Connect Tech Inc.

Embedded Computing Experts

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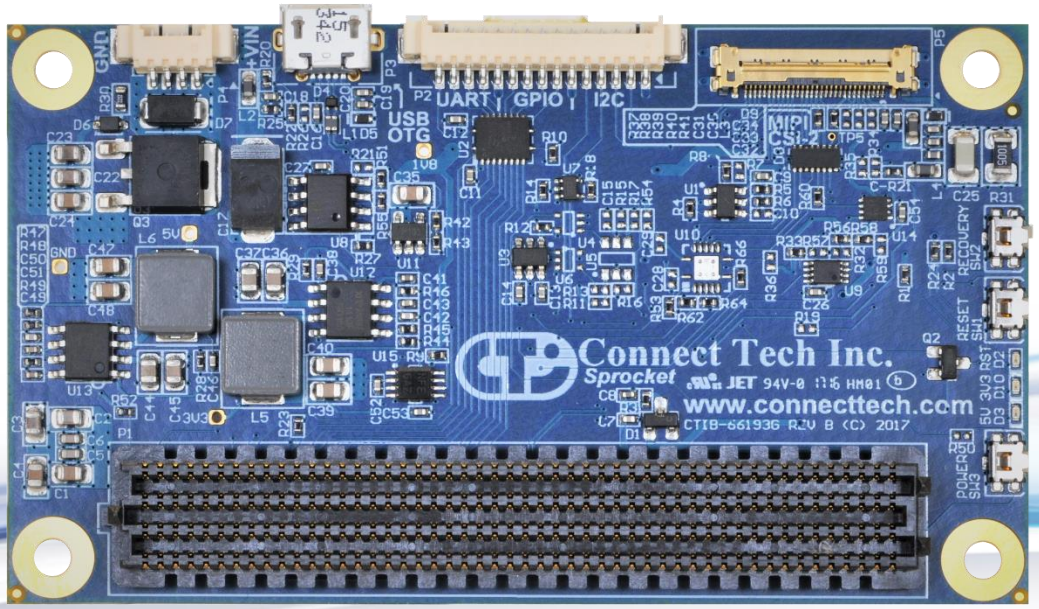
USERS GUIDE

Sprocket Carrier for NVIDIA® Jetson™ TX2/TX2i/TX1

Users Guide



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Sprocket User Manual CTIM-00152 Revision 0.10 2019/04/01

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Preface

Disclaimer

The information contained within this user's guide, including but not limited to any product specification, is subject to change without notice.

Connect Tech assumes no liability for any damages incurred directly or indirectly from any technical or typographical errors or omissions contained herein or for discrepancies between the product and the user's guide.

Customer Support Overview

If you experience difficulties after reading the manual and/or using the product, contact the Connect Tech reseller from which you purchased the product. In most cases the reseller can help you with product installation and difficulties.

In the event that the reseller is unable to resolve your problem, our highly-qualified support staff can assist you. Our support section is available 24 hours a day, 7 days a week on our website at: http://connecttech.com/support/. See the contact information section below for more information on how to contact us directly. Our technical support is always free.

Contact Information

Mail/Courier
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Technical Support
42 Arrow Road
Guelph, Ontario
Canada N1K 1S6

Email/Internet

sales@connecttech.com
support@connecttech.com
www.connecttech.com

Note:
Please go to the **Connect Tech Resource Center** for product manuals, installation guides, device drivers, BSPs and technical tips. Submit your **technical support** questions to our support engineers.

Telephone/Facsimile
Technical Support representatives are ready to answer your call Monday through Friday, from 8:30 a.m. to 5:00 p.m. Eastern Standard Time. Our numbers for calls are:

Toll Free: 800-426-8979 (North America only)
Telephone: 519-836-1291 (Live assistance available 8:30 a.m. to 5:00 p.m. EST, Monday to Friday)
Facsimile: 519-836-4878 (on-line 24 hours)

Limited Product Warranty

Connect Tech Inc. provides a one year Warranty for the Sprocket Carrier. Should this product, in Connect Tech Inc.'s opinion, fail to be in good working order during the warranty period, Connect Tech Inc. will, at its option, repair or replace this product at no charge, provided that the product has not been subjected to abuse, misuse, accident, disaster or non-Connect Tech Inc. authorized modification or repair.

You may obtain warranty service by delivering this product to an authorized Connect Tech Inc. business partner or to Connect Tech Inc. along with proof of purchase. Product returned to Connect Tech Inc. must be pre-authorized by Connect Tech Inc. with an RMA (Return Material Authorization) number marked on the outside of the package and sent prepaid, insured and packaged for safe shipment. Connect Tech Inc. will return this product by prepaid ground shipment service.

The Connect Tech Inc. Limited Warranty is only valid over the serviceable life of the product. This is defined as the period during which all components are available. Should the product prove to be irreparable, Connect Tech Inc. reserves the right to substitute an equivalent product if available or to retract the Warranty if no replacement is available.

The above warranty is the only warranty authorized by Connect Tech Inc. Under no circumstances will Connect Tech Inc. be liable in any way for any damages, including any lost profits, lost savings or other incidental or consequential damages arising out of the use of, or inability to use, such product.

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ESD Warning

Electronic components and circuits are sensitive to ElectroStatic Discharge (ESD). When handling any circuit board assemblies including Connect Tech carrier assemblies, it is recommended that ESD safety precautions be observed. ESD safe best practices include, but are not limited to:

- Leaving circuit boards in their antistatic packaging until they are ready to be installed.
- Using a grounded wrist strap when handling circuit boards, at a minimum you should touch a grounded metal object to dissipate any static charge that may be present on you.
- Only handling circuit boards in ESD safe areas, which may include ESD floor and table mats, wrist strap stations and ESD safe lab coats.
- Avoiding handling circuit boards in carpeted areas.
- Try to handle the board by the edges, avoiding contact with components.

Revision History

Revision	Date	Changes
0.00	2017/03/15	Initial Release
0.01	2017/05/02	-Updated Cable Kit information - Added pinout for P2 connector
0.02	2017/05/5	- Updated cover page picture - Updated Cable Kit information - Added important notes on power supply kits for NA and EU
0.03	2017/05/24	- Added important notes on power supply kit: Now we will only have one multi-region kit instead of Multiple region-specific kits
0.04	2017/05/25	-Changed Sprocket kits two different kits again: one North American and second Multi-region -updated Cables and accessories table with 3rd party accessories
0.05	2017/06/21	-added crimp info for essential cables -added important note under 'Typical Installation' section for using serial console using TTL to USB serial cables -updated description for CBG252 in 'cables and Kit information table' - added observed maximum current consumption details
0.06	2018/03/08	Added GPIO KDB link
0.07	2018/04/25	Added BSP information
0.08	2018/07/31	Added TX2i compatibility
0.09	2019/02/15	Added TX2i Power Circuitry Note
0.10	2019/04/01	Corrected power consumption figures

Introduction

Connect Tech's Sprocket Carrier for NVIDIA® Jetson™ TX2/TX2i/TX1 is designed to match the NVIDIA Jetson module form factor. The Sprocket's design includes 1x USB OTG, 1 x4 lane MIPI CSI-2, 2x 3.3V UART, 2x I2C, and 4x GPIO.

This design provides our smallest and lowest profile solution yet. The Sprocket and Jetson TX2, TX2i or TX1 stack can be mounted flat in the smallest of spaces, perfect for space constrained payloads such as that of a drone.

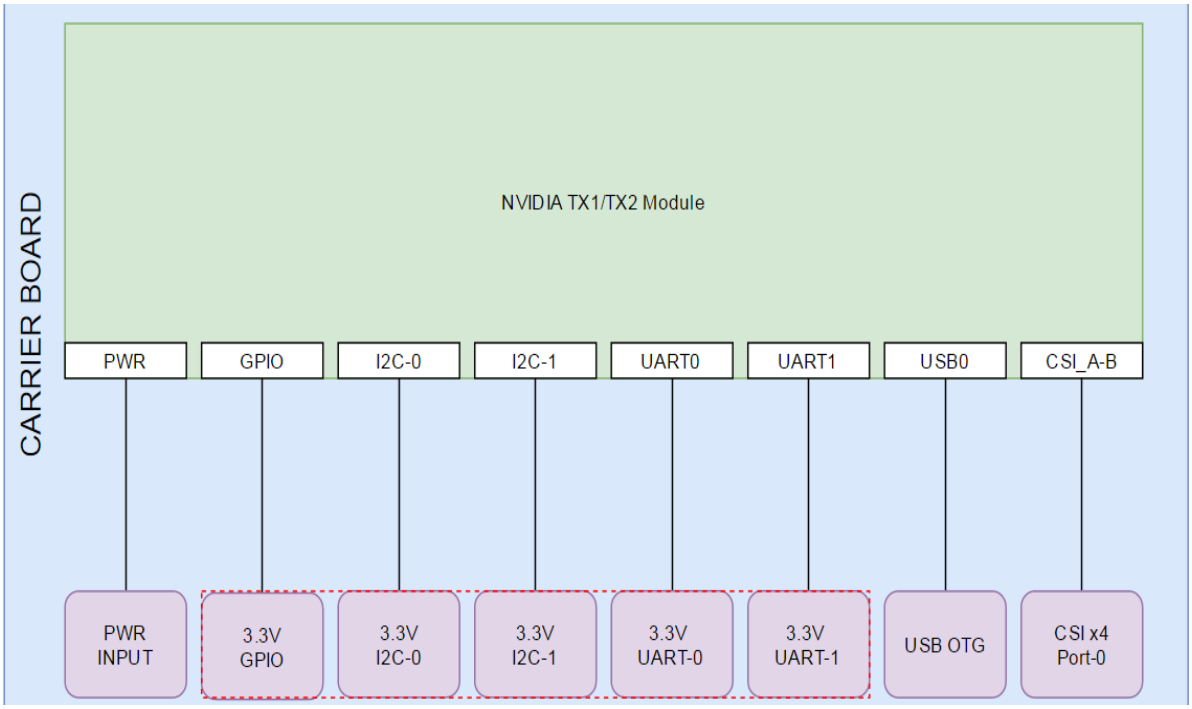
Product Features and Specifications

Feature	Sprocket Carrier for NVIDIA Jetson TX2/TX1
Module Compatibility	NVIDIA Jetson TX2, NVIDIA Jetson TX2i, NVIDIA Jetson TX1
GPU	Jetson TX2/TX2i: -NVIDIA Pascal™, 256 CUDA cores (Up to 1.3 GHz) Jetson TX1: -NVIDIA Maxwell™, 256 CUDA cores (998 MHz)
CPU	Jetson TX2/TX2i: -HMP Dual Denver 2/2MB L2 + Quad ARM® A57/2MB L2 Jetson TX1: -Quad ARM® A57/2MB L2
Dimensions	87mm x 50mm (3.425" x 1.968") Single-sided assembly, all components fit "under" the module – for slimmest design possible in Z-axis
Video Input	1 x MIPI CSI-2 Input x4 or x2 lane configuration (30-pin connector)
USB	1 x USB OTG (Micro-AB)
UART	2 x 3.3V from TX2/TX2i/TX1 UART0 and UART1 Pico-blade SMT RA (shared)
I2C	2 x I2C Ports @ 3.3V Pico-blade SMT RA (shared)
GPIO	4 bits of 3.3V (level shifted GPIO) Pico-blade SMT RA (shared)
LEDs	+5V/+3.3V/RESET LEDs
Input Power	+12V to +16V DC Input Range
Buttons	Power, Reset, Recovery
Operating Temperature	-40°C to +85°C (-40°F to +185°F)[1]
Weight	28g
Accessories	Cable Kit
Warranty and Support	1 Year Warranty

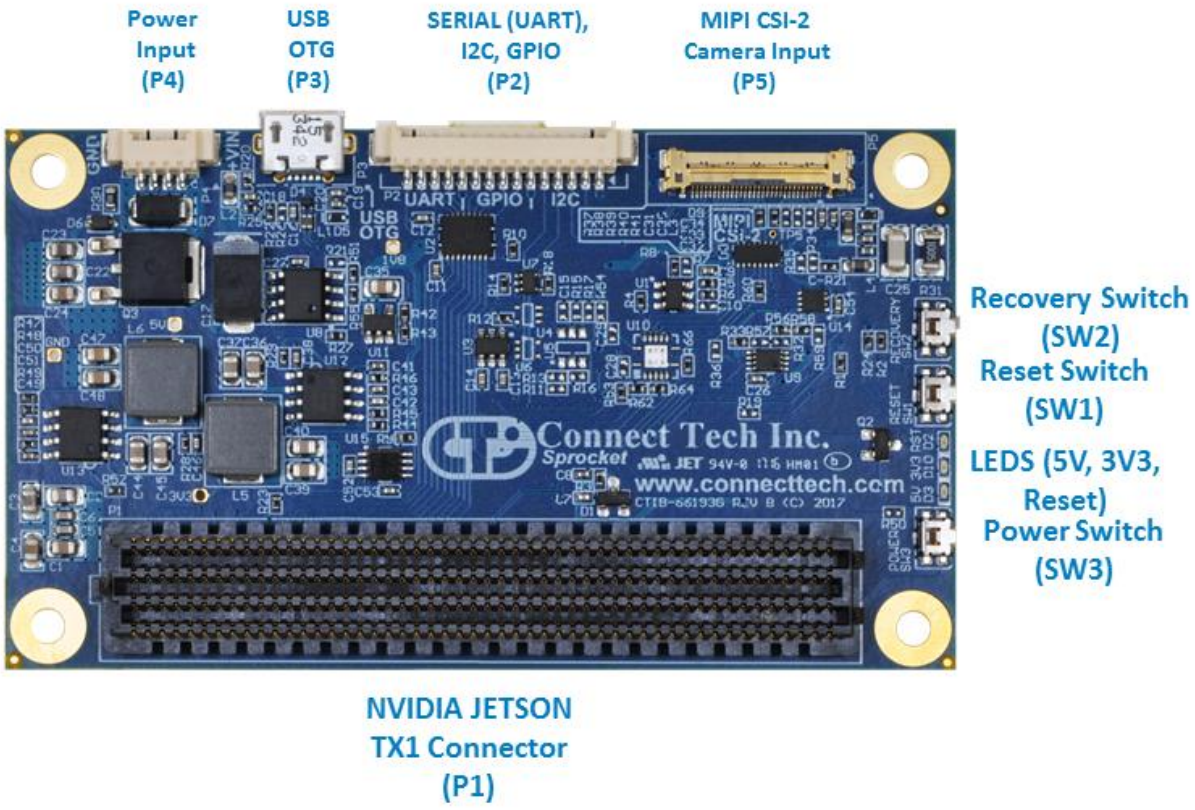
[1] The Jetson TX2/TX1 Module is rated for -25°C to +80°C (measured at thermal heat plate)

Product Overview

Block Diagram



Connector Locations – Top Side



Connector Locations – Bottom Side (Single sided assembly –No components on Bottom)

Connector Summary

Designator	Connector	Description
P1	NVIDIA Jetson TX2/TX2i/TX1	NVIDIA Jetson TX2/TX2i/TX1 Module Connector
P2	GPIO, Serial (UART TTL), I2C	Molex 15pin PicoBlade Connector
P3	USB 2.0 OTG	USB 2.0 Link 0 OTG Micro-AB Connector
P4	Power	Input Power Molex 4pin PicoBlade Connector
P5	Camera	MIPI CSI-2 Camera Input

Switch Summary

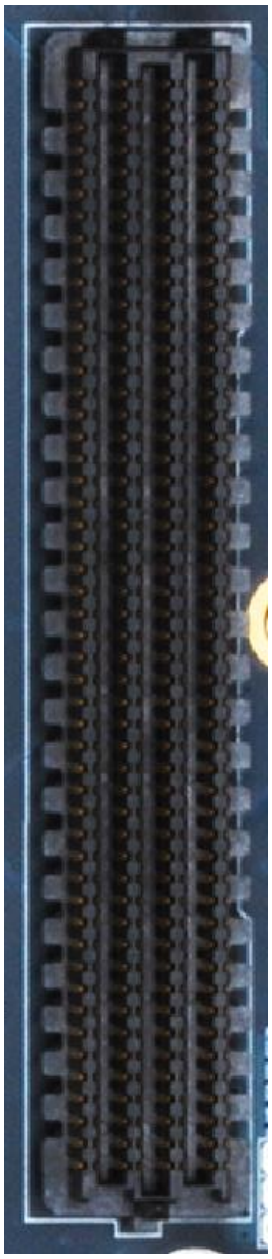
Designator	Function	Description
SW1	RESET	RST_IN# Switch
SW2	RECOVERY	FORCE_RECOV# Switch
SW3	POWER	PWR_BTN# Switch

Detailed Feature Description

Jetson™ TX2/TX2i/TX1 Board-to-Board Connector

With the NVIDIA Jetson™ TX2/TX2i/TX1, the processor and chipset are implemented on the Jetson™ TX2/TX2i/TX1 Module. This connects to the Sprocket Carrier via a Samtec SEARAY™ Board to Board Connector.

Function	NVIDIA Jetson™ TX2/TX2i/TX1 Interface
Location	P1
Type	Samtec SEARAY™ Connector
Carrier Connector P/N	SEAM-50-03.0-S-08-2-A-K-TR (8.0mm stacking height) Manufacturer: Samtec
Mating Connector P/N	SEAF-50-05-S-08-02-A-K (installed on Jetson™ TX2/TX2i/TX1) Manufacturer: Samtec
Pinout	Refer to NVIDIA's Jetson™ TX2/TX2i/TX1 System-on-Module datasheet for pinout details
Standoffs	8.0mm Standoffs Required between NVIDIA Jetson TX2 /TX1 Module and Sprocket (ASG008) Carrier 5.0mm Standoffs Required between NVIDIA Jetson TX2i Module and Sprocket (ASG008) Carrier



MIPI CSI-2 Camera Input

Function	MIPI CSI-2 Camera Interface
Location	P5
Type	IPEX Right Angle Surface Mount Connector
P/N	20525-030E-02C
Mating	FAW-1233-03 Manufacturer: Leopard
Cable	CBG255

Pinout

Pin	Description
1	+3.3V
2	+3.3V
3	+3.3V
4	+5V
5	-
6	+1.8V
7	-
8	-
9	CAM_PWR#
10	-
11	-
12	-
13	-
14	CAM_FLASH
15	CAM_MCLK
16	CAM_RST#
17	CAM_SDA
18	CAM_SCL
19	-
20	DATA2_N
21	DATA2_P
22	DATA0_N
23	DATA0_P
24	CLK_N
25	CLK_P
26	GND
27	DATA1_N
28	DATA1_P
29	DATA3_N
30	DATA3_P

GPIO/Serial/I2C

Function	GPIO/Serial/I2C
Location	P2
Type	Molex PicoBlade (15 pin) Right Angle Surface Mount
P/N	53261-1571
Mating	51021-1500 Manufacturer: Molex Crimp: 0500798100 or 0500588100 Manufacturer: Molex
Cable	CBG251

Pinout

Pin	Description
1	GND
2	I2C_GP1_SDA
3	I2C_GP1_CLK
4	I2C_GP0_SDA
5	I2C_GP0_CLK
6	GND
7	GPIO_EXP1_INT
8	GPIO_EXP0_INT
9	GPIO9
10	GPIO8
11	GND
12	UART0_RX
13	UART0_TX
14	UART1_RX
15	UART1_TX

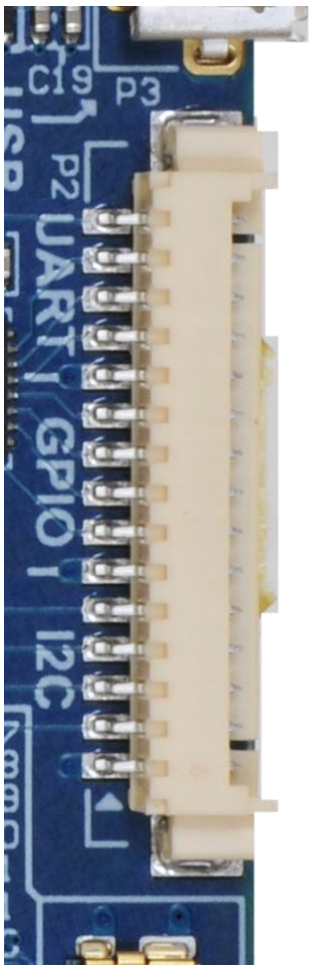
NOTE:

a) All P2 signals are +3.3V level translated.

b) The I2C interface I2C_GP0 uses I2C bus 0 and I2C_GP1 uses I2C bus 1 within Linux for Tegra.

c) Please reference our **GPIO KDB** for TX2/TX2i/TX1 values.

d) A UART (from UART0) to USB cable can be connected to a computer and console can be accessed using a terminal emulator (e.g. Putty).



USB OTG

The NVIDIA Jetson TX2/TX2i/TX1 has a single USB 2.0 OTG Port.

Function	USB 2.0 OTG
Location	P3
Type	Molex Micro-AB USB Connector
P/N	47589-0001
Mating	Any Micro USB 2.0 Plug

USB OTG – Host Mode

To put the USB OTG port into HOST mode, the USB ID pin needs to be left floating. Most USB Micro-A to Type A (Female) cables will do this internally.

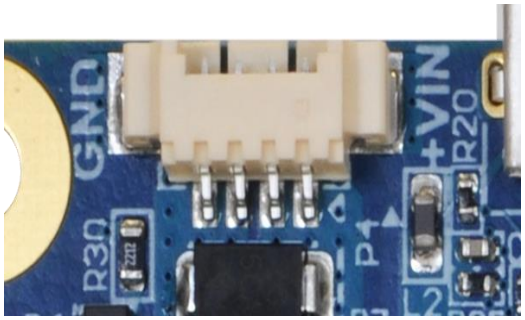
USB 2.0 OTG Client Mode (Used for Image Flashing)

To put the Sprocket into Client Mode, the ID Pin on the Micro-AB Connector needs to be pulled high. Most USB Micro-B Cables will do this internally. Please refer to 'Force USB Recovery Mode' under the Software / BSP section of the Manual for instructions on how to do this. Once in Client Mode, the Sprocket will connect the OTG USB 2.0 Link to the Micro-AB Connector. At this point the Sprocket can be connected to a Host PC for software image flashing.

Power Input

The Sprocket Carrier accepts a single power input to power all on-board devices. A power input range of +12V to +16V is acceptable, while a single +12V input is nominal for operation.

WARNING: Please do not attempt to plug in the NVIDIA's Development kit power supply which is 19.5V. Doing this will damage the carrier board.

<table>
<tr><td>Function</td><td>Power</td><td rowspan="5"> 
</td></tr>
<tr><td>Location</td><td>P4</td></tr>
<tr><td>Type</td><td>Molex PicoBlade (4 pin) Right Angle Surface Mount</td></tr>
<tr><td>P/N</td><td>53261-0471</td></tr>
<tr><td>Mating</td><td>51021-0400
Manufacturer: Molex

Crimp: 0500798100
Manufacturer: Molex</td></tr>
<tr><td>Cable</td><td>CBG252
OR
MSG069 (North America)
OR
MSG073 (Multi-region)</td><td></td></tr>
<tr><td>Pinout</td><td><table><tr><th>Pin</th><th>Description</th></tr><tr><td>1-2</td><td>+VIN (12V to 16V DC)</td></tr><tr><td>3-4</td><td>GND</td></tr></table></td><td></td></tr>
<tr><td>Notes</td><td>Below is the breakdown of MSG069 and MSG073

MSG069: Wall mount kit (NA) for Sprocket
First part is CUI power supply: SWI24-12-N-P5 – North American Plug.
Second part is a custom cable that will connect to this power supply on one end and to Sprocket at the other end.

MSG073: Wall mount kit (Multi-region) for Sprocket:

First part is CUI power supply: SMI24-12-V-P5 – Plug with Multi-region blades (see image on right).
Second part is a custom cable that will connect to CUI power supply on one end and to Sprocket at the other end.</td><td>SMI24-12-V-P5 (image for reference only; see product specs at Manufacturer website)
  </td></tr>
</table>

Auto Start

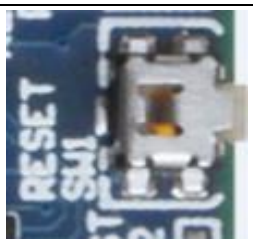
The Sprocket Carrier has an on-board Auto Start Functionality, the module will boot automatically when power is applied.

Note: Due to the changes done to the PMIC circuitry of the TX2i Jetson Module the Sprocket Carrier will always remain ON when in AT (Automatic Power ON) and ATX (Push Power button) modes. This will cause the Sprocket Carrier to automatically power ON when voltage is applied to the system. The system will in addition be unable to shut down in software (Soft Shutdown), due to the characteristics of the TX2i power circuitry as such the system will perform a Reset/Reboot function.

Switch Description

S1 Push Button Switch – Reset

Function	NVIDIA Jetson TX2/TX2i/TX1 Reset
Location	S1
Pinout	**Switch** / **Description**: S1 – RST_IN# Switch



S2 Push Button Switch – Force Recover

Function	NVIDIA Jetson TX2/TX2i/TX1 Force Recovery
Location	S2
Pinout	**Switch** / **Description**: S2 – FORCE_RECOV# Switch

S3 Push Button Switch – Power Button

Function	NVIDIA Jetson TX2/TX2i/TX1 Power
Location	S3
Pinout	**Switch** / **Description**: S3 – PWR_BTN# Switch

Typical Installation

1. Ensure all external system power supplies are off.

2. Install the Jetson TX2/TX2i/TX1 Module onto the Samtec SEARAY Connector P1. Be sure to follow the manufacturer's directions for proper installation of mounting hardware, heatsink/heatspreader, and any other applicable requirements from the manufacturer.

3. Install the necessary cables for application. At a minimum these would include:

   a) Power cable to the input power connector
   b) Serial console from the 15 pin I/O cable
   c) Hardware tools like Bus Pirate (https://www.seeedstudio.com/, https://www.adafruit.com/ or for EU customers http://www.watterott.com/) to connect TTL signals from Sprocket to USB port of your computer in order to acess console (Uart0).

      Alternatively, TTL to USB cable like TTL-232R-3V3-WE or similar could be used) can also be used to the emaulate the serial console over Putty (or similar opensource serial port emulator) on your PC.

Note: Serial Console using Bus Pirate:

Sprocket has been tested working with Bus Pirate v3.6 right out of the box. TX from Sprocket goes to MISO pin on BusPirate and RX goes to MOSI pin; finally GND goes to GND.

Serial Console using TTL (+3.3V) to USB cable:

TTL to USB serial adapter cable may require an external 5KΩ series resistor to be added between CB251-Pin 13 (Uart0-TX) and RXD pin of TTL-232R-3V3-WE. Similarly, may require an external 2KΩ series resistor to be added between CB251-Pin 12 (Uart0-RX) and TXD pin of TTL-232R-3V3-WE.

4. Connect the Power Cable to the Power Supply

5. Switch ON the Power Supply. DO NOT power up your system by plugging in live power.

On-Board Indicator LEDs

The Sprocket Carrier has 3 on-board indicator LEDs.

LED	Description
D2	RST_OUT#
D3	+5V
D10	+3V3

Current Consumption Details

Below are the maximum ratings of the Sprocket Carrier.

Theoretical Maximum	Watts
Theoretical absolute maximum total draw of all functionality on the Sprocket Carrier Board (not including TX2/TX2i/TX1 Module)	TBD

Below are measurements taken with the Sprocket Carrier running in various configurations. Some values will change depending on what operation or software is installed. Measurements also include the Jetson™ TX2/TX2i/TX1 Module. All measurements were taken in a lab environment with an ambient temperature of 25 degrees Celsius.

Actual Measurements	Watts
Module not installed, power applied to Sprocket Carrier only	0.11 W
Module not installed, power applied to Sprocket Carrier with MIPI Camera only	0.38 W
Module installed, booted into Ubuntu, idle	1.14 W
Module Installed, booted into Ubuntu, running MIPI camera and USB OTG functionality	4.08 W

Software / BSP Details

All Connect Tech NVIDIA Jetson TX2/TX2i/TX1 based products are built upon a modified Linux for Tegra (L4T) Device Tree that is specific to each CTI product.

WARNING: The hardware configurations of CTI's products differ from that of the NVIDIA supplied evaluation kit. Please review the product documentation and install ONLY the appropriate CTI L4T BSPs. Failure to follow this process could result in non-functional hardware.

Connect Tech's Custom L4T BSP (CTI-L4T)

Connect Tech also offers a custom BSP to add in additional peripheral support on CTI's Jetson Carrier Boards. In the case of the Sprocket Carrier Board the CTI-L4T will expose software control of most of the carrier interfaces including MIPI CSI-2, USB and more.

The CTI-L4T can be downloaded directly from Connect Tech here:

http://www.connecttech.com/jetson

NVIDIA Jetpack for L4T

The Jetpack for L4T is an on-demand all-in-one package that bundles and installs all software tools required to develop for the NVIDIA's TX2/TX2i/TX1 Platform with Connect Tech's TX2/TX2i/TX1 Carrier Boards. Jetpack includes host and target development tools, APIs and packages (OS images, tools, APIs, middleware, samples, documentation including compiling samples) to enable developers to jump start their development environment for developing with the Jetson Embedded Platform. The latest release of Jetpack runs on an Ubuntu Linux 64-bit host system and supports both the latest Jetson TX2/TX2i/TX1 Development Kit and Jetson TK1 Development Kit.

NVIDIA's Jetpack can be downloaded directly from NVIDIA here:

https://developer.nvidia.com/embedded/jetpack

Force USB Recovery Mode

The Sprocket Carrier does support USB Force Recovery Mode or USB OTG on the USB 2.0 port. To update the firmware on your NVIDIA Jetson TX2/TX2i/TX1, mount the module onto the Sprocket and place the system into USB OTG Client Mode. This is done by attaching a USB Micro B Cable/Connector to the Sprocket OTG Port. Press and Hold Recovery Button, wait for 5 seconds, while still holding RECOVERY button press for 1 second and release the RESET button. After this wait for 2 seconds, now you can release the recovery button and the module should now be in recovery mode. From there follow the instructions as detailed in the NVIDIA Jetson TX2/TX2i/TX1 Developer Kit User Guide or contact support@connecttech.com.

Thermal Details

The Sprocket Carrier Board has an Operating Temperature Range of -40°C to +85°C.

However, it is important to note that the NVIDIA Jetson TX2 and TX1 Modules have its own properties separate to that of the Sprocket Carrier Board. The NVIDIA Jetson TX2i matches the Sprocket Operating Temperature Range of -40°C to +85°C.

Customer responsibility requires proper implementation of a thermal solution that maintains the TX2/TX2i/TX1 SoC and Thermal Transfer Plate (TTP) temperatures below the specified temperatures (shown in the tables below) under the maximum thermal load and system conditions for their use case.

Jetson TX2i Thermal Specifications

Parameter	Value	Units
Maximum TTP operating temperature	85	°C
Recommended Tegra X2 operating temperature limit	T.cpu = 95.5	°C
	T.gpu = 95.5	°C
Tegra X2 maximum operating temperature limit	T.cpu = 101	°C
	T.gpu = 101	°C
	T.diode = 110	°C

Jetson TX2/TX1 Thermal Specifications

Parameter	Value	Units
Maximum TTP operating temperature	80	°C
Recommended Tegra X2 operating temperature limit	T.cpu = 95.5	°C
	T.gpu = 93.5	°C
Tegra X2 maximum operating temperature limit	T.cpu = 101	°C
	T.gpu = 101	°C

NVIDIA provides complete Thermal Design Guides, which include all of the information required to implement a complete thermal solution for the Jetson TX2, TX2i or TX1 Module. The Thermal Design Guides can be downloaded here:

Jetson TX2i:
http://developer.nvidia.com/embedded/dlc/jetson-tx2i-thermal-design-guide

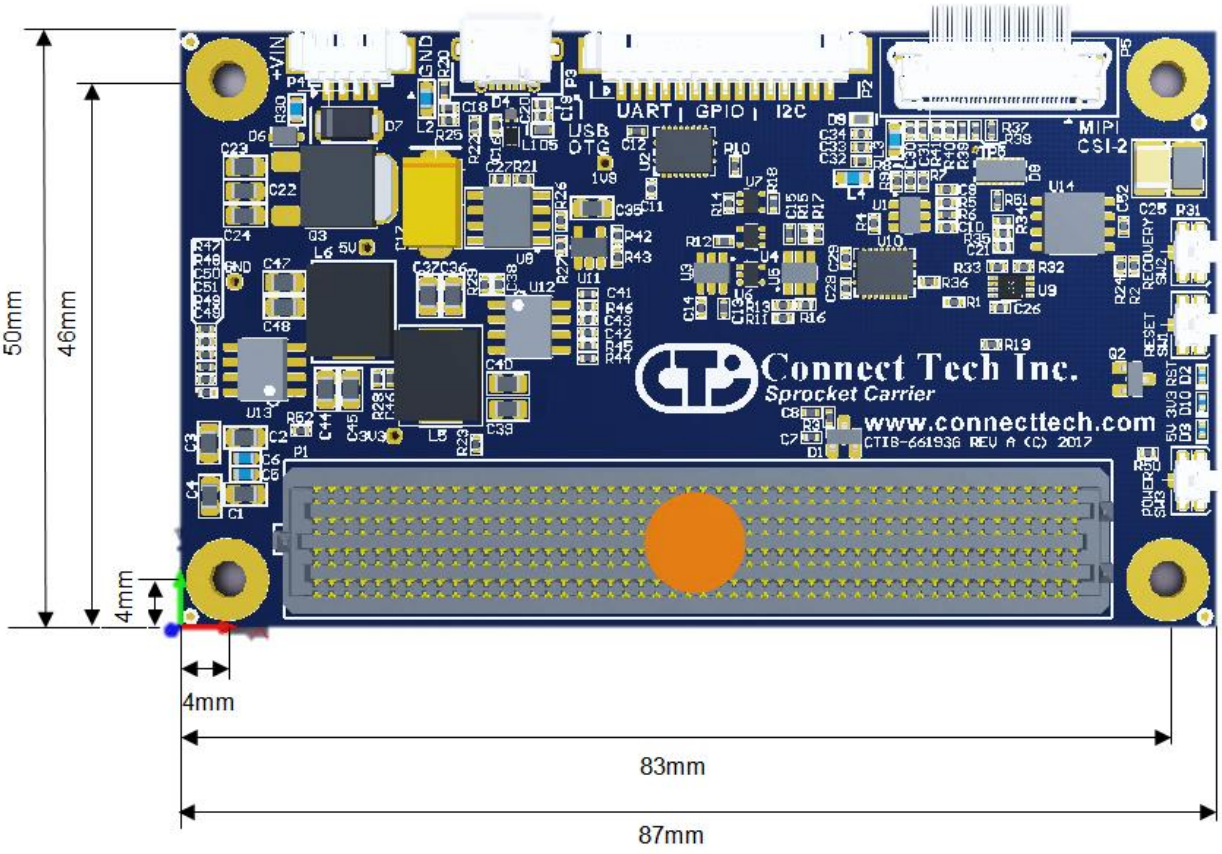
Jetson TX2/TX1:
http://developer.nvidia.com/embedded/dlc/jetson-tx2-thermal-design-guide

Mechanical Details

Sprocket 3D model is available at the link below:
http://connecttech.com/resource-center/downloads-sprocket-carrier-asg008/

Top View

Dimensions in mm.



Cables and Cable Kit information

The following table summarizes the Sprocket Carrier cables and cable kit information available.
All the cable are avaible as a la carte items. However, two starter cable kits,deemed to be bare minumum that a customer would need to get started, are also available: CKG046 (inlcudes 1 x MSG069 and 1x CBG251) is intended for North American customers; while CKG048 (inlcudes 1 x MSG073 and 1x CBG251) is intended for customers outside North America. Please refer to notes in 'Power Input' section for important details.

Drawing No.	Part No.	Description	ASG008 North America Starter Cable kit (CKG046)	ASG008 Multi-region Starter Cable kit (CKG048)
-	MSG069	12V North America Power Adapter to PicoBlade Kit	1	-
-	MSG073	12V Multi-Region Power Adapter to PicoBlade Kit	-	1
-	CBG251	IO Cable with Flying Leads	1	1
-	CBG252	4 pin Molex Picoblade Cable to Flying Leads	-	-
	CBG254	Micro USB to USB Type-A Female (For Host)	-	-
-	CBG247	Micro USB to USB Type-A Male (For OTG/Programming)	-	-
-	XHG301	TX2/TX1 Passive Heat Sink	-	-

3rd Party Accessories

Part Number	Manufacturer	Description
FAW-1233-03	Leopard Imaging Inc	Micro Coax I-PEX Cable: 300mm, MIPI Camera Cable
LI-IMX274-MIPI-CS	Leopard Imaging Inc	Sony IMX274 4K MIPI Interface camera module with CS Mount lens (Datasheet Link)
LI-IMX185-MIPI-CS	Leopard Imaging Inc	Sony IMX185 MIPI Interface camera module with CS Mount lens (Datasheet Link)

Please note a USB to USB Type-A Male cable would be required to flash the module, if customer does not have this available, CBG247 can be ordered.

Furthermore, some customers may require some TTL 3V3 to USB tool like BusPirate to connect TTL signals from Sprocket to USB port of your computer in order to acess console (Uart0). Sprocket has been tested with Bus Pirate v3.6.

Alternatively, TTL to USB cable like TTL-232R-3V3-WE or similar could be used. For more information on this, please refer to the 'Note' on page 17 under 'Typical Installation' section.