Welnavigate, Inc
GS-100 Instruction Guide
L1 C/A CODE GPS SIMULATOR
Rev. D, Jan 2002

GS-100: GPS SATELLITE SIMULATOR

INTRODUCTION

Welnavigate is pleased to provide you with the GS-100, a single channel GPS satellite simulator. This unit has been designed to provide a low-cost and effective method of testing GPS receiver hardware. Generating the L_1 C/A code signal, the GS-100 will allow you to emulate the 37 pseudo-random codes as specified in ICD-GPS-200B (the spec manual for all GPS signal and data format), with the ability to control doppler, code, and data, a diverse signal can be sent continuously to the receiver. This allows the user to create conditions attainable and unattainable in the real world, but more importantly, repeat them consistently.

FRONT PANEL AND OPERATION

1) Plug the unit into AC power. 110 or 220 volts - auto detecting circuit.

2) Turn the front panel power switch "ON".

3) Allow the unit to warm-up for 30 minutes.

4) On the GS-100, power level is controlled by the **FRONT PANEL ATTENUATOR DIALS**. By setting these dials to the correct attenuation signal strength from -60 dbm to -140 dbm can be obtained. Typically, a setting of 65 db on the attenuator dials (which translates to signal strength of -125 dbm) is acceptable for most GPS receivers. To determine signal strength subtract the attenuator settings from -60 dbm and the resulting number is the signal strength generated by the GS-100.

Attenuation	Signal Strength
0 db	-60 dbm
10 db	-70 dbm
20 db	-80 dbm
30 db	-90 dbm
40 db	-100 dbm
50 db	-110 dbm
60 db	-120 dbm
70 db	-130 dbm
80 db	-140 dbm

5) Select the desired satellite using the **SATELLITE I.D. SWITCH**. Any of the 1 thru 37 pseudo-random codes can be chosen.

6) To prompt code modulation (the pseudo-random code that is specific to a single satellite) onto the L_1 signal, turn the **CODE SWITCH** to the "ON" position.

7) If data modulation is required, turn the **DATA SWITCH** to the "ON" position. The satellite ID should be set to any satellite ID between 1-37. 12.5 minutes of data is stored within the GS-100. This data repeats continuously once activated.

8) If doppler shift is desired, turn the **DOPPLER SWITCH** to the "+" or "-" position; using the **DOPPLER CONTROL KNOB**, zero doppler is to the extreme counterclockwise position. The DOPPLER switch has three settings:

"+" = plus 5 KHz from the center frequency of 163.68 MHz.

"-" = minus 5 KHz from the center frequency of 163.68 MHz.

"Off" = no doppler offset.

9) Connect the GPS receiver to the **RF OUTPUT** using a standard N-type connector. Have the GPS receiver search for the center frequency being generated by the GS-100. It is important to note that the data is repeated every thirty seconds and depending on the GPS receiver's software it may decided to search for a satellite different then specified by the GS-100.

CAUTION: IF THERE IS DC POWER ON THE ANTENNA FROM THE GPS RECEIVER (i.e., ACTIVE ANTENNA) A DC BLOCK IS REQUIRED.

BACK PANEL INPUT AND OUTPUT CONNECTORS

The GS-100 has a number of Input and Output connectors that allow the user to monitor and control the signals that are derived from the unit. Starting with the top row of connectors, going left to right (see diagram, GS-100 REAR PANEL):

1) ***10.23 MHz OUTPUT***: Allows the user to monitor the signal provided by the internal crystal oscillator. A counter is required to measure signal.

2) ***IF 163.68 MHz***: The Intermediate Frequency Carrier allows the user to monitor the carrier frequency before its upconversion to the L_1 frequency. Spectrum analyzer and a counter is required to measure frequency.

3) ***C/A CHIP RATE 1.023 MHz***: The 1.023 MHz rate at which the pseudo-random code is being sent by the GS-100.

4) ***DATA RATE***: The 50 Hz rate at which the almanac and ephemeris data is being sent.

5) ***C/A CODE***: Allows the user to monitor the pseudo-random code that is specific for each satellite. The pseudo-random code is chosen from the front panel satellite ID switch. 1 thru 37 satellite codes are identified by the GS-100.

6) ***C/A EPOCH***: The 1 KHz start signal that marks the boundary at which the pseudo random code repeats every 1 millisecond.

7) ***DATA SYN***: Short for DATA SYNCHRONIZATION. This connector will allow the user to start and stop the 12.5 minutes of repeating data being sent from the GS-100. To operate this feature the DATA SWITCH on the front panel must be off. Second, the user must place +5 volts (TTL) on the center pin this will start the data. When the +5 volts is removed the data will stop.

8) ***CODE SYN***: Short for CODE SYNCHRONIZATION. This connector will allow the user to start and stop the pseudo-random as specified by the satellite ID switch on the front panel. To operate this feature the CODE SWITCH on the front panel must be off. Second, the user must place +5 volts (TTL) on the center pin this will start the data on the next 1.023 rise time.

9) ***DOPPLER FREQ. MONITOR***: Allows the user to monitor the doppler signal being generated by the GS-100. With the doppler switch at the ON position, turn the DOPPLER CONTROL KNOB on the front panel (4 to 5 turns clockwise) until a reading registers on a frequency counter. Range is $\pm$ 5 KHz.

10) ***DATA OUTPUT***: This connector allows the user to monitor the 12.5 minutes of repeating almanac data being sent by the GS-100.

ALMANAC

The GPS almanac stored within the EPROM of this unit is repeated EVERY 12.5 minutes. The below is a PORTION of the GPS almanac and represents the first 5 sub-frames of the standard 12.5 minute almanac broadcasted by the GPS satellites. The following is a partial listing of the almanac data stored within the GS-100.

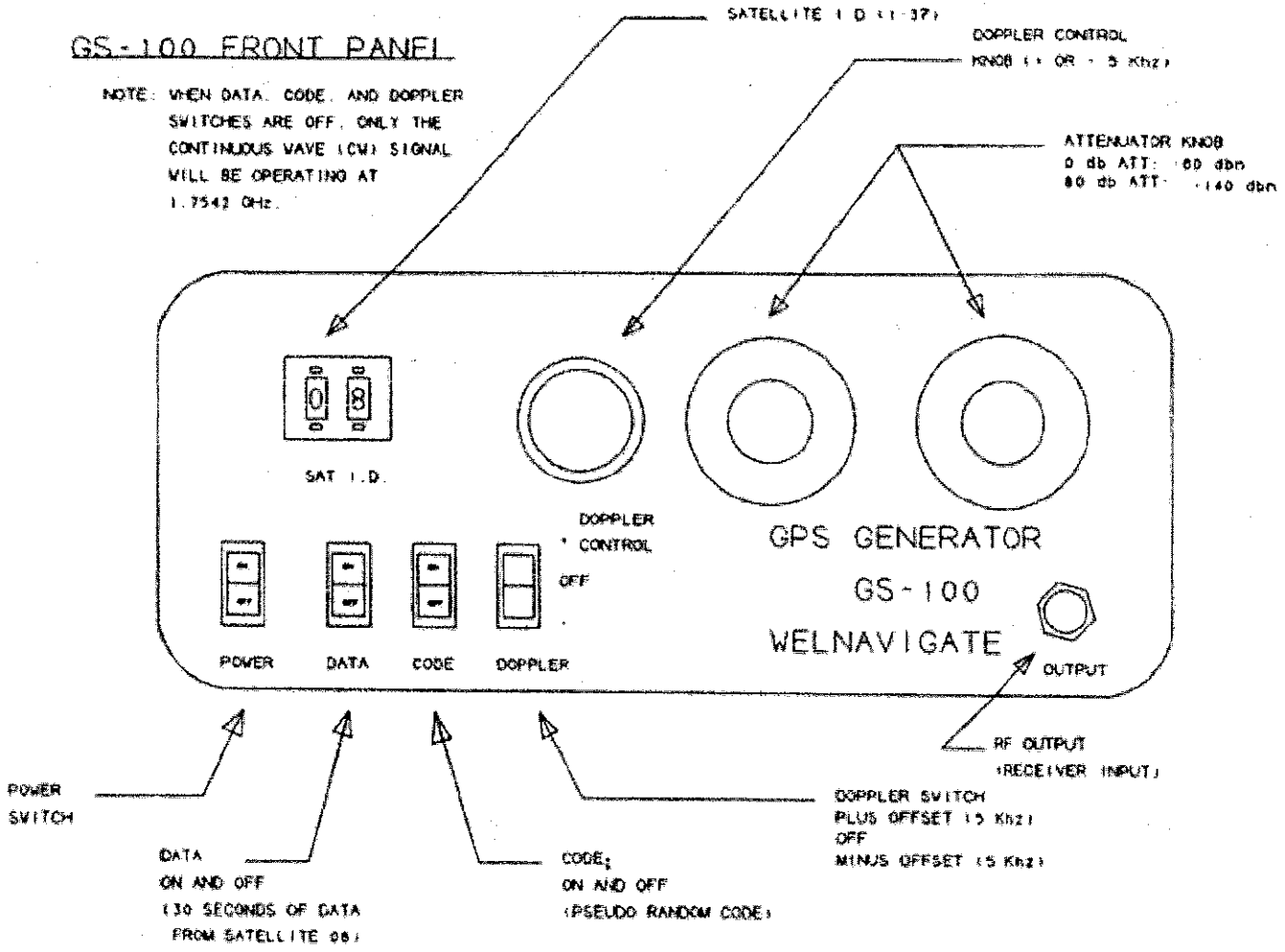
```
_$A0000.
8B,00,03,90,00,01,92,0A,49,00,06,7F,FF,FF,D6,00,
00,00,A7,FF,FF,FD,60,00,00,0A,7E,3A,11,12,00,FF,
60,F5,69,62,3B,08,B0,00,39,00,00,4A,A4,07,00,00,
80,00,01,22,42,CE,0E,C9,80,00,01,87,83,6F,FF,2F,
FF,FD,79,3F,2B,BF,FD,FA,11,2A,F4,8B,00,03,90,00,
06,B2,C0,00,04,67,1F,DC,02,D6,00,00,2D,FA,50,D9,
9D,60,00,06,7F,F6,C7,7F,F9,00,43,5F,48,1C,00,0A,
C8,B0,00,39,00,00,8C,DC,79,00,00,C7,FF,FF,FD,60,
```

APPENDIX ONE, WAAS

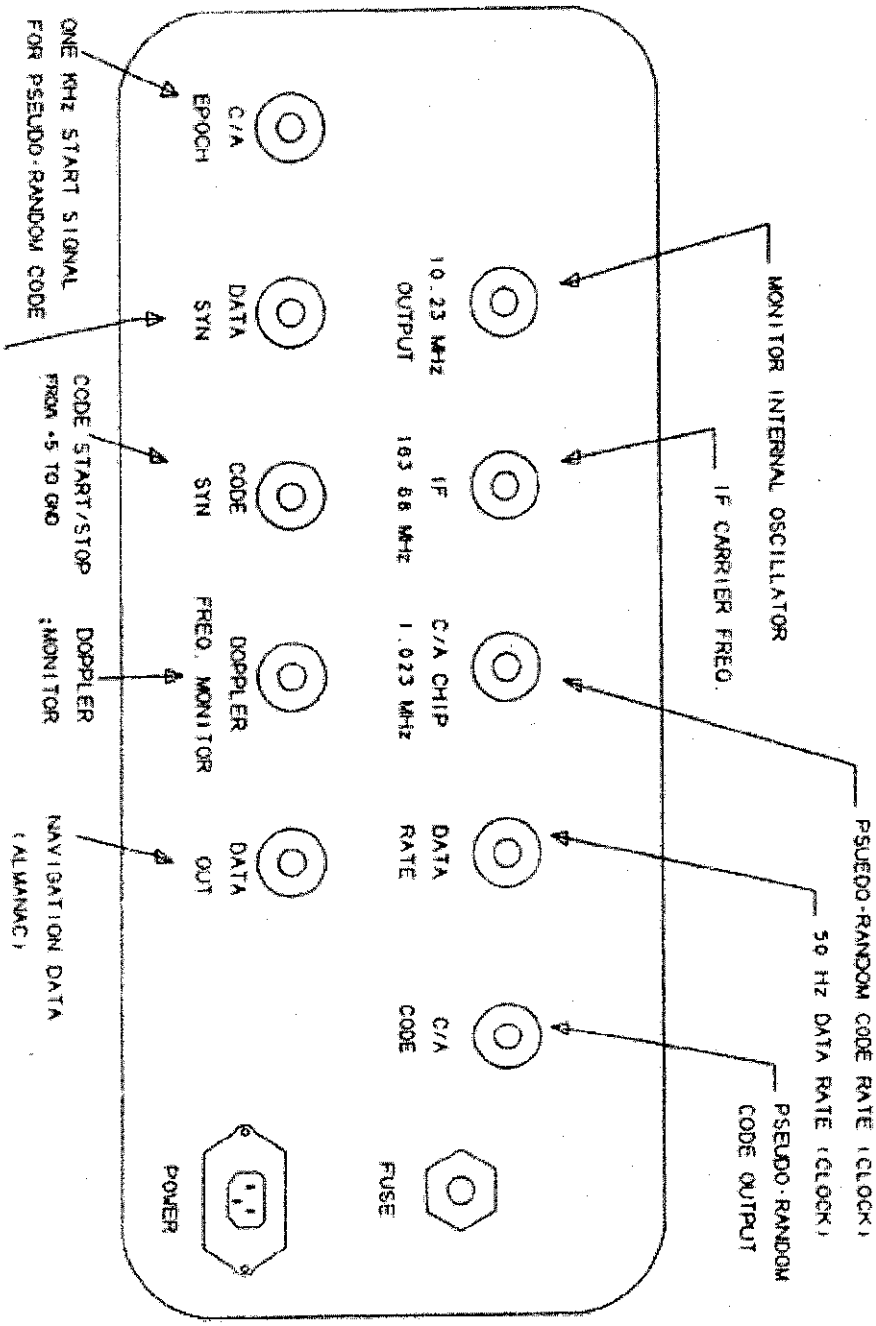
The GS100W is an upgraded version of the basic GS100 that has the capability to generate a RF signal that corresponds to the WAAS (wide area augmentation system) signal. This unit can generate a RF signal at the center frequency with data modulated onto the signal that matches the GPS and WAAS specifications; either signal can be selected through the front panel.

Like the GS100, this unit outputs the modulated data stream via BNC connectors on the back panel, and will allow the end user to compare what the GPS receiver decodes on a scope.

FRONT PANEL ID	WAAS ID
40	120
41	121
42	122
43	123
44	124
45	125
46	126
47	127
48	128
49	129
50	130
51	131
52	132
53	133
54	134
55	135
56	136
57	137
58	138


GS-100 FRONT PANEL
NOTE: WHEN DATA, CODE, AND DOPPLER SWITCHES ARE OFF, ONLY THE CONTINUOUS WAVE (CW) SIGNAL WILL BE OPERATING AT 1.7542 GHz.
SATELLITE I.D. (1-37)
DOPPLER CONTROL KNOB (+ OR - 5 Khz)
ATTENUATOR KNOB
0 db ATT: -60 dbm
80 db ATT: -140 dbm
SAT I.D.
DOPPLER CONTROL
OFF
GPS GENERATOR
GS-100
WELNAVIGATE
POWER
DATA
CODE
DOPPLER
OUTPUT
RF OUTPUT (RECEIVER INPUT)
POWER SWITCH
DATA ON AND OFF (30 SECONDS OF DATA FROM SATELLITE 08)
CODE; ON AND OFF (PSEUDO RANDOM CODE)
DOPPLER SWITCH PLUS OFFSET (5 Khz) OFF MINUS OFFSET (5 Khz)

GS-100 REAR PANEL



LIMITED WARRANTY

Welnavigate warrants to the original purchaser of this GPS satellite simulator product that the material used to produce this product be free from defect in material and workmanship for one year from date of purchase. In no event will Welnavigate be liable for special, incidental or consequential damage resulting from possession, use or malfunction of this product.

If this device is found defective within one year of purchase, Welnavigate agrees to repair, free of charge, any such product upon receipt at its Oxnard facility. This warranty is limited to the material used to produce this product. This warranty shall not be applicable and shall be void if the defect has arisen through abuse, mistreatment or neglect.

WELNAVIGATE, INC

GS-100 STATIC GPS SATELLITE SIMULATOR FUNCTIONALITY TEST

May 1991 (2001)

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1.0 Scope

This document describes the acceptance test plan for the GPS static simulator, GS-100, developed by Welnavigate Inc. This plan describes the method by which Welnavigate Inc verifies the functionality of each unit.

2.0 Applicable Documents

This functionality test plan references the following applicable documents:

Reference 1. System specification for the NAVSTAR Global Positioning System; ICD-GPS-200B, March 1988.

Reference 2. GS-100 brochure, 1990

3.0 Test Requirements

3.1 General Requirements

Functionality testing of the GS-100 will be conducted at Welnavigate's Simi Valley facility. Commercial test equipment will be available to support the testing.

3.1.1 Test Failure/Anomaly

Anomalous performance of the GS-100 exceeding the specification as described in Ref.1 and Ref.2 constitutes a test failure.

Failure action will be as follows: Cause of failure determined. Corrective action taken. Resume testing.

3.1.2 Test Sequence

Functionality testing of the GS-100 will consist of the following sequence:

-Reference frequency test
-IF test
-Doppler test
-Power level test
-Code and modulation test
-Code chip rate test
-C/A epoch test
-Verify SV identification

3.1.3 Signal requirements

The following table summarizes the performance requirements of the GS-100.

OUTPUT SIGNALS

RF L_1: 1575.42 MHz
IF : 112.53 Mhz (Prior to 1997: 163.68MHz)
C/A: 1.023 MHz CHIP RATE (TTL)
CLOCK: 10.23 MHz (TTL)
DATA RATE AND BIT STREAM (TTL)
DOPPLER FREQ. (TTL)
C/A EPOCH 1 KHz (TTL)

INPUT SIGNALS

C/A CODE SYNC. (TTL)
DATA SYNC. (TTL)
EXT 10.23 MHz (TTL)

3.2 Physical Characteristics

The GS-100 consists of one L_1 RF signal generator.
The functionality test will be conducted under the following ambient conditions:

Temp: 25 to $\pm 10^{o}$ C
Atom: 725 $\pm$ 50, -75mm HG
Humd: 50 $\pm$ 30 %

3.3 Commercial Test Equipment

Oscilloscope
Spectrum Analyzer
Frequency Counter

4.0 Test Procedure

This test will be performed with the use of the commercial test equipment described in section 3.3.

1.
The GS-100 will be powered up and allowed to warm-up for a period of at least 30 minutes.

2.
The reference frequency being generated by the internal crystal oscillator will be monitored with a frequency counter to ensure a frequency of 10,230,000 $\pm$ 2 Hz is being provided through the 10.23 MHz output connector.

3.
The IF will be monitored with a frequency counter to ensure a signal of 112,530,000 $\pm$ 22Hz (Prior to 1997: 163,680,000 $\pm$ 32 Hz) is being generated. Once the intermediate frequency is established, a doppler offset of $\pm$5 KHz (from the center frequency of 112.53 Mhz or 163.68 MHz) will be enabled and monitored by the following steps:

A) Front panel doppler switch to "+", and turn doppler control knob.
   i) The frequency counter should measure a signal of 112.53 Mhz (or 163.68MHz) plus 5KHz

B) Front panel doppler switch to "-", and turn doppler control knob.
   i) The frequency counter should measure a signal of 112.53 Mhz (or 163.68mhz) minus 5Khz

4.
Set the GS-100 to output a signal of 1575.42 MHz. A spectrum analyzer with a calibrated input will be used to monitor the signal being generated through the RF L_1 connector.

5.
Connect spectrum analyzer to the L_1 RF output. Set the attenuator control knobs to ZERO, the L_1 RF output from the GS-100 should be -60dbm $\pm$ 2 db.

6.
Connect spectrum analyzer to the L_1 RF output. Turn the code switch to "ON". Monitor the signal from the GS-100 to ensure a SINX/X spectrum is shown on the spectrum analyzer.

7.
Connect the frequency counter to the C/A code chip rate output on the rear panel. Monitor the signal to ensure a frequency of 1,023,000 $\pm$ 2 Hz (with zero doppler and TTL signal level output).

8.
Connect the oscilloscope to the C/A epoch output on the rear panel. Monitor the signal to ensure an one KHz pulse wave is being generated. (TTL signal level)

9.
Connect the oscilloscope to the C/A epoch output connector on the rear panel, this signal will be used as a trigger. Connect the second channel on the oscilloscope to the C/A code output on the rear panel. Using the front panel thumb wheel switch, select SV# 01. Verify wave pattern using figure 1. Repeat for SV# 3,5,6,9,12,24,29,32.

Appendix One: Power adjustment

Equipment required: Spectrum Analyzer (must have calibrated output), & DC block.

Procedure

1) Remove top cover by loosening the six screws located on the bottom recess holes of the GS-100.

2) Within the GS-100 there is an internal shielded box with an access hole. Within the access hole the power adjustment control can be seen.

3) Turn the unit ON and allow for 30 minutes warm-up.

4) To monitor the power level of the GS-100, set the attenuation knobs to a setting of zero/zero. Connect a spectrum analyzer to the front panel N-connector. If the receiver sends voltage to the antenna use a DC block.

5) Using a small screwdriver adjust the power adjustment control (variable potentiometer) until the power level reads -60 dbm $\pm$ 1db @ zero/zero.

<end of appendix>