SONY GXB5005/GXB5210

GPS RECEIVER

INTEGRATION GUIDE

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Time proven products and support

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LIST OF CHANGES

17JAN06	Original Release
11APR06	Page 8 - Corrected pin-outs for pins 13and 14. Pin 13 was called out as Common and 14 as Status in original release. Page 14 - Corrected drawing for 5V antenna operation to include level shifter for /AEN signal.

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Chapter 1 – GPS BASICS

The Global Positioning System enables users worldwide to accurately determine position, velocity, heading, and time, using low-cost receivers such as the Sony GXB5005 and GXB5210 that can download and decode the data emanating from 24 satellites constantly orbiting the Earth. Accuracy may be enhanced by utilizing receivers such as the GXB5005 and GXB5210 that can receive additional data from **S**atellite **B**ased **A**ugmentation **S**ystem (SBAS) satellites. As of this date (October 2005) there is one operational SBAS system: the **W**ide **A**rea **A**ugmentation **S**ystem (WAAS) that covers the continental United States. The **E**uropean **G**eostationary **N**avigation **O**verlay **S**ervice (EGNOS) system is currently going through final testing and is expected to go online in 2006. When the Japanese **M**ultifunctional **S**atellite **A**ugmentation **S**ervice (MSAS) system is activated, SBAS coverage will be essentially worldwide.

1.1 The GPS System

As mentioned above, the basic GPS system consists of 24 satellites in orbit about the Earth, plus a variable number of orbiting spares that may be added to the constellation as necessary as older satellites malfunction or otherwise become unusable. The satellites themselves are arranged in six orbital planes of four satellites each, at an inclination of 55° to the equator so that GPS coverage is essentially worldwide. Typical orbital altitude is approximately 20,000 km, resulting in 12 hour orbital periods. This is a point that is generally misunderstood. The GPS satellites are not geosynchronous – they are constantly moving overhead.

The satellites all transmit data on a carrier frequency of 1.575 GHz (the so-called "L1" frequency). Each satellite transmits data using its own pseudo-random noise (PRN) code, allowing its signal to be uniquely identified by a GPS receiver even though all satellites are transmitting on the same carrier. The Coarse Acquisition (C/A) data transmitted is freely available to all commercial GPS receivers.

1.2 Autonomous Positioning Accuracy

Typical positioning accuracies currently attainable using the C/A signals from these satellites are normally in the 5–15 meter range. Note that this 5-15 meter range is under conditions without a system known as Selective Availability (SA). SA was originally imposed by the U.S. government to limit the accuracy of non-military receivers, resulting in positioning errors in the range of 100 meters or more. SA was disabled in May of 2000, mainly at the behest of the U.S. **F**ederal **A**viation **A**dministration (FAA) that required improved accuracy in order to make the system usable for directing aircraft in flight and allowing aircraft to use the signals for precision landing approaches in poor weather conditions. SA may be re-imposed at any time, but this is considered highly unlikely, given the degree to which it has been integrated into the U.S. Air Traffic Control system.

1.3 SBAS Augmentation

To further increase the accuracy of GPS location fixes, the SBAS system delivers correction (or augmentation) signals to SBAS enabled receivers. Unlike the GPS satellites, the SBAS satellites are in geosynchronous orbit at approximately 36,000 km. At present, the active WAAS signals are created by dedicated transmitters mounted on INMARSAT communications satellites. Using these signals the Sony GPS receivers are able to consistently deliver position fixes with an error of two meters or less.

Amazingly, the three different SBAS systems actually use the same frequencies (L1) and the same encoding schemes as the original GPS system, meaning that a receiver that is SBAS enabled can ideally use data from all three systems. The receivers merely identify these SBAS sources as standard GPS satellites and assign them Satellite Vehicle Numbers (SVN's), just as if they were part of the original GPS system. A listing of both active and planned satellites is shown below.

WAAS Satellites

Name	SVN	PRN	Position
Atlantic Ocean Region – West (AOR-W)	35	122	54.0°W
Pacific Ocean Region (POR)	47	134	178°E

EGNOS Satellites

Name	SVN	PRN	Position
Atlantic Ocean Region – East (AOR-E)	33	120	15.5°W
Artemis	37	124	21.3°E
Indian Ocean Region – West (IOR-W)	44	131	65.5°E

MSAS Satellite

Name	SVN	PRN	Position
MTSAT-1R	42	129	140°E

1.4 GPS Information Sources

There are countless sources of information concerning global positioning and navigation systems on the web. A couple of good places to start are:

- General GPS Information – United States Coast Guard Navigation Center

  http://www.navcen.uscg.gov/gps/default.htm

- National Geospatial-Intelligence Agency – General information on terrestrial uses for GPS based data. Contains a good geodetic datum reference listing, up to date satellite information, geoid calculators, etc.

  http://earth-info.nga.mil/GandG/sathtml/index.htm

- GPS Basics

  http://gps.faa.gov/gpsbasics/gps_basics-text.htm

  http://en.wikipedia.org/wiki/GPS

  http://www.colorado.edu/geography/gcraft/notes/gps/gps_f.html

- European Space Agency EGNOS homepage

  http://www.esa.int/esaNA/egnos.html

- National Marine Electronics Association (NMEA) homepage

  http://www.nmea.org/

Chapter 2 – RECEIVER DESCRIPTIONS

The Sony GXB5005 and GXB5210 GPS receivers are miniature 12 channel GPS modules with support for SBAS augmented positioning. Both receivers are based on Sony's CXD2951GA-4 single-chip GPS receiver IC.

2.1 GXB5005

2.1.1 GXB5005 Physical Characteristics

The GXB5005 is approximately 23 mm square by 3.2 mm high. Attachment to the user's host circuit board is made through 19 surface mount pads on the periphery of the receiver. The pads are 1.2 mm x 1.45 mm and are on 2.2 mm centers. The pad plating continues on the side of the GXB5005 circuit board so that the receiver may be mounted manually without reflow equipment. A mechanical drawing of the GXB5005 is shown below. Note that there is a blank position between pins 2 and 3 to help in orienting the unit properly.

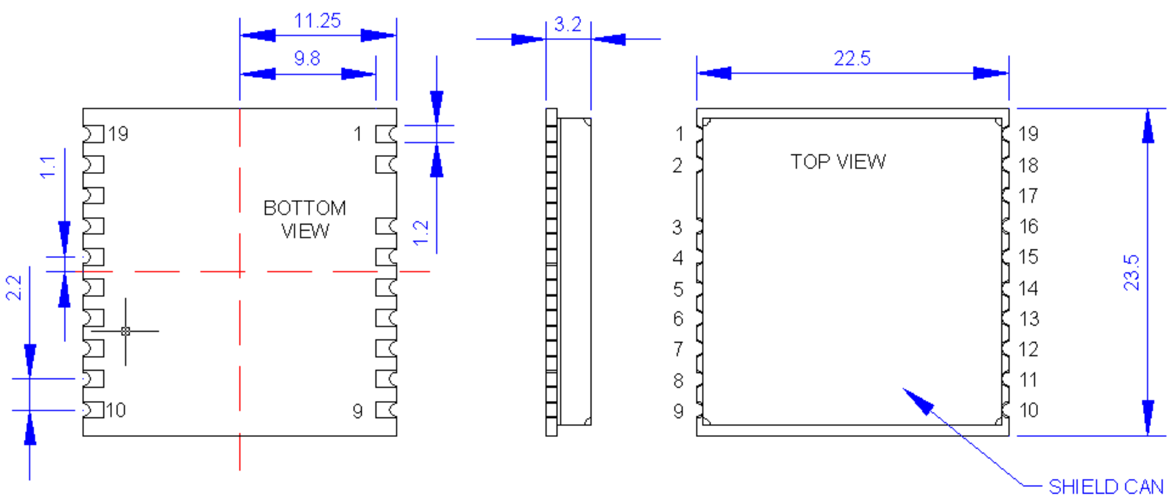

Figure 2.1 GXB5005 Physical Layout

Table 2.1 GXB5005 Receiver Characteristics

Characteristic	Type	Value
Time to First Fix (TTFF)	Hot Start	2-3s typical
	Warm Start	33s typical
	Cold Start	40s typical
Sensitivity	Acquisition	-139 dBm typical
	Tracking	-152 dBm typical
Communications	NMEA-0183, v3.01	GGA, GLL, GSA, GSV, RMC, VTG, ZDA, PSA
	Baud Rates	4800/9600/19,200/38,400
Power Requirements	Operating Voltage	+3.1 - 3.7V (+3.4V nominal)
	Ripple	<50mV p-p max
	Operating Current	70mA during acquisition @ 3.4V
		41mA while tracking @ 3.4V
	Backup Power	2.6 - 3.0V, 7μA typical
Antenna Requirements	RF	Active antenna with 8-30 dB gain,
		noise figure < 2 dB
	Power	User definable as power is
		not routed through receiver
Environmental	Operating Temperature	-40°C - +85°C
	Storage Temperature	-40°C - +105°C
	Humidity	95%, non-condensing
Physical Characteristics	Dimensions	22.4mm x 23.5mm x 3.2mm
	Weight	6 gms
	Electrical Connections	19 smd pads, 2.2mm pitch
	Shielding	Entire module enclosed in shield

2.1.2 GXB5005 Electrical Connections

Signal definitions for the 19 electrical connections to the GXB5005 are shown in the following table.

Table 2.2 GXB5005 Electrical Connections

Pin	Signal Name	Description
1	AS0	A/D Input 0 - Antenna current sense input
2	AS1	A/D Input 1 - Antenna current sense input
3	/AEN	Antenna bias enable (active low)
4	BR1	Baud rate select 1
5	BR0	Baud rate select 0
6	RXD0	Command input (4800/9600/19200/38400 baud)
7	TXD0	GPS data out (4800/9600/19200/38400 baud)
8	WA1	WAAS mode select 1
9	WA0	WAAS mode select 0
10	RF GND	Ground
11	RF IN	RF input from GPS antenna
12	RF GND	Ground
13	Status	Receiver status indicator
14	Pwr/Sig GND	Ground
15	Pwr/Sig GND	Ground
16	/Reset	Active LOW receiver reset
17	VDD	+3.4V +/- 10%
18	Backup	Optional backup power input
19	1PPS Out	Rising edge tied to top of UTC second

Pins 1-3: Antenna bias control. If desired by the user, these pins can be used to limit current to the GPS antenna in case of damage to the antenna or shorting of the cable. A current sense resistor is connected across Pins 1 and 2 (AS0 and AS1). If the voltage drop across the resistor exceeds approximately 0.96V, Pin 3 will go high, disabling the external PFET pass transistor, removing power from the antenna. The receiver will automatically cycle Pin 3 every 3 seconds until the short is cleared, at which point normal operation will resume.

Pins 4, 5: Power ON baud rate select. Sets default baud rate to 4800/9600/19200/38400 depending on high/low state of pins at power up. Once receiver has powered up baud rate may be changed at any time using the Sony "@CB" command.

Table 2.3 GXB5005 Power On Baud Rates

BR0 (Pin 5)	BR1 (Pin 4)	BAUD RATE
High	Low	4800
Low	Low	9600
Low	High	19200
High	High	38400

Pin 6: Commands in. 3.3V logic. Baud rate as defined by H/W or S/W.

Pin 7: Data out. 3.3V logic. Baud rate as defined by H/W or S/W.

Pins 8, 9: Power On SBAS function control. Used to turn SBAS augmentation ON or OFF. As with baud rate select, these pins are only read at power up.

- If Pin 8 (WA1) is high at power up, SBAS configuration will be determined by the state of Pin 9 (WA0).
- If Pin 8 (WA1) is low at power up parameters may **ONLY** be changed using the @WA command.

Table 2.4 GXB5005 Power On Default SBAS Selection

WA0 (Pin 9)	WA1 (Pin 8)	STATUS
Low	High	SBAS Disabled
High	High	SBAS On, automatic satellite selection
Don't care	Low	Software control only

Pin 11: RF Input. An active antenna system that presents a net signal gain of between +8-30dB (25dB nominal) to this pin is recommended.

Pin 13: Receiver Status output. When the receiver is searching for satellites this output will be a 0.5 Hz square-wave. When the receiver is actively tracking satellites the square-wave will increase frequency to 1 Hz. When the receiver is computing position fixes this pin will remain HIGH.

Pin 16: Receiver reset, active LOW, 3.3V logic.

Pin 17: V_{DD} - nominally 3.4V. When receiver is first turned on and attempting to acquire satellites current draw will be approximately 70mA. When actively computing positions with good signal strengths this current will decrease to approximately 41mA.

Pin 18: Back-up supply. Optional RAM back-up power pin. Input parameters are 2.6 - 3.0 volts at approximately 7μA.

Pin 19: 1PPS output. 1 Hz square-wave with rising edge tied to top of UTC second. 3.3V logic. Jitter = approximately +/- 100ns p-p max with WAAS enabled.

Pins 10, 12, 14, 15: RF and power/signal grounds. All pins should be tied to a low impedance ground plane.

2.2 GXB5210

2.2.1 GXB5210 Physical Characteristics

The GXB5210 is approximately 35 mm square by 7.5 mm high. Attachment to the user's host circuit board can be made using adhesive, double-backed tape, or by soldering the bottom shield can directly to the user’s PC board. Connections to the GXB5210 are made through a 10 circuit flexible printed circuit (FPC) with a 1mm pitch. A mechanical drawing of the GXB5210 is shown below.

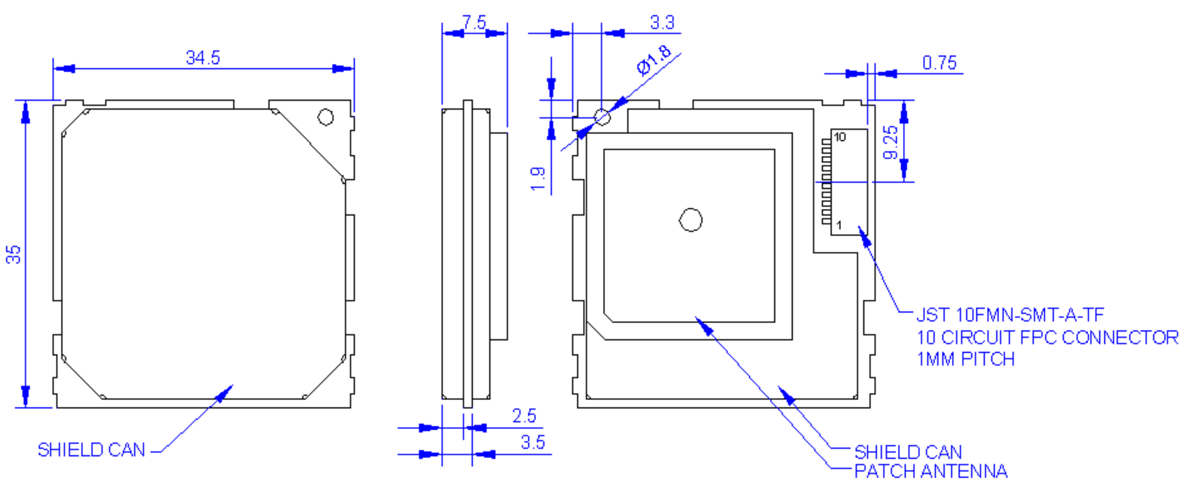

Figure 2.2 GXB5210 Physical Layout

Table 2.5 GXB5210 Operational Characteristics

Characteristic	Type	Value
Time to First Fix (TTFF)	Hot Start	2-3s typical
	Warm Start	33s typical
	Cold Start	40s typical
Sensitivity	Acquisition	-132 dBm typical
	Tracking	-145 dBm typical
Communications	NMEA-0183, v3.01	GGA, GLL, GSA, GSV, RMC, VTG, ZDA, PSA
	Baud Rates	4800/9600/19200/38400
Power Requirements	Operating Voltage	+3.1V - +3.7V (+3.4V nominal)
	Ripple	<50mV p-p max
	Operating Current	70mA during acquisition, 41mA while tracking
	Backup Power	+2.6V - +3.0V, 7µA typical
Environmental	Operating Temperature	-40°C to +85°C
	Storage Temperature	-40°C to +105°C
Physical	Dimensions	34.5mm x 35mm x 7.5mm
	Weight	8 grams
	Electrical Connections	10 Circuit FPC, 1mm Pitch
	Shielding	Entire module enclosed in shield

2.2.2 GXB5210 Electrical Connections

Connections to the module are made with a 10-pin flex-circuit with a 1mm pitch. Signal definitions are as follows:

Table 2.6 GXB5210 Electrical Pinout

Pin	Signal Name	Description
1	TXD0	GPS data out (4800/9600/19200/38400 baud)
2	RXD0	Command Input (4800/9600/19200/38400 baud)
3	1PPS Out	Square wave output with rising edge tied to top of UTC second
4	BR1	Baud rate select 1
5	BR0	Baud rate select 0
6	/Reset	Active LOW receiver reset
7	Pwr/Sig GND	Ground
8	V_{DD}	+3.4V, +/-10%
9	Backup	Optional RAM backup power input.
10	RF GND	Ground

GXB5210 Electrical Connection Details

Pin 1: Data out. 3.3V logic. Baud rate as defined by H/W or S/W.

Pin 2: Commands in. 3.3V logic. Baud rate as defined by H/W or S/W.

Pin 3: 1PPS output. 1 Hz square-wave with rising edge tied to top of UTC second. 3.3V logic. Accuracy $\leq$ 100ns.

Pins 4,5: Power ON baud rate select. Sets default baud rate to 4800/9600/19200/38400 depending on high/low state of pins at power up. Once receiver has powered up the baud rate may be changed at any time using the Sony "@CB" command.

Table 2.7 GXB5210 Power On Default Baud Rates

BR0 (Pin 5)	BR1 (Pin 4)	BAUD RATE
High	Low	4800
Low	Low	9600
Low	High	19200
High	High	38400

Pin 6: Active low receiver RESET. 3.3V logic.

Pin 7: Signal and power ground. The metal shield surrounding receiver may also be used as a ground.

Pin 8: V_{DD} - nominally 3.4V. When the receiver is first turned on and attempting to acquire satellites current draw will be approximately 70mA. While actively computing positions with good signal strengths this current will decrease to approximately 41mA.

Pin 9: Back-up supply input. Optional receiver RAM back-up power.

Pin 10: Signal and power ground.

2.3 GXB5005 Antenna Monitoring and Power Control

The Sony GXB5005 GPS receiver includes hardware and software that allows for monitoring and control of the GPS antenna and bias current. While the GXB5210 includes its own patch antenna and LNA, the GXB5005 can be used with many types of external antennas, and several types of external monitor/control circuits may be added depending on how complex a circuit the application requires. This note will detail the most common configurations and how to implement them.

2.3.1 Basic GXB5005 Active Antenna Drive

This configuration adds a simple Bias-T to the circuitry to provide power to the low-noise amplifier (LNA) in the antenna. As shown in the schematic below, C2 and C3 provide high-frequency bypass while L1 provides DC current to the center conductor of the coax while presenting an open circuit to RF.

A series resistor (R1* in the circuit shown below), is an optional component, but it is recommended to limit the current being pulled from the power supply in case the antenna should short out (or the coax gets pinched). With a modern low current antenna that draws approximately 4mA a 100 ohm series resistor will only cause a drop of approximately 0.4V during normal operation, but limit the current drawn from the supply under shorted conditions to about 33mA. The value of this resistor will ultimately depend on the type of antenna used with the receiver. Typical is 22 ohms.

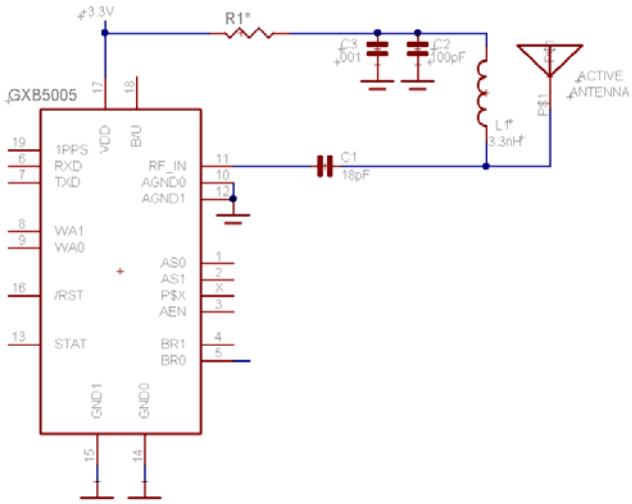

Figure 2.3 Basic GXB5005 Active Antenna Drive

2.3.2 Active Antenna Supply with Over-current Shutdown

The circuit shown on the next page is very similar to the "simple" active supply shown above, but now both sides of the series resistor have been connected to the two A/D converter pins on the GXB5005 (pins 1 and 2). In addition, a PFET (Q1) has been added to control the bias to the antenna under the control of Pin 3 (/AEN). Note that control of Pin 3 is only available when this option has been selected using the “@ANT” antenna monitoring and control command as shown in the next chapter.

During normal operation, Pin 3 of the GXB5005 is low, turning on Q1 and allowing the antenna bias voltage to flow to the antenna. Pin 3 will remain low and Q1 will stay turned on so long as the drop across R1 (AS1 - AS0) does not exceed 0.96V. In the event of a problem (short circuit in the antenna or coax), a voltage drop in excess of 0.96V will cause the GXB5005 to shut down Q1 for three seconds, turn Q1 briefly, and continue to cycle Q1 to see if the short has cleared. Once the voltage drop across R1 is below 0.96V when Q1 is enabled, normal operation will resume.

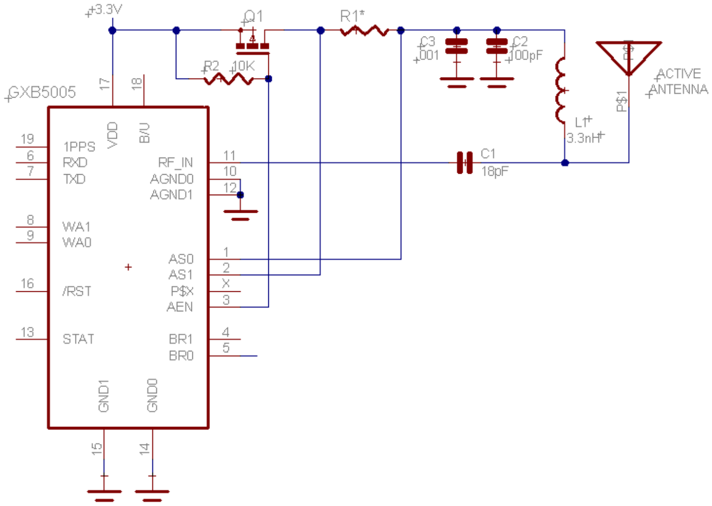

Figure 2.4 GXB5005 3V Active Antenna Drive with Overcurrent Shutdown

2.3.3 5V Active Antenna Supply with Over-current Shutdown

This circuit is almost identical to the previous one except that the antenna sense circuitry has been modified by the addition of resistor dividers R2/R3 and R5/R4 to allow A/D channels AS0 and AS1 to operate with input voltages higher than +3.3V. A 3V to 5V level shifter is also required for the /AEN signal to ensure that the PFET turns off in overload conditions. This configuration is required if the GXB5005 is used to control current to GPS antennas that require +5V bias.

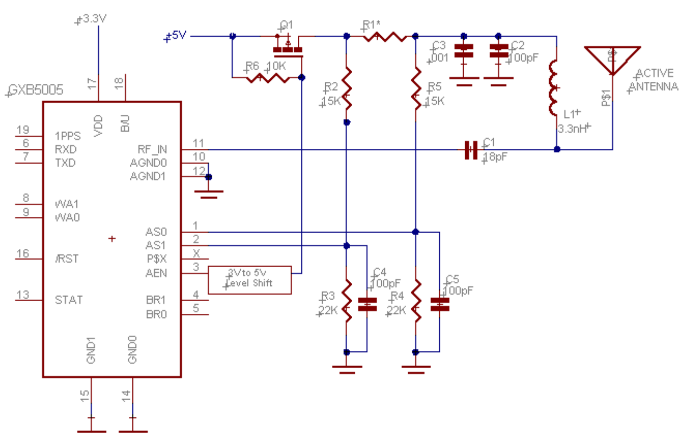

Figure 2.5 5V Active Antenna Drive with Overcurrent Shutdown

Chapter 3 – RECEIVER COMMUNICATIONS

The Sony GXB5005 and GXB5210 GPS receivers both communicate using ASCII command and data sentences. GPS data is output in NMEA-0183 v3.01 format. Unlike standard NMEA where the baud rate is fixed at 4800 baud, the GXB series are capable of communicating at 4800, 9600, 19200, and 38400 (NMEA-0183-HS) baud.

3.1 Communication Details

- Interface: Asynchronous serial interface (UART)
- Baud rate: 4800/9600/19200/38400bps
- Start bit: 1 bit
- Data bit: 8 bits, LSB first
- Stop bit: 1 bit
- Parity bit: None
- Flow control: None

3.2 Input Commands

3.2.1 General Command Format

Commands to the Sony GPS receivers utilize a simple, proprietary Sony command format starting with a single "@" symbol, a two or three character command identifier, and optional command parameter(s), in that order. The command is completed with the CR (carriage return) and LF (line feed) characters.

When a command is successfully recognized, an echo is sent back. If the command name and specified parameter values are entered correctly, the command is processed accordingly. However, if commands or characters other than those noted in this specification are used, operation is indeterminate.

Commands are limited in length to 127 characters (from the "@" symbol to line feed). If there are over 128 characters including line feed, operation cannot be guaranteed. When the command is processed properly, a processing message (shown below) is output as follows depending on the contents of the command.

Examples:

- To command the receiver to perform a Cold-Start -

Tx>	@CD	Command to receiver to execute a Cold-Start
<Rx	@CD	Echo acknowledging receipt of command
<Rx	[CD] (Done)	Output from receiver indicating completion of task

- To request the current geodetic datum being used -

Tx>	@SK	Command to receiver to send current datum
<Rx	@SK	Echo acknowledging receipt of command
<Rx	[SK] Done (WGS84)	Response from receiver showing current datum

- To request the receiver's firmware revision –

Tx>	@PV	Command to receiver requesting firmware version
<Rx	@PV	Echo acknowledging receipt of command
<Rx	[PV] 001092_113	Output from receiver showing firmware version
<Rx	[PV] Done	Output from receiver indicating completion of task

If an entered command is incorrectly formatted, or if a parameter setting is incorrect, an error message (as shown below) will be output and the command will be ignored.

Response from Receiver	Cause
Err: COMMAND	Command error. e.g., command name error
[XX]Err: PARAMETER	Parameter error. e.g., parameter setting error
[XX]Err: DATA	Data error. e.g., input data error or timeout (no data sent to receiver for 4 seconds or longer following initial command input of AMI or EMI command)
[XX]Err: 1	Position solution not available (no 2D or 3D fix), so requested information cannot be determined
[XX]Err: 2	Position solution not available (no 2D or 3D fix), so the specified value cannot be set
[XX]Err: 3	Other undetermined error

3.2.2 Sending Multiple Commands

When multiple commands are sent in succession, commands after the first one should not be transmitted until the receiver returns the echo for the previous command. If the receiver is not allowed to acknowledge commands as they are received, only the **LAST** command entered will be processed.

3.2.3 Command Timing After a Reset

When a software or hardware reset is performed, commands should not be sent to the GPS receiver until at least one character is received back from the UART. This ensures that the receiver is out of reset and the UART is ready to accept commands. If the receiver is not allowed to completely come out of reset, a command may not be received.

Commands that will cause a software reset are:

@CLR	Clears user set parameters and resets firmware
@SS	Clears position and resets firmware
@CD	Commands a Cold-Start
@SW	Commands a Warm-Start
@SR	Commands a Hot-Start
@WA	Changes SBAS parameters

3.2.4 Baud Rate Control Caveat

As noted earlier, the default baud rate is determined by the voltage levels present on the BR0 and BR1 lines during power-up or a software reset. Baud rate can also be changed during normal operation using the Sony @CB command.

Use of the @CB command should be considered carefully. If the baud rate for a given receiver has been changed using the @CB command, the baud rate will RETURN to the default setting if the software is reset for any reason (see paragraph 3.2.3 above.)

This means that if an application changes the default baud rate, and the receiver undergoes a hardware or software reset for any reason, the application must ALSO change baud rates in order to continue to communicate with the receiver.

3.3 Command List

Sony Command Identifier	Function Description
@TM	Sets/queries receiver date and time
@PM	Sets/queries receiver position
@AM	Inputs/Outputs Almanac data
@CB	Sets receiver UART baud rate
@EM	Inputs/Outputs Ephemeris data
@CLR	Sets user parameters to the default values and performs a software reset*
@SS	Clears position and performs software reset
@CD	Cold-Start - Clears memory and performs a software reset
@SW	Warm-Start - Clears Ephemeris data and performs a software reset
@SR	Hot-Start - Performs a software reset
@SK	Sets/queries geodetic system (WGS-84 is default)
@OI*	Sets/queries the message output interval
@PV	Requests receiver firmware version
@NC	Sets output interval for each NMEA sentence
@ANT	Controls and outputs result of antenna sense and drive circuitry
@PLM*	Sets low power mode
@ST*	Sets sleep mode
@WA*	Sets/queries SBAS options

* These commands are not applicable to the GXB5210 since the SBAS augmentation function is always active on this receiver, invalidating use of the @OI, @PLM, @ST, and @WA commands.

Parameters	Default	Setting After	
		@CLR, @CD	@SR, @SS, @SW
Time/Date	00:00:00, Jan 3, 2003	Default	Last Valid Value
Position	Nulled	Default	Last Valid Value
Almanac	Nulled	Default	Last Valid Value
Ephemeris	Nulled	Default	Last Valid Value
Geodetic System	WGS-84	WGS-84	WGS-84
Output Interval	1 second	Default	Last Valid Value
Position Filter	Off	Off	Off
Low-Power Mode	Off	Off	Off
Sleep/Active Mode	Off	Off	Off
SBAS[1]	Dependent on WA0/WA1	Dependent on WA0/WA1	Dependent on WA0/WA1

Note 1: If receiver pin WA1 is HIGH during reset the parameters depend on the setting of receiver pin WA0. See Table 2.4 for GXB5005 pin designations.

3.4 Command and Data Formatting

As mentioned earlier in section 3.2.1, a valid command starts with a command header (the "@" symbol followed by a two or three character command identifier.) A complete command normally also includes a variable number of parameters, followed by the Carriage Return <CR> and Line Feed <LF> characters. The formatting of these parameters is extremely important.

By way of example, consider the SBAS configuration command, @WA. As shown in section 3.4.18 of this guide, the general format of this command is:

@WA M S<CR><LF>

In the interests of clarity, the command header "@WA" and the command parameters "M" and "S" are in black text and are separated by spaces. In addition, the <CR> and <LF> characters are shown in a lighter gray, indicating that you will not normally see them in a terminal emulator screen, but that they are quite necessary.

Spaces do increase the readability of the commands, but they must be used with caution. In general, spaces may or may not be required between individual parameters, but there cannot be a space between the last parameter and the <CR> character. Make sure to note the command formatting for each command you use. The following example should help demonstrate this:

- @WA<CR><LF> — Acceptable syntax
- @WA <CR><LF> — Unacceptable – the space between @WA and <CR> is not permitted
- @WAON122<CR><LF> — Unacceptable syntax – receiver will interpret "ON122" as the "M" parameter
- @WA ON 122<CR><LF> — Acceptable syntax

In the following pages, examples of typical communication exchanges between the Sony receiver and the host application are included with each command. "Tx>" denotes commands sent to the receiver, while "<Rx" denotes responses from the receiver. Note that the data that would normally be seen on a terminal emulator is shown in `Courier` font.

Example:

```
Tx>  @WA ON 0
<Rx  @WA ON 0
<Rx  [WA] Done (ON) SVID:AUTO
```

3.4.1 TM Command (Set or Query Receiver Date and Time)

This command is used to either set the receiver time and date based on UTC time, or to request UTC time and date from the receiver. If the receiver is currently decoding date and time from the GPS satellite constellation, the command to set the receiver time and date will be ignored.

Format: @TM YYYYMMDDhhmmss<CR><LF>

Parameters:	YYYY	Year
	MM	Month
	DD	Day
	mm	Minutes
	ss	Seconds

Valid ranges for date and time parameters are as follows:

Year:	2000 to 2099
Month:	01 to 12
Day:	01 to 31
Hours:	00 to 23
Minutes:	00 to 59
Seconds:	00 to 59

Examples:

- To set the receiver date and time to August 29, 2005, 15:30:10 the sequence is:

```
Tx>  @TM 20050829153010
<Rx  @TM
<Rx  [TM] Done (20050829153010)
```

- To request the date and time currently in receiver RAM:

```
Tx>  @TM
<Rx  @TM
<Rx  [TM] Done (20050713192436)
```

3.4.2 PM Command (Set or Query Receiver Position)

This command is used to either set the receiver's initial 2D position, or to request the current 2D position fix from the receiver. If the receiver is currently calculating a fix the command to set the receiver's position will be ignored.

Format: @PM axxdxx.xxxxbyyydyy.yyyy<CR><LF>

Parameters:	a:	North Latitude (N), South Latitude (S)
	xx:	Whole degrees part of Latitude
	d:	Dividing character between degrees and minutes
	xx.xxxx:	Minutes part of Latitude
	b:	East Longitude (E), West Longitude (W)
	yyy:	Whole degrees part of Longitude
	d:	Dividing character between degrees and minutes
	yy.yyyy:	Minutes part of Longitude

Variable ranges for position parameters are as follows:

Latitude:	0.00 to 90.00
Longitude:	0.00 to 180.00

Examples:

- To set receiver position to Latitude 35° north, Longitude 139° west:

```
Tx>  @PM N35W139
<Rx  @PM
<Rx  [PM] Done (Lat:n 35d0000 Lon:w 139d0000)
```

  Note that you can also set the receiver position with higher precision. For instance, to set the position to Latitude 26°, 23.5500' south, 146°, 06.4344' east the command sequence would be:

```
Tx>  @PM S35d23.55E146d06.4344
<Rx  @PM
<Rx  [PM] Done (Lat:S 35d23.55 Lon:s 146d06.4344)
```

- To request the receiver's current 2D position solution:

```
Tx>  @PM
<Rx  @PM
<Rx  [PM] Done (LAT:n 32d54.2645  LON:w 117d8.8706)
```

3.4.3 CB Command (Baud Rate Select)

This command changes the baud rate for the GXB receivers. Valid baud rates are 4800, 9600, 19200, and 38400.

If the baud rate parameter is not included in the command, the current setting is reported.

NOTE: If the receiver software is reset for any reason the baud rate will return to the default rate as selected by the voltage levels of the @BR0 and @BR1 pins (see Tables 2.3 and 2.7).

Format: @CB b<CR><LF>

Parameter: b: 4800, 9600, 19200, 38400

Example:

- To set the baud rate to 19200:

```
Tx>   @CB 19200
<Rx   @CB 19200
<Rx   [CB] Done (Baudrate: 19200)
```

3.4.4 AM Command (Almanac Data I/O)

The AM command can be used to both download current almanac data from the receiver or to upload a previously recorded almanac file to the receiver. See "4.1 Almanac Data" to see formatting details for the almanac file.

To send an almanac to the receiver the "@AMI" command is sent. As soon as this command is acknowledged by the receiver it enters the standby mode and outputs the "[AMI] Ready" echo. The host then has 4 seconds to start uploading the almanac or the receiver will return to normal mode and ignore any input of almanac data.

Format: @AMm<CR><LF>

Parameters: m: I - Upload recorded almanac file to receiver
O - Download receiver almanac to host platform

Examples:

- To request that the receiver download the current almanac:

```
Tx>   @AMO
<Rx   AMO
<Rx   --------------64 lines of almanac information-----------------
<Rx   [AMO] Done
```

- To upload a previously saved almanac:

```
Tx>   @AMI
<Rx   [AMI] Ready
Tx>   --------------64 lines of almanac information-----------------
<Rx   [AMI] Done
```

3.4.5 EM Command (Ephemeris Data I/O)

The @EM command can be used to either download Ephemeris data from the receiver, or upload an existing Ephemeris file to the receiver. See "4.2 Ephemeris Data" for the Ephemeris I/O interface for this command.

To send an ephemeris file to the receiver the “@EMI” command is sent. As soon as this command is acknowledged by the receiver it enters the standby mode and outputs the “[EMI] Ready” echo. The host then has 4 seconds to start uploading the ephemeris or the receiver will return to normal mode and ignore any input of ephemeris data.

Format: @EMm<CR><LF>

Parameters: m: I - Upload recorded ephemeris file to receiver
O - Download receiver ephemeris to host platform

Examples:

- To request that the receiver download the current ephemeris data:

```
Tx>  @EMO
<Rx  @EMO
<Rx  --------------96 lines of ephemeris information-----------------
<Rx  [EMO] Done
```

- To upload a previously saved ephemeris file:

```
Tx>  @EMI
<Rx  [EMI] Ready
Tx>  --------------96 lines of ephemeris information-----------------
<Rx  [EMI] Done
```

3.4.6 CLR Command (Clear Parameters)

This command resets all user-set parameters to the default values; time, position, Almanac data, Ephemeris data, and forces a Cold-Start.

See Table 2.2 for the user-set parameter default values.

Format: @CLR<CR><LF>

Parameters: None

Example:

```
Tx>   @CLR
<Rx   @CLR
<RX   [CLR] Done
      Copyright (C) Sony Corp. 2001-05 All rights reserved.
           Software Version 001092
```

3.4.7 SS command (Clear Position)

This command clears the position and resets the software. While some user-set parameters are held, others return to the default values. See Table 2.2.

This command may shorten the time-to-first-fix (TTFF) when the receiver has been moved a long distance from the last known position.

Format: @SS<CR><LF>

Parameters: None

Example:

```
Tx>   @SS
<Rx   @SS
<Rx   [SS] Done

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           Software Version 001092
```

3.4.8 CD Command (Cold-Start)

This command performs a Cold-Start reset. A Cold-Start clears the time, position, almanac data, ephemeris data, and resets the software. While some user-set parameters are held, others return to the default values. See Table 2.2.

Format: @CD<CR><LF>

Parameters: None

Example:

```
Tx>   @CD
<Rx   @CD
<Rx   [CD] Done

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                 Software Version 001092
```

3.4.9 SW Command (Warm-Start)

This command performs a Warm-Start reset. A Warm-Start clears the ephemeris data and resets the software. While some user-set parameters are held, others return to the default values. See Table 2.2.

If the receiver does not have almanac data from four or more visible satellites, a cold start will be performed instead.

Format: @SW<CR><LF>

Parameters: None

Example:

```
Tx>  @SW
<Rx  @SW
<Rx  [SW] Done

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          Software Version 001092
```

3.4.10 SR Command (Hot-Start)

This command performs a Hot-Start. A Hot-Start resets the software while retaining the time, initial position, Almanac data, and Ephemeris data. While some user-set parameters are held, others return to the default values. See Table 2.2.

If the receiver does not have Ephemeris data from four or more visible satellites, then a warm start is performed instead. If the receiver does not have Almanac data from four or more visible satellites, a cold start is performed.

Format: @SR<CR><LF>

Example:

```
Tx>   @SR
<Rx   @SR
<Rx   [SR] Done
      Copyright (C) Sony Corp. 2001-05 All rights reserved.
                 Software Version 001092
```

3.4.11 SK Command (Geodetic Datum Selection)

This command sets the geodetic system used for calculating position information. Two different geodetic systems can be set; WGS-84 and the Tokyo geodetic system. The default setting is WGS-84. If the geodetic system argument is not set, the current setting value is reported. The setting is held internally even if the @CD, @SW, @SS or @SR reset commands are transmitted.

Format: @SK d<CR><LF>

Parameters: d: A - WGS-84 *(default)*
B - Tokyo geodetic system

Examples:

- To change to the Tokyo geodetic system:

```
Tx>  @SK B
<Rx  @SK
<Rx  [SK] Done (JAPAN)
```

- To request the currently selected geodetic system:

```
Tx>  @SK
<Rx  @SK
<Rx  [SK] Done (JAPAN)
```

3.4.12 OI Command (Message Output Interval Setting)

This command changes the output interval of positioning result messages. Valid settings are 0, 1, 2, 5, and 10 seconds. If 0 is set, message reporting is disabled. To resume output, set a value other than 0. The default value is 1.

If the interval parameter is not included, the current setting is reported. The setting is maintained even if the @CD, @SW, @SS or @SR reset commands are transmitted.

Format: @OI i<CR><LF>

Parameter: i: 0, 1, 2, 5, or 10

Example:

- To set the output interval to 5 seconds:

```
Tx>   @OI 5
<Rx   @OI 5
<Rx   [OI] Done (5(sec))
```

3.4.13 PV command (Request Software Version)

This command causes the receiver to output the software version.

Format: @PV<CR><LF>

Parameters: None

Example:

```
Tx>   @PV
<Rx   @PV
<Rx   [PV] 001092_113
<Rx   Done
```

3.4.14 NC command (NMEA Sentence Request)

This command sets the output intervals for the seven standard NMEA sentences (GGA, GLL, GSA, GSV, RMC, VTG, ZDA) and the SONY proprietary PSGSA sentence.

The command requires 8 integer values (0, 1, 2, 5) to set the rate of message output. The first number indicates the GGA output interval; the second the GLL; the third the GSA; the fourth the GSV; the fifth the RMC; the sixth the VTG; the seventh the ZDA; and the eighth indicates the PSGSA output interval.

If 0 is set for any variable, that particular message is not output.

The message settings are held internally even if the @CD, @SW, @SS or @SR reset commands are transmitted.

Format: @NC dddddddd<CR><LF>

Parameters: d: 0, 1, 2, or 5

Example:

- To output GGA every second and GSA once every two seconds send the following command:

```
Tx>  @NC 10200000
<Rx  @NC  10200000
<Rx  [NC] Done (GGA: 1, GLL: 0, GSA: 2, GSV: 0, RMC: 0, VTG:
     0, ZDA: 0, PSGSA: 0)
```

3.4.15 ANT Command (Antenna Bias Control)

This command requests the state of the antenna bias current sensing circuitry. If enabled, antenna current sensing is performed once each second. This command works in combination with pins 1 and 2 of the GXB5005.

Pins 1 (AS0) and 2 (AS1) are A/D inputs. In use, a current sensing resistor is placed across the two A/D channels. If a short is detected (greater than a 0.96V delta between AS0 and AS1), a short circuit is declared. Pin 3 of the GXB5005 goes high for about 3 seconds, removing drive from the pass transistor. Pin 3 then goes to the original level (low) and antenna sensing is performed again.

This command is not usable with the GXB5210.

Format: @ANT<CR><LF>

Parameters:	Normal	Current draw by the antenna is within defined limits
	Open	The antenna is not drawing current - check cabling
	Short	Current draw by the antenna exceeds defined limits
	ON	Antenna sensing is ON
	OFF	Antenna sensing is OFF

Examples:

- To turn antenna current sensing ON:

```
Tx>  @ANT ON
<Rx  @ANT
<Rx  [ANT] Done (ON)
```

- To check antenna current:

```
Tx>  @ANT
<Rx  @ANT
<Rx  [ANT] Normal
<Rx  [ANT] Done (ON)
```

3.4.16 WLK Command (Position Filter Control)

This command sets the mode for the position filter. If the receiver is to be used solely in low velocity applications, enabling the "Walking" filter will result in decreased wandering of the reported position. The commanded filter mode is held even if the @CD, @SW, @SS or @SR reset commands are transmitted.

Format: @WLK M<CR><LF>

Parameters:	M:	ON:	Enable filter
		OFF:	Disable filter *(default)*

Example:

- To enable the position filter:

```
Tx>  @WLK ON
<Rx  @WLK
<Rx  [WLK] Done (ON)
```

3.4.17 PLM command (Power Mode Control)

This command controls the low-power mode of the GXB5005 receiver. If the low power mode is invoked, the receiver will go into a power saving mode between position fixes as specified by the time interval parameter (T). Message Control and Antenna Bias Control are selected using the (M) and (P) parameters respectively.

Antenna Bias Control: If “PE” is set as the P parameter, the Pin 3 level is synchronized with the sleep-mode. Pin 3 is HIGH when the GXB5005 is in "inactive" state. If 0 is set as the time parameter, the sleep mode is terminated and the receiver operates normally.

Format: @PLM T M P<CR><LF>

Parameters:	T:	0, 5, 6, 7, 8, 9, 10	*(0 is default)*
	M:	MD	Messages disabled while in low-power mode
		ME	Messages enabled while in low-power mode *(default)*
	P:	PD	Antenna bias control not controlled *(default)*
		PE	Antenna bias control synchronized with low-power mode

Time Interval (T): Valid interval settings are 0, 5, 6, 7, 8, 9, and 10 seconds. If 0 is set, the low power mode is terminated and the receiver returns to the settings in effect before the low-power mode was invoked.

Message Control (M): ME - If the ME option is selected, NMEA messages will continue to be generated periodically at 1Hz while the receiver is in low power mode. These messages do not contain any new information, but are repeats of the messages sent before the low-power interval was entered.

MD - If the MD option is selected, messages with new fixes will only be generated at the specified interval.

Antenna Bias Control (P): PE - If the PE option is selected, Pin 3 of the GXB5005 is synchronized with low power operation mode. Pin 3 will go HIGH when the receiver is in low power mode, disabling the antenna bias current. When the GXB5005 goes back to the "active" state, Pin 3 goes LOW, reestablishing antenna bias current so that a new fix may be obtained.

PD – If the PD option is selected, antenna bias will stay on during low-power intervals.

Notes:

1. Low-Power mode should only be enabled AFTER the receiver has downloaded valid almanac and ephemeris information. In addition, it is recommended that Low-Power mode be disabled once an hour for several minutes to allow fresh ephemeredes to be downloaded.

2. Low-power mode cannot be invoked if the WAAS/EGNOS option is enabled. If entry into Low-power mode is attempted with WAAS/EGNOS active, the receiver will return an error message and ignore the command.

3. Low-power mode and the sleep mode (@ST command) cannot be used at the same time. If Sleep mode is invoked when the Low-Power mode is active, the Low-Power mode will be cancelled and the sleep-awake mode will be invoked.

- This mode cannot be used if the @OI function is active.

Examples:

- To enable the Low-Power mode with a 10 second interval, messages disabled between fixes, and antenna bias control synchronized:

```
Tx>   @PLM 10 MD PE
<Rx   @PLM 10 MD PE
<Rx   [PLM] Done (Time:10 Msg:MD Port:PE)
```

- To exit Low-Power mode:

```
Tx>   @PLM 0
<Rx   @PLM 0
<Rx   [PLM] Done (Time:0 Msg:ME Port:PD)
```

Note that when Low-Power mode is turned off that the “M” and “P” parameters go to “ME” and “PD” automatically, thereby relinquishing message control to the “@OI” or “@NC” command (whichever was active before Low-Power mode was entered) and control of the antenna bias current to the “@ANT” command.

3.4.18 ST Command (Sleep Mode Control)

This command controls the GXB5005 receiver sleep mode. If the sleep mode is invoked, the receiver will go into a power saving mode between position fixes as specified by the interval parameter (T). Message behavior and antenna bias control are selected using the (M) and (P) parameters respectively.

Valid settings for the “T” parameter are 0, 5, 6, 7, 8, 9, and 10 seconds.

Message Control: If “ME” is set as the “M” parameter, NMEA messages will continue to be output at 1Hz while the receiver is “sleeping”. These NMEA messages are not “new” information, but rather repeat(s) of the last messages sent by the receiver before sleep mode was enabled. If “MD” is set as the “M” parameter, NMEA messages will only be output when the receiver is active.

Antenna Bias Control: If PE is set, the Pin 3 level is synchronized with the sleep-mode. Pin 3 is HIGH when the GXB5005 is in "inactive" state. If 0 is set as the time parameter, the sleep mode is terminated and the receiver operates normally.

When the GXB5005 is back in "active" state, the port takes on the previous state before "inactive" state depended on antenna sense function.

Format: @ST T M P<CR><LF>

Parameters:	T:	0, 5, 6, 7, 8, 9, or 10 - Time between fixes
	M:	MD - Messages disabled while asleep
		ME - Messages enabled while asleep
	P:	PD - Antenna bias control always LOW
		PE - Antenna bias control HIGH while asleep, disabling antenna bias current to save power

The default values are:

Interval time:	0 (normal mode)
Message output:	ME
Port control:	PD

Notes:

1. Sleep mode (ST) and Power Control mode (PLM) <u>cannot</u> be used at the same time. If Power Control mode is active when Sleep mode is requested, the request to enable Sleep mode will be ignored and the Power Control mode settings will be maintained.

2. Sleep mode should only be enabled after the receiver has established a position fix. If Sleep Mode is enabled before a fix is determined, the receiver will not be able to develop a fix. In addition, while this mode is active the ephemeris data is not updated. If the receiver cannot develop fixes for an extended period while this command is active, the mode should be terminated.

3. Sleep mode cannot be invoked if the WAAS/EGNOS option is enabled. If sleep is attempted with WAAS/EGNOS active, the receiver will return an error message and ignore the command.

Examples:

- To set the receiver for 10 seconds between fixes, messages output during sleep period and antenna bias control enabled -

```
>Tx   @ST 10 ME PE
<Rx   @ST 10 ME PE
<Rx   [ST] 10 ME PE (Done)
```

3.4.19 WA command (WAAS/EGNOS Configuration)

This command configures the WAAS/EGNOS function in the GXB5005 receiver. When set to ON, the receiver utilizes WAAS/EGNOS signals from Space Based Augmentation Satellites (SBAS) to improve position accuracy. Correction information is downloaded after the initial position is determined. Once the information from the satellite is decoded, the correction information will be included in subsequent position fixes.

If 0 is selected for the PRN number, the satellite at the highest elevation is automatically selected. If desired, the user may specify the satellite the receiver should attempt to use. This function should be used with caution. If the user specifies a satellite that is not visible, corrections will not be available.

The setting is held internally even if the @CD, @SW, @SS or @SR commands are transmitted.

Format: @WA M S<CR><LF>

Parameters:
M: ON - WAAS/EGNOS function enabled
OFF - WAAS/EGNOS function disabled *(default)*
S: 0, or 120…138 - WAAS/EGNOS satellite PRN number *(0 is default)*

Note:

1. If the WAAS/EGNOS function is turned ON or OFF a software reset is performed.

Examples:

- To enable WAAS/EGNOS corrections with automatic satellite selection, send the command string:

```
Tx>   @WA ON 0
<Rx   @WA ON 0
<Rx   [WA] Done (ON) SVID:AUTO
```

- To turn the WAAS/EGNOS function off -

```
Tx>   @WA OFF
<Rx   @WA OFF
<Rx   [WA] Done (OFF) SVID:AUTO
      Copyright (C) Sony Corp. 2001-05 All rights reserved.
           Software Version 001092
```

Chapter 4 NMEA OUTPUT MESSAGES

This chapter describes the formatting of the various output messages created by the GPS receiver. The Sony receiver output messages are compliant with NMEA-0183, Version 3.01.

4.1 NMEA-0183 Format

In their simplest form, NMEA messages are comma-separated-variable (CSV) ASCII sentences. Fields are variable width.

The Sony GPS receivers can output 7 standard NMEA sentences: GPGGA, GPGLL, GPGSA, GPGSV, GPRMC, GPVTG, GPZDA, and the Sony proprietary “PSGSA” sentence.

Depending on the baud rate selected at power-up the receiver will send out different subsets of NMEA messages. If the power-up baud rate is 4800, the receiver will automatically output the GGA, GSA, GSA, and RMC messages.

If the power-up baud rate is 9600, 19200, or 38400, the receiver will transmit 7 NMEA sentences: GPGGA, GPGSA, GPGSV, GPRMC, GPVTG, GPZDA, and PSGSA.

This variation in the default number of output messages is because the full set of NMEA messages cannot be transmitted by the receiver in a 1 second time period at 4800 baud. Any data transmitted by the receiver after the end of the data period will be lost. As a rule of thumb, no more than 6 NMEA sentences should be enabled at 4800 baud.

4.1.1 GPGGA Sentence

The GPGGA sentence is defined as the “Global Positioning System Fix Data” sentence, and it is the standard message used when 3D positioning is needed. The message outputs UTC time, Latitude, Longitude, Height, and a myriad of status indicators. The basic format is as follows:

Format: $GPGGA,hhmmss,ddmm.mmmm,N,dddmm.mmmm,
E,q,ss,yy.y,hhhhh.h,M,ggg.g,M,t.t,iiii*CS<CR><LF>

Parameters:	hh:	hours
	mm:	minutes
	ss:	seconds
	dd:	degrees of latitude
	mm.mmmm:	minutes of latitude
	N:	N or S – direction of latitude
	ddd:	degrees of longitude [1]
	mm.mmmm:	minutes of longitude
	E:	E or W – direction of longitude
	q:	GPS status 0 = Fix not available or invalid 1 = GPS SPS mode, fix valid 2 = Differential fix valid
	ss:	number of satellites being tracked
	yy.y:	HDOP
	hhhhh.h:	Mean Sea Level (msl) height [2]
	M:	meters (height unit of measure)
	ggg.g:	geoidal separation between msl height and GPS height [3]
	M:	meters (height unit of measure)
	t.t:	age of differential correction data (always null)
	iiii:	differential station ID code (always null)

Examples:

- Appearance of GPGGA sentence after reset before any satellites are tracked:

```
$GPGGA,000001,,N,,E,0,00,,,M,,M,,*6C
```

- Typical output while a valid fix is being computed:

```
$GPGGA,032823,3254.2721,N,11708.8749,W,1,05,01.5,00086.9,M,-032.8,M,,*71
```

Notes:

1. The Longitude is always expressed as 0 degrees when the Latitude is +/- 90 degrees (North or South Pole).

The possible range of Longitude is 180.000000 degrees East to 179.599999 degrees West.

2. Height is expressed as five integer digits and one decimal digit, with a minus sign (-) added as necessary. Maximum range is 99999.9 to –99999.9 meters.

3. The difference from the geoidal surface is expressed as three integer digits and one decimal digit. A minus sign is added if required.

4.1.2 GPGLL Sentence

The GPGLL sentence is defined as the "Geographic Position – Latitude/Longitude" sentence and is a short sentence used when only a simple 2D fix and UTC time is required. The message outputs Latitude, Longitude, UTC time, and a fix status character.

Format: $GPGLL,ddmm.mmmm,N,dddmm.mmmm,E,
hhmmss,q,M *CS<CR><LF>

Parameters:	dd:	degrees of latitude	
	mm.mmmm:	minutes of latitude	
	N:	N or S – direction of latitude	
	ddd:	degrees of longitude	
	mm.mmmm:	minutes of longitude	
	E:	E or W – direction of longitude	
	hh:	hours	
	mm:	minutes	
	ss:	seconds	
	q:	GPS status	A = Valid fix V = Invalid fix
	M:	Positioning Mode	A – autonomous D – differential mode N – data not valid

Examples:

- Appearance of GPGLL sentence after reset before any satellites are tracked:

```
$GPGLL,,N,,E,000001,V,N*6E
```

- Typical output while a valid fix is being computed:

```
$GPGLL,3254.2735,N,11708.8523,W,031807,A,A*58
```

4.1.3 GPGSA Sentence

The GPGSA sentence is defined as the "GNSS DOP and Active Satellites" sentence, and outputs the current satellite information and DOP values. The sentence outputs satellite acquisition mode (always "automatic" with GXB series receivers), type of GPS fix, ID's of the satellites used in the solution, along with PDOP, HDOP, and VDOP values.

Format: $GPGSA,a,m,s1,s2,s3,s4,s5,s6,s7,s8,s9,s10,s11,s12,
pp.p,hh.h,vv.v*CS<CR><LF>

Parameters:

	a:	acquisition mode	A = automatic (always)
	b:	positioning mode	1 = No fix
			2 = 2D fix
			3 = 3D fix
	s1...s12		satellites used in position solution
	pp.p		PDOP
	hh.h		HDOP
	vv.v		VDOP

Examples:

- Appearance of GPGSA sentence after reset before any satellites are tracked:

  `$GPGSA,A,1,,,,,,,,,,,,,,,*1E`

- Typical output with data for 7 satellites:

  `$GPGSA,A,3,02,04,05,07,09,10,30,,,,,,02.0,01.0,01.7*08`

4.1.4 GPGSV Sentence

The GPGSV sentence is defined as the "GNSS Satellites in View" sentence, and outputs detailed satellite information including the satellite's PRN number, elevation above the horizon, azimuth in degrees True, and carrier-to-noise ratio (C/No). Depending on the number of satellites currently visible there may be up to <u>three</u> GPGSV sentences transmitted, with data for up to <u>four</u> satellites in each message.

Format: $GPGSV,t,m,ss,nn,ee,aaa,ss*CS<CR><LF>

Parameters:	t:	total number of GSV sentences being output (1-3)
	ss:	total number of satellites in view (0-12)
	nn:	satellite PRN number
	ee:	satellite elevation angle (0-90 degrees)
	aaa:	satellite azimuth angle (0-359 degrees)
	ss:	signal strength (C/No in dB-Hz)

*The "nn,ee,aaa,ss" data structure may be repeated up to four times in a single GSV sentence

Example:

- Appearance of GPGSV sentence before any satellites are tracked after reset:

```
$GPGSV,1,1,00,,,,,,,,,,,,,,,,*79
```

- Typical output with data for 10 satellites

```
$GPGSV,3,1,10,02,85,080,42,04,40,044,46,05,57,317,41,06,05,273,00*7B
$GPGSV,3,2,10,07,17,074,38,09,40,226,35,10,19,155,40,17,59,016,00*7C
$GPGSV,3,3,10,24,01,040,00,30,23,314,42,,,,,,,,*79
```

4.1.5 GPRMC Sentence

The GPRMC sentence is defined as the “Recommended Minimum Specific GNSS Data” sentence, and outputs UTC time, GPS fix status, latitude, longitude, speed, date, direction, and fix mode data.

Format: $GPRMC,hhmmss,q,ddmm.mmmm,N,dddmm.mmmm,
E,kkk.k,ccc.c,ddmmyy,x.x,z,M*CS<CR><LF>

Parameters:

hh:	hours [1]		
mm:	minutes		
ss:	seconds		
q:	GPS status:	A = valid fix V = invalid fix	
dd:	degrees of latitude		
mm.mmmm:	minutes of latitude		
N:	N or S – direction of latitude		
ddd:	degrees of longitude [2]		
mm.mmmm:	minutes of longitude		
E:	E or W – direction of longitude		
kkk.k:	velocity over ground (knots) [3]		
ccc.c	Course (degrees True)		
dd:	day		
mm:	month		
yy:	year		
x.x:	magnetic variation (always nulled)		
z:	E or W – direction of variation (always nulled)		
M:	Positioning Mode	A – autonomous D – differential mode N – data not valid	

Examples:

- $GPRMC sentence immediately after a reset:

  ```
  $GPRMC,000001,V,,N,,E,,,010303,,,N*58
  ```

- Typical $GPRMC sentence while a valid fix is being computed:

  ```
  $GPRMC,030712,A,3254.2736,N,11708.8468,W,000.2,000.0,011005,,,A*6F
  ```

Notes:

1. Before time is downloaded from the satellites, the hhmmss field starts out at 00:00:00 and counts up once per second until UTC time is available from the

satellites.

2. The Longitude is always expressed as 0 degrees when the Latitude is +/-90 degrees, (North or South pole), and ranges from Longitude 180 degrees East to Longitude is 179.99.9999 degrees West under normal positioning conditions.

3. The Speed over ground is expressed as three integer digits and one decimal digit. Max range is 999.9 knots to –999.9 knots.

4.1.6 GPVTG Sentence

The GPVTG sentence is defined as the “Course Over Ground and Ground Speed” sentence, and is a short sentence that outputs Course (degrees True), Course (degrees Magnetic), speed over ground (knots), speed over ground km/hr, date, and fix mode data.

Format: $GPVTG,ddd.d,T,X,M,sss.s,N,sss.s,K,q*CS<CS><LF>

Paramaters:	ddd.d:	track, degrees true	
	T:	T – formatting constant	
	X:	track, degrees magnetic [1]	
	M:	M – formatting constant	
	sss.s:	speed – knots	
	N:	N – formatting constant for knots	
	sss.s:	speed – km/hr	
	K:	K – formatting constant for km/hr	
	q:	GPS fix status:	A – Autonomous Mode D – Differential Mode N – Data not Valid

Examples:

- Output from receiver after a reset and before a fix has been calculated:

```
$GPVTG,,T,,M,,N,,K,N*2C
```

- Typical output from receiver once a valid fix has been obtained:

```
$GPVTG,014.5,T,,M,000.3,N,000.6,K,A*08
```

Note:

1. The track (magnetic degrees) field is always nulled since the receiver only puts out track in degrees true.

4.1.7 GPZDA sentence

The GPZDA sentence is defined as the “Time and Date” sentence, and is a short sentence that outputs UTC time, Day, Month, Year, and local time zone corrections.

Format: $GPZDA,hhmmss,dd,mm,yyyy,hh,mm*CS<CS><LF>

Parameters:	hh:	hours
	mm:	minutes
	ss:	seconds
	dd:	day
	mm:	month
	yyyy:	year
	hh:	local time zone hours (always nulled) [1]
	mm:	local time zone minutes (always nulled) [1]

Examples:

- Output from receiver after a reset and before a fix has been calculated:

  ```
  $GPZDA,000001,01,03,2003,,*4A
  ```

- Typical output from receiver once time and date are decoded:

  ```
  $GPZDA,034430,01,10,2005,,*4F
  ```

Note:

2. The GXB series receivers do not calculate local time zone offsets so these two fields are always nulled.

4.1.8 PSGSA Sentence

The PSGSA sentence is a proprietary Sony sentence that deals with speed calculations.

Format: $PSGSA,m,ss,ss,ss,ss,ss,ss,ss,ss,ss,ss,ss,ss,pp.p,hh.h,vv.v,xxxxx,
hhmmssss,D*CS<CR><LF>

Parameters:	$PSGSA	Sentence Identifier
	m:	0 - Speed non-positioning 1 - 2D speed positioning 2 - Pseudo 3D speed positioning 3 - 3D speed positioning
	ss:	Satellite ID number used in speed calculation
	pp.p:	Speed Calculation PDOP
	hh.h:	Speed Calculation HDOP
	vv.v:	Speed Calculation VDOP
	xxxxx:	TCXO offset value
	hh:	hours
	mm:	minutes
	ssss:	seconds (ssss denotes ss:ss seconds)
	D:	reserved

- Output from receiver after a reset and before a fix has been calculated:

```
$PSGSA,1,,,,,,,,,,,,,,,,00000,,0*4B
```

- Typical output from receiver once a valid fix has been obtained:

```
$PSGSA,4,05,02,10,06,,,,,,,,,04.0,01.9,03.5,00358,04120408,5*5A
```

4.2 NMEA Message Data

The following tables describe the values of the NMEA data fields in three states:

- immediately after a Cold-Start
- during valid positioning
- after a valid position has been lost

4.2.1 GPGGA Sentence

Field	Parameter	After Cold Start	With Valid Fix	After Loss of Fix
1	Time (UTC)	00:00:00	UTC time	UTC (free running)
2	Latitude	null	Current Value	Last Valid Value
3	N/S (North/South)	N	Current Value	Last Valid Value
4	Longitude	null	Current Value	Last Valid Value
5	East/West	E	Current Value	Last Valid Value
6	GPS Quality	0	1 or 2	0
7	# of satellites	00	Current Value	00
8	HDOP	null	Current Value	null
9	Altitude	null	Current Value	Last Valid Value
10	Geoidal Separation	null	Current Value	Last Valid Value
11	Age of DGPS data	null	null	null
12	DGPS station ID	null	null	null

4.2.2 GPGLL sentence

Field	Parameter	After Cold Start	With Valid Fix	After Loss of Fix
1	Latitude	null	Current Value	Last Valid Value
2	N/S (North/South)	N	Current Value	Last Valid Value
3	Longitude	null	Current Value	Last Valid Value
4	East/West	E	Current Value	Last Valid Value
5	Time (UTC)	00:00:00	UTC time	UTC (free running)
6	Status	V	A	V
7	Mode indicator	N	A or D	N

4.2.3 GPGSA sentence

Note: Field 3 may be repeated up to twelve times as needed.

Field	Parameter	After Cold Start	With Valid Fix	After Loss of Fix
1	Mode indicator	A	A	A
2	Positioning mode	1	2 or 3	1
3	Satellite ID number	null	Current Value	null
4	PDOP	null	Current Value	null
5	HDOP	null	Current Value	null
6	VDOP	null	Current Value	null

4.2.4 GPGSV sentence

Note: Fields 4-7 may be repeated up to four times per sentence, containing information for four different satellites.

Field	Parameter	After Cold Start	With Valid Fix	After Loss of Fix
1	# of sentences	1	1 – 3 as needed	1 – 3 as needed
2	Sentence #	1	1 – 3 as needed	1 – 3 as needed
3	Satellites in view	00	03 – 12	Last valid value
4	Satellite ID number	Null	Current Value	Last valid value
5	Satellite elevation	Null	Current Value	Last valid value
6	Satellite azimuth	Null	Current Value	Last valid value
7	Signal (C/No)	Null	Current Value	Current Value

4.2.5 GPRMC sentence

Field	Parameter	After Cold Start	With Valid Fix	After Loss of Fix
1	Time (UTC)	00:00:00	UTC time	UTC (free running)
2	Status	V	A	V
3	Latitude	Null	Current Value	Last Valid Value
4	N/S (North/South)	N	Current Value	Last Valid Value
5	Longitude	Null	Current Value	Last Valid Value
6	East/West	E	Current Value	Last Valid Value
7	Speed over ground	null	Current Value	Last Valid Value
8	Course over ground	null	Current Value	Last Valid Value
9	Date	010303	Current Value	Last Valid Value
10	Magnetic variation	null	null	null
11	Variation direction	Null	null	null
12	Mode indicator	N	A or D	N

4.2.6 GPVTG sentence

Field	Parameter	After Cold Start	During Valid Fix	After Loss of Fix
1	Course (True)	null	Current Value	Last Valid Value
2	Course (Magnetic)	null	null	null
3	Speed (knots)	null	Current Value	Last Valid Value
4	Speed (km/hr)	null	Current Value	Last Valid Value
5	Mode indicator	N	A or D	N

4.2.7 GPZDA sentence

Field	Parameter	After Cold Start	During Valid Fix	After Loss of Fix
1	Time (UTC)	00:00:00	UTC Time	UTC (free running)
2	Day	01	Current day	Last Valid Value
3	Month	03	Current month	Last Valid Value
4	Year	2003	Current year	Last Valid Value
5	Local Time Hours	null	null	null
6	Local Time Minutes	null	null	null