

Ground Station requirements for Duplicate 24 Bit Addresses and Position Outliers

Multiple ADS-B Messages will be received from a particular aircraft/vehicle on the 1090ES link to ascertain complete information for that aircraft/vehicle. It is vital that each individual Message is associated with the transmitting aircraft/vehicle and not another aircraft/vehicle, as incorrect association could result in the reporting of inaccurate information for both aircraft/vehicles.

The 24-bit address transmitted in each ADS-B Message can be used to identify and associate the Messages for a particular aircraft/vehicle. Though each aircraft/vehicle should have a unique 24-bit address, there will be occasions on which duplicate target addresses exist within a Service Volume. When this circumstance arises, association of ADS-B Messages using only the 24-bit address is not possible.

In addition to the duplicate 24-bit address issue, position information transmitted in a particular ADS-B Message could become corrupt, leading to incorrect position reporting for that aircraft/vehicle (position outlier).

Incorrect association of a received ADS-B Message containing position or incorrect update of a target position with corrupted position information in an ADS-B Message, has the potential to impact the CPR decoding such that an incorrect position is reported for the entire time that aircraft/vehicle is in the Service Volume. Additionally, an incorrect Version Number could be identified for an aircraft/vehicle or the information stored in Table 3-1 could be associated with and reported for an aircraft/vehicle other than the one that transmitted the information.

A candidate Duplicate Address potentially results is initiated when a Position Message is received for a 24 bit address that is identified as a Position Outlier. Assuming no Duplicate Address condition exists for a particular 24 bit address, the receipt of a Position Message that fails the Position Outlier test is stored as a separate track record that records the receipt of the even or odd Position Message. The existing track is the Primary track for this 24 bit address and the second track record is a candidate Duplicate track. In order for this 24 bit address to be declared a Duplicate Address, a Global CPR decode would need to be completed by the receipt of both an even and odd Position Message within 10 seconds for the candidate Duplicate track. Association of subsequent Position Messages with this 24 bit address is first attempted on the Primary track for this 24 bit address. If the Position Outlier test fails on the Primary track, this Position Message is used to update the candidate Duplicate Address record. Otherwise, it is associated with the Primary track.

In order for this 24 bit address to be declared a Duplicate Address, first a Global CPR decode would need to be completed by the receipt of both an even and odd Position Message within 10 seconds for the candidate Duplicate track. If the candidate Duplicate Address track Global CPR decode is completed by the receipt of both an even and odd Position Message within 10 seconds and passes the global CPR reasonableness test, the 24 bit address is declared a Duplicate Address. Once declared a Duplicate Address, Output of an ADS-B Report for either track record is designated as a Duplicate Address. Both track records are

designated as Version 0. Receipt of all Extended Squitter Messages, other than Position Messages, are not to be associated with any track –since there is no foolproof way to associate these messages with the correct aircraft. Position Messages are associated with the record that results in the Position Outlier test being satisfied. The output of an ADS-B Report based on receipt of a Position Message is performed for the track record for which the Position Outlier test is satisfied. If the ADS-B Service is configured to output ADS-B Reports based on the receipt of a Velocity Message, the service shall not output a Velocity triggered report for any track record identified as a Duplicate Address.

A 24 bit address is meant as the 24 bit address in combination with the Address Qualifier that defines the type of address included in the 24 bit address field. The duplicate address test must consider both the 24 bit address and the address qualifier.

- a. The ADS-B Service **shall** identify a 24-bit address as a Duplicate Address when an multiple aircraft/vehicle airborne aircraft and another aircraft/vehicle airborne transmitting the same 24-bit address are detected as a result of a track initiated by a Position Outlier (§3.2.2.1.1.1.4.c, §3.2.2.1.1.1.4.d, or §3.2.2.1.1.1.4.e) and subsequently passing the global CPR reasonableness test (§3.2.2.1.1.1.2.b) separated by at least 6 NM, the global CPR reasonableness test (§3.2.2.1.1.1.2.b) has been passed for at least one of the aircraft, and the time difference between the most recent position updates for the aircraft having the same 24 bit address does not exceed 30 seconds.

Notes:

1. *The Duplicate Address designator is used to indicate that any previously stored information associated with that address is not to be included in any output ADS-B Report.*
2. *The specific technique for determining when a duplicate address is in use is not specified herein. Any received position update that is defined to be a Position Outlier is a potential candidate for Duplicate Address.*
3. *This requires that CPR decoding is applied separately to the positions reported by each aircraft/vehicle. Separate decoding procedures are performed for each of the duplicate addressed tracks (since a local CPR decode assumes knowledge of the previously decoded position).*
4. *The range threshold of 6 NM was derived from the assumption of 600 knots maximum ground speed over 30 seconds, yielding 5 NM, with an additional 1 NM being added to allow for positional error.*

The ADS-B Service shall [3793] identify a 24 bit address as a Duplicate Address when multiple aircraft/vehicles are reporting the surface condition and surface transmitting the same 24 bit address fare separated by at least 0.75 NM, the global CPR reasonableness test (§3.2.2.1.1.1.2.b) has been passed for at least one of the aircraft/vehicles, and the time difference between the most recent position updates for the aircraft/vehicles having the same 24 bit address does not exceed 30 seconds.

~~Note:—The range threshold of 0.75 nautical miles was derived from the assumption of 60 knots maximum groundspeed over 30 seconds—yielding 0.5 nautical miles. Since the surface CPR encoding is 4 times more precise than the airborne encoding, assume 0.25 nautical miles extra for a total of 0.75 miles.~~

~~The ADS-B Service **shall** [xxxx] identify a 24-bit address as a Duplicate Address when an aircraft/vehicle reporting the surface condition and another airborne aircraft/vehicle transmitting the same 24-bit address are detected as a result of a track initiated by a Position Outlier (§3.2.2.1.1.4.g) and subsequently passing the global CPR reasonableness test (§3.2.2.1.1.2.b).~~

~~Note:—The range threshold of 2.5 nautical miles was derived from the assumption of 250 knots maximum speed for a target transitioning from the surface state to an airborne state over 30 seconds—yielding approximately 2 nautical miles—with an additional 0.5 NM being added to allow for positional errors.~~

b. The ADS-B Service **shall** associate ADS-B Position Messages with the correct Aircraft/Vehicle when aircraft/vehicles transmitting a 24-bit address are identified as transmitting Duplicate Addresses.

c. The ADS-B Service **shall** identify an ADS-B Message as a Position Outlier when the reported position in the ADS-B Airborne Position Message differs from the last reported position by more than 6 NM for an airborne aircraft when the last reported position was received -less than 30 seconds before.

Notes:

1. The Position Outlier designator is used to indicate that an ADS-B Report will not be output.
2. The Position Outlier threshold value is based on the assumption of a maximum aircraft speed of 600 knots over a maximum extrapolation time of 30 seconds. This yields a maximum positional difference of approximately 5 nautical miles. An additional nautical mile is added to the Position Outlier threshold to account for additional ADS-B positional measurement uncertainty.
3. Position outliers are candidates for duplicate address reports.

d. The ADS-B Service **shall** identify an ADS-B Message as a Position Outlier when the reported position in the ADS-B Surface Position Message differs from the last reported position by more than 0.75NM for surface aircraft/vehicles that are reporting the surface condition when the last reported position was received -less than 30 seconds before.

e. The ADS-B Service **shall** identify an ADS-B Message as a Position Outlier when the reported position for a surface aircraft/vehicle and an airborne aircraft/vehicle differ from the last reported position by more than 2.5 NM for one aircraft/vehicle that is reporting the surface condition and another aircraft reporting an airborne position when the last reported position was received less than 30 seconds before.

f. ADS-B Messages from aircraft/vehicles with 24-bit addresses identified as Duplicate Addresses **shall** [3734] be processed as Version ZERO (0) format Messages and identified in the ADS-B Reports as Version 0.-

Note: Even if Version 1 is reported in a particular ADS-B Message, it may be difficult or impossible to associate that Message with a particular aircraft/vehicle when a duplicate 24-bit address condition exists. Therefore Messages from each of the duplicate aircraft/vehicles are to be considered Version 0.

- g. The ADS-B service shall [3914] no longer identify targets an aircraft/vehicle as having a Duplicate Address when 360 seconds has elapsed with no Position Message update for an aircraft/vehicle track with an address identified as a Duplicate Address. the conditions specified in 3.2.2.1.1.1.4.a for airborne targets and in 3.2.2.1.1.1.4.b for surface targets are no longer ap