Technical Characteristics

Interrogation Modes			
Interrogation Modes	3/A, C, S Enhanced Surveillance		
Interlace capability	Customisable for individual interrogations, sector-specific interrogations, maintaining silent sectors		
Intermode capability	A/C for all-call interrogations only, A/C/S for all-call interrogations		
Mode S capability	Mode S Elementary and Enhanced Surveillance (UF/DF 4, 5, 11, 20, 21; Comm A, Comm B incl. AICB, GICB)		
ADS-B, Extended Squitter (1090 MHz)	Automatic Dependent Surveillance - Broadcast, receipt and extraction of position squitter replies, silent Mode S acquisition, cone of silence tracking, classification of reflections		
Interrogation rate in Mode A/C	< 450 Hz, dynamically depending on interlace pattern		
Rate of Mode S all-call interrogations only	typically < 60 Hz (5-6 rpm)		
Interrogation Transmitter			
Transmit frequency	1030 ± 0.01 MHz		
Output power at antenna port	500 W, 1500 W, 2000 W, 2 x 2000 W (scalable)		
Bandwidth	12 MHz		
Gain control	adjustable in steps of 1 dB, independently for ∑ and Ω		
Duty cycle (DC) of main beam (according to EURO-CONTROL specification, unless otherwise specified)	65% in intervals of 2.4 ms 8.2% in intervals of 40 ms (FAA) 6.4% permanently		
ISLS duty cycle	< 0.1%		
Output VSWR	< 1.5		
Reply Receiver			
Centre frequency	1090 ± 0.5 MHz		
Bandwidth	12 MHz		
Sensitivity	- 89 dBm		
Dynamic range	80 dB		
Gain time control	programmable in sectors		
Instrumented range	0.08 to 331 NM (resolution of 0.06 m) with ASTERIX cat. 048 extension		
Processed range	0.08 NM to max. 331 NM (limit to be predefined)		
Image frequency rejection	> 70 dB		
Performance Figures			
According to EUROCONTROL, using a standard LVA antenna (antenna rotation speed of 10 to 15 rpm):			
Target capacity (equal distribution)	2,000 targets over 360°	400 targets over 45 °	110 targets over 3.5 °
Range resolution (2 targets with the same azimuth)	≤ 75 m		
Azimuth resolution (2 targets with the same range)	≤ 0.72°		
Range accuracy (mainly due to transponder errors)	σ ≤ 30 m for SSR	σ ≤ 15 m for Mode S	σ ≤ 7 m w/o transponder error
Azimuth accuracy	σ ≤ 0.05°		
Probability of detection: (EUROCONTROL EMS Funct. Spec., v3.11, section 4.2.3.2.1)	≥ 99%		
False alarm rate (EUROCONTROL EMS Funct. Spec., v3.11, section 4.2.5.1)	≤ 0.1%		
Target resolution (EUROCONTROL EMS Funct. Spec., v3.11, section 4.2.7.1, 300 Hz, ATT 5s, M3/A+MC) • area 1: 0.96° < Δθ < 4.68°, ΔR < 2 NM • area 2: 0° < Δθ < 0.96°, 0.05 NM < ΔR < 2 NM • area 3: 0° < Δθ < 0.96°, 0 NM < ΔR < 0.05 NM	 Pd ≥ 99% Pd ≥ 99% Pd ≥ 83 %	 PcvA ≥ 99% PcvA ≥ 99% PcvA ≥ 70 %	 PcvC ≥ 99% PcvC ≥ 90 % PcvC ≥ 70 %
External Interfaces			
Power supply	115 to 230 V, 47 to 440 Hz		
Power consumption	< 1,500 W (full duty cycle)		
Physical connections	2 x LAN, 4 x RS-422		
Communication layer protocols	X25, UDP, TCP/IP, HDLC		
Application layer protocols	ASTERIX (Cat. 017, 018, 021, 034, 048, 253), NTP, NMEA		

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Detect and Protect.

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Air Traffic Control

MSSR 2000 I®

Monopulse IFF/ATC Interrogator and Mode S Radar

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Detect and Protect.

MSSR 2000 I

The MSSR 2000 I fulfils all needs expressed by civil operators for Mode S air traffic control radar. It meets the current standard requirements placed by volume IV of ICAO's Annex 10 and by EUROCONTROL's European Mode S Station Functional Specification (version 3.11) on monopulse secondary surveillance radar with Mode S capability – offering a favourable price-performance ratio at the same time.

General

The MSSR 2000 I interrogator fulfils all requirements for Mode S enhanced surveillance systems.

It incorporates its own data processing and tracking functions, which deliver plot and track data according to Mode S for ATC purposes. The system can be operated fully autonomously within its area of coverage. Its modular architecture, its programmable digital signal processing unit, its software-controlled post-processing function and its system management concept allow customised configurations and performance optimisation to be implemented for various applications in different systems, such as civil ATC systems, airport approach control radars or mobile air surveillance systems (seaborne or ground-based).

Operational Advantages

The MSSR 2000 I product family provides the following extraordinary and outstanding features for the benefit of users, operators and maintainers worldwide:

Connection to SSR antennas
Each MSSR 2000 I variant can be connected to any SSR antenna. If the antenna only offers ∑ and Ω channels, the interrogator can also operate in sliding window mode instead of monopulse operation. The stated performance figures are achieved with a standard, 3-channel LVA monopulse antenna as specified by EUROCONTROL. An antenna rotation speed between 60 and 2 rpm and devices with an angular resolution between 10 and 16 bits are suitable.

Motion Compensation
To also support antenna systems that are not mechanically stabilised or to compensate for the movement of the platform, the interrogator offers a customisable serial or LAN interface to import data describing the platform's movements. Using this data, the interrogator performs a 3D coordinate transformation to create a motion-stabilised and corrected recognized air picture for air traffic surveillance.

Mode Interlace Capability
The type of interrogations issued by the MSSR 2000 I is highly customisable. Apart from directed interrogations, silent sectors and complete 360° interrogations, the system can handle sectors with different interrogation patterns. Within each sector, a different combination of predefined interrogation modes and Mode S functionality (interlace pattern) can be selected. Even the pulse repetition frequency (PRF) and gain time control (GTC) may be different in each sector. Furthermore, it is also possible to repeat any interlace pattern at predetermined scan intervals.

ADS-B (1090 MHz) Mode S Extended Squitter
The MSSR 2000 I is able to receive and extract ADS-B Mode S Extended Squitter via its three receive channels. This squitter is used for passive acquisition in Mode S, classification of reflections and internal track support, e.g. for the radar antenna cone of silence. The interrogator reports ADS-B messages in ASTERIX category 021. It verifies the transmitted position of aircraft using selective Mode S interrogations.

Mode S Clustering Capability
The MSSR 2000 I is able to operate in a Mode S radar data network as a node of a Mode S cluster according to version 2.06 of EUROCONTROL's EMS ICD regulations.This enables the operator to overcome Mode S II/SI code shortages by using only a single code for the whole Mode S cluster comprising up to 6 Mode S stations.

EUROCONTROL-certified II/SI Code Operation (EC 262/2009)
The MSSR 2000 I has been certified by EUROCONTROL to comply with the European Commission Regulation 262/2009, which involves increased safety in air traffic control when using Mode S. This processing feature allows legacy Mode S transponders with malfunctions to be detected and corresponding reports to be sent to the supervisory authorities, while maintaining full detection capability.

Safety and Reliability
The MSSR 2000 I has been developed to achieve safety targets in accordance with the RTCA DO-278 AL4 standard, a pre-requisite for being used as ATC ground equipment, and has been type-certified by the German civil aviation authority. It was granted the CE mark on the basis of independent product safety testing, and has been certified by the German association for technical inspection TÜV Rheinland to meet the German LGA state testing authority's requirements.

The figures concerning the MSSR 2000 I's operational availability, which had been calculated based on MIL-HDBK-217, have not only been proven by operations in the field, but have even been exceeded. Experience with the multitude of systems in service and the huge number of hours of fault-free operation suggest that the life cycle costs will in fact be significantly below the conservative estimate.

Product Variants

The system's modular and thus scalable design allows several variants to be implemented, which ultimately include identical LRUs to ensure maximum commonality in the logistic support chain.

- MSSR 2000 I – 500 W – Mode S
- MSSR 2000 I – 1,500 W – Mode S
- MSSR 2000 I – 2000 W – Mode S
- MSSR 2000 I DR

MSSR 2000 I – 500W – Mode S
The variant with a transmission power of 500 W and capable of being fully operated in Mode S is particularly appropriate for systems with medium range requirements. For example, it is intended for use in ASR systems. Thanks to a standard large vertical aperture (LVA) antenna, an operating range of more than 150 NM can be achieved.

MSSR 2000 I – 1,500 W – Mode S
With a nominal transmission power of 1500 W, the interrogator offers Mode S functionality with a limited duty cycle and the fully instrumented range of 256 NM in a one-box design. This device is completely waterproof and pressure-resistant. Thanks to its very good weight-performance ratio, this variant is suitable for transportable or mobile platforms.

MSSR 2000 I – 2,000 W – Mode S
The Mode S version with 2000 W consists of an interrogator and a booster unit, with the booster comprising 6 transmitter modules. This variant meets all functional system requirements of an ATC system in a single-chain configuration. It is the best choice for elementary and enhanced surveillance in Mode S over long ranges (256 NM) with a maximum duty cycle, including datalink functionality.

MSSR 2000 I DR
In the DR version, the MSSR 2000 I offers Mode S capability and dual redundancy for any power variant, and also a switch-over unit to meet the availability requirements of state-of-the-art ATC systems.
The MSSR 2000 I DR has all necessary interfaces to be integrated into a Mode S cluster for receiving and transmitting surveillance data. Within a Mode S cluster, it can be operated in both central and distributed mode as specified by EUROCONTROL. In addition, it offers high-level Mode S protocols for ADLP and GDLP.

Integrated Single-Cabinet Solution
The fully integrated MSSR 2000 I DR with dual redundancy, additional communication and network devices, NTP time servers and ancillary equipment fits into a single 19-inch cabinet – whether in the long-range version for en-route air surveillance or as an individual airport approach control radar. This makes the MSSR 2000 I the most compact and also the most robust Mode S enhanced surveillance radar, which complies with ICAO's Annex 10 requirements and EUROCONTROL's EMS Functional Specification.