

Doc 9924
AN/474



Aeronautical Surveillance Manual

Approved by the Secretary General
and published under his authority

First Edition — 2010

International Civil Aviation Organization

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FOREWORD

Air traffic is growing at a significant rate and at the same time, there are increasing demands for more operating flexibility to improve aircraft efficiency and to reduce the impact of air travel on the environment. Aeronautical surveillance systems are major elements of modern air navigation infrastructure required to safely manage increasing levels and complexity of air traffic.

This manual has been produced by the Aeronautical Surveillance Panel (ASP) as a reference document consolidating the updated guidance material previously published in other manuals with new material covering more recent or emerging techniques. The chapters provide the reader with a basic understanding of various systems and how they are used for air traffic surveillance while the appendices contain detailed information on some specific systems and related topics.

Comments on this manual from States and other parties outside ICAO concerned with surveillance system development and provision of services would be appreciated and should be addressed to:

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EXPLANATION OF TERMS

Acquisition squitter. The spontaneous periodic transmission by a Mode S transponder (nominally once per second) of a specified format, including the aircraft address, to permit passive acquisition.

Aircraft. Any machine that can derive support in the atmosphere from the reactions of the air other than the reaction of the air against the earth's surface.

Note.— In the context of aeronautical surveillance, the term “aircraft” should be understood as “aircraft or vehicle (A/V).”

Aircraft address. A unique combination of 24 bits that is available for assignment to an aircraft for the purpose of communications, navigation and surveillance.

*Note.— The aircraft address is sometimes referred to as the **Mode S address**, the **aircraft Mode S address**, or the **24-bit address**.*

Aircraft identification. A group of letters, figures or a combination thereof which is either identical to, or the coded equivalent of, the aircraft call sign to be used in air-ground communications, and which is used to identify the aircraft in ground-ground or air traffic services communications.

*Note.— The aircraft identification is also referred to as **flight identification**.*

All-call. An intermode or Mode S interrogation that elicits replies from more than one transponder.

All-call (Mode A/C-only). An intermode interrogation that elicits replies from Mode A/C transponders only. Mode S transponders do not accept this interrogation.

All-call (Mode S-only). A Mode S interrogation that elicits all-call replies from Mode S transponders that are currently not in the lockout state for that interrogator code.

All-call (stochastic). A Mode S-only all-call that elicits all-call replies from only a random subset of the Mode S transponders that are currently not in the lockout state.

Antenna diversity. An installation that consists of top and bottom mounted antennas that is used in SSR, ACAS and ADS-B systems to improve the transmission and reception capabilities.

Altitude. The vertical distance of a level, point or an object measured above mean sea level.

Antenna (electronically scanned, E-Scan). An SSR antenna consisting of a number of planar arrays or a circular array of radiating elements. A beam former unit allows it to electronically steer the beam to the desired azimuth angle by applying phase shifting. The antenna elements may either be active or passive, depending on the order in which the beam former and transmitters are set up.

Antenna (hog-trough). An SSR antenna comprising a horizontal linear array of radiating elements installed in an extended corner reflector assembly (resembling in shape a hog-trough). The linear array is usually of sufficient length to give an azimuth beamwidth of between 2 and 3 degrees, and the hog-trough reflector achieves typically between ± 40 and 45 degrees vertical beamwidth. For special purposes shorter arrays can be used. These have increased azimuth beamwidth.

Antenna (large vertical aperture LVA). An SSR antenna comprising two-dimensional array radiating elements. A typical LVA consists of a number of columns (each consisting of a vertical linear array designed to produce beam shaping in the vertical plane) arranged in a horizontal linear array to produce an azimuth beamwidth of between 2 and 3 degrees. LVA antennas are widely used for monopulse SSR systems.

Antenna (linear array). An antenna consisting of an array of radiating elements in a straight line. The desired radiation characteristic of the antenna is obtained by the varied distribution of radio frequency energy in amplitude or phase so as to produce the shaped “beam” or wave front.

Antenna (monopulse). See antenna (sum and difference).

Antenna (omnidirectional). An antenna with the same gain in all directions.

Antenna (sum and difference). A hog-trough or LVA antenna which is electrically split into two halves. The two half-antenna outputs are added in phase at one output port (sum, Σ) and added in anti-phase at a second output port (difference, Δ) to produce output signals which are sensitive to the azimuth angle of arrival of received signals, enabling an off-boresight angle for the signal source to be obtained. This kind of antenna is required for monopulse and Mode S operation.

Antenna (reflector). An antenna producing the beam by a method analogous to optics. In most cases the “reflector” surface of the antenna is illuminated by a radio frequency source (e.g. a radio-frequency “horn” assembly). The dimensions of the reflector antenna both in the horizontal and vertical plane, together with the characteristics of the illuminating source, determine the shape and magnitude of the radar beam produced.

BDS1 code. The BDS1 code is defined in the RR field of a surveillance or Comm-A interrogation.

BDS2 code. The BDS2 code is defined in the RRS of the SD field of a surveillance or Comm-A interrogation when DI = 7. If no BDS2 code is specified (i.e. DI \neq 7), it signifies that BDS2 = 0.

Beamwidth. An angle subtended (either in azimuth or elevation) at the half-power points (3 dB below maximum) of the main beam of an antenna.

Boresight. A main lobe electrical (radio) axis of an antenna.

Capability report. An indication provided by the capability (CA) field of an all-call reply and a squitter transmission of the communications capability of the Mode S transponder (see also “data link capability report”), and some information on the aircraft status.

Chip. A 0.2-microsecond carrier interval following possible data phase reversals in the P₆ pulse of Mode S interrogations (see “data phase reversal”).

Closeout. A command from the Mode S ground station that terminates a communication transaction.

Cluster. A set of Mode S interrogators with overlapping coverage that use the same interrogator code. The interrogators communicate with each other to provide acquisition or reacquisition to neighbouring interrogators. The cluster operation requires fewer interrogator codes, and Mode S aircraft within the cluster airspace normally remain in a state of lockout, which reduces Mode S all-call transmissions.