



SIR-S SECONDARY SURVEILLANCE MODE S RADAR

SIR-S Secondary Surveillance Radar is a modular system fully compliant with ICAO and EUROCONTROL recommendations on Mode-S operation.

SIR-S is a dual-channel system with automatic changeover, solid state transmitter and receiver, designed for unmanned operation.

Single channel configurations are also available, on request. Each SSR channel consists of a transmitter, a receiver, and a programmable extractor/controller.

The powerful processing platform is based on COTS equipment and is completely software programmable in order to exploit improvements of commercial platforms and prevent obsolescence problems.

Furthermore, it provides all programmable functions of the transmitter and receiver units.

The antenna typically used in conjunction with the sensor is the ALE-9 LVA antenna, designed for full monopulse use. It provides high directional properties and vertical aperture, as recommended by ICAO, also needed for the Enhanced Mode-S Surveillance (EHS). SIR-S is the relevant part of the SELEX SI Mode-S System

and, according to the system configuration, it can operate in SSR Conventional Mode, Elementary Surveillance, Enhanced Surveillance up to full Mode-S data link operation employing level 5 transponders.

No Hardware changes are required to upgrade the system from one configuration to another.

MONOPULSE ADVANTAGES

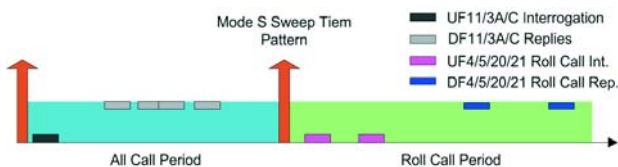
SIR-S implements a full monopulse algorithm that is able to detect and correct SSR and Mode-S Replies from more than -2.4° to 2.4° , thus allowing a powerful exploitation of the antenna beam width for SSR detection in "resolution cases" and an efficient Mode-S Roll Call scheduling process.

The main purpose of the monopulse technique is to obtain accurate azimuth information from a single transponder reply. The *Mode S Sweep Timing pattern* technique uses Σ and Δ beam patterns, inclusive of phase information, to obtain the correct bearing (off-boresight angle) of the target with respect to the actual position of the sum beam. A very accurate plot position is thus obtained.



SIR-S Dual Channel Configuration

In case of close targets or crowded airspaces, monopulse technique allows reducing the Interrogation Repetition Frequency (IRF), thus reducing RF pollution. The following picture depicts a typical Mode S sweep timing pattern.



Mode S Sweep Timing pattern

ADVANTAGES OF MODE-S

Mode-S eliminates or reduces of a great extent problems so far related to standard Secondary sensors such as garbling, fruit and over interrogation, and 3/A Codes shortage. Mode-S interrogation increases the performance of secondary radars in terms of enhanced surveillance functions by introducing the following capabilities:

- All-Call based acquisition
- Lockout Protocols

- Selective and unique addressing
- Error detection and correction
- Adaptive interrogation
- Single surveillance interrogation per antenna scan

Furthermore Mode-S supports digital data exchange among ground and airborne computers, implementing ATN (Aeronautical Telecommunication Network) air/ground functions. This service allows the exchange of any kind of data, mostly kinematics, with aircraft in order to improve awareness of target motion, identity, and intention.

SIR-S EQUIPMENT MAIN FEATURES

Use of state-of-the-art technology:

- Latest generation of RF Power Transistors
- Very Large Scale Integration (SMD technique)
- Latest generation processors and architectures

Full redundancy of critical items:

- Two Transmitter Units
- Two Receiver Units
- Two Processor Units
- One automatic changeover unit

Cross-coupled configuration

In case of critical failures and as an extreme operational configuration SIR-S automatically crosses the operational channels, using the extractor of one channel with the Transmitter/Receiver of the other.

This configuration is the “last choice” after subsequent failures in different sub-assemblies of different channels.

EXTENDED PERFORMANCE MONITORING

- Processing of Replies from Test Transponder
- Generation of Replies at RF level with TTG circuitry
- On-line receiver logarithmic characteristic calibration
- Extensive on-line BITE for LRU fault detection

Improved azimuth monopulse estimation

Two algorithms are used for the azimuth angle estimation in order to improve detection performances:

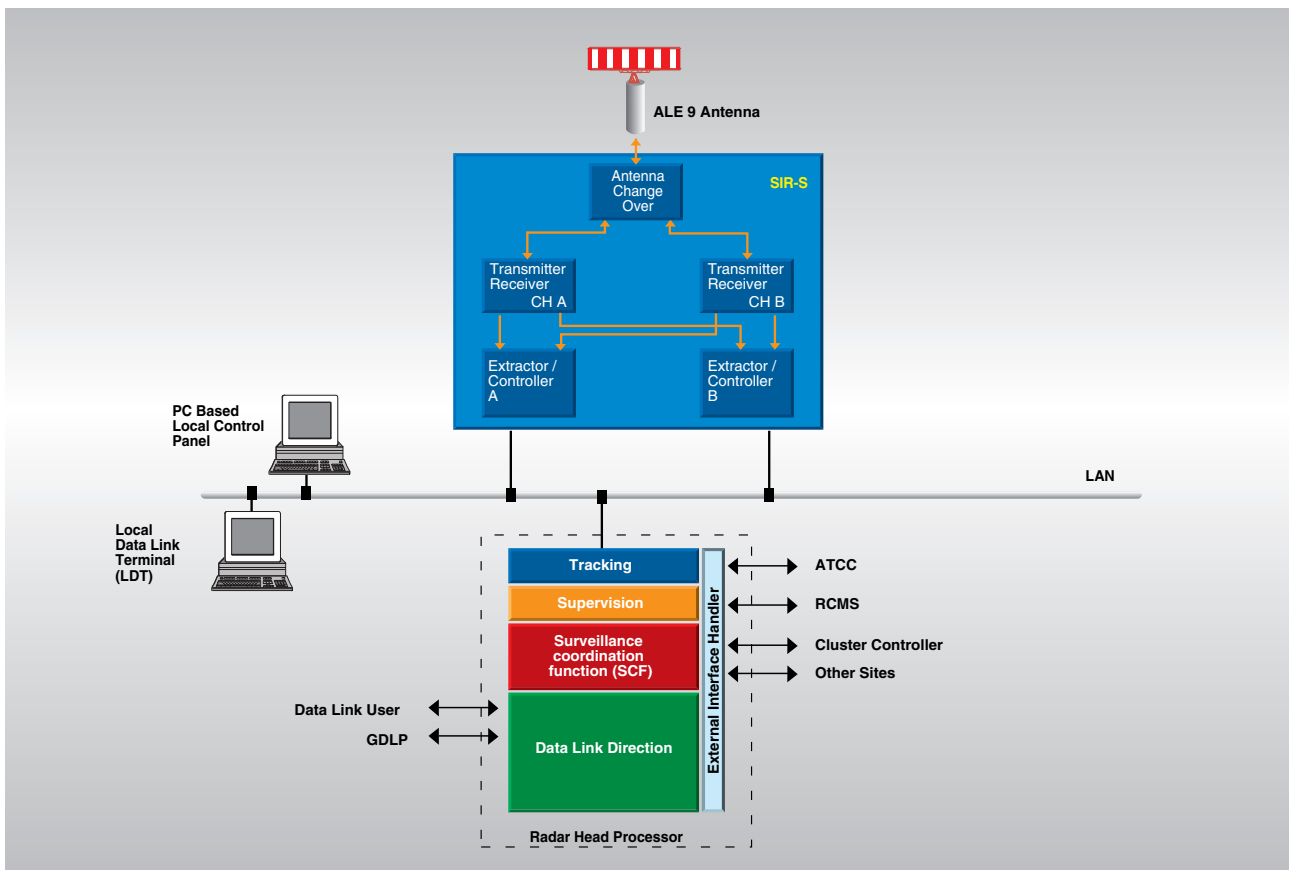
- Amplitude and sign processing (ASP)
- Dot Product Processing (DPP)

Selection logic activates DPP algorithm for replies very close to boresight in order to minimize estimate errors.

Full Mode-S operation

SIR-S fully complies with ICAO latest Mode-S requirements and with the Eurocontrol EMS (European Mode-S Station) ones.

Mode-S Can be enabled or disabled with just one click as well locally as remotely (via the Remote Control and Monitoring Station).



Mode S System (SIR-S + Radar Head Processor) full mode S configuration

SIR EQUIPMENT CHARACTERISTICS: TRANSMITTER UNIT

Technology:

- Full Solid State with plug-in modules
- VME Standard for inter-board comms.

Configuration:

- One redundant transmitter
- Automatic Changeover

TX frequency:

- 1030 MHz ± 0.01 MHz (SIR- S)

ATC & MIL modes:

- Fully supported

TX monitoring logic:

- BITE and status reporting
- Malfunction detection at LRU level
- Protection Circuits
- Short and open circuit
- Over-voltage from P.S. faults
- Excess duty cycle and temperature on heat sink

SIR EQUIPMENT CHARACTERISTICS: RECEIVER UNIT

Technology:

- Full Solid State and plug-in devices

Configuration:

- Three amplitude and phase matched LOG channels

Signal Output characteristics:

- SUM, DIFF and OMNI channels:
- Automatic Selection of Master Video and Trigger
- Phase detector channel

RX control logic:

- Autotest procedure for each channel
- Test arget Generator (RF Signal)

RX monitoring logic:

- BITE and Status Reporting
- Malfunction Detection at LRU level
- Protection Circuits
- Over-voltage from P.S. faults
- Input interference protection

PROCESSING UNIT

It is a multiprocessor system based on a Power PC hardware platform which can be easily upgraded. Due to its modular design, technological enhancements can be incorporated in the HW platform without impacts on the architecture and SW applications.

The receiver interface consists of dedicated boards performing all necessary operations to process received

replies using 4 A/D converters (Sum, Diff, Omni and Sin). All boards interface each other by a VME Bus.

PROCESSOR MAIN FUNCTIONS

Uplink control:

- Sector-based control of TX power
- Pulse to pulse modulation
- PRF selection
- Interlace management
- Interrogation staggering
- Interrogation modes management
- Frame management (SIR-S version)

Downlink Control:

- STC function with Range/Azimuth Map
- Adaptive thresholds for multipath rejection

Pulse & Reply Processing:

- Rx Output Processing
- Pulse Detection
- Reply Processing for modes 1,2,3/A, B, C, D, 4
- Reply Processing for Mode-S (SIR-S version)

Plot Extraction:

Correlation among replies (ATC, MIL and Mode-S) received during the "dwell time" and construction of plots (for A/C targets) and target reports (for Mode-S targets). Civilian and Military Emergency codes are detected.

Channel Management:

It includes all the functionalities necessary to use the RF channel in order to accomplish the surveillance and communication functions of the radar.

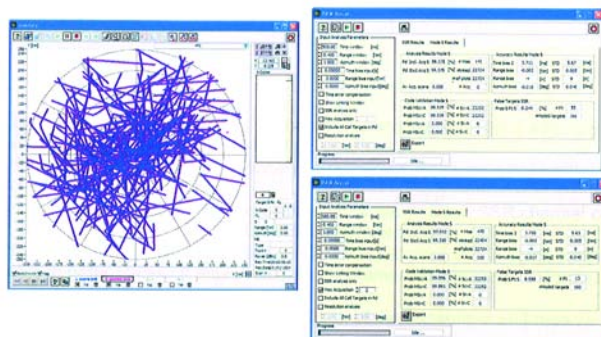
Timing of the channel activities is performed in order to accomplish correct interrogation and accurate management of the relevant replies.

Ancillary Functions:

- BIT (Built-In-Test)
- UDP/IP and Serial Line communications
- Master-Slave management
- Automatic Master/Slave channel alignment

MODE-S OPERATIONAL STATION

The station has been designed for all performances and functional characteristics specified by Eurocontrol. Functionalities provided are as follows:



Surveillance Coordination (Cluster):

Mode-S interrogations performed by associated stations are coordinated and handover is managed according to the sensor coverage maps.

Data Link:

Enhanced surveillance and Mode-S services are provided to local and remote users through the Mode-S communication link.

Supervision:

A complete control of the system is guaranteed by means of a graphical user-friendly interface operating as well locally as remotely on a stand-alone personal computer.

SYSTEM PERFORMANCES

Mode-S has been fully tested and validated using third party international evaluation tools developed in the framework of the Pre-Operational Mode-S Station Implementation Programme (POEMS) and certified by EUROCONTROL. The system proved to be compliant with all the SSR and Mode S performance requirements demonstrating outstanding performances in terms of accuracy figures and de-garbling, de-fruiting algorithm efficiency.