875-0176-000

SBX-4
OEM Board

Integrator Guide

Revision: B2

January 12, 2018

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions:

(1) This device may not cause harmful interference, and
(2) this device must accept any interference received, including interference that may cause undesired operation.

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6549091	7292186	7808428	8140223	8311696	
6711501	7373231	7835832	8174437	8334804	
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Table of Contents

Terms and Definitions

The following table lists the terms and definitions used in this document

Term	Definition
DGPS/DGNSS	Differential GPS/GNSS refers to a receiver using Differential Corrections.
Firmware	Firmware is the software loaded into the receiver that controls the functionality of the receiver and runs the GNSS engine.
GNSS	Global Navigation Satellite System (GNSS) is a system that provides autonomous 3D position (latitude, longitude, and altitude) along with very accurate timing globally by using satellites. Current GNSS providers are: GPS, GLONASS and Galileo. BeiDou is expected to have global coverage by 2020.
GPS	Global Positioning System (GPS) is a global navigation satellite system implemented by the United States.
NMEA	National Marine Electronics Association (NMEA) is a marine electronics organization that sets standards for communication between marine electronics.
RTCM	Radio Technical Commission for Maritime Services (RTCM) is a standard used to define RTK message formats so that receivers from any manufacturer can be used together.
SBAS	Satellite Based Augmentation System (SBAS) is a system that provides differential corrections over satellite throughout a wide area or region.
Signal-to-Noise Ratio	Signal-to-Noise Ratio (SNR) is the ratio of the message content of the signal against the noise of the signal.
Subscription	A subscription is a feature that is enabled for a limited time. Once the end-date of the subscription has been reached, the feature will turn off until the subscription is renewed.

Chapter 1: Introduction

Product Overview

Chapter 1: Introduction

Product Overview

Welcome to the SBX-4 Integrator Manual and thank you for considering Hemisphere GNSS for your differential GPS requirements. The purpose of this manual is to familiarize you with the proper installation, configuration and operation of the SBX-4 beacon receiver module and to introduce you the mechanical, electrical and communication properties of this OEM receiver.

This document provides instructions and recommendations related to a successful integration of the SBX-4 engine.

The SBX-4 is an extremely sensitive 300 kHz minimum shift keying (MSK) demodulator. It obtains differential GPS corrections broadcast by radio beacons adhering to standards such as International Telecommunications Union M.823 and various broadcast standards in the frequency range of 283.5 to 325.0 kHz.

This document is intended to assist a systems designer with the integration of the SBX-4. Successful integration of this module within a system will require significant electronics expertise, such as power supply design, serial port level translation, reasonable radio frequency competency, an understanding of electromagnetic compatibility and circuit design and layout.

The SBX-4 engine is a low-level module intended for custom integration with the following general integration requirements:

- Regulated power supply input (3.3 VDC +/- 3%) and 70 mA continuous
- Low-level serial port communications (3.3 V CMOS)
- The beacon antenna is powered with a separate regulated voltage source of 5 VDC
- The antenna input impedance is 50 ohms

The chapters that follow provide detailed information on the SBX-4 module, including the hardware and software interface, in addition to various descriptions of technologies and features that it supports.

Some notable features of the SBX-4 module are:

- Dual channel tracking for increased robustness
- Dual serial ports accommodate both NMEA and RTCM communications
- Certified IEC 61108-4 compliant
- Patented ceramic filter blocks out-of-band signals, optimizing reception
- Low power and lock status LEDs permit visual verification of receiver status
- Reverse compatibility ensures operation in existing SBX-2 and SBX-3 integrations
- Boot loader for firmware upgrade reliability

Chapter 2: Integrating the SBX-4

Chapter 2: Integrating the SBX-4 OEM Board

Mechanical Layout

Figures 1-1 to 1-3 provide the physical layout of the SBX-4 beacon receiver, including dimensions and key components.

Note: Figure 1-1 to Figure1-3 dimensions are in inches.

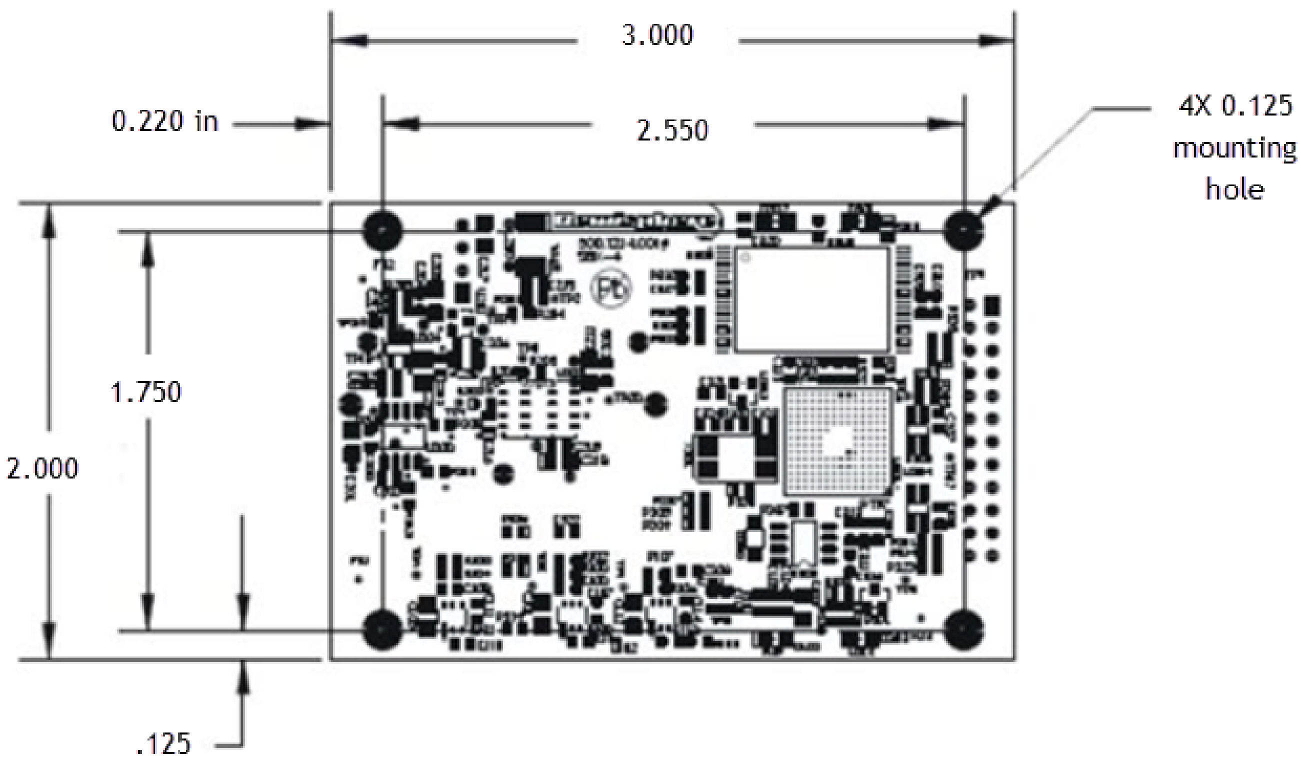

Figure 1-1: Top-side view of SBX-4

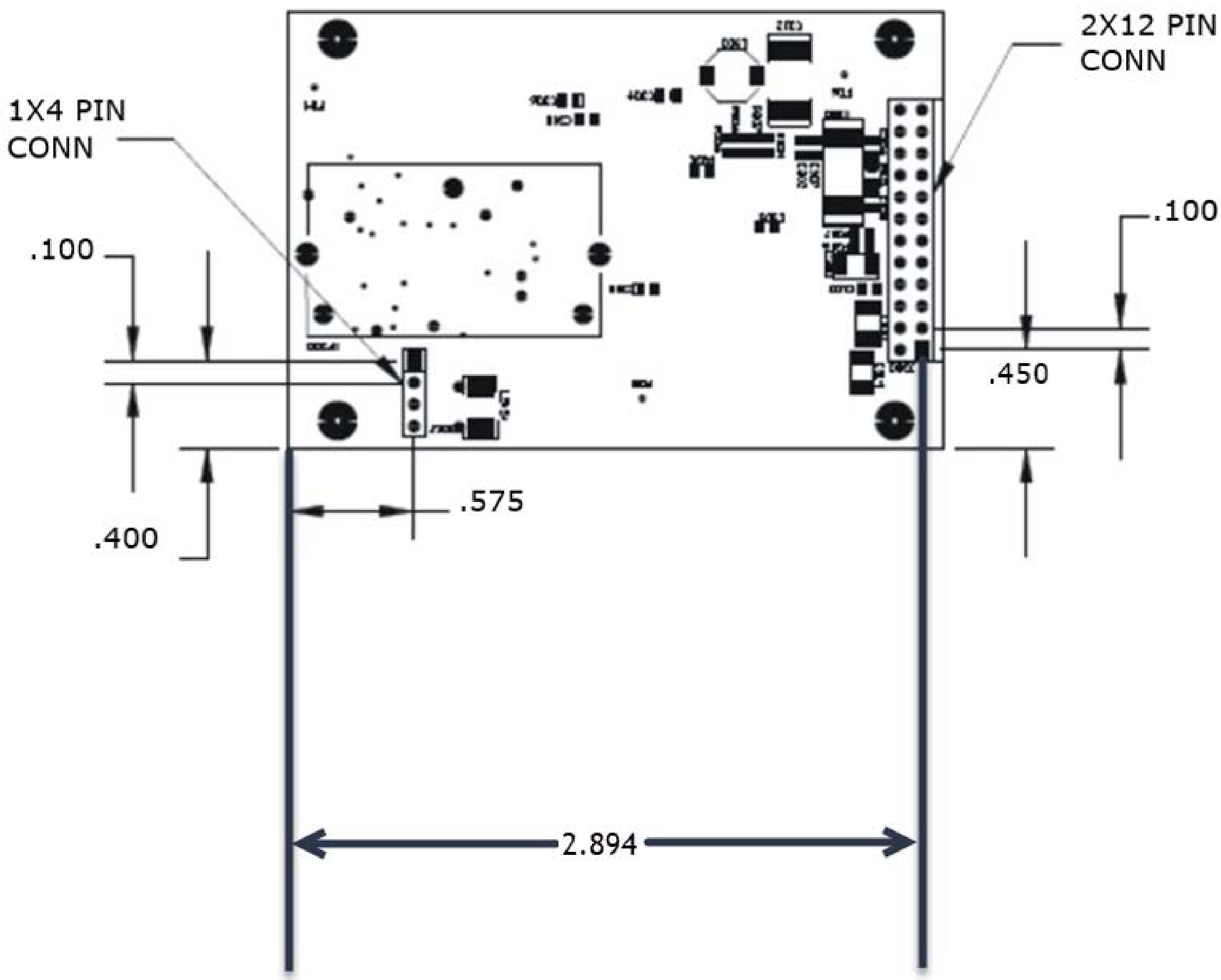

Figure 1-2: SBX-4 bottom view

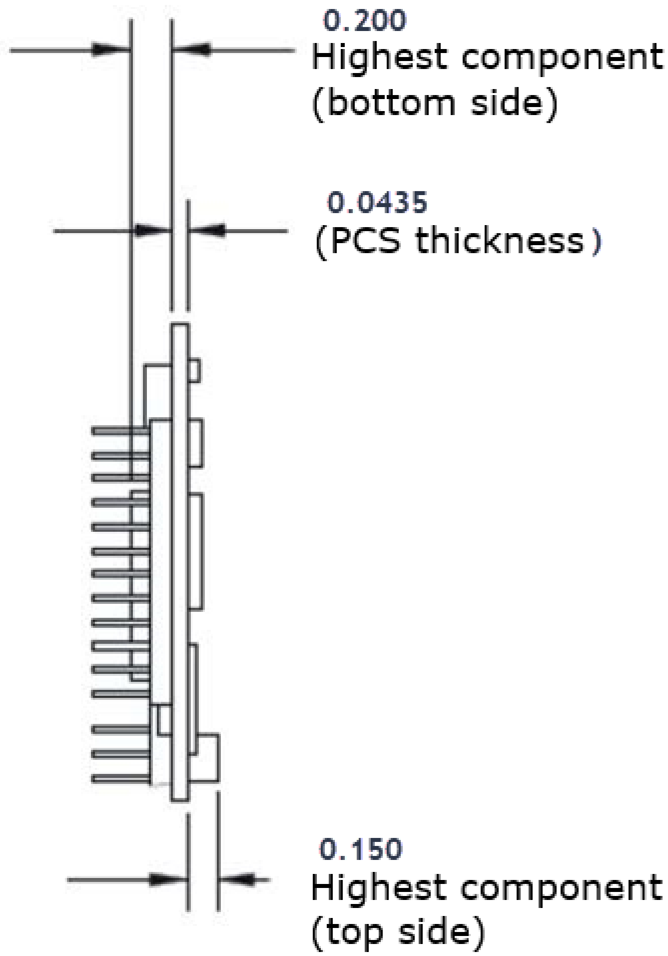

Figure 1-3: SBX-4 side view

LED Indicators

The SBX-4 engine has two surface-mounted LED indicators located on the opposite side of the board in relation to the header connectors. The red LED is for signaling the power-on status of the receiver, labeled with “PWR” silk-screening. The green LED is for indicating signal acquisition, labeled with “LOCK” silk-screening.

When power is applied to the SBX-4, the power LED illuminates and when the SBX-4 achieves signal acquisition on a valid DGPS beacon, the lock LED illuminates.

Figure 1-4 shows the front and back of the SBX-4, including the illumination of the power and lock LED indicators.

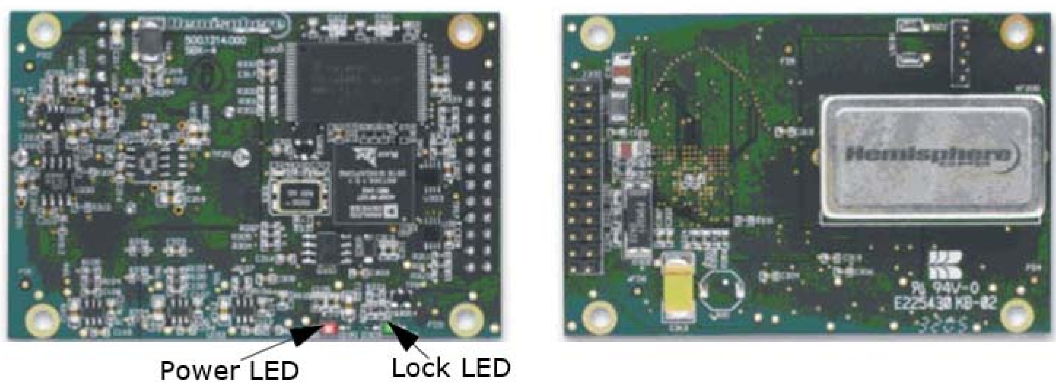

Figure 1-4: SBX-4, front and back

SBX-4 Block Diagram

The SBX-4 accepts an analog input signal between 283.5 kHz and 325.0 kHz from an antenna into its front end where it is filtered and converted to a digital output.

The Digital Signal Processor (DSP) demodulates GPS correction information from the digital stream. The output of the SBX-4 is RTCM SC-104 DGPS correction data at a 3.3V CMOS interface level. Figure 1-3 provides a view of the block diagram. Figure 1-5 displays the block diagram.

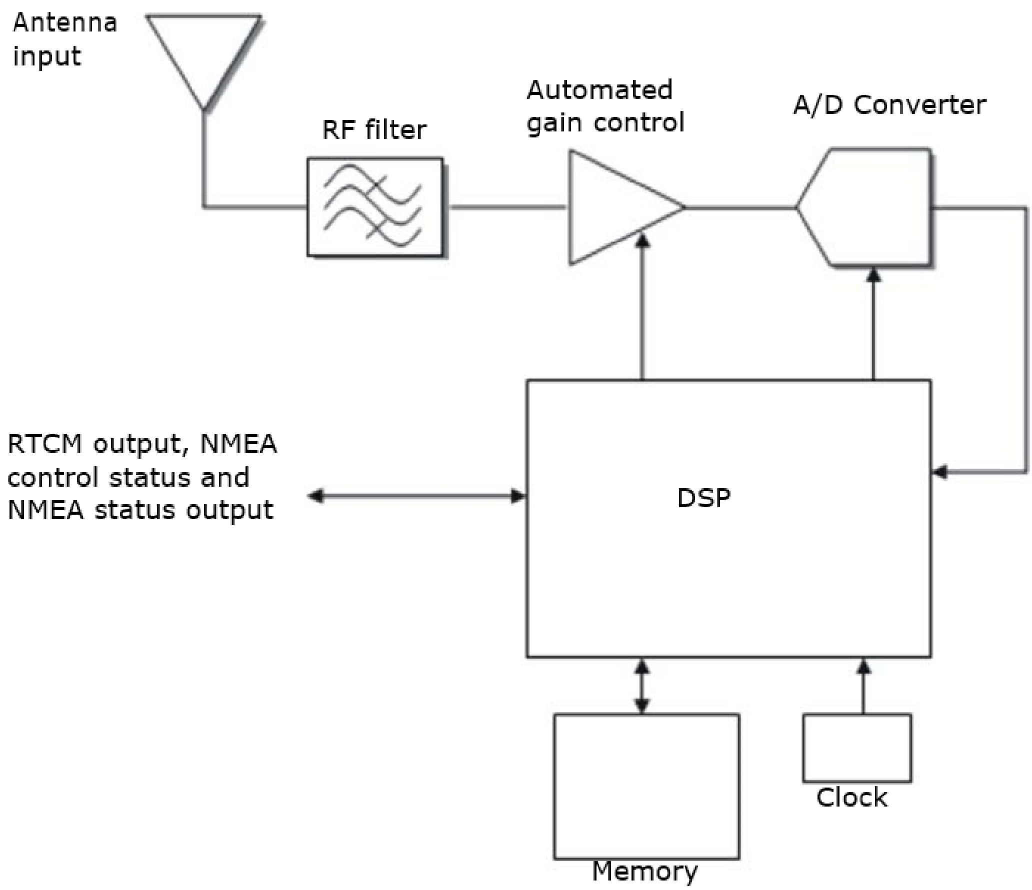

Figure 1-5: Block diagram

SBX-4 Connector Pin Assignments

The SBX-4 has two header connectors designated as J200 and J300, labeled with on-board silk-screening. The J200 connector is a 1 x 4 pin header with 0.1 in (2.54 cm) spacing that provides antenna power input, and signal distribution. The J300 connector is a 2 x 12 pin header with 0.1 in (2.54 cm) spacing that provides access to antenna power input, receiver serial ports, receiver power, external reset and external lock indicator functions.

Table 1-1 provides pin-out information for connector J200:

Table 1-1: SBX-4 connector J200 pin-out (Samtec TSW-10407-G-S)

Pin	Signal	Description
1, 3	Ground	Analog ground
2	RF signal input	Antenna RF signal input
4	Antenna power output	Antenna power supply 5 VDC

Table 1-2 provides pin-out information for connector J300:

Table 1-2: SBX-4 connector J300 pin-out (Samtec TSW 11207-G-D)

Pin	Signal	Description
1, 2	Antenna power in	Antenna power supply input: 5 VDC
3, 4	SBX-4 power in	Receiver power supply input: 3.3 VDC
14	TXD0 output, 3.3 V CMOS	NMEA, RTCM and status output
15	TXD1 output, 3.3 V CMOS	NMEA and status output
16	Lock	Lock indicator (active high)
17	RXD0 Input, 3.3 V CMOS	Command/query input
18	RXD1 Input, 3.3 V CMOS	Command/query input
19	External reset input	External reset input (active low)
21, 22 23, 24	Ground	Digital ground

Note: In order to maintain backwards hardware compatibility with the SBX-3, it is possible to power the SBX-4 with 5 V. The serial data output level will track the input voltage when greater than 3.3 V is supplied. The serial data inputs will be tolerant to voltages up to the level of the supplied input voltage.

Signal Lock Indicator Pin

Pin 16 of connector J300 may be used to drive an LED or sensor to indicate that the SBX-4 is locked to a beacon signal and is demodulating RTCM SC-104 data. The maximum current available from this pin is 5 mA at an input voltage 3.3 V. The output of this signal may be transistor buffered within your integration if greater current is required.

Figure 1-6 illustrates an example lock indicator circuit.

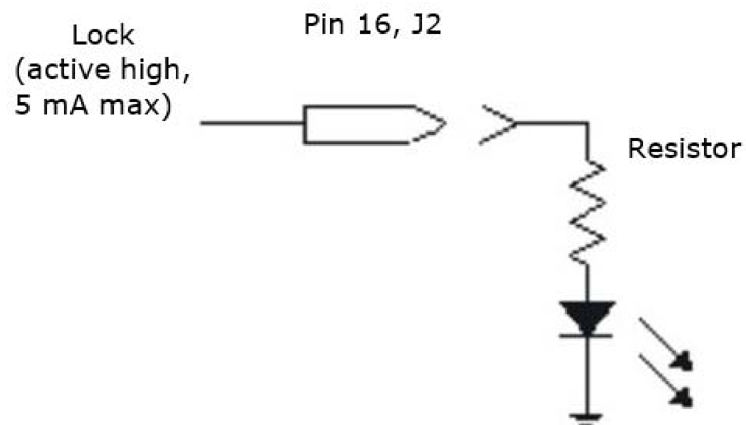

Figure 1-6: Lock indicator circuit

Reset Pin

Pin 19 of connector J300 may be used to reset the SBX-4. Activating the reset circuit of the SBX-4 results in the same effect as cycling the input power to the receiver. The operating configuration of the receiver before reset is maintained, including operating mode, baud rate, frequency and MSK rate of the last tuned station.

Figure 1-7 illustrates an example reset switch circuit.

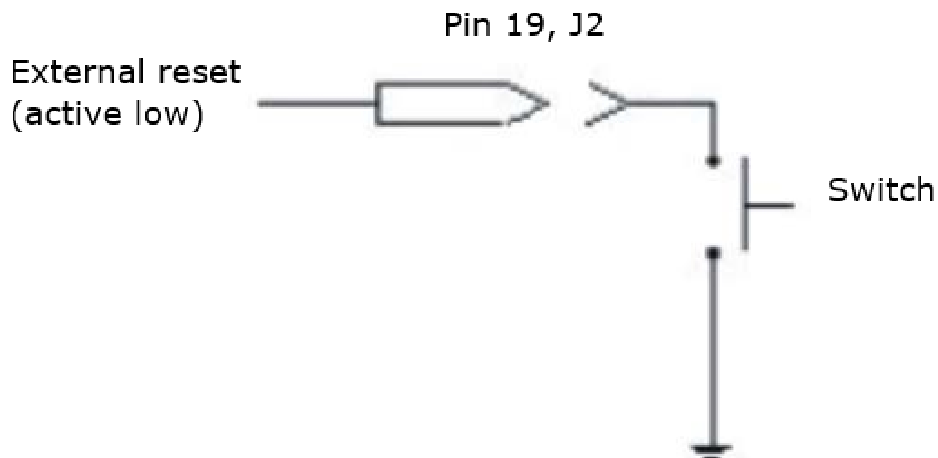

Figure 1-7: Reset switch circuit

Antenna Interface

Power may be supplied to the antenna externally through the SBX-4 OEM beacon receiver in one of two ways:

- Connect Pin 4 of J200 to the antenna power supply (+5 VDC) and connect pin 1 and 3 to ground
- Connect Pin 1 and 2 of SBX-4 connector J300 to the associated power supply (+5 VDC) and connect pin 1 and 3 of J200 to ground

Pin 4 of connector J200 is internally connected to Pins 1 and 2 of connector J300. Antenna signal input to the receiver is provided via Pin 2 of J200.

Note: The antenna input voltage is not current limited on the SBX-4 board. If current limiting is required, the circuitry must be provided within your integration.

Note: External power applied to the SBX-4 for powering the antenna is internally coupled to the signal input pin (Pin 2 of J300). You do not have to provide this circuitry within your integration.

If you intend to use a 4-pin connector (for example, Panduit CE100F22-4) and a length coaxial cable to interface the antenna to the SBX-4, follow these instructions:

1. Connect the center conductor of the coaxial cable to Pin 2 of J200.
2. Connect the shield of the coaxial cable to Pin 1 or Pin 3 of J200.

Radio Frequency Immunity and Emissions

When integrating the SBX-4, ensure that complete integration does not emit significant noise within the 283.5 to 325.0 kHz beacon band. In-band interference incident upon the SBX-4 or its antenna can influence the reception enough that its quality may be degraded, resulting in a lower SNR measurement with reduced GPS correction data throughput.

Beacon antennas are designed to pick up any radio frequency energy within the 283.5 to 325.0 kHz beacon band. Both beacon signals and environment noise will be picked up by the antenna and amplified before going to the receiver. Eliminating the majority of noise within the beacon band is crucial to achieve optimal system performance.

It is very important to consider the overall performance objectives of the system design with respect to radio frequency emissions.

Certain nations and industries around the world require positioning and navigation electronics to achieve certain levels of electromagnetic emissions.

SBX-4 Dual Serial Port Overview

The SBX-4 features two full duplex serial ports (Port 0 and Port 1). Use of the second serial port is an option as the SBX-4 supports identical functionality as its predecessor, the SBX-3 on Port 0.

The main purpose of the second serial port is to allow the continuous flow of RTCM data from Port 0 to a GPS receiver while allowing monitoring of SBX-4 performance via NMEA response messages on Port 1. Separating RTCM differential data from NMEA status data when output via the same serial port poses software integration challenges and potential GPS RTCM reception conflicts.

Single Serial Port Operation

Some integration designs using the SBX-4 beacon receiver include a micro-controller between the beacon and GPS receiver to provide enhanced communication and data parsing capability. Within this type of integration, it is possible for the micro-controller to command and query the beacon receiver and to parse NMEA response strings from RTCM data without impeding the continuous flow of RTCM data to the connected GPS sensor.

To separate NMEA messages from RTCM data output by Port 0 through a parsing routine, without causing a parity failure of the RTCM, it is necessary to take advantage of the fact that “$” and “<LF>” are not supported within the RTCM specification, provided there are no bit errors in the RTCM stream to start with. Therefore, if a “$” is received, then it should be considered as the beginning of a NMEA sentence and a “<LF>” should be expected within a window of certain length. If the parsing routine does not receive one, due to an unlikely communication line error, after a window of a particular number of bits has passed, re-synchronization to the RTCM data must occur.

Note: If port 1 is not being used, pin 18 should be connected to the input power supply through a 10 Kohm resistor.

Dual Serial Port Operation

Although an integration may be designed with a microprocessor between the SBX-4 and the GPS receiver to tune and monitor SBX-4 status, the second serial port of the SBX-4 eliminates the requirement to develop a NMEA message parsing algorithm.

With this type of architecture, the SBX-4’s main serial port may be interfaced to the GPS receiver’s receive line to provide RTCM correction data. The secondary serial port interfaces to the microprocessor for NMEA configuration and querying. This ensures that NMEA response messages do not interrupt the continuous flow of RTCM data to the GPS receiver.

Factory Default Settings

Table 1-3 presents the factory default SBX-4 operating mode, while Table 1-4 lists the default SBX-4 communication settings. These operation and port settings are valid upon initial power-up. The SBX-4 maintains any changes made to its operating or port settings in non-volatile memory for subsequent power cycles.

Table 1-3: Default SBX-4 operating mode

Tune mode
Automatic

Table 1-4: Default SBX-4 port settings

Baud Rate	Data Bits	Parity	Stop bit	Interface level
4800	8	None	1	3.3 V CMOS

SBX-4 Integration Summary

The following steps summarize the general requirements for integrating the SBX-4 and identifies the command and control features provided:

1. SBX-4 Power Input - Apply a 3.3 VDC power input to Pin 3 of J300 with the power-return connection at Pin 21 of J300.
2. Antenna Power Input - Apply +5 VDC to either
    - Pin 4 of J200 with an antenna power ground connection on Pin 1 of J200

      -or-
    - Pin 1 of J300 with an antenna power ground connection to Pin 1 of J200
3. Antenna Signal Input to SBX-4 - Connect the coaxial cable center conductor to Pin 2 of J200 and the shield to Pin 3 of J200.
4. SBX-4 Serial Ports - The SBX-4 serial ports communicate at a 5 V CMOS interface level. You must provide level translation circuitry to connect to a standard RS232/422 type device. Pin assignments for the communication ports of the SBX-4 are as follows:
    - Pin 14 of J300 - TXD0, this is the Port 0 transmit data output from the SBX-4
    - Pin 15 of J300 - TXD1, this is the Port 1 transmit data output from the SBX-4
    - Pin 17 of J300 - RXD0, this is the Port 0 receive data input to the SBX-4
    - Pin 18 of J300 - RXD1, this is the Port 1 receive data input to the SBX-4
    - Pin 23 of J300 - Signal return, Port 0
    - Pin 24 of J300 - Signal return, Port 1

5. The following events occur when the SBX-4 is powered-up, or reset:
    - Receiver serial number is output
    - Configuration and beacon tables are verified and defaulted if required
    - Software identification and version are reported
    - Channel status information is reported

The following strings are output by the SBX-4 during power up or following receiver reset:

$PCSI,DGPS,P0
$PCSI,S/N:00019001
$PCSI,FCFGcrc,CBF8,CCFGcrc,CBF8,Pass
$PCSI,FGLBcrc,448A,CGLBcrc,448A,Pass
$PCSI,FLSHcrc,1C12 Pass
$PCSI,FSTAcrc,FBEA User,FFFF,FFFF
$PCSI,SBX~4 P030-0 2 Channel DGPS Version 001
$PCSI,F2835,0,R100,0,C0,0
$PCSI,F2835,0,R100,0,C1,0

6. When powered for the first time, the SBX-4 will operate in the default ABS mode and will conduct a Global Search (GS) to identify the highest quality beacon signal. Following the signal acquisition phase of the GS and when the primary receiver channel has acquired a beacon, the receiver's second channel will conduct a background search.
7. When the SBX-4 receives a valid RMC message on Port 0, it will switch to database mode.
8. You may tune the receiver to a specific beacon using the $GPMSK Manual Tune command referred to in Hemisphere GNSS' Technical Reference Manual.
9. When tuned to a valid beacon, the SBX-4 monitors RTCM SC-104 message lock, parity check and outputs RTCM corrections through its primary communications port. The SBX-4 asserts the lock signal on pin 16 of J300 (active high).
10. When input power to the SBX-4 is cycled, or the receiver reset circuit is activated, the SBX-4 will attempt to reacquire the last station to which it was tuned. In Automatic mode, the SBX-4 will try to lock to this station for 10 seconds before initiating a fresh GS to identify valid beacons. If set to Manual mode, the receiver will attempt to lock to the last known beacon indefinitely, or until commanded to a new frequency and bit rate. In Database mode, the SBX-4 will try to lock to the closest station using the last valid position.

Chapter 3: SBX-4 Operation

Chapter 3: SBX-4 Operation

Introduction

Many marine authorities, such as coast guards, have installed networks of radio beacons that broadcast DGPS corrections to users of this system. With the increasing utility of these networks for terrestrial applications, there is an increasing trend towards densifying networks inland.

The SBX-4 is able to operate in manual or automatic tuning mode, or using Database mode which will select the closest station in compliance with IEC 61108-4 standards. In Database mode, the receiver will search for the closest station based on its current location and distance to the internal list of station locations.

This chapter includes information on the following topics:

- Beacon information
- Operating modes
- Evaluating performance

Beacon Information

The International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA) endeavors to maintain an accurate listing of DGPS radio beacons worldwide that is available on the Internet from their home page:

http://www.iala-aism.org/

This listing contains the following information regarding currently operating beacons and potential new sites:

- Station name
- Frequency
- MSK rate
- Location Transmitting ID
- Reference station ID
- Field Strength
- Operating notes

For detailed information on radio beacon transmissions, please refer to Hemisphere GNSS' Technical Reference Manual.

Operating Modes

The SBX-4 may be operated in Automatic Beacon Search (ABS) mode, Manual Tune or Database mode. In ABS mode, the receiver will identify and tune to the station providing the strongest DGPS signal using two receiver channels. In Manual mode, you specify the frequency to which the receiver will tune. In Manual mode, only the primary receiver channel is used. In Database mode, the receiver will search for the closest station based on its current location and distance to the internal list of station locations.

Refer to Hemisphere GNSS' Technical Reference Manual Manual for commands relating to changing the operating mode and monitoring receiver performance.

Automatic Beacon Search (ABS) Mode

The SBX-4 beacon receiver operates in ABS mode by default, selecting and tuning to the most appropriate beacon without operator intervention. The SBX-4 uses its two independent channels to identify and lock to the best DGPS beacon.

ABS mode is ideal for navigation applications over considerable areas with various beacon stations available, eliminating the need for operator intervention when traveling from one beacon coverage zone to another.

ABS Global Search

When powered for the first time in ABS mode, the SBX-4 initiates a Global Search (GS), examining each available DGPS beacon frequency, and recording Signal Strength (SS) measurements in units of decibel micro volts to the Global Search Table. The receiver uses these measured values to compute an average SS, noise floor and to sort the frequencies in descending order of SS.

This initial phase of the GS takes approximately 3 to 4 seconds to scan all 84 beacon channels in the frequency band using both channels. Once scanned, and with SS numbers identified for each beacon channel, both receiver channels cooperatively examine the frequencies with the highest SS measurements, above the computed noise floor, to determine the station providing the strongest RTCM signal.

The receiver's primary channel locks to the first identified DGPS broadcast, while the second channel continues searching in the background for superior beacon signals. If no signal is available, the SBX-4 will initiate a fresh GS, continuing this cycle until it finds a valid beacon.

The secondary acquisition phase of the GS composes the remainder of the time required to acquire the beacon signal. The time required to acquire a beacon in ABS mode is dependent upon the signal quality of DGPS beacons in your area, and their relative strength to other non-DGPS beacon signals in the 283.5 to 325.0 kHz band.

As this frequency range is a navigation band, it is shared with other navigation aides such as non-directional beacons used for aviation and marine navigation. Depending on the signals available, initial acquisition make take less than 15 seconds for a strong beacon station, from a cold start or up to a couple minutes if a beacon site is weak relative to other signals. During the acquisition phase, if bit errors occur due to a weak DGPS beacon signal or environmental noise occurs, the time to acquire may be longer.

ABS Background Search

During the Background Search, the second channel examines all frequencies at both the 100 and 200 bps MSK bit rates to identify beacons possessing superior signal quality. If a DGPS broadcast is identified that exhibits a 2 dB greater signal strength than that of the primary station, the receiver will automatically switch to this beacon. No loss of lock occurs on the primary station during the background scan process. If the secondary receiver channel finds a superior station, the main channel is instructed to tune to the new beacon.

The SBX-4 stores the current primary beacon in memory so that it is available upon subsequent power-up. You may force a new GS at any time using the $PCSI,4<CR><LF> proprietary NMEA 0183 command defined in Hemisphere GNSS' Technical Reference Manual.

Manual Mode

In Full Manual Tune mode, you may specify a frequency and bit rate for the receiver to tune to or specify the frequency only, allowing the SBX-4 to identify the correct MSK bit rate automatically (Partial Manual Tune mode). Setting manual operation is discussed in Hemisphere GNSS' Technical Reference Manual, using the $GPMSK NMEA 0183 command.

Acquisition of a beacon in manual tune mode is dependent upon the data rate of the station. In Full Manual Tune mode with an MSK rate of 200 bps, signal acquisition should occur within 5 seconds if no demodulation errors occur. Signal acquisition should occur within 10 seconds for a modulation rate of 100 bps provided that no demodulation errors occur.

Partial Manual Tune mode requires that the SBX-4 identify the correct MSK rate automatically. This automatic detection could result in signal acquisition rates of up to approximately 15 seconds.

Database Mode

This operating mode has been added to the SBX-4 in order to be compliant with the specification IEC 61108-4 for ship borne DGPS maritime radio beacon receiver equipment. The basic operation is outlined below.

1. The receiver will determine the 10 closest stations after receiving a valid RMC message on PORT 0. This list can be accessed using the command $PCSI,3,2.
2. The primary channel tries to tune to the closest available station, using the frequency and bit rate specified in the station database.
3. The background channel tunes to the frequency of the closest station using an alternate bit rate.
4. The primary channel retunes to the alternate bit rate if lock is achieved on the background channel (with acceptable station health and WER).
5. The background channel continually searches for a closer station using the station database once a lock is achieved on the primary channel.
6. The primary channel will remain tuned to the same station unless one of the following occurs:
   - Word error rate (WER) drops below 10%
   - Station becomes unhealthy or unmonitored
   - Background channel finds a closer station
   - Position changes enough to affect station list

NEW SBX-4 Commands

Database tune command:

$GPMSK,,D,,D<CR><LF>

Display contents of station database:

$PCSI,3,3<CR><LF>

Response:

$PCSI,3,3,IDref1,IDref2,StationID,name,freq,lat,long,datum,s tatus

$PCSI,3,3, ...

$PCSI,3,3, ...

$PCSI,3,3, ...

Example:

$PCSI,3,3,0282,0283,0891,Level Island AK,2950,20554,- 24221,1,0

$PCSI,3,3,0306,0307,0906,Sandspit BC,3000,19377,- 23991,1,0

$PCSI,3,3,0278,0279,0889,Annette Is. AK,3230,20044,- 23951,1,0

$PCSI,3,3,0300,0301,0909,Alert Bay BC,3090,18412,- 23099,1,0

$PCSI,3,3,0302,0303,0908,Amphitrite Pt BC,3150,17806,- 22850,1,0

$PCSI,3,3,0270,0271,0885,C. Mendocino CA,2920,14718,- 22641,1,0

$PCSI,3,3,0272,0273,0886,Fort Stevens OR,2870,16817,- 22559,1,0

$PCSI,3,3,0304,0305,0907,Richmond BC,3200,17903,- 22407,1,0

$PCSI,3,3,0276,0277,0888,Whidbey Is. WA,3020,17587,- 22331,1,0...

- Latitude is scaled by 364 (+ indicates N, - indicates S)
- Longitude is scaled by 182 (+ indicates E, - indicates W)
- Datum: 1 (NAD83), 0 (WGS84)
- Status: 0 (operational, 1 (undefined), 2 (no information), 3 (do not use)

Display list of 10 closest stations:

$PCSI,3,2<CR><LF>

Response:

$PCSI,3,2,StationID,name,freq,status,distance,*time,date*,health, WER

$PCSI,3,2, ...

$PCSI,3,2, ...

$PCSI,3,2, ...

Example:

$PCSI,3,2, 849,Polson MT,2870,0,210,0,0,-1,-1

$PCSI,3,2, 848,Spokane WA,3160,0,250,0,0,-1,-1

$PCSI,3,2, 907,Richmond BC,3200,0,356,0,0,-1,-1

$PCSI,3,2, 888,Whidbey Is. WA,3020,0,363,0,0,-1,-1

$PCSI,3,2, 887,Robinson Pt. WA,3230,0,383,0,0,-1,-1

$PCSI,3,2, 874,Billings MT,3130,0,389,0,0,-1,-1

$PCSI,3,2, 871,Appleton WA,3000,0,420,0,0,-1,-1

$PCSI,3,2, 908,Amphitrite Pt BC,3150,0,448,0,0,-1,-1

$PCSI,3,2, 886,Fort Stevens OR,2870,0,473,0,0,-1,-1

$PCSI,3,2, 909,Alert Bay BC,3090,0,480,0,0,-1,-1

Notes:

- Distance is calculated in nautical miles
- The name field will display time/date of update for a station added by using information from an almanac message (in the format ddmmyy->time)
- The time and date fields have not yet been implemented and currently display 0
- Status: 0 (operational), 1 (undefined), 2 (no information), 3 (do not use)
- Health: -1 (not updated), 8 (undefined), 0-7 (valid range)
- WER: -1 (not updated), 0-100 (valid range) Status message: $PCSI,1,1<CR><LF>

Response:

$PCSI,CS0,Pxxx- y.yyy,SN,fff.f,M,ddd,R,SS,SNR,MTP,**WER**,,ID,H,T,**G**

Example:

$PCSI,CS0,P030- 0.000,19001,313.0,D,100,D,18,8,80,**0**,63,0,1,**48**

Notes:

- Tune modes are "**A**"uto, "**M**"anual and "**D**"atabase
- WER: percentage of bad 30-bit RTCM words in the last 25 words
- G: AGC gain in dB (0 to 48 db)
- ID: 1024 (undefined), 0-1023 (valid range)
- H: 8 (undefined) 0-7 (valid range)

Evaluating Performance

The SBX-4 calculates a Signal to Noise Ratio (SNR), measured in dB (Decibels), which indicates the receiver's performance. The SNR is height of the signal above the noise floor. The higher the SNR, the better your beacon receiver is demodulating the signal. By monitoring the SNR, you can determine the optimum location with respect to beacon reception. The SNR is available in the $CRMSS NMEA message described in Hemisphere GNSS' Technical Reference Manual.

The SNR is also a function of the installation, as it may differ between locations, depending on the amount of local noise at each. The optimum antenna location will be the position where your average SNR is highest. You should turn on all accessories that you intend to use during normal operation to test the installation. If noise is affecting performance, try to find a better location with higher SNR.

Table 2-1 describes the general quality of reception as measured by the SNR reading of the SBX-4.

Table 2-1: SBX-4 Performance - SNR reading

SNR	Reception Reading	Data Throughput
> 25	Excellent	100% data throughput
20 to 25	Very good	100% data throughput
15 to 20	Good	Good data throughput up to 100%
10 to 15	Stable	Moderate to good data throughput
7 to 10	Intermittent	Low data throughput
< 7	No lock	No data throughput

Appendix A: Troubleshooting

Appendix A: Troubleshooting

Table A-1 provides troubleshooting for common SBX-4 problems.

Table A-1: Troubleshooting

Symptom	Possible solution
No data from SBX-4	• Check receiver power status (power LED illuminated?) • Verify that SBX-4 is locked to a valid beacon (Lock LED illuminated) • Check integrity of power, antenna and cable connections
Random data from SBX-4	• Check transmitting beacon status • Verify baud rate of SBX-4 and terminal device (SBX-4 default baud rate = 4800 bd) • Ensure pin 18 of J300 is tied high if Port 1 is not being used
Low SNR	• Check integrity of antenna connections • Check MBA-3 antenna ground • Select alternate antenna position
Database mode not selectable	• Ensure that the SBX-4 is receiving valid RMC messages on Port 0

Symptom	Possible solution
No signal lock	• Check antenna connections • Verify MSK rate is set correctly or choose Auto MSK rate (100, 200 or Auto) • Verify frequency of transmitting beacon or choose Auto Frequency Mode • Check MBA-3 antenna • Verify SBX-4 antenna port output voltage (5 VDC) • Verify 5 VDC across antenna cable connector
No response to NMEA commands and queries	• Verify baud rate settings of SBX-4 and terminal device (SBX-4 default baud rate = 4800 bd) • Verify communication parameter settings (8 data bits - no parity - 1 stop bit) • Check integrity of data cable connections • Verify pin connectivity between SBX-4 and terminal device
Non-differential GPS output	• Verify SBX-4 lock status • Verify matched SBX-4 output and GPS RTCM input baud rates • Verify GPS receiver RTCM compatibility • Verify GPS receiver DGPS configuration • Verify pin connectivity between SBX-4/Evaluation Module and GPS receiver • Verify communication parameter settings (8 data bits - no parity - 1 stop bit) • Verify communication levels of SBX-4 and GPS receiver are matched (HCMOS vs RS-232C vs RS-422) • Verify data cable connections

Appendix B: Technical Specifications

Appendix B: Technical Specifications

SBX-4 Specifications

Tables B-1 to B-5 provide the SBX-4's operational, serial interface, power, mechanical and environmental specifications.

Table B-1: Operational

Item	Specification
Channels	2-channel parallel tracking
Frequency range	283.5 - 325.0 kHz
Channel spacing	500 Hz
MSK bit rate	50, 100 and 200 bps
Operating modes	Manual, automatic and database
Cold start time	< 1 minute typical
Re-acquisition time	< 2 seconds typical
Demodulation	Minimum shift key (MSK)
Sensitivity	2.5 microvolts/meter for 6 dB SNR @ 200 bps
Out of band rejection	60 dB < 204 kHz and > 404 kHz
Spurious response	< -55 dB (0.1 MHz to 1.6 MHz)
Ripple (in-band)	3 dB
Dynamic range	100 dB
Frequency offset	+/- 8 Hz (~ 27 ppm)
Adjacent channel rejection	61 dB +/- 1 dB @ frequency center +/-400 Hz
Antenna input impedance	50 Ohms
Decoding	RTCM 6/8
Frequency selection	Manual or offset

Table B-2: Serial Interface

Item	Specification
Serial ports	2 full-duplex
Interface level	HCMOS, tracks input voltage
Data connector	2 x 12 0.1 in (.25 cm) header
Data port baud rate	4800, 9600, 19200, 38400 and 57600 baud
Correction input/ output protocol	RTCM SC-104
Data input/output format	NMEA 0183

Table B-3: Power

Item	Specification
Input voltage	3.3 to 5.5 VDC
Power consumption	< 0.25 W @ 3.3 VDC (no antenna)
Current consumption	< 70 mA @ 3.3 VDC (no antenna)
Antenna voltage output	5 VDC applied externally

Table B-4: Mechanical

Item	Specification
Dimension	76.2 mm L x 50.8 mm W x 13.8 mm H (93.0 in L x 2.0 in W x 0.54 in H)
Weight	30.0 g (1.1 oz)
Connector J200	1 x 4 pin header, 2.54 mm (0.1 in) spacing
Connector J300	2 x 12 pin header, 2.54 mm (0.1 in) spacing

Table B-5: Environmental

Item	Specification
Storage temperature	-30° C to +70° C (-22° F to +158° F)
Operating temperature	-40° C to +80° C (-40° F to +176° F)
Humidity	95% non-condensing
EMC	EN50081-4-2 ESD
Output	5 VDC applied externally

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