Bringing the real world into the lab

An introduction to GNSS RF Record Playback Systems

SPIRENT®

Global Navigation Satellite Systems (GNSS) are versatile, cost-effective and efficient navigation technologies.

GNSS are relied upon in a myriad of applications, from the provision of pedestrian and vehicle navigation and information, to the timing of the world's financial system, spacecraft launches and extra-terrestrial manoeuvres – but they are also vulnerable to signal interference, unavailability and atmospheric disturbance.

With so much key infrastructure, commerce and safety depending on GNSS, their proper design and testing is essential.

For professional, rigorous testing of GNSS navigation technology and systems, the repeatability of test signals is crucial. But in the real world neither the GNSS constellation, nor its signals and the environmental conditions in which they are propagated, remain the same from one moment to the next.

The fundamental methods for testing and optimisation are therefore RF simulation and RF record and playback. RF simulation has been well documented and proven over the last 25 years as an essential piece in the GNSS test jigsaw.

Record and Playback, while a relatively new method, is another essential part. Both are indispensable in a complete end-to-end test plan.

This E-book discusses the concept of RF Record and Playback, and introduces the Spirent GSS6400 Record Playback System (RPS) – a key addition to the GNSS test solutions offered by Spirent.

Download the original "Introduction to Record & Playback System".

What is a GNSS RF Record Playback System (RPS)?

A GNSS Radio Frequency Record and Playback System does exactly as the name suggests. In simple terms, the whole RF spectrum in a specified bandwidth is recorded, down-converted, digitised and stored as samples on suitable storage media. For playback, the samples are converted back to an analogue signal, up-converted and output at the original RF frequency.

All RF energy in the specified bandwidth is recorded. In addition to the GNSS signals, noise in the form of interference is present. This noise is from many sources such as other RF communications, broadband interference from electrical systems (vehicle ignition etc.), and even radiation from solar activity.

The recorded GNSS signals are captured as they arrive incident upon the recorder's antenna, including the effects of the propagation environment and the satellite and observer's motion – this includes 'multipath' interference in its full richness, fades, signal loss and carrier phase/signal group delay due to atmospheric influences.

When played back into a GNSS receiver the GNSS signals will be extracted from the noise just as they would be if the receiver's antenna were pointing skyward receiving real GNSS signals.
The receiver will then de-modulate them and derive its position, navigation and time solution. The behaviour and performance of the receiver will be determined by the environment in which the RF energy was recorded.

The key benefits of record playback systems

Real world richness captured

The full richness of the ‘real-world’ operating environment is captured with an RPS, so in terms of realism, it can’t get much better.

Complete repeatability

If the test requirements are not concerned with quantifying the signals then RPS is an ideal method to use as it allows the signal to be precisely repeated back in the laboratory, over and over again.

Ease of use

An RPS system provides an easy-to-use method for GNSS testing. All you need for record and playback is contained in one box with a built in hard drive, front panel LED display, internal battery and a simple one-touch record.

Complementary to GNSS simulators

The first stage in the design of GNSS products and devices usually involves the testing of the device using signals generated by a GNSS simulator.

With simulation different scenarios can be produced that may vary the speed or dynamics corresponding to the application of the products, add interference, atmospheric effects, obscuration effects, multipath, satellite ephemeris errors, clock errors etc.

An important stage in any complete test plan is then to try the system in the real world. However, repeated field trials are expensive. This is where the RPS comes in. Instead of having to test the product in the field, return to the lab and optimise the system, go back into the field again and perform several iterations, it is much simpler to bring the real-world into the lab – recording the real-world signals once on the RPS, and replaying them as often as you like. The RF output of a Spirent simulator can also be recorded, extending the flexibility of your testing.

So what can the GSS6400 Record Playback System (RPS) be used for?

Chipset and GNSS product design

Reduce field trials

Tuning of software and algorithms to provide optimum performance in real world situations occupies a lot of development time. In some environments, the traditional approach has been to position development resources on site and conduct real time trials whilst developing improvements and solutions to problems.

This has the added difficulty of not recreating the exact conditions on subsequent tests, and requires engineers to be away from mainstream development for extended periods of time.

With the RPS system the signal environment can be recorded once, maybe at different times of day or constellation, and then used back at “base” for subsequent development and testing. If local personnel are available for recording, then travel for development engineers is eliminated entirely because the unit can be controlled remotely and/or files can be uploaded to a ftp site for download somewhere else.

Prove new algorithms, especially for new high sensitivity receivers

GNSS receivers begin their testing and performance proving with simulator signals and long test campaigns. Moving to the “real world” as experienced by end customers often requires the algorithms to be field tested, using repeated runs in known environments such as city areas and locations with high interference or obscuration.

By holding a library of pre-recorded signals from such areas, much of this work can be achieved without leaving the bench, thus cutting both costs and development time. Changes to algorithms are easily proven using the same signals over and over, without the need for more field testing.

Testing telematics, and finding faults in multimedia and control BCM units

RPS systems capable of recording CAN Bus data simultaneously with GNSS signals have particular applications in automotive R&D – supporting the testing and troubleshooting of various on-vehicle system components.

Customer conformance testing

- Prove you can meet customer's required performance.
- Examples of this testing include applications for automotive and mobile communications.

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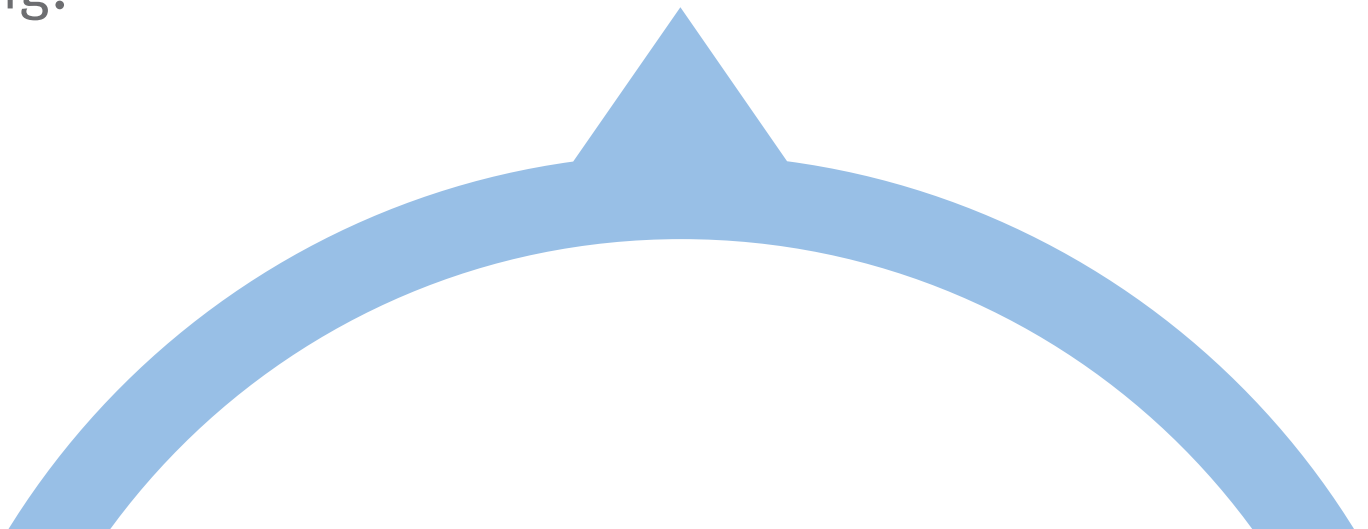
Production testing

Repeatable signals

Production testing usually involves the replay of the same signal scenario for each test run, or using off air signals for testing.

The GSS6400 provides a cost effective method of repeatable testing, providing GNSS signals under the control of a test PC, or from its front panel. Once the test signal has been recorded (ideally from a Spirent simulator) then consistent replay is obtained, freeing up the simulator for other work or preventing off-air anomalies interfering with testing.



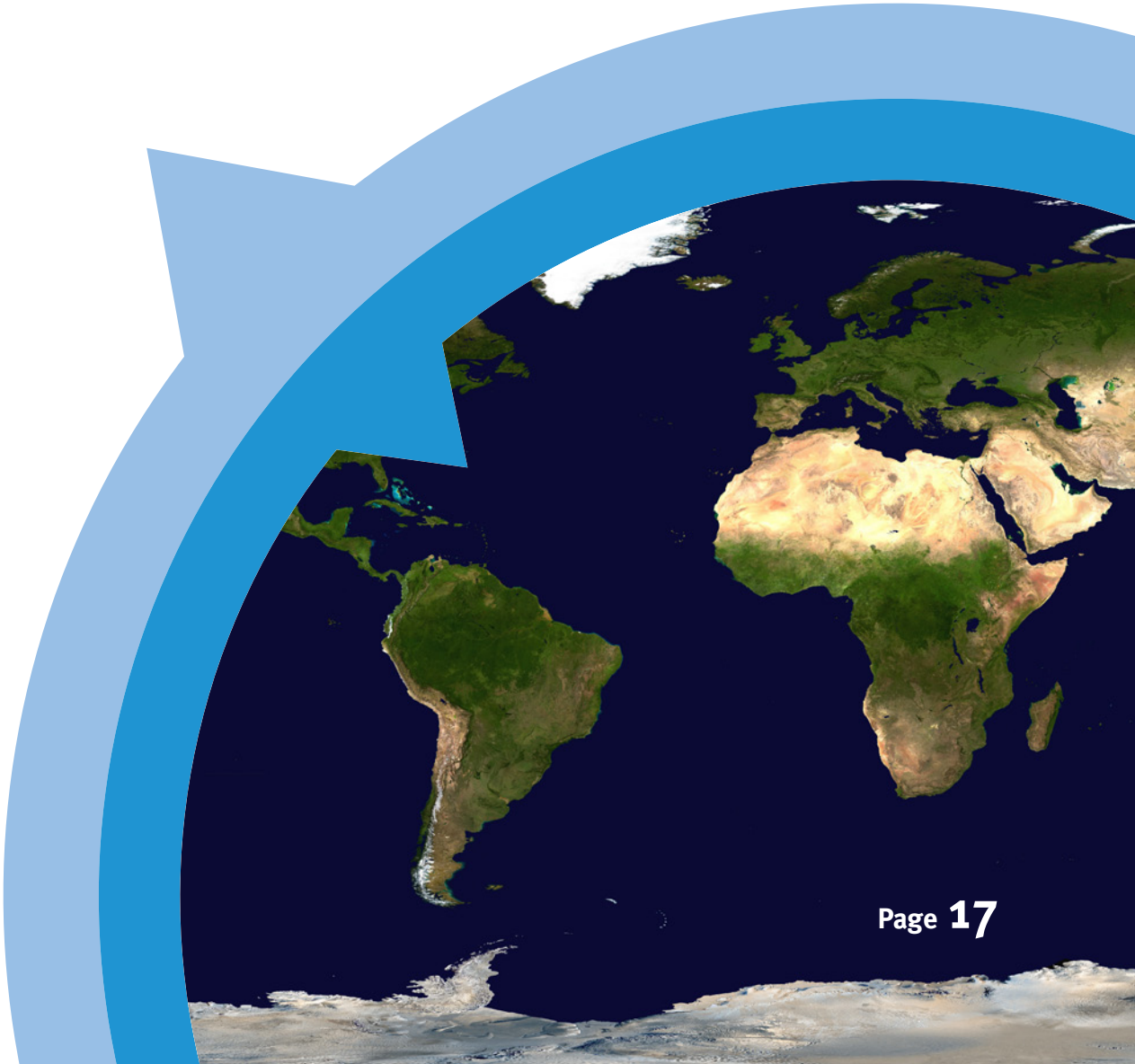
Take the problematic signals back to the lab to work on

Take the problematic signals back to the lab for further analysis. GNSS designers recognise that there are many places on earth where the GNSS signals are disturbed by phenomena such as multipath, shielding, attenuation, interference or combinations of everything. When considering how to tackle such anomalies in the receiver's signal processing, the lab environment is much more convenient than taking all of the tools and development equipment to the real site.

Recording of signals therefore provides a mechanism for separating the signal environment from the development one, and providing much better efficiency at analysing the problem and providing solutions.

Research

- Improving algorithms
- Comparing signals from different parts of the world
- Ionospheric and sunspot activity



The GSS6400 Record Playback System (RPS) from Spirent

The GSS6400 Record Playback System from Spirent is a simple and efficient way to capture real world GNSS signals and replay them in the laboratory.

Spirent's GSS6400 represents the best value and easiest to use solution on the market. With the GSS6400, it's simple and quick to record real GPS L1, GLONASS L1, QZSS and Galileo signals. Once captured, the RPS can be used in the laboratory to replay the captured environment time and time again to the device under test. You save project cost while improving product performance and quality.

High fidelity record and playback

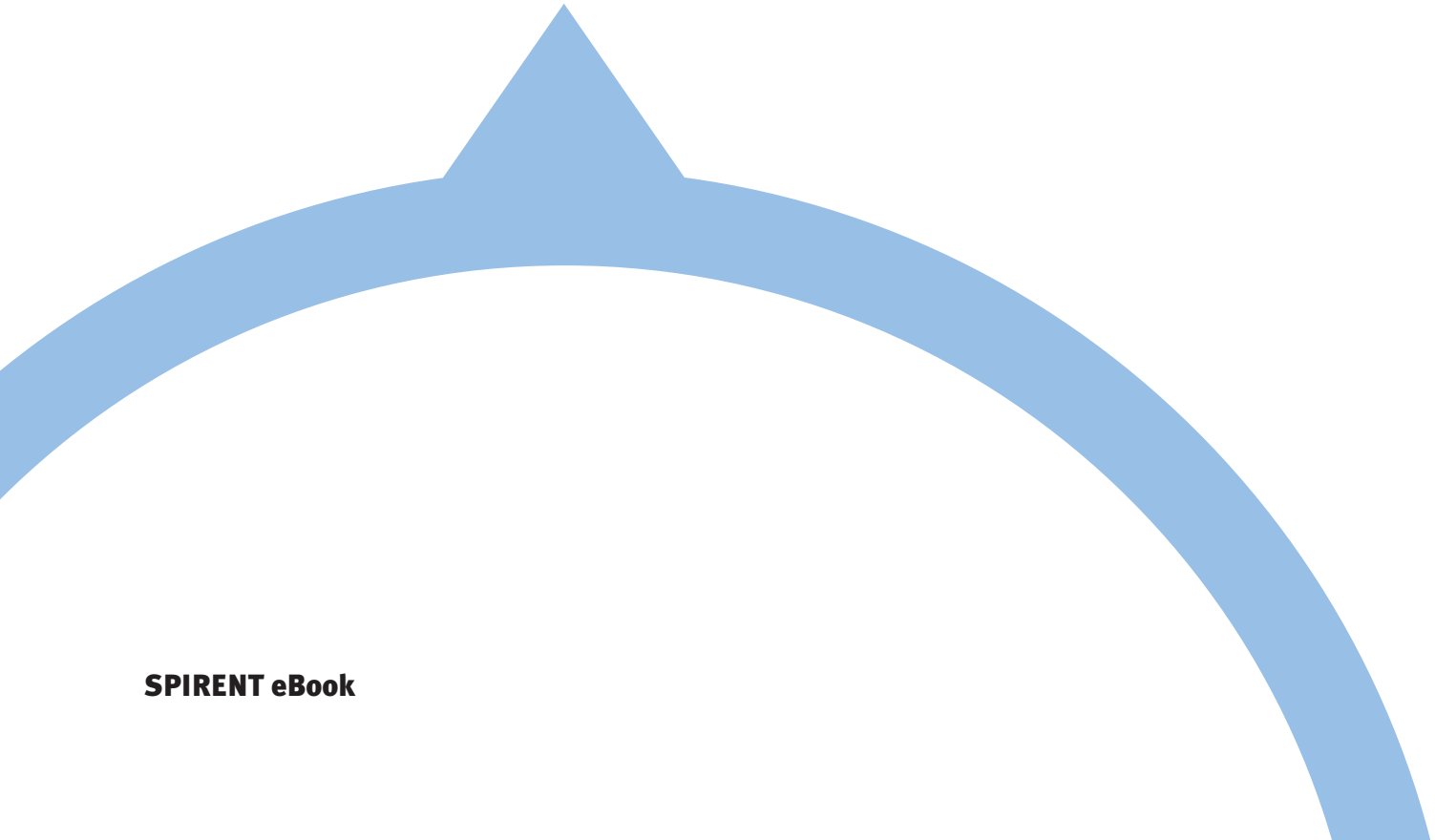
The GSS6400 is designed to capture complex environments with the fidelity to ensure that playback results in the laboratory are truly representative of captured real world conditions.

Dual-bit sampling is required in order to adequately capture the detail of the real signals over a large enough dynamic range. Sampling at 1-bit provides inadequate resolution to fully-capture real world signal fades and dynamics, especially in high-interference environments. For most test applications, sampling at bit rates higher than two results in huge file sizes, without necessarily improving the useful signal information.

To test the sensitivity of a GNSS product, the RPS's outputs signal can be attenuated by up to 31dB, in steps of 1 dB.

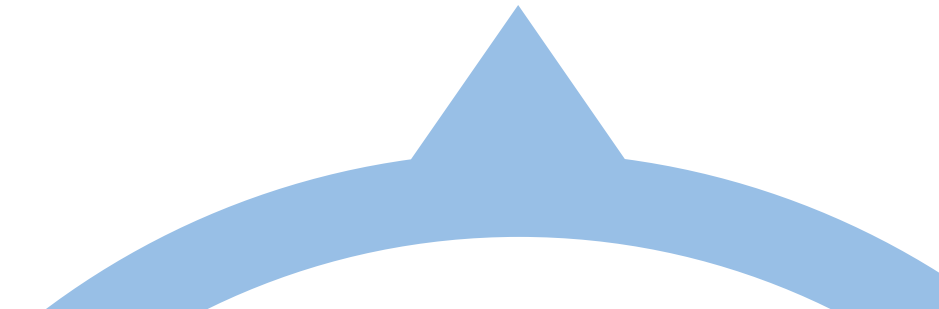
One box – a complete and easy to use solution

Spirent's market leading GSS6400 is a self-contained unit with everything you need to start testing. Many other systems require peripherals such as personal computers, hard drives, external power and cabling. With the GSS6400 it's simply a case of connecting the supplied antenna and pressing the one touch record button.



When done, select the required file from the two line display and press the play button and the captured data is replayed at RF – and OCXO playback comes built in.

With a 500 GB internal hard drive up to 30 hours of signal can be recorded, and a Solid State Drive option is available for rugged applications. In the laboratory, data can be downloaded using a high speed SATA connection, or USB and the unit can be controlled remotely over the network.



The GSS6400 is designed for maximum portability and is provided with a versatile carry-handle which also provides for flexible orientation of the unit in the lab or in the field.

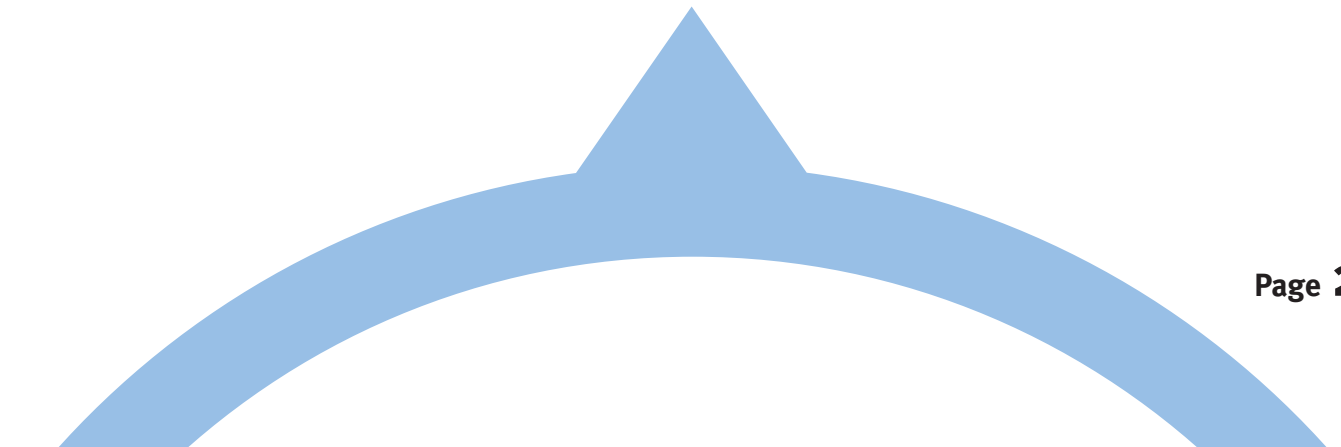
An external battery pack and a 12v car adapter are also available for longer recording sessions and recharging in the field.

Integrated testing

The GSS6400 can also record and playback serial data from a wide range of data sources including: CAN Bus; Inertial sensors; DR sensors (gyros and wheel speed sensors); reference receivers; 1pps signals.

The system supports the synchronous/asynchronous record and playback of two channels of such serial digital data alongside the GNSS signals, giving you the power to design and test integrated GNSS devices.

The GSS6400 can also start and stop both record and playback on a pulse, enabling easy integration of the GSS6400 with other test systems.



24 hour testing

The GSS6400 has other features which allow you perform tests 24 hours a day, so you can optimise the use of the system, or meet those customer deadlines.

Remote control

The GSS6400 can be hooked into the Internet as it is identified by an IP address. It can then be controlled remotely through the Webserver provided. It also has VNC access for remote access direct to the embedded Linux PC.

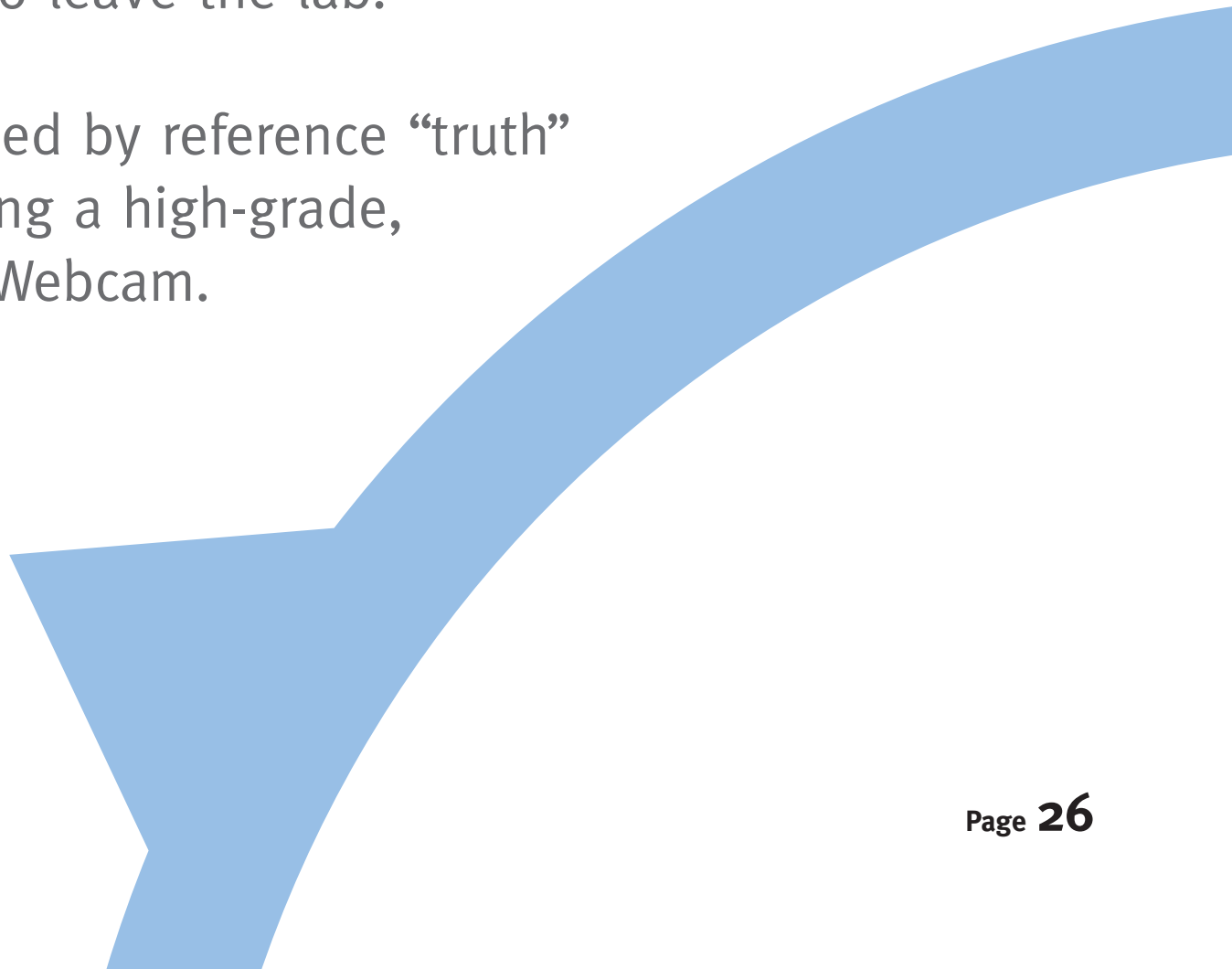
Test automation

It is also possible to write scripts for the embedded Linux PC that would automatically control the output of the RPS. For example you could fully automate a complete test system that runs different stored scenarios one after another, while you record the output of the system under test.

Global live sky data sets

To complement the GSS6400, Spirent also offers a live sky global data set subscription. The data sets give you access to a broad range of representative GNSS environments recorded at locations worldwide, without you ever needing to leave the lab.

Each data set is accompanied by reference “truth” position data, recorded using a high-grade, inertial-aided receiver and Webcam.



Why not find out more about the GSS6400 Record Playback System (RPS) from Spirent, the world leader in GNSS test solutions?

If you found this article of interest, find out more:

www.spirent.com/Campaign-Folder/GSS6400_Record_and_Playback_campaign.aspx

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