CIVIL AVIATION PUBLICATION

CAP 34

MODE S & ELT CODING

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CHAPTER 1

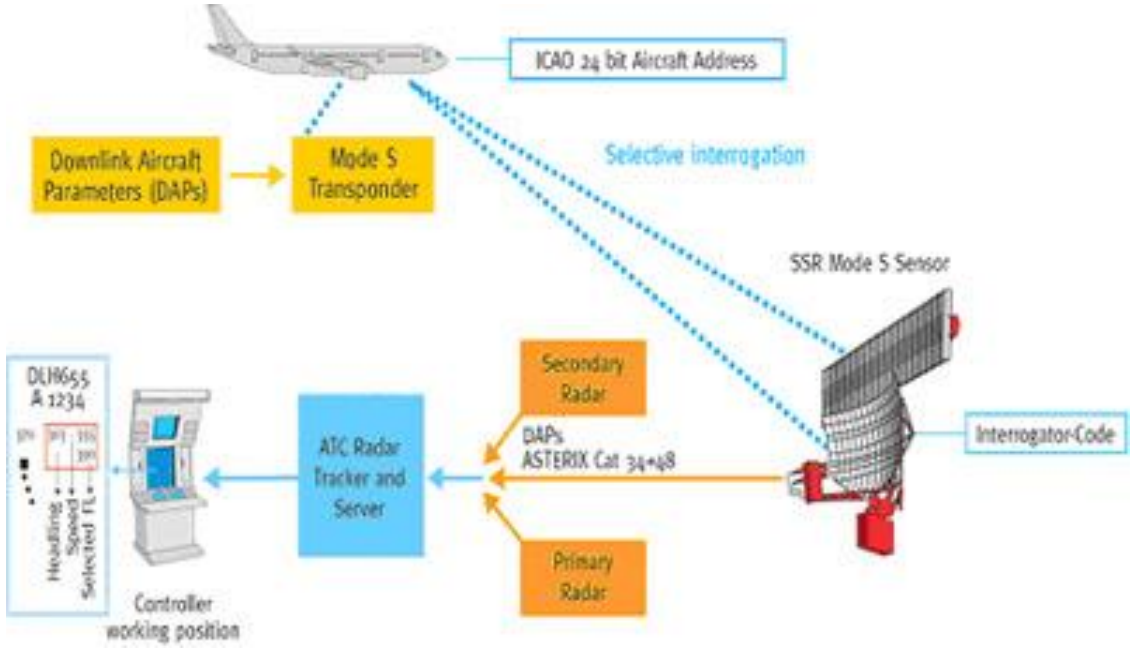
MODE S

1.1 MODE S BACKGROUND

1.1.1 SSR Mode S Overview

Mode S allows selective addressing of aircraft through the use of a 24-bit aircraft address that uniquely identifies each aircraft and has a two-way data link between the ground station and aircraft for the exchange of information. It was designed to be backward compatible with, and supports all functions of, Mode A/C.

The Mode S data link allows additional information such as airspeed, heading, ground speed, track angle, track angle rate vertical rate and roll angle to be obtained from the aircraft. Such aircraft derived data may be used to improve the tracking of the aircraft and to alleviate the need for radio calls for obtaining the information. Other information that may be obtained via the Mode S data link includes the aircraft ID, the altitude selected by the flight crew on the aircraft's mode control panel and an ACAS RA report.



In parts of Europe, there have been mandates issued requiring all aircraft that fly into designated airspace to be equipped with a Mode S transponder capable of supplying aircraft derived data.

The Mode S data link also allows information to be uplinked or sent from the radar to aircraft. This uplink is used in a function known as traffic information service where an aircraft is provided, upon request, information on the aircraft detected by the radar to be in its vicinity.

1.1.2 Mode S Characteristics

The capabilities of SSR Mode S system include:

(a) accommodation of Mode A/C capabilities;

(b) reporting of pressure altitude in either 100-ft or 25-ft increments;

(c) selective interrogation of aircraft eliminating interference between closely spaced aircraft resulting in high probability of message decoding in high density traffic;

(d) protection against transmission errors by a cyclic redundancy check (CRC) to ensure data integrity; and

(e) provision of a two-way data link between the aircraft and ground that can be used to obtain aircraft information.

1.1.3 Mode S Implementation

The implementation of SSR Mode S systems requires:

(a) aircraft to be equipped with a functioning Mode S transponder; and

(b) proper configuration of aircraft installation (e.g. allocation and configuration of a 24-bit aircraft address, and interface with other aircraft systems).

1.2 24-BIT AIRCRAFT ADDRESS

1.2.1 Allocation

The allocation and the correct configuration of the aircraft address in the aircraft are key elements for aircraft operation and associated communication protocols used to support Communication, Navigation and Surveillance (CNS) systems. These cooperative surveillance systems depend on the use of a unique 24-bit aircraft address.

A block of 24-bit aircraft addresses is allocated by ICAO to the CAA to uniquely assign, from that block, an address to each individual aircraft. This unique address must be used by all installed avionics that are required to use the 24-bit aircraft address. Therefore, it is important that this address be correctly configured and verified during initial installation and testing.

The 24-bit aircraft address can change during the life of an aircraft (e.g. when changing registration). When an aircraft changes its State of Registry, the previously assigned address is no longer valid and a new aircraft address, assigned by the new registering authority, is required. Therefore, the previous owner of the aircraft needs to ensure the de-registration of the aircraft (including removing the old aircraft address) and the new owner is required to contact the appropriate registering authority to obtain a new registration and a new 24-bit aircraft address.

1.2.2 Assignment Process

The process of assigning an aircraft address to an aircraft is automatically triggered by an application to the CAA for aircraft registration.

Note 1: The objective is to avoid an aircraft owner from omitting to initiate a separate request to obtain an aircraft address when registering its aircraft in a country.

Note 2: The aircraft registration and the aircraft address assignment may be separate processes. However, in this case, a procedure will ensure that the allocation of an aircraft address is not inadvertently omitted after an aircraft registration.

For San Marino the national code is 0101 00 000. The remaining 15 bits provide the individual aircraft address code, which, for San Marino-registered aircraft, comprise the binary form of the aircraft identification number in the CAA database. An example of a complete address is 0101 00 000 000 0110 0110 0110. To make the Mode S code easier to read and interpret, it is often expressed as a six-character hexadecimal (hex) and an eight character octal format.

1.3 APPLICATION

An application for Mode S is made on Form SM 59A and should accompany the application for a Certificate of Registration.

On receipt of this form the CAA will issue a certificate (Form SM 59) indicating the 24-bit Mode S address to the specific aircraft from its allocation. The certificate contains the binary 24 bit code, the individual aircraft hexadecimal code as well as the octal code.

1.4 TRANSPONDER

1.4.1 Issues

The CAA has become aware of incorrect 24-bit addresses being installed/hard wired on individual aircraft. This has happened not only on first installation of a Mode S transponder but also when a modification has been made or following a change of State of Registration.

Incorrect installation, such as setting the address to all zeros or inadvertent duplication of an address, can pose a risk to flight safety. In particular, the airborne collision avoidance system (ACAS) operates on the assumption that only a single, and therefore unique 24-bit aircraft address exists per airframe. The performance of ACAS can be seriously degraded and in some cases disabled if an incorrect or duplicate address is installed on an aircraft.

In order to ensure that the 24-bit Mode S address is installed correctly at the time of the initial CAA certificate of airworthiness issue, as well as throughout the in-service life of the aircraft and at the time it leaves the San Marino register, the following should be accomplished:

(a) A positive check that the correct Mode S address is assigned for each transponder installed on the aircraft.

(b) The correct Mode S address is periodically confirmed and recorded for each transponder installed on the aircraft, via a field test set at an appropriate maintenance opportunity (should not to exceed a 2 year periodicity). This task should be incorporated into the Approved Maintenance Schedule or Programme.

(c) Ensure whenever the aircraft is subject to modification that the Mode S address has not been changed.

(d) The assigned Mode S address is removed when the aircraft leaves the San Marino register.

Operators are requested to review their documented procedures and update them, as appropriate, to ensure the above points are addressed. These procedures should also include a method to record that the applicable actions have been accomplished.

1.4.2 Ground testing

Maintenance operations can result in connector pins being broken. It is therefore important that the operator regularly check that the 24-bit aircraft address is correct for the airframe. This should be checked at least after each maintenance operation on the transponder.

When conducting any ground testing of the transponder or ACAS, it is most important to follow proper procedures to prevent interference to ATC operations or other ACAS aircraft operating in the area. Ground maintenance checks or ramp testing (such as altimetry or bearing accuracy testing) can cause data to be transmitted by the transponder that could produce false targets for the ground ATC surveillance systems or for airborne ACAS aircraft.

These false indications of “intruder aircraft” could result in unnecessary ATC communications and possibly in ACAS-induced aircraft manoeuvres. The problem of false ACAS warnings is more noticeable when ground testing of transponders takes place at airfields located beneath terminal control areas or in the vicinity of control areas and zones where aircraft movements

Ground testing should be conducted in coordination with ATC and by the use of antenna shielding (i.e. transmission absorption covers or caps) to adequately attenuate transmitted signals. Using high-powered, hangar mounted transponders is NOT an acceptable means for conducting either ACAS or transponder ramp testing. The following guidelines should be followed to minimize the aforementioned risks:

(a) when not required, ensure all transponders are set to “off” or “standby”;

(b) before starting any test, the local ATC authority shall be notified of the intended transponder testing.

(c) Information such as start time, test duration. aircraft ID (flight ID) and, if appropriate, the Mode A code to be used (subject to due coordination) should be provided to the ATC authority;

(d) prior to switch-on, or with the transponder in “standby” mode, set the Mode A code to the agreed/coordinated value.

(e) set the aircraft ID (flight ID) to the first eight characters of the name of the company that is conducting the tests;

(f) set the on-the-ground status for all Mode S replies, except when an airborne reply is required (e.g. for altitude testing);

(g) where possible, perform the testing inside a hanger to take advantage of any shielding properties it may provide;

(h) as a precaution, use antenna transmission covers, regardless of whether the testing is performed inside or outside;

(i) when testing the altitude (Mode C or S) parameter, radiate directly into the ramp test set via the prescribed attenuator;

(j) manually set the altitude to an unrealistically high value (i.e. over 60000 ft);

(k) in-between testing (e.g. during transition from one altitude to another or changing the Mode A code), set the transponder to “standby” mode before changing the input;

(l) when testing is complete, immediately set the transponder to “OFF” or “standby”; and

(m) simulation of ACAS operation must not be carried out by the radiating from an antenna located on the ground (e.g. in a workshop).

1.4.3 In-flight testing

A transponder in-flight tester may be provided to indicate normal or faulty operation.

When a tester is used, it should not radiate a signal level outside the aircraft that is stronger than –70 dBm. Moreover, the test interrogation signal should not exceed the rate of 450 per second.

The test should be limited to a short period that is just enough to determine the status of the transponder.

Note: As with ground testing of the transponder or ACAS, it is important to follow proper procedures to prevent being an airborne source of interference to ATC or other ACAS aircraft operating in the area.

1.5 ANSWERS TO FREQUENTLY ASKED QUESTIONS

(Q = question; A = answer)

Q1. Is there a requirement for the installation of a second transponder?

A1. No. However, most civil operators install a second transponder to improve dispatch ability to airspace.

Q2. If I have not yet received my assigned 24-bit aircraft address from the CAA, is it permissible to use ALL ZEROs (0’s) or ALL ONEs (1’s) until it is received?

A2. No. At no time should you use ALL ZEROs (0’s) or ALL ONEs (1’s) as the 24-bit aircraft address. These are illegal addresses.

Q3. Can I keep the 24-bit aircraft address currently configured in the aircraft when I have purchased the aircraft in another State and a change of registration is required?

A3. No. When an aircraft changes its State of Registry, the previously assigned address shall be relinquished, and a new address shall be assigned by the new registering authority.

Q4. For delivery of a new aircraft, is it acceptable to use a 24-bit aircraft address composed of my country code followed by ALL ZEROs?

A4 No. A country code followed by ALL ZEROs is a legal address, but it can only be assigned by the CAA, as the State of Registry to a single aircraft. For an aircraft delivery, the aircraft operator must inform the airframe manufacturer of a complete 24-bit aircraft address assignment. The airframe manufacturer or other organization responsible for the delivery must ensure the installation of a correctly assigned address supplied by the CAA.

Q5. When other aircraft systems (particularly communications) need access to the 24-bit aircraft address, is it appropriate to connect them to the transponder or to the ACAS (XT) high-speed bus?

A5. No. Connection to the XT bus increases the possibility of corrupting the bus data due to interference. This can result in intermittent communication between ACAS and the transponder and ACAS system failures. It is preferred that other systems obtain the address from the transponder maintenance output bus or from separate interfaces.

CHAPTER 2

ELT CODING

2.1 ELT BACKGROUND

An Emergency Locator Transmitter, or ELT, is a device that transmits a distress signal that allows search and rescuers to find or locate the device. There are generally only two types referred to: 'automatic ELT' or 'survival ELT', which both emit signals on 406 MHz.

An automatic ELT must automatically activate, or start transmitting, on impact. A survival ELT does not detect impact and must be activated manually (deployed) but can be removed from the aircraft and hence can be kept on your person.

For an ELT to be of use, someone needs to be listening for a distress transmission. The COSPAS-SARSAT satellite system detects 406 MHz signals and alerts the search and rescue authority in the region where the signal is detected.

The 406 MHz signal contains an identification code called the hexadecimal identity (HEX ID or hex code). This HEX ID is used to identify the owner of the beacon and emergency contacts of the owner if the distress beacon is registered. Hence the importance of the ELT being correctly registered.

All aircraft registered in San Marino are required to carry Emergency Locator Transmitters(ELTs) of a type and quantity required by CAR OPS1.820, OPS 2A.417, OPS 2H.435,or OPS 3.820, as applicable.

2.2 ELT APPLICATION AND REGISTRATION

2.2.1 Registration

Registration of your ELT is an operator/owner responsibility. This can be done online on the COSPAS-SARSAT website at www.406registration.com which will result in a specific type approval (CSTA) number that must be indicated on Form SM 09. The CAA also maintains a register of the information on the ELT application, which is then registered with the San Marino Rescue Coordination Centre (RCC).

Note: If there are difficulties registering the ELT, instead of programming the 24-bit binary code (aircraft address), try entering either the aircraft 15-bit aircraft binary code or the aircraft registration marking or the ELT serial number.

2.2.2 Application

To assist the applicant, the following information is required;

(a) Transmitter identification (expressed in the form of an alphanumerical code of 15 hexadecimal characters);The ELT shall be uniquely coded with a digital message that contains one of the following protocols as appropriate:

(1) The ELT Serial Number;

(2) Aircraft Operator Designator and Serial Number;

(3) Mode“S”24-bit Aircraft Address;

(4) Aircraft Nationality and Registration Marks

(b) Transmitter manufacturer, model and, when available, manufacturer’s serial number; This will enable the RCC to confirm the correct ELT by the transmission format.

(c) The ELT location on the aircraft, e.g.: permanently fitted to aircraft, life raft or portable device etc;

(d) COSPAS-SARSAT type approval (CSTA) number; will confirm that ELT is registered and an approved unit;

(e) Name, email address (postal and e-mail) and emergency telephone number of the owner;

(f) Name, email address (postal and e-mail) and telephone number of other emergency contacts (two, if possible) to whom the owner or the operator is known;

(g) Aircraft manufacturer and type; and

(h) Colour of the aircraft.

Note: ELT coding should be accomplished in accordance with ICAO Annex 10 Volume III and further guidance can also be found in COSPAS-SARSAT Guidelines Document Ref: C/S G.005.https://cospas-sarsat.int/en/documents-pro/system-documents

2.2.3 Emergency Contact

It is essential that at least one of the emergency contacts provided on the form is available at all times, even when the aircraft is not flying, who knows the current whereabouts of the aircraft and can contact the crew or the Airworthiness Coordinator or the maintenance organisation if the aircraft is undergoing maintenance.

The organisation which monitors the Search and Rescue satellite constellation do not have any responsibility in organising a rescue attempt. That function is the responsibility of the Rescue Coordination Centre (RCC) of the country of registration so it is essential that the San Marino RCC has all the information available to identify the aircraft, confirm that the distress signal is genuine, and organise and coordinate any rescue attempts.

It is also vital that any false warnings are identified quickly so that expensive search and rescue operations are aborted as soon as possible, and the SAR units are available for another genuine emergency.

Therefore it is important to have some person whose contact details are available to the San Marino RCC and who can be contacted at any time of the day or night and who also knows the current whereabouts of the aircraft and can contact the crew.