IS4S
Integrated Solutions for Systems

PNT Integrity Toolkit Assembly Guide

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Table of Contents

IS4S
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List of Figures

List of Tables

1 Introduction

The PNT Integrity Toolkit provides a means for end-users to quickly build a reference system for utilizing the PNT Integrity Library. The kit is comprised entirely of COTS components that can obtained by an end-user. This document provides a bill of materials and assembly instructions for end-users to procure and follow. This assembly guide only gives instruction on assembling the hardware and installing the proper operating system on the embedded host platform. Additional documentation should be reviewed for detailed instructions on using the toolkit application and the PNT Integrity Library software packages that are provided with the kit.

The suggested reading order is as follows:

1. PNT Integrity Toolkit Assembly Guide (this document)
2. Build Guide
3. PNT Integrity Library Guide (Chapter 1 only)
4. PNT Integrity Toolkit (Chapters 1 & 3)
5. Toolkit User Interface Guide

2 Parts Procurement

Prior to assembly and use of the PNT Integrity Toolkit, the end user must source all of the parts needed for the kit from various suppliers. The figure below shows a diagram of all the components needed for the kit. A detailed descriptions of all the components and a bill of material follows.

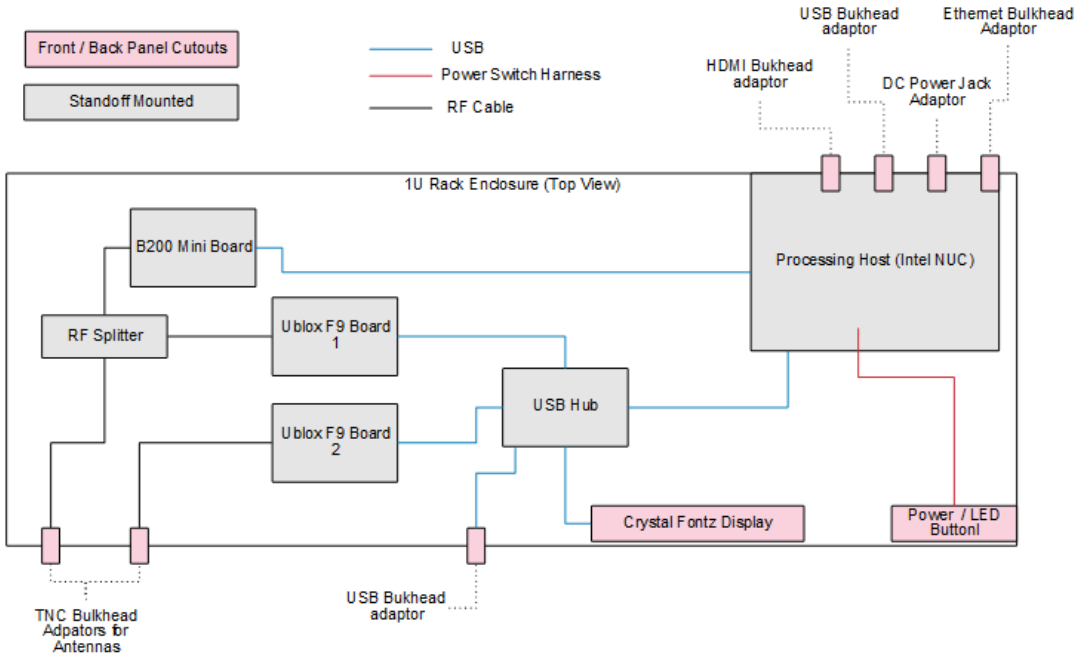


Figure 2-1. Component Diagram

2.1 Chassis and Fasteners

A custom-designed enclosure for the toolkit is available to end-users. The step file included with the kit package can be provided to Protocase for fabrication. Protocase will provide the proper fasteners needed for box assembly with the order.

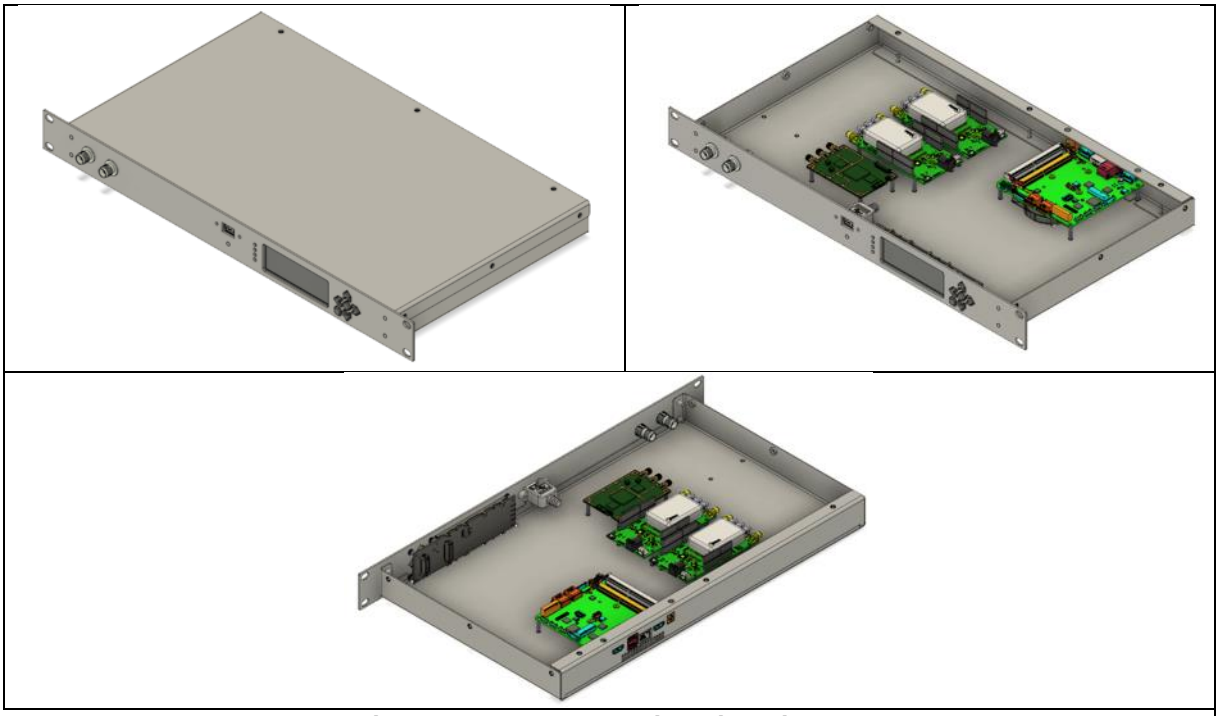


Figure 2-2. Custom Designed Enclosure

2.2 Host Processing Components

This particular reference implementation in the toolkit calls for an embedded Intel NUC processing platform (running Ubuntu 18.04 LTS). The toolkit has been thoroughly tested with this processing host. The tookit should run with any platform capable of running a compatible Linux distribution. However, the custom enclosure is only designed for the specific NUC motherboard provided below. Performance with other hosts is not tested and may vary depending on the choice / configuration of host platform. The following components should be sourced for proper mounting / alignment in the 1U case.

Intel NUC Board (Qty 1)

SAMSUNG EVO 860 SSD (QTY 1)

HYPERX SODIMM RAM (QTY 1)

Figure 2-3. Host Processing Components

2.3 External Operation Interfaces

The kit utilizes a USB-drive LCD interface to display outputs from the PNT Integrity Library. A momentary power switch must also be installed to allow the operator to turn on the internal host processing platform.

Crystal Fontz LCD Display (Qty 1)

Momentary Power Switch (Qty 1)

Figure 2-4. Full System Diagram

2.4 Passive RF Components

The following passive RF components are needed to route the incoming RF from external antenna connections. The TNC female bulkhead connections will be exposed on the front of the box for these connections.

		
RF Splitter Qty 1	Flex form SMA Cable (1 ea 6”, 9”)	SMA to TNC Female Bulkhead (1 ea 6”,12”)

Figure 2-5. Passive RF Components

2.5 Receiver Processing Devices

	
B200-mini USRP Cable (Qty 1)	Ublox F9 Receiver Kit (Qty 2)

Figure 2-6. Full System Diagram

2.6 USB Components

	
USRP – USB Cable (Qty 1)	Receiver USB Cable (Qty 2)

Figure 2-7. Full System Diagram

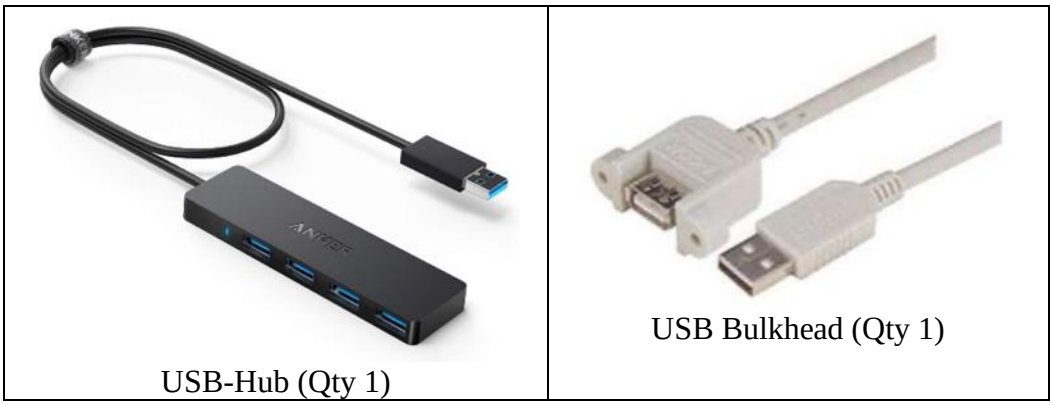


Figure 2-8. Full System Diagram

2.7 Bills of Material

The following tables provide a bill of materials (BOM) for the kit. The first table lists the custom enclosure needed for the kit along with appropriate hardware / fasteners. The second table identifies all of the internal components needed for the kit.

Table 2-1. Chassis and Hardware

Components	Qty	Part #	Function / Description	Source
1U Chassis	1		19” rack mount 1U chassis to house all kit components	Protocase
Hardware	26	98164A061	3/16” 4-40 machine screws for component mounting	McMaster
Hardware	2	98164A435	1” 4-40 machine screws for RF splitter	McMaster

Table 2-2. Internal Kit Components

Components	Qty	Part #	Function / Description	Source
Processing Host	1	NUC7i7DNBE	Processing host platform	Intel
SSD	1	MZ-N6E250BW	Primary storage / OS Drive	Amazon
RAM	1	HX426S16IB2/16	Memory	Amazon
Power Cord	1		AC adapter for processing host	Amazon
SDR – B200 Mini	1	USRP B200mini (Board only)	SDR for running Acquisition Check	Intel / Various
Receiver (Ublox F9)	2	C099-F9P-2-02	Receiver 1 / 2 to provide data for assurance checks	DigiKey
RF Splitter	1	ZAPD-23-S+	Routing RF from antenna to Receiver 1 and USRP	Mini Circuits

USB-Hub	1	Various	Any slimline USB hub will work. Amazon link provides a representative choice	Amazon
USB Bulkhead	1	UPMAA-03M	Front-panel USB access to processing host	L-Com
Crystal Fontz Display	1	CFA635TFKKU1	Display Integrity Toolkit output information	Crystal Fontz
Power / LED Switch	1	U16B1SW	Power on / hard reset of unit	Amazon
TNC to SMA bulkhead 1 (6 in.)	1	PE39484-6	Antenna 1 input	Pasternack
TNC to SMA bulkhead 2 (12 in.)	1	PE39484-12	Antenna 2 input	Pasternack
SMA Cable 1 (6 in.) (Splitter to USRP)	1	141-6SMRSM+	RF plumbing inside box	Mini Circuits
SMA Cable 2 (9 in.) (Splitter to RX 1)	1	141-9SMRSM+	RF plumbing inside box	Mini Circuits
USB cable for receivers	2	CAA-90LMICB-03M	RF plumbing inside box	L-Com
USB cable for USRP	1	CAU3AMICB-03M	Data cable for USRP to host	L-Com

3 Assembly Instructions

3.1 Processing Host Assembly

The first process in kit assembly is to assemble the NUC host processing platform. Detailed procedures are outlined below

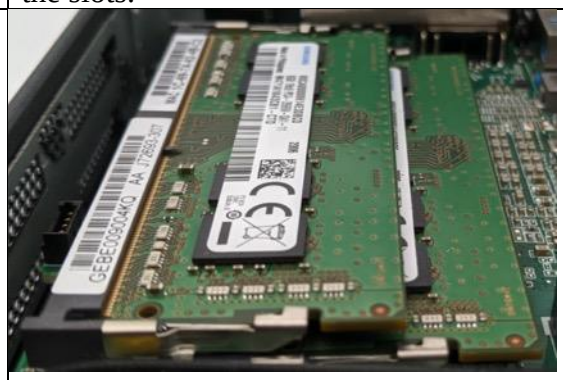
3.1.1 SSD and RAM Installation

Locate the SO-DIMM slots and SATA M.2 slot on the NUC. The SO-DIMM slots will be much wider than the SATA M.2.

Insert the SSD with the label facing up into the SATA M.2 slot at an angle. The SSD should have a snug press fit into the slot.

Insert both RAM modules with the labels facing up into the SO-DIMM slots. It does not matter which module goes into which slot. They should make a snug press fit into the slots.

Take the included set screw and fasten the other side of the SSD into the mounting hole.

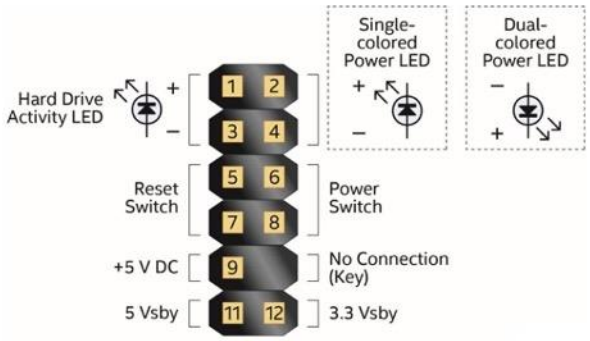


Push both modules down gently until the metal retainers on the sides snap them into place.

Figure 3-1-1. SSD and RAM installation

3.1.2 Power Switch Assembly

Step 1:
The NUC motherboard has pins available to integrate an external switch to power the unit on/off. Because of the height of the board and the low profile of the 1U enclosures, wires must be soldered to these pints to allow the enclosure lid to be secured to the chassis. There is not enough room for a 90-degree pin header. Appropriate heat-shrink should be used to prevent accidental contact between the soldered leads and the enclosure lid.



NOTE: since the power switch uses a single LED, pin 2 is (+) and pin 4 is (-)

Consider using 2 green wires for the switch and 1 red and 1 black wire for the LED in the switch

Figure 3-1-2 Full System Diagram

Step 2:

The power switch is equipped with 4 screw terminals. Insert the red wire (pin 2) into the terminal labeled with (+) and insert the black/white wire (pin 4) into the terminal labeled with (-). The 2 remaining terminals are for the green wires (pin 6 and 8). Screw each cable down as they are inserted.

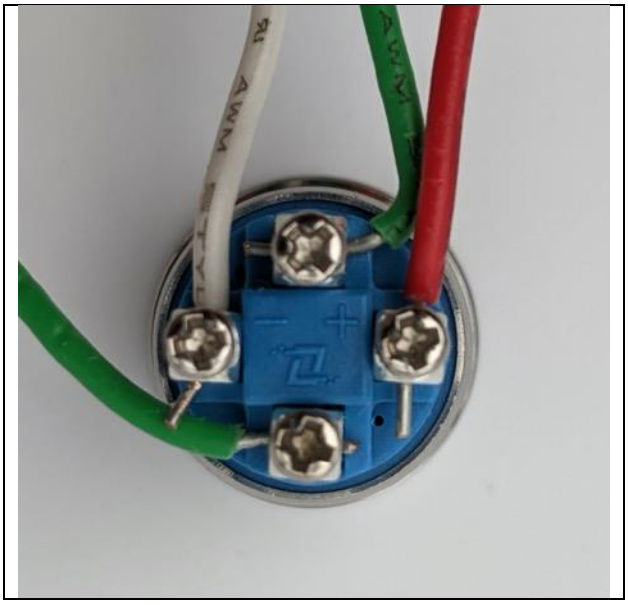


Figure 3-2-2 Power Switch Wiring

3.2 Chassis Mounting

Mount the processing host, receivers, display, and SDR-B200 Mini with appropriate 4-40 machine screws. The RF splitter does not have fixed mounting holes. It can be secured with a suitable adhesive or command strip. Refer to the image below for the correct placement of components within the enclosure.

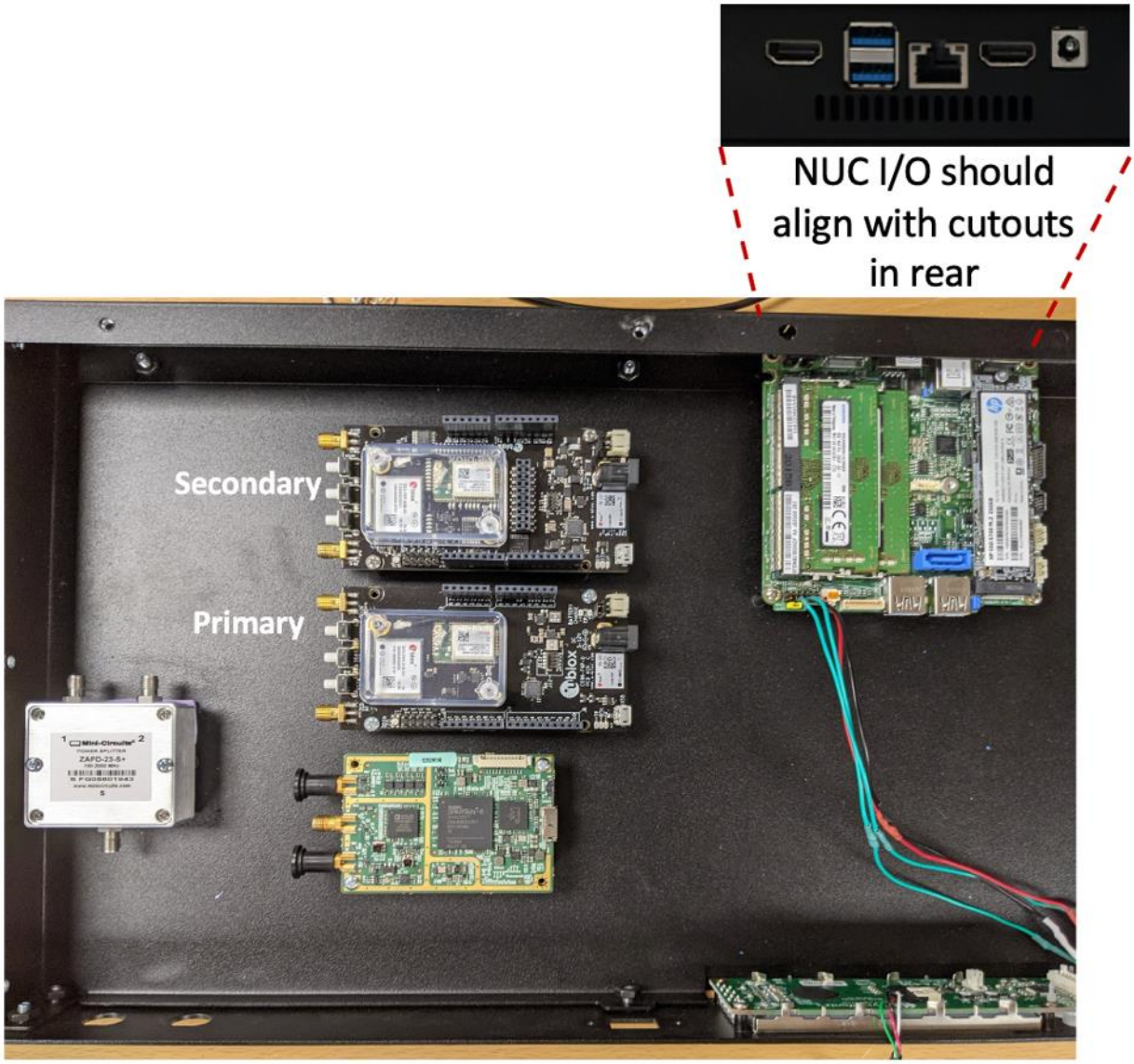


Figure 3-3. Component Placement inside Enclosure

3.3 Component Interconnects

The USB hub should be connected to an available USB 3.0 port on the host. The Ublox F9s should then be connected to the hub with the appropriate USB-A to USB-A Micro cables.

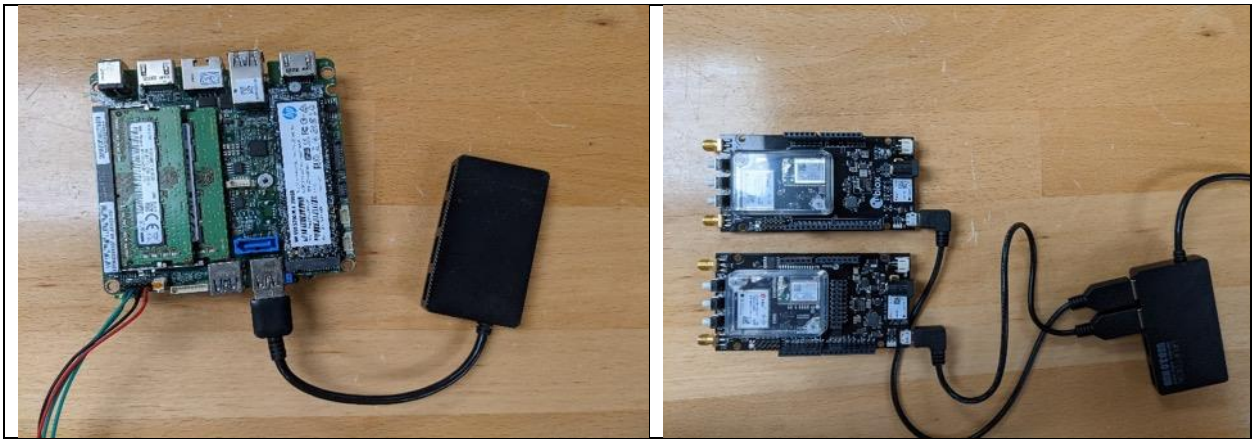


Figure 3-4. USB Hub and Receiver Connections

Next, the USRP should be connected directly to the host with the USB3-B cable.

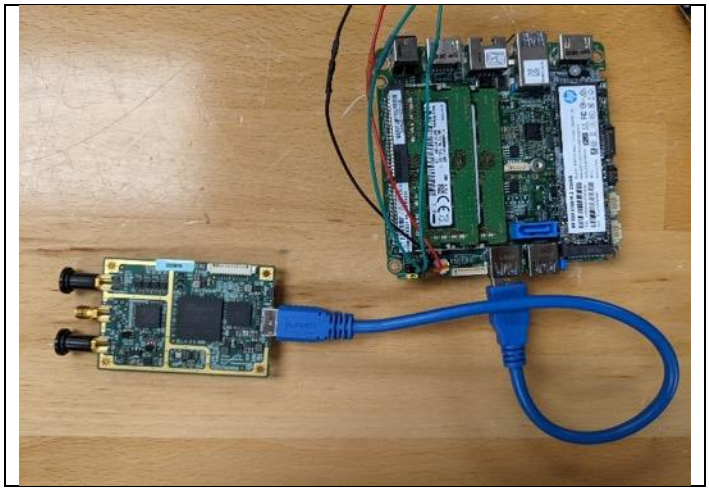


Figure 3-5. USRP Connection

After the USB connections have been made, RF coaxial connections from the primary Ublox receiver (the one closest to the front panel) and the USRP to the RF splitter should be made. Proper torque should be applied to each SMA assembly to ensure proper connection. An SMA torque wrench is recommended but not required. If not using a torque wrench, be sure not to over tighten the connections as damage to the solder on the components could ensue. A slight wrench turn beyond finger tight is usually sufficient.

Figure 3-6. Splitter to Ublox / USRP connections

Connect the short SMA to TNC cable to the RF splitter and the longer cable to the secondary Ublox receiver. Again, use proper torque on the SMA connectors.

Figure 3-7. TNC Bulkhead Connections

Next, the power switch, display, TNC bulkheads and USB bulkhead should be secured to the enclosure front panel. The TNC bulkheads should be aligned (D-shaped insert) and secured with a threaded nut from the front side of the enclosure. The momentary power switch is secured in a similar fashion. The display is secured to the front panel with 4-40 machine screws to standoffs on the internal side of the panel. The USB bulkhead is secured to the panel with provided screws.

Figure 3-8. Front Panel with Secured Components

Inside the enclosure, the display and USB bulkhead should be connected with the provided USB device cable to the hub.

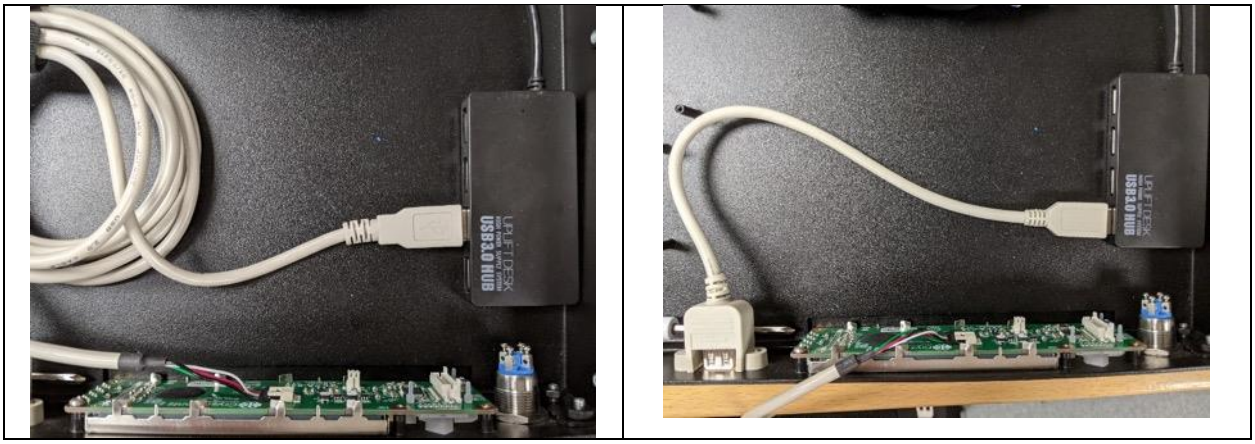


Figure 3-9. Front Panel USB Connections

A fully assembled kit should resemble the following figures. The enclosure lid can now be fixed to the device to complete assembly.

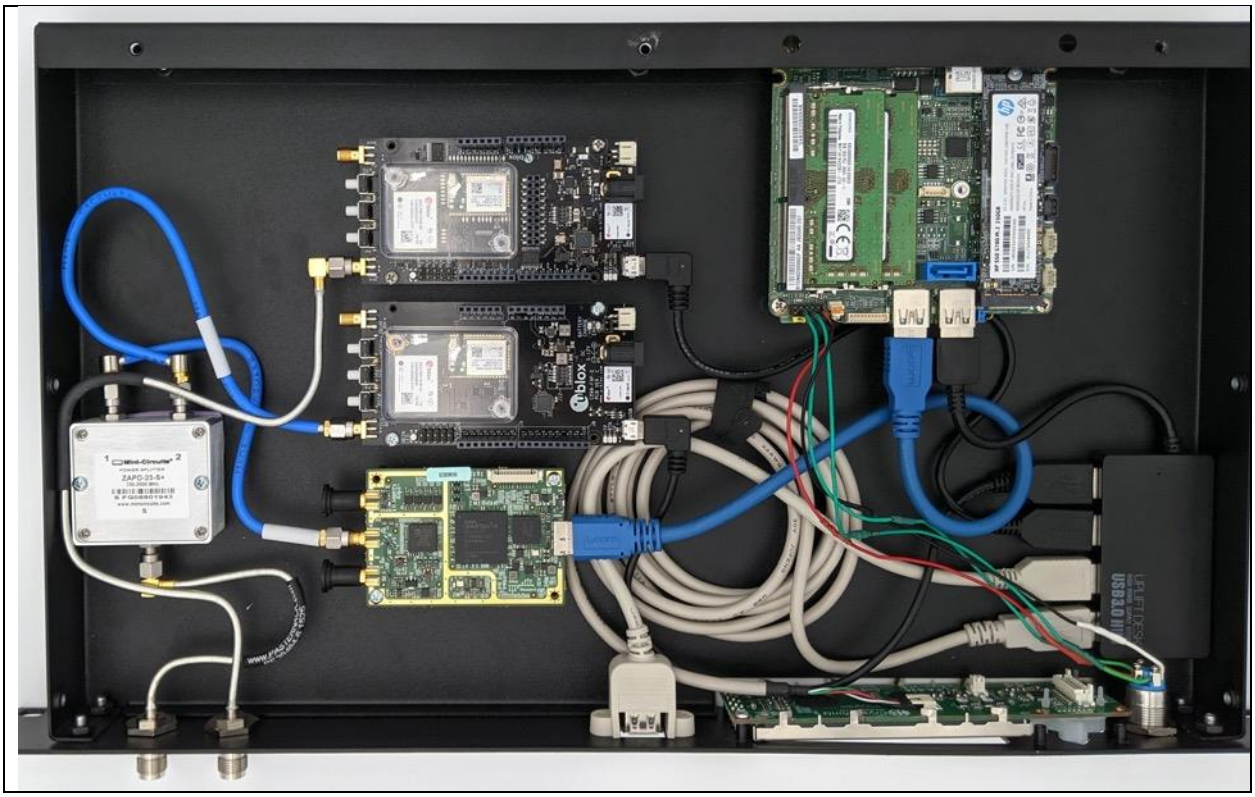


Figure 3-10. Fully Assembled Kit (Top view with lid removed)

Figure 3-11. Fully Assembled Kit (Top view with lid installed)

Figure 3-12. Fully Assembled Kit (Bottom View)

Figure 3-13. Fully Assembled Kit (Front View)

Figure 3-14. Fully Assembled Kit (Rear View)

4 System Setup

4.1 I/O Power Connections

The toolkit is powered by the 19V power supply included in the bill of materials. It is also equipped with an HDMI, ethernet, and 2 USB 3.0 slots along with the slot for the power supply for debugging purposes. The end-user should connect these ports to appropriate I/O devices for operation.

4.2 Installing Ubuntu 18.04

Refer to the following link for installing Ubuntu 18.04 on the NUC Host via USB drive: installing Ubuntu.

4.3 Building / Installing the Kit Software

Refer to the build guide document included with the package for detailed instructions on installing the necessary pre-requisites and building the kit software packages.