Technical Characteristics

Interrogation Modes

<table>
<thead>
<tr>
<th>Mode/S capability</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>Mode S capability</td>
<td>Mode S Elementary and Enhanced Surveillance (UF/DF 4, 5, 11, 20, 21; Comm A, Comm B incl. ACIB, GICB)</td>
</tr>
<tr>
<td>ADS-B, Extended Squitter [1090 MHz]</td>
<td>Automatic Dependent Surveillance - Broadcast, resumpt and extraction of position squitter replies, silent Mode S acquisition, cone of silence tracking, classification of reflections</td>
</tr>
</tbody>
</table>

Directed interrogation capability
Selector identification/interrogation with any possible interface pattern, externally induced on 3D position or track number

Mode XII interrogation rate
< 450 Hz, dynamically depending on interface pattern

Rate of Mode S all-call interrogations only
Typically < 60 Hz (5-6 rpm)

Interrogation Transmitter

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Bandwidth</th>
<th>Output power</th>
<th>Gain control</th>
<th>Duty cycle (DC) of main beam (according to EUROCONTROL specification, unless otherwise specified)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1030 ± 0.01 MHz</td>
<td>12 MHz</td>
<td>500 W, 1500 W, 2000 W, 2 x 2000 W (scalable)</td>
<td>adjustable in steps of 1 dB, independently for Σ and Ω</td>
<td>65% in intervals of 2.4 ms, 9.2% in intervals of 40 ms (FAA), 6.4% permanently</td>
</tr>
</tbody>
</table>

Reply Receiver

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Bandwidth</th>
<th>Sensitivity</th>
<th>Dynamic range</th>
<th>Gain time control programmable in sectors</th>
</tr>
</thead>
<tbody>
<tr>
<td>1090 ± 0.5 MHz</td>
<td>12 MHz</td>
<td>- 80 dBm</td>
<td>80 dB</td>
<td></td>
</tr>
</tbody>
</table>

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) α ≤ 30 m for SSR, α ≤ 15 m for Mode S, α ≤ 7 m w/o transponder error
- Azimuth accuracy α ≤ 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, MD A-MC)
  - area 1: 0.96° < ∆θ < 4.68°, ∆R < 2 NM
  - area 2: 0° < ∆θ < 0.96°, 0.05 NM < ∆R < 2 NM
  - area 3: 0° < ∆θ < 0.96°, 0 NM < ∆R < 0.05 NM
  - Pd ≥ 99%
  - Pd ≥ 99%
  - Pd ≥ 70%
  - 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 ≤ 1500 W (full duty cycle)
- Physical connections 2 x LAN, 4 x RS-422
- Communication layer protocols X25, UDP, TCP/IP, HDLC
The MSSR 2000 I fulfills all requirements for Mode S enhanced surveillance systems as well as for the procuring of military IFF interrogators using Mode S Levels 1 and 2. It incorporates its own data processing and tracking functions, which deliver plot and track data using Mode S for IFF/ATC purposes. The system can be operated fully autonomously within its area of coverage. Its modular architecture, its digital programmable signal processing, its software-controlled post-processing and its system management concept allow customised configurations and performance optimisation to be implemented for various applications in different systems, such as civil and military ATC systems, air defence radars, airport approach control, radar stations and 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 manufacturers worldwide:

- **Connection to SSR antennas** Each MSSR 2000 I variant can be connected to any IFF/SSR antenna. If the antenna only offers Σ and Δ 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 traffic surveillance picture. Even for non-rotating active or passive IFF antennas, the MSSR 2000 I offers integrated beam steering control and full track-while-scan functionality to allow the automatic emission of selective interrogations to be reduced to a minimum.

- **Directed Interrogation** For military applications, it may be essential to reduce the RF emissions as far as possible or to emit selective interrogations in encrypted, secure mode only. To fulfil these requirements, the MSSR 2000 I is not only able to provide silent sectors, but can also be run with directed interrogations (ASTERIX cat. 007). Such externally triggered interrogations allow the targets to be selectively identified with any combination of MKXII-A/S interrogation modes. On the receive side, the MSSR 2000 I continues to collect the responses and track the targets.

- **Mode Interface 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 off-axis target patterns. Within each sector, a different combination of predefined MKXII-A and Mode S interrogations (interlace pattern) can be selected. Even the pulse repetition frequency (PRF) may be different in each sector. Furthermore, it is also possible to restrict the available interface patterns and predefined scan intervals.

- **ADS-B (1090 MHz) Mode S Extended and Mode S Level 2 Squitter** The MSSR 2000 I is able to receive and extract ADS-B Mode S extended and Mode S Level 2 squitter via its three receive channels. This squitter is used for passive acquisition in Mode S, for classification of reflections and internal track support, e.g. for the cone of silence of the radar antenna. 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, both in central and distributed mode. This enables the operator to overcome Mode S IFF code shortages by using only a single code for the whole Mode S cluster comprising up to 6 Mode S stations.

- **Mode S Level 1 and 2** Thanks to its digital receiver, the MSSR 2000 I is capable of receiving Mode S Level 2 replies and squitters in all three RF channels thus increasing Mode S Level 2 coverage. When interrogating and receiving synchronous Mode S Level 1 replies, the system calculates the exact azimuth direction of the aircraft using the amplitude-of-pulse monopulse; when Mode S Level 2 signals are received, the position of friendly aircraft is decrypted in the report.

- **Multi-Crypto-Computer Compatibility** The MSSR 2000 I is certified according to AIMS 03-1000B Amendment 1 and is compatible with all crypto-computers which comply with AIMS 04-9000A and B, including QR4TKING, QR4TKING, BIT2010, KIV76 and KIV77.

- **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 DR** In the DR version, the MSSR 2000 I offers Mode S/5 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 ADP and GDL. In just one 19” cabinet, the MSSR 2000 I DR with 200 W represents a dual-redundant 2 kW radar station for Mode S enhanced surveillance.

- **Naval IFF Rack** This variant of the system is suggested for all platforms that require the complete IFF/ATC equipment for identification of aircraft and to be fitted. It consists of the MSSR 2000 I in one of the variants described above and a military LTR 400 transponder with Mode S Level 2 capability and Mode S Elementary and Enhanced Surveillance capability.

**Proven and flexible Platform Integration**

The MSSR 2000 I is highly flexible when it comes to integration into platforms. It offers external interfaces based on international standards, such as EUROCONTROL’s ASTERIX information exchange standard for command, control and reporting. Moreover, it is compatible with a wide variety of antenna systems, including dual rotator systems. It can be scaled to meet the customers’ specific requirements and can be configured through individual parameter settings. More than 400 units of the MSSR 2000 I have so far been sold to over 40 countries for integration in more than 160 platform types: 50 different types of military and civil ATC platforms, 25 types of mobile ground-based air defence radars and 85 types of naval platforms.