



Data Recorders





Introduction

Data recording systems are systems designed to faithfully capture digital and analogue data, using a variety of standard and non-standard electronic interfaces and protocols, in such a way that the captured data can be analysed, reproduced, and replayed as a number of time-synchronised streams of data.

Data recording systems are used to carry out specific missions, for example capturing data from a number of active or passive sensors (radar, video, sonar, EW, audio etc), or for test applications, where the purpose of the recording is to capture many streams of data such that when a trial is complete, all recorded data is available to support investigation of events that may or may not have occurred during the test.

A typical data recording system usually consists of a data acquisition function (sometimes built into the recorder), a recording function, a real-time monitor and display, and post-recording analysis and replay facility. SES provide products to meet all of these requirements as either off the shelf components, or as bespoke system solutions.



Land

SES have delivered S3DR data recording solutions into the Warrior and CVR armoured vehicles. Commercial versions of the products are available for use in carry-on installations, capable of being powered from a 12V DC power source.

SES are in the process of developing very lightweight, battery-powered devices for use by infantry.

Sea

S3DR recorders are in-use with most current submarine types employed by the UK Royal Navy. Installations have been provided for Trafalgar, Trident and Astute class submarines. Surface vessels using SES products include Type 22, Type 23, Type 45 and Brunei Offshore Patrol Vessels.

Air

SES data recorders are widely used in the aerospace community, where extremes of environmental performance are required.

S3DR recorders are used on the following aircraft: Tornado GR4, F16, JSF, Eurofighter Typhoon, Jaguar, C130J, EW-Sentry, Nimrod MR1, Merlin EH101, Apache, Puma, Lynx, Gazelle, Eurocopter AS355, Airbus Beluga, Mi-17, Sky-X UAV, Eagle 1 UAV, and Meteor Missile. These recorders are used to provide a number of mission recording, Health Usage Monitoring (HUMS), OLM engine usage and monitoring systems, and flight test solutions for operational applications.

Civil

S3DR data recorders are equally applicable to civil and military applications, providing high-speed data acquisition and recording applications for many different uses.

Recent civil applications have included police surveillance recording, power-line surveillance systems, airborne RF recordings for air traffic control research, as well as recording of multiple data sources during surgical procedures.

Military

S3DR data recorders are designed to operate in the harshest of environments. Such harsh environments are typical of the products used in extreme, military-type applications.

The S3DR range of products fully support these extremes of temperature, vibration, shock, acceleration, contaminants, EMC, sand, water and dust.

SES

Specialist Electronics Services Ltd (SES) are a system and product development company, specialising in the development, manufacture and support of solid state data recording systems, control display units and analysis tools for use in environmentally challenging land, sea and airborne applications.

Formed in 1991, SES have seen rapid growth in turnover, staff and products. With turnover exceeding £3.6 Million and with 45 members of staff, SES now offer the widest range of data recording and display products in the market place.

SES have products installed on over 50 different platform types, with thousands of operational installations. Ongoing post-design and operational support is available as a service to all installations.

The company work to the highest levels of quality and are accredited to ISO9000-2000, TickIT, and AS9100 (aerospace). In addition the company undertake safety-related developments for safety-related certification of products on a customer requested basis.

To support qualification of products, SES maintain in-house facilities for vibration, shock, temperature, humidity, EMC, water ingress. These facilities allow SES to rapidly develop and underwrite the performance for all its product range.







Environmental Performance

Mil-Std-810F is the latest in a series of guidelines, defined by the US Department of Defense. First published in 1962 these standards define the levels of environmental performance that an equipment might be expected to achieve when used in a military context on a variety of different platform types. The standard sets out "methods" for determining the effects of natural and induced physical environments on equipment used in extreme applications. The procedures provide test methods for ensuring correct performance under a number of extremes of physical environment, including Low Pressure (Altitude), High Temperature, Low Temperature, Temperature Shock, Contamination, Solar Radiation, Rain, Humidity, Fungus, Salt, Sand, Dust, Immersion, Acceleration, Vibration, Mechanical Shock and Ballistic shock.



In addition standards exist for testing and proving performance in noisy electromagnetic environments, Mil-Std-461, and for power supply performance BS3G100. These environmental performance have parallel similar standards such as RTCA DO160D.



SES have been qualifying and testing products to the requirements of these standards for the aerospace/defence and commercial industries for more than 10 years. Thanks to an ongoing investment in test facilities many of these tests can be performed in-house. S3DR products are demonstrated to achieve and often to exceed the requirements of these guidelines.

Data Acquisition

The concept of a data acquisition system, as far as its application in data recording, means acquiring data from the outside world by means of sensors, and turning it into useful information which can be subsequently processed to determine information about the system or outside world being monitored.

Sensors are devices which turn different physical quantities available in the environment into electrical signals. In general a sensor changes one form of energy (light, vibration, sound, speed, temperature) into an electrical measurement of the original physical quantity. The data acquisition system combines multiple sensors, with the purpose of creating a sequence of electrical signals that can be read by a computer, before being packaged together and recorded on a permanent storage media.

S3DR products provide a wide variety of self-contained data acquisition functions. These allow the recorders to operate autonomously, capturing data from a range of different sensors and over a full selection of communications interfaces. Where the internal data acquisition functions are insufficient, the S3DR recorders can be interfaced to external specialist data acquisition systems, using open systems interfaces such as IRIG106 PCM, Fast Ethernet or proprietary high-speed distributed interfaces utilising 1000Mb/s LVDS signalling.

Interfaces

S3DR recorders support a large number of data and communications interfaces, allowing data from many different sensors and communications media to be acquired by a recorder. Interfaces available within the S3DR products include:- RS422/485/232 Serial, High Speed A/D converters, Strain gauges, Thermocouples, CAN Bus, 10/100/1000 Ethernet, 1553B, Arinc 429, Arinc 717, Synchro/Resolver, Audio, Video, NTDS, IRIG106 PCM, IRIG-B, Pan bus, Discretes and USB 2.0.

All S3DR products include FPGA technology, which is utilised to implement bespoke and other high-speed interfaces.

The FPGA is fully integrated into the product supporting off-loading of interface processing as well as providing dedicated hardware implemented functions that remove the burden on the main processor.

In a typical S3DR application, less than 10% of the FPGA resources are used and therefore excellent capacity remains for special additional interfaces.

New interfaces are continually being added, making sure that whatever data is required, the S3DR recorders have an interface that will allow it to be captured.

Rugged Computing

At their most fundamental the S3DR recorders are rugged computers with special hardware, programmable logic and precision timers that allow many different sources of data to be captured and recorded on solid state media.

Two of the recorders in the S3DR range, S3DR-F and S3DR-E, contain high-performance processors capable of running industry standard RTOS operating systems. Both recorders can be specified to reserve a percentage of the available processing power to be used by customer-specific software applications running in parallel with the main software application.

Alternatively, where a recording application is not required, either of these recorders can be supplied as a rugged computing platform, which can be used by a customer to host their own software. Such a solution benefits from the body of qualification and certification support already available with the S3DR products and may be a particularly cost effective way to provide a system onto an air, sea or land platform for which full qualification support evidence is required.

Multinational companies, such as BAE SYSTEMS and Rolls-Royce, already use S3DR products as rugged airborne computers.

Board support packages are available for customer software operating under Windows Embedded XP, Red Hat 7.0, Linux, DOS, Windows CE.Net, VXWorks. Further RTOS are available, contact SES for details. Program languages supported are C++ and ADA.



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RECORD

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S3DR-E

S3DR-E (Expandable) is a high-speed, high capacity expandable data recorder with extensive data acquisition and communications flexibility. The recorder is built from the concept of multiple recording, data acquisition and communication modules that are assembled together to provide a system that meets the specific bespoke requirements of a customer application.

The recorder always contains a master processor module which provides control and configuration of any other modules contained in the system. This master processor provides a high-performance general purpose processor that controls all other data acquisition, recording and communication modules. The processor module also provides multiple high-speed USB 2.0, Giga Ethernet and VGA interfaces.

A minimum S3DR-E recorder is built from a master processor combined with a recording module and an integrated power supply. Alternative recorder configurations can be built from any combination of up to seven data acquisition, communications and recording modules.

- **Recording Modules:** Each recording module can be built from either a dual PCMCIA recorder with a dedicated I/O processor, or a high capacity (100 Gbyte), high speed (up to 480Mbits per second) dedicated recording module.
- **Data Acquisition:** The available data acquisition modules include high-speed A/D converters, video (MPEG2), thermocouples, RTDs and strain gauges.
- **Communications:** The communications modules supported include 10/100/1000 Ethernet, 1553-B, Arinc-429, NTDS-E, RS422/485, CAN bus, Synchro and IRIG-106 (PCM).



S3DR-C

S3DR-C (Compact) is a highly compact, high performance dedicated recorder, providing a data recording solution where space and mass are at a premium. The unit features a high-speed recording function that is able to write data to a removable solid state memory module from multiple monitored interfaces at speeds up to 60 Mbits (7.5 Mbytes) per second. Memory modules are available in many sizes up to 32GBytes.

The S3DR-C weighs less than 1lb (450g), providing unmatched levels of performance from a miniature recorder and is engineered for low-power application, consuming only 3.5W. The recorder meets extremes of environmental performance operating between -40°C and +85°C and supporting extreme levels of vibration.

The S3DR-C is extremely configurable through the presence of an onboard embedded computer and FPGA allowing application specific data gathering regimes and I/O options to be accommodated. The S3DR-C can be used as a data recorder or for data uploading applications.

A key feature of the S3DR-C is the wide range of interface options available as standard, including high speed synchronous serial data (including IRIG 106), IRIG-B timecode, asynchronous RS232/485, CAN bus, ARINC 429, analogue, voice/ audio channels and discrete I/O.



S3DR-F

S3DR-F (Facia-Mounted) provides a high-speed recording solution where space and mass are at a premium and where access to the cartridge is required from within a cockpit. The unit is capable of writing data to a removable solid state memory module from multiple monitored interfaces.

The recorder provides a number of standard interfaces providing high and low-speed serial interfaces, discrete digital I/O, 10/100Mbs Ethernet and IRIG-B timecode. In addition the unit can be expanded, providing other specialised interfaces such as Audio, Video, 1553B, Arinc 429 and high speed A/D.

The S3DR-F supports two removable solid state memory cartridges, which can be used to store different data streams, or as a combined total memory store, providing a total storage capacity of up to 64GB.

Processing functions are provided by a Pentium compatible processor, allowing application specific data gathering regimes to be accommodated.

S3DR-F can also be used as a data-transfer or a combined data-transfer and recording system, in applications where data upload is an important function.



S3DR-CE

S3DR-CE (Compact Extended) builds on the core processing, I/O and recording functions of the S3DR-C, but allows for extension of the available interfaces through the use of a specialised expansion module.

The expansion module can be selected to provide Video, 1553B, Arinc 429, 10/100 Ethernet, high-speed A/D, thermocouples and strain gauge channels. These are provided in addition to the set of interfaces already available within the S3DR-C product.

The unit features an identical recording module to the S3DR-C product providing a high-speed solid recording function, that is able to write data to memory media from multiple monitored interfaces at combined speeds of up to 60 Mbits (7.5 Mbytes) per second.

The S3DR-CE supports ATA Flash memory cartridges with a current maximum storage capacity of 32Gbytes.



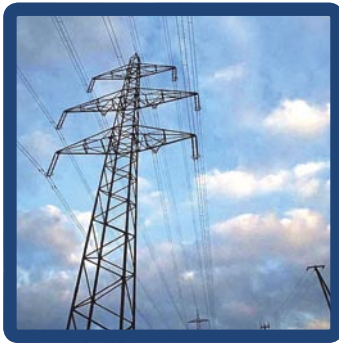
S3DR-CB

S3DR-CB (Compact Bulk Storage) again builds on the core processing, I/O and recording functions of the S3DR-C. The unit is ideally suited where space and mass are at a premium, but where very-high capacity recording is required. The unit features a high-speed solid state memory recording function, that is able to write data to memory media from multiple monitored interfaces at combined speeds of up to 80 Mbits (10 Mbytes) per second. Memory can be manipulated/replayed on the ground in real time or at variable speeds up to 6X recording rate (480 Mbits per second).

The S3DR-CB supports ultra-high capacity cartridges with max storage capacity of 128GB.

The I/O and processing associated with S3DR-CB is identical to S3DR-CE, the only difference being the use of a very high-capacity, high-speed removable cartridge.





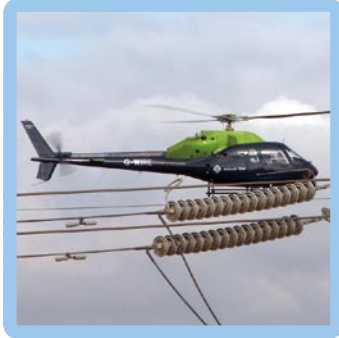
Case Study

National Grid Helicopter Unit undertakes aerial survey of power lines and their associated infrastructure of towers and insulators. The Unit's team of experienced pilots and observers, led by Chief Pilot Peter Gibson, operates a fleet of Eurocopter Twin Squirrel helicopters equipped with daylight and infrared video camera equipment. Video data is recorded during flight for detailed review, analysis and generation of reports when on the ground.

Traditionally aerial surveillance has been recorded using analogue tape recordings utilising expensive, bulky and generally unreliable video tape equipment mounted in the aircraft.



SES worked with Peter Gibson's team to implement digital video capture using S3DR data recorder products to capture video from the aircraft's FLIR video camera pod. The digital nature of the captured video produces enhanced image quality, reliability and allows ground-based replay and analysis to proceed immediately from the point and location at which the aircraft lands.



The system fundamentally consists of two distinct equipments; the airborne video data recorder, an S3DR-F supporting 2 channels of video data, and the ground-based REVEAL data analysis tool. The S3DR-F is a cockpit mounted recorder which utilises a removable flash memory card. The REVEAL software reads data from the removable flash memory card and presents the captured data (video in this case) to the user in a random-access, time-indexed format. Current recording technology supports more than 10 hours of video capture.

The digital nature of the recorded video allows very rapid analysis of captured data. This combined with pilot injected event marking allows the video replay to move straight to the parts of the recordings considered most significant by the pilot. Because the data is fully indexed and digital the user can move straight to points of most interest.

During review using SES REVEAL, video replay can take place at multiples or sub-multiples of the original record speed. Still pictures can be extracted at will, using a coarse-and-fine seek facility, and pasted in a report or simply sent by e-mail. The whole video session can be archived to DVD before or after review.

REVEAL visualisation can also be controlled using jog/shuttle devices for speed and precision.

The combination of the improved quality, combined with rapid replay, archiving and data export features are cited by National Grid as the main driver for moving to the SES digital video solution.

Since initial system delivery National Grid have reported significant reductions in the time required to analyse recorded data and to generate reports for subsequent maintenance/repair action. Video image quality is also perceived as dramatically improved over previous analogue techniques, providing much better images for subsequent analysis and review.

Solid State Memory

SES solid state data recorder products are designed around the concept of removable solid state memory media based on the industry standard ATA Flash format, and as such the media devices used in SES products are critical to the success of these products.

SES have invested significantly in securing and proving the best available technology for its memory products, both to protect its ability to provide high performance COTS solutions and to be able to provide the best solutions to our customers.

SES manufacture ATA Flash memory cards at its Camberley facility, in the UK, under strict quality controls and in accordance with audited Standard Operating Procedures that apply to all our aerospace and defence business.

SES have worked closely with the manufacturers of solid state memory, to develop a range of memory cartridges that offer exceptional performance when used within an S3DR data recorder.

This range of memory cartridges include a bespoke high-performance controller, that can be used to provide "value-added" functions within an S3DR system including data security, secure erase and enhanced wear levelling functions.

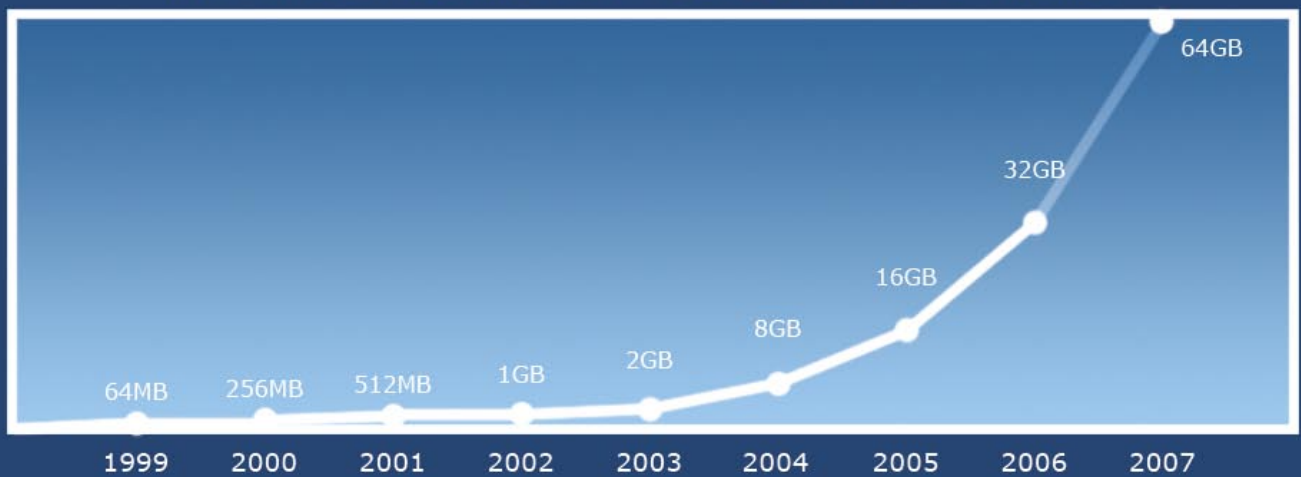
SES solid-state memory cartridges offer exceptional high-speed performance and capacity. The PC Card variant memory card supports typical sustained transfer rates of 8MBytes per second (64Mbits per second) with capacity up to 32GBytes. These cartridges are also backwards compatible with PCMCIA flash cards and can be loaded into a PCMCIA slot in a laptop computer and accessed as "removable" media through the numerous operating systems that support flash memory cards.

The larger cartridges support transfer rates of 60Mbytes per second (480 Mbits per second) with capacity up to 128GB. These products have associated dedicated data readers utilising high speed serial ATA interfaces.

All SES solid-state memory cartridges are environmentally and functionally qualified for use within any S3DR recorder.

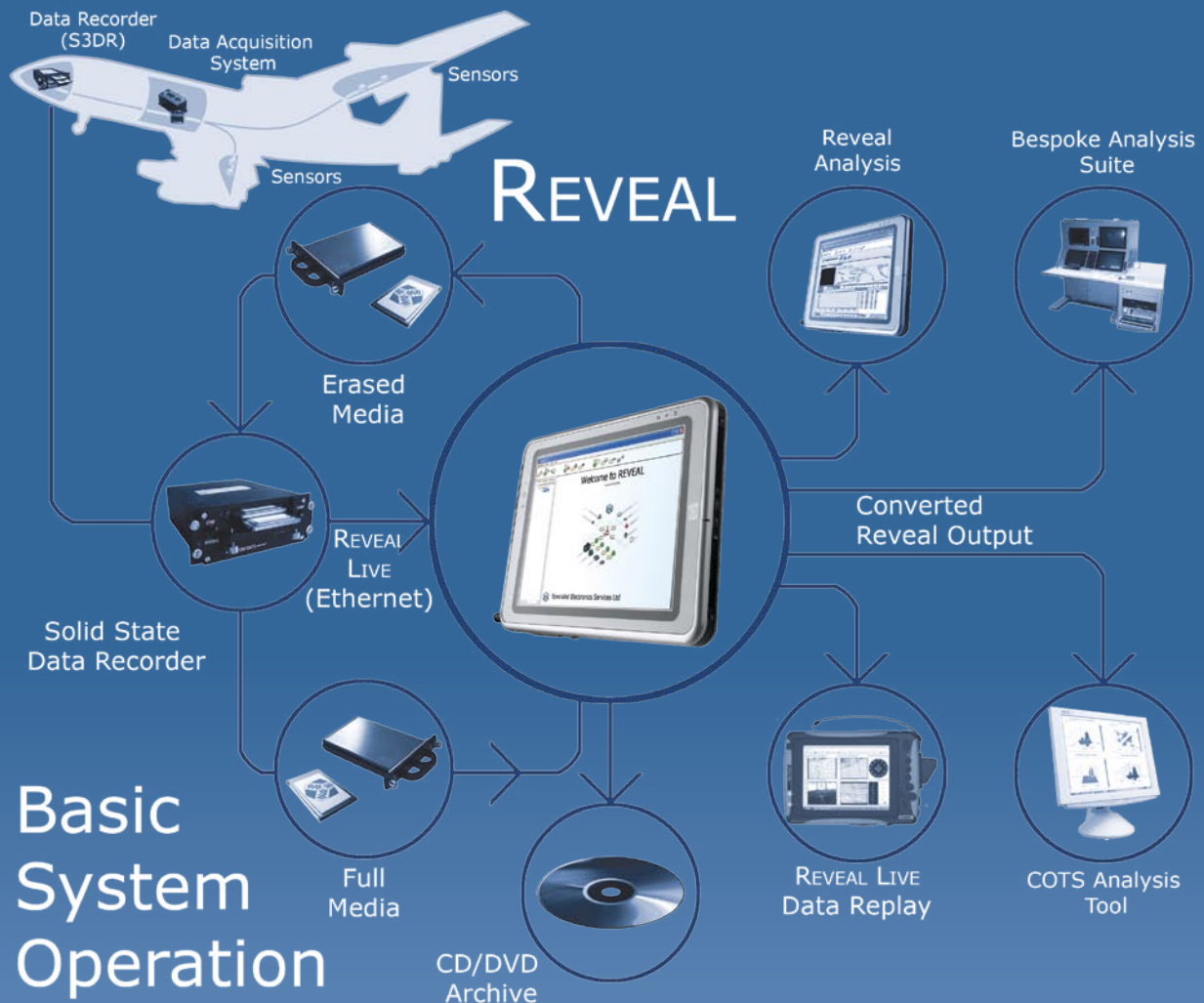


ATA FLASH CAPACITY IN PCMCIA TYPE 2 FORMAT



REVEAL

REVEAL is a partner product to the S3DR data recorder range. It allows the user to extract and manipulate data from a removable memory cartridge and to prepare the cartridge for reuse by an S3DR Recorder. REVEAL is an application for Microsoft Windows that provides a wealth of features for extracting, interpreting, visualising and analysing data captured using an SES data recorder.



Basic System Operation

Key features of the tool include:-

- Conversion of data to a variety of formats to allow analysis with domain specific tools.
- Interpretation of data from a data stream into its constituent parameters using flexible Data Definition Formats.
- Archiving of data to hard disk, CD or DVD for later analysis or long term storage.
- Visualisation of data to allow visual analysis within REVEAL using a framework that supports real-time and fast-time playback where suitable hardware is available. Available visualisers include Video, Audio, Graph, 1553, CANBus, Gauge, Text, and Time.
- Declassification of S3DR data storage media.
- Annotation of recorded data with supplementary data.
- Automated analysis of data streams to identify patterns of data or events within streams.

The architecture of the application allows for easy customisation of the application to suit specific requirements, for example introduction of a new plug-in to output data in a new format. Alternatively, the underlying components can be reused to provide a bespoke application to automate the extraction and processing of S3DR data cartridges.

Customisation

SES are acknowledged experts in embedded software and electronic design applications and are able to work with you to produce a fully customised version of an S3DR to meet your specific requirements.

The S3DR product architecture supports large FPGA devices and microcontroller firmware which can be modified to meet the needs of any specific requirements; various locations into which expansion modules can be added are provided in all but our smallest recorder.

Because our products are designed to support customisation, the costs associated with producing a bespoke recorder are remarkably low, and offer a far more cost-effective route than building a unit from scratch. Often minimal changes to software and hardware are required, and re-qualification can be limited by the minimal extent of the change.

Modification of the recorders often works hand-in-hand with modifications to the REVEAL software in order to achieve an overall end-to-end system solution in which data formats in and out are **exactly** what the customer requires, allow them to leverage an investment in existing legacy tools.

Current bespoke-to-purpose variants of S3DR include;

S3DR-CVR - Cockpit Voice and Flight Data Recorder

S3DR-OLM - Operational Loads Management,

S3DR-DARS - Data Acquisition and Recording System

S3DR-DTS - Data Transfer System,

S3DR-QAR - Quick Access Recorder for Flight Data

S3DR-EMR - Engine Monitoring Recorder.

Each of these custom system solutions is based on one of the existing S3DR base products detailed here.

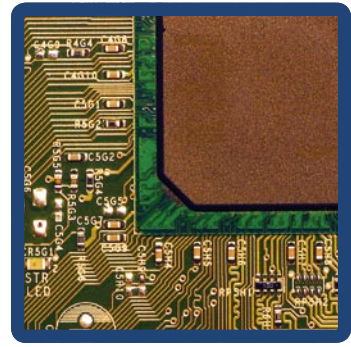
Support

All S3DR products are designed, manufactured and fully supported by SES. A dedicated In-Service support organisation operates within SES and provides the factory-based service and support options required of our customers.

First-line support for all products is available through the SES distributor network, which can provide on-site support where necessary. SES operate an online helpdesk for our REVEAL product, allowing patches and latest versions of software to be downloaded for all customers still within support.

In addition to the standard levels of support that all customers enjoy from SES products, a number of customers have also employed SES in a "Post Design Support" role. Under these arrangements, SES undertake to maintain a product build standard at a fixed point in time and to effectively treat such a supported piece of equipment as a unique system whose configuration is maintained and controlled in accordance with strict MoD/CAA/MilStd requirements.

SES can be contracted to provide full in-service operational support, for support requirements extending out 15-20 years. This support can extend from basic levels of survey and repair, through to full contractor logistic support (CLS). Because our products are fully under our configuration control and the use of COTS parts is minimal, SES can be relied upon to ensure that your purchase really will meet your requirements for many years to come.



S3DR-CVR: Cockpit Voice Recorder

- 2 Channels • 1 Cockpit Area Microphone • Continuous Loop Recording • ARINC 717 • In-flight Recording



S3DR-EMR: Engine Monitoring Recorder

- 3 Channels • Thermocouple Channels • Serial FADEC Diagnostic Channels • Altitude • Tri-axial Acceleration • 100+ Hours Continuous Loop Flight Recording



S3DR-QAR: Quick Access Recorder

- Data Recorded in Parallel with Crash Removable PC ATA Flash Card • Rapid Graphical Analysis



S3DR-OLM: Operational Loads Management

- 5000 Gauges • Link to nSoft Analysis • Close Integration With KAM-5000 • G-Force Control



S3DR-DTS: Data Transfer System

- 5000 Memory Cartridges • TCP/IP + Ethernet • ARINC 429 • MIL-STD



S3DR-VR: Solid State Video Recorder

- 1000 Hours Video • 4 Channel Audio • Replay While Recording • 6 Hours DVD Quality Recording



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