

**MBS Leopard Transmitter**  
**User NOC Operating Manual**  
**SYS-NN-SS-OG-1158.00-NextNav Leopard NOC User manual**  
**Version 1.5**

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## History

Version	Date	Author	Notes
1	Initial Draft Version	Arun Narayan	1,2
2	November 20, 2013	Waldemar Kunysz	3
3	February 26, 2014	Waldemar Kunysz	4
4	March 10, 2014	Waldemar Kunysz	5
5	Sept 09, 2014	Waldemar Kunysz	6

## Notes:

1. Initial Version
2. Document naming convention used.
3. Revised version
4. Revised ERP Table
5. Revised ERP Table for IDB mode to bring ERP levels to 30 Watts
6. Revised ERT Table 2 to include transmission of 5 MHz signal over bandwidth of 922.308-924.692 MHz.

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## 1 Introduction

The goal of the MBS system is to provide high precision, reliable, ubiquitous positioning system providing GPS like accuracies in indoors and urban canyons where it is challenging to get any reliable position using GPS or other wide area reliable technologies. In addition to improved 2-D accuracy the MBS system also provides meter level accuracy in the vertical dimension with the aid of a MEMS pressure sensor. MBS technology provides a very fast time to first fix (TTFF) in the order of ~5 seconds under cold start conditions. Similar to GPS, MBS technology allows computation of the location on the device without any network dependence thus enabling a wide variety of standalone applications. The signal structure of MBS is designed so that the signal processing entities of a standard GPS receiver's baseband can be reused. The system is fundamentally designed for low power consumption of the receivers.

### 1.1 Purpose and Scope

This document describes the commissioning and normal usage procedure for the NextNav Local beacon box (A4P-100-0013-01).

### 1.2 Intended Use

The NextNav Leopard beacon system is intended to be used in restricted access locations (RAL) in outdoor and indoor environments. The NextNav Leopard beacon is powered by a AC power system approved for use in telecommunications equipment.

### 1.3 FCC Compliance Statements

FCC Section 15.21 Information to user.

Any changes or modifications to the equipment operation settings must be approved by the NextNav, LLC for FCC compliance; otherwise the user's authority to operate the equipment will be voided.

Section 15.105(b) Class A digital device Information to the user

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful

interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

### RF Exposure Statement

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with a minimum distance of 1m between the antenna and any body part of the user or nearby persons.

## 2 NextNav Leopard Beacon Commissioning

Once the NextNav leopard Box is installed in the field and the installation checklist is verified, a field technician follows the following sequence of operations to power up the box as illustrated in **Error! Reference source not found.** and the following checklist can be used for verification of completion of the steps needed.

	Installation Tech checklist	
1	GPS antenna connection	Yes <input type="checkbox"/> No <input type="checkbox"/>
2	Tx antenna connection	Yes <input type="checkbox"/> No <input type="checkbox"/>
3	EvDO antenna connection	Yes <input type="checkbox"/> No <input type="checkbox"/>
4	Ethernet router port activity	Yes <input type="checkbox"/> No <input type="checkbox"/>
5	Able to browse internet from field service laptop using Ethernet port on MBS Leopard beacon box	Yes <input type="checkbox"/> No <input type="checkbox"/>
6	Enable port forwarding if not already done at manufacturing site	Yes <input type="checkbox"/> No <input type="checkbox"/>
7	TX antenna LLA survey done	Yes <input type="checkbox"/> No <input type="checkbox"/>
8	Weather board LLA survey done	Yes <input type="checkbox"/> No <input type="checkbox"/>
9	GPS antenna LLA survey done	Yes <input type="checkbox"/> No <input type="checkbox"/>
10	Survey ground truth of the TX antenna, GPS antenna and weatherboard	Yes <input type="checkbox"/> No <input type="checkbox"/>

**Table 1 Commissioning Procedure Steps for Installation Technician**

## 2.1 Equipment List

- NextNav Leopard Beacon
- Approved Transmit Antenna (See section )
- GPS Antenna (PN: BL1R-A-XTB-1-FKM)
- EVDO Antenna (PN: PSKN-900/1900S)
- NextNav WeatherBoard unit

RF cables as per chart below:

Description	Cable Type	Cable Length (max)
GPS Cable	LMR400	150'
	AL4RPV-50	250'
Tx Cable	LMR400	250'
	AL4RPV-50	400'

## 2.2 Confirm Front Panel Cable Connections

The slave unit (bottom module shown in Fig 1 and the master units are connected to the timing tray using a backplane board (behind the units) and 4 coaxial cables in the front as shown. Make sure that GPS antenna cable is connected to the top right hand side connector and TX antenna to the bottom one.



**Figure 1 Leopard Front Panels**

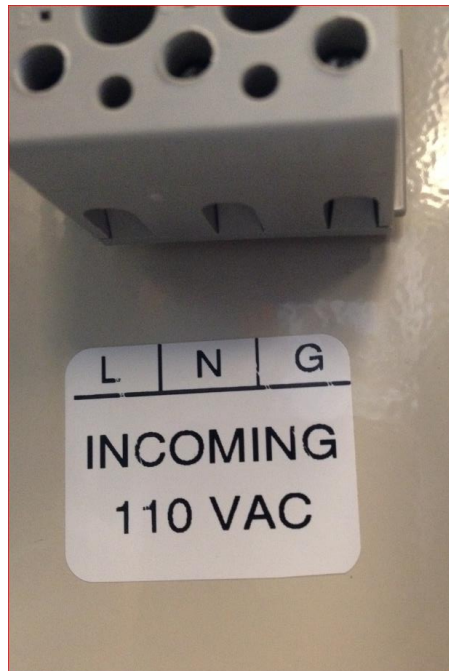
1. Verify the following external connections to the beacon:
  - a) GPS antenna connection to the Leopard Box
  - b) Tx antenna cable connection to the 'TX' port.
  - c) Weather box connection to the WEATHER port.
  - d) EvDO antenna cables to the EvDO Tx port. In cases of sites which have been documented as requiring EvDO diversity, connect the diversity

antenna to the EvDO DIV port. In cases of sites which have been documented as needing a POTS line, connect the phone line to the 'TELCO' port.

2. Verify that the following LEDs (located at the front panel) are lit indicating proper operation:
  - a) Primary unit: Status indicator LED is lit in RED
3. Connect the field service laptop with an Ethernet cable to the 'Ethernet' port on the MARS beacon box. Wait for a few seconds to get an IP address on the field service laptop. Try and browse the internet to ensure connectivity. Once connectivity is ensured, call the operator at the NOC to further commission the beacon box.

### 2.3 Power-up Sequence

Connect AC Lince Feed to terminal block labled Incoming AC.

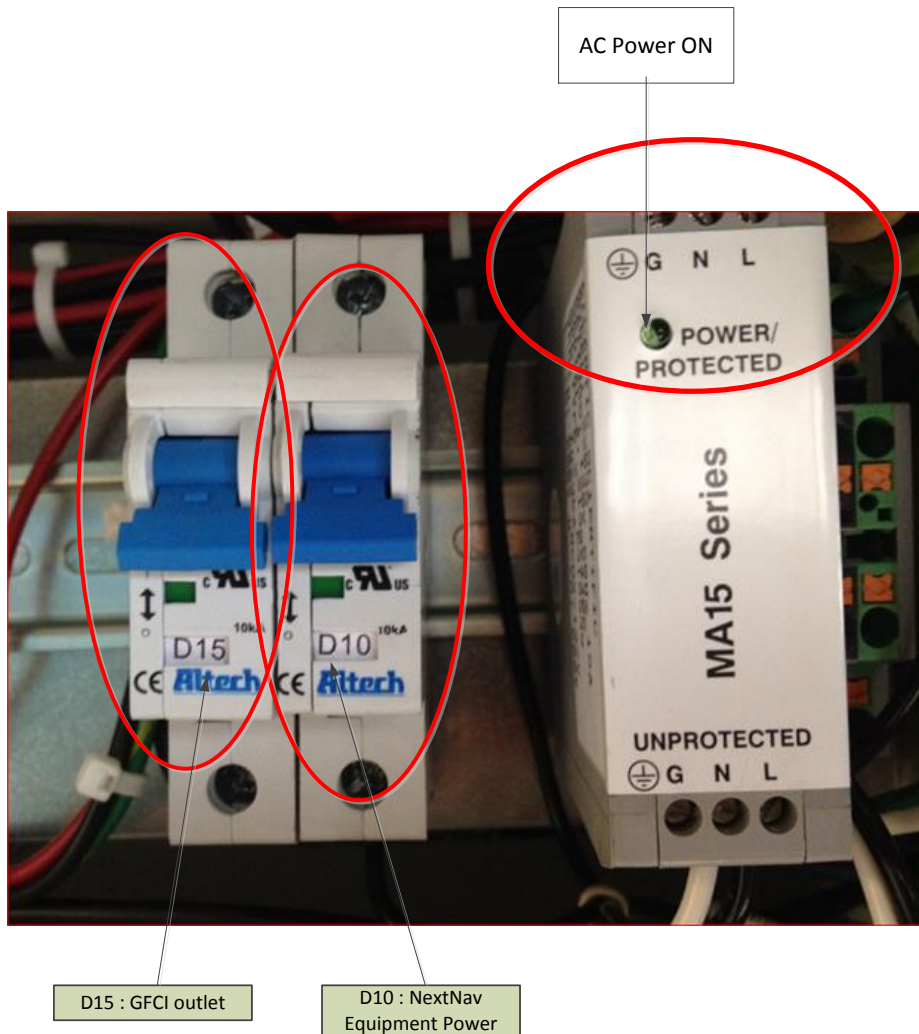


**Figure 2 AC Mains Connect**



The Protected Power LED on the MA15 surge protector should turn on “GREEN LED” Indicates AC power is on. This will only happen after the AC is connected and AC mains breaker turned on.

Turn on Circuit Breaker D10 to power all NextNav equipment. At this time the Elteck Valare Controller should turn on. Wait approximately 1 minute before turning on the load breakers.



**Figure 3 Cabinet Power**

The Protected Power LED on the MA15 surge protector should turn on “GREEN LED” Indicates AC power is on. This will only happen after the AC is connected and AC mains breaker turned on.

Turn on Circuit Breaker D10 to power all NextNav equipment. At this time the Eltek Valare Controller should turn on. Wait approximately 1 minute before turning on the load breakers.

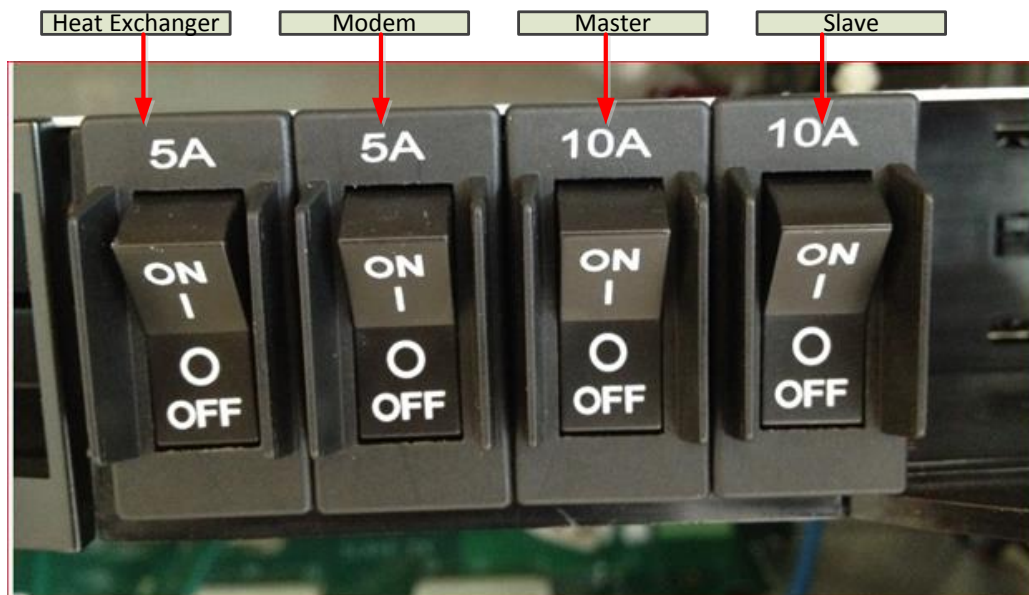
Turn on D15 ; the circuit breaker to power the GFCI outlet in the cabinet and.

After waiting about a minute after turning on the D10 breaker, turn on the following breakers. Heat Exchanger – 5 Amp load breaker; fan in the heat exchanger should start running.

Modem- 5 Amp load breaker; The switch ports on the modem should start blinking.

Master Transmitter 10 Amp breaker; Turn on the 10 Amp load breaker labelled Master then toggle the switch on the front panel of the Master Transmitter located on the bottom slot in the rack to **ON**. The LED on the switch panel will light up to indicate that the Master Transmitter is powered on. Also the GREEN LED on the Timing Tray ( Middle tray) will turn ON and stay on after about 45 seconds.

Slave Transmitter 10 Amp Breaker; Turn on the 10 Amp load breaker labelled Slave then toggle the switch on the front panel of the Slave Transmitter located on the bottom slot in the rack to **ON**. The LED on the switch panel will light up to indicate that the Slave Transmitter is powered on. Toggle power **OFF** on the **Master** transmitter tray and the LED on the Timing tray should turn **RED**. After verifying this toggle the Master Transmitter to ON.



**Figure 4 Load Breaker**

Turn on Battery Breakers FBI and FB2



**Figure 5 Battery Breaker Antenna Mounting**

## 2.4 TX Antenna

Tx antenna will be installed indoors. In normal configurations, antenna is to be attached to the ceiling structures. Proper installation procedures must be followed as defined in site specific construction drawing. As a general rule the TX antenna shall be kept a minimum distance of 6 feet from any metallic vertical structures or other types of obstructions.

This radio transmitter (FCC ID: A4P-100-0013-01) has been approved by FCC to operate with the antenna types listed below with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

This radio transmitter may only operate using a vertically polarized antenna.

## 2.5 GPS Receive Antenna

GPS antenna should be installed such that it has clear view of sky. Ideally, you would keep the antenna close to the ground away from obstruction

- Keep any horizontal blockage smaller than 10 degrees
- Obstruction Clearance guideline
  - If it is 1 ft wide it should be at least 6 ft away
  - If it is 10 ft wide, it should be at least 60 ft. away.
  - If it is significantly less than 1 ft wide (like a guy wire, or a post) it should not cause any measurable effect

## 2.6 Tune-up procedure not to exceed maximum TX power

A CSV file (configuration file) per transmitter are created by the NOC engineer based on the installation parameters such as line lengths, antenna type etc. **The TX output power level setting is contained in the CSV file.**

The output power is adjusted by the 'PA gain' setting. This value in the CSV file is calculated by a formula to set the output power (not to exceed 30W ERP). The variables used in the calculation include PA Gain (Gpa), TX Antenna Gain (Gant), TX filter insertion loss (ILflt), internal cable loss (ILint), external cable loss (ILExt), and transceiver output power (PTCVR).

$$\text{ERP (W)} = 10^{((\text{PTCVR} - \text{ILint} + \text{Gpa} - \text{ILflt} - \text{ILExt} + \text{Gant}) / 10) / 1000}$$

The PA gain setting should be set to a proper value so that total sum of net antenna gain and cable loss coupled with PA output does not exceed 30 Watts EIRP, PEP (Peak Envelope Power). Table 2 is a list of all possible antennas and RF cable combinations with corresponding RF power settings required to comply with the FCC requirement of 30 Watts EIRP Peak Envelope Power (PEP).

Tx Band	PA Gain (dB)	PA out (dBm)	Antenna Type	Antenna Gain (dBd)	Cable Loss (dB)	ERP (dBm)	ERP (W) (PEP)
5 MHz	61.0 max	+43.18	DB586-Y	6.0	4.5 min	+44.78	29.4
			SC433-HF6LDF	2.5	1.0 min	+44.78	29.4
			BCD-8707	6.5	5.0 min	+44.78	29.4
			OD9-5	2.9	1.4 min	+44.78	29.4
2 MHz	60.3 max	+41.53	DB586-Y	6.0	2.8 min	+44.73	29.7
	61.0 max	+42.23	SC433-HF6LDF	2.5	0.0 min	+44.73	29.7
	60.3 max	+41.53	BCD-8707	6.5	3.3 min	+44.73	29.7
	60.6 max	+41.83	OD9-5	2.9	0.0 min	+44.73	29.7
IDB Modes with interleaved 2 MHz and 5 MHz channel	59.0 max	+41.33	DB586-Y	6.0	2.8 min	+44.53	28.4
			SC433-HF6LDF	2.5	0.0 min	+43.83	24.2
			BCD-8707	6.5	3.3 min	+44.53	27.9
			OD9-5	2.9	0.0 min	+44.23	26.5

Table 2 Maximum allowable RF power settings with various antenna/cable

Note 1: PA module provides means of RF Gain control in steps of 0.1 dB from 0 to 65 dB.

Maximum PA Gain values listed in the table2 are required to ensure that conducted and radiated spurious emission standards of Part 90 are met. The difference of PA output

levels between 2 MHz, 5 MHz and IDB modes are compensated using internal RF attenuation that can be set remotely by NOSS engineers to ensure that 30 Watts ERP is met in both cases.

### 3 Technical Specifications

Parameter	Value/Description
Modulation	BPSK modulation with CDMA spreading
Maximum ON time	200ms/1second
Duration of a single burst	100ms
Center Frequencies	From 920.773 to 926.227 MHz for 2 MHz signal From 922.308 to 924.692 MHz for 5 MHz signal IDB modes are combination of 2 and 5 MHz signals transmitted in different time frames (1sec apart)
Necessary Signal Bandwidth	2.046MHz for single band, 5.115MHz for IDB band Type A & B
Frequency Stability	<10ppb
EIRP	30W ERP`
Data Rate	99 bits in a 100ms slot
Power Supply	Nominal: 110 VAC (primary means) 48 VDC (secondary means – battery backup)
Power Consumption	330 W max, 140 W average, 7.5A
Operating Conditions	-40°C to +50°C, plus solar radiation 0 to 95% humidity, non-condensing
Remote Monitoring	Via SNMP protocol
Environmental Standard	IP66