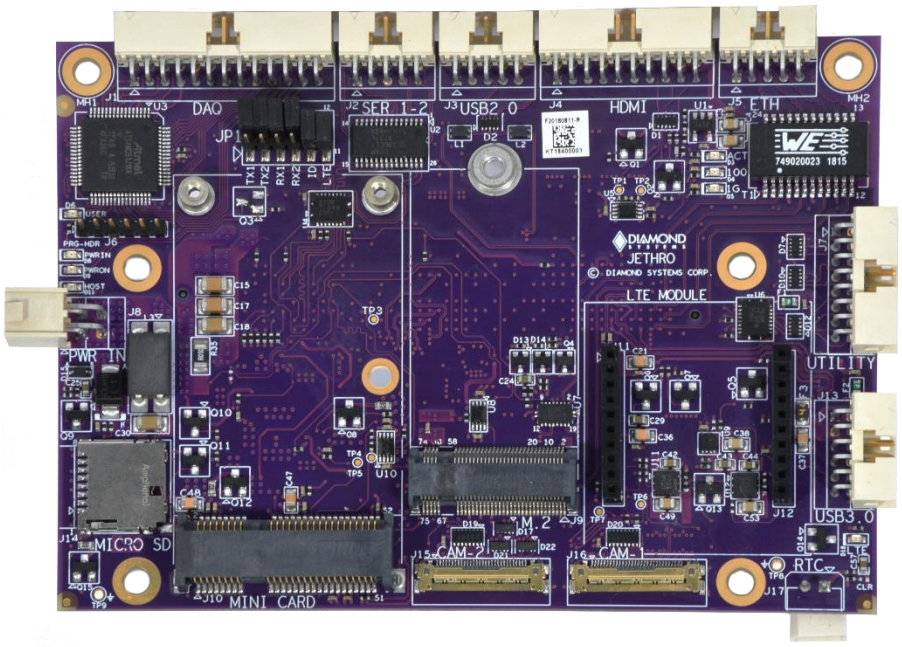
JETHRO BASE BOARD

Integrated NVIDIA® JETSON™ TX2/TX2i SoM

USER MANUAL



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Contents

1. IMPORTANT SAFE HANDLING INFORMATION

WARNING! Electrostatic Discharge (ESD)

ESD-Sensitive Electronic Equipment

Observe ESD-safe handling procedures when working with this product.

Always use this product in a properly grounded work area and wear appropriate ESD-preventive clothing and/or accessories.

Always store this product in ESD-protective packaging when not in use.

Safe Handling Precautions

Diamond Systems Boards are designed with complex circuitry and electronic components that are ESD-sensitive. This increases the likelihood of the boards incurring accidental damage during handling, installation and connection to other equipment.

It is highly recommended that the following precautionary measures and best practices be observed in a sequential order:

- Wear an anti-static Wristband/Strap or/and an antistatic Lab Coat or/and Rubber-soled shoes.
- Spread anti-static mats over the table or work surface or/and anti-static mats on the floor.
- Unpack components and remove them from their anti-static bags only when they are ready to be used.
- Avoid ungrounded surfaces such as plastic, carpets, floors, or tables, in the work area.
- Handle boards by the edges and the metal mounting brackets. Avoid touching components on the boards and the edge connectors that connect to expansion slots.

The following information describes common causes of failure found on boards and systems returned to Diamond Systems for repair. It is provided as a guideline to avoid accidental damage.

ESD Damage – This type of damage is usually almost impossible to detect because there is no visual sign of failure or damage. In this type of damage, the board eventually stops working because of some defective components. Usually the failure can be identified and the chip can be replaced.

To prevent ESD damage, always follow proper ESD-prevention practices when handling computer boards.

Damage During Handling or Storage – Physical damage on boards also occur due to mishandling. A common observation is that of a screwdriver slipping on the board during installation, causing a gouge on the PCB surface, cutting signal traces or damaging components.

Another common observation are damaged board corners, indicating the board was dropped. This may or may not cause damage to the circuitry, depending on components located near the edges. Most of our boards are designed with minimum 25 mils clearance between the board edge and component pad. The ground/power planes are located minimum 20 mils from the edge to avoid possible shorting from this type of damage. However, these design rules do not prevent damage in all situations.

Another cause of damage occurs when a metal screwdriver tip slips, or a screw drops onto the board while it is powered-up, causing a short between a power pin and a signal pin on a component. This can cause over voltage/power supply problems described below.

To avoid this type of failure, assembly operations must be performed when the system is powered off.

Sometimes boards are stored in racks with slots that grip the edge of the board. This is a common practice for board manufacturers. Though, our boards are resilient to damages, the components located close to the board edges can be damaged or even knocked off the board if the board lies tilted in the rack.

Diamond Systems recommends that all our boards be stored only in individual ESD-safe packaging units. If multiple boards are stored together, they should be contained in bins with dividers placed between the boards. Do not pile boards on top of each other or cram too many boards within a small location. This can cause damage to connector pins or fragile components.

Power Supply Wired Backwards – Our power supplies and boards are not designed to withstand a reverse power supply connection. This will destroy almost all ICs connected to the power supply. In this case the board will most likely be irreparable and must be replaced. A chip destroyed by reverse power or excessive power will often have a visible hole or show some deformation on the surface due to vaporization inside the package.

IMPORTANT! Check twice before Powering Up!

Overvoltage on Analog Input – If a voltage applied to an analog input exceeds the power specification of the board, the input multiplexor and/or parts behind it can be damaged. Most of our boards will withstand an erroneous connection of up to 36V on the analog inputs, even when the board is powered off, but not on all boards, and not under all conditions.

Overvoltage on Analog Output – If an analog output is accidentally connected to another output signal or a power supply voltage, the output can be damaged. On most Diamond boards, a short circuit to ground on an analog output will deter any damage to the board.

Overvoltage on Digital I/O Line – If a digital I/O signal is connected to a voltage above the maximum specified voltage, the digital circuitry can be damaged. The acceptable range of voltage, on most of our boards connected to digital I/O signals is 0-5V, with overvoltage protection up to 5.5V (-0.5 to 5.5V). Overvoltage beyond this limit can damage the circuitry.

Another consideration are logic signals which are commonly generated between 12V to 24V. If a Digital I/O Line of 12V to 24V is connected to a 5V logic chip, the chip will be damaged, and the damage could extend to other chips in the circuit.

Bent Connector Pins – This type of problem can be easily fixed by re-bending the pins to their original shape using needle-nose pliers.

The most common cause of a bent connector pin is when the board is pulled off the stack by rocking it at angles, from one end of the connector to the other, in an effort to release it off the stack. Tugging the board off the stack in this manner can bend the pin(s) significantly.

A similar situation can occur when pulling a ribbon cable off a pin header. If the pins are bent too severely, bending them back can cause them to weaken or break. In this case, the connector must be replaced.

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2. INTRODUCTION

2.1 JETHRO Base Board Overview

The Jethro Base Board integrate NVIDIA® Jetson™ TX2/TX2i Modules in an ultra-compact sized Form Factor measuring 4.2” H x 3” W (106.68 mm x 76.2 mm).

Engineered with complex circuitry and I/O connectors, the Base Board utilizes all available features of the Jetson TX2/TX2i Modules to deliver highly versatile performance in industrial environments.

The Jetson™ TX2/TX2i Modules transform the Base Board into a full-featured, rich, embedded system that significantly enhances performance, power efficiency, Deep Learning, optimized I/O capabilities and more, all designed to accommodate a new generation of products.

Integrated Components

- Camera Interface
- Power Supply: +9V/+5.5V to +18VDC in; +12V Typical
- PCIe Mini Card Expansion Socket M.2 SATA Module
- MicroSD Card Storage Options
- I/O Capabilities

2.2 JETSON TX2/TX2i Modules Overview

The Jetson TX2/TX2i are 1.96” x 3.42” (50 mm x 87 mm) sized high-end, low-powered Modules embedded with Artificial Intelligence (AI) capabilities which enable Deep Learning Applications to operate in Small Form-Factor (SFF) products like Computer-on-Modules (COMs), Smart Cameras, Legacy and Smart Devices, within a secure and automotive environment.

Modeled on Neural Networking Technology, the Jetson TX2/TX2i Modules interpret and translate media: numerical, graphical, sound, video and text dataset patterns. Deep Learning Applications identify these dataset patterns and deliver advanced, superior results at amazing speeds.

Integrated Components

- 256 Core NVIDIA Pascal GPU
- ARMv8 (64-bit) Multi-Processor CPU
- Advanced HD Video Encoder and Decoder
- eMMC Flash, SATA, SD Card Storage
- Camera Interface: MIPI CSI 2.0 - 2.5 Gbps Per Lane
- Power Supply: 7.5W

3. PRODUCT SPECIFICATIONS

3.1 JETHRO Base Board Specifications

Mechanical Properties

COM Form Factor Dimensions	4.2” H x 3” W (106.68 mm x 76.2 mm}
Weight	TBU

Electrical Properties

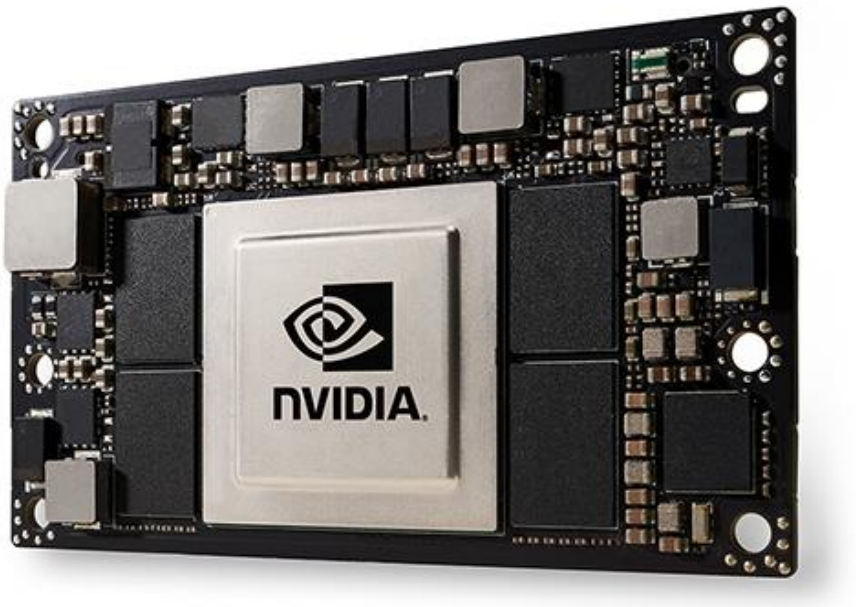
DC Power Input Voltage	+9V/+5.5V to +18VDC; +12V Typical Load
TX2 Module	+5.5V to +18VDC
TX2i Module	+9VDC to +18VDC

Power Consumption	~10W
Ambient Operating Temperature	-40°C to +85°C on Outer Surface of Heat Spreader -40°C to +85°C (-40°F to +185°F)
Cooling	Conduction Cooling, Heat Spreader

Environmental Properties

Shock	MIL-STD-202G Compatible Method 213-B, Table 213-1 Condition A, 50G / 11ms half sine, Non-Operational
Vibration	MIL-STD-202G, Method 214A, Table 214-1, Condition D, 11.95G random vibration, 15 minutes per axis, Operational
RoHS	Compliant

3.2 JETSON TX2/TX2i Modules Specifications



Front View: JETSON TX2/TX2i Series Module

Mechanical Properties

COM Form Factor Dimensions	1.96” H x 3.42” W (50 mm x 87 mm)
Weight	85 Grams, including TTP
Board-to-Board Connector	Samtec 400-pin

Electrical Properties

Power Input	5.5-19.6VDC (7.5W Under Typical Load)

Power Consumption	7.5-Watt – 15 Watts
Temperature Range at Module Thermal Transfer Plate (TTP)	-40°C to +85°C on Outer Surface of Heat Spreader -40°C to +85°C (-40°F to +185°F)
Cooling	Conduction Cooling

Environmental Properties

Shock	140G, 2ms
Vibration	10Hz ~200Hz, 1g & 2g RMS
Humidity	85°C / 85% RH, 168 Hours
RoHS	Compliant

4. JETHRO BASE BOARD COMPONENTS AND SPECIFICATIONS

The JETHRO Base Board Components and Specifications are summarized in the following Table.

Components	***Specifications***			
NVIDIA Jetson Modules	***Components***	***TX2i 4 GB***	***TX2***	***TX2i***
	GPU	NVIDIA Pascal Architecture with 256 NVIDIA CUDA Cores		
	CPU	Dual-core Denver 2 64-bit CPU and Quad-Core ARM A57 Complex		
	SYSTEM on a CHIP (SoC)	Parker Series		
	MEMORY	4 GB 128-Bit LPDDR4	8 GB 128-Bit LPDDR4	8 GB 128-Bit LPDDR4
	STORAGE	16 GB eMMC 5.1	32 GB eMMC 5.1	32 GB eMMC 5.1
	DISPLAY	HDMI 2.0 / eDP 1.4 / 2x DSI / 2x DP 1.2		
	VIDEO ENCODE	3x 4k @ 30 (HEVC)		
	VIDEO DECODE	4x 4k @ 30 (HEVC)		
	CONNECTIVITY	Wi-Fi requires External Chip	Wi-Fi On-Board	Wi-Fi requires External Chip

On-Board Components	***Specifications***
Memory	1x mSATA SSD Socket
Camera	2x MIPI CSI-2 4 Lane - up to 2.5 Gbps
Connectivity	1x 10/100/100 Mbps Ethernet routed from Module 1x NimbeLink Skywire® 4G LTE
SATA	1 Port from Module to M.2 SATA Interface
USB Ports	2x USB 2.0 Ports to Standard Header Interface. *1x USB 2.0 From Module through Mux to Mini PCI-Express (mPCIe) and LTE Module. Interface

On-Board Components		*Specifications*
		1x USB 3.0 Ports to USB 3.0 Header Interface **NOTE: Only one USB 3.0 port is supported by the current software**.
Display	HDMI	Routed from Module Interface
Serial Ports		2 Ports with RS-232/422/485 Capability 4 RS-232/422/485 Ports
Mass Storage		1x M.2 SATA, 1x MicroSD Slot
DAQ		13x Digital I/O with 6x ADC Input 2x DAC Output
Expansion Slots		1x PCIe Mini Card with 1x PCIe and USB
Utility		1x I2C, 1x UART, 1x SPI, 1x CAN Reset
Cooling		Heat Spreader
Operating System		Linux Kernel version 4.4.38, Ubuntu 16.04 AArch64

5. JETHRO BASE BOARD FUNCTIONAL OVERVIEW

5.1 Functional Description

The Base Board implements the processor and chipset functionalities of the Jetson™ TX2/TX2i Modules.

Designed to harnesses the power of Jetson TX2/TX2i Modules, the JETHRO Base Board complements the advanced technological resources embedded in the Module. Utilizing its extensive set of system and peripheral interfaces, it enables Users to seamlessly install, operate, and maintain a wide array of applications for use in industrial and commercial environments.

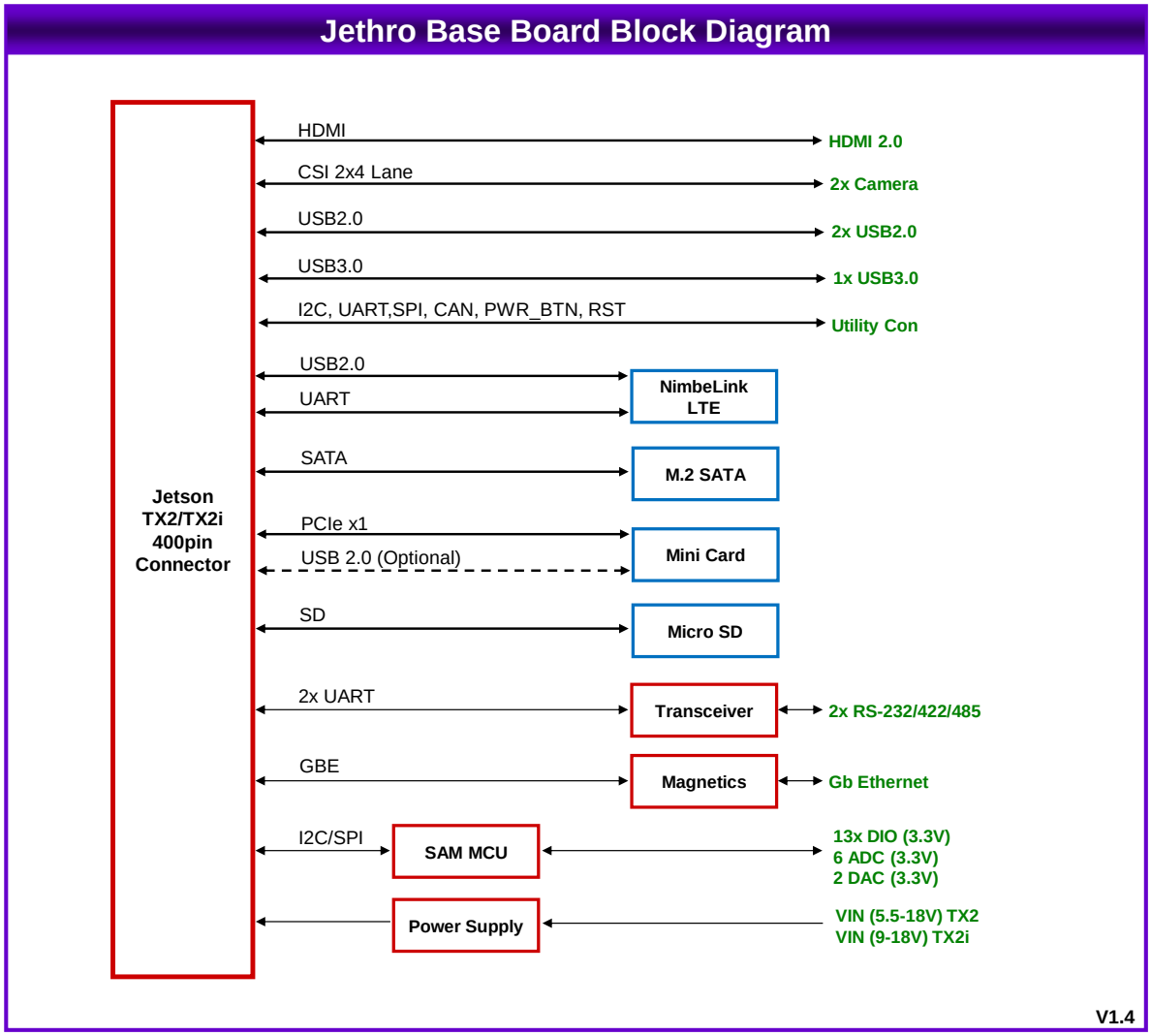
Media features such as, Audio and Video I/O, wide ranging Camera Image Signal Processing, and Deep Learning Application capabilities are only some of the highlights of the JETHRO Base Board functionalities.

The Built-in SAM Microcontroller interface provides Digital I/O and Analog Input Signals, and stores ADC/DAC calibration values using the SPI interface linked to the Module.

Power is supplied through the +9VDC/+5.5V to 18VDC wide-range DC power supply, which is built-in the Base Board. This enables the Board to connect to Industrial Power Standards.

6. FUNCTIONAL BLOCK DIAGRAM

The following Block Diagram illustrates the Key Functional Blocks of the JETHRO Base Board with the integrated NVIDIA Jetson TX2/TX2i Modules.



Functional Block Diagram: JETHRO Base Board and JETSON TX2/TX2i Module Connector

6.1 JETHRO Base Board Key Subsystems

This Section provides details of the key sub-systems implemented on the JETHRO Base Board.

The term 'Module' references components and specifications applicable to both Jetson TX2 and TX2i Modules unless wherein specified.

6.1.1 JETSON TX2/TX2i Processor Modules

The Base Board supports Jetson TX2/TX2i Modules.

The Jetson TX2/TX2i Modules are the fastest power-efficient embedded AI computing devices and the latest addition to the industry-leading Jetson embedded platform technology.

The TX2/TX2i Module complex consists of ARMv8 (64-bit) Multi-Processor CPU that contains 128-Bit GB LPDDR4 Main Memory and 32 GB eMMC Flash Memory that deliver up to 59.7 GB/s Peak Bandwidth on the TX2 Module and up to 51.2 GB/s Peak Bandwidth on the TX2i Module.

With advanced built-in HD Encoders and Decoders, both modules are capable of handling Hi-Res Videos along with Audio processing.

The Modules contain built-in Ethernet, Wi-Fi and Bluetooth ports and a CAN Bus Controller and feature a variety of standard hardware interfaces that make them easy to integrate into a wide range of products and form factors.

6.1.2 Backup Battery

A 2x1 Input Connector is provided on the Base Board to connect an external backup battery.

6.1.3 Ethernet Port

The Base Board provides one 10/100/1000 Ethernet port routed from the Module. The Ethernet port contains On-board magnetics to enable the use of a DSC standard Ethernet cable.

On-board LEDs are provided to indicate the Link, Activity, and Speed status of each port. The LEDs are located along the edge of the Base Board adjacent to the Ethernet connectors.

6.1.4 Display Output

The Base Board supports HDMI 2.0 a/b Video Output.

The HDMI port is routed from the Jetson TX2/TX2i Module and is accessible on a 2x10 Header. Integrated audio support is provided along with HDMI Display.

6.1.5 Camera Serial Interface

The Jetson TX2/TX2i Modules support three MIPI CSI x4 bricks. This enables a variety of device types and combinations to be supported. Up to three quad lane stereo cameras or six dual lane camera streams are available. Each data lane has a peak bandwidth of up to 2.5 Gbps.

The Base Board supports two MIPI CSI x4 camera interfaces through the 30-pin I-PEX Connector. It supports I2C Signals and Control Signals which are accessible through the Connector. This enables the User to directly interface the camera to the Base Board.

6.1.6 SATA Controller

The SATA Port is routed from the Jetson TX2/TX2i Module to the M.2 SATA socket sized 22 mm x 42 mm form factor on the Base Board. The SATA Controller enables external SATA devices such as SSD, HDD or ODD Drives to connect. One M3 threaded spacers is mounted on the board for installing the 2242 module

6.1.7 USB Interfaces

Based on the USB 3.0, PCIe and SATA Lane Mapping Configuration 3, 3x USB 2.0 ports, and 2x USB 3.0 ports are routed from the Jetson TX2/TX2i Module. The USB interfaces are mapped as follows:

- Two USB 2.0 ports are routed to 2x5 USB 2.0 Header.
- One USB 2.0 connection routed from the Jetson TX2/TX2i Module is interfaced to the NimbeLink LTE Module and PCIe Minicard socket via high speed mux

NOTE: A Jumper selection option is available to select USB 2.0 port via the NimbeLink LTE Module or the PCIe Minicards.

- One USB 3.0 port is routed through the 2x5 Header.

NOTE: Only USB 3.0 Signals are supported by the 2x5 Header. Backward compatibility to USB 2.0 is not supported.

6.1.8 Audio Interface

The Audio interface is integrated with the HDMI interface. No additional audio analog outputs are provided.

6.1.9 Serial Ports

The Base Board provides 4 Serial Ports routed from the Jetson TX2/TX2i Module.

- Two Serial Ports are available on the 2x5 Header through SP336 Transceiver with the option to select RS232/422/485 serial interface. Jumpers for Termination Control Circuit are implemented to enable Termination Resistor (120 Ohm) for RS422 and RS485 protocols.
- One Serial Port is reserved for connecting NimbeLink LTE Module. The second UART interface is connected to the Utility Header for extensibility.

6.1.10 DAQ I/O Component

The Base Board integrates a SAM Microcontroller which hosts 13 Digital I/O Signals, 6 Analog Inputs, and 2 DAC Outputs, made available through the 2x13 Header. The I/Os operate at 3.3V range level.

The SAM Microcontroller interfaces the Jetson TX2/TX2i Module via the SPI interface. An EEPROM is connected to the controller for storing the calibration values of ADC/DAC.

6.1.11 PCIe Minicard Socket

The Base Board is equipped with a full size PCIe Minicard socket which is 51 mm in length. The socket supports an optional USB 2.0 interface for further expansion/connectivity. Two M2 threaded spacers are mounted on the board for installing a full-size module

Refer to Section 6.1.7 for more details on the USB interfaces.

6.1.12 PCIe Link Routing

Based on USB 3.0, PCIe and SATA Lane Mapping Configuration 2, one PCIe port with x4 lane is available from the Jetson TX2/TX2i Module. Only x1 lane is utilized on the Base Board for the Mini PCIe socket.

6.1.13 Network Connectivity

The Jetson TX2/TX2i Module supports WLAN and Bluetooth connectivity which are integrated with the Male I-PEX antenna connectors. Both are located on the Jetson TX2/TX2i Module.

WLAN Connectivity

- 2x2 MIMO
- 802.11ac compliant. Backward compatible with Legacy 802.11b/g/a/n devices.

Bluetooth Connectivity

- Bluetooth 4.1: Connects Bluetooth 4.1 enabled devices.
- HIDP
- Audio: Advanced Audio Distribution Profile (A2DP)
- RFKILL

The Base Board supports sockets for plugging Skywire LTE CAT1 Module from the NimbeLink LTE Module.

A 2x10 sized socket is provided on the Base Board with USB and UART interfaces to support the LTE Module.

6.1.14 Led Indicators

The Base Board hosts the LED Indicators. The On-Board LED Indicator panel is located at the Base Board edge. The LEDs are displayed on a silkscreen panel with a description of their function and status as listed below.

LED INDICATORS	*Description*
User LED	Green LED indicates DAQ Activity Status.
Power In	Green LED indicates that Power is IN.
Power OK	Green LED indicates Standby Power is Good.
Host LED	Green LED indicates Module Booted Successfully.
Ethernet	Green LED indicates Link, Activity, and Speed Status for each Port.

6.1.15 Power Supply Specification

The Base Board is powered by a wide range pf power supply ranging from +9VDC/+5.5V to 18VDC. The typical input voltage is +12VDC.

The On-board voltage supply is generated from the Input Connection.

The voltage supplied meets the maximum capacity standards specified by the Jetson TX2/TX2i Module specifications and yet contains reserves to power additional peripherals and features listed in the Table below.

Input Voltage Operating Power Specifications

12 Volts	*5 Volts*	*3.3 Volts*	*Feature*
1.6A			Jetson TX2/TX2i Module
		2A	PCIe Minicard Socket
		1A	M.2 SSD
	2A		USB Ports (USB2:0.5A, USB3: 1A)
	0.2A	0.2A	Camera Circuit

7. MECHANICAL DRAWINGS

7.1 JETHRO Base Board

Figure 1 illustrates the Mechanical Top View of the JETHRO Base Board.

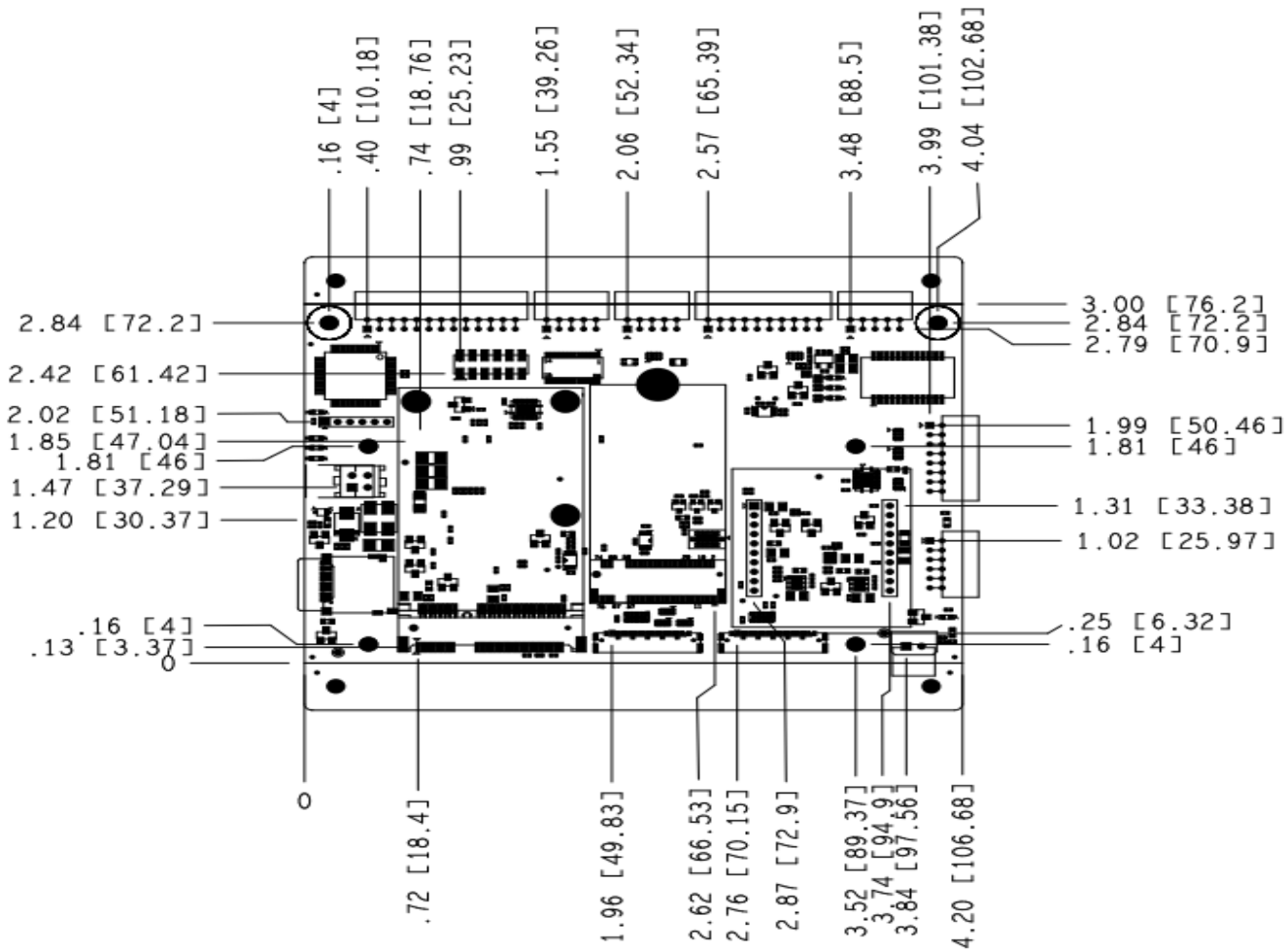
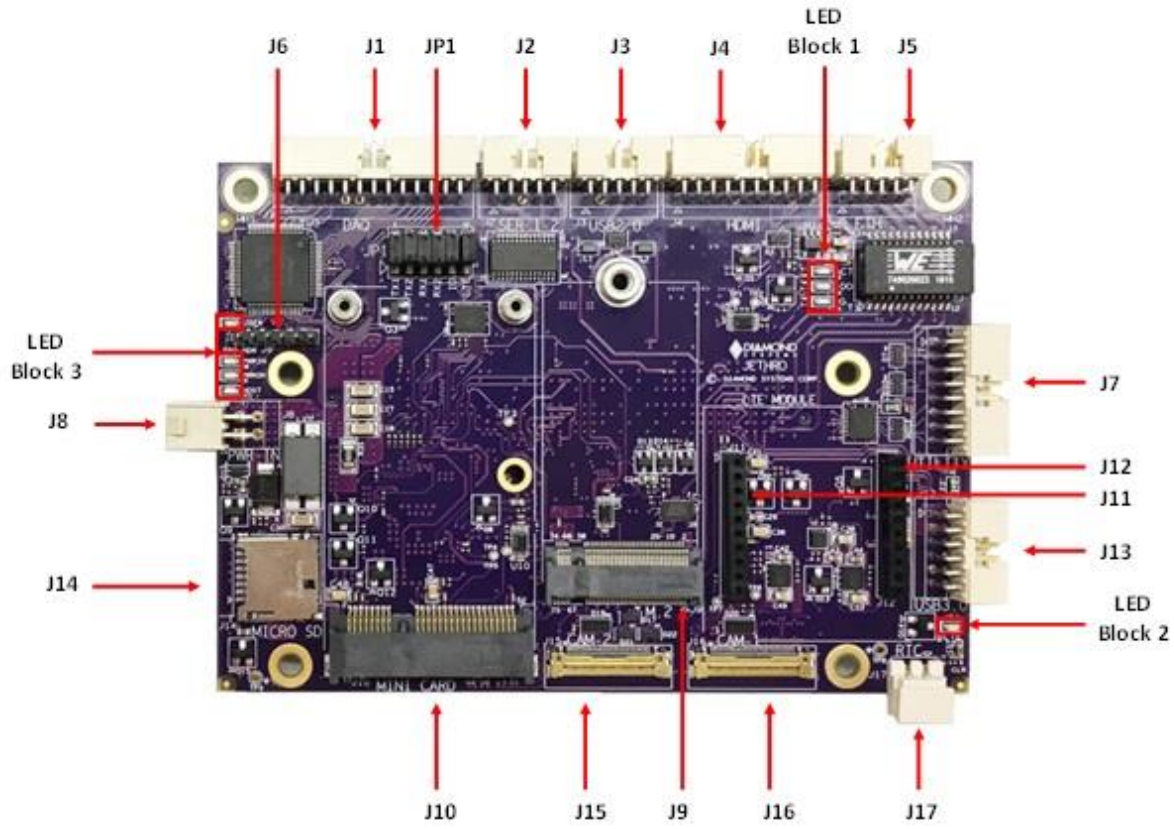


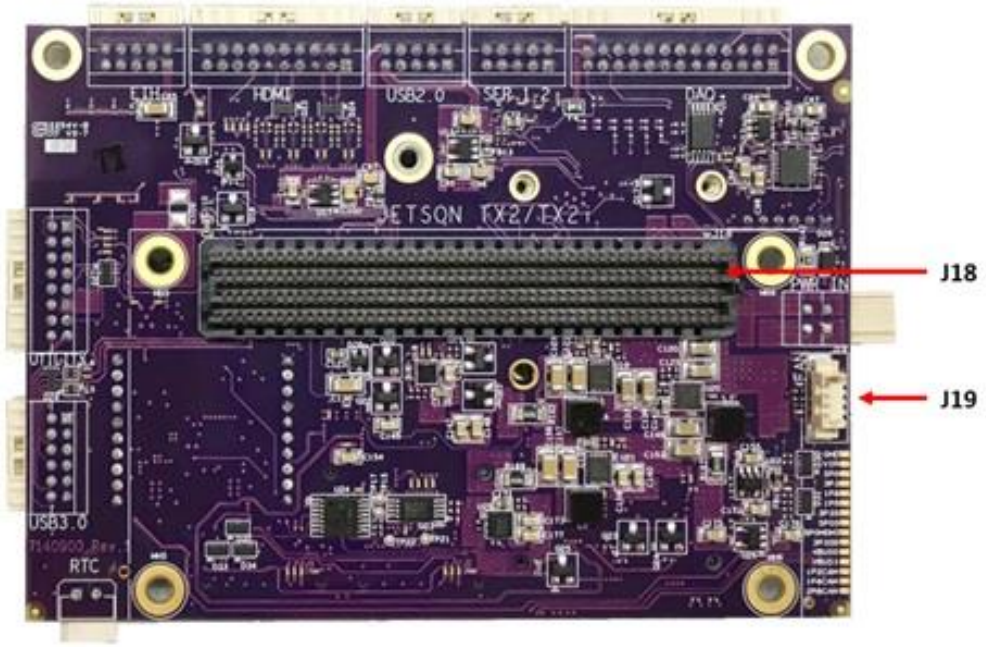
Figure 1: Top View of JETHRO Base Board

8. BASE BOARD CONNECTOR AND JUMPER LOCATIONS LAYOUT

The following images display the Top and Bottom Layouts of the JETHRO Base Board. A description of the Jumpers and Connectors is tabulated below.



JETHRO Base Board: Top View of Jumpers and Connectors



JETHRO Base Board: Bottom View of Jumpers and Connectors

8.1 I/O Connectors, Jumpers and LED Specifications

The following Table provides the I/O Connector and Jumper Specifications.

Connector	*Function*	*Jumper*	*Function*
J1	DAQ	**JP1**	Serial Termination, USB selection
J2	Serial ports 1,2		
J3	USB2.0	***LED Block 1***	
J4	HDMI	1st LED: Top of the Block	1Gbps link
J5	GbE Port	2nd LED	100Mbps link
J6	SAM Programming Header	3rd LED	Gbe ACT
J7	Utility	***LED Block 2***	
J8	Power In	Single LED	LTE Link/Sleep
J9	M.2 SATA	***LED Block 3***	
J10	PCIe Mini Card	1st LED: Top of the Block	SAM User LED
J11/J12	LTE Socket	2nd LED: Centered on the Block	Power In
J13	USB3.0	3rd LED	Power OK
J14	MicroSD	4th LED	Host LED
J15	MIPI Camera-2		
J16	MIPI Camera-1		
J17	External Battery		
J18 (Bottom)	Jetson TX2 Module		
J19 (Bottom)	FAN		

9. I/O PIN CONNECTOR SPECIFICATIONS

9.1 Connector Pin-out and Signal Definition

9.1.1 Data Acquisition (DAQ) Connector: J1

Connector Type: Standard 2mm Dual Row RA Header

Mating Cable Part No. for Latching Connector: 6980606

The following Table provides the Connector Pin and Signal specifications.

Pin Signal	*Pin No.*	*Pin No.*	*Pin Signal*
AIN0 / 0-	**A01**	**B01**	AIN1 / 0+
AIN2 / 1-	**A02**	**B02**	AIN3 / 1+
AIN4 / 2-	**A03**	**B03**	AIN5 / 2+
DAC0	**A04**	**B04**	DAC1
Aground	**A05**	**B05**	Aground

Pin Signal	*Pin No.*	*Pin No.*	*Pin Signal*
Dground	**A06**	**B06**	+3.3V Fused
DIO 0	**A07**	**B07**	DIO 1
DIO 2	**A08**	**B08**	DIO 3
DIO 4	**A09**	**B09**	DIO 5
DIO 6	**A10**	**B10**	DIO 7
DIO 8	**A11**	**B11**	DIO 9
DIO 10	**A12**	**B12**	DIO11
DIO 12 /RESET_IN	**A13**	**B13**	Dground

The following Table provides the Signal Name and its Definition.

Signal Name	*Definition*
AIN 5-0/AIN 2-0	Single/Differential Ended Analog Inputs at 3.3V Level
DAC 1-0	DAC Outputs at 3.3V Level
DIO 11-0	Digital I/O Port. Programmable Direction at 3.3V Level
DIO 12/RESET_IN	Digital IO at 3.3V Level. Reset In Signal at 1.8V Level
Dground	Digital Ground
Aground	Analog Ground

9.1.2 Serial Ports Connector: J2

Two serial ports from Jetson TX2/TX2i Module terminate at the 2x5 Connector. All ports for RS-232, RS-422, or RS-485 can be configured.

Connector Type: Standard 2mm Dual Row RA Header.

Mating Cable Part No. for Latching Connector: 6980601

RS232 Interface:

Pin Signal	Pin No.	Pin No.	*Pin Signal*
TX1	**A01**	**B01**	RTS1
RX1	**A02**	**B02**	CTS1
GND	**A03**	**B03**	GND
TX2	**A04**	**B04**	RTS2
RX2	**A05**	**B05**	CTS2

RS422 Interface:

Pin Signal	Pin No.	Pin No.	*Pin Signal*
TX1+	**A01**	**B01**	TX1-
RX1 +	**A02**	**B02**	RX1-
GND	**A03**	**B03**	GND
TX2+	**A04**	**B04**	TX2-
RX2+	**A05**	**B05**	RX2-

RS485 Interface:

Pin Signal	Pin No.	Pin No.	*Pin Signal*
TX1/RX1+	**A01**	**B01**	TX1/RX1-
NC	**A02**	**B02**	NC
GND	**A03**	**B03**	GND
TX2/RX2+	**A04**	**B04**	TX2/RX2-
NC	**A05**	**B05**	NC

9.1.3 USB 2.0 Ports Connector: J3

The USB 2.0 Connector provides access to two USB 2.0 ports.

Connector Type: Standard 2mm Dual Row RA Pin Header

Mating Cable Part No. For Latching Connector: 6980602

The following Table provides the Key positions and specifications.

Pin Signal	Pin No.	Pin No.	*Pin Signal*
Key	**A01**	**B01**	Shield
USB1 Power -	**A02**	**B02**	USB0 Power-
USB1 Data+	**A03**	**B03**	USB0 Data+
USB1 Data-	**A04**	**B04**	USB0 Data-
USB1 Power +	**A05**	**B05**	USB0 Power +

9.1.4 HDMI Connector: J4

The Connector Shell is tied to chassis ground.

Connector Type: Standard 2mm Dual Row RA Pin Header

Mating Cable Part No. For Latching Connector: 6980605

The following Table provides the Connector Pin and Signal specifications.

Pin Signal	*Pin No.*	*Pin No.*	*Pin Signal*
Data 2+	**A01**	**B01**	Ground
Data 2-	**A02**	**B02**	Data 1+
Ground	**A03**	**B03**	Data 1-
Data 0+	**A04**	**B04**	Ground
Data 0-	**A05**	**B05**	Clock+

Pin Signal	Pin No.	Pin No.	Pin Signal
Ground	**A06**	**B06**	Clock-
CEC	**A07**	**B07**	Reserved
DDC Clock	**A08**	**B08**	DDC Data
Ground	**A09**	**B09**	+5V
Hot Plug Detect	**A10**	**B10**	Chassis Ground

9.1.5 Ethernet Ports Connector: J5

Connector Type: Standard 2mm Dual Row RA Pin Header

Mating Cable Part No. for Latching Connector: 6980604

The following Table provides the Connector Pin and Signal specifications

Signal	Pin No.	Pin No.	Signal
ETH CH. Gnd	**A01**	**B01**	Key
DA+	**A02**	**B02**	DA-
DB+	**A03**	**B03**	DB-
DC+	**A04**	**B04**	DC-
DD+	**A05**	**B05**	DD-

9.1.6 SAM Programming Header Connector: J6

Connector Type: 1x 6 2mm Pitch Header

The following Table provides the Connector Pin and Signal specifications.

Pin No.	Pin Signal
1	3V3
2	SAM_RESET
3	SWCLK
4	SWDIO
5	GND
6	NC

9.1.7 Utility Connector: J7

Connector Type: Standard 2mm Dual Row RA Pin Header

Mating Cable Part No. for Latching Connector: 6980607

The following Table provides the Connector Pin and Signal specifications.

Pin Signal	Pin No.	Pin No.	Pin Signal
Power Button	**A01**	**B01**	Sleep
Ground	**A02**	**B02**	Force Recovery
Reset In	**A03**	**B03**	SPI1 Clock
I2C GP1 Clk	**A04**	**B04**	SPI1 MISO

Pin Signal	Pin No.	Pin No.	Pin Signal
I2C GP1 Data	**A01**	**B01**	SPI1 MOSI
5V (Fused)	**A02**	**B02**	SPI1 CS
WDT_TIME_OUT	**A03**	**B03**	UART7 TX
3.3V fused	**A04**	**B04**	UART7 RX
CAN 0 TX	**A01**	**B01**	CAN0_ERR
CAN0 RX	**A02**	**B02**	Ground

The following Table provides the Signal and its Definition.

Signal Name	Definition
Power Button	Use Switch/Drive using open collector at 5V Level
Sleep	Use Switch/Drive using open collector at 1.8V Level
Force Recovery	Use Switch/Drive using open collector at 1.8V Level
Reset In	Use Switch/Drive using open collector at 1.8V Level
I2C GP1	I2C Interface at 3.3V Level
SPI1	SPI1 Interface at 3.3V Level
UART7	UART7 Interface at 3.3V Level
CAN0	CAN0 Interface at 3.3V Level

9.1.8 Power-In Connector: J8

+VIN = +9V to +18V

Connector Type: 2x2 Samtec IPL1

Mating Cable: 6981507

The following Table provides the Connector Pin and Signal specifications.

Pin Signal	Pin No.	Pin No.	Pin Signal
VIN	**1**	**2**	GND
VIN	**3**	**4**	GND

9.1.9 M.2 SATA SSD Socket Connector: J9

Connector Part No.: MDT320M03001

The TX and RX Signals are implemented by the Host interface. TX is mapped to the socket drives interface, and RX is mapped to the Jetson TX2/TX2i Module. The RX interface is interconnected to the TX interface.

One mounting standoff located at the far end of the module installation position is not connected to ground.

The Table below provides the Connector Pin and Signal specifications.

Pin Signal	Pin No.	Pin No.	Pin Signal
Gnd	**1**	**2**	+3.3V
Gnd	**3**	**4**	+3.3V
	5	**6**	

Pin Signal	*Pin No.*	*Pin No.*	*Pin Signal*
	7	**8**	
	9	**10**	DAS/DSS#
	11	**12**	
	13	**14**	
	15	**16**	
	17	**18**	
	19	**20**	
Gnd	**21**	**22**	
	23	**24**	
	25	**26**	
Gnd	**27**	**28**	
	29	**30**	
	31	**32**	
Gnd	**33**	**34**	
	35	**36**	
	37	**38**	DEVSLP
Gnd	**39**	**40**	
SATA_RX+	**41**	**42**	
SATA_RX-	**43**	**44**	
Gnd	**45**	**46**	
SATA_TX-	**47**	**48**	
SATA_TX+	**49**	**50**	
Gnd	**51**	**52**	
	53	**54**	
	55	**56**	
Gnd	**57**	**58**	
KEYS			
GND	**67**	**68**	+3.3V
GND	**69**	**70**	+3.3V
GND	**71**	**72**	+3.3V
GND	**73**	**74**	+3.3V
GND	**75**		+3.3V

9.1.10 PCIe Mini Card Connector: J10

Connector Part No.: MM60-52B1-E1-R650

The TX and RX Signals are implemented by the Host interface. TX is mapped to the socket drives interface, and RX is mapped to the Jetson TX2/TX2i Module. The RX interface is interconnected to the TX interface.

One mounting standoff located at the far end of the module installation site is not connected to ground.

The Table below describes the Connector Pins and Signals.

Pin Signal	***Pin No.***	***Pin No.***	***Pin Signal***
	1	**2**	+3.3V
	3	**4**	Gnd
	5	**6**	+1.5V
Clkreq-	**7**	**8**	
Gnd	**9**	**10**	
PCIe 1 Clk-	**11**	**12**	
PCIe 1 Clk+	**13**	**14**	
Gnd	**15**	**16**	
KEYS			
	17	**18**	Gnd
	19	**20**	Disable-
Gnd	**21**	**22**	PCIe Reset-
PCIe 1 RX-	**23**	**24**	+3.3V
PCIe 1 RX+	**25**	**26**	Gnd
Gnd	**27**	**28**	+1.5V
Gnd	**29**	**30**	SMB Clk
PCIe 1 TX-	**31**	**32**	SMB Data
PCIe 1 TX+	**33**	**34**	Gnd
Gnd	**35**	**36**	
Gnd	**37**	**38**	
+3.3V	**39**	**40**	Gnd
+3.3V	**41**	**42**	WWAN LED-
Ground	**43**	**44**	WLAN LED-
	45	**46**	WPAN LED-
	47	**48**	+1.5V
Pull-up to +3.3V	**49**	**50**	Gnd
	51	**52**	+3.3V

9.1.11 LTE Socket Connector: J11, J12

Connector Type: 1x10 2mm Pitch Socket

The following Table provides the Connector Pin and Signal specifications.

Pin Signal	*J11*	*J12*	*Pin Signal*
5V	**1**	**20**	LTE_ON_OFF
UART_RX	**2**	**19**	NC
UART_TX	**3**	**18**	NC
GND	**4**	**17**	NC
RESET_N	**5**	**16**	UART_RTS
5V	**6**	**15**	GND
USB+	**7**	**14**	1V8
USB-	**8**	**13**	LTE_ON/SLEEP
DTR_LTE	**9**	**12**	UART_CTS
GND	**10**	**11**	GND

9.1.12 USB 3.0 Port Connector: J13

A USB 3.0 Connector on the Jetson TX2/TX2i Module is routed to the 2x5 Header.

Connector Type: Standard 2mm Dual Row RA Header

NOTE: The USB 3.0 is not backward compatible with USB 2.0 protocol.

Mating Cable Part No. for Latching Connector: 6980603

The following Table provides the Connector Pin and Signal specifications.

Pin Signal	*Pin No.*	*Pin No.*	*Pin Signal*
USB_SSRX0-	**A01**	**B01**	Shield
USB_SSRX0+	**A02**	**B02**	USB1 Power-
USB1 Power -	**A03**	**B03**	NC
USB_SSTX0-	**A04**	**B04**	NC
USB_SSTX0+	**A05**	**B05**	USB Power+

9.1.13 MicroSD Slot Connector: J14

Connector Part No.: 114-00841-68

Pin No.	*Pin Signal*
1	DAT2
2	CD/DAT3
3	CMD
4	VDD 3.3V
5	CLK
6	Ground
7	DAT0
8	DAT1

9.1.14 Camera Connector J15, J16

There are two identical 30-pin MIPI CSI Connectors on-board for Camera Modules.

The 30-pin I-PEX Connector is used to connect Camera Modules.

Connector Type: 20525-030E-02C

Mating Cable: FAW-1233-03 (Pinouts are crossed in the cable)

Camera Tested: LI-IMX274-MIPI-CS and LI-IMX185-MIPI-CS

The Table below describes the Connector Pins and Signals.

Pin No.	*Pin Signal*
1	3.3V
2	3.3V
3	3.3V
4	5V-
5	NC
6	NC
7	NC
8	NC
9	PWR#
10	NC
11	NC
12	NC
13	NC
14	FLASH
15	MCLK
16	RST#
17	SDA
18	SCL
19	NC
20	DATA2-
21	DATA2+
22	DATA0-
23	DATA0+
24	CLK-
25	CLK+
26	GND
27	DATA1-
28	DATA1+
29	DATA3-
30	DATA3+

9.1.15 External Battery Connector: J17

VBAT = +3.0V Min. 1.65V to 5.5V

Connector Type: 2x1 Header

Mating Cable: 6980524

The following Table provides the Connector Pin and Signal specifications.

Pin No.	*Pin Signal*
1	VBAT
2	Ground

9.1.16 Fan Connector: J19

A 4-pin 1.25mm pitch Vertical SMD Connector is used to connect the Heatsink Fan.

Connector Part No.: 533980471

The Table below describes the Connector Pins and Signals.

Pin No.	*Pin Signal*
1	FAN PWM (5V level)
2	FAN TACH (1.8V level)
3	VDD 5V
4	GND

9.2 Base Board List of Connectors

The following Table provides a summary of the I/O Connectors on the Base Board.

Function	*Manufacturer*	*Part No.*	*Description*	*DSC Mating Latching Cable*
Power In	Samtec	IPL1-102-01-L-D-K	2x2 Box Header T/H Angle .1" Pitch	6981507
External Battery	Molex	22-03-5025	2 Pos. TH VERT HDR, .1" Pitch Shrouded	6980524
Serial Ports	FCI	98464-G61-10ULF	2x5, 2mm pitch, TH RA Header	6980601
USB 2.0	FCI	98464-G61-10ULF	2x5, 2mm pitch, TH RA Header	6980602
USB 3.0	FCI	98464-G61-10ULF	2x5, 2mm pitch, TH RA Header	6980603
GbE Ethernet	FCI	98464-G61-10ULF	2x5, 2mm pitch, TH RA Header	6980604
HDMI	FCI	98464-G61-20ULF	2x10, 2mm pitch, TH RA Header	6980605
DAQ	FCI	98464-G61-26ULF	2x13, 2mm pitch, TH RA Header	6980606
Utility	FCI	98464-G61-20ULF	2x10, 2mm pitch, TH RA Header	6980607
Camera (x2)	I-PEX	20525-030E-02C	30-Pin I-PEX RA SMD	FAW-1233-03
FAN	Molex	533980471	4-Pin 1.25mm Pitch, Vert SMD	
PCIe Minicard	JAE	MM60-52B1-E1-R650	52-Pin Minicard, Full Size, with PCB Mount Threaded Spacers	NA
M.2 SSD Socket	Amphenol	MDT320M03001	75-Pin M.2 M Keyed Socket, 2242, with PCB Mount Threaded Spacer	NA
MicroSD	Amphenol	114-00841-68	10 (8 + 2) Position Card Connector Secure Digital - MicroSD™ Surface Mount, RA	NA
Module Connector	Samtec	SEAM-50-03.0-S-08-2-A-K-TR	400-Pin Board-to-Board Connector, 8mm B2B	NA

10. I/O CABLES

10.1 CK-JETHRO-01

CK-JETHRO-01 Latching Cables

The following Table provides Latching Cable specifications included in the CK-JETHRO-01 package.

Photo No	*Cable Part No*	*Description*	*Jethro Connector*
1	6981507	Power in	**J8**
2	6980524	External Battery	**J17**
3	6981075	Serial Ports	**J2**
4	6981082	USB 2.0	**J3**
5	6980530	USB 3.0	**J13**
6	6981080	GbE Ethernet	**J5**
7	6980522	HDMI	**J4**
8	6980516	DAQ	**J1**
9	6980527	Utility	**J7**

Figure 1: CK-JETHRO-01

11. JUMPER DESCRIPTION

Figure 1 represents the Connector and Jumper blocks on the JETHRO Base Board.

The Default Jumper positions are highlighted in Blue color.

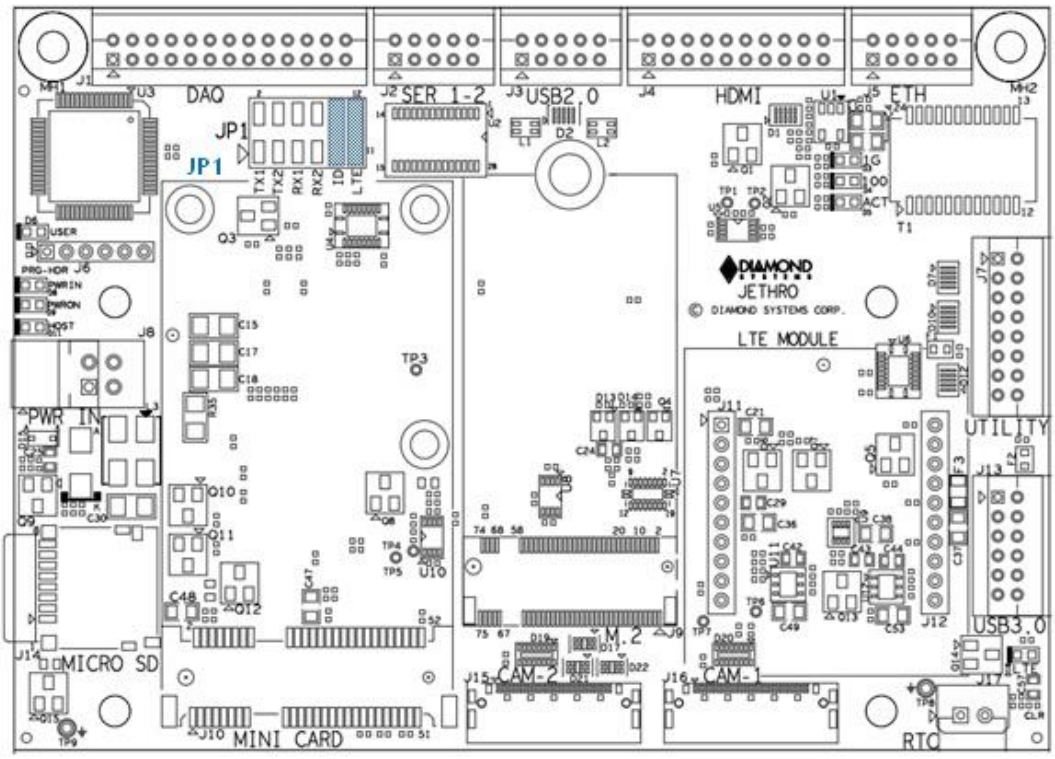


Figure 1: JETHRO Base Board Default Jumper Locations

Jumper	*Description*
JP1	Serial Termination, USB Host, LTE USB selection

11.1 Serial Termination and USB Selection: JP1

The first 4 positions of the Jumper are the termination points for 2x serial ports in RS422 mode. The 5th position will set **USB0** Port to the Default **HOST** mode or the **Client** mode. The 6th position of the Jumper directs the USB routing to either the LTE Module which is the default setting, or to the PCIe Minicard.

The Default Jumper location is shown above in Figure 1.

The following Table lists the different combinations of Jumper Block **JP1**. The cells in bold and italics show the default configuration of **Jumper Block JP1.**

Position	Function	IN	OUT
TX1	Serial Port1 TX Termination	Enabled	***Disabled***
RX1	Serial Port1 RX Termination	Enabled	***Disabled***
TX2	Serial Port2 TX Termination	Enabled	***Disabled***
RX2	Serial Port2 RX Termination	Enabled	***Disabled***
ID	USB0 Port	***Host***	Client
LTE	USB3 Port	***LTE module***	Minicard

12. GETTING STARTED

This section provides instructions to install and set up the JETHRO Base Board.

12.1 Quick Setup Guide

1. **Optional**: Connect the Monitor, Keyboard, and Mouse to the cables.
2. Connect the HDMI Cable Number 6980605 to PIN **J4**.
3. Connect the USB Cable Number 6980602 to PIN **J3**.
4. Connect the Jumpers according to the specifications listed in Section 8 Table: 8.1**: I/O Connectors, Jumpers and LED Specifications** at the default settings. The default settings can be modified.
5. Connect a 12V external power supply to the Power Input Connector **J8** using power cable number: 6981507.

WARNING! Connecting the Power Connector incorrectly will damage the JETHRO Base Board.

After successfully connecting the components:

6. Turn ON the system.

The JETHRO Base Board will boot to Linux Operating System.

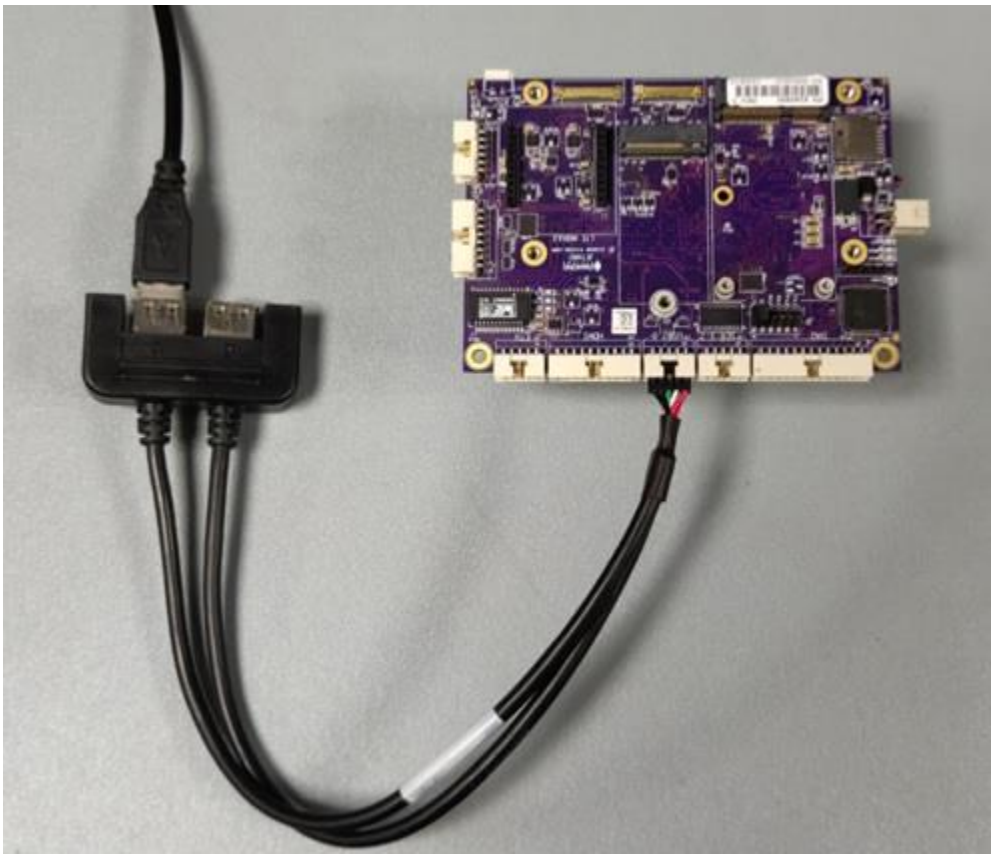
12.2 Installing DSC Image in Jetson TX2/TX2i Module

To update the image, the JETHRO Base Board must be in **Recovery Mode**.

To accomplish this, connect **J7 Pin 4**, which is the **FORCE RECOVERY** Pin, to **J7 Pin 3 GND**.

1. Power ON the Base Board.
2. Connect **USB0** Port **J3** to the Host PC using **USB A2A** Cable.
3. Connect the cable **Port A** to enable **USB0** to access the **USB0** Port.

Refer to the Image below which displays the connections specified in this Section.



Screen: Recovery Mode Cable Connection

To verify the Base Board is in **Recovery Mode**, in the Host PC running Ubuntu Operating System version 16.04 Terminal:

4. Enter **lsusb**

The Terminal will display the NVIDIA device listed under USB devices as shown below.

```
administrator@test:~$
administrator@test:~$ lsusb
Bus 001 Device 018: ID 0955:7c18 NVidia Corp.
Bus 001 Device 001: ID 1d6b:0002 Linux Foundation 2.0 root hub
Bus 005 Device 001: ID 1d6b:0001 Linux Foundation 1.1 root hub
Bus 004 Device 002: ID 093a:2510 Pixart Imaging, Inc. Optical Mouse
Bus 004 Device 001: ID 1d6b:0001 Linux Foundation 1.1 root hub
Bus 003 Device 001: ID 1d6b:0001 Linux Foundation 1.1 root hub
Bus 002 Device 002: ID 413c:2107 Dell Computer Corp.
Bus 002 Device 001: ID 1d6b:0001 Linux Foundation 1.1 root hub
administrator@test:~$
administrator@test:~$
```

Screen: Recovery Mode USB Detected

After the verification process is complete, follow the Steps below to install/update the DSC Image.

1. To unzip the Image file, enter the following:

   sudo tar -pxvf dsc-tx2-tx2i-wdeb-jethro-20190204.tar.gz

2. Switch to the extracted directory by entering:

   cd Linux_for_Tegra

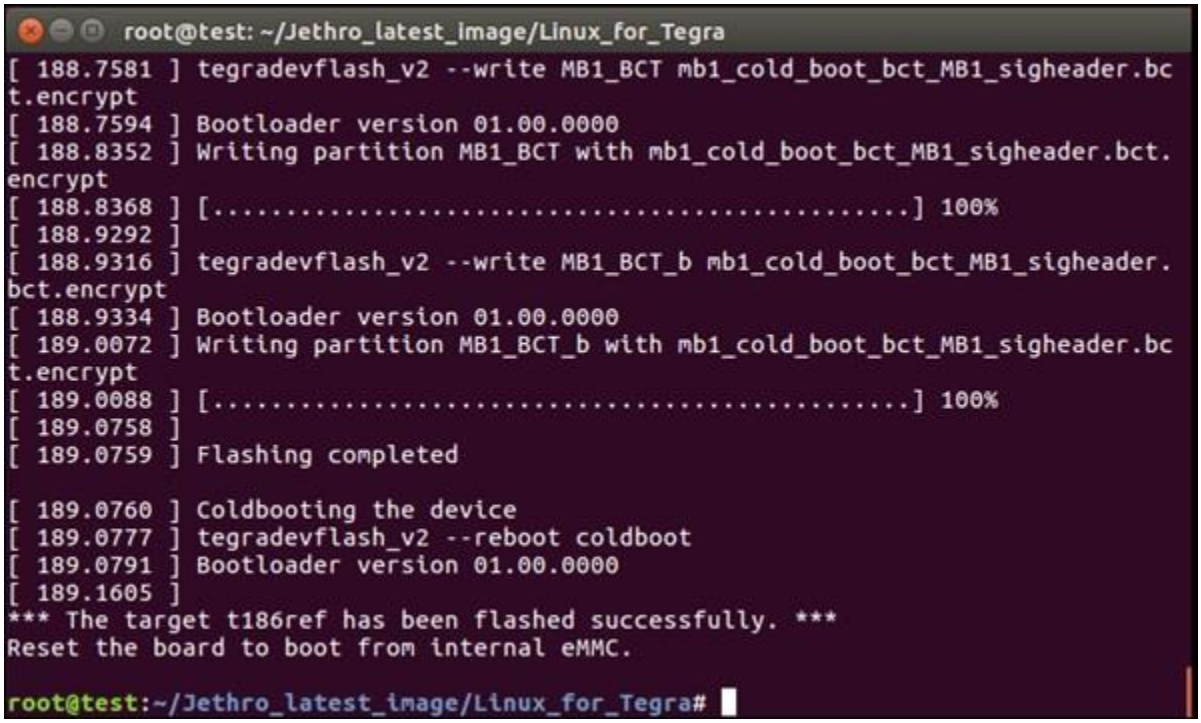
3. To program Jetson TX2/TX2i, enter the following:

sudo ./flash.sh jetson-tx2 mmcblk0p1

The programming process will take 15-20 minutes to complete.

After updating, the Jetson TX2/TX2i Module will automatically Reboot.

On completion, a window confirming a successful update to the Module will be displayed as shown below.



Screen: Recovery Mode After Programming

4. Turn off the system and remove the **FORCE RECOVERY** mode connections.

13. DATA ACQUISITION (DAQ)

13.1 Overview

The SAM Microcontroller Interface provides A/D (Analog-to-Digital), D/A (Digital-to-Analog), and Digital I/O functions.

The A/D components include:

- One 12-bit A/D Converter with six Analog Input Channels
- Four On-board Analog Voltage Channels

The D/A components include:

- Two 12-bit D/A Channels

The Digital I/O capabilities include:

- Up to 13 Programmable Direction Lines

The following Table describes the components as implemented by the SAM Microcontroller Interface.

Component	*Description*
A/D Channels	6 Analog Inputs 4 On-board Voltage Range
D/A Channels	2 Analog Outputs
DIO Lines	13 Lines: Port A – 8 Port B - 5

13.2 A/D CIRCUIT

13.2.1 A/D Input Range and Resolution

The SAM Microcontroller Interface supports the following Input Range and Resolutions.

- 12-bit A/D Converter that supports 12 bit, 14 bit, 15 bit and 16 bit oversampling resolutions.
- 1, 2, 4, 8, 16, 32, 64, 128, 256, 512 and 1024 accumulated samples for averaging resolution and conversions.
- Analog Input Voltage can be measured to the precision of a binary number. The maximum value of a binary number is 2 (bit resolution number) – 1, so the full range of numerical values that can be received from the SAM Input Channel is 0 – 4095 for 12 bit, 0 – 16383 for 14 bit, 0 – 32767 for 15 bit and 0 – 65535 for 16 bit.

The smallest change in input voltage that can be detected is 1/ (2 which is the bit resolution number) of the full-scale input range. This smallest change results in an increase or decrease of one in the A/D code and is referred to as one Least Significant Bit (1 LSB).

13.2.2 A/D Input Operation

The SAM Microcontroller A/D circuit performs both, Single-Ended and Differential-Ended input operations.

The input voltage ranges for single-ended operation is 0 – 3.3 V (0 to 4095).

For differential-ended signals the voltage range is -3.3 V to + 3.3 V (-2048 to +2047).

13.2.3 Conversion Formulas

Use the following formulas to convert the A/D value to the corresponding input voltage, depending on single or differential-ended mode of operation.

Conversion Formula for Single-Ended Operation

Input voltage = A/D code / $2^{\text{number of bit resolution}}$ * Full-scale input range
Example:
Given A/D code is 2048 and 12-bit resolution Therefore, Input voltage = 2048 /4096 * 3.3V = 1.65V

Conversion Formula for Differential-Ended Operation

Input voltage = (A/D code / ($2^{\text{number of bit resolution}}$/2)) * Full-scale input range
Example:
Given A/D code is 1024 and 12-bit resolution Therefore, Input voltage = 1024 / 2048 * 3.3V = 1.65V

For a detailed description of the Analog Input Section and API Usage, refer to *SAMD51 Software User Manual* at:

https://diamondsystems.gitbook.io/user-manuals/samd51-software-user-manual/3.-common-task-reference/3.1-performing-an-ad-conversion

13.3 D/A CIRCUIT

13.3.1 D/A Input Range and Resolution

The SAM Microcontroller Interface supports a 12-bit D/A converter with a voltage range of 0 – 3.3 V (0 to 4095).

A 12-bit DAC can generate output voltages with the precision of a 12-bit binary number. The maximum value of a 12-bit binary number is 212 - 1, or 4095, so the full range of numerical values that the DAC supports is 0 - 4095.

The value 0 will correspond to the lowest voltage in the output range, and the value 4095 will correspond to the highest voltage minus 1 LSB.

The smallest change in output value or resolution, is 1/ (2^{12}) or 1/4096.

13.3.2 Conversion Formulas

The formulas given below, explain how to convert D/A codes and output voltages.

The D/A code is always an integer. For a 12-bit D/A, the D/A code ranges between 0 and 4095 (212 -1).

The D/A voltage will range from 0 V to full scale voltage – 1 LSB. Thus the full scale range is the same as the full scale voltage.

D/A Code = (Output voltage / Full scale voltage) * 4096
Output Voltage = (D/A code / 4096) * Full scale voltage
1 D/A LSB = Full scale voltage / 4096

For a detailed description of the Analog Output Section and API Usage, refer to *SAMD51 Software User Manual* at:

https://diamondsystems.gitbook.io/user-manuals/samd51-software-user-manual/3.-common-task-reference/3.3-performing-a-da-conversion

13.4 DIGITAL I/O

The SAM Microcontroller Interface supports two Digital I/O Ports specified as **A** and **B** respectively, set as follows:

- Port A = 8 bits
- Port B = 5 bits

To control the DIO Direction, set the register as follows:

Integer **0** directs the Input Mode. Integer **1** directs the Output Mode.

NOTE: By default, all DIO lines reset to Input mode during Power-Up or Board Reset.

For a detailed description of the Digital I/O Section, refer to *SAMD51 Software User Manual* at:

https://diamondsystems.gitbook.io/user-manuals/samd51-software-user-manual/3.-common-task-reference/3.4-performing-digital-io-operations

14. THERMAL SOLUTIONS

The JETHRO Base Board implements an optimized Thermal Management System to ensure that the Board and components are maintained at their maximum specified temperatures. Applying a thermal management component below recommended standards will produce undesirable consequences.

The following Table provides the standard operating temperature ranges for the JETHRO Base Board and Jetson TX2/TX2i Modules.

	Temperature Range			
	JETHRO Base Board	***Jetson TX2***	***Jetson TX2-4 GB***	***TX2i***
Operating Temperature	-40°C to +85°C	-25°C to +80°C	-25°C to +80°C	-40°C to +85°C

The Jetson TX2/TX2i Modules are designed to be integrated with product-level thermal solutions such as a:

- Passive Heat Sink
- Active Heat Sink
- Cold Plate
- Chassis Mount or similar components

The Thermal Solution to be implemented interfaces the NVIDIA TTP.

The Tegra X2 SoC processor is located directly under the TTP and absorbs maximum TMP. This necessitates the installation of a robust thermal solution at the center of the TTP that can dissipate the heat generated by the Module and optimize emissivity.

The thermal solution must be attached to the top surface of the TTP. However, based on the chassis design, a number of configurations are possible.

For typical scenarios the following recommendation are applicable:

- The contact of the thermal solution must be well administered on the TTP for maximizing thermal performance.
- NVIDIA thermal testing has demonstrated that the maximum specified TTP temperature controls the temperature range of all components on the Board.

To determine the best method to interface the TTP with the respective thermal solution and ensure thermal, mechanical and qualification compatibility at the system-level, refer to NVIDIA's *Jetson TX2 Series Thermal Design Guide* for details on specifications which can be downloaded from the NVIDIA Site: http://developer.nvidia.com/embedded/dlc/jetson-tx2-series-thermal-design-guide.

14.1 Jetson TX2 Series Mechanical Illustrations: Thermal Solution

The following Mechanical views illustrate the Jetson TX2 Series Dimensions to enable users to implement the right Thermal Solution.

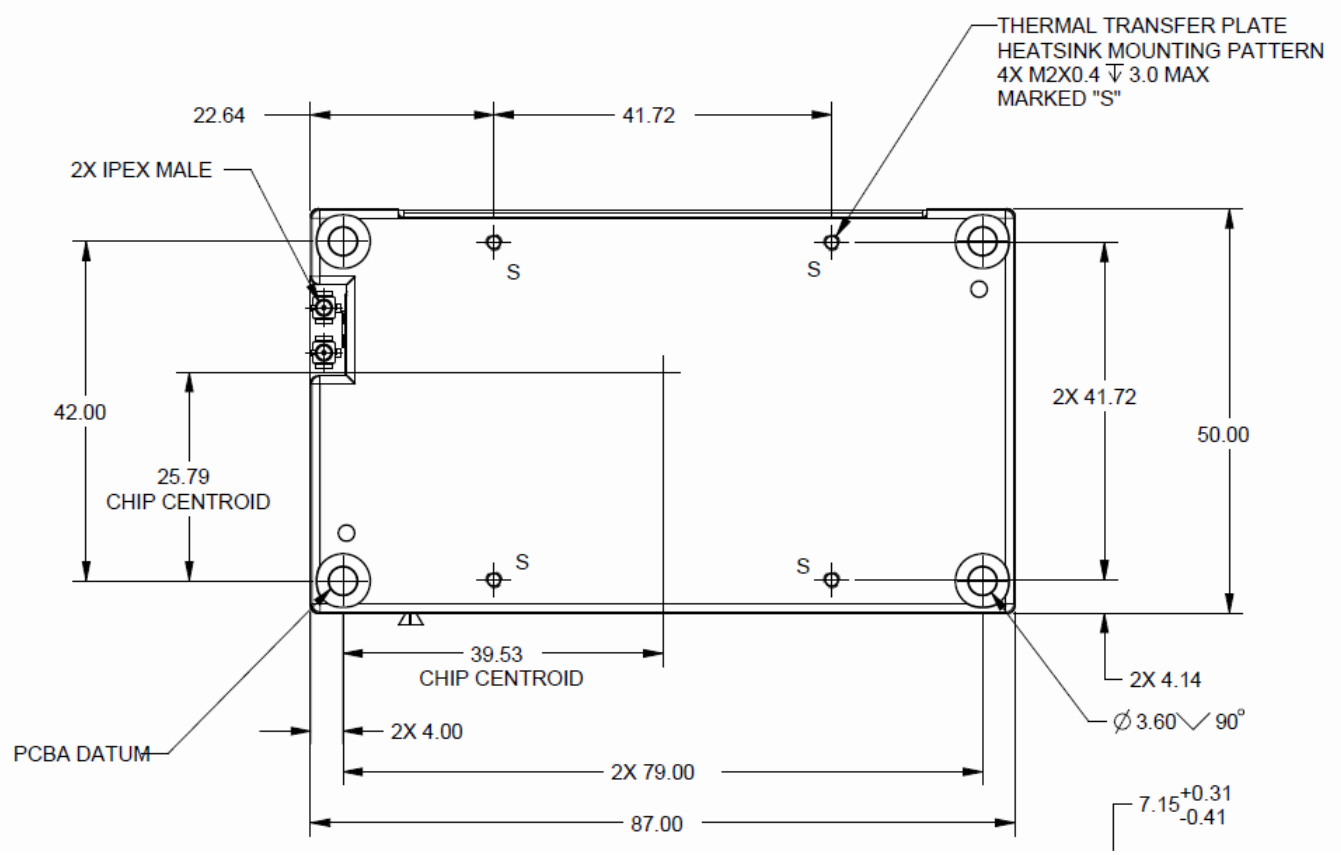


Figure 13-1: Jetson TX2: Top View Dimensions for Thermal Solution

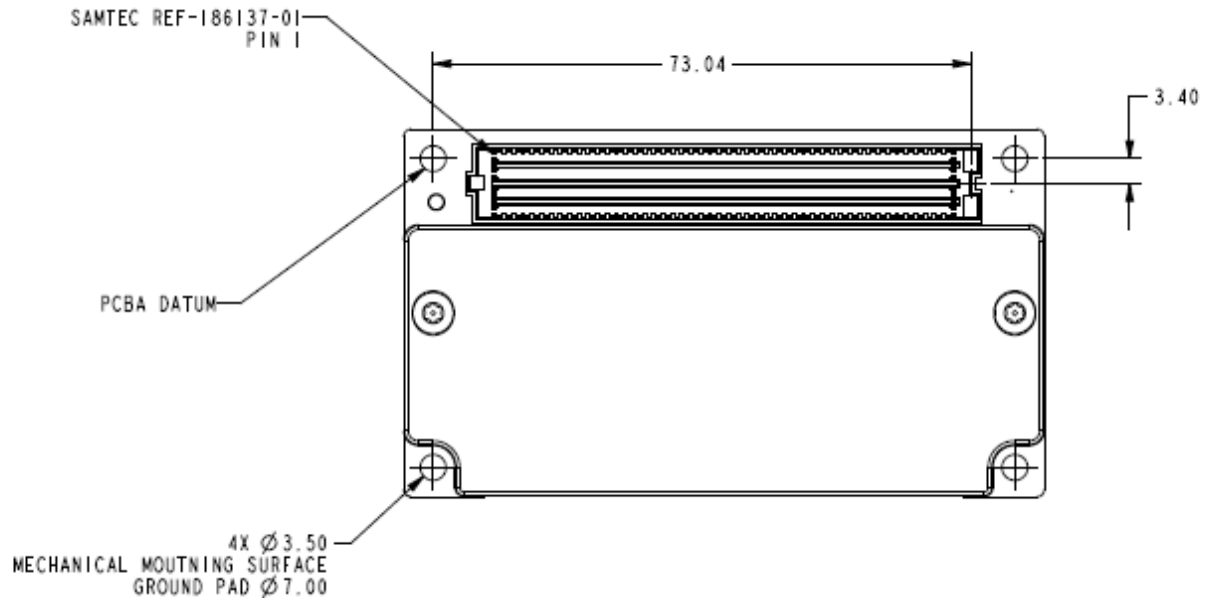


Figure 13-2: Jetson TX2: Bottom View Dimensions for Thermal Solution

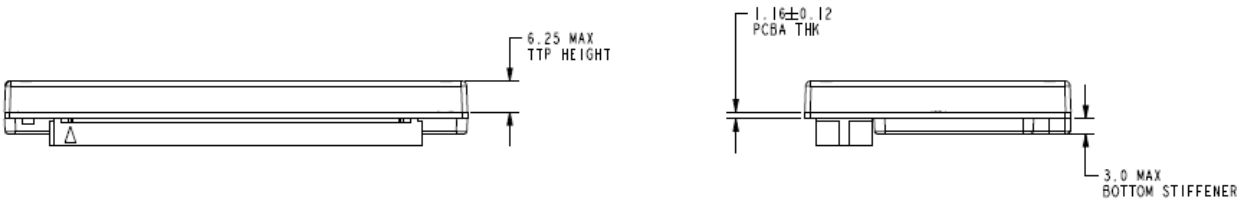


Figure 13-3: Jetson TX2: Side View Dimensions for Thermal Solution

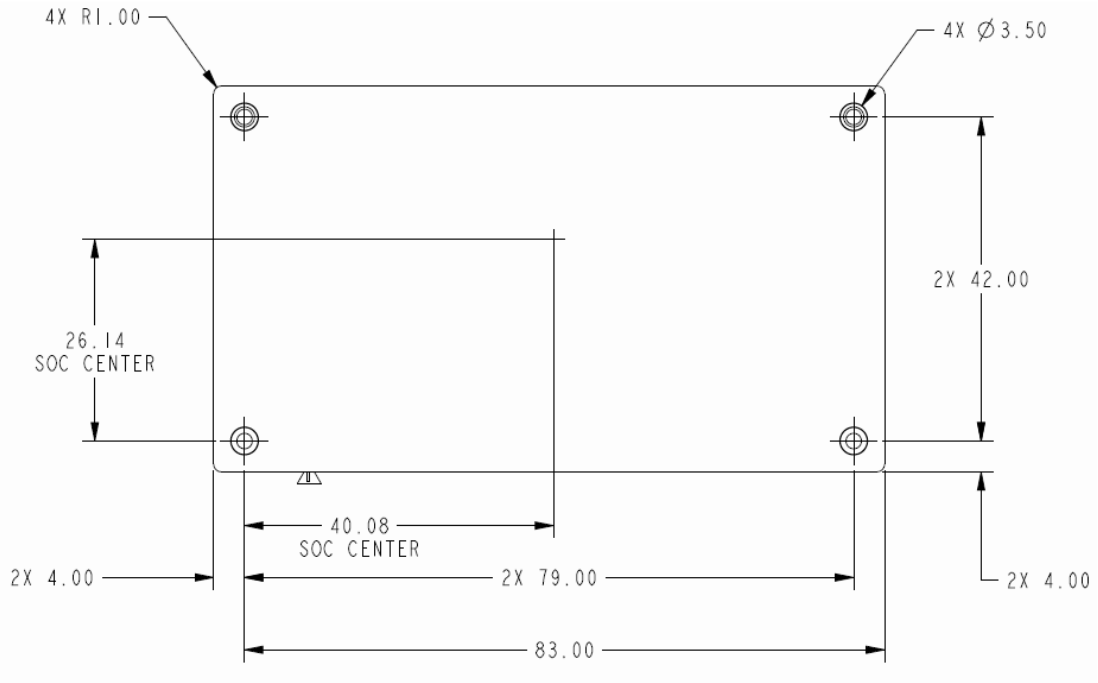


Figure 13-4: Jetson TX2 4 GB: Top View Dimensions for Thermal Solution

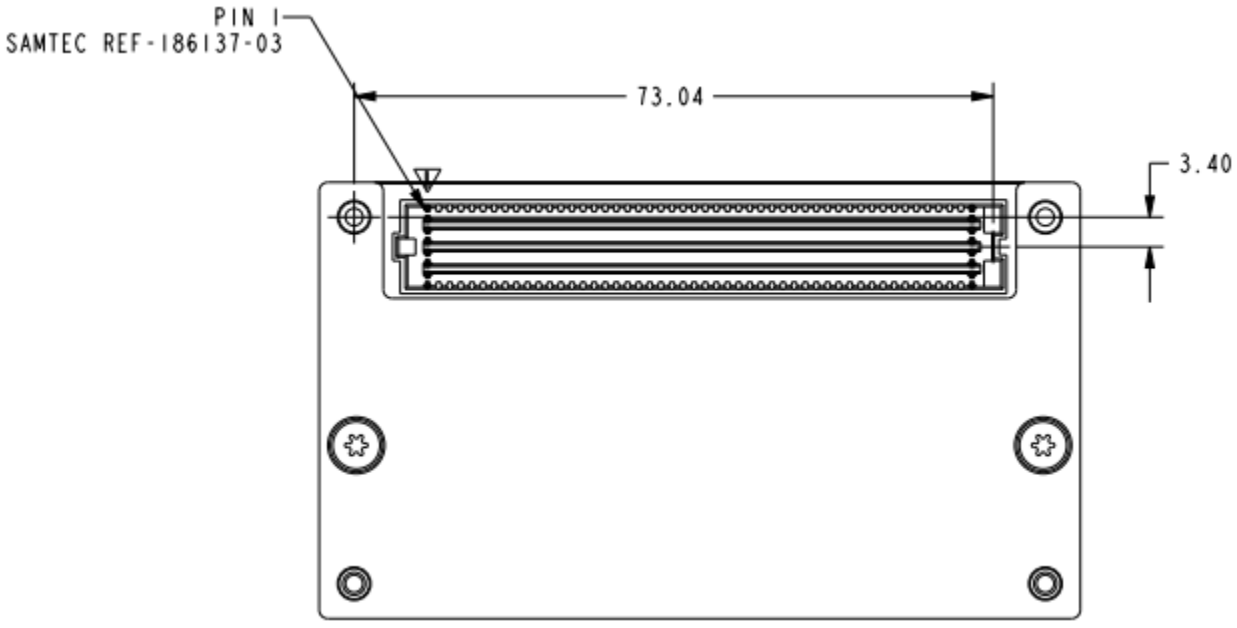


Figure 13-5: Jetson TX2 4 GB: Bottom View Dimensions for Thermal Solution

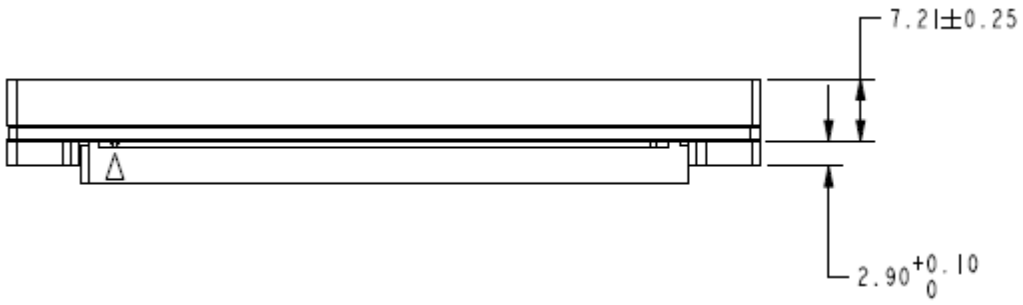


Figure 13-6: Jetson TX2 4 GB: Side View Dimensions for Thermal Solution

14.2 Module Temperature Specifications

The Table below lists temperature specifications that meet the maximum thermal load based on the respective Jetson TX Module installed in the system.

Parameter	***Value***			***Units***
	Jetson TX2	***Jetson TX2-4 GB***	***TX2i***	
Maximum TTP Operating Temperature[1]	80	80	85	°C
Recommended Tegra X2 Operating Temperature Limit[2]	T.cpu = 95.5	T.cpu = 95.5	T.cpu = 95.5	°C
	T.gpu[3] = 95.5	T.gpu[4] = 95.5	T.gpu[4] = 95.5	°C
Tegra X2 Maximum Operating Temperature Limit[4]	T.cpu = 101	T.cpu = 101	T.cpu = 101	°C
	T.gpu = 101	T.gpu = 101	T.gpu = 101	°C

[1] The temperature of the TTP must always be kept below 80 °C limit to maintain the required performance and reliability. The measurement location is provided in Figure 13-1 (Jetson TX2) and Figure 13-2 (Jetson TX2 4GB/TX2i).

[2] The Tegra X2 recommended operating temperature limit is the temperature threshold below which the product will operate at the specified clock speeds. Software processes will apply clock speed reductions once this temperature is reached. These temperature sensors have an accuracy of ±3 °C. Note that power fluctuations that induce Tj fluctuations above these thresholds will cause temporary clock reductions. See Section 4.3 for details in the *Jetson TX2 Series Thermal Design Guide*.

[3] The T.gpu temperature is measured by the “ao-therm” sensor.

[4] The Tegra X2 will shut down the Jetson TX2 module or reset the Jetson TX2 4GB/TX2i module once any of these software-imposed temperature limits are reached to maintain the reliability of the Tegra X2. See Section 4.5 for details in the *Jetson TX2 Series Thermal Design Guide*.