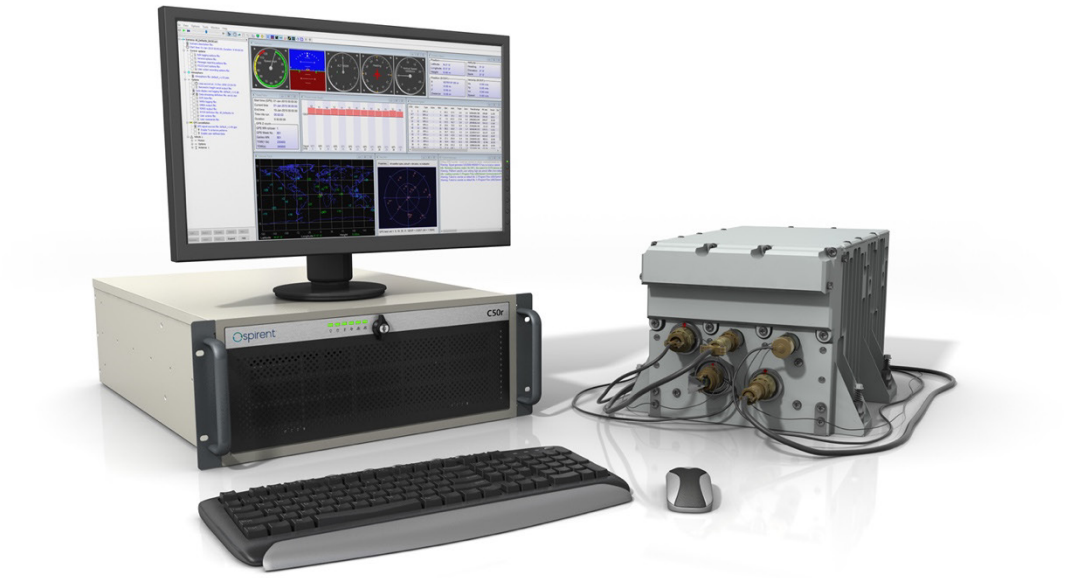
DATASHEET



MS3030 SimINERTIAL

Integrated GNSS/Inertial Test

Spirent MS3030 SimINERTIAL

Purpose of this Document

This document describes the configuration, functionality, performance and deliverables of SimINERTIAL packages for Spirent's GSS9000 series constellation simulators. SimINERTIAL is also compatible with Spirent's earlier GSS8000 systems with SimGEN™ for Windows.

The packages include solutions for Northrop Grumman (formerly Litton) EGIs and IMUs, Honeywell EGIs and IMUs, NATO STANAG 4572 Open Standard Architecture test interface and Collins Aerospace (formerly Atlantic Inertial Systems (AIS)) inertial interfaces.

All SimINERTIAL variants for Northrop Grumman are only available to customers in the USA. Customers outside the USA will require specific authorisation for all variants with the exception of NATO STANAG 4572 Open Standard Architecture and AIS (Collins Aerospace) variants.

The full issue of this document shall form the basis of any equipment procurement contract for a SimINERTIAL package and should be read in conjunction with the relevant signal generator product specification in Referenced Documents. Northrop Grumman and Honeywell products typically have a number of variants. Compatibility with the SimINERTIAL package must be verified before contract acceptance. Some information on supported variants is contained in this document. However, in all cases, please contact your Spirent representative before ordering to confirm compatibility.

New SimINERTIAL variants can be added in many cases. The architecture of SimINERTIAL is designed to be flexible and support additional products as required. If the variant you are interested in is not listed, please contact Spirent for further information.

Supported configurations are often complex; please contact your Spirent representative for guidance and to confirm the appropriate configuration.

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Introduction

The GSS9000, GSS8000 and GSS7700 series of GPS and GNSS simulators have been designed as precision general-purpose equipment for testing and evaluating GPS/GNSS receiver equipment in a development, qualification, certification or integration environment.

When operated with SimGEN™ executive software, the comprehensive and flexible nature of these products ensures that user equipment under test behaves as if it were receiving RF signals from real satellites when installed on a vehicle performing complex and/or high-speed manoeuvres.

The **SimINERTIAL** packages enhance the capability of Spirent GNSS Simulation systems by adding the capability to either stimulate the Inertial Test inputs of several types of Integrated GNSS/INS (IGI) navigation sensors (also known as EGIs, Embedded GNSS in INS) or to emulate the presence of an Inertial Measurement Unit (IMU). These packages allow IGI's to be dynamically tested in the laboratory in terms of generation of Inertial-only, GNSS-only or blended GNSS/Inertial position solutions, or for GNSS receiver systems to be tested whilst being aided or assisted by data from an emulated IMU (sensor fusion).

SIMINERTIAL C50R V5.xx

In all cases the inertial sensors themselves (accelerometers and gyroscopes) are NOT physically stimulated. SimINERTIAL provides a substitute for the inertial sensor outputs that are compatible with the particular test interfaces that are supported.

A wide range of IGIs and IMUs are supported by SimINERTIAL as shown in Table 1.

For applications requiring provision of an independent altitude reference, Spirent's **SimBARO** option, available separately, offers a source of barometric pressure altitude as a 1553B Remote Terminal (reference [5] in Referenced Documents on page 14). Note that, outside USA, the Spirent SimBARO package is available to authorised customers only. However, there is a generic barometric pressure data port available as standard within SimGEN.

SimBARO can be used to transfer the barometric altitude to the UUT over 1553. The standard C01/C03 messages are used to do this. Most UUT EGI's use barometric correction data as a way to damp down the vertical plane errors inherent within inertial systems.

SimBARO is now hosted on the SimINERTIAL C50r instead of the PosApp controller as previously.

SimINERTIAL running in concert with a GSS9000, PosApp and the attendant C50r can achieve the 1 KHz update rate, note this performance is not fully achieved with Legacy systems.

SimINERTIAL for Honeywell ISRSII (and variants thereof) dictates the ISRSII card is hosted in a separate expansion box, functionality and performance remains as before

From July 2017 the SimINERTIAL product structure has been subtly amended and as such hardware, software and the supported interface are ordered separately, the complete package however delivers the whole solution as previously.

Please contact your Spirent representative for the most up-to-date information and to discuss your particular testing and configuration needs, plus required approvals for customers outside USA.

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Table 1 SimINERTIAL currently supported inertial types

Inertial Supplier	Product Supported	Type	Variants Supported (if applicable)
Northrop Grumman	LN100G[1]	IGI	
Northrop Grumman	LN250/LN251[1,2]	IGI	
Northrop Grumman	LN260[1]	IGI	
Northrop Grumman	LN200 SDLC	IMU	
Honeywell	H-764G & SIGI[1,3]	IGI	
Honeywell	Nav100™[3]	IMU	
Honeywell	HG-9900[3]	IMU	
Honeywell	HG-1700 SDLC	IMU	AG58, AG59, AG60 HG-1900, HG-1930, HG-9848
Honeywell	HG-1700 AMRAAM	IMU	AG43, AG70, AG71, AG72, AG73, AG74
AIS (Collins Aerospace)	SilMU02	IMU	
AIS (Collins Aerospace)	SiNAV	IMU	
NATO	StanAg 4572		

Notes:

1. Many of these systems have differing variants and interface specifications. Please check with Spirent to ensure support for your specific systems / variants and for Spirent part number(s) to order.
2. For customers in the USA, bundles of SimINERTIAL capability are offered. Details are provided in this document, please see page “SimINERTIAL bundles (US market only)”.
3. Spirent is not at liberty to supply any underlying Interface Control Documents (ICDs). It is the customer’s responsibility to make sure they obtain the required information from the specific vendor or organisation.

1 Normally requires SimBARO option for INS-only operation
2 LN250/1 normally requires an RS422 interface to control test mode and to capture data.
3 Requires ISRS2. ISRS2 can be sourced from Honeywell or, if required, supplied by Spirent.

SimINERTIAL System

Spirent's SimINERTIAL package delivers simulated inertial sensor data for the GNSS/Inertial Navigation system under test.

A range of data interface types and protocols are supported, relevant to the application.

Inertial Sensor Data Sources

SimINERTIAL runs on its own controller and links to the SimGEN core of the GPS / GNSS Simulator accessing truth data relating to the simulated motion and orientation of the vehicle via SimGEN™ 's data streaming function. This data could represent the output of one of SimGEN™ 's vehicle models or externally supplied data.

SimINERTIAL is able to derive from the truth data the appropriate accumulated values for the simulated inertial sensor output data. The inertial sensors are typically accelerometers and gyros.

All data generated are fully synchronous and coherent with the GNSS signalling provided by the GPS / GNSS Simulator.

Delta-Vee

Accelerometers detect changes in vehicle velocity in three orthogonal physical axes. These axes can be aligned with the natural body frame of the host vehicle. Where they are not aligned, their contributions can be translated into the body frame.

In the test environment, simulated vehicle motion is usually referred to the body frame, and SimINERTIAL makes the translation to the sensor frame.

This is normally referred to as the 'delta-vee' or δV data.

Delta-Theta

Gyroscopes or Gyros are used to detect changes in the orientation or attitude of a moving vehicle. Traditional spinning gyroscopes have long since disappeared to be replaced by Ring-Laser optical sensors and more recently by miniature solid-state devices that vibrate (MEMS).

As with acceleration sensors, gyros are usually organised around three orthogonal axes, and translation to body axes may again be performed through SimINERTIAL.

This is normally referred to as the 'delta-theta' or $\delta\theta$ data.

Barometric Pressure Input

Many IGIs require an altitude reference data input when operating in INS-only mode. Normally this would be a Barometric Pressure Altimeter (Baro) with MIL-STD-1553B capability. The system Control and Display Unit (CDU) would normally perform occasional altitude updates to the EGI via a 1553B RT-RT or RT-BC-RT transfer.

Spirent's SimBARO option, available separately (reference [5] in Referenced Documents on page 14) maintains a user-specified RT-address on the supplied MIL-STD-1553B card that contains an appropriate barometric pressure altitude value.

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SimINERTIAL Variants

Although the operational concept for SimINERTIAL is common, the test configurations required differ depending on the system(s) under test.

As such, orders for Northrop Grumman IGI variants are ONLY accepted as agreed Tailored Solutions to ensure compatibility and scope.

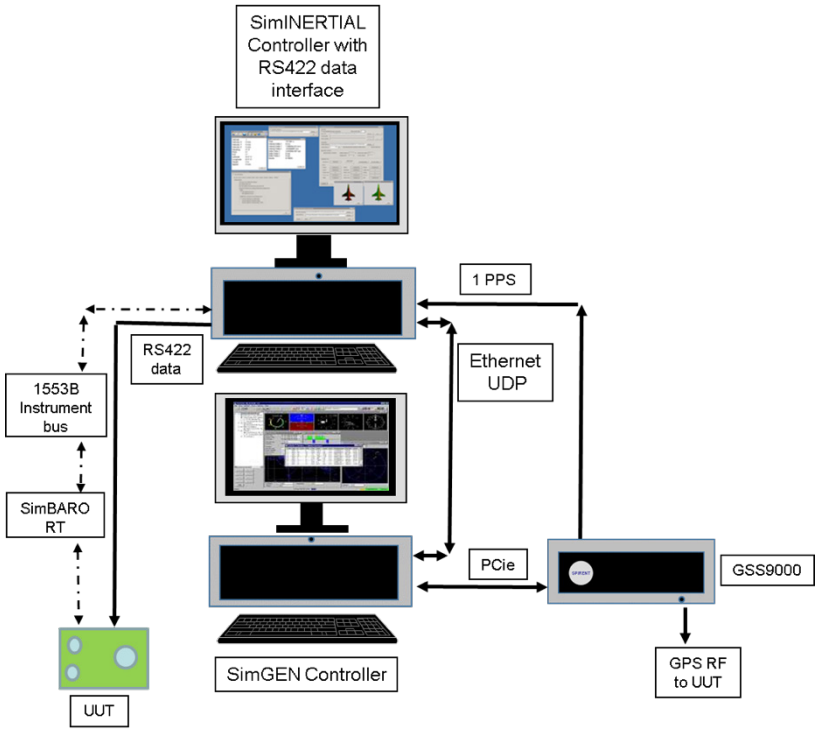
Configurations for SimINERTIAL for Northrop Grumman IGI

These configurations apply to SimINERTIAL for LN100G, LN250, LN251, LN260.

In this configuration, SimINERTIAL uses an RS422 connection via a commercial interface card housed in the SimINERTIAL controller for transmission of the inertial sensor data to the IGI.

Figure 1 shows a typical system schematic for this configuration in relation to LN100 and LN260. Also shown in Figure 1 is Spirent's SimBARO upgrade.

Figure 1 SimINERTIAL for NG LN100/260 IGIs with optional SimBARO



As there are several variants for these IGIs, cabling is not supplied and remains a customer furnished item.

No cables or bus couplers are supplied for the 1553B connections.

A DC power source for the IGI is not supplied.

Configuration for SimINERTIAL for Honeywell EGI

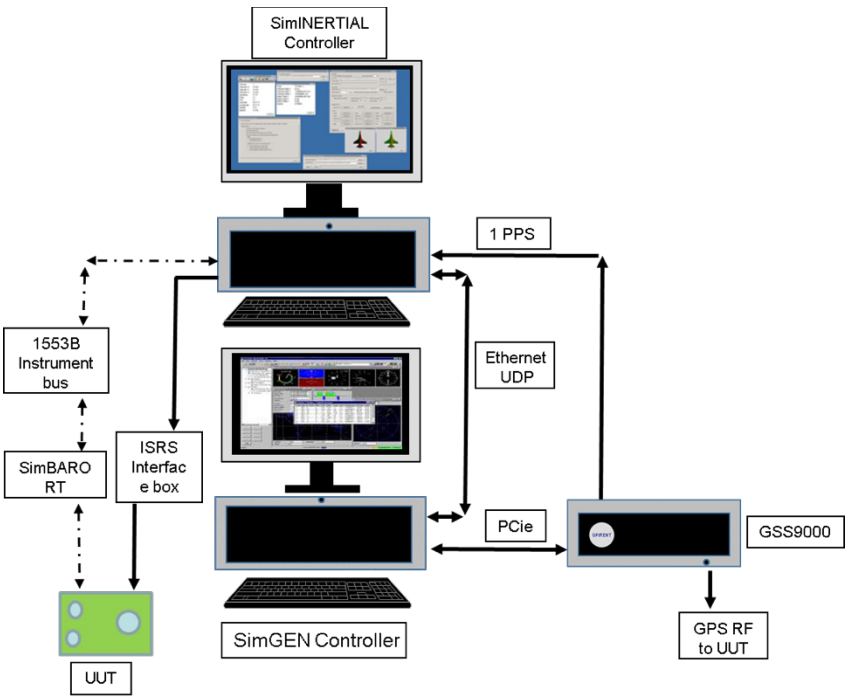
This configuration applies to SimINERTIALfor H-746G, SIGI, NAV100 and HG9900.

In this configuration, the test interface is provided through Honeywell's proprietary ISRS2 interface card solution. The ISRS2 is housed in the SimINERTIAL Controller to provide the transport interface to the unit under test.

Figure 2 shows a system schematic for SimINERTIAL in this configuration.

The figure also shows the SimBARO option which is usually required to support INS only operating modes.

Figure 2 SimINERTIAL for H-764G



Further information and logistics information is available from Spirent.

Configuration for SimINERTIAL for IMU Emulation

Since the physical and electrical configuration of the units being tested are not standardised, suitable cabling between the Serial card and the system under test is not supplied by Spirent.

SimINERTIAL variants for IMU testing are also compatible with the SimBARO option (reference [5] in Referenced Documents on page 14).

For the STANAG 4572 interface SimINERTIAL testing also supports data from two inertial sensor blocks, providing a total of 6 accelerometer and 6 gyro data fields in one stream.

Inertial Error Modelling

Physical sensors such as accelerometers and gyroscopes suffer from a complex range of imperfections that yield errors in the measurements made. In order for a test system to reproduce operationally representative sensor outputs it is necessary to apply an error model to the nominal δv and $\delta\theta$ data produced by the base simulation.

SimINERTIAL uses of a generic error model specified in Appendix 2 to STANAG 4572. This model has been derived from mature Accelerometer and Ring Laser Gyroscope designs plus recognised IEEE standards.

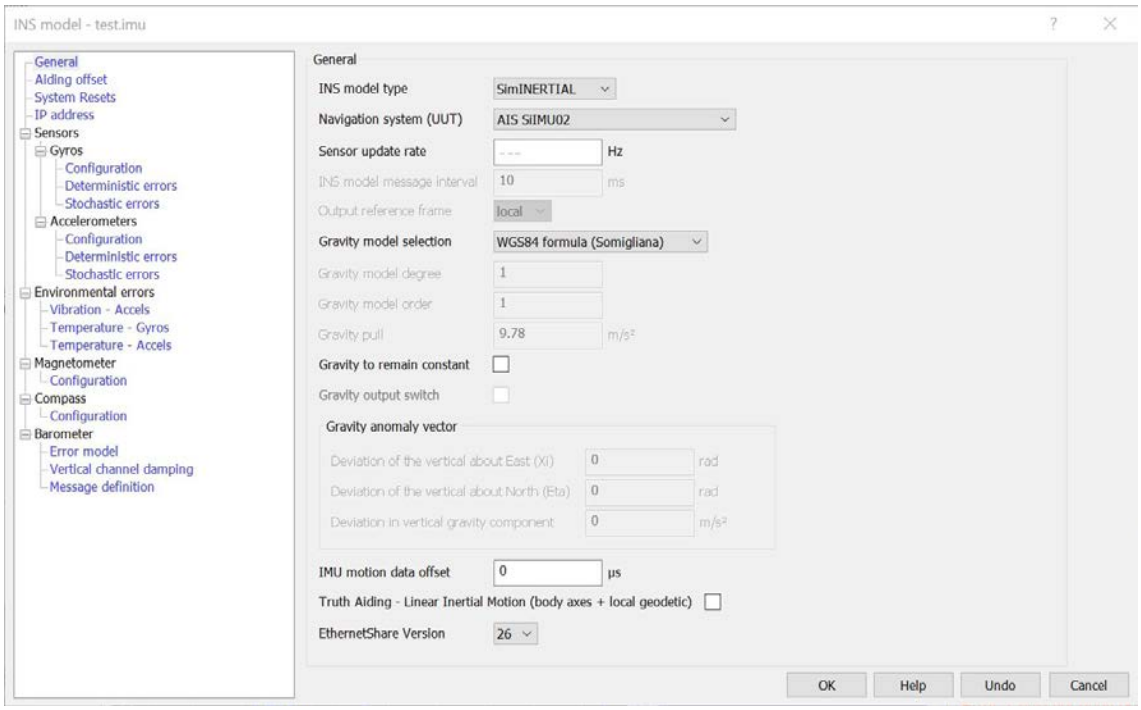
The strapdown model includes a quaternion co-ordinate transformation from the body frame to the sensor frame and the user may specify the coefficients of this model that covers scaling factors, biases, misalignments, lags, and stochastic error terms.

For NG and Honeywell SimINERTIAL variants, representative error model coefficients for the particular navigator under test must be obtained from NG or Honeywell.

The error model is supplied as a separate DLL.

Note that this architecture also supports the possibility of integrating user-defined models compiled by the customer (or Spirent, if appropriate) as a DLL sharing the existing Spirent DLL interface.

Figure 3 SimINERTIAL error model



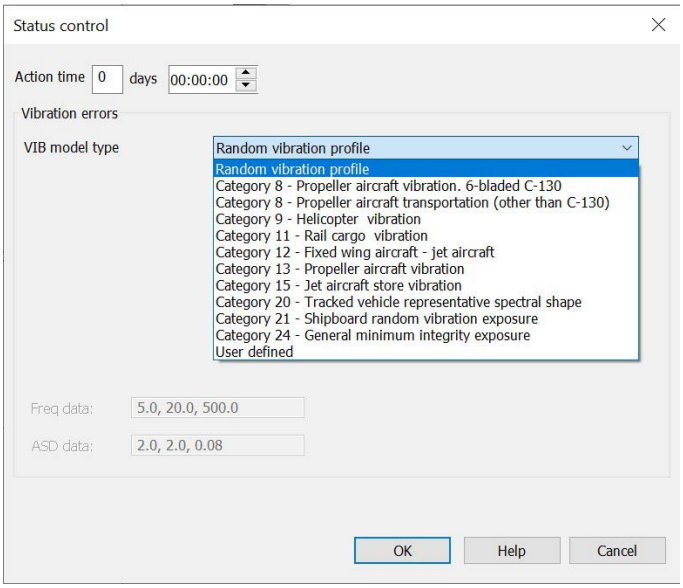
Temperature and vibration models

The effects of environmental errors such as temperature and vibration on inertial sensors are applied via embedded temperature and vibration error models.

Vibration-induced errors affecting accelerometers are simulated via a vibration model based on MIL-STD-810-H. The model includes the pre-defined vibration profiles defined in the standard (e.g. aircraft, helicopter, shipboard), as well as user-defined ASD vs. frequency vibration profiles. Multiple vibration profiles can be applied at different time in a given scenario.

The temperature model is based on two industry-recognised research papers and simulates the effects of temperature on MEMS-based accelerometers and gyroscopes. The user can define the scenario temperature profile and set the values of critical temperature parameters.

Figure 4 Vibration error model



GNSS-to-inertial BIAS

SimINERTIAL is able to adjust the relative timing between the generation of the GNSS Signals and the simulated inertial sensor data to ensure that these are coherently presented to the embedded navigation algorithms and hardware being tested.

Software Licencing

SimINERTIAL uses licences embedded in a licence key to provide the type-specific capabilities for the test interface standards supported.

Licences and the associated interface hardware are priced separately to provide system capability against a specific IMU type or standard.

Approvals may be required for provision of licences outside USA, except in the case of the STANAG4572 and AIS (Collins Aerospace) variants (reference comments in the Introduction section of this document).

Multiple Inertial Interface Configurations

Multiple Devices Under Test

For customers wishing to exercise more than one device-under-test simultaneously, for example in dual-redundant applications or supporting multi-vehicle simulations, it is possible to operate SimGEN with several instances of SimINERTIAL installed in separate SimINERTIAL Controllers (additional timing distribution elements from Spirent are usually required).

This includes using a single RF generator representing one antenna that is to be shared or multiple RF generators/outputs to represent multiple antennas or vehicles.

SimBARO can also support multiple independent barometric sources on a single or multiple vehicles.

Orders involving multiple SimINERTIAL variants are ONLY accepted as agreed Tailored Solutions to ensure compatibility and scope.

Please contact your Spirent sales representative for further advice on supported configurations.

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Deliverables

Variant: SimINERTIAL for Northrop Grumman / Litton IGIs[1,4]

Table 2 SimINERTIAL for Northrop Grumman / Litton IGIs Deliverables

Item No.	Quantity	Component	Comment
1	1	SimINERTIAL Licence[5]	Pre programmed into controller
2	1	SimINERTIAL Rack Mount Controller with RS422 Interface Card + Timer Card	Pre installed
3	1	SimINERTIAL Application Software	Pre installed and on CD-ROM
4	1	Simple cable for RS422 Interface	
5	1 (optional)	Firmware and Timer Card PROM upgrade for Signal Generator	If needed, format as appropriate
6	1 (optional)	SimGEN™ Upgrade	If needed, on CD-ROM

Variant: SimINERTIAL for Honeywell IGI[1]

Table 3 SimINERTIAL for Honeywell Deliverables

Item No.	Quantity	Component	Comment
1	1	SimINERTIAL Licence[6]	Pre programmed into controller
2	1	SimINERTIAL Rack Mount Controller with Timer Card	Pre installed
3	1	SimINERTIAL Application Software	Pre installed and on CD-ROM
4	1 (optional)	Firmware and Timer Card PROM upgrade for Signal Generator	If needed, format as appropriate
5	1 (optional)	SimGEN™ Upgrade	If needed, on CD-ROM

Table 4 Honeywell Sourced Items

Item No.	Quantity	Component	Comment
1	1	Honeywell ISRS-2 Card7	For use with Item 2, Table 3

4 Subject to Tailored Solution configuration review regarding peripheral deliverables
5 Supports all Northrop Grumman types listed as NG IGI variants in Table 1. Approvals may be required.
6 Supports all Honeywell IGIs listed as Honeywell IGI variants in Table 1. Approvals may be required.
7 May be sourced from Honeywell or from Spirent. In all cases Spirent will require ISRS2 for integration and testing with SimINERTIAL Honeywell deliverables.

Variant: SimINERTIAL for IMU Testing

Deliverables for SimINERTIAL for Honeywell and Northrop Grumman IMUs, SimINERTIAL for Atlantic Inertial Systems (Collins Aerospace) and SimINERTIAL for NATO StanAg 4572.

Table 5 SimINERTIAL for IMU testing deliverables

Item No.	Quantity	Component	Comment
1	1	SimINERTIAL Licence[8]	Pre programmed into controller
2	1	SimINERTIAL Rack Mount Controller with RS422 PCI Interface Card + Timer Card	Pre installed
3	1	SimINERTIAL Application Software	Pre-installed and on CD-ROM
4	1	Simple cable for RS422 Interface	
5	1 (optional)	Firmware and Timer Card PROM upgrade for Signal Generator	If needed, format as appropriate
6	1 (optional)	SimGEN™ Upgrade	If needed, on CD-ROM

8 Supports only those IMU variants purchased as listed in Table 1. Approvals required for Honeywell and NG variants.

Referenced Documents

The following documents are referenced in this publication:

Reference	Document No.	Title	Issue
[1]	MS3057	GSS8000 GNSS Simulator Series Datasheet	Latest issue
[2]	MS3008	SimGEN™ for Windows Product Specification	Latest issue
[3]	MS3056 Error! Bookmark not defined.	SimBARO Product Specification	Latest issue
[4]		NATO Standard Agreement 4572[9]	Issue 1.0
[5]	MS9000	GSS9000 GNSS Simulator Series Datasheet	Latest issue

Related Product Publications

Related product	Description	Brochure title	Datasheet / Specification
GSS9000	GNSS Constellation Simulator	GSS9000 Series	MS9000
GSS8000	GNSS Constellation Simulator	GSS8000 Series	MS3057
SimGEN	GNSS Application Software Suite	GSS9000 Series	MS3008

9 Document not publicly available and not provided by Spirent. It is the customer's responsibility to enquire with their national Ministry of Defence or national Representation at NATO HQ.

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About Spirent Positioning Technology

Spirent enables innovation and development in the GNSS (global navigation satellite system) and additional PNT (positioning, navigation and timing) technologies that are increasingly influencing our lives.

Our clients promise superior performance to their customers. By providing comprehensive and tailored test solutions, Spirent assures that our clients fulfill that promise.

Why Spirent?

Across five decades Spirent has brought unrivaled power, control and precision to positioning, navigation and timing technology. Spirent is trusted by the leading developers across all segments to consult and deliver on innovative solutions, using the highest quality dedicated hardware and the most flexible and intuitive software on the market.

Spirent delivers

- Ground-breaking features proven to perform
- Flexible and customizable systems for future-proofed test capabilities
- World-leading innovation, redefining industry expectations
- First-to-market with new signals and ICDs
- Signals built from first principles — giving the reliable and precise truth data you need
- Unrivaled investment in customer-focused R&D
- A global customer support network with established experts

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Spirent Communications (LSE: SPT) is a global leader with deep expertise and decades of experience in testing, assurance, analytics and security, serving developers, service providers, and enterprise networks. We help bring clarity to increasingly complex technological and business challenges. Spirent's customers have made a promise to their customers to deliver superior performance. Spirent assures that those promises are fulfilled. For more information visit: www.spirent.com

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