LWA Memo 227:
LWA-NA Timing and Power Control

Craig Taylor*, Greg Taylor†, & Jayce Dowell‡

January 29, 2025

1 Introduction

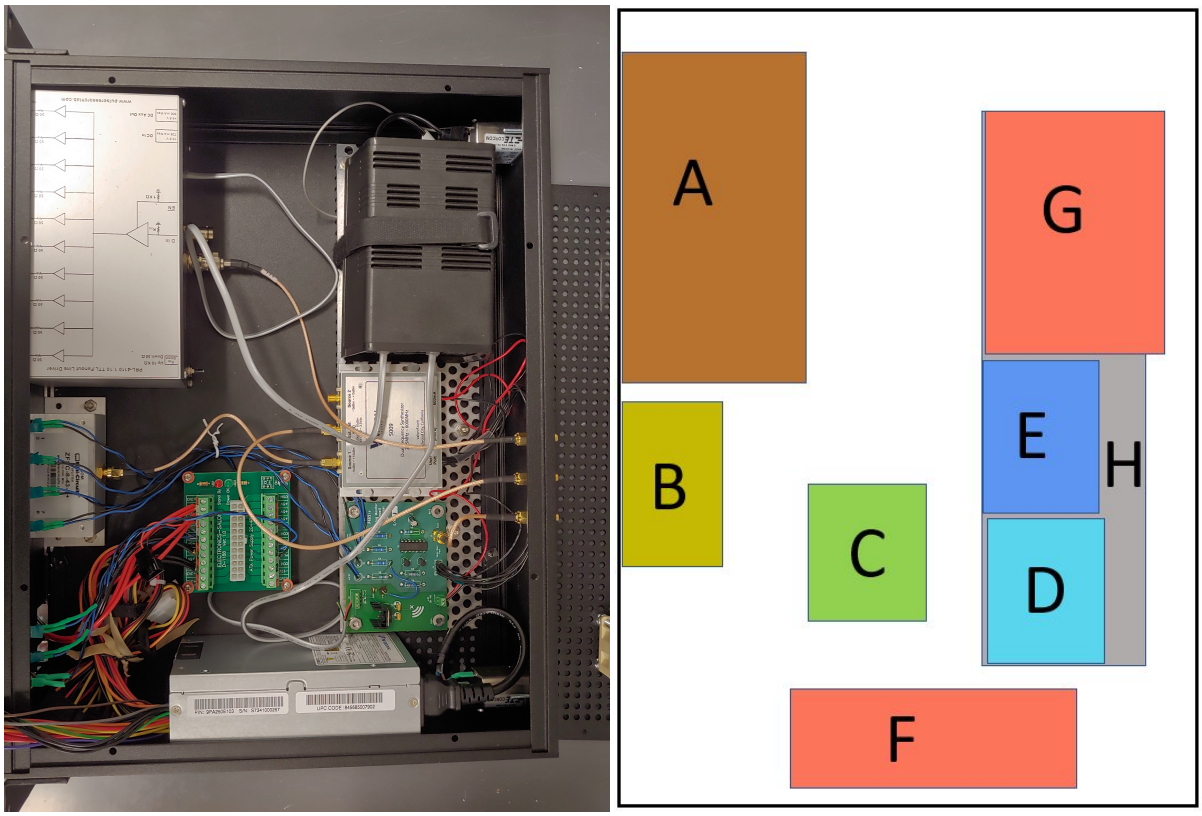
The newest station to the Long Wavelength Array (LWA) collaboration in New Mexico is an experimental mini-station or 'swarm' station. This swarm station is be a 64-element LWA concept and is constructed along the North Arm (LWA-NA) of the Very Large Array. This new station features new SNAP-2 digitizers as a part of a partial redesign of the analog signal path. SNAP2 boards will be replacing the ROACH2 boards to handle digitization of the ARX output and F-Engine duties. This upgrade, in addition with the more compact platform that the mini-station is designed for, meant we needed to build a new control unit compatible with our "off-the-shelf" electronics shelter. This memo will outline the North Arm Timing and Power Control (NA-TPC) unit that will serve to interface between the SNAP-2 boards and the 8 Analog Receiver (ARX) boards for the LWA-NA station. Section 2 details the metal enclosure housing the module as well as the machining that was commissioned to create all of the ports on the front and rear. Section 3 shows images of the final product along with a brief synopsis of the components included in the control box. Lastly, Section 4 shows the NA-TPC unit installed on-site at LWA-NA and the machining schematics are contained in the subsequent appendix.

2 NACB Housing and Machining

The box itself is manufactured by Hammond Enclosures and is an RM2U series unit. It is 3.50" × 16.60" × 13.00", has a perforated top and bottom panel for air flow, and has been modified by the UNM machine shop to allow for several ease of use and installation requirements. Alterations to the NA-TPC front panel include: rewiring monitor LEDs on the LWA timing monitor board and Electronics Salon breakout to forward pass-throughs, ten holes were machined into the bottom left to directly pass the BNC-terminals of the fanout line driver through, a rectangular cutout to mount the clock's output SMA-terminals

*University of New Mexico. E-mail: ctaylor98@unm.edu
†University of New Mexico. E-mail: gbtaylor@unm.edu
‡University of New Mexico. E-mail: jdowell@unm.edu

flush with the NA-TPC front panel, two small square holes to feed the power cables to the SNAP2 boards out, and lastly a hole was cut to externally mount the system power switch. For the back, a hole for each power supply's plug and three SMA-connection holes were machined. For more efficient cooling a 1/16" perforated aluminium sheet was commissioned from the UNM machine shop (see Appendix) to stand the PRL-760C4 power supply off of the bottom panel due to the exhaust port location on the bottom of the unit. Originally the perforated sheet was designed to span the width of the box to support both power supplies, however upon test fitting the components inside the NA-TPC we found it more efficient to place the FSP250-60FAG power supply flush with the bottom panel on its narrow side (see Figure 1). To accommodate this change the perforated sheet was cut to approximately 13-5/8" in length such that we could still offset the larger power supply, timing monitor, and dual frequency synthesizer. For complete plans used by the UNM Machine Shop for making alterations please see the Appendix.



(i) Top-Down View **(ii)** Schematic of Components

Figure 1: Overhead image of the NA-TPC (i) and schematic of the electronics (ii) not including the connections to the front or back of unit . Components are as follows: Fanout line driver (A), clock splitter (B), power breakout board (C), timing monitor board (D), dual frequency synthesizer (E), breakout power supply (F), timing fanout power supply (G).

3 Components and Connections

In this section I will describe the connections made within the NA-TPC. The labels on the diagram in Figure 1ii correspond to specific component names within Table 1 along with their estimated cost for a single unit.

For timing, the module receives a 1-PPS (pulse per second) reference signal and a 10 MHz clock signal as a phase-locked pair from the GPS unit mounted on the weather station adjacent to the electronics shelter. The 1 PPS is supplied to the head SNAP2 board to create a master synch pulse that is fed into the TPC module, before a fanout line driver (A) distributes this pulse to each of two SNAP2 boards and to the timing monitor board (D; see Figure 2). For a swarm station of this architecture we only end up using three of ten available ports on the line driver, but for a full station deployment the number of available fanout ports will need to be increased. The 10 MHz GPS output is used to synthesize a 196 MHz sample clock using a Valon 5009 dual-frequency synthesizer (E) and passed through an 8-port splitter (B) to the digitizers to form the required F-Engine channels.

For power, there are two internally mounted power supplies. The FSP power supply (F) interfaces with Electronics Salon breakout board (C) to power the SNAP2s at +12V and is controlled with a rocker switch mounted on the front panel. There are square ports machined into the front panel of the TPC unit to allow cables to feed this power to the SNAP2s. Power for the fanout line driver, timing monitor board, and synthesizer are supplied by the PRL power supply (G) mounted to the perforated offset.

North Arm Control Box Parts List		
Part Name	Function	Est. Cost ($USD)
FSP250-60FAG	Breakout Power	79.99
PRL-4110 1:10 TTL Fanout Line Driver	Sync out	1500.00
PRL-760C4	Fanout Power	175.00
Electronics Salon D118 Ver. 1.0	Breakout board	9.99
Mini-circuits ZFSC-8-43-S+	Clock Splitter	215.95
Valon 5009	Dual Frequency Synthesizer	699.00
Timing Monitor Board Rev 1.0	Clock	100.00
Noctua NF-A 4x20 FLX	Fan	14.95
DaierTek MLH-5-2	LED Pass-through	0.65
Hammond Enclosures RM2U	Enclosure	215.82
SPST Rocker Switch 30-16605	Power Switch	2.36
SMA F-to-F Bulkhead	SM in/out	7.41

Table 1: List of major components implemented in this prototype SNAP2 control suite and approximations of the cost per part used.

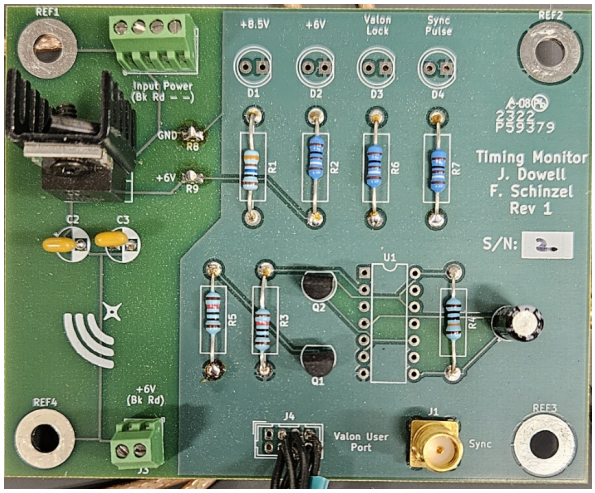


Figure 2: Timing Monitor Board Rev. 1.0

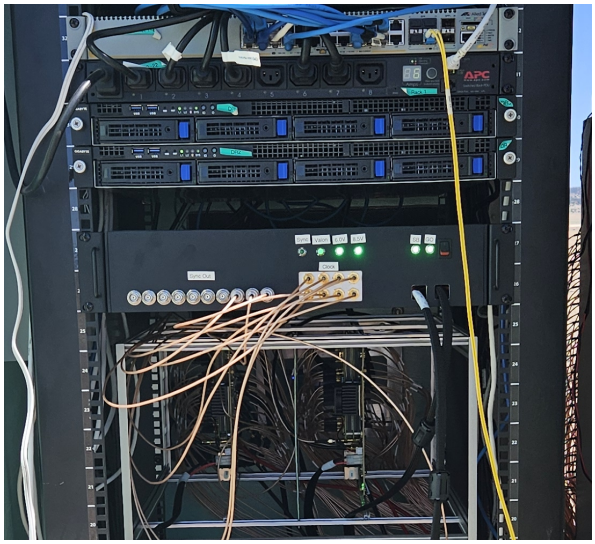


Figure 3: Timing and power control module deployed at LWA-NA.

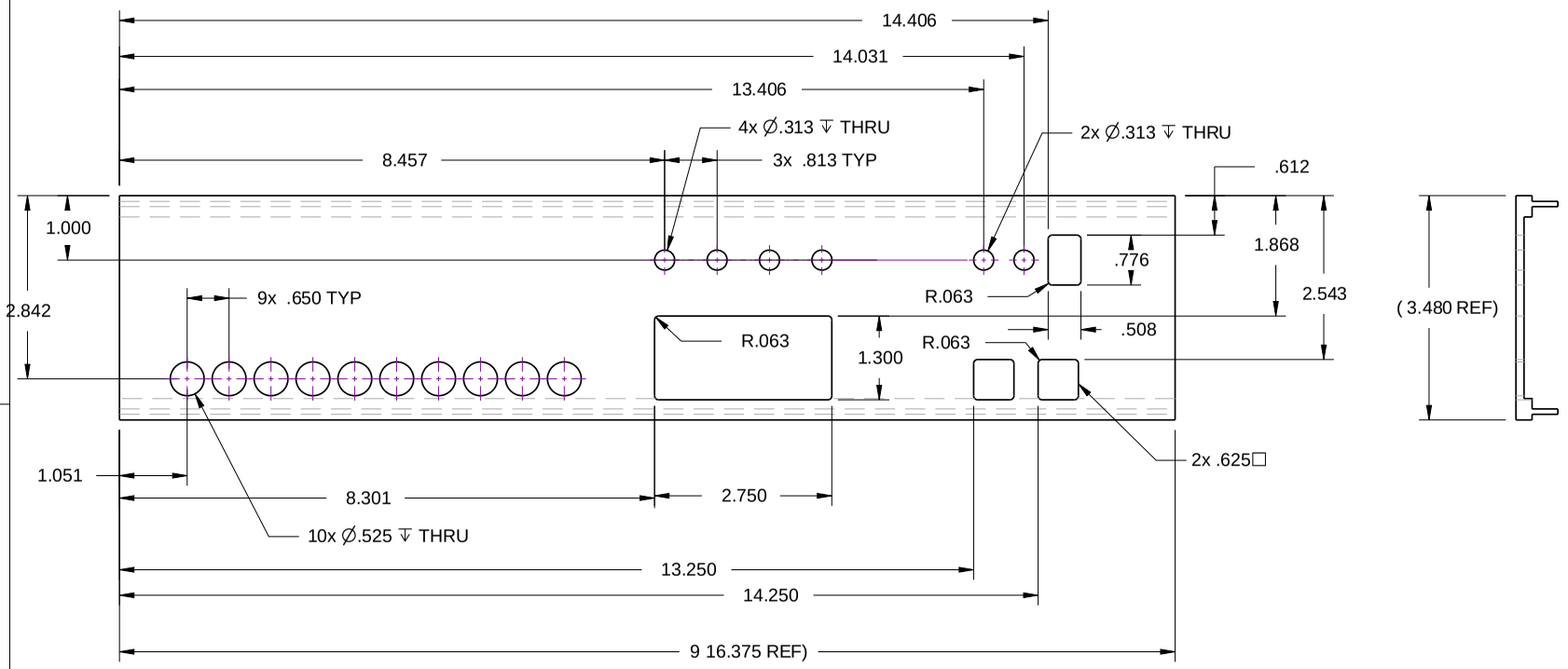
4 Deployment

The NA-TPC was tested at UNM with all of the digitizing hardware to verify proper performance, then deployed to the site in August 2023. Since the commissioning of LWA-NA, the timing module has had no failures but will require a partial redesign to increase compatibility for future LWA stations.

A UNM Machine Schematics

The following are the machine drawings provided by the UNM machine shop for the requested modifications to the Hammond Enclosure RM2U rack box used for the North Arm Control Box.

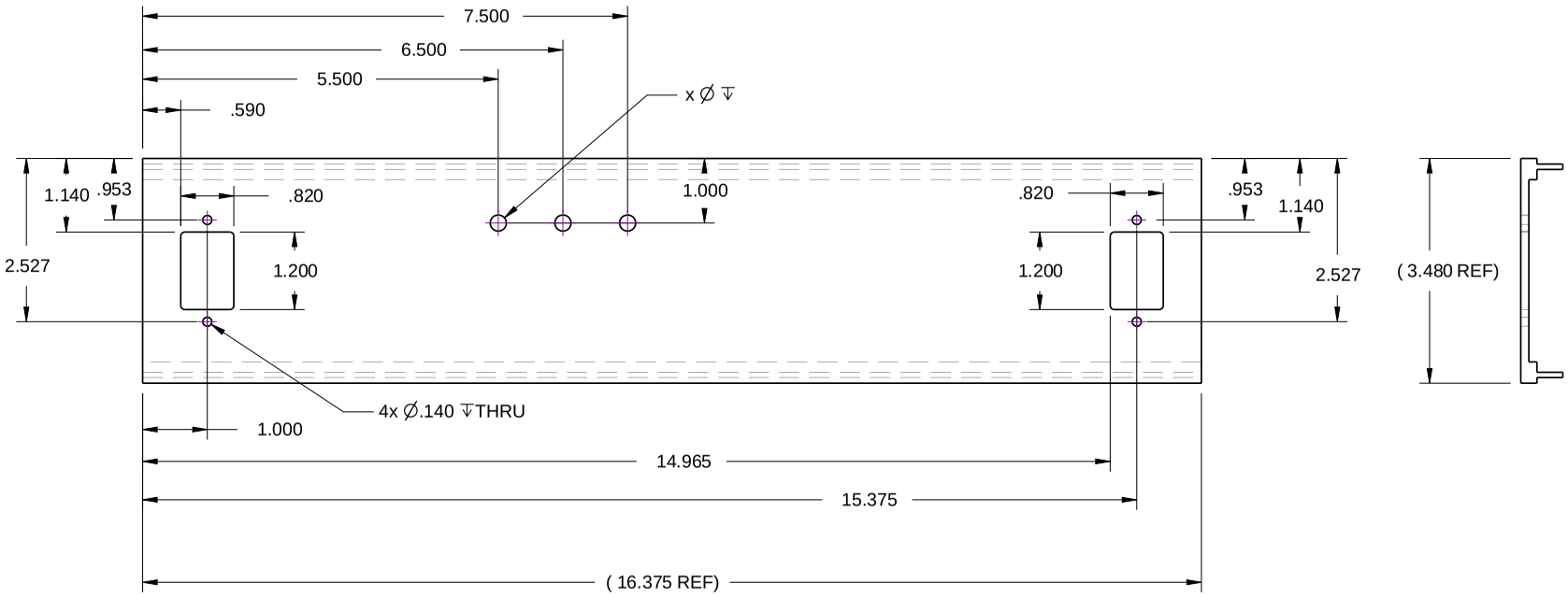
REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED



THE UNIVERSITY of NEW MEXICO
Department of Physics & Astronomy
Machine shop
210 Yale Blvd. NE
Albuquerque, NM 87106
505-277-4327

DRAWN: A GRAVAGNE	DATE: 9/6/2022	RACK BOX MODS		
CHECKED		FRONT PANEL		
MATERIAL: PANEL AS SUPPLIED				
THIRD ANGLE PROJ	QTY: 1EA	SIZE: A	FSCM NO.	DWG NO.: 98715-1A-AL25 / REV
DIMENSIONS ARE IN INCHES TOLERANCE ± .005 UNLESS SPEC.		SCALE		SHEET: 1 OF 3

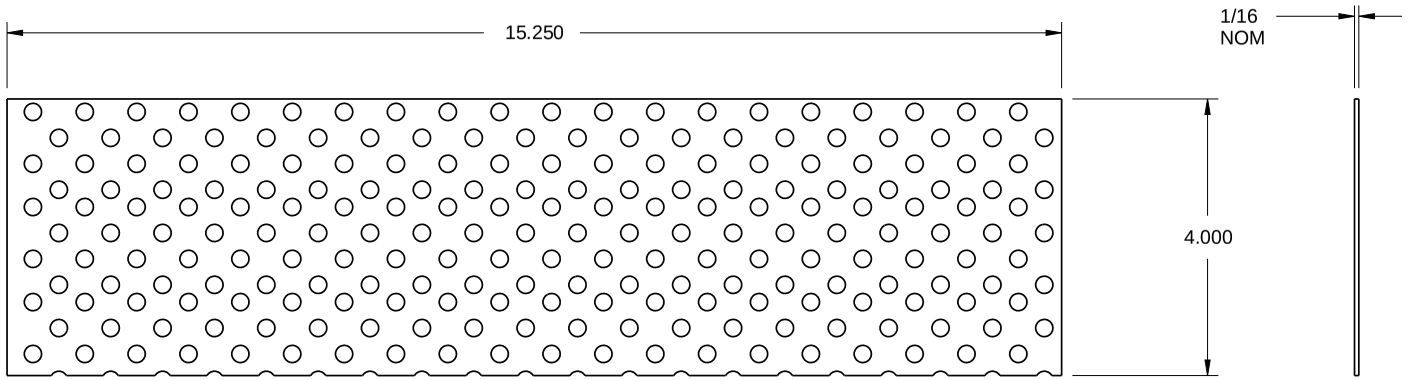
REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED



THE UNIVERSITY of NEW MEXICO
Department of Physics & Astronomy
Machine shop
210 Yale Blvd. NE
Albuquerque, NM 87106
505-277-4327

DRAWN: A GRAVAGNE	DATE: 9/6/2022	RACK BOX MODS		
CHECKED		REAR PANEL		
MATERIAL: SUPPLIED PANEL				
THIRD ANGLE PROJ	QTY: 1EA	SIZE: A	FSCM NO.	DWG NO.: 98715-2A-AL25 / REV
DIMENSIONS ARE IN INCHES TOLERANCE ± .005 UNLESS SPEC.		SCALE		SHEET: 2 OF 3

REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED



PERFORATED 1/16 ALUMINUM SHEET
SHEAR TO SIZE

THE UNIVERSITY of NEW MEXICO
Department of Physics & Astronomy
Machine shop
210 Yale Blvd. NE
Albuquerque, NM 87106
505-277-4327

DRAWN: A GRAVAGNE	DATE: 9/6/2022	RACK BOX MODS		
CHECKED		INTERNAL MOUNTING PLATE		
MATERIAL: PERF. 1/16" ALUM SHEET				
THIRD ANGLE PROJ	QTY: 1EA	SIZE: A	FSCM NO.	DWG NO.: 98715-3A-AL25 / REV
DIMENSIONS ARE IN INCHES TOLERANCE ± .005 UNLESS SPEC.		SCALE		SHEET: 3 OF 3