a. If altitude data is not present, the message **shall** be discarded.

b. If altitude data is present, it may be used to update altitude as needed.

***Note:*** *For TCAS systems, this could be an aircraft that was being maintained via hybrid surveillance when the position data input failed. In this case, altitude only could be used for a short period of time. Interrogation would have to begin at the update rate for that track to ensure update of range and bearing information on the TCAS display.*

### 2.2.8 ADS-B Report Characteristics

The intent of the following subparagraphs is to provide an example coding of each type of ADS-B report. Implementations may use alternative report structures and coding of the ADS-B reports. However, the contents of each Report Type, as specified in Table 2-82 **shall** include, as a minimum, the data parameters as specified in the following subparagaphs.

***Note:*** *This requirement describes the Report Type structure, not the contents of each report that can contain a subset of the complete allowed parameters.*

#### 2.2.8.1 ADS-B State Vector Report Characteristics

Table 2-81 and the subsequent subparagraphs identify the data structure for all ADS-B State Vector Reports generated for each ADS-B vehicle being reported.

The Report Assembly Function **shall** be compatible with the current and prior versions of the relevant 1090 MHz ADS-B Messages (e.g., Airborne Position, Surface Position, Airborne Velocity) that are used as the basis for generating State Vector Reports. The relevant Version Two (2) messages are identified below and the relevant Version Zero (0) messages, conformant to RTCA DO-260, including Change 1, and Version One (1) messages, conformant to DO-260A including Change 1 and Change 2, and their required use for ADS-B State Vector Report generation are defined in Appendix N, Section N.3.

The intent of Table 2-81 is to illustrate the structure of all Items (i.e., parameters) required to be reported in an ADS-B State Vector Report. The exact structure of the data indicated in columns 10 and 11 is provided as a guideline or one possible method of satisfying the report structure. Implementers may choose to organize the data in another format; however, delivery to a user interface or application of all Items in Table 2-81 **shall** be consistent with the range, resolution, and units indicated in column 7, 8 and 9 of Table 2-81 respectively. If data is not available to support a field that is delivered to an application, then the data provided to the application **shall** be set to ALL ZEROs. Those requirements in §2.2.8.1.1 to §2.2.8.1.22 below that relate to specific data structure details (byte numbers, and bit numbers within the bytes) **shall** only apply to equipment that uses the sample report data structure shown in columns 10-11 of Table 2-81.

***Note:*** *Table 2-81 is structured such that column 1, 2, and 6 through 11, pertain to the State Vector Report elements and how such elements should be structured into the report. Columns 3 through 5 provide information on where the appropriate data can be located in the ADS-B Messages for each of the Report elements.*

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## Table 2-81: ADS-B State Vector Data Elements - Source Data Mapping To Report Structure

| Table 2-81: ADS-B State Vector Data Elements – Source Data Mapping To Report Structure | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Column # | REPORT STRUCTURE | | MESSAGE STRUCTURE RELEVANT | | | REPORT STRUCTURE RELEVANT | | | | | |
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| Item # | Parameter / Contents | Notes | Received Message Structure | "ME" Field Bits | Message Field Bits | # of Bits | Range | Resolution | Units | Data Structure | Data Byte # |
| 0a, 0b | Report Type and Structure Identification | 2 | N/A | N/A | 1 – 5 | 24 | N/A | N/A | discrete | MddL Mddd ddddddd dddddddL | 0 -2 |
| 0c | Validity Flags | | N/A | N/A | N/A | 16 | N/A | N/A | discrete | dddddddd ddddddd | 3 - 4 |
| 1 | Participant Address | | Airborne Position - "AA"<br>Surface Position - "AA"<br>Airborne Velocity – "AA" | N/A<br>N/A<br>N/A | 9 - 32<br>9 – 32<br>9 - 32 | 24 | N/A | N/A | discrete | Mddddddd ddddddd dddddddL | 5 - 7 |
| 2 | Address Qualifier | | Aircraft ID & Category<br>"Emitter Category"<br>All Messages with DF=18 – "CF" | 6 – 8<br><br>N/A | 38 – 40<br><br>6 - 8 | 8 | N/A | N/A | discrete | xxxxxMdL | 8 |
| 3 | Report Time of Applicability (Position and Velocity) | 3 | Airborne Position – "Time"<br>Surface Position – "Time"<br>Airborne Velocity | 21<br>21<br>N/A | 53<br>53<br>N/A | 48 | 511.9921875 | 0.0078125 (1/128) | seconds | Mddddddd ddddddd L<br>Mddddddd ddddddd L<br>Mddddddd ddddddd L | 9 - 14 |
| 4 | Encoded Latitude (WGS-84) | | Airborne Position<br><br>Surface Position – | 23 - 39<br><br>23 - 39 | 55 - 71<br><br>55 – 71 | 24 | ± 180 | 0.0000215 | degrees | SMddddd ddddddd dddddddL | 15 - 17 |
| 5 | Encoded Longitude (WGS-84) | | Airborne Position<br><br>Surface Position | 40 - 56<br><br>40 - 56 | 72 - 88<br><br>72 – 88 | 24 | ± 180 | 0.0000215 | degrees | SMddddd ddddddd dddddddL | 18 - 20 |
| 6 | Altitude, Geometric (WGS-84) | 4 | Airborne Position – "TYPE", & "Altitude"<br>Airborne Velocity - "Diff. from Baro Alt sign" & "Diff. from Baro. Alt." | 1 - 5, &<br>9 - 20<br><br>49<br>50 - 56 | 33 - 37<br>41 – 52<br><br>81<br>82 - 88 | 24 | ± 131072 | 0.015625 | feet | SMddddd ddddddd dddddddL | 21 – 23 |
| 7 | North/South Velocity | 4 | Airborne Velocity – "N/S Direction" & "N/S Velocity" | 25<br><br>26 - 35 | 57<br><br>58 – 67 | 16 | ± 4096 | 0.125 | knots | SMddddd ddddddL | 24 – 25 |
| 8 | East/West Velocity | 4 | Airborne Velocity - "E/W Direction" & "E/W Velocity" | 14<br><br>15 - 24 | 46<br><br>47 – 56 | 16 | ± 4096 | 0.125 | knots | SMddddd ddddddL | 26 – 27 |
| 9 | Ground Speed while on the Surface | 5 | Surface Position – "Movement" | 6 - 12 | 38 – 44 | 8 | N/A | N/A | discrete | MdddddL | 28 |
| 10 | Heading while on the Surface | 5 | Surface Position – "Heading" | 14 - 20 | 46 – 52 | 8 | ± 180 | 1.40625 | degrees | SMdddL | 29 |
| 11 | Altitude, Barometric (Pressure Altitude) | 4 | Airborne Position – "TYPE", & "Altitude" | 1 - 5<br>9 - 20 | 33 – 37<br>41 – 52 | 24 | ± 131072 | 0.015625 | feet | SMddddd ddddddd dddddddL | 30 – 32 |
| 12 | Vertical Rate, Geometric/Barometric (WGS-84) | 4 | Airborne Velocity – "Vert. Rate Source", "Vert. Rate Sign" & | 36<br>37 | 68<br>69 | 16 | ± 32768 | 1.0 | ft./min. | SMddddd ddddddL | 33 – 34 |

**Table 2-81: ADS-B State Vector Data Elements – Source Data Mapping To Report Structure**

| Column # | REPORT STRUCTURE | | MESSAGE STRUCTURE RELEVANT | | | REPORT STRUCTURE RELEVANT | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| **Item #** | **Parameter / Contents** | **Notes** | **Received Message Structure** | **"ME" Field Bits** | **Message Field Bits** | **# of Bits** | **Range** | **Resolution** | **Units** | **Data Structure** | **Data Byte #** |
| | | | "Vert. Rate" | 38 - 46 | 70 – 78 | | | | | | |
| 13 | Navigation Integrity Category (NIC) | | Airborne Position "Type Code" & "NIC Supplement-A" Operational Status "NIC Supplement-B" Surface Position "Type Code" & Operational Status " NIC Supplement-A" & "NIC SUPPLEMENT-C"~~Airborne Position "Type Code" & NIC SUPPLEMENT-A & B Surface Position "Type Code" & NIC SUPPLEMENT-A & B~~ | 1 – 5<br>8<br>1 - 5<br>44, 56<br>~~1 – 5~~ | 33 – 37<br>40<br>33 - 37<br>76, 88<br>~~33 – 37~~ | 8 | N/A | N/A | discrete | xxx~~x~~MdddL | 35 |
| 14 | Estimated Latitude (WGS-84) | 6 | Airborne Position – "Encoded Latitude"<br>Surface Position – "Encoded Latitude" | 23 – 39<br>23 - 39 | 55 – 71<br>55 – 71 | 24 | ± 180 | 0.0000215 | degrees | SMdddddd ddddddd ddddddL | 36 – 38 |
| 15 | Estimated Longitude (WGS-84) | 6 | Airborne Position – "Encoded Longitude"<br>Surface Position – "Encoded Longitude" | 40 - 56<br>40 - 56 | 72 - 88<br>72 – 88 | 24 | ± 180 | 0.0000215 | degrees | SMdddddd ddddddd ddddddL | 39 – 41 |
| 16 | Estimated North/South Velocity | 6 | Airborne Velocity – "N/S Direction" & "N/S Velocity" | 25<br>26 - 35 | 57<br>58 – 67 | 16 | ± 4,096 | 0.125 | knots | SMdddddd ddddddL | 42 – 43 |
| 17 | Estimated East/West Velocity | 6 | Airborne Velocity - "E/W Direction" & "E/W Velocity" | 14<br>15 - 24 | 46<br>47 – 56 | 16 | ± 4,096 | 0.125 | knots | SMdddddd ddddddL | 44 – 45 |
| 18 | Surveillance Status/Discretes | | Airborne Position – "Surveillance Status"<br>Airborne Velocity – "Intent Change Flag" | 6 – 7<br>9 | 38 – 39<br>9 | 4<br>4 | N/A | N/A | discrete | dddd dddd | 46 |
| 19 | Report Mode | | N/A | N/A | N/A | 8 | N/A | N/A | discrete | xxxxxxML | 47 |
| | | | | | | | | | | **TOTAL BYTES** | 48 |

***Notes:***

1. *In the "Data Structure" column (i.e., column 10), "S" indicates the "sign-bit," "M" indicates the Most Significant Bit of the data field, "d" indicates data bits in the field, "L" indicates the Least Significant Bit of the data field, "0" indicates the bit is to always be set to a value of zero (0) and "x" indicates "Don't Care" bits in the data field.*
2. *The Report Type Identifier is used to identify the type of ADS-B Report being generated as specified in §2.2.8.1.1.1.*

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3. *The Time of Applicability is actually a grouping of 3 individual parameters as specified in §2.2.8.1.4.*
4. *Parameters annotated with Note 4 are only present in the State Vector Report when the aircraft is airborne*
5. *Parameters annotated with Note 5 are only present in the State Vector Report with the aircraft is on the airport surface*
6. *Estimated values may be either an actual value from a received message, if available, or a calculated value such as produced by a surveillance tracker algorithm. For example it is possible for a surveillance tracker to produce an updated estimate of the target's horizontal position based on just the receipt of a new velocity message.*

### 2.2.8.1.1 State Vector Report Type and Structure Identification and Validity Flags

#### 2.2.8.1.1.1 State Vector Report Type and Structure Identification

The Report Type is used to identify the type of ADS-B Report being generated by the report generation function and being provided to the User Application. The Report Type is a 4-bit field and **shall** be provided in the most significant nibble (i.e., bits 7 - 4) of the first byte (i.e., byte "0") of the Report. The Report Type formats and maximum number of bytes to be contained in each report are identified in Table 2-82.

**Table 2-82: ADS-B Report Type Coding**

| Coding (binary) | Coding (decimal) | Report Type | Maximum Number of Bytes in Report |
|---|---|---|---|
| 0000 | 0 | Undefined Report Type or no Report Available | 1 |
| 0001 | 1 | State Vector Report for ALL Class "A" Equipment | 48 |
| 0010 | 2 | Mode-Status Report for Class "A1S", "A1", "A2" and A3~~1~~" Equipment | 35 |
| 0011 | 3 | Reserved for Version 1 ADS-B Target State Report ~~for Class "A2" and "A3" Equipment (Optional for Class "A1S and A1" equipment)~~ | 22 |
| 0100 | ~~4~~4 | Air Reference Velocity Report for Class "A1S," "A1," "A2" and "A3" equipment | 14 |
| 0101 | 5 | ADS-B Target State Report for Class "A2" and "A3" Equipment (Optional for Class "A1S and A1" equipment)~~Reserved for Trajectory Change Report for Class "A2" and "A3" equipment~~ | 22 |
| 0110 | 6 | Reserved for Trajectory Change Report for Class "A2" and "A3" equipment | |
| 0111~~0~~ through 1111 | | Not Assigned (Reserved for Future Assignment) | |

The Report Structure field is used to indicate the exact data parameters identified in Table 2-81 that are being provided in the State Vector report and is intended to provide a methodology for the report processor to structure shorter reports when data for some parameters or groups of related parameters are not available. In order to provide the capability to provide shorter State Vector reports the following basic conventions **shall** be adhered to:

a. Any given data parameter to be used in the report **shall** use the designated number of bytes and format as designated in Table 2-81.

b. Whenever a data parameter identified in Table 2-81, or a required grouping of data parameters as identified in Table 2-83, is not provided in the report, then it is permissible to concatenate the next parameter to be included into the report immediately following the inclusion of the previous reported parameter. This feature **shall** be used accommodate the reporting of the different sets of required parameters,

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such as for when the aircraft is in the airborne condition versus on the airport surface as indicated in Table 2-81.

c. Each parameter of the State Vector report identified in Table 2-81 **shall** be properly declared in the Report Structure field as detailed in the following paragraphs and Table 2-83.

***Note:*** *Implementation of the methodology just provided is realizable and controllable due to the fact that the exact length of each report parameter is specified in Table 2-81 and the Report Structure field identifies exactly which parameters are included in the report. Therefore, the report user can easily re-construct the length and general format of the report.*

The Report Structure is a 20-bit field and **shall** be provided in the least significant nibble (i.e., bits 3 - 0) of the first byte (i.e., byte "0") and continuing into bytes 1 and 2 of the Report. The Report Structure format is specified in Table 2-83 where each bit is associated with a particular data parameter, or group of data parameters, of the State Vector Report. If the bit is set to ONE (1), then the data parameter, or group of identified data parameters, is considered to be available and **shall** be transmitted in the report. Otherwise, the data parameter, or group of identified data parameters, is considered to not be available and **shall** not be transmitted in the report. Note that Table 2-83 does not address the Report Type and Structure Identification parameter, the Validity Flags parameter, nor the Participant Address parameter and the Address Qualifier, **since these four parameters shall be included in the State Vector Report. Also, certain of the other State Vector data parameters are required to be reported, as specified in §2.2.9, even though bits have been allocated in the report structure field as shown in Table 2-83.**

**Table 2-83: ADS-B State Vector Report Structure Coding**

| Byte # | Bit # | State Vector Data Parameter(s) to be Reported | Number of Bytes |
|---|---|---|---|
| 0 | 3 | Time of Applicability for Estimated Position/Velocity | 2 |
| | 2 | Position Time of Applicability | 2 |
| | 1 | Velocity Time of Applicability | 2 |
| | 0 | Latitude (WGS-84) & Longitude (WGS-84) | 7 |
| 1 | 7 | Altitude, Geometric (WGS-84) | 4 |
| | 6 | North/South Velocity & East/West Velocity | 5 |
| | 5 | Ground Speed while on the Surface | 2 |
| | 4 | Heading while on the Surface | 2 |
| | 3 | Altimeter, Barometric | 4 |
| | 2 | Vertical Rate Geometric/Baro. | 3 |
| | 1 | Navigation Integrity Category | 1 |
| | 0 | Estimated Latitude | 3 |
| 2 | 7 | Estimated Longitude | 3 |
| | 6 | Estimated North/South Velocity | 2 |
| | 5 | Estimated East/West Velocity | 2 |
| | 4 | Surveillance Status/Discretes | 1 |
| | 3 | Report Mode | 1 |
| | 2 | Reserved for Future Expansion | |
| | 1 | Reserved for Future Expansion | |
| | 0 | Reserved for Future Expansion | |

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#### 2.2.8.1.1.2 State Vector Report Validity Flags

Validity Flags for data provided in the State Vector Report **shall** be indicated in bytes #3 and #4 of the State Vector Report as shown for item "0c" in Table 2-81. The State Vector Report elements that require validity flags are identified in Table 2-84. Table 2-84 identifies the byte and bit that **shall** be used as a flag for each element that requires a validity flag. Each validity flag bit **shall** be set to ONE (1) to indicate that the corresponding State Vector Report Element data is valid. If such data is not valid, then the corresponding validity flag bit **shall** be set to ZERO (0).

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**Table 2-84: ADS-B State Vector Report Validity Flag Requirements**

| SV Report Item # | State Vector Report Element | Validity Flag Bit Required? | Validity Flag Bit Assignment | |
|---|---|---|---|---|
| 0a | Report Type | No | **Byte #** | **Bit #** |
| 0b | Structure Identification | No | | |
| 0c | Validity Flags | No | | |
| 1 | Participant Address | No | | |
| 2 | Address Qualifier | No | | |
| 3 | Report Time of Applicability | No | | |
| 4 | Latitude (WGS-84) | **Yes** (This validity flag bit is for Horizontal Position Valid) | 3 | 7 (MSB) |
| 5 | Longitude (WGS-84) | **Yes** (This validity flag bit is for Horizontal Position Valid) | 3 | 7 |
| 6 | Altitude, Geometric (WGS-84) | **Yes** (This bit is validity flag bit for Geometric Altitude Valid) | 3 | 6 |
| 7 | North/South Velocity | **Yes** (This bit is validity flag bit for Airborne Horizontal Velocity Valid) | 3 | 5 |
| 8 | East/West Velocity | **Yes** (This bit is validity flag bit for Airborne Horizontal Velocity Valid) | 3 | 5 |
| 9 | Ground Speed while on the Surface | **Yes** (This bit is validity flag bit for Surface Ground Speed Valid) | 3 | 4 |
| 10 | Heading while on the Surface | **Yes** (This bit is validity flag bit for Surface HeadingValid) | 3 | 3 |
| 11 | Altitude, Barometric (Pressure Altitude) | **Yes** (This bit is validity flag bit for Barometric Altitude Valid) | 3 | 2 |
| 12a | Vertical Rate, Geometric (WGS-84) | **Yes** (This bit is validity flag bit for Geometric Vertical Rate Valid) | 3 | 1 |
| 12b | Vertical Rate, Barometric (WGS-84) | **Yes** (This bit is validity flag bit for Barometric Vertical Rate Valid) | 3 | 0 |
| 13 | Navigation Integrity Category (NIC) | No | | |
| 14 | Estimated Latitude (WGS-84) | **Yes** (This validity flag bit is for Estimated Horizontal Position Valid -- If for some reason an estimation cannot be made of the horizontal position at the TOA of the report, then this could be indicated by zeroing the validity flag for the estimated horizontal position.) | 4 | 7 (MSB) |
| 15 | Estimated Longitude (WGS-84) | **Yes** (This validity flag bit is for Estimated Horizontal Position Valid -- If for some reason an estimation cannot be made of the horizontal position at the TOA of the report, then this could be indicated by zeroing the validity flag for the estimated horizontal position.) | 4 | 7 |
| 16 | Estimated North/South Velocity | **Yes** (This validity flag bit is for Estimated Horizontal Velocity Valid -- It may be possible to estimate velocity at some time after the TOA of the velocity message.) | 4 | 6 |
| 17 | Estimated East/West Velocity | **Yes** (This validity flag bit is for Estimated Horizontal Velocity Valid -- It may be possible to estimate velocity at some time after the TOA of the velocity message.) | 4 | 6 |
| 18 | Surveillance Status/Discretes | No | | |
| 19 | Report Mode | No | | |

#### 2.2.8.1.2 Participant Address

The Participant Address **shall** be encoded as specified in §2.2.3.2.1.5.

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### 2.2.8.1.3 Address Qualifier

The Address Qualifier is used to indicate the type of Participant Address (§2.2.3.2.1.5) being reported. The 3 least significant bits of the one byte field (byte 8 of the Report Field) are used to convey the Address Qualifier information. The Address Qualifier subfield **shall** be coded as shown in Table 2-85.

**Table 2-85: Address Qualifier Coding**

| **Coding** (MdL) | **Meaning** | **ADS-B Emitter Cateogry Set** (see Notes 1 & 2) |
|---|---|---|
| 000 | ICAO address being reported as Participant Address for an unknown emitter category | See Note 3 |
| 001 | Non-ICAO address being reported as Participant Address for an unknown emitter category | See Note 3 |
| 010 | ICAO address being reported as Participant Address for an Aircraft | "A" or "B" |
| 011 | Non-ICAO address being reported as Participant Address for an Aircraft | "A" or "B" |
| 100 | ICAO address being reported as Participant Address is for a Surface Vehicle, a Fixed Ground or Tethered Obstruction | "C" |
| 101 | Non-ICAO address being reported as Participant Address is for a Surface Vehicle, a Fixed Ground or Tethered Obstruction | "C" |
| 110 | Reserved | N/A |
| 111 | Reserved | N/A |

***Notes for Table 2-85:***

1. *All transponder-based based 1090 MHz ADS-B systems are required to use an ICAO 24-bit address. Certain types of non-transponder-based 1090 MHz ADS-B systems may under certain conditions be permitted to broadcast an address other than an ICAO 24-bit address. ADS-B Messages received from Non-Transponder Devices transmitting with DF=18 and CF=1 indicate that a non-ICAO Address is being used (see Figure 2-2).*
2. *The Emitter Category associated with the Participant Address is to be obtained from the "ADS-B Emitter Category" subfield (§2.2.3.2.5.2) of the ADS-B Aircraft Identification and Category Message.*
3. *An Address Qualifier Code of 000 or 001 is to be reported if the value from the "ADS-B Emitter Category" subfield indicates "No ADS-B Emitter Category Information," or if an ADS-B Aircraft Identification and Category Message has not been received.*

### 2.2.8.1.4 Report Time of Applicability

Since separate messages are used for position and velocity, the Time of Applicability is reported individually for the position related report parameters and the velocity related report parameters. Also the State Vector Report may include estimated position and/or velocity values (i.e., not based on the receipt of a message with updated position or velocity information). In this latter case the State Vector report **shall** include a Time of

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Applicability for the estimated position/velocity parameters. The six-byte Report Time of Applicability Parameter field, as specified in Table 2-81, is sub-divided into three subfields as shown in Table 2-86. The coding of the subfields is specified in the following subparagraphs.

**Table 2-86: Report Time of Applicability Parameter Coding**

| Subfield | Coding |
|---|---|
| Time of Applicability for Estimated Position/Velocity | Mdddddd ddddddL |
| Position Time of Applicablity | Mdddddd ddddddL |
| Velocity Time of Applicabilty | Mdddddd ddddddL |

***Note:*** *In the "Coding" column, "M" indicates the Most Significant Bit of the data field and "L" indicates the Least Significant Bit of the data field.*

#### 2.2.8.1.4.1 Time of Applicability for Estimated Position/Velocity

The Time of Applicability for the estimated position and velocity **shall** be generated under the conditions specified below:

a. Each time that an individual State Vector Report is updated as specified in §2.2.8.1.17, §2.2.8.1.18, §2.2.8.1.19, ***OR*** §2.2.8.1.20, the Report Assembly Function **shall** update the Time of Applicability for the Estimate Position/Velocity data in the State Vector Report with either the GPS/GNSS UTC Measure Time data (§2.2.8.5.1) or the Established Receiver Unit Time (§2.2.8.5.2), whichever is applicable to the Receiving device Report Assembly Function installation requirements.

b. Time of Applicability data **shall** be provided in the State Vector report in binary format as specified in Table 2-86**.**

#### 2.2.8.1.4.2 Position Time of Applicability

Processing of Position Time of Applicability depends on the UTC Time of Message Receipt of the Position Message and the value of the "TIME" (T) bit in the Position Message.

##### 2.2.8.1.4.2.1 Position Time of Applicability when "TIME" (T)=0

Each time that an Airborne or Surface Position Message is received with valid Latitude ***AND*** Longitude data and "TIME" (T)=0, the Report Assembly Function **shall** update the Position Time of Applicability data in the State Vector Report with the Time of Message Receipt of the Position Message expressed as either GPS/GNSS UTC Measure Time data (see §2.2.8.5.1), or the Established Receiver Unit Time (see §2.2.8.5.2). Time of Applicability shall be rounded to the nearest LSB of the Position Time of Applicability field.

##### 2.2.8.1.4.2.2 Position Time of Applicability when "TIME" (T)=1 and UTC Time of Message Receipt is Available

Each time that an Airborne or Surface Position Message is received with "TIME" (T)="1" and valid Latitude ***AND*** Longitude data, and when a valid UTC Time of

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Message Receipt is available per §2.2.8.5.1, the Report Assembly Function **shall** update the Position Time of Applicability data in the State Vector Report with the appropriate 0.2 second UTC epoch. The appropriate 0.2 second UTC epoch is determined as follows:

- If "CPR Format" (F)=0, Position Time of Applicability **shall** be the nearest even 0.2 second UTC epoch to the time that the Airborne Position Message is received, expressed as GPS/GNSS UTC Measure Time data (see §2.2.8.5.1) and rounded to the nearest LSB of the Position Time of Applicability field.

- If "CPR Format" (F)=1, Position Time of Applicability **shall** be the nearest odd 0.2 second UTC epoch to the time that the Airborne Position Message is received, expressed as GPS/GNSS UTC Measure Time data (see §2.2.8.5.1) and rounded to the nearest LSB of the Position Time of Applicability field.

***Note:*** *An "even 0.2 second UTC epoch" is defined as that moment on the UTC time that occurs at an even number of 200-millisecond intervals after an exact even-numbered UTC second. Likewise, an "odd 0.2 second UTC epoch" is defined as that moment on the UTC time scale that occurs at an odd number of 200 millisecond intervals after an even numbered UTC second. Examples of even 0.2 second epochs are 12.0 seconds, 12.4 seconds, 12.8 seconds, 13.2 seconds, 13.6 seconds, etc. Examples of odd 0.2 second epochs are 12.2 seconds, 12.6 seconds, 13.0 seconds, 13.4 seconds, 13.8 seconds, etc.*

#### 2.2.8.1.4.2.3 Position Time of Applicability when "TIME" (T)=1 and UTC Time of Message Receipt is NOT Available

Each time that an Airborne or Surface Position Message is received with "TIME" (T)=1 and valid Latitude ***AND*** Longitude data, and when no valid UTC Time of Message Receipt per §2.2.8.5.1 is available, the Position Time of Applicability **shall** be processed as specified in §2.2.8.1.4.2.1.

#### 2.2.8.1.4.3 Velocity Time of Applicability

Each time that an Airborne Velocity Message - Subtype=1 or "2" is received with valid East/West AND North/South Velocity data, the Report Assembly Function **shall** update the Velocity Time of Applicability data in the State Vector Report with either the GPS/GNSS UTC Measure Time data (see §2.2.8.5.1) or the Established Receiver Unit Time (see §2.2.8.5.2), whichever is applicable to the Receiving device Report Assembly Function installation requirements.

Each time that a Surface Position Message is received with valid Movement AND Ground Track data, the Report Assembly Function **shall** update the Velocity Time of Applicability data in the State Vector Report with either the GPS/GNSS UTC Measure Time data (see §2.2.8.5.1) or the Established Receiver Unit Time (see §2.2.8.5.2), whichever is applicable to the Receiving device Report Assembly Function installation requirements.

### 2.2.8.1.5 Latitude (WGS-84)

The ADS-B Report Assembly Function **shall** decode the Encoded Latitude data (§2.2.3.2.3.7 and /or §2.2.3.2.4.7) provided in the ADS-B broadcast. Decoding of the

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encoded latitude data **shall** be performed in accordance with §A.1.7.4 through §A.1.7.8.2 of Appendix A. Latitude data **shall** be provided to the user application in the State Vector report in angular weighted binary format (M bit = 90 degrees, S bit = negative, or 180 degrees) as specified in Table 2-81.

When valid encoded latitude data is not available, the latitude data provided to the user application **shall** be set to ALL ZEROs, and the Horizontal Position Validity Flag bit, i.e., bit #7 (MSB) of byte #3 of the State Vector Report (§2.2.8.1.1.2), **shall** be set to ZERO (0) to indicate that the reported Horizontal Position data is not valid. Otherwise, the Horizontal Position Validity Flag bit, i.e., bit #7 (MSB) of byte #3 of the State Vector Report, **shall** be set to ONE (1), unless modified by other conditions.

#### 2.2.8.1.6 Longitude (WGS-84)

The ADS-B Report Assembly Function **shall** decode the Encoded Longitude data (§2.2.3.2.3.8 and / or 2.2.3.2.4.8) provided in the ADS-B broadcast. Decoding of the encoded longitude data **shall** be performed in accordance with §A.1.7.4 through A.1.7.8.2 of Appendix A. Latitude data **shall** be provided to the user application in the State Vector report in angular weighted binary format (M bit = 90 degrees, S bit = negative, or 180 degrees) as specified in Table 2-81.

When valid encoded longitude data is not available, the longitude data provided to the user application **shall** be set to ALL ZEROs, and the Horizontal Position Validity Flag bit, i.e., bit #7 (MSB) of byte #3 of the State Vector Report, **shall** be set to ZERO (0) to indicate that the reported Horizontal Position data is not valid. Otherwise, the Horizontal Position Validity Flag bit, i.e., bit #7 (MSB) of byte #3 of the State Vector Report, **shall** be set to ONE (1), unless modified by other conditions.

#### 2.2.8.1.7 Altitude, Geometric (WGS-84)

a. When Geometric Altitude Data is indicated by the "TYPE" subfield (§2.2.3.2.3.1) the ADS-B Report Assembly Function **shall** decode Altitude Data (§2.2.3.2.3.4) that has been encoded by the ADS-B Transmitting Subsystem as specified in §2.2.3.2.3.4.2.

b. Alternatively, Barometric Altitude Data (§2.2.3.2.3.4.1), Difference from Barometric Altitude Sign Bit (§2.2.3.2.6.1.14, §2.2.3.2.6.2.14, §2.2.3.2.6.3.14 or §2.2.3.2.6.4.14), and Difference from Barometric Altitude (§2.2.3.2.6.1.15, §2.2.3.2.6.2.15, §2.2.3.2.6.3.15 or §2.2.3.2.6.4.15), **shall** be decoded and the Geometric Altitude computed by the receiver Report Assembly Function.

c. Geometric Binary Altitude data **shall** be provided to the user application in the State Vector report in binary format as specified in Table 2-81. This format represents a true two's complement format where the MSB has a weight of 65,536 and the LSB has a weight of 0.015625. The maximum range of the data is then given by ±[2*MSB - LSB] or ±131071.984375.

d. When valid Geometric Altitude data is not available, the ADS-B receiver **shall** set the Geometric Altitude data provided to the user interface to ALL ZEROs, and the Geometric Altitude Validity Flag bit, i.e., bit #6 of byte #3 of the State Vector Report (§2.2.8.1.1.2), **shall** be set to ZERO (0) to indicate that the reported Geometric Altitude is not valid. Otherwise, the Geometric Altitude Validity Flag bit, i.e., bit #6

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of byte #3 of the State Vector Report, **shall** be set to ONE (1), unless modified by other conditions.

***Note:*** *Geometric Altitude is not required to be estimated when a State Vector Report is prepared as a result of receiving an airborne position and velocity messages. (i.e. The State Vector Report can include the most recently received value for this field.)*

**2.2.8.1.8 North/South Velocity**

a. The ADS-B Report Assembly Function **shall** extract the North/South Direction Bit (§2.2.3.2.6.1.8 or §2.2.3.2.6.2.8) and the North/South Velocity subfield (§2.2.3.2.6.1.9 or §2.2.3.2.6.2.9) from the ADS-B Message and provide North/South Velocity information to the user Application in the State Vector report in binary format as specified in Table 2-81. This format represents a true two's complement format where the MSB has a weight of 2,048 and the LSB has a weight of 0.125. The maximum range of the data is then given by ± [2*MSB - LSB] or ±4,095.875.

b. When valid North/South Velocity data is not available, the North/South Velocity data provided to the user application **shall** be set to ALL ZEROs, and the Airborne Horizontal Velocity Validity Flag bit, i.e., bit #5 of byte #3 of the State Vector Report (§2.2.8.1.1.2), **shall** be set to ZERO (0) to indicate that the reported Airborne Horizontal Velocity is not valid. Otherwise, the Airborne Horizontal Velocity Validity Flag bit, i.e., bit #5 of byte #3 of the State Vector Report, **shall** be set to ONE (1), unless modified by other conditions.

**2.2.8.1.9 East/West Velocity**

a. The ADS-B Report Assembly Function **shall** extract the East/West Direction Bit (§2.2.3.2.6.1.6 or §2.2.3.2.6.2.6) and the East/West Velocity subfield (§2.2.3.2.6.1.7 or §2.2.3.2.6.2.7) from the ADS-B Message and provide East/West Velocity information to the user application in the State Vector report in binary format as specified in Table 2-81. This format represents a true two's complement format where the MSB has a weight of 2,048 and the LSB has a weight of 0.125. The maximum range of the data is then given by ±[2*MSB - LSB] or ±4,095.875.

b. When valid East/West Velocity data is not available, the East/West Velocity data provided to the user application **shall** be set to ALL ZEROs, and the Airborne Horizontal Velocity Validity Flag bit, i.e., bit # 5 of byte #3 of the State Vector Report (§2.2.8.1.1.2), **shall** be set to ZERO (0) to indocate that the reported Airborne Horizontal Velocity is not valid. Otherwise, the Airborne Horizontal Velocity Validity Flag bit, i.e., bit #5 of byte #3 of the State Vector Report, **shall** be set to ONE (1), unless modified by other conditions.

**2.2.8.1.10 Ground Speed While on the Surface**

a. The ADS-B Report Assembly Function **shall** extract the Movement Data (§2.2.3.2.4.2) from the ADS-B Surface Position Message and provide Ground Speed information to the user application in the State Vector report as specified in Table 2-81. Coding of the Movement information **shall** be the same as that identified for the Movement Data in §2.2.3.2.4.2.

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b. When valid Movement data is not available, the ADS-B Report Assembly Function **shall** set the Ground Speed data provided to the user application to ALL ZEROs, and the Surface Ground Speed Validity Flag bit, i.e., bit #4 (LSB) of byte #3 of the State Vector Report, **shall** be set to ZERO (0) to indicate that the reported Surface Ground Speed is not valid. Otherwise, the Surface Ground Speed Validity Flag bit, i.e., bit #4 (LSB) of byte #3 of the State Vector Report, **shall** be set to ONE (1), unless modified by other conditions.

#### 2.2.8.1.11 Heading While on the Surface

a. The ADS-B Report Assembly Function **shall** extract the Status Bit for Heading (§2.2.3.2.4.3) and Heading Data (§2.2.3.2.4.4) from the ADS-B Surface Position Message and provide Heading while on the surface information to the user application in the State Vector Report in binary format as specified in Table 2-81. This format represents a true two's complement format where the MSB has a weight of 90 degrees and the LSB has a weight of 1.40625 degrees. The maximum range of the data is then given by ±[2*MSB - LSB] or ±178.59375 degrees. Alternately, the format may be referred to as angular weighted binary.

b. When valid Heading while on the surface data is not available, the ADS-B Report Assembly Function **shall** set the Heading while on the surface data provided to the user application to ALL ZEROs, and the Surface Heading Validity Flag bit, i.e., bit #3 (MSB) of byte #3 of the State Vector Report, **shall** be set to ZERO (0) to indicate that the reported Surface Heading is not valid. Otherwise, the Surface Heading Validity Flag bit, i.e., bit #3 (MSB) of byte #3 of the State Vector Report, **shall** be set to ONE (1), unless modified by other conditions.

#### 2.2.8.1.12 Altitude, Barometric (Pressure Altitude)

a. When Barometric Altitude Data is indicated by the "TYPE" subfield (§2.2.3.2.3.1) of the ADS-B Airborne Position Message, the ADS-B Report Assembly Function **shall** decode Altitude Data (§2.2.3.2.3.4) that has been encoded by the ADS-B Transmitting Subsystem as specified in §2.2.3.2.3.4.1. Binary Altitude data **shall** be provided to the user application in the State Vector report as specified in Table 2-81. This format represents a true two's complement format where the MSB has a weight of 65,536 and the LSB has a weight of 0.015625. The maximum range of the data is then given by ± [2*MSB - LSB] or ±131071.984375.

b. When valid Barometric Altitude data is not available, the ADS-B Report Assembly Function **shall** set the Barometric Altitude data provided to the user application to ALL ZEROs, and the Barometric Altitude Validity Flag bit, i.e., bit #2 of byte #3 of the State Vector Report, **shall** be set to ZERO (0) to indicate that the reported Barometric Altitude is not valid. Otherwise, the Barometric Altitude Validity Flag bit, i.e., bit #2 of byte #3 of the State Vector Report, **shall** be set to ONE (1), unless modified by other conditions.

***Note:*** *Barometric Altitude is not required to be estimated when a State Vector Report is prepared as a result of receiving an airborne position and velocity messages. (i.e. The State Vector Report can include the most recently received value for this field.)*

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#### 2.2.8.1.13 Vertical Rate, Geometric/Barometric

The "Vertical Rate" field in the State Vector Report contains the altitude rate of an airborne ADS-B Participant. This **shall** be either the rate of change of pressure altitude, or of geometric altitude, as specified by the "Vertical Rate Type" element in the Mode Status Report (§2.2.8.2.18).

#### 2.2.8.1.14 Vertical Rate, Geometric (WGS-84)

a. When Geometric Altitude Rate Data is indicated by the "Source Bit for Vertical Rate" subfield (§2.2.3.2.6.1.10, §2.2.3.2.6.2.10, §2.2.3.2.6.3.10 or §2.2.3.2.6.4.10) the ADS-B Report Assembly Function **shall** extract the "Sign Bit for Vertical Rate" subfield (§2.2.3.2.6.1.11, §2.2.3.2.6.2.11, §2.2.3.2.6.3.11 or §2.2.3.2.6.4.11) and the "Vertical Rate" subfield (§2.2.3.2.6.1.12, §2.2.3.2.6.2.12, §2.2.3.2.6.3.12 or §2.2.3.2.6.4.12) from the ADS-B Message and provide Vertical Rate, Geometric information to the user application in the State Vector report in binary format as specified in Table 2-81. This format represents a true two's complement format where the MSB has a weight of 16,384 and the LSB has a weight of 1. The maximum range of the data is then given by ±[2*MSB - LSB] or ±32,767.

b. When valid Geometric Altitude Rate data is **not** available, the ADS-B Report Assembly Function **shall** set the Vertical Rate, Geometric data provided to the user application to ALL ZEROs, and the Geometric Vertical Rate Validity Flag bit, i.e., bit #1 of byte #3 of the State Vector Report (§2.2.8.1.1.2), **shall** be set to ZERO (0) to indicate that the reported Geometric Vertical Rate is not valid. Otherwise, the Geometric Vertical Rate Validity Flag bit, i.e., bit #1 of byte #3 of the State Vector Report, **shall** be set to ONE (1), unless modified by other conditions.

***Note:*** *Geometric Altitude Rate is not required to be estimated when a State Vector Report is prepared as a result of receiving an airborne position and velocity messages. (i.e. The State Vector Report can include the most recently received value for this field.)*

#### 2.2.8.1.15 Barometric Altitude Rate

a. When Barometric Altitude Rate Data is indicated by the "Source Bit for Vertical Rate" subfield (§2.2.3.2.6.1.10, §2.2.3.2.6.2.10, §2.2.3.2.6.3.10 or §2.2.3.2.6.4.10) the ADS-B Report Assembly Function **shall** extract the "Sign Bit for Vertical Rate" subfield (§2.2.3.2.6.1.11, §2.2.3.2.6.2.11, §2.2.3.2.6.3.11 or §2.2.3.2.6.4.11) and the "Vertical Rate" subfield (§2.2.3.2.6.1.12, §2.2.3.2.6.2.12, §2.2.3.2.6.3.12 or §2.2.3.2.6.4.12) from the ADS-B Message and provide Vertical Rate, Barometric information to the user application in the State Vector report in binary format as specified in Table 2-81. This format represents a true two's complement format where the MSB has a weight of 16,384 and the LSB has a weight of 1. The maximum range of the data is then given by ±[2*MSB - LSB] or ±32,767.

b. When valid Barometric Altitude Rate data is **not** available, the ADS-B Report Assembly Function **shall** set the Vertical Rate, Barometric data provided to the user application to ALL ZEROs, and the Barometric Vertical Rate Validity Flag bit, i.e., bit #0 of byte #3 of the State Vector Report, **shall** be set to ZERO (0). Otherwise, the Barometric Vertical Rate Validity Flag bit, i.e., bit #0 of byte #3 of the State Vector Report, **shall** be set to ONE (1), unless modified by other conditions.

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***Note:*** *Barometric Altitude Rate is not required to be estimated when a State Vector Report is prepared as a result of receiving an airborne position and velocity messages. (i.e. The State Vector Report can include the most recently received value for this field.)*

### 2.2.8.1.16 Navigation Integrity Category (NIC)

The ADS-B Report Assembly Function **shall** provide Navigation Integrity Category (NIC) information in the State Vector Report. The NIC is derived from the~~extract~~ "TYPE" Code data (§2.2.3.2.3.1~~2.2.3.2.3.1~~) and the NIC Supplement-B value (§2.2.3.2.3.3~~2.2.3.2.3.3~~) from the ADS-B Airborne Position Message and the NIC Supplement-A value (§2.2.3.2.7.2.6~~2.2.3.2.7.2.6~~) from the ADS-B Aircraft Operational Status Message, or the "TYPE" Code data (§2.2.3.2.4.1~~2.2.3.2.4.1~~) from the ADS-B Surface Position Message, and the NIC Supplement-A -value (§2.2.3.2.7.2.6~~2.2.3.2.7.2.6~~) and the NIC Supplement-C value (§XXXXXXXX) from the ADS-B Aircraft Operational Status Message. The NIC values are encoded ~~, and provide Navigation Integrity Category (NIC) information~~ according to the NIC values given in Table 2-70 except for $R_C$ < 0.3 NM which is encoded with a value of 6 in bits 0 to 3 in byte 35 and bit 4 in byte 35 set to ONE (1) of the State Vector Report. The NIC parameter is provided to the user application in the State Vector Report as specified in Table 2-81. ~~Definition of the NIC coding is provided in Table 2-70.~~

***Note:*** *For backward compatability, applications designed to interface to DO-260A State Vector Report structure will decode $R_C$ < 0.3 NM (22) as a NIC of 6 and interpret it as $R_C$ < 0.6 NM. Applications designed to these MOPS will properly decode the NIC as $R_C$ < 0.3 NM.*

### 2.2.8.1.17 Estimated Latitude (WGS-84)

a. New Latitude Data Received

(1). Airborne or Surface Message Received: - Each time that the Report Assembly Function establishes a new decoded Latitude in accordance with §2.2.8.1.2, the Report Assembly Function **shall** update the Estimated Latitude (WGS-84) data in the State Vector Report with the new Latitude data received.

(2). Airborne or Surface Message Received: - The Estimated Latitude update **shall** be completed by the Report Assembly Function also updating the Report Time of Applicability in the State Vector Report with either the GPS/GNSS UTC Measure Time data (see §2.2.8.5.1) or the Established Receiver Unit Time (see §2.2.8.5.2) whichever is applicable to the Receiving device Report Assembly Function installation requirements.

b. New North/South Velocity Data Received: (Airborne Velocity Message Received)

(1). Each time that an Airborne Velocity Message - Subtype=1 or "2" is received with valid North/South Velocity data, the Report Assembly Function **shall** compute a new Estimated Latitude (WGS-84) position based on the last known

Estimated Latitude (WGS-84), the last known North/South Velocity (***Note:*** Not the North/South Velocity data just received), and the time that has elapsed since the last update of the Estimated Latitude (WGS-84).

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Accuracy of the Estimated Latitude (WGS-84) computation **shall** be within ±20 meters of the theoretical noise free position that could be established based on the previous position, the last known velocity, and the time of travel.

***Note:*** *The accuracy requirement is stated in the manner given in order to specifically allow the implementation to use estimation techniques such as Kalman filters, alpha-beta trackers, or linear estimation as deemed necessary by the implementer to satisfy the accuracy requirement.*

(2). The new Estimated Latitude (WGS-84) computed in b.(1) **shall** be used by the Report Assembly Function to update the Estimated Latitude (WGS-84) data in the State Vector Report.

(3). The Estimated Latitude update **shall** be completed by the Report Assembly Function also updating the Report Time of Applicability in the State Vector Report with either the GPS/GNSS UTC Measure Time data (see §2.2.8.5.1) or the Established Receiver Unit Time (see §2.2.8.5.2) whichever is applicable to the Receiving device Report Assembly Function installation requirements.

c. Estimated Horizontal Position Validity Flag Requirements

When valid estimated Latitude or Longitude position data is not available, the estimated latitude and longitude data provided to the user application **shall** be set to ALL ZEROs and the Estimated Horizontal Position Validity Flag bit, i.e., bit #7 of byte #4 of the State Vector Report (§2.2.8.1.1.2), **shall** be set to ZERO (0) to indicate that the reported Estimated Horizontal Position is not valid.

Otherwise, the Estimated Horizontal Position Validity Flag bit, i.e., bit #7 of byte #4 of the State Vector Report, **shall** be set to ONE (1), unless modified by other conditions.

### 2.2.8.1.18 Estimated Longitude (WGS-84)

a. New Longitude Data Received

(1). Airborne or Surface Message Received: - Each time that the Report Assembly Function establishes a new decoded Longitude in accordance with §2.2.8.1.6, the Report Assembly Function **shall** update the Estimated Longitude (WGS-84) data in the State Vector Report with the new Longitude data received.

(2). Airborne or Surface Message Received: - The Estimated Longitude update **shall** be completed by the Report Assembly Function also updating the Report Time of Applicability in the State Vector Report with either the GPS/GNSS UTC Measure Time data (see §2.2.8.5.1) or the Established Receiver Unit Time (see §2.2.8.5.2) whichever is applicable to the Receiving device Report Assembly Function installation requirements.

b. New East/West Velocity Data Received: (Airborne Velocity Message Received)

(1). Each time that an Airborne Velocity Message - Subtype=1 or “2” is received with valid East/West Velocity data, the Report Assembly Function **shall** compute a new Estimated Longitude (WGS-84) position based on the last known

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Estimated Longitude (WGS-84), the last known East/West Velocity (***Note:*** Not the East/West Velocity data just received), and the time that has elapsed since the last update of the Estimated Longitude (WGS-84).

Accuracy of the Estimated Longitude (WGS-84) computation **shall** be within ±20 meters of the theoretical noise free position that could be established based on the previous position, the last known velocity, and the time of travel.

***Note:*** *The accuracy requirement is stated in the manner given in order to specifically allow the implementation to use estimation techniques such as Kalman filters, alpha-beta trackers, or linear estimation as deemed necessary by the implementer to satisfy the accuracy requirement.*

(2). The new Estimated Longitude (WGS-84) computed in b.(1) **shall** be used by the Report Assembly Function to update the Estimated Longitude (WGS-84) data in the State Vector Report.

(3). The Estimated Longitude update **shall** be completed by the Report Assembly Function also updating the Report Time of Applicability in the State Vector Report with either the GPS/GNSS UTC Measure Time data (see §2.2.8.5.1) or the Established Receiver Unit Time (see §2.2.8.5.2) whichever is applicable to the Receiving device Report Assembly Function installation requirements.

c. Estimated Horizontal Position Validity Flag Requirements

When valid estimated Latitude or Longitude position data is not available, the estimated latitude and longitude data provided to the user application **shall** be set to ALL ZEROs and the Estimated Horizontal Position Validity Flag bit, i.e., bit #0 of byte #3 of the State Vector Report (§2.2.8.1.1.2), **shall** be set to ZERO (0) to indicate that the reported Estimated Horizontal Position is not valid.

Otherwise, the Estimated Horizontal Position Validity Flag bit, i.e., bit #0 of byte #3 of the State Vector Report, **shall** be set to ONE (1), unless modified by other conditions.

### 2.2.8.1.19 Estimated North/South Velocity

***Note:*** *The estimation of North/South Velocity is considered to be an optional function to be implemented in the ADS-B Report Assembly Function at the discretion of the implementer. If estimation of North/South Velocity is implemented then the requirements provided in the following subparagraphs a. through b.(3) are to be used as the minimum acceptable performance for such estimation.*

a. New North/South Velocity Received: (Airborne Velocity or Surface Position Message Received)

(1). Each time that the Report Assembly Function establishes a new North/South Velocity in accordance with §2.2.8.1.8, the Report Assembly Function **shall** update the Estimated North/South Velocity data in the State Vector Report with the new North/South Velocity data received.

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(2). The Estimated North/South Velocity update **shall** be completed by the Report Assembly Function also updating the Report Time of Applicability in the State Vector Report with either the GPS/GNSS UTC Measure Time data (see §2.2.8.5.1) or the Established Receiver Unit Time (see §2.2.8.5.2) whichever is applicable to the Receiving device Report Assembly Function installation requirements.

b. New Latitude Position Data Received: (Airborne Position or Surface Position Message Received)

(1). Each time that the Report Assembly Function establishes a new decoded Latitude in accordance with §2.2.8.1.2, the Report Assembly Function **shall** compute a new Estimated North/South Velocity based on the last known Estimated Latitude (WGS-84), the new Latitude position data just received, and the time that has elapsed since the last update of the Estimated North/South Velocity.

Accuracy of the Estimated North/South Velocity computation **shall** be within ±0.3 meters/second of the theoretical noise free Estimated North/South Velocity that could be established based on the previous position, the new position, and the elapsed time of travel between the two positions.

***Note:*** *The accuracy requirement is stated in the manner given in order to specifically allow the implementation to use estimation techniques such as Kalman filters, alpha-beta trackers, or linear estimation as deemed necessary by the implementer to satisfy the accuracy requirement.*

(2). The new Estimated North/South Velocity computed in b.(1) **shall** be used by the Report Assembly Function to update the Estimated North/South Velocity data in the State Vector Report.

(3). The Estimated North/South Velocity update **shall** be completed by the Report Assembly Function also updating the Report Time of Applicability in the State Vector Report with either the GPS/GNSS UTC Measure Time data (see §2.2.8.5.1) or the Established Receiver Unit Time (see §2.2.8.5.2) whichever is applicable to the Receiving device Report Assembly Function installation requirements.

c. Estimated Velocity Validity Flag Requirements

When valid estimated North/South or East/West Velocity data is not available, the estimated North/South or East/West Velocity data provided to the user application **shall** be set to ALL ZEROs and the Estimated Horizontal Velocity Validity Flag bit, i.e., bit #6 of byte #4 of the State Vector Report (§2.2.8.1.1.2), **shall** be set to ZERO (0) to indicate that the reported Estimated Horzontal Velocity is not valid.

Otherwise, the Estimated Horizontal Velocity Validity Flag bit, i.e., bit #6 of byte #4 of the State Vector Report, **shall** be set to ONE (1), unless modified by other conditions.

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**2.2.8.1.20 Estimated East/West Velocity**

***Note:*** *The estimation of East/West Velocity is considered to be an optional function to be implemented in the ADS-B Report Assembly Function at the discretion of the implementer. If estimation of East/West Velocity is implemented then the requirements provided in the following subparagraphs a. through b.(3) are to be used as the minimum acceptable performance for such estimation.*

a. New East/West Velocity Data Received: (Airborne Velocity or Surface Position Message Received)

(1). Each time that the Report Assembly Function establishes a new East/West Velocity in accordance with §2.2.8.1.9, the Report Assembly Function **shall** update the Estimated East/West Velocity data in the State Vector Report with the new East/West Velocity data received.

(2). The Estimated East/West Velocity update **shall** be completed by the Report Assembly Function also updating the Report Time of Applicability in the State Vector Report with either the GPS/GNSS UTC Measure Time data (see §2.2.8.5.1) or the Established Receiver Unit Time (see §2.2.8.5.2) whichever is applicable to the Receiving device Report Assembly Function installation requirements.

b. New Longitude Position Data Received: (Airborne or Surface Position Message Received)

(1). Each time that the Report Assembly Function establishes a new decoded Longitude in accordance with §2.2.8.1.6, the Report Assembly Function **shall** compute a new Estimated East/West Velocity based on the last known Estimated Longitude (WGS-84), the new Longitude position data just received, and the time that has elapsed since the last update of the Estimated East/West Velocity.

Accuracy of the Estimated East/West Velocity computation **shall** be within ±0.3 meters/second of the theoretical noise free Estimated East/West Velocity that could be established based on the previous position, the new position, and the elapsed time of travel between the two positions.

***Note:*** *The accuracy requirement is stated in the manner given in order to specifically allow the implementation to use estimation techniques such as Kalman filters, alpha-beta trackers, or linear estimation as deemed necessary by the implementer to satisfy the accuracy requirement.*

(2). The new Estimated East/West Velocity computed in b.(1) **Shall** be used by the Report Assembly Function to update the Estimated East/West Velocity data in the State Vector Report.

(3). The Estimated East/West Velocity update **shall** be completed by the Report Assembly Function also updating the Report Time of Applicability in the State Vector Report with either the GPS/GNSS UTC Measure Time data (see §2.2.8.5.1) or the Established Receiver Unit Time (see §2.2.8.5.2) whichever is applicable to the Receiving device Report Assembly Function installation requirements.

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c. Estimated Horizontal Velocity Validity Flag Requirements

When valid estimated North/South or East/West Velocity data is not available, the estimated North/South or East/West Velocity data provided to the user application **shall** be set to ALL ZEROs and the Estimated Horizontal Velocity Validity Flag bit, i.e., bit #7 of byte #4 of the State Vector Report (§2.2.8.1.1.2), **shall** be set to ZERO (0) to indicate that the reported Estimated Horzontal Velocity is not valid.

Otherwise, the Estimated Horizontal Velocity Validity Flag bit, i.e., bit #7 of byte #4 of the State Vector Report, **shall** be set to ONE (1), unless modified by other conditions.

### 2.2.8.1.21 Surveillance Status / Discretes

a. The ADS-B Report Assembly Function **shall** extract the Surveillance Status (§2.2.3.2.3.2) from the ADS-B Airborne Position Message (§2.2.3.2.3) and map the surveillance status data into the most significant nibble of the State Vector Report byte on a bit for bit basis as shown in Table 2-81.

b. When valid Surveillance Status data is not available, the ADS-B Report Assembly Function **shall** set the Surveillance Status data provided to the user application to ALL ZEROs.

c. The ADS-B Report Assembly Function **shall** extract the Intent Change Flag (§2.2.3.2.6.1.3 and Figure 2-7, Figure 2-8) from the ADS-B Airborne Velocity Message (§2.2.3.2.6) and map the Intent Change Flag into the bit "b1" of the least significant nibble of the State Vector Report byte on a bit for bit basis as shown in Table 2-81.

d. The ADS-B Report Assembly Function **shall** insert a ZERO (0) into bit "b0" of the least significant nibble of the State Vector Report byte shown in Table 2-81.

### 2.2.8.1.22 Report Mode

The Report Mode is used to indicate the current state of the Report for each ADS-B vehicle being reported. Each time that the State Vector Report is updated, the Report Mode **shall** be updated with the encoding being as shown in Table 2-87.

**Table 2-87: Report Mode Encoding**

| Coding | Report Mode |
|---|---|
| xxxx 0000 | No Report Generation Capability |
| xxxx 0001 | Acquisition Mode (see §2.2.10.2) |
| xxxx 0010 | Track Mode (see §2.2.10.3) |
| xxxx 0011 through xxxx 1111 | Reserved for Future Expansion |

***Note:*** *"x" in the table above, denotes "DON'T CARE."*

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### 2.2.8.2 ADS-B Mode Status Report Characteristics

Table 2-88 and the subsequent subparagraphs identify the data structure for all ADS-B Mode Status Reports.

The Report Assembly Function **shall** be compatible with the current and prior versions of the relevant 1090 MHz ADS-B Messages (e.g., Operational Status, Airborne Position, Surface Position, Airborne Velocity, Aircraft Status and Aircraft Identification) that are used as the basis for generating Mode Status Reports. The relevant Version Two (2) messages are identified below and the relevant Version Zero (0) messages, conformant to RTCA DO-260, including Change 1, and the relevant Version One (1) messages, conformant to RTCA DO-260A, including Change 1 and Change 2, and their required use for ADS-B Mode Status Report generation are defined in Appendix N, Section N.4.

The intent of Table 2-88 is to illustrate the structure of all Items required to be reported in an ADS-B Mode Status Report. The exact structure of the data indicated in columns 10 and 11 is provided as a guideline or one possible method of satisfying the report structure. Implementers may choose to organize the data in another format; however, delivery to a user interface or application of all Items in Table 2-88 **shall** be consistent with the range, resolution, and units indicated in column 7, 8 and 9 of Table 2-88 respectively. If data is not available to support a field that is delivered to an application, then the data provided to the application **shall** be set to ALL ZEROs. Those requirements in §2.2.8.2.1 to §2.2.8.2.4 below that relate to specific data structure details (byte numbers, and bit numbers within the bytes) **shall** only apply to equipment that uses the sample data structure shown in columns 10-11 of Table 2-88.

***Note:*** *Table 2-88 is structured such that column 1, 2, and 6 through 11, pertain to the Mode Status Report elements and how such elements should be structured into the report. Columns 3 through 5 provide information on where the appropriate data can be located in the ADS-B Messages for each of the Report elements.*

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## Table 2-88: ADS-B Mode Status Data Elements - Source Data Mapping To Report Structure

| Table 2-88: ADS-B Mode Status Data Elements – Source Data Mapping To Report Structure | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Column # | REPORT STRUCTURE | | MESSAGE STRUCTURE RELEVANT | | | REPORT STRUCTURE RELEVANT | | | | | |
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| **Item #** | **Parameter / Contents** | **Notes** | **Received Message Sources** | **"ME" Field Bits** | **Message Field Bits** | **# of Bits** | **Range** | **Resolution** | **Units** | **Data Structure** | **Data Byte #** |
| 0a, 0b | Report Type and Structure | | N/A | N/A<br>N/A | 1 – 5<br>1 - 5 | 24 | N/A | N/A | discrete | MddL Mddd ddddddd<br>ddddddL | 0 - 2 |
| 0c | Validity Flags | | N/A | N/A | N/A | 8 | N/A | N/A | discrete | dddddddd | 3 |
| 1 | Participant Address | | Airborne Velocity - "AA"<br>- OR -<br>Operational Status – "AA"<br>- OR -<br>Target State & Status - "AA"<br>- OR -<br>Aircraft ID & Category Msg – "AA" | N/A<br><br>N/A<br><br>N/A<br><br>**N/A** | 9 – 32<br><br>9 – 32<br><br>9 – 32<br><br>9 - 32 | 24<br><br>24<br><br>24<br><br>24 | N/A | N/A | discrete | Mddddddd ddddddd<br>ddddddL | 4 – 6 |
| 2 | Address Qualifier | | Aircraft ID & Category "Emitter Category"<br>All Messages with DF=18 – "CF" | 6 – 8<br><br>N/A | 38 – 40<br><br>6 – 8 | 8 | N/A | N/A | discrete | xxxxxMdL | 7 |
| 3 | Time of Applicability | | Operational Status<br>Airborne Position<br>Target State & Status | N/A | N/A | 16 | 511.9921875 | 0.0078125 (1/128) | seconds | Mddddddd dddddddL | 8 - 9 |
| 4 | ADS-B Version | | Operational Status – "Version Number" | 41 - 43 | 73 - 75 | 8 | 0 - 7 | 1 | discrete | xxxxxMdL | 10 |
| 5a | Call Sign | | Aircraft ID & Category Msg – "Ident Char." | 14 – 56 | 41 – 88 | 64 | N/A | N/A | Alphanumeric characters | xMdddddL xMdddddL<br>xMdddddL xMdddddL<br>xMdddddL xMdddddL<br>xMdddddL xMdddddL | 11 – 18 |
| 5b | Emitter Category | | Aircraft ID & Category Msg – "Emitter Category" | 6 – 8 | 38 - 40 | 8 | N/A | N/A | discrete | xxxMdddL | 19 |
| 5c | A/V Length and Width Code | 3~~4~~ | Operational Status – Subtype=1 – "L/W Code" | 21 – 24 | 53 – 56 | 8 | N/A | N/A | discrete | xxxxMddL | 20 |
| 6 | Emergency/Priority Status | | Aircraft Status Message – Subtype 1 – "Emergency / Priority Status" | 9 - 11 | 36 - 38 | 8 | N/A | N/A | discrete | xxxxxMdL | 21 |
| 7 | Capability Class Codes | | Operational Status ~~– Subtype=0 –~~ "CC"<br><br>Target State & Status "TCAS Operational"~~Target State & Status "Capability/Mode Codes"~~ | 9 - 24<br><br>~~52 –~~ 53 | 41 - 56<br><br>~~84 –~~ 85 | 24~~24~~<br><br>~~24~~ | See Section 2.2.8.2.10 | | | dddddddd ddddddd<br>ddddddd | 22 - 24 |

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**Table 2-88: ADS-B Mode Status Data Elements – Source Data Mapping To Report Structure**

| Column # | REPORT STRUCTURE | | MESSAGE STRUCTURE RELEVANT | | | REPORT STRUCTURE RELEVANT | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| **Item #** | **Parameter / Contents** | **Notes** | **Received Message Sources** | **"ME" Field Bits** | **Message Field Bits** | **# of Bits** | **Range** | **Resolution** | **Units** | **Data Structure** | **Data Byte #** |
| 8 | Operational Mode | 4 | Operational Status – "OM"<br>~~Target State & Status "Capability/Mode Codes"~~ | 25 – 40<br>~~52 – 53~~ | 57 - 72<br>~~84 – 85~~ | 16<br>~~16~~ | See Section 2.2.8.2.11 | | | dddddddd ddddddd | 25 - 26 |
| 9a | SV Quality - NACp | | Operational Status – "$NAC_P$"<br>Target State & Status - "$NAC_P$" | 45 - 48<br>40 - 43 | 77 - 80<br>72 - 75 | 8 | N/A | N/A | discrete | xxxxMddL | 27 |
| 9b | SV Quality - $NAC_V$ | | Airborne Velocity – "$NAC_V$"<br>Operational Status – Subtype = 1 -"$NAC_V$" | 11 – 13<br>17 – 19 | 43 – 45<br>49 - 51 | 8 | N/A | N/A | discrete | xxxxxMdL | 28 |
| 9c | SV Quality – SIL | | Operational Status – "SIL"<br>Target State & Status - "SIL" | 51 – 52<br>45 – 46 | 83 - 84<br>77 – 78 | 8 | N/A | N/A | discrete | xxxxxxML | 29 |
| 9d | SV Quality – SIL Supplement | | Operational Status – "SIL Supplement"<br>Target State & Status - "SIL" | 55<br>8 | 87<br>40 | 8 | N/A | N/A | discrete | xxxxxLxx | 29 |
| 9e | SV Quality – SDA | | Operational Status – ~~"SIL Supplement~~SDA" | 31 – 32 | 63 – 64 | 8 | N/A | N/A | discrete | xxxMLxxx | 29 |
| 9f~~d~~ | SV Quality – GVA | | Operational Status – "GVA" | 49 – 50 | 81 – 82 | 8 | N/A | N/A | discrete | xxxxxx~~d~~ML | 30 |
| 9g~~e~~ | SV Quality – $NIC_{BARO}$ | | Operational Status – Subtype=0 – "$NIC_{BARO}$"<br>Target State & Status - "$NIC_{BARO}$" | 53<br>44 | 85<br>76 | 8 | N/A | N/A | discrete | xxxxxxxL | 31 |
| 10a | Track/Heading and Horizontal Reference Direction (HRD) | | Operational Status – Subtype=1 – Trk/Hdg & Subtype=0,1 – HRD" | 53 -54 | 85 -86 | 8 | N/A | N/A | discrete | xxxxxxML | 32 |
| 10b | Vertical Rate Type | | Airborne Velocity – "Vert. Rate Source" | 36 | 68 | 8 | N/A | N/A | discrete | xxxxxxxL | 33 |
| 11 | (Reserved for) Flight Mode Specific Data | | | | | 8 | N/A | N/A | discrete | xxxxxMdL | 34 |
| 12 | Other (Reserved)~~Other (Reserved)~~ | | Reserved~~Reserved~~ | | | 8 | Reserved~~Reserved~~ | | | dddddddd~~dddddddd~~ | 35~~35~~ |
| | | | | | | | | | | **TOTAL BYTES:** | 36 |

***Notes:***

1. *In the "Data Structure" column (i.e., column 10), "S" indicates the "sign-bit," "M" indicates the Most Significant Bit of the data field, "d" indicates data bits in the field, "L" indicates the Least Significant Bit of the data field, and "x" indicates "Don't Care" bits in the data field.*

2. *The Report Type and Structure Identifier is used to identify the type of ADS-B Report being generated and the data parameters provided in the report as specified in §2.2.8.1.1.*

3. *The A/V Length and Width Code parameter is only applicable to Mode Status Reports for aircraft~~s~~ or vehicles that ~~are on~~are reporting the ~~airport~~ surface formats.*

4. *The Operational Mode subfield includes the GPS Antenna Offset parameter in Mode Status Reports for aircraft or vehicles when reporting the surface formats.*

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### 2.2.8.2.1 Mode Status Report Type and Structure Identification and Validity Flags

#### 2.2.8.2.1.1 Mode Status Report Type and Structure Identification

The Report Type requirements were previously provided in §2.2.8.1.1. Report Type formats and the maximum number of bytes to be contained in each report are identified in Table 2-88.

The Report Structure field is used to indicate the exact data parameters identified in Table 2-88 that are being provided in the Mode Status report and is intended to provide a methodology for the Report Assembly Function to structure shorter reports when data for some parameters is not available. In order to provide the capability to provide shorter Mode Status reports the following basic conventions **shall** be adhered to:

a. Any given data parameter to be used in the report **shall** use the designated number of bytes and format as designated in Table 2-88.

b. Parameters that are designated in Table 2-88 are restricted to byte boundaries.

c. Whenever a data parameter identified in Table 2-88 is not provided in the report, then it is permissible to concatenate the next parameter to be included into the report immediately following the inclusion of the previous reported parameter.

d. Each parameter of the Mode Status report identified in Table 2-88 must be properly declared in the Report Structure field as detailed in the following paragraphs and Table 2-89.

***Note:*** *Implementation of the methodology just provided is realizable and controllable due to the fact that the exact length of each report parameter is specified in Table 2-88 and the Report Structure field identifies exactly which parameters are included in the report. Therefore, the report user can easily re-construct the length and general format of the report.*

The Report Structure is a 20-bit field and **shall** be provided in the least significant nibble (i.e., bits 3 - 0) of the first byte (i.e., byte "0") and continuing into bytes 1 and 2 of the Report. The Report Structure format is specified in Table 2-89 where each bit is associated with a particular data parameter of the Mode Status Report. If the bit is set to ONE (1), then the data parameter is considered to be available and **shall** be transmitted in the report. Otherwise, the data parameter is considered to not be available and **shall** not be transmitted in the report. Note that Table 2-89 does not address the Report Type and Structure Identification parameter, the Validity Flags parameter, nor the Participant Address parameter since these four parameters **shall** be included in the Mode Status Report. Also, certain of the other Mode Status data parameters are required to be reported, as specified in §2.2.9, even though bits have been allocated in the report structure field as shown in Table 2-89.

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**Table 2-89: ADS-B Mode Status Report Structure Coding**

| Byte # | Bit # | Mode Status Data Parameter to be Reported | Number of Bytes |
|---|---|---|---|
| 0 | 3 | Time of Applicability | 2 |
| | 2 | ADS-B Version | 1 |
| | 1 | Call Sign | 8 |
| | 0 | Emitter Category | 1 |
| 1 | 7 | A/V Length and Width Code | 1 |
| | 6 | Emergency / Priority Status | 1 |
| | 5 | Capability Codes | 2 |
| | 4 | Operational Mode | 2 |
| | 3 | SV Quality - $NAC_P$ | 1 |
| | 2 | SV Quality - $NAC_V$ | 1 |
| | 1 | SV Quality – SIL, SIL Supplement, SDA | 1 |
| | 0 | SV Quality – GVA | 1 |
| 2 | 7 | SV Quality - $NIC_{BARO}$ | 1 |
| | 6 | True/Magnetic Heading (HRD) | 1 |
| | 5 | Vertical Rate Type | 1 |
| | 4 | (Reserved for) Flight Mode Specific Data | 1 |
| | 3 | Other (Reserved) | 1 |
| | 2 | Reserved | |
| | 1 | Reserved | |
| | 0 | Reserved | |

#### 2.2.8.2.1.2 Mode Status Report Validity Flags

Validity Flags for data provided in the Mode Status Report **shall** be indicated in byte #3 of the Mode Status Report as shown for item "0c" in Table 2-88. The Mode Status Report elements that require validity flags are identified in Table 2-90. Table 2-90 identifies the byte and bit that **shall** be used as a flag for each element that requires a validity flag. Each validity flag bit **shall** be set to ONE (1) to indicate that the corresponding Mode Status Report Element data is valid. If such data is not valid, then the corresponding validity flag bit **shall** be set to ZERO (0). Only the six most significant bits of the subfield are currently assigned. The remaining 2 bits are reserved for future use.

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**Table 2-90: ADS-B Mode Status Report Validity Flag Requirements**

| MS Report Item # | Mode Status Report Element | Validity Flag Bit Required? | Validity Flag Bit Assignment Bit # |
|---|---|---|---|
| 0a | Report Type | No | |
| 0b | Report Data Structure Definition | No | |
| 0c | Validity Flags | No | |
| 1 | Participant Address | No | |
| 2 | Address Qualifier | No | |
| 3 | Time of Applicability | No | |
| 4 | ADS-B Version | No | |
| 5a | Call Sign | No | |
| 5b | Emitter Category | No | |
| 5c | A/V Length and Width Code | No | |
| 6 | Emergency/Priority Status | **Yes**<br>If an update has not been received within 100 seconds, via an Extended Squitter Aircraft Status Message, or a Target State and Status Message, then this report element is not considered valid. | 2 |
| 7 | Capability Codes | **Yes**<br>If an update has not been received within 24 seconds, via a Operational Status and/or a Target State and Status Message, then this report element is not considered valid | 7<br>(MSB) |
| 8 | Operational Mode | **Yes**<br>If an update has not been received within 24 seconds, via a Operational Status and/or a Target State and Status Message, then this report element is not considered valid | 6 |
| 9a | SV Quality - NACp | **Yes**<br>If an update has not been received within 24 seconds, via a Operational Status and/or a Target State and Status Message, then this report element is not considered valid | 5 |
| 9b | SV Quality - $NAC_V$ | **Yes**<br>If an update has not been received within 24 seconds via Airborne Velocity Message, then this report element is not considered valid | 4 |
| 9c | SV Quality – SIL | **Yes**<br>If an update has not been received within 24 seconds, via a Operational Status and/or a Target State and Status Message then this report element is not considered valid | 3 |
| 9d | SV Quality – GVA | No | |
| 9e | SV Quality – NICbaro | No | |
| 10a | True/Magnetic Heading | No | |
| 10b | Vertical Rate Type | No | |
| 11 | (Reserved for) Flight Mode Specific Data | No | |
| 12 | Other (Reserved) | No | |

### 2.2.8.2.2 Paritcipant Address

The Participant Address **shall** be encoded as specified in §2.2.3.2.1.5.

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#### 2.2.8.2.3 Address Qualifier

The Address Qualifier is used to indicate the type of participant address (§2.2.8.1.3) being reported. The 3 least significant bits of the one byte field are used to convey the Address Qualifier information. The Address Qualifier subfield **shall** be coded as shown in Table 2-85.

#### 2.2.8.2.4 Report Time of Applicability

Each time that an individual Mode Status Report is updated, the Report Assembly Function **shall** update the Report Time of Applicability data in the Mode Status Report with either the GPS/GNSS UTC Measure Time data (see §2.2.8.5.1) or the Established Receiver Unit Time (see §2.2.8.5.2), whichever is applicable to the Receiving device Report Assembly Function installation requirements.

Report Time of Applicability data **shall** be provided in the Mode Status report in binary format as specified in Table 2-88.

#### 2.2.8.2.5 Version Number

The ADS-B Report Assembly Function **shall** extract the Version Number data from the ADS-B Aircraft Operational Status Message (§2.2.3.2.7.2.5) and provide the Version Number to the user application in the Mode Status Report in the binary format specified in Table 2-88.

When a valid Version Number is not available, the Version Number sent to the user application **shall** be set to ALL ZEROs.

#### 2.2.8.2.6 Call Sign

The ADS-B Report Assembly Function **shall** first extract the Aircraft Identification Character subfields (§2.2.3.2.5.3) from the ADS-B Flight Identification and Category Message (§2.2.3.2.5.3) for further processing.

Each of the eight characters extracted is encoded in a subset of International Alphabet No. 5 (IA-5) in accordance with §2.2.3.2.5.3. The encoding of each character is 6 bits long with bit_6 being the most significant and bit_1 being the least significant. IA-5 is a seven bit encoding with bit_7 being the most significant and bit_1 being the least significant. In order to provide an IA-5 encoding in an eight bit format as indicated in Table 2-88, the Report Assembly Function **shall**:

(1). Retain bit_6 through bit_1 of the character encoding.

(2). If bit_6 is “ZERO,” set bit_7 to “ONE”

(3). If bit_6 is “ONE,” set bit_7 to “ZERO”

(4). Set bit_8 to “ZERO”

(5). Format bit_8 through bit_6 into “0MdddddL” for entry into the report as shown in Table 2-88.

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When valid Flight Identity data is not available, the Call Sign data sent to the user application **shall** be set to ALL ZEROs.

#### 2.2.8.2.7 Emitter Category

The ADS-B Report Assembly Function **shall** extract "TYPE" (§2.2.3.2.5.1) and "ADS-B Emitter Category" (§2.2.3.2.5.2) from the Aircraft Identification and Category Message (§2.2.3.2.5) and encode the "Emitter Category" field of the Mode Status Report as shown in Table 2-91.

**Table 2-91: Emitter Category Encoding**

| **Coding** (Decimal) | **Meaning** |
|---|---|
| 0 | No Emitter Category Information Available |
| 1 | Light (<15,500 lbs.) |
| 2 | Reserved for Future Growth |
| 3 | Small (15,500 to 75,000 lbs.) |
| 4 | Reserved for Future Growth |
| 5 | Large (75,000 to 300,000 lbs.) |
| 6 | High-Vortex Large (aircraft such as B-757) |
| 7 | Heavy (>300,000 lbs.) |
| 8 | High Performance (>5 g acceleration ***and*** >400 knots) |
| 9 | Reserved for Future Growth |
| 10 | Rotorcraft |
| 11 | Glider / Sailplane |
| 12 | Lighter - than - Air |
| 13 | Unmanned Aerial Vehicle |
| 14 | Space / Trans-atmospheric Vehicle |
| 15 | Ultralight / hang-glider / paraglider |
| 16 | Parachutist / Skydiver |
| 17 | Reserved for Future Growth |
| 18 | Reserved for Future Growth |
| 19 | Reserved for Future Growth |
| 20 | Surface Vehicle - Emergency Vehicle |
| 21 | Surface Vehicle - Service Vehicle |
| 22 | Point Obstacle (includes Tethered Ballons) |
| 23 | Cluster Obstacle |
| 24 | Line Obstacle |
| 25 through 31 | Reserved for Future Growth |

When valid ADS-B Emitter Category data is not available, the Emitter Category data sent to the user application **shall** be set to ALL ZEROs.

#### 2.2.8.2.8 Aircraft/Vehicle (A/V) Length and Width Code

The ADS-B Report Assembly Function **shall** extract the Aircraft/Vehicle (A/V) Length and Width Code from the Aircraft Operational Status Message (§2.2.3.2.7.2) when the A/V is on the airport surface. The A/V Length and Width Code **shall** be encoded bit for bit as specified in Table 2-74, into the Mode Status Report as specified in Table 2-88.

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#### 2.2.8.2.9 Emergency / Priority Status

The ADS-B Report Assembly Function **shall** extract the "Emergency / Priority Status" data from the Extended Squitter Aircraft Status Message (§2.2.3.2.7.8.1) (TYPE=28, Subtype=1), and provide that Emergency / Priority Status information to the user application in the Mode Status Report in the binary format specified in Table 2-88.

"Emergency/Priority Status," bits 9 - 11 (see Appendix A, Figure A-8), of the Extended Squitter Aircraft Status Message **shall** be mapped bit for bit into the three least significant bits of the report byte as indicated in Table 2-88.

When valid "Emergency/Priority Status" data is not available (i.e., has not been received within the past 100 seconds as per Table 2-102, Note #5), then the Emergency/Priority Status data sent to the user application **shall** be set to ALL ZEROs and flagged as being "invalid" as per Table 2-90.

#### 2.2.8.2.10 Capability Class Codes

The ADS-B Report Assembly Function **shall** extract the "Capability Class Codes" data (§2.2.3.2.7.2.3) and the Target State and Status Message from the Aircraft Operational Status Message (§2.2.3.2.7.2) and provide the Capability Class Codes to the user application in the Mode Status Report in the binary format specified in Table 2-88.

Capability Class Codes from the ADS-B Operational Status and the Target State and Status Messages, **shall** be mapped bit for bit into the 3-byte long Capability Class Codes field of the ADS-B Mode Status Report as specified in Table 2-92.

When valid "Capability Class" data is not available for a given parameter, then the Capability Class data sent to the user application for that parameter **shall** be set to ALL ZEROs.

When a Mode Status Report is generated and when the only received update to the "Capability Class" data has come from a Target State and Status Message, the reported value of all Capability Class parameters **shall** be based on the most recently received Operational Status Message, except updated with the data (i.e., TCAS parameter) received in the subsequent Target State and Status Message.

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**Table 2-92: Capability Code Mapping**

| MS Report | | | Operational Status Message Subtype 0 (Airborne) | | Operational Status Message Subtype 1 (Surface) | | Target State and Status Message | |
|---|---|---|---|---|---|---|---|---|
| MS Report CC Field Byte # | Bit # | Parameter | Msg. Bit # (ME field) | Mapping to MS Report | Msg. Bit # (ME field) | Mapping to MS Report | Msg. Bit # (ME field) | Mapping to MS Report |
| 0 | 7 | Service Level | 9 | Direct Mapping | 9 | Direct Mapping | | |
| | 6 | | 10 | Direct Mapping | 10 | Direct Mapping | | |
| | 5 | | 13 | Direct Mapping | 13 | Direct Mapping | | |
| | 4 | | 14 | Direct Mapping | 14 | Direct Mapping | | |
| | 3 | B2 Low | | | 15 | Direct Mapping | | |
| | 2 | Reserved | | | | | | |
| | 1 | Reserved | | | | | | |
| | 0 | Reserved | | | | | | |
| 1 | 7 | TCAS | 11 | ~~Inverse~~ Direct Mapping | | | ~~52~~53 | ~~Inverse~~ Direct Mapping |
| | 6 | ~~CDTI~~1090 IN | 12 | Direct Mapping | 12 | Direct Mapping | | |
| | 5 | ARV | 15 | Direct Mapping | | | | |
| | 4 | TS Report | 16 | Direct Mapping | | | | |
| | 3 | TC Report | 17 | Direct Mapping | | | | |
| | 2 | | 18 | Direct Mapping | | | | |
| | 1 | POA | | | 19 | Direct Mapping | | |
| | 0 | ~~Reserved~~UAT IN | 19 | Direct Mapping | 16 | Direct Mapping | | |
| 2 | 7 | Reserved | | | | | | |
| | 6 | Reserved | | | | | | |
| | 5 | Reserved | | | | | | |
| | 4 | Reserved | | | | | | |
| | 3 | Reserved | | | | | | |
| | 2 | Reserved | | | | | | |
| | 1 | Reserved | | | | | | |
| | 0 | Reserved | | | | | | |

***Note:*** *Direct Mapping means the message bit state (i.e., 0 or 1) remains the same when mapped into the Mode Status Report. Inverse Mapping means the message bit state is reversed when mapped into the Mode Status Report.*

### 2.2.8.2.11 Operational Mode

The ADS-B Report Assembly Function **shall** extract the "Operational Mode" data, "ME" bits 25 through 40, (see Table 2-68 and §2.2.3.2.7.2.4) from the Aircraft Operational Status Message (§2.2.3.2.7.2) and **shall** be mapped bit for bit into the 2-byte long Operational Mode field of the ADS-B Mode Status Report in the binary format specified in Table 2-88.

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Operational Mode Codes from the ADS-B Operational Status Message **shall** be mapped bit for bit into the 2-byte long Capability Class Codes field of the ADS-B Mode Status Report as specified in Table 2-92A.

**Table 2-92A: Operational Mode Mapping**

| MS Report | | | Operational Status Message Subtype 0 (Airborne) | Operational Status Message Subtype 1 (Surface) |
|---|---|---|---|---|
| **MS Report CC Field Byte #** | **Bit #** | **Parameter** | **Msg. Bit # (ME field)** | **Msg. Bit # (ME field) ~~Mapping to MS Report~~** |
| 0 | 7 | OM Format~~Service Level~~ | ~~9~~25 | 25~~9~~ ~~Direct Mapping~~ |
| | 6 | OM Format | 26~~10~~ | 26~~10~~ ~~Direct Mapping~~ |
| | 5 | TCAS RA Active | ~~13~~27 | 27~~13~~ ~~Direct Mapping~~ |
| | 4 | IDENT Switch | 28~~14~~ | 28~~14~~ ~~Direct Mapping~~ |
| | 3 | Reserved for Receiving ATC Services~~B2 Low~~ | 29 | ~~15~~ ~~Direct Mapping~~29 |
| | 2 | Single Antenna Flag~~Reserved~~ | 30 | 30 |
| | 1 | Reserved | | |
| | 0 | Reserved | | |
| 1 | 7 | GPS Antenna Offset~~TCAS 1090 IN ARV TS Report TC Report~~ | ~~11~~ | 33 |
| | 6 | | ~~12~~ | 34~~12~~ ~~Direct Mapping~~ |
| | 5 | | ~~15~~ | 35 |
| | 4 | | ~~16~~ | 36 |
| | 3 | | ~~17~~ | 37 |
| | 2 | | ~~18~~ | 38 |
| | 1 | ~~POA UAT IN~~ | | 39~~19~~ ~~Direct Mapping~~ |
| | 0 | | ~~19~~ | 40~~16~~ ~~Direct Mapping~~ |

### 2.2.8.2.12 SV Quality – $NAC_P$

The ADS-B Report Assembly Function **shall** extract the $NAC_P$ data from the Aircraft Operational Status Message (§2.2.3.2.7.2) and from the Target State and Status Message (§2.2.3.2.7.1.3.8) and map the $NAC_P$ value bit for bit from the most recently received ADS-B Message to the Mode Status Report in the binary format specified in Table 2-88.

### 2.2.8.2.13 SV Quality – $NAC_V$

The ADS-B Report Assembly Function **shall** extract the $NAC_V$ data from the ADS-B Airborne Velocity Message (§2.2.3.2.6) and the Operational Status Message (§2.2.3.2.7.2~~2.2.3.2.7.2~~) and map the $NAC_V$ value bit for bit from the received ADS-B Message to the Mode Status Report in the binary format specified in Table 2-88.

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#### 2.2.8.2.14 SV Quality – SIL, SIL Supplement, SDA

##### 2.2.8.2.14.1 SV Quality - SIL

The ADS-B Report Assembly Function **shall** extract the SIL data from the Aircraft Operational Status Message (§2.2.3.2.7.2.9~~2.2.3.2.7.2.9~~) and from the Target State and Status Message (§2.2.3.2.7.1.3.10~~2.2.3.2.7.1.3.10~~), and map the SIL Value bit for bit from the most recently received ADS-B Message to the Mode Status Report in the binary format specified in Table 2-88.

##### 2.2.8.2.14.2 SV Quality - SIL Supplement

The ADS-B Report Assembly Function **shall** extract the SIL Supplement data from the Aircraft Operational Status Message (§2.2.3.2.7.2.9~~2.2.3.2.7.2.9~~) and from the Target State and Status Message (§2.2.3.2.7.1.3.10~~2.2.3.2.7.1.3.10~~), and map the SIL Supplement Value bit for bit from the most recently received ADS-B Message to the Mode Status Report in the binary format specified in Table 2-88.

##### 2.2.8.2.14.3 SV Quality - SDA

The ADS-B Report Assembly Function **shall** extract the SDA data from the Aircraft Operational Status Message (§2.2.3.2.7.2.9~~2.2.3.2.7.2.9~~)and map the SDA Value bit for bit from the most recently received ADS-B Message to the Mode Status Report in the binary format specified in Table 2-88.

#### 2.2.8.2.15 SV Quality – GVA

The ADS-B Report Assembly Function **shall** extract the GVA data from the Aircraft Operational Status Message (§2.2.3.2.7.2.8) and map the value of the GVA field to the Mode Status Report in the format specified in Table 2-88.

#### 2.2.8.2.16 SV Quality – $NIC_{BARO}$

The ADS-B Report Assembly Function **shall** extract the $NIC_{BARO}$ data from the Aircraft Operational Status Message (§2.2.3.2.7.2.10) and from the Target State and Status Message (§2.2.3.2.7.1.3.9), and map the value of the $NIC_{BARO}$ bit from the most recently received ADS-B Message to the Mode Status Report in the binary format specified in Table 2-88. The $NIC_{BARO}$ field in the Mode Status Report uses the least significant bit of a one-byte field as a one-bit flag that indicates whether or not the barometric pressure altitude that is provided in the State Vector Report has been cross-checked against another source of altitude.

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### 2.2.8.2.17 Track/Heading and Horizontal Reference Direction (HRD)

The ADS-B Report Assembly Function **shall** extract the Track Angle/Heading (§2.2.3.2.7.2.12) and the Horizontal Reference Direction (HRD) (§2.2.3.2.7.2.13) flag bits from the Aircraft Operational Status Message (§2.2.3.2.7.2) and set the True/Magnetic Heading field in the Mode Status Report in the binary format specified in Table 2-88. This item within the Mode Status Report is used to indicate the nature of the Horizontal Direction information being reported in the State Vector Reports. This applies to the aircraft reported Horizontal Direction (in the State Vector Report). The encoding of bits 0 and 1 of the report True/Magnetic Heading field **shall** be as specified in Table 2-93. Bit 1 of the True/Magnetic Heading field indicates when Ground Track is being reported (i.e., set to zero) or when Heading is being reported (i.e., set to one). Bit 0 of the True/Magnetic Heading field indicates when Heading based on True North (i.e., set to zero) or when heading based on Magnetic North (i.e., set to one) is being reported.

**Table 2-93: True/Magnetic Heading Encoding**

| Coding | | Meaning |
|---|---|---|
| **bit 1** | **bit 0** | |
| 0 | 0 | No Track/Heading or HRD Information Available |
| 0 | 1 | Ground track being reported |
| 1 | 0 | Heading relative to true north being reported |
| 1 | 1 | Heading relative to magnetic north being reported |

***Note:*** *Bits 2 through 7 of byte 32 of the True/Magnetic Heading subfield are always set to ZERO (0).*

### 2.2.8.2.18 Vertical Rate Type

The ADS-B Report Assembly Function **shall** extract the Vertical Rate Source (§2.2.3.2.6.1.10, §2.2.3.2.6.2.10, §2.2.3.2.6.3.10, §2.2.3.2.6.4.10) data from the ADS-B Airborne Velocity Message (§2.2.3.2.6) and set the Vertical Rate Type in the Mode Status Report in the binary format specified in Table 2-88. The Vertical Rate Type field uses the least significant bit of a one-byte field in the Mode Status Report. This one-bit flag **shall** be set to ZERO (0) to indicate that the Vertical Rate field in the State Vector Report holds the rate of change of barometric pressure altitude. Or, this one-bit flag **shall** be set to ONE (1) to indicate that the Vertical Rate field holds the rate of change of geometric altitude.

### 2.2.8.2.19 (Reserved for) Flight Mode Specific Data

A 3-bit field in the Mode Status Report is reserved for future use as a “Flight Mode Specific Data” field. In the current version of these MOPS, this field **shall** be set to ALL ZEROs.

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### 2.2.8.3 ADS-B On-Condition Report Characteristics

ADS-B On-Condition Reports include, but will not necessarily be limited to:

a. The Target State Report

b. The Air Referenced Velocity Report

***Note:*** *It is anticipated that the Trajectory Change Reports will be specified by a future revision of these MOPS as an additional type of "On-Condition" Report.*

#### 2.2.8.3.1 ADS-B Target State Report

Table 2-94 and the subsequent subparagraphs identify the data structure for all ADS-B Target State Reports.

The Report Assembly Function **shall** be compatible with the current ADS-B Version Two (2) of the relevant 1090 MHz ADS-B Messages (e.g., Target State and Status, Subtype=1) that are used as the basis to generate Target State Reports. The relevant Version Two (2) messages are identified below~~, and Version One (1) messages, conformant to DO-260A including Change 1 and Change 2, and their required use for ADS-B Target State Report generation are defined in Appendix N, Section N.3~~.

***Note:*** *Version 0 messages cannot be used as the basis for Target State Reports, because there are no Version 0 messages that contain the necessary data elements. Version 1 message formats for the Target State and Status Message with Subtype=0 are defined in Appendix N but are not used to generate the Version 2 Target State Report.*

The intent of Table 2-94 is to illustrate the structure of all Items that are required to be reported in an ADS-B Target State Report. The exact structure of the data indicated in columns 10 and 11 is provided as a guideline or one possible method of satisfying the report structure. Implementers may choose to organize the data in another format; however, delivery to a user interface or application of all Items in Table 2-94 **shall** be consistent with the range, resolution, and units indicated in column 7, 8 and 9 of Table 2-94 respectively. If data is not available to support a field that is delivered to an application, then the data provided to the application **shall** be set to ALL ZEROs. Those requirements in the subparagraphs below that relate to specific data structure details (byte numbers, and bit numbers within the bytes) **shall** only apply to equipment that uses the sample data structure shown in columns 10 and 11 of Table 2-94.

***Note:*** *Table 2-94 is structured such that column 1, 2, and 6 through 11, pertain to the Target State Report elements and how such elements should be structured into the report. Columns 3 through 5 provide information on where the appropriate data can be located in the ADS-B Messages for each of the Report elements.*

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**Table 2-94: ADS-B Target State Data Elements - Source Data Mapping To Report Structure**

| Table 2-94: ADS-B Target State Data Elements – Source Data Mapping To Report Structure | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Column # | REPORT STRUCTURE | | MESSAGE STRUCTURE RELEVANT | | | REPORT STRUCTURE RELEVANT | | | | | |
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| Item # | Parameter / Contents | Notes | Received Message Sources | "ME" Field Bits | Message Field Bits | # of Bits | Range | Resolution | Units | Data Structure | Data Byte # |
| 0a, 0b | Report Type and Structure Identification | 3 | N/A | N/A | 1 - 5 | 16 | N/A | N/A | discrete | MddL Mddd ddddddL | 0 - 1 |
| 0c | Validity Flags | | N/A | N/A | N/A | 16 | N/A | N/A | discrete | dddddddd dddddddd | 2 - 3 |
| 1 | Participant Address | | Target State & Status - "AA" | N/A | 9 - 32 | 24 | N/A | N/A | discrete | Mddddddd dddddddd ddddddL | ~~2 - 4~~4 - 6 |
| 2 | Address Qualifier | | Aircraft ID & Category "Emitter Category" All Messages with DF=18 – "CF" | 6 – 8<br>N/A | 38 – 40<br>6 – 8 | 8 | N/A | N/A | discrete | xxxxxMdL | ~~5~~7 |
| 3 | Report Time of Applicability | | Target State & Status | N/A | N/A | 16 | 511.9921875 | 0.0078125 (1/128) | seconds | Mddddddd ddddddL | ~~6 - 7~~8 - 9 |
| 4a | Selected Altitude: Selected Altitude Type~~Horizontal Intent: Horizontal Data Available & Horizontal Target Source Indicator~~ | | Target State & Status – "Selected Altitude Type~~Horizontal Data Available/Source Indicator~~" | ~~9~~26 – 27 | ~~58 – 59~~41 | 8 | N/A | N/A | discrete | xxxxxxx~~M~~L | ~~8~~10 |
| 4b | Selected Altitude: MCP/FCU Selected Altitude or FMS Selected Altitude~~Horizontal Intent: Target Heading or Track Angle~~ | | Target State & Status – "MCP/FCU Selected Altitude or FMS Selected Altitude~~Target Heading/Track Angle~~" | ~~28 – 36~~10 – 20 | 42 - 52~~60 – 68~~ | 16 | 0 - 65472~~359~~ | ~~1~~32 | ~~degree~~feet | xxxxxMdd~~xxM~~ ddddddL | ~~9 - 10~~11 - 12 |
| 4c | Selected Altitude: Barometric Pressure Setting (Minus 800 millibars)~~Horizontal Intent: Target Heading/Track Indicator~~ | | Target State & Status – "Barometric Pressure Setting (Minus 800 millibars)"~~Target State & Status – "Target Heading/Track Indicator"~~ | 21 - 29~~37~~ | 53 - 61~~69~~ | 16~~8~~ | 0 – 408.0~~N/A~~ | 0.8~~N/A~~ | mbars~~discrete~~ | xxxxx~~Mdd~~xxM ddddddL~~xxxxxxxL~~ | 13 - 14~~11~~ |

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**Table 2-94: ADS-B Target State Data Elements – Source Data Mapping To Report Structure**

| Column # | REPORT STRUCTURE | | MESSAGE STRUCTURE RELEVANT | | | REPORT STRUCTURE RELEVANT | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| **Item #** | **Parameter / Contents** | **Notes** | **Received Message Sources** | **"ME" Field Bits** | **Message Field Bits** | **# of Bits** | **Range** | **Resolution** | **Units** | **Data Structure** | **Data Byte #** |
| ~~4d~~5 | ~~Horizontal Intent: Reserved for Heading/Track Capability~~Selected Heading | | Target State & Status – "Selected Heading"~~N/A~~ | ~~30~~1 - 39 | ~~62~~3 - 71 | 16~~8~~ | ± 180~~N/A~~ | 0.703125~~N/A~~ | degrees~~discrete~~ | xxxxxxxS MddddddL~~xxxxxxxL~~ | 15 - 16~~12~~ |
| ~~4e~~6a | Mode Indicators: ~~Horizontal Intent: Horizontal Mode Indicator~~Autopilot Engaged | | Target State & Status – "Autopilot Engaged~~Horizontal Mode Indicator~~" | ~~38 - 39~~48 | 80~~70 - 71~~ | 8 | N/A | N/A | discrete | xxxxxxx~~M~~L | 17~~13~~ |
| ~~4f~~6b | Mode Indicators: ~~Horizontal Intent: Reserved for Horizontal Conformance~~VNAV Mode Engaged | | Target State & Status – "VNAV Mode Engaged"~~N/A~~ | 49 | 81 | 8 | N/A | N/A | discrete | xxxxxxxL | ~~14~~18 |
| 6c~~5a~~ | Mode Indicators: ~~Vertical Intent: Vertical Data Available & Vertical Target Source Indicator~~Altitude Hold Mode | | Target State & Status – "~~Vertical Data Available/Source Indicator~~Altitude Hold Mode " | ~~8 - 9~~50 | ~~40 - 41~~82 | 8 | N/A | N/A | discrete | xxxxxxx~~M~~L | ~~15~~19 |
| ~~5b~~6d | Mode Indicators: ~~Vertical Intent: Target Altitude~~Approach Mode | | Target State & Status – "Approach Mode~~Target Altitude~~" | ~~16 - 25~~52 | ~~48 - 57~~84 | ~~16~~8 | N/A~~-1000 to +100,000~~ | N/A~~100~~ | discrete~~feet~~ | xxxxxxxL~~xxxxxxxMddddddddL~~ | 20~~16 - 17~~ |
| ~~5c~~7 | ~~Vertical Intent: Target Altitude Type~~Reserved | | N/A~~Target State & Status – "Target Altitude Type"~~ | ~~10~~ | ~~42~~ | 8~~8~~ | N/A~~N/A~~ | N/A~~N/A~~ | discrete~~discrete~~ | xxxxxxxL~~xxxxxxxL~~ | 21~~18~~ |
| ~~5d~~ | ~~Vertical Intent: Target Altitude Capability~~ | | ~~Target State & Status – "Target Altitude Capability"~~ | ~~12 - 13~~ | ~~44 - 45~~ | ~~8~~ | ~~N/A~~ | ~~N/A~~ | ~~discrete~~ | ~~xxxxxxxML~~ | ~~19~~ |
| ~~5e~~ | ~~Vertical Intent: Vertical Mode Indicator~~ | | ~~Target State & Status – "Vertical Mode Indicator"~~ | ~~14 - 15~~ | ~~46 - 47~~ | ~~8~~ | ~~N/A~~ | ~~N/A~~ | ~~discrete~~ | ~~xxxxxxxML~~ | ~~20~~ |
| ~~5f~~ | ~~Vertical Intent: Reserved for Vertical Conformance~~ | | ~~N/A~~ | | | ~~8~~ | ~~N/A~~ | ~~N/A~~ | ~~discrete~~ | ~~xxxxxxxL~~ | ~~21~~ |
| | | | | | | | | | | **TOTAL BYTES:** | **22** |

***Notes:***

1. *In the "Data Structure" column (i.e., column 10), "S" indicates the "Sign-Bit," "M" indicates the Most Significant Bit of the data field, "d" indicates data bits in the field, "L" indicates the Least Significant Bit of the data field, and "x" indicates "Don't Care" bits in the data field.*

2. *The Report Type Identifier is used to identify the type of ADS-B Report being generated as specified in §2.2.8.1.1.1.*

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#### 2.2.8.3.1.1 Report Type and Structure Identification

The Report Type requirements were previously provided in §2.2.8.1.1. Report Type formats and the maximum number of bytes to be contained in each report are identified in Table 2-94.

The Report Structure field is used to indicate the exact data parameters identified in Table 2-94 that are being provided in the Target State Report and is intended to provide a methodology for the Report Assembly Function to structure shorter reports when data for some parameters is not available. In order to provide the capability to provide shorter Target State Reports the following basic conventions **shall** be adhered to:

a. Any given data parameter to be used in the report **shall** use the designated number of bytes and format as designated in Table 2-94.

b. Parameters that are designated in Table 2-94 are restricted to byte boundaries.

c. Whenever a data parameter identified in Table 2-94 is not provided in the report, then it is permissible to concatenate the next parameter to be included into the report immediately following the inclusion of the previous reported parameter.

d. Each parameter of the Target State Report identified in Table 2-94 must be properly declared in the Report Structure field as detailed in the following paragraphs and Table 2-95.

***Note:*** *Implementation of the methodology just provided is realizable and controllable due to the fact that the exact length of each report parameter is specified in Table 2-94 and the Report Structure field identifies exactly which parameters are included in the report. Therefore, the report user can easily re-construct the length and general format of the report.*

The Report Structure is a 12-bit field and **shall** be provided in the least significant nibble (i.e., bits 3 - 0) of the first byte (i.e., byte "0") and continuing into byte 1 of the Report. The Report Structure format is specified in Table 2-95 where each bit is associated with a particular data parameter of the Target State Report. If the bit is set to ONE (1), then the data parameter is considered to be available and **shall** be transmitted in the report. Otherwise, the data parameter is considered to not be available and **shall** not be transmitted in the report. Note that Table 2-95 does not address the Report Type and Structure Identification parameter, the Participant Address parameter, the Address Qualifier parameter, nor the Report Time of Applicability parameter, since these four parameters **shall** be included in the Target State Report. Also, certain of the other Target State data parameters are required to be reported, as specified in §2.2.9, even though bits have been allocated in the report structure field as shown in Table 2-95.

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**Table 2-95: ADS-B Target State Report – Structure Parameter Coding**

| Byte # | Bit # | Target State Data Parameter to be Reported | Number of Bytes |
|---|---|---|---|
| 0 | 3 | Selected Altitude: ~~Horizontal Intent/Horizontal Data Available & Horizontal Target Source Indicator~~Selected Altitude Type | 1 |
| | 2 | Selected Altitude: ~~Horizontal Intent/Target Heading or Track Angle~~MCP/FCU Selected Altitude or FMS Selected Altitude | 2 |
| | 1 | Selected Altitude: Barometric Pressure ~~Horizontal Intent/Target Heading/Track Indicator~~Setting (Minus 800 millibars) | 2~~1~~ |
| | 0 | ~~Horizontal Intent/Reserved for Heading/Track Capability~~Selected Heading | ~~1~~2 |
| 1 | 7 | ~~Horizontal Intent/Horizontal Mode Indicator~~Mode Indicators: Autopilot Engaged | 1 |
| | 6 | Mode Indicators: VNAV Mode Engaged~~Horizontal Intent/Reserved for Horizontal Conformance~~ | 1 |
| | 5 | Mode Indicators: Altitude Hold Mode~~Vertical Intent/Vertical Data Available & Vertical Target Source Indicator~~ | 1 |
| | 4 | Mode Indicators: Approach Mode~~Vertical Intent/Target Altitude~~ | 1~~2~~ |
| | 3 | ~~Vertical Intent/Target Altitude Type~~Reserved | x~~1~~ |
| | 2 | Reserved~~Vertical Intent/Target Altitude Capability~~ | x~~1~~ |
| | 1 | Reserved~~Vertical Intent/Vertical Mode Indicator~~ | x~~1~~ |
| | 0 | Reserved~~Vertical Intent/Reserved for Vertical Conformance~~ | x~~1~~ |

### 2.2.8.3.1.2 Target State Report Validity Flags

Validity Flags for data provided in the Target State Report **shall** be indicated in bytes #3 and #4 of the Target State Report as shown for item "0c" in Table 2-965A. The Target State Report elements that require validity flags are identified in Table 2-95A~~6~~. Table 2-95A~~6~~ identifies the byte and bit that **shall** be used as a flag for each element that requires a validity flag. Each validity flag bit **shall** be set to ONE (1) to indicate that the corresponding State Vector Report Element data is valid. If such data is not valid, then the corresponding validity flag bit **shall** be set to ZERO (0).

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**Table 2-95A: ADS-B Target State Report Validity Flag Requirements**

| TS Report Item # | Target State Report Element | Validity Flag Bit Required? | Validity Flag Bit Assignment | |
|---|---|---|---|---|
| 0a | Report Type | No | Byte # | Bit # |
| 0b | Structure Identification | No | | |
| 0c | Validity Flags | No | | |
| 1 | Participant Address | No | | |
| 2 | Address Qualifier | No | | |
| 3 | Report Time of Applicability | No | | |
| 4a | Selected Altitude Type | No | | |
| 4b | MCP/FCU Selected Altitude or FMS Selected Altitude | **Yes** (This validity flag bit is for Selected Altitude Valid) | 3 | 7 |
| 4c | Barometric Pressure Setting (Minus 800 millibars) | **Yes** (This bit is validity flag bit for Barometric Pressure Setting Valid) | 3 | 6 |
| 5 | Selected Heading | **Yes** (This bit is validity flag bit for Selected Heading Valid) | 3 | 5 |
| 6 | MCP / FCU Mode Bits Status | **Yes** (This bit is validity flag bit for MCP / FCU Mode Bits Valid) | 3 | 4 |

### ~~2.2.8.3.1.2~~2.2.8.3.1.3 Participant Address

The Participant Address **shall** be encoded as specified in §2.2.3.2.1.5.

### ~~2.2.8.3.1.3~~2.2.8.3.1.4 Address Qualifier

The Address Qualifier is used to indicate the type of Participant Address (§2.2.8.1.3) being reported. The three (3) least significant bits of the one-byte field are used to convey the Address Qualifier information. The Address Qualifier subfield **shall** be coded as shown in Table 2-85.

### ~~2.2.8.3.1.4~~2.2.8.3.1.5 Report Time of Applicability

Each time that an individual Target State Report is updated, the Report Assembly Function **shall** update the Time of Applicability data in the On - Condition Report with either the GPS/GNSS UTC Measure Time data (see §2.2.8.5.1) or the Established Receiver Unit Time (see §2.2.8.5.2), whichever is applicable to the Receiving device Report Assembly Function installation requirements.

Report Time of Applicability data **shall** be provided in the Target State Report in binary format as specified in Table 2-94.

### ~~2.2.8.3.1.5~~2.2.8.3.1.6 ~~Horizontal Intent~~Selected Altitude: ~~Horizontal Data Available and Horizontal Target Source Indicator~~Selected Altitude Type

The ~~Horizontal Data Available and Horizontal Target Source Indicator~~Selected Altitude Type parameter **shall** use the ~~two (2)~~ least significant bit~~s~~ within byte 10~~8~~ to encode the parameter values specified in §2.2.3.2.7.1.3.7~~2.2.3.2.7.1.3.7~~2.

**2.2.8.3.1.7 ~~Ho~~Selected Altitude: MCP / FCU Selected Altitude or FMS Selected Altitude**

**~~2.2.8.3.1.6rizontal Intent: Target Heading or Track Angle~~**

The ~~Target Heading and Track Angle~~MCP / FCU Selected Altitude or FMS Selected Altitude parameter **shall** use the three (3) least significant bits within byte 11 and the 8 bits of byte 12 to encode the parameter values specified~~use the least significant bit with the first byte and the 8 bits of the second byte to encode the parameter values specified in~~ §~~Error! Reference source not found.~~2.2.3.2.7.1.3.3.

**~~2.2.8.3.1.7~~2.2.8.3.1.8 ~~Horiz~~Selected Altitude: ~~ontal Intent: Target Heading/Track Indicator~~Barometric Pressure Setting (Minus 800 millibars)**

The ~~Target Heading or Track Indicator~~Barometric Pressure Setting (Minus 800 millibars) parameter **shall** use the three (3) least significant bits within byte 13 and the 8 bits of byte 14~~least significant bit within byte 11~~ to encode the patameter values specified in §~~**Error! Reference source not found.**~~2.2.3.2.7.1.3.4.

**~~2.2.8.3.1.8~~2.2.8.3.1.9 ~~Horizontal Intent: Reserved for Heading/Track Capability~~Selected Heading**

~~A~~ The Selected Heading parameter **shall** use the least significant bit of byte 15 and the 8 bits of byte 16 to encode the heading values specified in §2.2.3.2.7.1.3.7.~~1~~ ~~bit field is reserved in the Target State Report for possible future use as a "Heading/Track Capability" field. This field will indicate whether or not the transmitting aircraft has the capability to provide the horizontal guidance target. In the current version of these MOPS, the "Reserved for Heading/Track Capability" field **shall** be set to ZERO.~~

**~~2.2.8.3.1.9~~2.2.8.3.1.10 Mode Indicators~~Horizontal Intent~~: ~~Horizontal Mode Indicator~~Autopilot Engaged**

The ~~Horizontal Mode Indicator~~Autopilot Engaged parameter **shall** use the ~~two (2)~~ least significant bit~~s~~ within byte 17~~3~~ to encode the parameter values specified in §~~**Error! Reference source not found.**~~2.2.3.2.7.1.3.12.

**~~2.2.8.3.1.10~~2.2.8.3.1.11 Mode Indicators: ~~Horizontal Intent: Reserved for Horizontal Conformance Parameter~~VNAV Mode Engaged**

~~A one (1) byte long parameter is reserved for possible futu~~The VNAV Mode Engaged parameter **shall** use the least significant bit within byte 18 to encode the parameter values specified in §2.2.3.2.7.1.3.13~~re use. The least significant bit within the byte would be used to convey the Horizontal Conformance information~~.

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**~~2.2.8.3.1.11~~2.2.8.3.1.12 Mode Indicators: Altitude Hold Mode~~Vertical Intent: Vertical Data Available and Vertical Target Source Indicator~~**

The Altitude Hold Mode parameter **shall** use the least significant bit within byte 19 to encode the parameter values specified in §2.2.3.2.7.1.3.14. ~~The Vertical Data Available and Vertical Target Source Indicator parameter **shall** use the two least significant bits within byte 15 to encode the parameter values specified in §2.2.3.2.7.1.3.1.~~

**~~2.2.8.3.1.12~~2.2.8.3.1.13 Mode Indicators: Approach Mode~~Vertical Intent: Target Altitude~~**

The Approach Mode parameter **shall** use the least significant bit within byte 20 to encode the parameter values specified in §2.2.3.2.7.1.3.16~~The Target Altitude parameter **shall** use the two (2) least significant bits within byte 16 and the 8 bits of byte 17 to encode the parameter values specified in §2.2.3.2.7.1.3.6~~.

**~~2.2.8.3.1.13~~2.2.8.3.1.14 ~~Vertical Intent: Target Altitude Type~~Reserved**

~~The~~ A one-byte parameter is reserved for possible future use. ~~Target Altitude Type parameter **shall** use the least significant bit within byte 18 to encode the parameter values specified in §2.2.3.2.7.1.3.2.~~

**~~2.2.8.3.1.15Vertical Intent: Target Altitude Capability~~**

~~The Target Altitude Capability parameter **shall** use the two least significant bits within byte 19 to encode the parameter values specified in §2.2.3.2.7.1.3.4.~~

**~~2.2.8.3.1.16Vertical Intent: Vertical Mode Indicator~~**

~~The Vertical Mode Indicator parameter **shall** use the two (2) least significant bits within byte 20 to encode the parameter values specified in §2.2.3.2.7.1.3.5.~~

**~~2.2.8.3.1.17Vertical Intent: Reserved for Vertical Conformance~~**

~~A one-byte parameter is reserved for possible future use. The least significant bit within byte 21 would be used to convey the Vertical Conformance information.~~

### 2.2.8.3.2 Air Referenced Velocity (ARV) Report

The Air Referenced Velocity (ARV) Report is an On-Condition Report type that **shall** be provided when air-referenced velocity information is received from a target aircraft.

The Report Assembly Function **shall** be compatible with the current and prior versions of the relevant 1090 MHz ADS-B Messages (e.g., Airborne Velocity) that are used to as the basis to generate Air Referenced Velocity Reports. The relevant Version Two (2) messages are identified below and the relevant Version Zero (0) messages, conformant to RTCA DO-260, including Change 1, and the relevant Version One (1) messages, conformant to RTCA DO-260A, including

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