

**MS3055**



**GSS7765 INTERFERENCE SIMULATION SYSTEM (ISS)  
PRODUCT SPECIFICATION**

**ABSTRACT**

This document specifies the nature and performance of a system that integrates commercial signal generators with Spirent simulators to model a satellite navigation environment that includes RF interference.

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**TABLE OF CONTENTS**

1	GENERAL .....	5
1.1	SCOPE & APPLICABILITY .....	5
1.2	GLOSSARY OF TERMS .....	5
1.3	REFERENCED DOCUMENTS .....	5
2	INTRODUCTION .....	6
3	OPERATING MODES .....	8
3.1	FIXED LEVEL MODE .....	8
3.2	MODELLED MODE .....	9
4	COTS SIGNAL GENERATOR .....	9
5	TECHNICAL PERFORMANCE .....	10
5.1	CW INTERFERENCE .....	10
5.1.1	SIGNAL TYPE .....	10
5.1.2	FREQUENCY .....	10
5.1.3	SPECTRAL PURITY .....	10
5.2	SWEPT CW INTERFERENCE .....	10
5.2.1	SIGNAL TYPE .....	10
5.3	STEPPED CW INTERFERENCE .....	10
5.3.1	SIGNAL TYPE .....	10
5.4	AM INTERFERENCE .....	11
5.5	FM INTERFERENCE .....	11
5.6	NOISE INTERFERENCE .....	11
5.7	PULSE MODULATION .....	12
5.8	RF LEVEL (PER SOURCE) FROM ICU OUTPUT .....	12
5.9	EXTERNAL FREQUENCY STANDARDS .....	12
6	OPERATIONAL PERFORMANCE .....	13
6.1	PHYSICAL FORM .....	13
6.2	ENVIRONMENTAL .....	13
7	DELIVERABLES .....	14
	APPENDIX A MORE COMPLEX SYSTEMS EMPLOYING THE GSS7765 .....	15
	APPENDIX B SIGNAL GENERATOR PROCUREMENT DETAILS .....	17
B.1	SIGNAL GENERATOR PROCUREMENT DETAILS .....	17
B.1.1	MANUFACTURER .....	17
B.1.2	SIGNAL GENERATOR DESCRIPTION .....	17
B.1.3	PRODUCT CODE .....	17
B.1.4	OPTIONS .....	17
B.2	SOFTWARE LICENCE KEY (REQUIRED) .....	17

**LIST OF FIGURES AND TABLES**

Figure 1 Base-line Single Interferer, Single Antenna Configuration (Controller not shown).....6  
Figure 2 Interference Combiner Unit (ICU).....7  
Figure 3 AWGN bandwidth up to 48 MHz .....9  
Figure 4 Differential Configuration with 4 Interference Sources ..... 15  
Figure 5 Differential Multiple GNSS Carrier Configuration ..... 16  
Table 1 Supported Signal Generator Types .....8

## 1 GENERAL

### 1.1 SCOPE & APPLICABILITY

The information contained in this document shall be the sole source of technical performance specification for contractual purposes in relation to the GSS7765 Interference Simulation System.

### 1.2 GLOSSARY OF TERMS

AM	Amplitude Modulation
AWGN	Additive white Gaussian noise
COTS	Commercial-Off-The-Shelf
CW	Continuous Wave (i.e. unmodulated)
FM	Frequency Modulation
GPS	Global Positioning System
ICU	Interference Combiner Unit
IP	Interplex code
ISS	Interference Simulation System
L1	GPS L1 Centre Frequency @ 1575.42 MHz
L2	GPS L2 Centre Frequency @ 1227.6 MHz
L5	GPS L5 Centre Frequency @ 1176.45 MHz
NON-COHERENT	Signals with no definable phase relationship
RF	Radio Frequency
GPIO	IEEE-488 General Purpose Interface Bus
I/S	Interference-to-signal ratio, usually expressed in dB
SatNav	satellite navigation, for example GPS or GLONASS
Source	RF signal generator producing one carrier with or without modulation.
SV	Satellite Vehicle, the navigation satellite being simulated

### 1.3 REFERENCED DOCUMENTS

Latest Issue unless otherwise stated.

- (a) MS3003 GSS6560 GPS/SBAS Multi-Channel Simulator Product Specification
- (b) MS3006 STR4760 GPS/SBAS Multi-Channel Simulator Product Specification
- (c) MS3007 GSS4750 GPS L5 Multi-Channel Simulator Product Specification
- (d) MS3009 STR4780 GLONASS Multi-Channel Simulator Product Specification
- (e) MS3010 STR4790 Multi-Output GPS Simulator Product Specification
- (f) MS3017 GSS7700 GPS/SBAS Multi-Channel Simulator (including M-Noise) Product Specification
- (g) MS3047 GSS7800 GNSS Multi-Channel Simulator Product Specification
- (h) MS3040 GSS7900 Multi-Channel GPS\_Galileo Simulator Product Specification
- (i) MS3025 GSS7790 Multi-Output GPS Simulator Product Specification
- (j) MS3008 SimGEN for Windows Product Specification
- (k) MS3015 SimREMOTE Remote Control Product Specification
- (l) MS3026 GSS4765 Interference Simulation System Product Specification
- (m) MS3057 GSS8000 series – Datasheet Specification (Latest Issue)
- (n) MS3058 GSS8700 Advanced GPS Simulator Specification (Latest Issue)
- (o) MS3067 GSS6700 with SimGEN Datasheet (Latest Issue)

## 2 INTRODUCTION

The GSS7765 Interference Simulation System (ISS) is an architecture that fully integrates commercial-off-the-shelf (COTS) signal generators as interference sources with Spirent SimGEN-based satellite navigation simulators, such as the GSS8000/8700, GSS7700, GSS7800, GSS6700, GSS6560, STR4760 and STR4780. A full list of supported generators is given in Table 1.



**Figure 1 Base-line Single Interferer, Single Antenna Configuration  
(Controller not shown)**

The ISS is designed for testing interference immunity of SatNav receiver equipment in a simulated environment.

Currently, up to 4 COTS signal generators may be controlled via GPIB from the simulator's SimGEN host computer. The interference signal is defined, along with all the other scenario parameters, from within the SimGEN for Windows GUI environment.

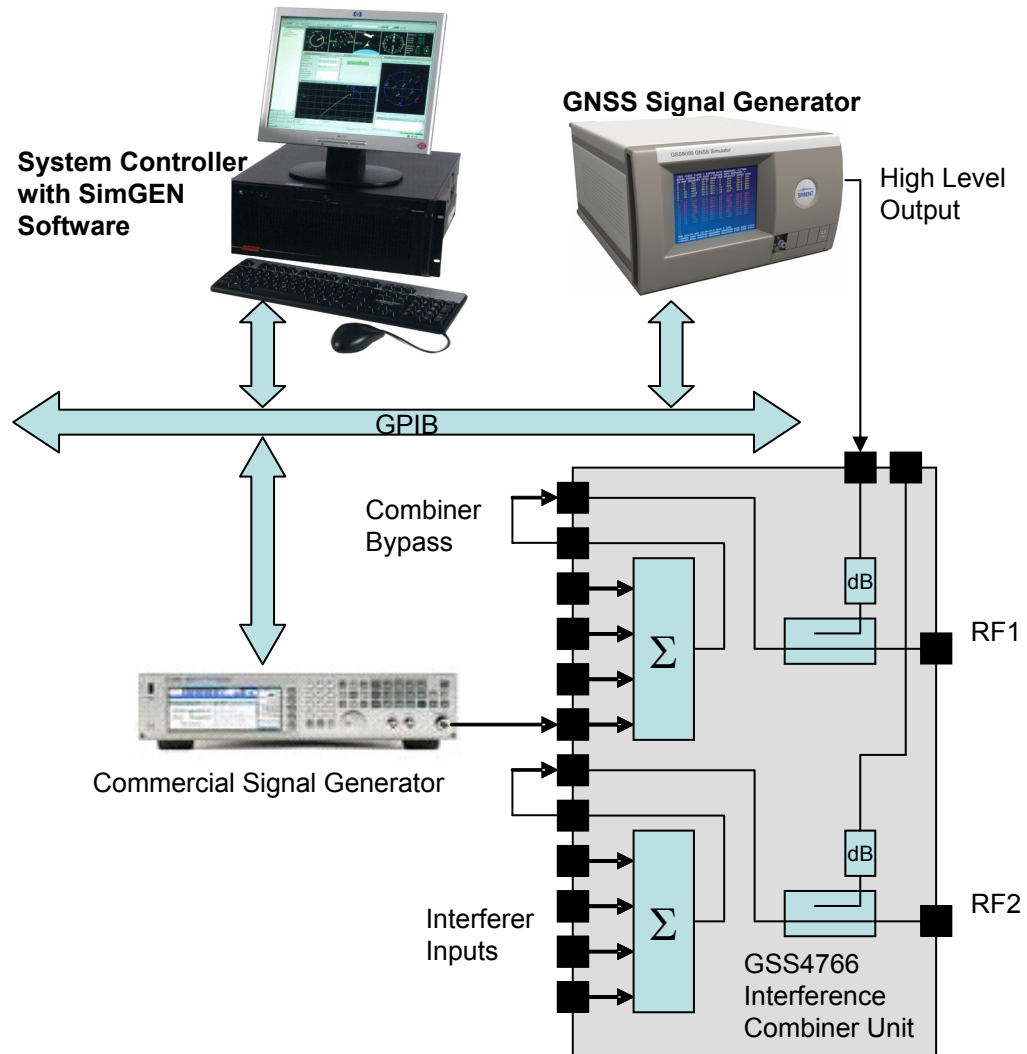
The **GSS7765** supports CW, swept CW, stepped CW, pulsed CW, AM and FM. The unit can also supply band-limited white Gaussian noise with a maximum bandwidth of up to 48 MHz.

Each interference source can operate independently using either fixed or modelled level (see section 3). It can be programmed to have any of the interference types and characteristics described in Section 5 of this specification.

Each signal generator produces one signal. This means that two sources would be required to generate noise at GPS L1 and L2 frequencies simultaneously, for example.

The GSS7765 Interference Simulation System supersedes the GSS4765 Interference Simulation System. See Ref (I) for details of the GSS4765 that has been replaced by the GSS7765.

The RF outputs are combined with the SatNav signals in the GSS4766 Interference Combiner Unit (ICU), (see Figure 2) which is a calibrated unit, manufactured by Spirent. The ICU has two outputs, to support differential systems. Each output is the combination of up to four Interferer inputs and one SatNav input. The four-way combiner in the ICU may be optionally bypassed when only one source is required, reducing the insertion loss and increasing the I/S ratio available. For simulation systems with more than two antenna outputs, ICU units can be combined as necessary.



**Figure 2 Interference Combiner Unit (ICU)**

The ISS has a flexible architecture and supports a wide range of options, from single-source/single-antenna to complex interference for multiple antennas. For examples of more complex applications of the GSS7765, see APPENDIX A.

The ISS is controlled via SimGEN software, reference (j), supplied with the compatible Spirent Simulators listed in Table 1. Alternatively, the user may directly control ISS sources independently either via their front panel controls or from a separate GPIB controller using their native command set.

**Table 1 Supported Signal Generator Types**

Model	Description	Spec reference	Comment
GSS6560	GPS/SBAS Simulator (L1)	(a)	C/A-code
GSS6700	GNSS Simulator (L1)	(o)	GPS, GLONASS, Galileo Commercial
GSS8000 Series	GNSS Simulator	(m)	All GPS, Galileo GLONASS L1/L2
GSS8700	GPS Simulator	(n)	L1/L2 all signals
GSS7700 Series	GPS/SBAS Simulator (L1, L2, L5)	(f)	With M-noise/M-code
GSS7800 Series	Galileo Simulator (L1, E5, E6)	(g)	
GSS7900 Series	GPS + Galileo simulator	(h)	
GSS4760	GPS/SBAS Simulator (L1, L2)	(b)	C/A, P(Y), L2C
GSS4750	GPS Simulator L5	(c)	
GSS4780	GLONASS Simulator	(d)	
STR4790/GSS7790	GPS/SBAS Simulator (L1, L2) Multi-Output	(i)	Normally combined port only

### 3 OPERATING MODES

Signals are generated under control of SimGEN running on the GPS Simulator PC controller.

SimGEN provides the following functionality for each interference channel:

- Interference type and characteristics (e.g. CW or FM, Centre Frequency, etc.)
- Fixed Interferer Position (Latitude, Longitude, Altitude)
- Interferer Initial or base RF Power Level. (The Interferer is assumed to transmit from an omni-directional antenna).
- Programmable Interferer 'ON' and 'OFF' periods

The Interference type and/or characteristics may be changed during the scenario using a file containing a time ordered script of events. The characteristics can be set to any value described in section 5.

The output level is further controlled by the specified operating mode, FIXED or MODELLED, as described in paragraphs 3.1 and 3.2

The operating mode can change as required during the scenario.

Both of the operating modes are compatible with operation from the SimREMOTE remote control option, reference (k).<sup>1</sup>

#### 3.1 FIXED LEVEL MODE

In fixed level mode the interferer power is set by an explicit user command and does not change. It is the default mode where a time-ordered script file controls the RF power level.

The power level is maintained until commanded to change by the script and is independent of any other scenario elements such as simulated vehicle motion and modelling of the receiver's reception antenna gain pattern.

<sup>1</sup> No additional GSS7765 commands are currently provided over the SimREMOTE link to support remote control of parameters.

### 3.2 MODELLED MODE

The modelled mode simulates interference power level variation due to realistic relative vehicle motion with respect to the fixed interference source locations.

The power level presented by the interference source varies in accordance with an inverse-square-law characteristic related to the range between the simulated host vehicle and the Interferer.

The power level is also varied to simulate the effects of the receiver's reception antenna gain pattern.

In Modelled mode scripts are used to set initial power levels and Interferer types.

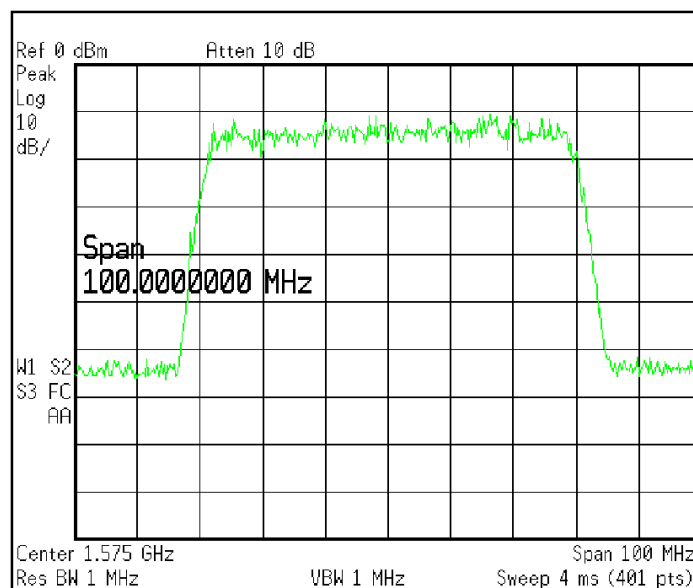
In this mode, the power level is updated at the SimGEN iteration rate<sup>2</sup>, 10 or 100 Hz.

## 4 COTS SIGNAL GENERATOR

The Spirent ISS architecture has been designed to operate with a COTS digital signal generator<sup>3</sup>.

This is a high performance unit with wideband FM, pulse modulation & AM. Frequency step sweeps are also supported.

Additionally additive white Gaussian noise (AWGN) is available as a standard facility of the signal generator. The AWGN bandwidth is variable from 1 Hz to 48 MHz and is generated real-time with a 90-bit pseudorandom generation giving a high level of randomness.



**Figure 3 AWGN bandwidth up to 48 MHz**

Spirent utilises the built in modulation capabilities of the COTS signal generator supplemented by additional waveforms implemented using the arbitrary signal generator function. In this way FM, AM and swept-CW are made available with all the specified modulation waveforms.

<sup>2</sup> Some compatible systems (see Table 1) are capable of a 250Hz iteration rate. This mode is not supported by the GSS7765.

<sup>3</sup> The signal generator, an Agilent N5182A, can be sourced directly by the customer in which case refer to Appendix B for procurement details.

## 5 TECHNICAL PERFORMANCE

Each interference source of the ISS is independently capable of generating signals with the following characteristics:

### 5.1 CW INTERFERENCE

#### 5.1.1 SIGNAL TYPE

A Continuous Wave or unmodulated carrier.

CW signals from multiple generators can be selected to be coherent or non-coherent via the SimGEN GUI. n.b. For coherent sources the interference generators require a common, external 10MHz reference.

#### 5.1.2 FREQUENCY

Frequency Range	0.5 to 2 GHz
Frequency Resolution	0.01 Hz
Frequency Stability	<±1ppm/yr ±1 ppm typical over 0 to +55°C

#### 5.1.3 SPECTRAL PURITY

Harmonics	<-30 dBc
Non-harmonics	<-48 dBc
Sub-harmonics <sup>4</sup>	<-76 dBc

### 5.2 SWEPT CW INTERFERENCE

#### 5.2.1 SIGNAL TYPE

The user defines the centre frequency and frequency span plus a sweep rate using the FM type.

Carrier:	as CW	
Frequency Span:	to 20MHz	(1.5 to 2 GHz band)
	to 10MHz	(0.75 to <1.5 GHz band)
	to 5MHz	(0.5 to <0.75 GHz)
Sweep type (cyclic):	Sine	
Sweep rate:	0.1 Hz to 2 MHz	
Additional frequency error <sup>5</sup>	±0.2% of set deviation + 1Hz	

### 5.3 STEPPED CW INTERFERENCE

#### 5.3.1 SIGNAL TYPE

Generated as a sequence of CW frequency steps. The user defines the start and stop frequencies, together with the number of steps and dwell time. The overall pattern is that of a sawtooth ramp.

Carrier:	as CW
Number of frequency step points:	2 to 65535
Dwell time at each step:	100 µs to 100s

<sup>4</sup> CW mode

<sup>5</sup> The following comment from the Agilent documentation applies "Specification valid for temperature changes of less than ± 5 °C since last DC FM calibration".

**5.4 AM INTERFERENCE**

Carrier: as CW  
 AM Depth: 0 to 90% in 0.1% steps (nominal)<sup>6</sup>  
 Distortion (1kHz rate): <2%, typical at 1kHz rate

Modulating signal:

Waveforms: sine, square, ramp and triangle  
 Rate: 0.1 Hz to 10 kHz (typical)  
 Resolution: 0.1 Hz  
 Frequency accuracy: same as RF reference source, typical

**5.5 FM INTERFERENCE**

Carrier: as CW  
 Maximum deviation: 20MHz (1.5 to 2.0 GHz band)  
 10MHz (0.75 to <1.5 GHz band)  
 5MHz (0.5 to <0.75 GHz)  
 Resolution: 0.1% of deviation or 1Hz, whichever is greater (nominal)  
 Distortion: <0.4%<sup>7</sup>  
 Additional frequency error:  $\pm 0.2\%$  of set deviation + 1Hz<sup>8</sup>

Modulating signal:

Waveforms: sine, square, ramp and triangle.  
 Rate: 5 Hz to 2 MHz (sine)  
 0.1 Hz to 10 kHz (square, ramp, triangle)  
 Resolution: 0.1 Hz  
 Frequency accuracy: same as RF reference source, typical

**5.6 NOISE INTERFERENCE**

Carrier: as CW  
 Bandwidth (3dB): 1 Hz to 48 MHz  
 Resolution on bandwidth: 0.1Hz

<sup>6</sup> Peak of AM envelope must not exceed the maximum available power

<sup>7</sup> The following comment from the Agilent documentation applies "1kHz rate with deviation 100kHz for carrier >1.5GHz or deviation 50kHz for carrier 0.75 to <1.5GHz"

<sup>8</sup> The following comment from the Agilent documentation applies "Specification valid for temperature changes of less than  $\pm 5^\circ\text{C}$  since last DC FM calibration"

## 5.7 PULSE MODULATION

Pulse may **only** be applied to **CW**, **Stepped CW**, and **Noise** Interference types.

### Pulse:

Period:	2.01 $\mu$ s to 42s
Width:	2 $\mu$ s to pulse period -10ns (typ), resolution 10ns
On/Off Ratio:	>80dB
Rise/Fall Time:	<50ns (typ)
Square wave rate:	0.1Hz to 10 MHz, resolution 0.1 Hz (nom)

## 5.8 RF LEVEL (PER SOURCE) FROM ICU OUTPUT

GPS signal level (L1 P, nominal, per SV)	-163.0	dBW
GPS signal level control (about nominal)	$\pm$ 20	dB
GPS signal level accuracy	$\pm$ 1.0	dB RSS

I/S ratio relative to any GPS L1 P-code signal at nominal GPS signal level		
- All modes	-1 to +136	dB

Interference level expressed as absolute power <sup>9</sup>		
- All modes	-164 to -27	dBW

Interference accuracy (CW) <sup>10</sup>		
- I/S 63 to 136 dB	$\pm$ 1.0	dB RSS
- I/S 16 to 63 dB	$\pm$ 1.1	dB RSS
- I/S -1 to 16 dB	$\pm$ 1.6	dB RSS
Interference level resolution	0.02	dB (nom)

Increase all Interferer ICU output levels by approximately 7 dB if the option to bypass the four-way combiners in the ICU is exercised.

## 5.9 EXTERNAL FREQUENCY STANDARDS

It is possible to lock the Interference signal generator(s) to an external 10 MHz reference frequency.

Each generator provides a 10MHz output that may be used as a reference source for other elements of the simulation system.

<sup>9</sup> Specified maximum interferer level in ambient +20 to +30 °C. Typically the maximum level reduces by 0.2 dB/°C outside of this range.

<sup>10</sup> These values assumes ISS uncertainty between 20 and 30 °C. For temperatures outside of this range the accuracy degrades by 0.01 dB/°C

## 6 OPERATIONAL PERFORMANCE

### 6.1 PHYSICAL FORM

The GSS7765 Interference Simulation System comprises a Spirent *ICU* single chassis together with a number of commercial signal generator chassis. All units are rack-mountable in the industry standard 19-inch format.

Dimensions (H x W X D)

COTS generators	103 H <sup>11</sup> x 426 W x 432 L mm (4.07"x16.8"x17") ≤ 12.5 kg (27.5 lb.)
ICU	89 H x 426 W x 200 L mm (3.5"x16.8"x7.9") ≤ 4 kg (9 lb.)

### 6.2 ENVIRONMENTAL

The equipment is suitable for operation only in a typical office or laboratory environment.

Operating Conditions

Temperature:	+10°C to +40°C
<i>The equipment employs forced-air cooling.</i>	
Relative Humidity:	75% max
Mechanical:	Not exposed to vibration, shock or bump.

Storage Conditions: -40°C to +70°C

Power Requirements (each generator):

- 100 to 120 VAC, 50 to 60 Hz
- 220 to 240 VAC, 50 to 60 Hz
- 250 W maximum

EMC:

Complies with European EMC Directive 89/336/EEC, amended by 93/68/EEC

- IEC/EN 61326
- CISPR Pub 11 Group 1, class A
- AS/NZS CISPR 11:2002
- ICES/NMB-001

Safety:

Complies with European Low Voltage Directive 73/23/EEC, amended by 93/68/EEC

- IEC/EN 61010-1
- Canada: CSA C22.2 No. 61010-1
- USA: UL 61010-1

<sup>11</sup> H includes removable feet. With feet removed the unit can be accommodated in 2U.

## 7 DELIVERABLES

ITEM	QTY	DESCRIPTION	COMMENT
1	1	GSS4766 Interference Combiner Unit	One required per system
2	1 set	Interconnection cables <ul style="list-style-type: none"> <li>• One GPIB Cable per generator (1m)</li> <li>• One RF Cable per generator (1.5m RG142 N to N))</li> <li>• One GNSS RF Cable (1.5m RG142 N to N))</li> <li>• One synchronisation cable per generator (1m BNC to BNC)</li> <li>• Two link cables (15cm BNC to BNC)</li> </ul>	appropriate for target system
3	up to 4	Digital Signal Generator	Can be customer furnished <sup>12</sup>
4	1	Printed User Manual	
5	1	Printed Calibration Procedure	
6	1	CD	Utilities and manuals

<sup>12</sup> If a customer furnished signal generator is used its serial number must be supplied to Spirent to allow a licence key to be generated. All other deliverables remain unchanged.

## APPENDIX A MORE COMPLEX SYSTEMS EMPLOYING THE GSS7765

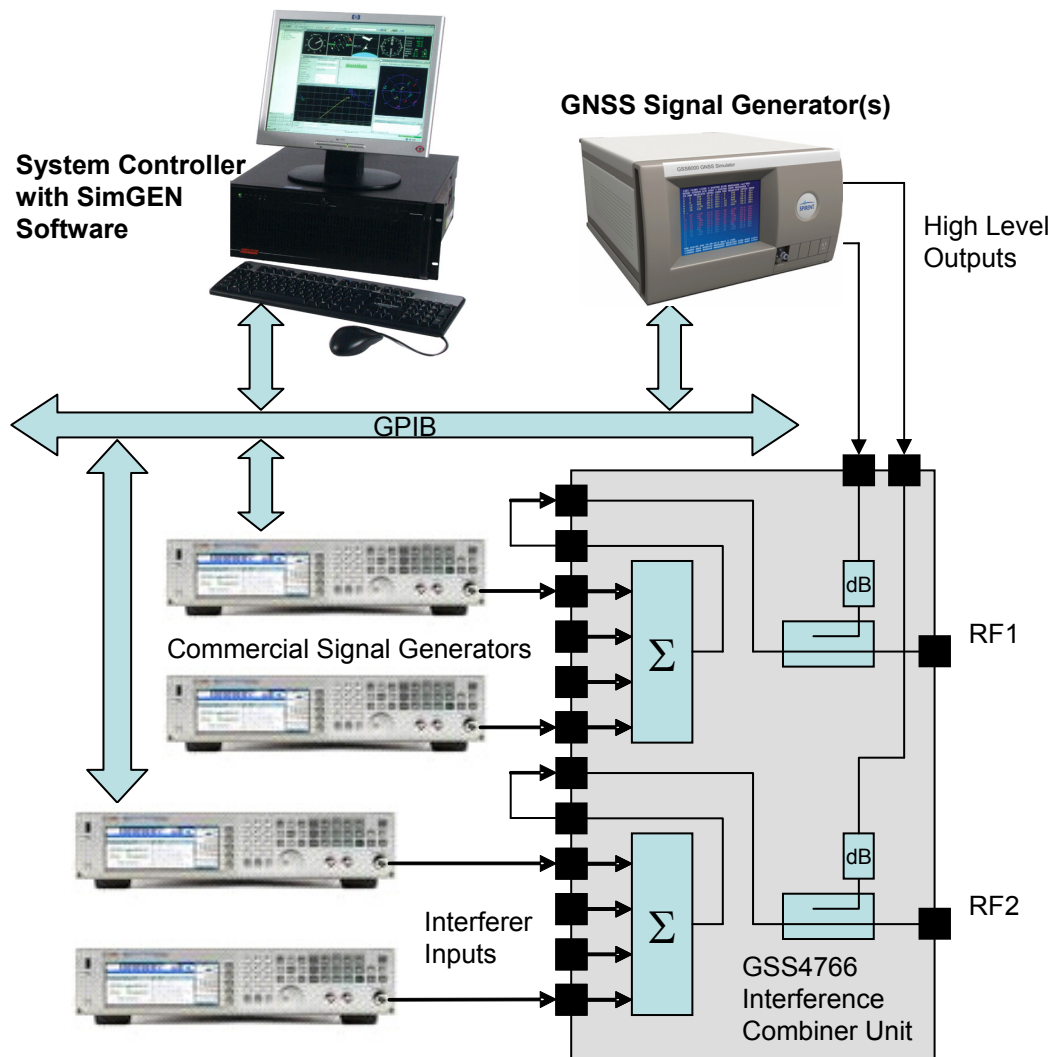


Figure 4 Differential Configuration with 4 Interference Sources

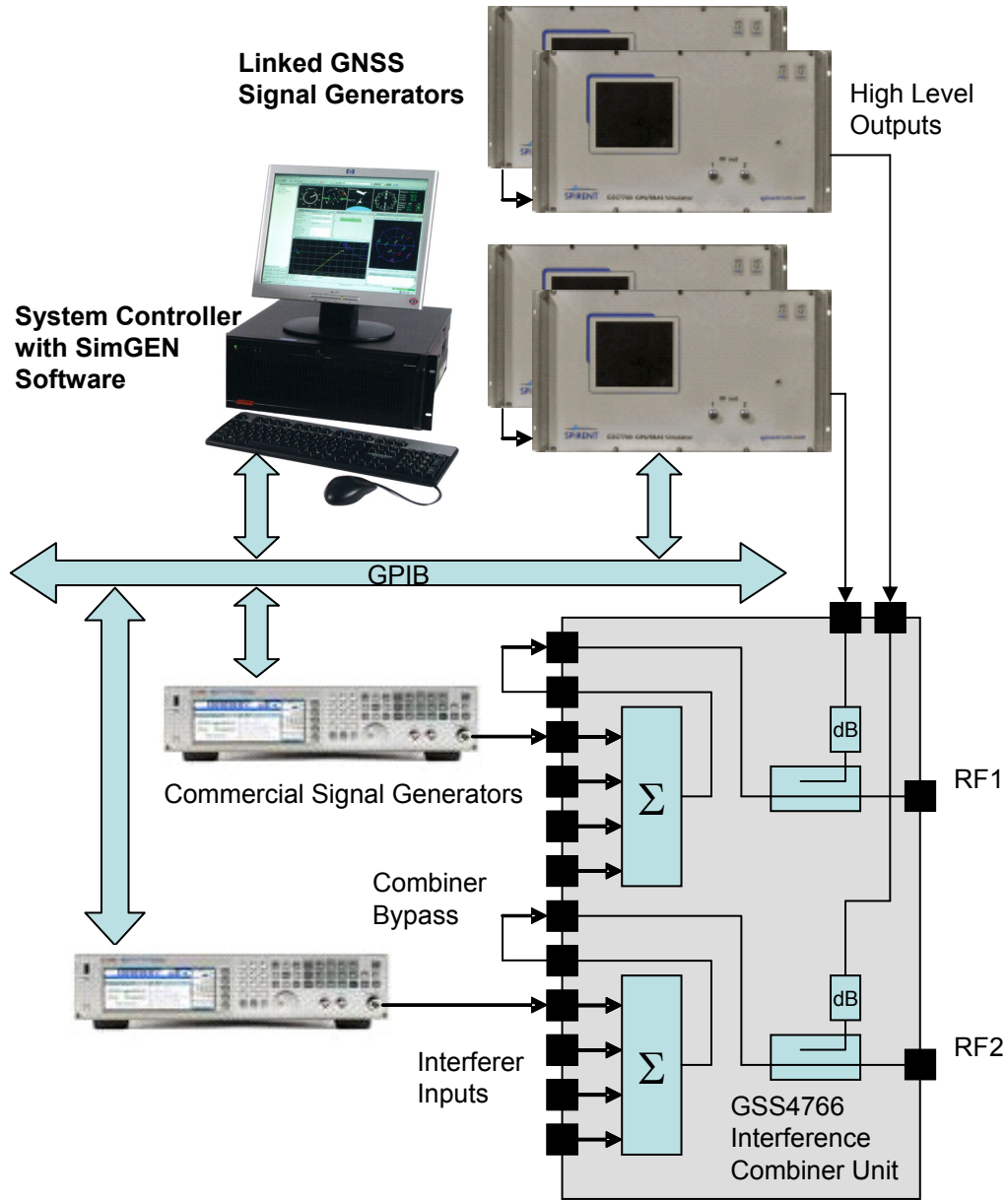


Figure 5 Differential Multiple GNSS Carrier Configuration

## APPENDIX B SIGNAL GENERATOR PROCUREMENT DETAILS

### B.1 SIGNAL GENERATOR PROCUREMENT DETAILS

#### B.1.1 MANUFACTURER

Equipment manufacturer: Agilent Technologies

#### B.1.2 SIGNAL GENERATOR DESCRIPTION

Equipment description: 250kHz – 3GHz, MXG Vector Signal Generator.

#### B.1.3 PRODUCT CODE

Manufacturer's product code: N5182A

#### B.1.4 OPTIONS

The equipment is to include the following optional features:

<u>Order Item</u>	<u>Description</u>	<u>GSS code:</u>
N5182A-503	Frequency range 250 kHz to 3 GHz	GSTE-0009
N5182A-1EQ	Low power <-110 dBm	GSTE-0010
N5182A-UNU	Pulse modulation	GSTE-0011
N5182A-UNT	AM, FM and phase modulation	GSTE-0013
N5182A-1EM	Move RF output to the rear panel	GSTE-0014
N5182A-652	Internal baseband generator (60 Msa/s, 8 Msa)	GSTE-0015
N5182A-403	Calibrated AWGN	GSTE-0016
N5182A-ICP	Rackmount and front handle kit	GSTE-0017

### B.2 SOFTWARE LICENCE KEY (REQUIRED)

It should be noted that a licence key enables each specific signal generator. In order that customers can purchase the licence key(s) and cable set(s) the serial number of any customer furnished signal generators need to be supplied to Spirent. Each signal generator will also need a unique GPIB address.