MS3037

GSS6100

SINGLE CHANNEL GPS / SBAS SIGNAL GENERATOR

PRODUCT SPECIFICATION

ABSTRACT

This document describes the performance of the GSS6100 Single Channel GPS / SBAS Signal Generator

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1-21	26 Jan. 09	SDM	Typos Bug 3024: 1PPS OUT = 100 ms

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1 GENERAL

1.1 SCOPE & APPLICABILITY

This document defines the facilities provided by the GSS6100 Single Channel GPS / SBAS Signal Generator.

1.2 REFERENCED DOCUMENTS

a) Standard Receiver Performance Tests
ICD-GPS-204
b) Minimum Operational Performance Standards for GPS/SBAS Airborne Equipment
RTCA/DO-229A June 8, 1998

1.3 GLOSSARY OF TERMS

C/A	Coarse / Acquisition, the civil ranging code of GPS
ATE	Automatic Test Equipment
BIST	Built In Self Test
EGNOS	European Geostationary Navigation Overlay Service
EUT	Equipment under Test
FEC	Forward Error Correction
GPIB	General Purpose Interface Bus (IEEE488 bus)
GPS	Global Positioning System
PC	Personal Computer
PRN	Pseudo Random Noise
RF	Radio Frequency
SBAS	Space Based Augmentation System for GPS, such as WAAS or EGNOS
TOW	Time Of Week, a GPS time reference based on 1.5 second intervals
WAAS	Wide Area Augmentation System

2 INTRODUCTION

Spirent has a long and illustrious history of producing accurate, high-quality GPS simulators. The GSS6100 maintains the tradition of class-leading features, performance, reliability and accuracy that customers have come to expect from Spirent's simulation systems and signal generators.

The GSS6100 Single-Channel GPS/SBAS Signal Generator is designed specifically for production test applications. Features such as the GPIB interface for ATE integration, rack mount chassis and in-rack annual calibration are provided as standard and facilitate use of the GSS6100 in the volume manufacturing test environment.

Although the GSS6100 is designed for Automatic Test applications, it is supplied with PC software to facilitate use as a general-purpose laboratory signal generator.

The GSS6100 will generate a single simulated GPS L1, C/A signal or SBAS satellite signal (WAAS or EGNOS) at any given time, the selection being made prior to the start of simulation.

The GSS6100 generates a GPS or SBAS RF satellite signal at the GPS L1 frequency (1.57542 GHz). In both cases, the carrier is modulated with the relevant pseudo-random ranging code and data message. The ranging code selection and data message definition are fully supported. The Doppler shift and power level of the signal is fully programmable so that acquisition tests can be made on a receiver in varying conditions of signal to noise ratio and signal dynamics. Control of carrier and code phase gives the ability to simulate ionospheric dispersion effects.

The GSS6100 includes two modes of operation – the primary mode and an alternative mode.

In the primary mode, GPS/SBAS message generation is typically controlled via integral GPIB (IEEE-488) interface, with USB and RS232 also being supported. Also supplied with the simulator is a software application package **SimCHAN for Windows** which allows the user to control the signal generator as an instrument via its intuitive graphical point-and-click interface, when installed on a suitable PC equipped with USB or IEEE-488.

In the alternative mode, the GSS6100 generates a pre-defined GPS signal constantly whenever the unit is powered up. The alternative mode may be used when a continuous GPS source is required for testing. The user may define PRN, power level and other parameters to be broadcast during alternative mode operation.

The signal generator uses direct digital waveform synthesis to provide a low-cost, stable instrument with very low life-cycle support costs.

The GSS6100 has full functional compatibility and comparable technical specification with the Spirent GSS4100.

3 HARDWARE DESCRIPTION

3.1 GENERAL

The GSS6100 signal generator is housed in a 2U, full width rack-mountable case and is powered via the ac mains connector. The rear panel mounted fan provides forced-air cooling.

The primary RF output is fitted on the front of the unit. All other connections are accessed via the rear-panel. Calibration adjustments may also be made via the rear panel.

Frequency accuracy is derived from a high-stability ovenised crystal oscillator fitted internally and its signal is made available for external use. Alternatively, the generator may be locked to an external frequency reference signal as specified in Section 3.3. The frequency of the external reference is software selectable.

The simulator may be additionally synchronised with other test equipment via its 1PPS input and output signals.

Two operating modes are supported; Primary (interactive) and Alternative (pre-defined, always-on).

Built-In-Test-Equipment (BITE) data are available via the IEEE-488 or USB interfaces. This enables any software to check that the simulator is operating correctly.

Signal Generator performance is defined in Section 7 of this specification.

3.2 CALIBRATION REQUIREMENTS

It is recommended that the unit be calibrated at 12 monthly intervals to guarantee performance within specification. This equipment has been designed to be easy to calibrate, requiring a minimum of expertise and time, and all adjusters are available externally on the rear panel of the simulator.

If the unit is to be used for very accurate absolute frequency measurements it is advisable to either check the absolute frequency of the simulator's internal frequency oscillator or frequency-lock the unit to an external reference. A calibrated Frequency Counter is required to measure 10.00 MHz with a resolution of 0.05 Hz. A frequency adjust control is provided on the rear panel of the unit.

The output power level may be checked and/or adjusted as necessary (via rear panel) whilst monitoring the higher level RF port specifically provided for this purpose. A calibrated power meter capable of measuring a signal of around -50 dBm at 1.57542 GHz is required.

3.3 CONNECTIVITY

Table 1 Coaxial connections

Signal	Type	Detail	Description
Primary RF ports	OUT	COAXIAL Type 'N' Female Front Panel	Provides the primary RF GPS signal output at specified levels. 50 ohm. VSWR <1.2:1 (in band). DC isolated[1].
CAL Output	OUT	COAXIAL Type 'SMA' Female Rear panel	Provides a high level output suitable for calibration with a power meter. 50 ohm. VSWR <1.45:1 (at L1). DC isolated[1].
External Reference	IN	COAXIAL BNC Socket Rear Panel	Allows the GSS6100 to be locked to an external reference. 5 or 10 MHz: sine or square wave, -5 to +10 dBm 1MHz square wave, 0 to +10 dBm 50 ohm Required accuracy <0.1 ppm.
INT REF OUT Internal Reference Oscillator	OUT	COAXIAL BNC socket Rear Panel	10 MHz sine 0 dBm minimum 50 ohm
TRIGGER	IN	COAXIAL BNC socket Rear Panel	A trigger input to allow an external signal to start the simulation. TTL level compatible 50 ohm

Baseband codes and clock signals may be accessed through a 15-way D-type external connector; see Table 2. All outputs are TTL compatible and capable of driving loads to 50 ohm. Inputs are 50 ohm terminated. Signal Ground returns are included.

Table 2 D-type connections

Signal	Type	Description
1PPS	OUT	1 pulse every second (independent of Doppler setting) The 1PPS OUT pulse width is 100 ms
1PPS	IN	1 pulse every second
PRN Code	OUT	The pseudorandom ranging code chip sequence (synchronous with Chip Clock)
Chip Clock	OUT	1.023 MHz nominal (varies with Doppler setting)
Code Epoch	OUT	One pulse every cycle of the PRN code (1 ms repetition interval)
Data Bit stream	OUT	Navigation data message
1Sec Epoch	OUT	1PPS based on chip clock (varies with Doppler setting)

[1] DC isolation can withstand a maximum DC level of ±100V and reverse RF levels to a maximum of 1W.

Table 3 Other Connections

Connector	Type	Description
HOST IEEE	Comm	Primary Control Interface IEEE-488
USB	Comm	Alternative Control Interface using USB 2.0
RS232	Comm	Alternative Control Interface using RS232 serial standard

4 GPIB CONTROL

The GSS6100 is designed for ATE applications and has been equipped with a GPIB (IEEE-488.1) industry standard interface for device control when in its Primary operating mode (see also section 6. All the hardware features of the unit may be controlled and varied via this interface.

Table 4 lists most of the available commands. A full ICD is available upon request that details the syntax of these operations. These commands are also available over USB and RS232 ports.

Table 4 GPIB Command List

*IDN?	; Query IEEE.488 Device ID String
ARMS	; Prepare simulation for run
BITE	; Query that returns ASCII string for Built in Test Equipment
COSW	; Switch PRN Code Off/On
EREF	; Select external reference frequency
EREF?	;Query that returns current reference signal setting
GPIB	; Specify the IEEE-488 bus Primary Address
HALT	; Halt simulation run
IDEN	; Query that returns Unit and Firmware details
SIGT	; Select GPS or SBAS mode
IPRG	; Specify Initial Pseudorange delay
NDSW	; Switch Data Message Off/On
LEVL	; Set signal level
LEVL?	; Query current signal level
MODE	; Set interactive or continuous mode
NSAV	; Load and save a data message template
NSEL	; Select a data message template
PFIL	; Select pre-defined Doppler profile
PROF	; Enable/Disable Doppler profiles
PROS	; Enact Doppler Profile using attached parameters
PRTY	; Enable/Disable Parity inversion
RSET	; Set the unit to its default power up state
RUNS	; Run (start) simulation
SNUM?	; Query that returns the units serial number
SG2D	; Select Satellite Identity or PRN code based on G2 delay
STAT	; Returns content of Serial Poll Status Register
SVID	; Select Satellite Identity or PRN code based on GPS/SBAS definitions
TIOP	; Select 1PPS output rule
TRIG	; Select external trigger mode

VCTY ; Set Doppler shift

WEEK ; Specify GPS Week number

WRTE ; Specify SBAS Data rate

ZCNT ; Specify simulated start time

5 SimCHAN SOFTWARE DESCRIPTION

The GSS6100 is supplied with a Microsoft Windows® 32-bit-compatible software package called SimCHAN, with the advantages of GUI displays and access to Multi-threading. SimCHAN communicates with the GSS6100 via the USB interface and is hence compatible with Windows98®, WindowsMe®, Windows2000® and WindowsXP®.

SimCHAN integrates the GPS and SBAS modes into a single application.

In GPS and SBAS modes the GSS6100 generates a data message based upon a message template stored in non-volatile memory. Any time related fields in the message are automatically inserted based on the start time specified. SBAS data is automatically forward error corrected. The stored template may be redefined via the USB port, using SimCHAN and a file stored on the PC.

5.1 SimCHAN Application Window

The application requires minimal familiarisation in order to be used effectively. All parameters are entered in engineering units and operator-entered parameters are checked to be within range. The software may be set to run in GPS or SBAS modes with the selected mode readily visible on a Toolbar control.

The application window allows all parameters to be entered and readily examined. Data entry is easily accomplished using either point and click techniques or keyboard shortcut keys. The form may be saved and re-loaded allowing a user to build sets of standard test cases and quickly switch between them.

A typical example of the application window for GPS and SBAS is provided in Figure 1, though minor differences may be apparent as product enhancements are made.

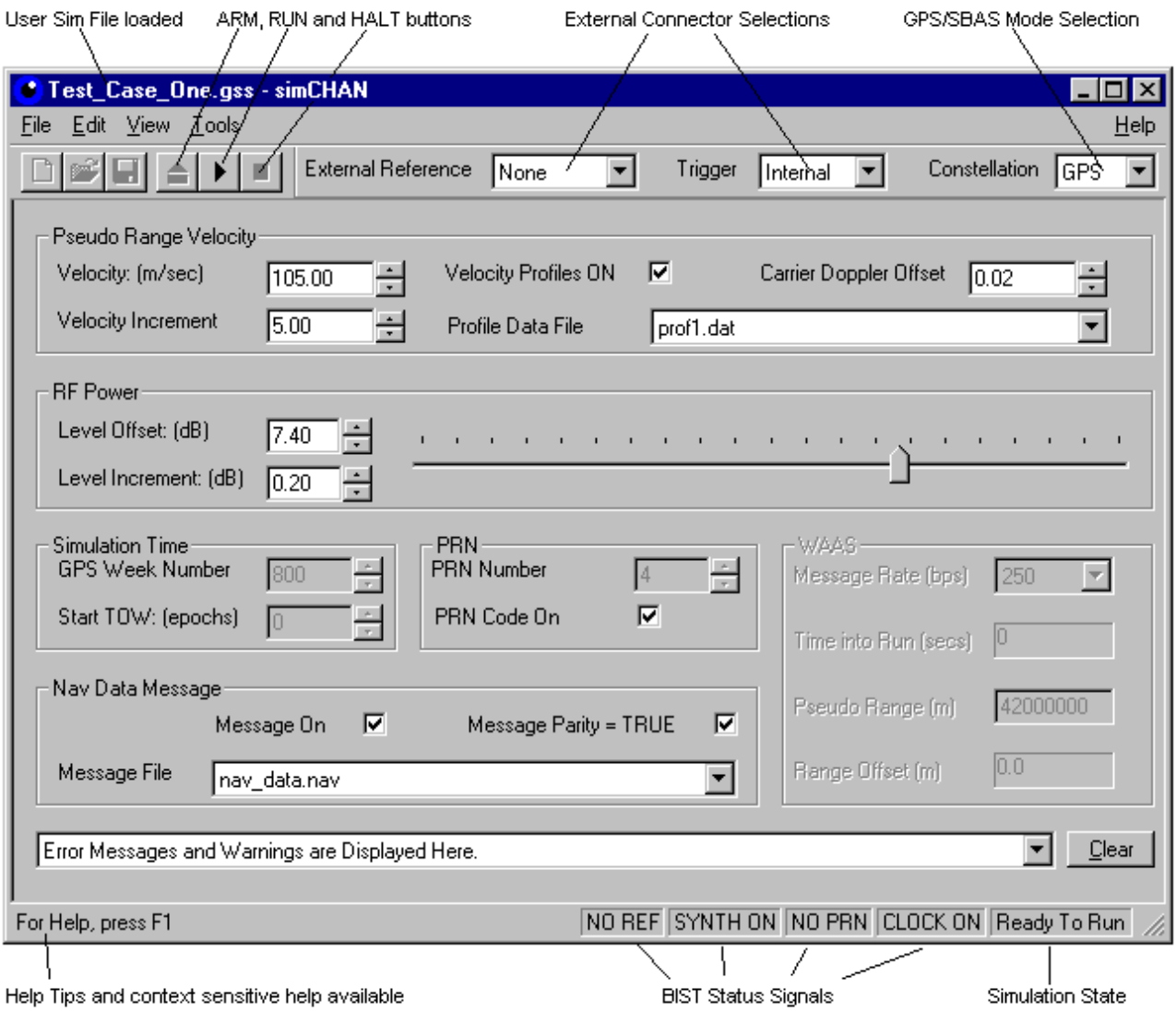

Figure 1: Typical Application Window from SimCHAN

The application runs as two threads. The data entry is the main thread and runs at normal priority. A second, hidden thread controls the hardware in real time and runs at a higher priority to ensure events are handled promptly. This allows the application to be running in the background whilst the PC is used to run other applications in the foreground.

All data entry parameters for both GPS and SBAS are shown in Table 5.

Table 5: Parameters

	GPS			SBAS (WAAS / EGNOS)		
Function Title	Range	Res[n]	Default	Range	Res[n]	Default
PRN Selection	1 to 37[2]	1	1	120 to 138[3]	1	120
Doppler Velocity (m/s)	-15000 to 15000	0.01	0	-15000 to 15000	0.01	0
Data Rate (bits/sec)	fixed		50	50,100, 200,250		250
Power Level	-20 to +20	0.1dB	20	-20 to +20	0.1dB	20
GPS Week Number	0 to 9999 modulo 1024	1	800			
C/A Code	On / Off		On	On / Off		On
Start TOW (epochs)	0 to 403199	4	0			
Data	On / Off		On	On / Off		On
Data Parity	True / False		True	True / False		True
Nav Data (from file)			nav_data.nav			waas_def.sbs
Ref Select	Internal / External		Internal	Internal / External		Internal
Velocity Profiles	On / Off		Off	On / Off		Off
External Trigger	Internal / External		Internal	Internal / External		Internal
Pseudorange (m)				0 to 99,999,999	1	38,700,000
Pseudorange Offset (m)				±9999	0.1	0
Carrier Doppler Offset (m/s)	±1000	0.01	0	±1000	0.01	0

5.2 DATA MESSAGE EDITING

Within both GPS and SBAS operating modes the user may fully define the respective data message. Both forms utilise ASCII data files to determine the message content template. A set of default message templates is supplied with SimCHAN. The GSS6100 stores the template in internal non-volatile memory, which may be overwritten with new content using SimCHAN.

5.2.1 GPS MODE

The GSS6100 internally calculates and appends all of the required data parity bits and also controls and inserts the Time of Week (TOW) and GPS week number. The user specifies TOW and GPS week number at the start of the test run, via GPIB or SimCHAN.

Satellite health data within the navigation data message is automatically calculated to reflect the selected PRN.

[2] Other PRN codes may be specified for fixed G1 and variable G2 delay.

5.2.2 SBAS MODE

The GSS6100 software calculates and appends CRC parity information bits to the required user defined data. This data is encoded into data symbols by the appropriate half-rate, convolutional forward error correction (FEC) algorithm. Both the parity and FEC operations are transparent to the user.

Appendix A shows a list of supported SBAS messages types.

5.3 DYNAMIC DOPPLER VELOCITY PROFILES

It is possible to generate dynamic Doppler velocity test patterns with the GSS6100 and SimCHAN. This allows testing of GPS/SBAS receiving equipment under varying conditions of acceleration and jerk.

The dynamic Doppler patterns defined in ICD-GPS-204 reference (a) are provided for standard GPS Receiver tests. These velocity profiles are selected from a set of pre-defined data files. The files are defined in the following terms:

Maximum Jerk	(range ±100 m/s^3)
Maximum Acceleration	(range ±100 m/s^2)
Period of constant acceleration	(range 0 to 540 s)
Period of constant velocity	(range 0 to 540 s)

A utility is provided that allows users to create their own profiles and is selected from the Tools menu.

6 ALTERNATIVE OPERATING MODE

The GSS6100 may be operated in an Alternative mode to that described in sections 4 and 5.

The Alternative mode provides a pre-defined GPS signal to be broadcast whenever the unit is powered up. The current mode is retained in non-volatile memory.

The user may issue a MODE2 bus command to enable the ‘Alternative’ mode, or the mode can be enabled and specified via the SimCHAN application software. The PRN, power level, Doppler and code selection settings may be defined via the SimCHAN ‘Tools’ menu or via the MODE2 command string.

During MODE2, all bus commands other than the MODE command are ignored.

The default MODE1 command can be used to restore the ‘Primary’ interactive operating mode.

7 SPECIFICATIONS SUMMARY

Parameter	Comments	Value	Units
Nominal carrier Frequency	L1	1575.42	MHz
Velocity Range	Relative Velocity Relative Frequency	± 15,000 ± 78.8255	m/s kHz
Velocity resolution		0.01	m/s
Master clock stability (internal)	Over temperature range Over one day (24 hours warm up) Over one year, continuous	$< \pm 2x10^{-8}$ $< \pm 1x10^{-9}$ $< \pm 1x10^{-7}$	
Unmodulated spectral Purity	Referred to the unmodulated carrier level, max in band spurious signals	< -30	dBc
Harmonics	Referred to unmodulated carrier	< -40	dBc
Phase Noise close to Carrier	Integrated phase noise, 10Hz to 10kHz offset from carrier	< 0.1	rad RMS
Maximum RF Signal Level	Primary port	-110	dBm
Maximum RF Signal Level	Secondary port (used for calibration or monitor)	- 50 (Typical)	dBm
Dynamic Range		40	dB
Power Control Resolution		0.1	dB
Power Control Linearity		± 0.5	dB
Power Control Accuracy		± 1.0 ± 2.0	dB RSS dB 3σ
Maximum Acceleration	(for velocity profiles)	100	m/s^2
Maximum Jerk	(for velocity profiles)	100	m/s^3
External Reference Frequency		10, 5, 1	MHz
External Reference Level	5 or 10MHz 1MHz	-5 to +10 (sine or square wave) 0 to +10 (square wave)	dBm dBm
External Trigger	To control start of simulation Active high	>2	μs pulse
1PPS Input	TTL, 50 ohm, Active high	>2	μs pulse
1PPS OUT to RF Delay	Timing Uncertainty between a rising transition on 1PPS OUT port and its corresponding event on the RF Primary Ports.	0 ± 5	nsecs 1σ (RSS) ref: 1PPS OUT 1.5v into 50 ohm

8 ENVIRONMENTAL

8.1 PHYSICAL AND ELECTRICAL

Dimensions, nominal	449 mm x 386 mm x 89 mm (W x D x H) (17.75 inch x 15.25 inch x 3.5 inch)
Weight Signal Generator (approx)	Approx. 6 kg (Approx. 13.2 lb)
Temperature Operating Temperature Humidity Storage Temperature Humidity	 +10°C to + 40°C (50°F to 104°F) 40 to 90% RH (non-condensing) -40°C to + 60°C (-40°F to 140°F) 20 to 90% RH (non-condensing)
Electrical Voltage (ac) Power Consumption Frequency	 100 to 120 V, 206 to 264 V ac (auto sensed) <70 W 48 to 62 Hz

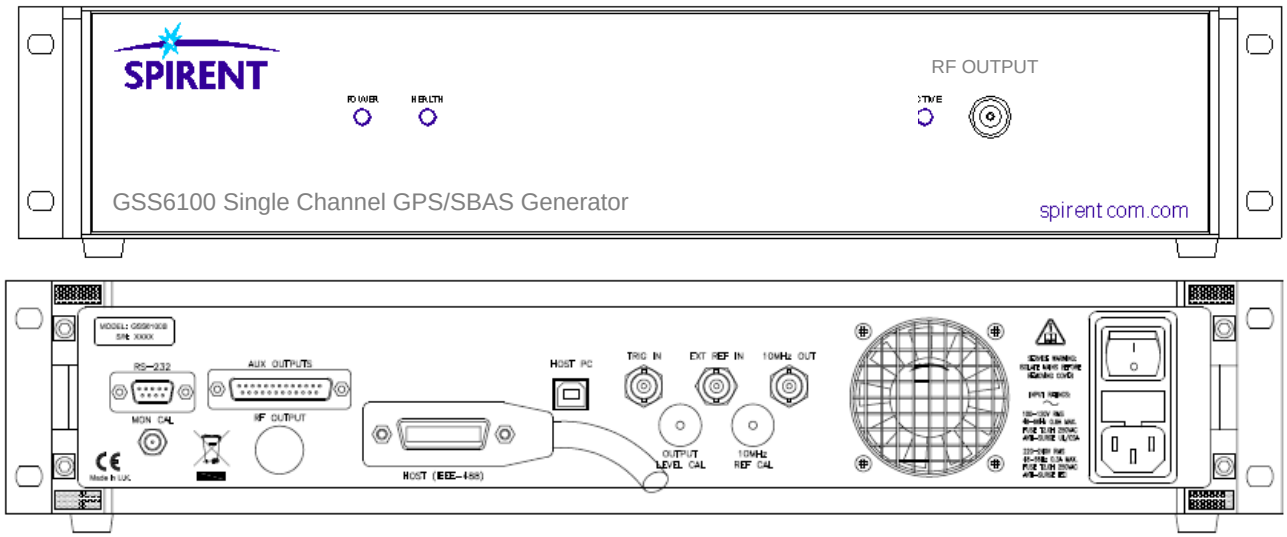

Figure 2 Typical Front/Rear Panel Layout

8.2 SAFETY AND EMC CONFORMITY

The GSS6100 complies with the Low Voltage Directive 73/23/EEC by application of the harmonised standard EN60950.

The GSS6100 complies with the EEC EMC Directive 89/336/EEC by application of the following harmonised standard:

EN61326-1 Electrical Equipment for Measurement, Control and Laboratory Use – EMC Requirements.

9 DELIVERABLES

ITEM	DESCRIPTION
1	GSS6100 Signal Generator.
2	USB cable (for use with SimCHAN software)
3	Power cable (Country specific)
4	CD-ROM Containing: - SimCHAN software for Windows98SE®, WindowsMe® or Windows2000/XP GSS6100 user manual Default GPS navigation data file Default correction files for SBAS Example files for velocity profiles

APPENDIX A - SBAS MESSAGES

See reference (b) for message definitions.

TYPE	CONTENTS
0	Do not use this signal for anything (for SBAS testing only)
1	PRN Mask Assignments, set up to 52 of 210 bits
2 to 5	Fast corrections
6	Integrity Information
7	Fast correction degradation factor
8	Reserved for future message
9	GEO navigation message (X,Y,Z, time etc)
10	Degradation Parameters
11	Reserved for future message
12	SBAS Network Time / UTC Offset parameters
13-16	Reserved for future messages
17	GEO satellite almanacs
18	Ionospheric grid point masks
19 to 23	Reserved for future messages
24	Mixed fast corrections / long term satellite error corrections
25	Long term satellite error corrections
26	Ionospheric delay corrections
27	SBAS service message
28-61	Reserved for future messages
62	Internal Test Message
63	Null message

Note: These messages are in accordance with Revision A of the referenced document. Provided the FEC and CRC and other fundamental structures remain unaltered in later revisions, any message type is supported through definition of the actual data content directly in hexadecimal format.