                |             | B3B_FPGA_D0                              | 3A          | AD7                    |                      |                      |                      |                      |
| 38                | 5CSx_HPS    | TRACE_CLK                                | 7A          | C21                    | TRACE_CLK            |                      |                      | HPS_GPIO48           |
| 39                | 5CSx_D      | nCONFIG                                  | 9A          | F7                     |                      |                      |                      |                      |
| 40                | PWR         | GND                                      |             |                        |                      |                      |                      |                      |
| 41                | 5CSx_D      | nSTATUS                                  | 9A          | H8                     |                      |                      |                      |                      |
| 42                | 5CSx_EIO    | B5A_TX_R5_P/NC with FPGA DDR Memory      | 5A/NC       | AC24                   |                      |                      |                      |                      |
| 43                | 5CSx_D      | nCSO                                     | 3A          | AA6                    |                      |                      |                      |                      |
| 44                | 5CSx_EIO    | B5A_TX_R5_N/NC with FPGA DDR Memory      | 5A/NC       | AB23                   |                      |                      |                      |                      |
| 45                | 5CSx_D      | MSEL1                                    | 9A          | H9                     |                      |                      |                      |                      |
| 46                | PWR-Enable  | VIO_ENABLE_2V5                           |             |                        |                      |                      |                      |                      |

| Module Pin Number | Class    | SCH NET Name                        | Bank Number | Cyclone V 5CSXFC6 U672 | HPS Pin Mux Select 3 | HPS Pin Mux Select 2 | HPS Pin Mux Select 1 | HPS Pin Mux Select 0 |
|-------------------|----------|-------------------------------------|-------------|------------------------|----------------------|----------------------|----------------------|----------------------|
| 47                | 5CSx_EIO | B5A_TX_R1_P/NC with FPGA DDR Memory | 5A/NC       | AF26                   |                      |                      |                      |                      |
| 48                | PWR_VIO  | +VIO_4A                             |             |                        |                      |                      |                      |                      |
| 49                | 5CSx_EIO | B5A_TX_R1_N/NC with FPGA DDR Memory | 5A/NC       | AE26                   |                      |                      |                      |                      |
| 50                | PWR      | GND                                 |             |                        |                      |                      |                      |                      |
| 51                | 5CSx_D   | MSEL2                               | 9A          | G6                     |                      |                      |                      |                      |
| 52                | 5CSx_IO  | B4A_TX_B80p/DQ8B/B_DM_4             | 4A          | AF27                   |                      |                      |                      |                      |
| 53                | 5CSx_EIO | B5A_TX_R3_P/NC with FPGA DDR Memory | 5A/NC       | AE25                   |                      |                      |                      |                      |
| 54                | 5CSx_IO  | B4A_TX_B80n/DQ8B/B_DQ_39            | 4A          | AF28                   |                      |                      |                      |                      |
| 55                | 5CSx_EIO | B5A_TX_R3_N/NC with FPGA DDR Memory | 5A/NC       | AD26                   |                      |                      |                      |                      |
| 56                | 5CSx_IO  | B4A_TX_B77p/DQ8B/B_DQ_38            | 4A          | AG28                   |                      |                      |                      |                      |
| 57                | 5CSx_D   | MSEL3                               | 9A          | K10                    |                      |                      |                      |                      |
| 58                | 5CSx_IO  | B4A_TX_B77n/DQ8B/GND                | 4A          | AH27                   |                      |                      |                      |                      |
| 59                | PWR      | GND                                 |             |                        |                      |                      |                      |                      |
| 60                | 5CSx_IO  | B4A_TX_B76n/DQ8B/B_DQ_35            | 4A          | AH26                   |                      |                      |                      |                      |
| 61                | 5CSx_IO  | B4A_RX_B78p/DQ8B/B_DQ_37            | 4A          | AF25                   |                      |                      |                      |                      |
| 62                | 5CSx_IO  | B4A_TX_B73p/DQ8B/B_DQ_34            | 4A          | AG26                   |                      |                      |                      |                      |
| 63                | 5CSx_IO  | B4A_RX_B78n/DQ8B/B_DQ_36            | 4A          | AG25                   |                      |                      |                      |                      |
| 64                | 5CSx_IO  | B4A_TX_B72p/DQ7B/B_DM_3             | 4A          | AG24                   |                      |                      |                      |                      |
| 65                | 5CSx_IO  | B4A_RX_B75p/DQ8B/B_DQS_4            | 4A          | AC22                   |                      |                      |                      |                      |
| 66                | 5CSx_IO  | B4A_TX_B72n/DQ7B/B_DQ_31            | 4A          | AH24                   |                      |                      |                      |                      |
| 67                | 5CSx_IO  | B4A_RX_B75n/DQ8B/B_DQS#_4           | 4A          | AC23                   |                      |                      |                      |                      |
| 68                | 5CSx_IO  | B4A_TX_B69p/DQ7B/B_DQ_30            | 4A          | AH23                   |                      |                      |                      |                      |
| 69                | 5CSx_IO  | B4A_RX_B74p/DQ8B/B_DQ_33            | 4A          | AE24                   |                      |                      |                      |                      |
| 70                | 5CSx_IO  | B4A_TX_B69n/DQ7B/GND                | 4A          | AH22                   |                      |                      |                      |                      |
| 71                | 5CSx_IO  | B4A_RX_B74n/DQ8B/B_DQ_32            | 4A          | AE23                   |                      |                      |                      |                      |
| 72                | PWR      | GND                                 |             |                        |                      |                      |                      |                      |
| 73                | 5CSx_IO  | B4A_RX_B70p/DQ7B/B_DQ_29            | 4A          | AG23                   |                      |                      |                      |                      |
| 74                | 5CSx_IO  | B4A_TX_B68n/DQ7B/B_DQ_27            | 4A          | AH21                   |                      |                      |                      |                      |
| 75                | 5CSx_IO  | B4A_RX_B70n/DQ7B/B_DQ_28            | 4A          | AF23                   |                      |                      |                      |                      |
| 76                | 5CSx_IO  | B4A_TX_B65p/DQ7B/B_DQ_26            | 4A          | AG21                   |                      |                      |                      |                      |
| 77                | 5CSx_IO  | B4A_RX_B67p/DQ5B/B_DQS_3            | 4A          | AD23                   |                      |                      |                      |                      |
| 78                | 5CSx_IO  | B4A_TX_B64p/DQ6B/B_DM_2             | 4A          | AF20                   |                      |                      |                      |                      |
| 79                | 5CSx_IO  | B4A_RX_B67n/DQ5B/B_DQS#_3           | 4A          | AE22                   |                      |                      |                      |                      |
| 80                | 5CSx_IO  | B4A_TX_B64n/DQ6B/B_DQ_23            | 4A          | AG20                   |                      |                      |                      |                      |
| 81                | PWR      | GND                                 |             |                        |                      |                      |                      |                      |
| 82                | 5CSx_IO  | B4A_TX_B61p/DQ6B/B_DQ_22            | 4A          | AG19                   |                      |                      |                      |                      |
| 83                | 5CSx_IO  | B4A_RX_B66p/DQ7B/B_DQ_25            | 4A          | AF22                   |                      |                      |                      |                      |
| 84                | 5CSx_IO  | B4A_TX_B61n/DQ6B/GND                | 4A          | AH19                   |                      |                      |                      |                      |
| 85                | 5CSx_IO  | B4A_RX_B66n/DQ7B/B_DQ_24            | 4A          | AF21                   |                      |                      |                      |                      |
| 86                | 5CSx_IO  | B4A_TX_B60p/B_RESET#                | 4A          | AG18                   |                      |                      |                      |                      |
| 87                | 5CSx_IO  | B4A_RX_B62p/DQ6B/B_DQ_21            | 4A          | AE20                   |                      |                      |                      |                      |
| 88                | 5CSx_IO  | B4A_TX_B60n/DQ6B/B_DQ_19            | 4A          | AH18                   |                      |                      |                      |                      |
| 89                | 5CSx_IO  | B4A_RX_B62n/DQ6B/B_DQ_20            | 4A          | AD20                   |                      |                      |                      |                      |
| 90                | 5CSx_IO  | B4A_TX_B57p/DQ6B/B_DQ_18            | 4A          | AF18                   |                      |                      |                      |                      |
| 91                | 5CSx_IO  | B4A_RX_B59p/DQ5B/B_DQS_2            | 4A          | AA19                   |                      |                      |                      |                      |
| 92                | PWR      | GND                                 |             |                        |                      |                      |                      |                      |
| 93                | 5CSx_IO  | B4A_RX_B59n/DQ5B/B_DQS#_2           | 4A          | AA18                   |                      |                      |                      |                      |
| 94                | 5CSx_IO  | B4A_TX_B56p/DQ5B/B_DM_1             | 4A          | AH17                   |                      |                      |                      |                      |
| 95                | 5CSx_IO  | B4A_RX_B58p/DQ6B/B_DQ_17            | 4A          | AE19                   |                      |                      |                      |                      |

| Module Pin Number | Class   | SCH NET Name                | Bank Number | Cyclone V 5CSXFC6 U672 | HPS Pin Mux Select 3 | HPS Pin Mux Select 2 | HPS Pin Mux Select 1 | HPS Pin Mux Select 0 |
|-------------------|---------|-----------------------------|-------------|------------------------|----------------------|----------------------|----------------------|----------------------|
| 96                | 5CSx_IO | B4A_TX_B56n/DQ5B/B_DQ_15    | 4A          | AH16                   |                      |                      |                      |                      |
| 97                | 5CSx_IO | B4A_RX_B58n/DQ6B/B_DQ_16    | 4A          | AD19                   |                      |                      |                      |                      |
| 98                | 5CSx_IO | B4A_TX_B53p/DQ5B/B_DQ_14    | 4A          | AG15                   |                      |                      |                      |                      |
| 99                | 5CSx_IO | CLK3p/B4A_RX_B55p           | 4A          | Y15                    |                      |                      |                      |                      |
| 100               | 5CSx_IO | B4A_TX_B53n/DQ5B/B_CKE_0    | 4A          | AH14                   |                      |                      |                      |                      |
| 101               | 5CSx_IO | CLK3n/B4A_RX_B55n           | 4A          | AA15                   |                      |                      |                      |                      |
| 102               | 5CSx_IO | B4A_TX_B52p/B_CKE_1         | 4A          | AG14                   |                      |                      |                      |                      |
| 103               | PWR     | GND                         |             |                        |                      |                      |                      |                      |
| 104               | 5CSx_IO | B4A_TX_B52n/DQ5B/B_DQ_11    | 4A          | AH13                   |                      |                      |                      |                      |
| 105               | 5CSx_IO | B4A_RX_B54p/DQ5B/B_DQ_13    | 4A          | AD17                   |                      |                      |                      |                      |
| 106               | 5CSx_IO | B4A_TX_B49p/DQ5B/B_DQ_10    | 4A          | AH12                   |                      |                      |                      |                      |
| 107               | 5CSx_IO | B4A_RX_B54n/DQ5B/B_DQ_12    | 4A          | AE17                   |                      |                      |                      |                      |
| 108               | PWR     | GND                         |             |                        |                      |                      |                      |                      |
| 109               | 5CSx_IO | B4A_RX_B51p/DQ5B/B_DQS_1    | 4A          | W14                    |                      |                      |                      |                      |
| 110               | 5CSx_IO | B4A_TX_B48p/DQ4B/B_DM_0     | 4A          | AG11                   |                      |                      |                      |                      |
| 111               | 5CSx_IO | B4A_RX_B51n/DQSn5B/B_DQS#_1 | 4A          | V13                    |                      |                      |                      |                      |
| 112               | 5CSx_IO | B4A_TX_B48n/DQ4B/B_DQ_7     | 4A          | AH11                   |                      |                      |                      |                      |
| 113               | 5CSx_IO | B4A_RX_B50p/DQ5B/B_DQ_9     | 4A          | AF17                   |                      |                      |                      |                      |
| 114               | 5CSx_IO | B4A_TX_B45p/DQ4B/B_DQ_6     | 4A          | AG10                   |                      |                      |                      |                      |
| 115               | 5CSx_IO | B4A_RX_B50n/DQ5B/B_DQ_8     | 4A          | AG16                   |                      |                      |                      |                      |
| 116               | 5CSx_IO | B4A_TX_B45n/DQ4B/B_ODT_1    | 4A          | AH9                    |                      |                      |                      |                      |
| 117               | 5CSx_IO | CLK2p/B4A_RX_B47p           | 4A          | Y13                    |                      |                      |                      |                      |
| 118               | 5CSx_IO | B4A_TX_B44p/B_ODT_0         | 4A          | AG9                    |                      |                      |                      |                      |
| 119               | 5CSx_IO | CLK2n/B4A_RX_B47n           | 4A          | AA13                   |                      |                      |                      |                      |
| 120               | 5CSx_IO | B4A_TX_B44n/DQ4B/B_DQ_3     | 4A          | AH8                    |                      |                      |                      |                      |
| 121               | 5CSx_IO | B4A_RX_B46p/DQ4B/B_DQ_5     | 4A          | AF15                   |                      |                      |                      |                      |
| 122               | 5CSx_IO | B4A_TX_B41p/DQ4B/B_DQ_2     | 4A          | AG8                    |                      |                      |                      |                      |
| 123               | 5CSx_IO | B4A_RX_B46n/DQ4B/B_DQ_4     | 4A          | AE15                   |                      |                      |                      |                      |
| 124               | 5CSx_IO | RZQ_0/B4A_TX_B41n           | 4A          | AH7                    |                      |                      |                      |                      |
| 125               | PWR     | GND                         |             |                        |                      |                      |                      |                      |
| 126               | -       | Key <sup>3</sup>            |             |                        |                      |                      |                      |                      |
| 127               | -       | Key <sup>3</sup>            |             |                        |                      |                      |                      |                      |
| 128               | -       | Key <sup>3</sup>            |             |                        |                      |                      |                      |                      |
| 129               | -       | Key <sup>3</sup>            |             |                        |                      |                      |                      |                      |
| 130               | -       | Key <sup>3</sup>            |             |                        |                      |                      |                      |                      |
| 131               | -       | Key <sup>3</sup>            |             |                        |                      |                      |                      |                      |
| 132               | -       | Key <sup>3</sup>            |             |                        |                      |                      |                      |                      |
| 133               | 5CSx_IO | B4A_RX_B43p/DQS4B/B_DQS_0   | 4A          | U14                    |                      |                      |                      |                      |
| 134               | PWR_VIO | +VIO_3B                     |             |                        |                      |                      |                      |                      |
| 135               | 5CSx_IO | B4A_RX_B43n/DQSn4B/B_DQS#_0 | 4A          | U13                    |                      |                      |                      |                      |
| 136               | PWR     | GND                         |             |                        |                      |                      |                      |                      |
| 137               | 5CSx_IO | B4A_RX_B42p/DQ4B/B_DQ_1     | 4A          | AG13                   |                      |                      |                      |                      |
| 138               | 5CSx_IO | B3B_TX_B29p/DQ2B/B_A_10     | 3B          | AE8                    |                      |                      |                      |                      |
| 139               | 5CSx_IO | B4A_RX_B42n/DQ4B/B_DQ_0     | 4A          | AF13                   |                      |                      |                      |                      |
| 140               | 5CSx_IO | B3B_TX_B29n/DQ2B/B_A_11     | 3B          | AF9                    |                      |                      |                      |                      |
| 141               | 5CSx_IO | B3B_RX_B38p/DQ3B/B_A_4      | 3B          | AE12                   |                      |                      |                      |                      |
| 142               | 5CSx_IO | B3B_TX_B28p/B_A_12          | 3B          | AE7                    |                      |                      |                      |                      |
| 143               | 5CSx_IO | B3B_RX_B38n/DQ3B/B_A_5      | 3B          | AD12                   |                      |                      |                      |                      |
| 144               | 5CSx_IO | B3B_TX_B28n/DQ2B/B_A_13     | 3B          | AF8                    |                      |                      |                      |                      |

| Module Pin Number | Class    | SCH NET Name                                          | Bank Number | Cyclone V 5CSXFC6 U672 | HPS Pin Mux Select 3 | HPS Pin Mux Select 2 | HPS Pin Mux Select 1 | HPS Pin Mux Select 0 |
|-------------------|----------|-------------------------------------------------------|-------------|------------------------|----------------------|----------------------|----------------------|----------------------|
| 145               | 5CSx_IO  | B3B_RX_B30p/DQ2B/B_A_8                                | 3B          | AD11                   |                      |                      |                      |                      |
| 146               | 5CSx_IO  | B3B_TX_B32p/DQ2B/B_CAS#                               | 3B          | AF5                    |                      |                      |                      |                      |
| 147               | 5CSx_IO  | B3B_RX_B30n/DQ2B/B_A_9                                | 3B          | AE11                   |                      |                      |                      |                      |
| 148               | 5CSx_IO  | B3B_TX_B32n/DQ2B/B_RAS#                               | 3B          | AF6                    |                      |                      |                      |                      |
| 149               | 5CSx_IO  | B3B_RX_B34p/DQ3B/B_BA_1                               | 3B          | AF11                   |                      |                      |                      |                      |
| 150               | 5CSx_IO  | B3B_TX_B33p/DQ3B/B_BA_0                               | 3B          | AF7                    |                      |                      |                      |                      |
| 151               | 5CSx_IO  | B3B_RX_B34n/DQ3B/B_BA_2                               | 3B          | AF10                   |                      |                      |                      |                      |
| 152               | 5CSx_IO  | B3B_TX_B33n/GND                                       | 3B          | AG6                    |                      |                      |                      |                      |
| 153               | PWR      | GND                                                   |             |                        |                      |                      |                      |                      |
| 154               | 5CSx_IO  | B3B_TX_B40p/DQ3B/B_A_0                                | 3B          | AH6                    |                      |                      |                      |                      |
| 155               | 5CSx_IO  | B3B_RX_B35p/DQ3B/B_CK                                 | 3B          | T13                    |                      |                      |                      |                      |
| 156               | 5CSx_IO  | B3B_TX_B40n/DQ3B/B_A_1                                | 3B          | AH5                    |                      |                      |                      |                      |
| 157               | 5CSx_IO  | B3B_RX_B35n/DQ3B/B_CK#                                | 3B          | T12                    |                      |                      |                      |                      |
| 158               | PWR      | GND                                                   |             |                        |                      |                      |                      |                      |
| 159               | 5CSx_IO  | B3B_RX_B27p/DQ3B/B_CS#_0                              | 3B          | T11                    |                      |                      |                      |                      |
| 160               | 5CSx_IO  | CLKOUT0,CLKOUTp,FPLL_BL_FB/<br>B3B_TX_B37p/DQ3B/B_A_2 | 3B          | AG5                    |                      |                      |                      |                      |
| 161               | 5CSx_IO  | B3B_RX_B27n/DQ3B/B_CS#_1                              | 3B          | U11                    |                      |                      |                      |                      |
| 162               | 5CSx_IO  | CLKOUT1,CLKOUTn/B3B_TX_B37n/DQ3B/B_A_3                | 3B          | AH4                    |                      |                      |                      |                      |
| 163               | 5CSx_IO  | CLK1p/B3B_RX_B39p                                     | 3B          | V12                    |                      |                      |                      |                      |
| 164               | 5CSx_IO  | B3B_TX_B25p/DQ2B/B_WE#                                | 3B          | AE4                    |                      |                      |                      |                      |
| 165               | 5CSx_IO  | CLK1n/B3B_RX_B39n                                     | 3B          | W12                    |                      |                      |                      |                      |
| 166               | 5CSx_IO  | B3B_TX_B25n/GND                                       | 3B          | AF4                    |                      |                      |                      |                      |
| 167               | 5CSx_IO  | CLK0p,FPLL_BL_FBp/B3B_RX_B31p                         | 3B          | V11                    |                      |                      |                      |                      |
| 168               | 5CSx_IO  | B3B_TX_B36p/B_A_6                                     | 3B          | AH3                    |                      |                      |                      |                      |
| 169               | 5CSx_IO  | CLK0n,FPLL_BL_FBn/B3B_RX_B31n                         | 3B          | W11                    |                      |                      |                      |                      |
| 170               | 5CSx_IO  | B3B_TX_B36n/DQ3B/B_A_7                                | 3B          | AH2                    |                      |                      |                      |                      |
| 171               | 5CSx_IO  | B3B_RX_B26p/DQ2B/B_A_14                               | 3B          | AD10                   |                      |                      |                      |                      |
| 172               | 5CSx_IO  | CLK6p,FPLL_TL_FBp/B8A_RX_T9p                          | 8A          | E11                    |                      |                      |                      |                      |
| 173               | 5CSx_IO  | B3B_RX_B26n/DQ2B/B_A_15                               | 3B          | AE9                    |                      |                      |                      |                      |
| 174               | 5CSx_IO  | CLK6n,FPLL_TL_FBn/B8A_RX_T9n                          | 8A          | D11                    |                      |                      |                      |                      |
| 175               | PWR      | GND                                                   |             |                        |                      |                      |                      |                      |
| 176               | PWR_VIO  | +VIO_8A                                               |             |                        |                      |                      |                      |                      |
| 177               | 5CSx_IO  | CLK7p/B8A_RX_T1p                                      | 8A          | D12                    |                      |                      |                      |                      |
| 178               | 5CSx_IO  | CLKOUT0,CLKOUTp,FPLL_TL_FB/B8A_TX_T4p                 | 8A          | E8                     |                      |                      |                      |                      |
| 179               | 5CSx_IO  | CLK7n/B8A_RX_T1n                                      | 8A          | C12                    |                      |                      |                      |                      |
| 180               | 5CSx_IO  | CLKOUT1,CLKOUTn/B8A_TX_T4n                            | 8A          | D8                     |                      |                      |                      |                      |
| 181               | PWR_VIO  | VIO_3A5A5B/NC with FPGA DDR Memory                    |             |                        |                      |                      |                      |                      |
| 182               | PWR      | GND                                                   |             |                        |                      |                      |                      |                      |
| 183               | 5CSx_EIO | B5A_RX_R2_P/NC with FPGA DDR Memory                   | 5A/NC       | AA20                   |                      |                      |                      |                      |
| 184               | 5CSx_EIO | B3A_TX_B8_P/NC with FPGA DDR Memory                   | 3A/NC       | AC4                    |                      |                      |                      |                      |
| 185               | 5CSx_EIO | B5A_RX_R2_N/NC with FPGA DDR Memory                   | 5A/NC       | Y19                    |                      |                      |                      |                      |
| 186               | 5CSx_EIO | B3A_TX_B8_N/NC with FPGA DDR Memory                   | 3A/NC       | AD4                    |                      |                      |                      |                      |
| 187               | 5CSx_EIO | B5A_RX_R4_P/NC with FPGA DDR Memory                   | 5A/NC       | Y17                    |                      |                      |                      |                      |
| 188               | 5CSx_EIO | B3A_TX_B6_P/NC with FPGA DDR Memory                   | 3A/NC       | AD5                    |                      |                      |                      |                      |
| 189               | 5CSx_EIO | B5A_RX_R4_N/NC with FPGA DDR Memory                   | 5A/NC       | Y18                    |                      |                      |                      |                      |
| 190               | 5CSx_EIO | B3A_TX_B6_N/NC with FPGA DDR Memory                   | 3A/NC       | AE6                    |                      |                      |                      |                      |
| 191               | 5CSx_EIO | B3A_RX_B7_P/NC with FPGA DDR Memory                   | 3A/NC       | Y11                    |                      |                      |                      |                      |
| 192               | 5CSx_EIO | B3A_TX_B4_P/NC with FPGA DDR Memory                   | 3A/NC       | AA4                    |                      |                      |                      |                      |

| Module Pin Number | Class    | SCH NET Name                        | Bank Number | Cyclone V 5CSXFC6 U672 | HPS Pin Mux Select 3 | HPS Pin Mux Select 2 | HPS Pin Mux Select 1 | HPS Pin Mux Select 0 |
|-------------------|----------|-------------------------------------|-------------|------------------------|----------------------|----------------------|----------------------|----------------------|
| 193               | 5CSx_EIO | B3A_RX_B7_N/NC with FPGA DDR Memory | 3A/NC       | AA11                   |                      |                      |                      |                      |
| 194               | 5CSx_EIO | B3A_TX_B4_N/NC with FPGA DDR Memory | 3A/NC       | AB4                    |                      |                      |                      |                      |
| 195               | 5CSx_EIO | B3A_RX_B5_P/NC with FPGA DDR Memory | 3A/NC       | U10                    |                      |                      |                      |                      |
| 196               | 5CSx_EIO | B3A_TX_B2_P/NC with FPGA DDR Memory | 3A/NC       | Y5                     |                      |                      |                      |                      |
| 197               | 5CSx_EIO | B3A_RX_B5_N/NC with FPGA DDR Memory | 3A/NC       | V10                    |                      |                      |                      |                      |
| 198               | 5CSx_EIO | B3A_TX_B2_N/NC with FPGA DDR Memory | 3A/NC       | Y4                     |                      |                      |                      |                      |
| 199               | 5CSx_EIO | B3A_RX_B3_P/NC with FPGA DDR Memory | 3A/NC       | U9                     |                      |                      |                      |                      |
| 200               | PWR      | GND                                 |             |                        |                      |                      |                      |                      |
| 201               | 5CSx_EIO | B3A_RX_B3_N/NC with FPGA DDR Memory | 3A/NC       | T8                     |                      |                      |                      |                      |
| 202               | 5CSX_GXB | GXB_RX_L0p                          | GXB_L0      | AF2                    |                      |                      |                      |                      |
| 203               | 5CSx_EIO | B3A_RX_B1_P/NC with FPGA DDR Memory | 3A/NC       | W8                     |                      |                      |                      |                      |
| 204               | 5CSX_GXB | GXB_RX_L0n                          | GXB_L0      | AF1                    |                      |                      |                      |                      |
| 205               | 5CSx_EIO | B3A_RX_B1_N/NC with FPGA DDR Memory | 3A/NC       | Y8                     |                      |                      |                      |                      |
| 206               | PWR      | GND                                 |             |                        |                      |                      |                      |                      |
| 207               | PWR      | GND                                 |             |                        |                      |                      |                      |                      |
| 208               | 5CSX_GXB | GXB_RX_L1p                          | GXB_L0      | AB2                    |                      |                      |                      |                      |
| 209               | 5CSX_GXB | GXB_TX_0_P                          | GXB_L0      | AD2                    |                      |                      |                      |                      |
| 210               | 5CSX_GXB | GXB_RX_L1n                          | GXB_L0      | AB1                    |                      |                      |                      |                      |
| 211               | 5CSX_GXB | GXB_TX_0_N                          | GXB_L0      | AD1                    |                      |                      |                      |                      |
| 212               | PWR      | GND                                 |             |                        |                      |                      |                      |                      |
| 213               | PWR      | GND                                 |             |                        |                      |                      |                      |                      |
| 214               | 5CSX_GXB | GXB_RX_L2p                          | GXB_L0      | V2                     |                      |                      |                      |                      |
| 215               | 5CSX_GXB | GXB_TX_1_N                          | GXB_L0      | Y1                     |                      |                      |                      |                      |
| 215               | 5CSX_GXB | GXB_TX_1_P                          | GXB_L0      | Y2                     |                      |                      |                      |                      |
| 216               | 5CSX_GXB | GXB_RX_L2n                          | GXB_L0      | V1                     |                      |                      |                      |                      |
| 218               | PWR      | GND                                 |             |                        |                      |                      |                      |                      |
| 219               | PWR      | GND                                 |             |                        |                      |                      |                      |                      |
| 220               | 5CSX_GXB | REFCLK0Lp                           | GXB_L0      | V5                     |                      |                      |                      |                      |
| 221               | 5CSX_GXB | GXB_TX_2_P                          | GXB_L0      | T2                     |                      |                      |                      |                      |
| 222               | 5CSX_GXB | REFCLK0Ln                           | GXB_L0      | V4                     |                      |                      |                      |                      |
| 223               | 5CSX_GXB | GXB_TX_2_N                          | GXB_L0      | T1                     |                      |                      |                      |                      |
| 224               | PWR      | GND                                 |             |                        |                      |                      |                      |                      |
| 225               | PWR      | GND                                 |             |                        |                      |                      |                      |                      |
| 226               | 5CSX_GXB | GXB_RX_L3p                          | GXB_L1      | P2                     |                      |                      |                      |                      |
| 227               | 5CSX_GXB | GXB_REFCLK1_P                       | GXB_L1      | P8                     |                      |                      |                      |                      |
| 228               | 5CSX_GXB | GXB_RX_L3n                          | GXB_L1      | P1                     |                      |                      |                      |                      |
| 229               | 5CSX_GXB | GXB_REFCLK1_N                       | GXB_L1      | N8                     |                      |                      |                      |                      |
| 230               | PWR      | GND                                 |             |                        |                      |                      |                      |                      |
| 231               | PWR      | GND                                 |             |                        |                      |                      |                      |                      |
| 232               | 5CSX_GXB | GXB_RX_L4                           | GXB_L1      | K2                     |                      |                      |                      |                      |
| 233               | 5CSX_GXB | GXB_TX_3_P                          | GXB_L1      | M2                     |                      |                      |                      |                      |
| 234               | 5CSX_GXB | GXB_RX_L4n                          | GXB_L1      | K1                     |                      |                      |                      |                      |
| 235               | 5CSX_GXB | GXB_TX_3_N                          | GXB_L1      | M1                     |                      |                      |                      |                      |
| 236               | PWR      | GND                                 |             |                        |                      |                      |                      |                      |
| 237               | PWR      | GND                                 |             |                        |                      |                      |                      |                      |
| 238               | 5CSX_GXB | GXB_RX_L5p                          | GXB_L1      | F2                     |                      |                      |                      |                      |
| 239               | 5CSX_GXB | GXB_TX_4_P                          | GXB_L1      | H2                     |                      |                      |                      |                      |
| 240               | 5CSX_GXB | GXB_RX_L5n                          | GXB_L1      | F1                     |                      |                      |                      |                      |
| 241               | 5CSX_GXB | GXB_TX_4_N                          | GXB_L1      | H1                     |                      |                      |                      |                      |

| Module Pin Number | Class      | SCH NET Name                             | Bank Number | Cyclone V 5CSXFC6 U672 | HPS Pin Mux Select 3 | HPS Pin Mux Select 2 | HPS Pin Mux Select 1 | HPS Pin Mux Select 0    |
|-------------------|------------|------------------------------------------|-------------|------------------------|----------------------|----------------------|----------------------|-------------------------|
| 242               | 5CSx_D     | USB1_FAULT_N                             |             |                        |                      |                      |                      |                         |
| 243               | PWR        | GND                                      |             |                        |                      |                      |                      |                         |
| 244               | 5CSx_HPS   | SDMMC_CLK_IN/USB0_CLK/HPS_GPIO44         | 7C          | B12                    | SDMMC_CLK_IN         | USB0_CLK             |                      | HPS_GPIO44              |
| 245               | 5CSX_GXB   | GXB_TX_5_P                               | GXB_L1      | D2                     |                      |                      |                      |                         |
| 246               | 5CSx_D     | USB1_PS_ON                               |             |                        |                      |                      |                      |                         |
| 247               | 5CSX_GXB   | GXB_TX_5_N                               | GXB_L1      | D1                     |                      |                      |                      |                         |
| 248               | 5CSx_HPS   | SDMMC_D1/USB0_D3/HPS_GPIO39              | 7C          | B6                     | SDMMC_D1             | USB0_D3              |                      | HPS_GPIO39              |
| 249               | 5CSx_D     | QSPI_SS0,BOOTSEL1/HPS_GPIO33             | 7B          | A6                     | QSPI_SS0,BOOTSEL1    |                      |                      | HPS_GPIO33              |
| 250               | 5CSx_HPS   | SDMMC_D0/USB0_D2/HPS_GPIO38              | 7C          | C13                    | SDMMC_D0             | USB0_D2              |                      | HPS_GPIO38              |
| 251               | 5CSx_HPS   | RGMI11_RX_CLK/NAND_DQ5/HPS_GPIO24        | 7B          | J12                    | NAND_DQ5             | RGMI11_RX_CLK        | USB1_D6              | HPS_GPIO24              |
| 252               | 5CSx_HPS   | SDMMC_PWREN/USB0_D1/HPS_GPIO37           | 7C          | A5                     | SDMMC_PWREN          | USB0_D1              |                      | HPS_GPIO37              |
| 253               | 5CSx_HPS   | HPS_GPIO28,BOOTSEL2/NAND_WE              | 7B          | D15                    | NAND_WE              | QSPI_SS1             |                      | HPS_GPIO28,B<br>OOTSEL2 |
| 254               | 5CSx_HPS   | SDMMC_CLK/USB0_STP/HPS_GPIO45            | 7C          | B8                     | SDMMC_CLK            | USB0_STP             |                      | HPS_GPIO45              |
| 255               | 5CSx_HPS   | RGMI11_RX_CTL/NAND_DQ3/HPS_GPIO22        | 7B          | J13                    | NAND_DQ3             | RGMI11_RX_CTL        | USB1_D4              | HPS_GPIO22              |
| 256               | 5CSx_D     | RTC_PSW/IRQ2_N                           |             |                        |                      |                      |                      |                         |
| 257               | 5CSx_HPS   | RGMI11_RXD0/NAND_DQ0/HPS_GPIO19          | 7B          | A14                    | NAND_DQ0             | RGMI11_RXD0          |                      | HPS_GPIO19              |
| 258               | 5CSx_HPS   | SDMMC_CMD/USB0_D0/HPS_GPIO36             | 7C          | D14                    | SDMMC_CMD            | USB0_D0              |                      | HPS_GPIO36              |
| 259               | 5CSx_HPS   | RGMI11_RXD1/NAND_DQ6/HPS_GPIO25          | 7B          | A11                    | NAND_DQ6             | RGMI11_RXD1          | USB1_D7              | HPS_GPIO25              |
| 260               | 5CSx_HPS   | SDMMC_D3/USB0_NXT/HPS_GPIO47             | 7C          | B9                     | SDMMC_D3             | USB0_NXT             |                      | HPS_GPIO47              |
| 261               | 5CSx_HPS   | RGMI11_RXD2/NAND_DQ7/HPS_GPIO26          | 7B          | C15                    | NAND_DQ7             | RGMI11_RXD2          |                      | HPS_GPIO26              |
| 262               | 5CSx_HPS   | SDMMC_D2/USB0_DIR/HPS_GPIO46             | 7C          | B11                    | SDMMC_D2             | USB0_DIR             |                      | HPS_GPIO46              |
| 263               | 5CSx_HPS   | RGMI11_RXD3/NAND_WP/HPS_GPIO27           | 7B          | A9                     | NAND_WP              | RGMI11_RXD3          | QSPI_SS2             | HPS_GPIO27              |
| 264               | 5CSx_HPS   | SDMMC_D4/USB0_D4/HPS_GPIO40              | 7C          | H13                    | SDMMC_D4             | USB0_D4              |                      | HPS_GPIO40              |
| 265               | 5CSx_HPS   | RGMI11_MDC/NAND_DQ2/I2C3_SCL/HPS_GPIO21  | 7B          | A13                    | NAND_DQ2             | RGMI11_MDC           | I2C3_SCL             | HPS_GPIO21              |
| 266               | 5CSx_HPS   | SDMMC_D5/USB0_D5/HPS_GPIO41              | 7C          | A4                     | SDMMC_D5             | USB0_D5              |                      | HPS_GPIO41              |
| 267               | 5CSx_HPS   | RGMI11_MDIO/NAND_DQ1/I2C3_SDA/HPS_GPIO20 | 7B          | E16                    | NAND_DQ1             | RGMI11_MDIO          | I2C3_SDA             | HPS_GPIO20              |
| 268               | 5CSx_HPS   | SDMMC_D6/USB0_D6/HPS_GPIO42              | 7C          | H12                    | SDMMC_D6             | USB0_D6              |                      | HPS_GPIO42              |
| 269               | 5CSx_HPS   | RGMI11_TX_CTL/NAND_DQ4/HPS_GPIO23        | 7B          | A12                    | NAND_DQ4             | RGMI11_TX_CTL        | USB1_D5              | HPS_GPIO23              |
| 270               | 5CSx_HPS   | SDMMC_D7/USB0_D7/HPS_GPIO43              | 7C          | B4                     | SDMMC_D7             | USB0_D7              |                      | HPS_GPIO43              |
| 271               | 5CSx_HPS   | RGMI11_TX_CLK/NAND_ALE/HPS_GPIO14        | 7B          | J15                    | NAND_ALE             | RGMI11_TX_CLK        | QSPI_SS3             | HPS_GPIO14              |
| 272               | 5CSx_D     | USB1_ID                                  |             |                        |                      |                      |                      |                         |
| 273               | PWR-Output | +1.8V                                    |             |                        |                      |                      |                      |                         |
| 274               | 5CSx_D     | USB1_D_N                                 |             |                        |                      |                      |                      |                         |
| 275               | 5CSx_HPS   | RGMI11_TXD3/NAND_RB/HPS_GPIO18           | 7B          | D17                    | NAND_RB              | RGMI11_TXD3          | USB1_D3              | HPS_GPIO18              |
| 276               | 5CSx_D     | USB1_D_P                                 |             |                        |                      |                      |                      |                         |
| 277               | 5CSx_HPS   | RGMI11_TXD2/NAND_RE/HPS_GPIO17           | 7B          | A15                    | NAND_RE              | RGMI11_TXD2          | USB1_D2              | HPS_GPIO17              |
| 278               | 5CSx_D     | +USB1_VBUS                               |             |                        |                      |                      |                      |                         |
| 279               | 5CSx_HPS   | RGMI11_TXD1/NAND_CLE/HPS_GPIO16          | 7B          | J14                    | NAND_CLE             | RGMI11_TXD1          | USB1_D1              | HPS_GPIO16              |
| 280               | PWR        | GND                                      |             |                        |                      |                      |                      |                         |
| 281               | 5CSx_HPS   | RGMI11_TXD0/NAND_CE/HPS_GPIO15           | 7B          | A16                    | NAND_CE              | RGMI11_TXD0          | USB1_D0              | HPS_GPIO15              |
| I2C               |            | I2C0_SDA                                 | 7A          | C19                    | I2C0_SDA             | UART1_RX             | SPIM1_CLK            | HPS_GPIO63              |
| I2C               |            | I2C0_SCL                                 | 7A          | B16                    | I2C0_SCL             | UART1_TX             | SPIM1_MOSI           | HPS_GPIO64              |
| QSPI              |            | QSPI_IO0/USB1_CLK/HPS_GPIO29             | 7B          | A8                     | QSPI_IO0             |                      | USB1_CLK             | HPS_GPIO29              |
| QSPI              |            | QSPI_IO1/USB1_STP/HPS_GPIO30             | 7B          | H16                    | QSPI_IO1             |                      | USB1_STP             | HPS_GPIO30              |
| QSPI              |            | QSPI_IO2/USB1_DIR/HPS_GPIO31             | 7B          | A7                     | QSPI_IO2             |                      | USB1_DIR             | HPS_GPIO31              |
| QSPI              |            | QSPI_IO3/USB1_NXT/HPS_GPIO32             | 7B          | J16                    | QSPI_IO3             |                      | USB1_NXT             | HPS_GPIO32              |
| QSPI              |            | QSPI_CLK/HPS_GPIO34                      | 7B          | C14                    | QSPI_CLK             |                      |                      | HPS_GPIO34              |
| QSPI              |            | QSPI_SS1/HPS_GPIO35                      | 7B          | B14                    | QSPI_SS1             |                      |                      | HPS_GPIO35              |

| Module Pin Number | Class | SCH NET Name                              | Bank Number | Cyclone V 5CSXFC6 U672 | HPS Pin Mux Select 3 | HPS Pin Mux Select 2 | HPS Pin Mux Select 1 | HPS Pin Mux Select 0 |
|-------------------|-------|-------------------------------------------|-------------|------------------------|----------------------|----------------------|----------------------|----------------------|
| QSPI              |       | HPS_GPIO0                                 | 7D          | E4                     | RGMII0_TX_CLK        |                      |                      | HPS_GPIO0            |
| USB1              |       | HPS_GPIO9                                 | 7D          | C6                     | RGMII0_TX_CTL        |                      |                      | HPS_GPIO9            |
| USB1              |       | USB1_D0                                   | 7D          | C10                    | RGMII0_TXD0          | USB1_D0              |                      | HPS_GPIO1            |
| USB1              |       | USB1_D1                                   | 7D          | F5                     | RGMII0_TXD1          | USB1_D1              |                      | HPS_GPIO2            |
| USB1              |       | USB1_D2                                   | 7D          | C9                     | RGMII0_TXD2          | USB1_D2              |                      | HPS_GPIO3            |
| USB1              |       | USB1_D3                                   | 7D          | C4                     | RGMII0_TXD3          | USB1_D3              |                      | HPS_GPIO4            |
| USB1              |       | USB1_D4                                   | 7D          | C8                     | RGMII0_RXD0          | USB1_D4              |                      | HPS_GPIO5            |
| USB1              |       | USB1_D5                                   | 7D          | D4                     | RGMII0_MDIO          | USB1_D5              | I2C2_SDA             | HPS_GPIO6            |
| USB1              |       | USB1_D6                                   | 7D          | C7                     | RGMII0_MDC           | USB1_D6              | I2C2_SCL             | HPS_GPIO7            |
| USB1              |       | USB1_D7                                   | 7D          | F4                     | RGMII0_RX_CTL        | USB1_D7              |                      | HPS_GPIO8            |
| USB1              |       | USB1_CLK                                  | 7D          | G4                     | RGMII0_RX_CLK        | USB1_CLK             |                      | HPS_GPIO10           |
| USB1              |       | USB1_STP                                  | 7D          | C5                     | RGMII0_RXD1          | USB1_STP             |                      | HPS_GPIO11           |
| USB1              |       | USB1_DIR                                  | 7D          | E5                     | RGMII0_RXD2          | USB1_DIR             |                      | HPS_GPIO12           |
| USB1              |       | USB1_NXT                                  | 7D          | D5                     | RGMII0_RXD3          | USB1_NXT             |                      | HPS_GPIO13           |
| E1                | -     | Reserved (Future Use) - 10-Pin Equivalent |             |                        |                      |                      |                      |                      |
| E2                | -     | Reserved (Future Use) - 10-Pin Equivalent |             |                        |                      |                      |                      |                      |
| E3                | PWR   | GND - 10-Pin Equivalent                   |             |                        |                      |                      |                      |                      |
| E4                | PWR   | GND - 10-Pin Equivalent                   |             |                        |                      |                      |                      |                      |

#### Notes:

- 1) For more information about pin definitions and pin connection guidelines please refer to the Cyclone V Device Family Pin Connection Guidelines (<http://www.altera.com/literature/dp/cyclone-v/PCG-01014.pdf>)
- 2) The Keys are shown in the numbering but no actual pins exist. The connector is 314-pins counted as follows: 281 total "pins" minus 7 for the "keys" plus 40 for the E1, E2, E3 and E4 pin-groups.

## ELECTRICAL CHARACTERISTICS

**Table 8: Electrical Characteristics**

| Symbol                                                                                                                                                                                       | Parameter                   | Conditions                                                 | Min | Typ | Max  | Units |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------|------------------------------------------------------------|-----|-----|------|-------|
| VIN                                                                                                                                                                                          | Voltage supply, volt input. |                                                            | 4.8 | 5.0 | 5.15 | Volts |
| I <sub>5,0</sub>                                                                                                                                                                             | Quiescent Current draw      | 5.0 volt input, 800 MHz DDR3, no FPGA fabric, Linux prompt |     | 410 |      | mA    |
| I <sub>5,0-max</sub>                                                                                                                                                                         | Max current draw            | 5.0 volt input                                             |     | TBS | TBS  | mA    |
|                                                                                                                                                                                              |                             |                                                            |     |     |      |       |
| 1. Power utilization of the MitySOM-5CSX is heavily dependent on end-user application. Major factors include: ARM CPU PLL configuration, CPU Utilization, and external DDR3 RAM utilization. |                             |                                                            |     |     |      |       |

## ORDERING INFORMATION

The following table lists the standard module configurations. For shipping status, availability, and lead time of these or other configurations please contact your Critical Link representative.

**Table 9: Standard Model Numbers**

| Model          | Cores  | CPU MHz | Speed Grade | FPGA KLE | NOR  | FPGA I/O | FPGA RAM | HPS RAM | Component Temperature Ratings |
|----------------|--------|---------|-------------|----------|------|----------|----------|---------|-------------------------------|
| 5CSE-L2-3Y8-RC | Single | 600     | 8           | 25       | 16MB | 133      | N/A      | 512MB   | 0°C to 70°C                   |
| 5CSE-S2-3Y8-RI | Single | 800     | 7           | 25       | 16MB | 133      | N/A      | 512MB   | -40°C to 85°C                 |
| 5CSE-H4-3YA-RC | Dual   | 800     | 7           | 40       | 16MB | 133      | N/A      | 1GB     | 0°C to 70°C                   |
| 5CSE-H4-3YA-RI | Dual   | 800     | 7           | 40       | 16MB | 133      | N/A      | 1GB     | -40°C to 85°C                 |
| 5CSX-H5-4YA-RC | Dual   | 800     | 7           | 85       | 32MB | 133      | N/A      | 1GB     | 0°C to 70°C                   |
| 5CSX-H5-4YA-RI | Dual   | 800     | 7           | 85       | 32MB | 133      | N/A      | 1GB     | -40°C to 85°C                 |
| 5CSX-H6-42A-RC | Dual   | 800     | 7           | 110      | 32MB | 107      | 256MB    | 1GB     | 0°C to 70°C                   |
| 5CSX-H6-42A-RI | Dual   | 800     | 7           | 110      | 32MB | 107      | 256MB    | 1GB     | -40°C to 85°C                 |
| 5CSX-H6-4YA-RC | Dual   | 800     | 7           | 110      | 32MB | 133      | N/A      | 1GB     | 0°C to 70°C                   |
| 5CSX-H6-4YA-RI | Dual   | 800     | 7           | 110      | 32MB | 133      | N/A      | 1GB     | -40°C to 85°C                 |
| 5CSX-H6-53B-RC | Dual   | 800     | 7           | 110      | 48MB | 107      | 512MB    | 2GB     | 0°C to 70°C                   |

## MECHANICAL INTERFACE

A mechanical outline of the MitySOM-5CSx is illustrated in Figure 2, below.

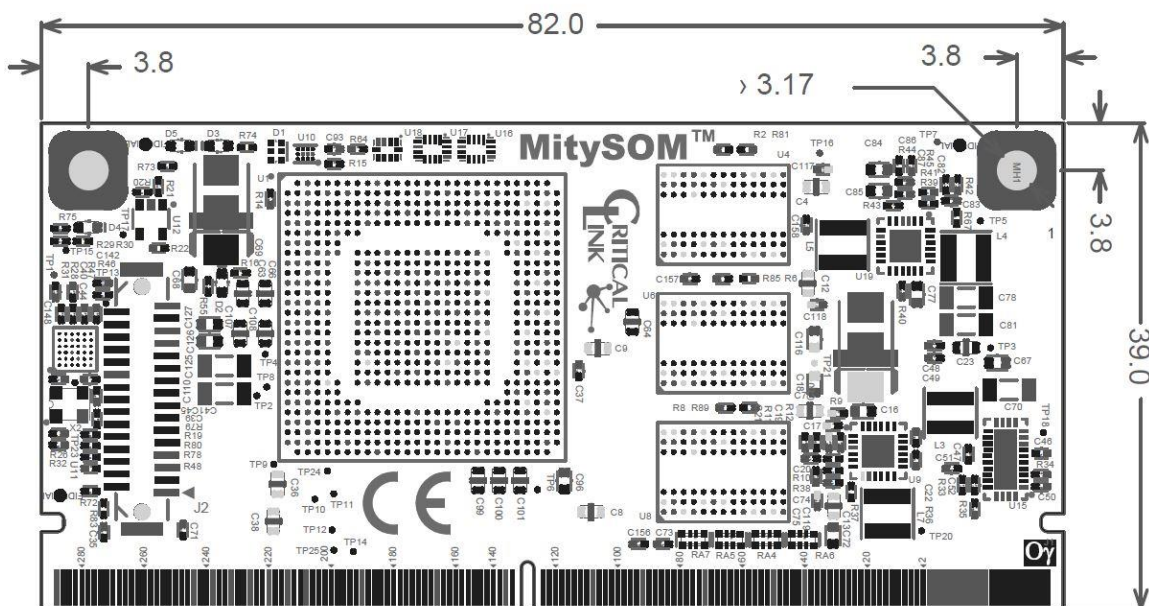


Figure 2 MitySOM-5CSx Mechanical Outline

## REVISION HISTORY

| Date               | Change Description             |
|--------------------|--------------------------------|
| May 31, 2013       | Preliminary specification      |
| September 12, 2013 | Initial release                |
| March 5, 2014      | Update MitySOM product name    |
| March 31, 2014     | Update memory data             |
| November 19, 2014  | Modifications for MitySOM-5CSE |

## FOOTNOTES

- [1] [http://www.altera.com/literature/hb/cyclone-v/cv\\_5400A.pdf](http://www.altera.com/literature/hb/cyclone-v/cv_5400A.pdf)
- [2] [http://www.altera.com/literature/hb/cyclone-v/cv\\_52007.pdf](http://www.altera.com/literature/hb/cyclone-v/cv_52007.pdf)
- [3] JTAG USB-Blaster I <http://components.arrow.com/part/search/P0302?region=na>
- [4] <http://www.altera.com/support/devices/estimator/pow-powerplay.jsp>



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