

# EyeStar-S3 Simplex Communications Module Interface Control Document (ICD)

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This document describes the functional, physical, and electrical characteristics of the EyeStar-S3 satellite transmitter module. This interface control document is intended to provide the payload integrator with the necessary technical information to integrate the EyeStar-S3 Simplex communications module.

## 1. Operational Description

The EyeStar-S3 module is designed to send small packets of data from the user to the LEO GlobalStar satellite network. The data is received by a ground station gateway, forwarded to the NearSpace Launch server, and delivered to the end user for processing. Two types of data packets are sent from the module: payload serial data and beacon data. Beacon data is a set of digital and analog inputs that are sent at a set interval for health and safety information. There are four digital and six analog inputs. Two parameters are setup for the user, transmit inhibit and beacon rate. Payload serial data is sent to the module through the serial port. Transmit rate for the serial data is set by the payload, while it is preconfigured for the beacon rate.

Upon power up, the unit will wait the user specified TX Inhibit Timer, then broadcast a user specified number of Wake Up beacons. After this, the EyeStar-S3 will be functioning normally, beacons at the set Beacon Rate, and available to be serially commanded between Beacons.

A nadir sensor (earth horizon sensor, or EHS) is now an option that can be included with the patch antenna to enforce zenith pointing transmission, in the case of a satellite without attitude control. This senses the earth pointing vector, and delays transmissions until the antenna is facing at the horizon or higher. This has been included to assist in meeting requirements from the FCC and Globalstar.

Document Classification	
X	NSL Proprietary

## 2. Block Diagram

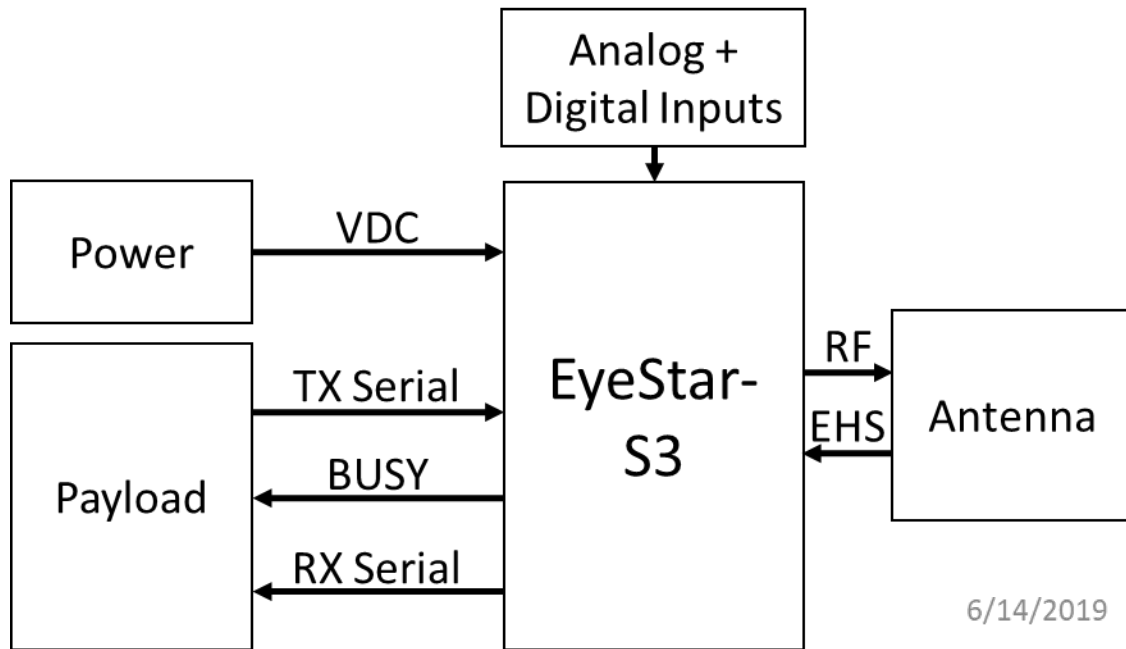


Figure 1 EyeStar-S3 Block Diagram.

## 3. Mechanical Layout

### 3.1. EyeStar-S3 Simplex Unit

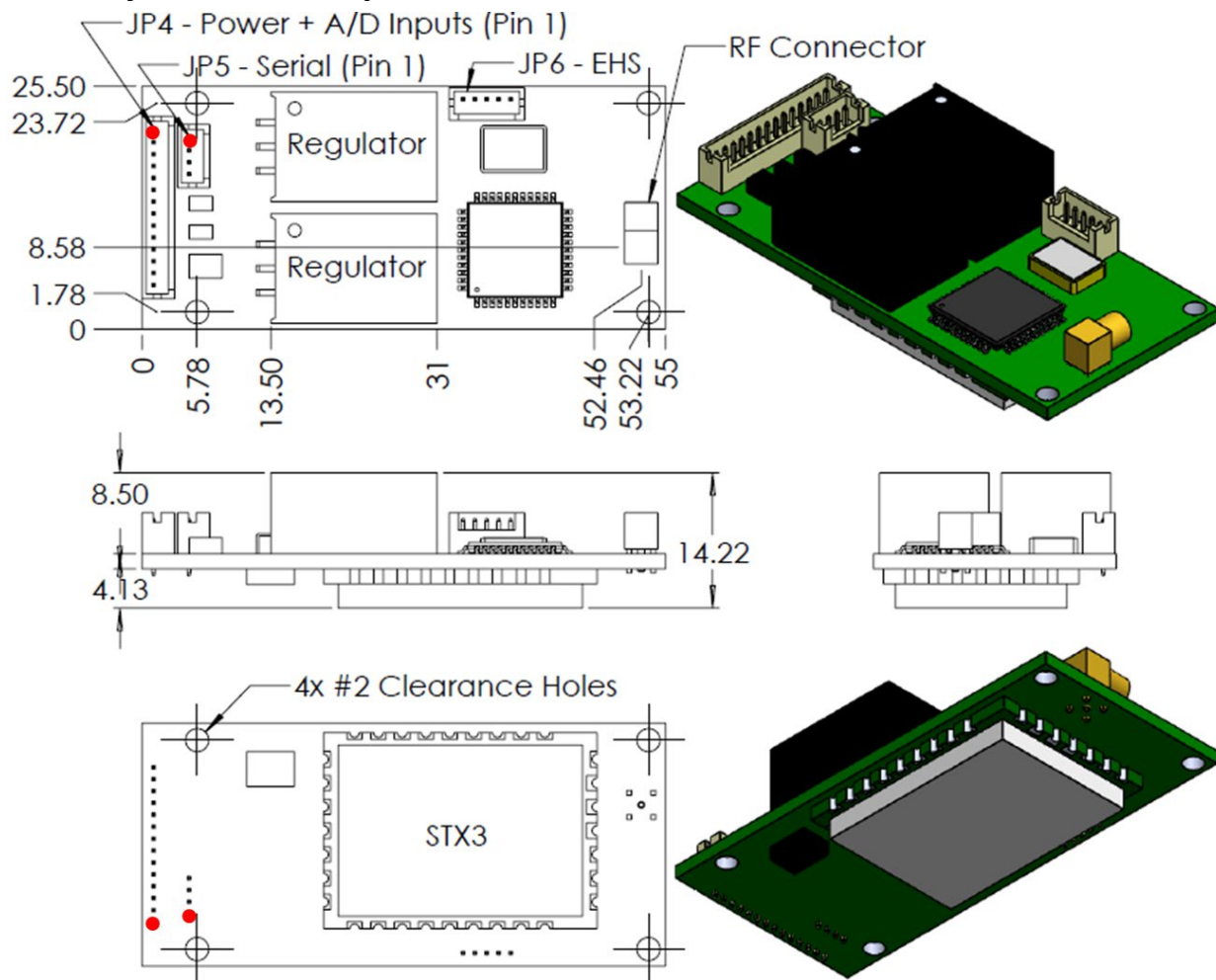
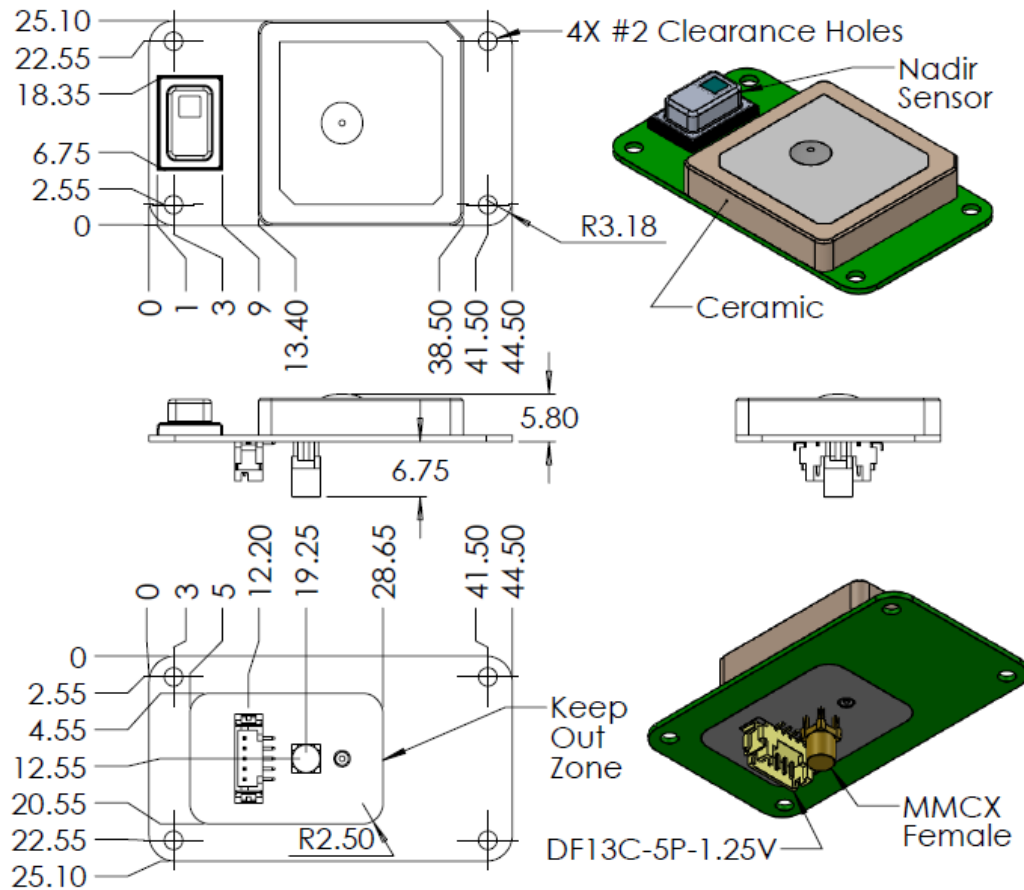


Figure 2 EyeStar-S3 Mechanical Layout. Note the hole locations, connector orientations, and connector labels. Mounting holes are made for #2-56 screws.

### 3.2. EyeStar-S3 Patch Antenna – Nadir Sensing



**Figure 3 EyeStar-S3 Patch Antenna mechanical layout. Note the nadir sensor and associated connector on the bottom. Cables are included for the RF and nadir sensor data.**

The Simplex patch antenna assembly, coax cable, and nadir sensor (EHS) cable are designed to integrate with the EyeStar module. The recommended cable length between the module and antenna is 6", with a max allowable length of 24". Antenna mounting holes are #2 Clearance holes.

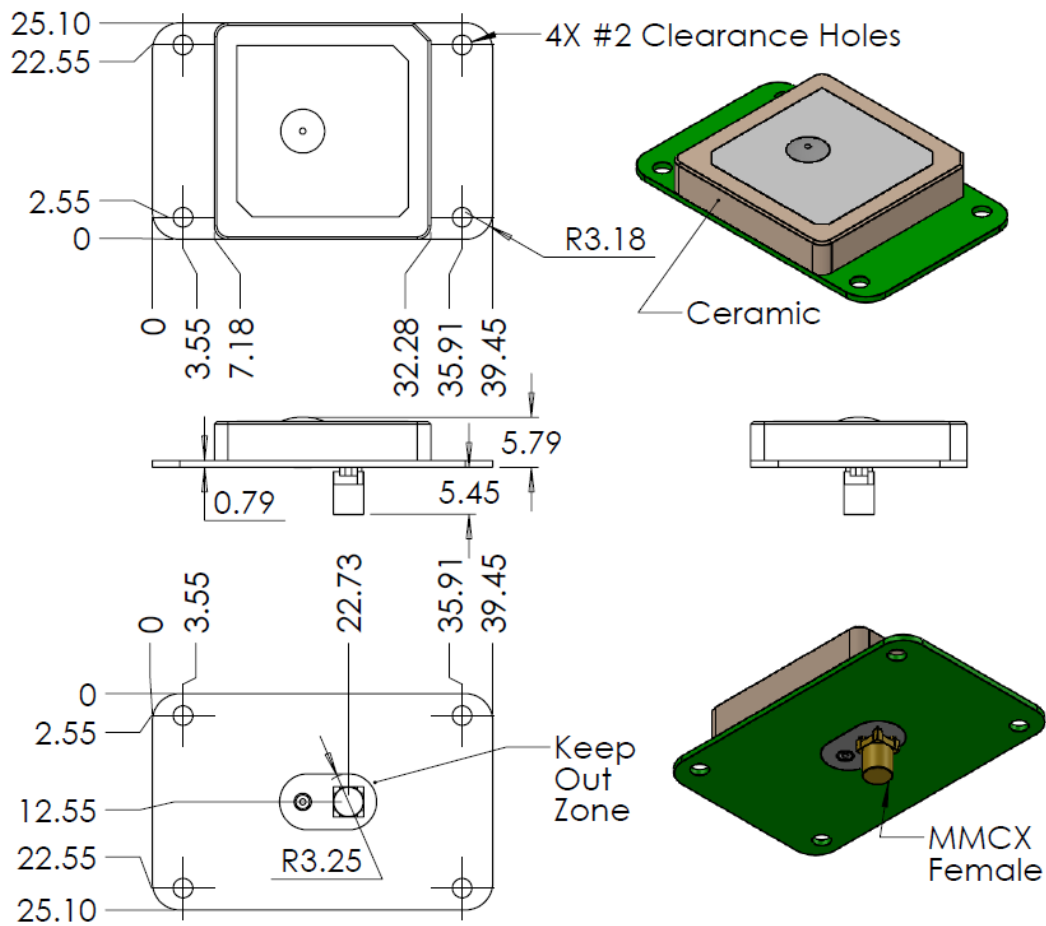
Note that the antenna requires a recessed surface for the cable connector. Include a keep out zone of at least 10 mm around the outside of the antenna assembly.

Please specify to NSL which antenna type is preferred.

#### 3.2.1. Simplex Patch Antenna Physical Characteristics

Characteristic	Spec	Units
Dimensions	44.5 x 25.1 x 6	mm
Weight	15	g
Operating Temperature	-30 to +60	°C

### 3.3. EyeStar-S3 Patch Antenna - Small



**Figure 4 Mechanical layout of EyeStar-S3 Small Patch Antenna**

The Simplex patch antenna assembly and coax cable are designed to integrate with the EyeStar module. The recommended cable length between the module and antenna is 6", with a max allowable length of 24". Antenna mounting holes are #2 Clearance holes.

Note that the antenna requires a recessed surface for the cable connector. Include a keep out zone of at least 10 mm around the outside of the antenna assembly.

Please specify to NSL which antenna type is preferred.

#### 3.3.1. 3.2.1 Simplex Patch Antenna Physical Characteristics

Characteristic	Spec	Units
Dimensions	39.5 x 25.1 x 6	mm
Weight	13	g
Operating Temperature	-30 to +60	°C

## 4. Communication Protocol

There are two transmit modes, Beacon and Serial. In Beacon mode, the EyeStar-S3 transmits set packet types with fixed formats at specified time intervals. This happens autonomously and requires no serial input or commanding to occur. In Serial mode, the EyeStar-S3 can be commanded to transmit any serial data that is sent to it, as long as the unit is available and not currently transmitting. If the EyeStar-S3 is beaconing, transmitting serial data, or unavailable, the BUSY line will be inserted. Otherwise, the BUSY line is not inserted and the unit is available to transmit.

### 4.1. Beacon Mode Example Packets

Below are several example packets that could be transmitted in Beacon mode. Actual packets will most likely vary slightly from these formats and should be clarified before flight. Health and Safety is the default Beacon.

#### 4.1.1. Health and Safety Beacon Packet

Function	6 Analog Inputs	Power	Temp	Counter	4 Digital Inputs + Status
B5	A1 – A6	VCC	Temp	Count	DI/Status
1 Byte	2 Bytes each	2 Byte	1 Byte	2 Byte	1 Byte

#### 4.1.2. GPS Beacon Packet

Function	GPS Coordinates			Digital	Temp	4 Analog Inputs			
F1	Lat	Lon	Alt	DI	Temp	A1	A2	A3	A4
1 Byte	8 Byte	8 Byte	8 Byte	1 Byte	2 Byte	2 Byte	2 Byte	2 Byte	2 Byte

#### 4.1.3. Camera Beacon Packet

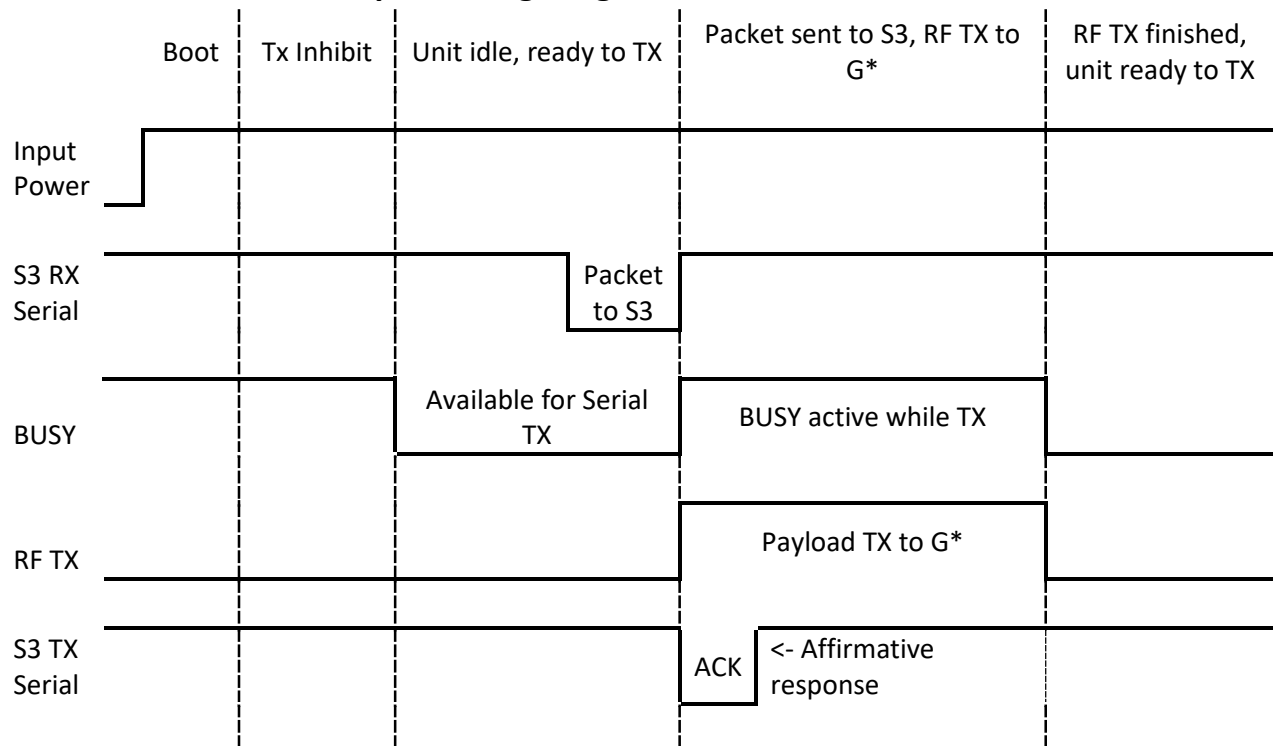
Function	Sequence	Camera Data
CF	Seq	Data
1 Byte	1 Byte	34 Byte

## 4.2. Serial Mode

### 4.2.1. Serial Payload Communication Packet Format

Payload sends data to the modem over the S3 Serial RX IN line, when the BUSY signal is LOW. Once data is sent to the modem, the modem will return an ACK (from S3 Serial TX OUT) to acknowledge the packet. If the packet is good, the modem will set the BUSY line HI and send the data to the Globalstar network. If the packet is not good, the BUSY line will not respond. Once finished sending, the BUSY line is set back to LOW and the module waits to receive the next packet from the payload. Note that serial packets are 18 bytes (with 17 payload) bytes. Consult NSL on recommended configurations, based on expected ADCS, usage, and orbit.

#### 4.2.2. Serial Mode Example Timing Diagram



#### Serial Payload Packet TX Format

Total Packet Size: 38 Bytes	
Header	Payload Data
3 Bytes	17 Bytes
Hex: 50 50 50	Raw Payload Data

Serial payload data is transmitted over the S3 Serial RX IN pin. A 3 byte header is first sent, followed by 17 bytes of payload data. If this sequence is correctly sent the S3 will respond by setting the BUSY line HI.

#### 4.2.3. Serial Payload Console Format

Function	Raw Payload Data
A1	Data
1 Byte	17 Byte

Once the data is received by Globalstar it is sent to the NSL servers and displayed on the NSL Online Console. Serial Payload packets will be displayed with the function code 'A1' (or other), followed by the 17 payload bytes.

#### 4.2.4. Serial Port

A half-duplex LVTTTL / TTL asynchronous serial port (UART) is the primary interface to payload. The serial port operates with the serial parameters of 38,400 bps, 8 data bits, no parity, 1 stop bit. The TX, RX, and BUSY lines are 5V TTL.

Each data packet to the modem is sent in serial. Upon receiving the packet, the modem answers with an ACK (from S3 Serial TX OUT) if the packet is correct, and transmits the packet. If the packet is incorrect, the BUSY line will not respond.

#### **4.2.5. Modem ACK Response**

Hex(AA 05 00) sent over the “S3 Serial TX OUT” line, or “Payload Serial RX IN”.



## 5. Connectors

### JP1 – RF Connector

- MMCX RF connector from antenna plugs directly into this port.
- Module is supplied with coax cable and patch antenna assembly kit.

### JP4 – Power + Analog/Digital Inputs (JP4 Mating connector: DF13-14S-1.25C)

Payload	PIN	EyeStar-S3	Notes
Analog Input 1 →	JP4.1	→ Analog Input 1	0 – 5 VDC / 10 bit
Analog Input 2 →	JP4.2	→ Analog Input 2	0 – 5 VDC / 10 bit
Analog Input 3 →	JP4.3	→ Analog Input 3	0 – 5 VDC / 10 bit
Analog Input 4 →	JP4.4	→ Analog Input 4	0 – 5 VDC / 10 bit
9.0 – 32.0 VDC →	JP4.5	→ 9.0 – 32.0 VDC	
9.0 – 32.0 VDC →	JP4.6	→ 9.0 – 32.0 VDC	
Analog Input 5 →	JP4.7	→ Analog Input 5	0 – 5 VDC / 10 bit
Analog Input 6 →	JP4.8	→ Analog Input 6	0 – 5 VDC / 10 bit
Digital Input 1 →	JP4.9	→ Digital Input 1	TTL 5 VDC
Digital Input 2 →	JP4.10	→ Digital Input 2	TTL 5 VDC
Digital Input 3 →	JP4.11	→ Digital Input 3	TTL 5 VDC
Digital Input 4 →	JP4.12	→ Digital Input 4	TTL 5 VDC
Diag Enable →	JP4.13	→ Diag Enable	GRD to Enable
Ground	JP4.14	Ground	

This connector contains power input, analog and digital inputs, and the Diagnostic Enable line.

To enable diagnostic mode, ground the Diag Enable line. This will remove the TX Inhibit Timer to allow for easier testing.

### JP5 – Serial (JP5 Mating connector: DF13-4S-1.25C)

Payload	PIN	EyeStar-S3	Notes
Ground	JP5.1	Ground	GRD
BUSY IN ←	JP5.2	← BUSY OUT	TTL 5V
Payload Serial TX OUT →	JP5.3	→ S3 Serial RX IN	TTL 3.3 or 5V
Payload Serial RX IN ←	JP5.4	← S3 Serial TX OUT	TTL 5V

This connector contains the serial data lines to send and receive data in the Serial Mode.

### JP6 – Earth Horizon Sensor

- DF13 – 5 Pin header from antenna plugs directly into this port.
- Connector and cable are supplied with antenna assembly.
- No port information is needed, as operation and reading of this sensor is handled completely by the EyeStar unit.

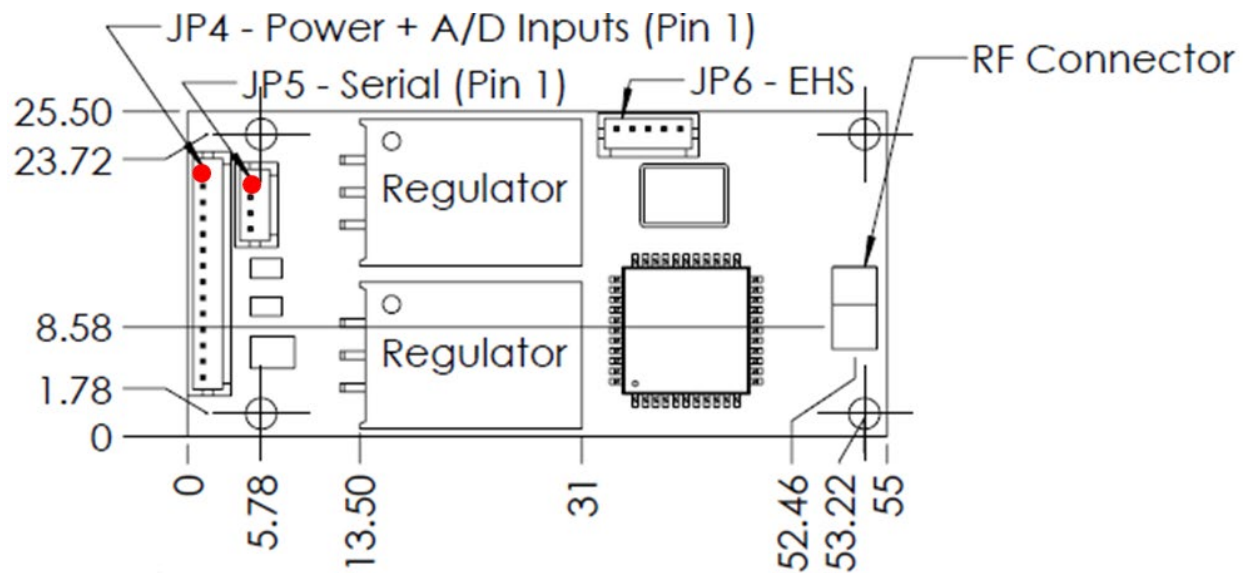


Figure 5 Connector locations and orientation for the EyeStar-S3.

## 6. Specifications

Specification	Symbol	Minimum	Nominal	Maximum	Units
<b>Power</b>					
Input Voltage	V <sub>in</sub>	6.0	15.0	36.0	V
Transmit Mode	V <sub>in</sub>	264.35	111.21	60.00	mA
		1.58	1.66	2.16	W
Idle Mode	V <sub>in</sub>	29.75	16.84	11.50	mA
		0.178	0.252	0.414	W
In Rush	V <sub>in</sub>	30.45	17.65	12.72	mA
		0.183	0.265	0.458	W
<b>RF Characteristics</b>					
Frequency			1616.25		MHz
Output power		+16	+18	+20	dBm
Bandwidth			2.5		MHz
Modulation			BPSK		
<b>Communication Port</b>					
Protocol			Serial N81		TTL
Bus Voltage		3.0		5.2	V
Serial Data Rate			38.4		Kbits
<b>Beacon Mode</b>					
Transmit Inhibit		0	0	60	Minute
Beacon Period		.1	5	60	Minute
<b>Analog/Digital Inputs</b>					
# of inputs	Analog		6		Inputs
	Digital		4		Inputs
Analog ADC			10		bit
Analog Range		0		5	VDC
Source impedance			50K		Ohm
<b>Antenna Characteristics</b>					
Polarization			LHCP		
Efficiency			80		%
Realized gain			4		dBic
Bandwidth (3dB)	Both axes		100		Degree

VSWR			1.3:1		
<b>Physical</b>					
<b>Simplex Module</b>					
Dimensions		55	26	15	mm
Weight			22		g
Operating Temperature		-30		+60	°C
<b>Patch Antenna</b>					
Dimensions		44.5	25.1	6	mm
Weight			15		g
Operating Temperature		-30		+60	°C

## 6.1. Absolute Maximum Ratings

Parameter	Symbol	Value	Units
Operating Temperature	Ta	-30 to +70	°C
Maximum Input Voltage	VIN MAX	+36.0	V
Maximum Analog Input Voltage	ADIN MAX	+5.0	V

## 7. Customer Specific Configuration

Communicate with NSL regarding the specific configuration of your EyeStar-S3 unit.

Configurable	Spec	Default	Units
TX Inhibit Timer	0 – 45	0	Minutes
Beacon Period	0.25 – 50	5	Minutes
Wake Up Beacons	0 - 15	10	# Beacons
Antenna	Nadir Sensing, Small	Nadir	--