uAvionix
UCP Transponder Interface Control Document

Rev J

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300 Pine Needle Lane

Bigfork, MT 59911

http://www.uavionix.com

support@uavionix.com

Contents

1 Revision History

Revision	Date	Comments
A	06/27/2018	Initial release.
B	10/22/2018	Rev'd the Transponder Config (ID=43) message to add the Default Squawk field
C	01/06/2019	Added the Test Mode field from spare bits in the Transponder Config (ID=43) message;
D	02/07/2019	Rev'd the GNSS Data (ID=45) message to increase the north-south Velocity and east-west Velocity fields from int16 to int32 along with modifying the units from (m/s * 1E1) to (mm/s)
E	09/05/2019	Rev'd the Transponder Status (ID=47) message and added PLC physical interface specifics
F	09/11/2019	Corrected errors in the GNSS field offsets for the last two fields, also corrected the saturation values for the N/S, E/W velocities in the same message. Also added clarity to byte order of all fields.
G	9/25/2019	Correct byte offsets in Transponder Configuration Message. Correct fault integrity value. Update Ownship message ID. Add Heartbeat, Geo Alt Ownship and uAvionix OEM messages.
H	10/11/2019	Add section describing Packet Frame Check Sequence
J	10/29/2019	Add validity bitmask to Transponder Configuration, add message id to Message Request. Clarify bit offsets in Ownship. Add Firmware and CRC to Identification message. Add Barometer Sensor Message. Clarify time reference in GNSS Data message.

2 Async HDLC

The datalink message structure is based on “Async HDLC”, as described in Minimum Aviation System Performance Standards (MASPS) for Flight Information Services-Broadcast (FIS-B) Data Link (RTCA/DO-267), Section 3.4.3.2.

3 Physical Interface

Communication to a uAvionix transponder is accomplished over a full-duplex asynchronous serial interface with either RS-232, or RS-485 physical layer drivers. The serial data interface is configured with the following characteristics:

Default Data bit rate:	57600bps
Data Length:	8 bits
Parity:	None
Stop Bits:	1 bit
Flow Control:	None

4 Packet Format

The uAvionix transponder packets follow the Async HDLC for framing, byte stuffing, control escape, and frame check sequencing. The standard flag byte of 0x7E and escape byte of 0x7D are used. Any data field not specified as “MSB first” is transmitted in little-endian order.

Frame Flag (0x7E)	Msg ID 1 byte	Payload N bytes	Frame Check Sequence 2 bytes	Frame Flag (0x7E)

4.1 Packet Frame Check Sequence

The frame check sequence is a CRC-CCITT. A table generated CRC calculation may be used. This table contains 256 elements and should be calculated at startup and left unchanged afterward. An example method for table construction is provided.

```
void crcInit( void )
{
        unsigned int i, bitctr, crc;
        for (i = 0; i < 256; i++)
        {
                crc = (i << 8);
                for (bitctr = 0; bitctr < 8; bitctr++)
                {
                        crc = (crc << 1) ^ ((crc & 0x8000) ? 0x1021 : 0);
                }
                Crc16Table[i] = crc;
        }
}
```

The CRC calculation can be produced with the following method.

```
unsigned int crcCompute(             // Return – CRC of the block
      unsigned char *block,          // i – Starting address of message
      unsigned long int length,      // i – Length of message
      )
```

```
{
	unsigned long int i;
	unsigned int crc = 0;
	for (i = 0; i < length; i++)
	{
		crc = Crc16Table[crc >> 8] ^ (crc << 8) ^ block[i];
	}
	return crc;
}
```

4.2 Packet Versioning

Some message definitions include a version which can be incremented in order to add data fields. Fields may NOT be removed or replaced to maintain backwards compatibility, and any code accessing these messages must be capable of properly handling multiple versions as appropriate.

5 Packet Types

uAvionix transponder supported packets are broken down into two categories related to the purpose of the packet. The first category is Configuration, this category relates to the initial setup of the transponder to the system or aircraft it's being installed into. The second category is Operational, which relates to the ongoing operation of the transponder once it's been installed into the aircraft and has been configured.

5.1 Configuration Packets

Message ID & Name	I/O	Section
43_{10} (0x2B) – Transponder Configuration	In/Out	***5.1.1***
44_{10} (0x2C) – Configuration Request	In	***5.1.2***

5.1.1 Transponder Configuration (Msg ID = 43_{10})

Direction: Bidirectional

Transponder configuration messages should be sent only as required to set or update the transponders version of the information contained within this message. Valid receipt of this message will cause the transponder to write the new data into non-volatile memory and all data will persist through a power cycle.

Offset	Type/Width	Value	Description
0	uint8_t	0x2B	Message ID
1	uint8_t	0x03	Message Version
2	uint8_t[3]		ICAO address (MSB first)
5	uint8_t (7:6)		SIL (Source Level Integrity) ***(6.1)***
5	uint8_t (5:4)		SDA (System Design Assurance) ***(6.2)***
5	uint8_t (3:3)		Barometer Altitude Source ***(6.4)***
5	uint8_t (2:0)		Aircraft Maximum Speed ***(6.3)***
6	uint8_t (7:6)		Test Mode (Set to 0's in normal operation)
6	uint8_t (5:4)		ADS-B IN Capability ***(6.5)***
6	uin8t_t (3:0)		Aircraft Length and Width ***(6.6)*** (in meters)
7	uint8_t (7:5)		GNSS Antenna Lateral Offset ***(6.7.1)***

7	uint8_t (4:0)		GNSS Antenna Longitudinal Offset *(6.7.2)*
8	uint8_t[8]		Aircraft Registration (ASCII string A-Z, 0-9 only), e.g. “N8644B “. Trailing spaces (0x20) only.
16	uint16_t		Aircraft Stall Speed (cm/s), 0 if equipped with on-ground sensor
18	uint8_t		Aircraft Emitter Type *(6.8)*
19	uint8_t (7:7)		Default 1090ES TX Mode
19	uint8_t (6:6)		Default Mode S Reply Mode
19	uint8_t (5:5)		Default Mode C Reply Mode
19	uint8_t (4:4)		Default Mode A Reply Mode
19	uint8_t (3:0)		Serial Port Baud Rate *(6.20)*
20	uint16_t		Default Mode A (squawk) code (typically 1200 [0x04B0] for VFR)
22	uint32_t		Validity Bitmask (on host to device, this bit controls whether valid data has been provided and should be applied) *(6.26)*

5.1.2 Message Request (Msg ID = 44_{10})

Direction: Host to device

When a message request message is sent to the transponder, the transponder will reply with the requestedTransponder Configuration (Msg ID = 43_{10}) messageID in reply. This allows a method for the host to request the transponder send any message. This allows a method to retrieve the current configuration for initialization and verifications purposes.

Offset	Type/Width	Value	Description
0	uint8_t	0x2C	Message ID
1	uint8_t	0x02	Message Version
2	uint8_t		Requested Message ID *(6.25)*

5.2 Operational Packets

Message ID & Name	I/O	Section
0_{10} (0x00) – Heartbeat	Out	*5.2.1*
10_{10}(0x0A) – Ownship Report	Out	*5.2.2*
11_{10}(0x0B) – Geo Alt Ownship Report	Out	*5.2.3*
37_{10}(0x25) – Identification Message	Out	*5.2.4*
45_{10} (0x2D) – Transponder Control	In	*5.2.5*
46_{10} (0x2E) – GNSS Data	In	*5.2.6*
47_{10} (0x2F) – Transponder Status	Out	*5.2.7*
117_{10} (0x75) – uAvionix OEM	In	*5.2.8*

5.2.1 Heartbeat (Msg ID = 0_{10})

Direction: Device to host

The Heartbeat message provides real-time indications of the status and operation of the transponder. The message will be transmitted with a period of 1 second.

Offset	Type/Width	Value	Description
0	uint8_t	0x00	Message ID
1	uint8_t (7:7)		GNSS Position Valid (1 = Position is available for ADS-B TX)
1	uint8_t (6:6)		Maintenance Required (1 = Device Maintenance Required)
1	uint8_t (5:5)		IDENT (1 = IDENT active)
1	uint8_t (4:4)		Address Type (0 = ICAO Assigned, 1 = Self-Assigned)
1	uint8_t (3:2)		Reserved
1	uint8_t (1:1)		Failure GNSS Data Frequency (1 = GNSS data frequency failure)
1	uint8_t (0:0)		Device Initialized (1 = Device is initialized)
2	uint8_t (7:7)		Time Stamp (MS bit) Seconds since 0000Z, bit 16
2	uint8_t (6:5)		Reserved
2	uint8_t (4:4)		Failure TX System (1 = Transmit system failure)
2	uint8_t (3:3)		Failure Broadcast Monitor (1 = Broadcast monitor detected failure)
2	uint8_t (2:2)		Failure GNSS No 3D Fix (No GNSS 3D fix)
2	uint8_t (1:1)		Failure GNSS Unavailable (1 = GNSS unavailable)
2	uint8_t (0:0)		UTC OK (1 = UTC timing is valid)
3	uint16_t		Time Stamp Seconds since 0000Z, bits 0-15
5	uint16_t		Reserved

5.2.2 Ownship (Msg ID = 10_{10})

Direction: Device to host

The Ownship message contains information on the GNSS position. If the Ownship GNSS position fix is invalid, the Latitude, Longitude, and NIC fields will all have the ZERO value. The Ownship message will be transmitted with a period of 1 second regardless of data status or update.

Offset	Type/Width	Value	Description
0	uint8_t	0x0A	Message ID
1	uint8_t (7:4)		Traffic Alert Status ***(6.13)***
1	uint8_t (3:0)		Address Type ***(6.14)***
2	uint8_t[3]		Participant Address (MSB first)

5	uint8_t[3]		Latitude in signed 24-bit decimal degree format with 180 deg/2^{23} resolution, (MSB first) ***(6.22)***
8	uint8_t[3]		Longitude in signed 24-bit decimal degree format with 180 deg/2^{23} resolution, (MSB first) ***(6.22)***
11	uint16_t (15:4)		Altitude in feet, with 25-foot resolution and offset by 1000ft. Alt = (x * 25) – 1000, If invalid set to 0xFFF ***(6.23)***
11	uint16_t (3:0)		Miscellaneous Indicators ***(6.15)***
13	uint8_t (7:4)		NIC ***(6.16)***
13	uint8_t (3:0)		NACp ***(6.16)***
14	uint32_t (31:20)		Horizontal Velocity in unsigned decimal format with 1 knot resolution
14	uint32_t (19:8)		Vertical Velocity in signed decimal format 64 fpm resolution
14	uint32_t (7:0)		Track/Heading in unsigned degree format with 360/256 resolution. 0=North, 128=South
18	uint8_t		Emitter Category ***(6.17)***
19	uint8_t[8]		Flight Identification: 8 ASCII characters, '0' through '9', 'A' through 'Z' or space. Spaces (0x20) used as a trailing pad character, or when call sign is unavailable. Reflects Control message setting.
27	uint8_t (7:4)		Emergency/Priority Code ***(6.18)***
27	uint8_t (3:0)		Reserved

5.2.3 Ownship Geometric Altitude (Msg ID = 11_{10})

Direction: Device to host

An Ownship Geometric Altitude message will be transmitted with a period of 1 second when the GNSS fix is valid.

Offset	Type/Width	Value	Description
0	uint8_t	0x0B	Message ID
1	int16_t		Geometric Altitude signed in feet, with 5-foot resolution. Alt = (x * 5) (MSB first)
3	uint16_t (15:15)		Vertical Warning Indicator
3	uint16_t (14:0)		Vertical Figure of Merit (VFOM) (m). If unknown set to 0x7FFF. Saturates at 0x7FFE (MSB first)

5.2.4 Identification Message (Msg ID = 37_{10})

Direction: Device to host

The Identification message contains information used to identify the connected device. The Identification message will be transmitted with a period of 1 second regardless of data status or update.

Offset	Type/Width	Value	Description
0	uint8_t	0x25	Message ID
1	uint8_t	0x02	Message Version
2	uint8_t		Primary Firmware Major Version
3	uint8_t		Primary Firmware Minor Version
4	uint8_t		Primary Firmware Build Version
5	uint8_t		Primary Hardware Identification *(6.19)*
6	uint64_t		Primary Device Serial Number
14	uint8_t		*Secondary Firmware Major Version
15	uint8_t		*Secondary Firmware Minor Version
16	uint8_t		*Secondary Firmware Build Version
17	uint8_t		*Secondary Hardware Identification *(6.19)*
18	uint64_t		*Secondary Device Serial Number
26	uint8_t		Primary Firmware Identification *(6.24)*
27	uint32_t		Primary Firmware CRC
31	uint8_t		*Secondary Firmware Identification *(6.24)*
32	uint32_t		*Secondary Firmware CRC

* All secondary bytes filled with 0xFF if device not equipped with secondary firmware

5.2.5 Control (Msg ID = 45_{10})

Direction: Host to device

The Control message contains all data to control the immediate status of the transponder along with configuration fields that are expected to change as a normal course of a flight. Control messages must be sent with a 1 second period regardless of data status or updates.

Offset	Type/Width	Value	Description
0	uint8_t	0x2D	Message ID
1	uint8_t	0x01	Message Version
2	uint8_t (7:7)		1090ES TX Enabled
2	uint8_t (6:6)		Mode S Reply Enabled
2	uint8_t (5:5)		Mode C Reply Enabled
2	uint8_t (4:4)		Mode A Reply Enabled
2	uint8_t (3:3)		Ident button active
2	uint8_t (2:1)		Aircraft Air-Ground State *(6.21)*
2	uint8_t (0:0)		External Barometer Sensor Cross Checked *(6.12)*
3	int32_t		External barometric pressure altitude relative to a standard atmosphere of 1013.2 mBar and NOT bar corrected altitude (meters * 1E3). If unknown set to INT32_MAX
7	uint16_t		Mode A (squawk) code (typically 1200 [0x04B0] for VFR)
9	uint8_t		Emergency State Status *(6.11)*
10	uint8_t[8]		Flight Identification: 8 ASCII characters, ‘0’ through ‘9’, ‘A’ through 'Z' or space. Spaces (0x20) used as a

			trailing pad character, or when call sign is unavailable. e.g. “UA123 “. Aircraft Registration is transmitted if Flight ID is set to all spaces.

5.2.6 GNSS Data (Msg ID = 46_{10})

Direction: Host to device

The GNSS Data message contains all position, velocity, and time data required to support the ADS-B functionality of the transponder. GNSS Data messages must be sent with a 200-millisecond period regardless of data status or updates.

Offset	Type/Width	Value	Description
0	uint8_t	0x2E	Message ID
1	uint8_t	0x02	Message Version
2	uint32_t		Seconds since GPS Epoch offset by the current leap seconds (UTC time)
6	int32_t		Latitude WGS84 (deg * 1E7). If unknown set to INT32_MAX
10	int32_t		Longitude WGS84 (deg * 1E7). If unknown set to INT32_MAX
14	int32_t		Altitude (meters * 1E3). Height above WGS-84 ellipsoid. If unknown set to INT32_MAX. Saturates at INT32_MAX-1.
18	uint32_t		Horizontal Protection Level (meters * 1E3). If unknown set to UINT32_MAX. Saturates at UINT32_MAX-1. May report HPL_{sbas} or HPL_{fd} (see state bit 0x01).
22	uint32_t		Vertical Protection Level (meters * 1E2). If unknown set to UINT32_MAX. Saturates at UINT32_MAX-1. May report VPL_{sbas} or VPL_{fd}
26	uint32_t		Horizontal Figure of Merit, 95% (HFOM) (meters * 1E3). If unknown set to UINT32_MAX. Saturates at UINT32_MAX-1.
30	uint16_t		Vertical Figure of Merit, 95% (VFOM) (meters * 1E2). If unknown set to UINT16_MAX. Saturates at UINT16_MAX-1.
32	uint16_t		Horizontal Velocity Figure of Merit, 95% (HVFOM) (m/s * 1E3). If unknown set to UINT16_MAX. Saturates at UINT16_MAX-1
34	uint16_t		Vertical Velocity Figure of Merit, 95% (HVFOM) (m/s * 1E3). If unknown set to UINT16_MAX. Saturates at UINT16_MAX-1
36	int16_t		GNSS vertical speed (m/s * 1E2) Up +ve. If unknown set to INT16_MAX. Saturates at INT16_MAX-1

38	int32_t		North-South velocity over ground (m/s * 1E3) North +ve. If unknown set to INT32_MAX. Saturates at INT32_MAX-1
42	int32_t		East-West velocity over ground (m/s * 1E3) East +ve. If unknown set to INT32_MAX. Saturates at INT32_MAX-1
46	uint8_t		GNSS Fix Quality ***(6.9)***
47	uint8_t		Navigation State Indicator Flags ***(6.10)***
48	uint8_t		Number of satellites in solution. Includes GNSS and GEO satellites. If unknown set to UINT8_MAX. Saturates at UINT8_MAX-1.

5.2.7 Transponder Status (Msg ID = 47_{10})

Direction: Device to host

The Transponder Status message contains data to report the immediate status of the transponder. Status packets will be transmitted from the transponder with a 1 second period regardless of data status or updates.

Offset	Type/Width	Value	Description
0	uint8_t	0x2F	Message ID
1	uint8_t	0x01	Message Version
2	uint8_t (7:7)		1090ES TX Enabled
2	uint8_t (6:6)		Mode S Reply Enabled
2	uint8_t (5:5)		Mode C Reply Enabled
2	uint8_t (4:4)		Mode A Reply Enabled
2	uint8_t(3:3)		Ident button active
2	uint8_t(2:0)		Reserved
3	uint16_t		Mode A Interrogations per Second
5	uint16_t		Mode C Interrogations per Second
7	uint16_t		Mode S Interrogations per Second
9	uint16_t		Mode A (squawk) code (typically 1200 [0x04B0] for VFR)

5.2.8 Senor Type 1 - Barometer (MsgID = 40_{10})

Direction: Device to Host

The barometer sensor message contains raw, high resolution data from the sensor. The sensor message will be transmitted from the transponder with a 1 second period regardless of data status or updates.

Offset	Type	Value	Description
0	uint8_t	0x28	Message ID
1	uint8_t	0x01	Sensor Type 1=Barometer
2	uint32_t		Barometric pressure in mbar * 1e2
6	int32_t		Barometric pressure altitude in mm
10	int16_t		Barometric sensor temperature in C * 1e2

5.2.9 uAvionix OEM (Msg ID = 117_{10})

Direction: Host to device

uAvionix OEM messages are constructed with a single message ID. A subtype field provides the ability to encapsulate multiple bidirectional functionalities under a single message ID.

5.2.9.1 System Command – Enter Update Mode (254_{10})

Enter bootloader mode for update. Regular operating mode may not resume until update completes or unit is power cycled.

Offset	Type	Value	Description
0	char	'u' 0x75	Message ID
1	char	'A' 0x41	Signature
2	uint8_t	0xFE	Subtype
3	uint8_t	0x01	Version
4	uint32_t	Baud rate or 0xFFFFFFFF for default/current	Baud rate
8	uint8_t		Update device depth, the number of hops to pass the update command before acting upon. To update an immediately downstream device (i.e. a device connected by serial) pass a value of 0. To update a device being bridged by another, pass a value of 1. For bridged updates to function, intermediate devices must be capable of entering a raw, bridged mode. Each time the message is passed to a bridged device this number should be decremented by 1.

6 Field Definitions

6.1 SIL (Source Level Integrity)

Probability of Exceeding the NIC Containment Radius	Value
Unknown	0
≤ $1x10^{-3}$ per flight hour or per sample	1
≤ $1x10^{-5}$ per flight hour or per sample	2
≤ $1x10^{-7}$ per flight hour or per sample	3

6.2 SDA (System Design Assurance)

Supported Failure Condition	Probability of Undetected Fault causing transmission of False or Misleading Information	Software & Hardware Design Assurance Level	Value

Unknown / No safety effect	> $1x10^{-3}$ per flight hour or Unknown	N/A	0
Minor	≤ $1x10^{-3}$ per flight hour	D	1
Major	≤ $1x10^{-5}$ per flight hour	C	2
Hazardous	≤ $1x10^{-7}$ per flight hour	B	3

6.3 Aircraft Maximum Speed

Mode S transponders can transmit their maximum airspeed characteristics to aircraft equipped with TCAS. This information is used to identify threats and to plan avoiding action by the TCAS equipped aircraft. The airspeeds are grouped in ranges.

Maximum Speed (knots)	Value
Data not Available	0
≤ 75 knots	1
75 < Speed ≤ 150	2
150 < Speed ≤ 300	3
300 < Speed ≤ 600	4
600 < Speed ≤ 1200	5
> 1200	6

6.4 Barometer Altitude Source

Select which source of barometric altitude should be used as the source for ADS-b data.

Maximum Speed (knots)	Value
Internal Barometer	0
External Barometer	1

6.5 ADS-B IN Capability

The ADS-B transmissions include an indication to the ground stations of whether the aircraft includes a 1090MHz ADS-B receiver, a UAT ADS-B receiver, or both.

Description	Value
None	0x00
1090 MHz	0x01
978 MHz	0x02
1090 & 978Mhz	0x03

6.6 Aircraft Length and Width

On the ground, ADS-B transmits encoded aircraft size information which is used by ATC to identify taxiing routes and potential conflicts. Enter the length and width (wingspan) fields in meters and the appropriate size codes will be calculated for transmission.

Length (meters)	Width (meters)	Value
No Data or Unknown		0

≤ 15	≤ 23	1
15 < Length ≤ 25	≤ 28.5	2
	28.5 < Width ≤ 34	3
25 < Length ≤ 35	≤ 33	4
	33 < Width ≤ 38	5
35 < Length ≤ 45	≤ 39.5	6
	39.5 < Width ≤ 45	7
45 < Length ≤ 55	≤ 45	8
	45 < Width ≤ 52	9
55 < Length ≤ 65	≤ 59.5	10
	59.5 < Width ≤ 67	11
65 < Length ≤ 75	≤ 72.5	12
	72.5 < Width ≤ 80	13
75 < Length ≤ 85	≤ 80	14
	80 < Width ≤ 90	15
Longer than 85 meters or wider than 90 meters		15

6.7 Antenna Offset

The GNSS antenna offset is used in conjunction with the length and width to manage taxiway conflicts. A typical GNSS does not report the geographic position of the center of the aircraft, or even the tip of the nose of the aircraft; instead, it usually reports the location of the actual GNSS antenna (not the GNSS receiver). In normal flight operation this distinction is of no importance at all, but if ADS-B is used to manage taxiway conflicts, a significant offset in antenna position could mean that the aircraft footprint is not in the same place as the ADS-B reported position. Although the GNSS Antenna Offset is primarily intended for position correction on large transport aircraft, General Aviation aircraft can also have a significant offset. For example, if the aircraft has a long tail boom and the GNSS antenna is on top of the tail, the GNSS position could be 4 meters or more from the nose of the aircraft.

6.7.1 GNSS Antenna Lateral Offset

Lateral from roll axis (meters)	Value
Offset Unknown	0
Left 2	1
Left 4	2
Left 6	3
0	4
Right 2	5
Right 4	6
Right 6	7

6.7.2 GNSS Antenna Longitudinal Offset

Longitudinal aft from aircraft nose (meters)	Value
Offset Unknown	0
Offset applied by Sensor	1
2m thru 31m	(meters/2 + 1)

6.8 Aircraft Emitter Type

Aircraft Type	Emitter Type
Type Not Listed	0
Light (ICAO) < 15500 lbs	1
Small - 15500 to 75000 lbs	2
Large - 75000 to 300000 lbs	3
High Vortex Large (e.g., aircraft such as B757)	4
Heavy (ICAO) - > 300000 lbs	5
Highly Maneuverable > 5G acceleration and high speed	6
Rotorcraft	7
Glider/sailplane	9
Lighter than air	10
Parachutist/sky diver	11
Ultra light/hang glider/paraglider	12
Unmanned aerial vehicle	14
Space/transatmospheric vehicle	15
Surface vehicle - emergency	17
Surface vehicle - service vehicle	18
Point Obstacle (includes tethered balloons)	19

6.9 GNSS Fix Quality

Description	Value
No Fix, Unknown	0x00
No Fix, Last Known Good data	0x01
2D fix	0x02
3D fix	0x03
Differential fix	0x04
RTK fix	0x05

6.10 Navigation State Indicator Flags

Description	Value
HPL_{fd} active	0x01
Fault, integrity failure (DO-229D 2.1.2.2.2)	0x02

6.11 Emergency State Status

Description	Value
No emergency	0
General emergency	1
Lifeguard/medical emergency	2
Minimum fuel	3
No communications	4
Unlawful interference	5
Downed aircraft	6
Not Provided	255

6.12 External Barometer Sensor Cross Checked

Description	Value
External barometric altitude **has not** been cross checked against another source of pressure altitude	0
External barometric altitude **has** been cross-checked against another source of pressure altitude	1

6.13 Traffic Alert Status

Four-bit field which indicates whether CSA has identified this target with an alert.

Description	Value
No alert	0
Traffic alert	1

6.14 Target Identity

The identity of a target is formed by the combination of the Address Type along with the Participant Address. Together these form a 28-bit field that uniquely identifies a given ADS-B or TIS-B participant.

Description	Value
ADS-B with ICAO Address	0
ADSB-B with Self-assigned address	1
TIS-B with ICAO address	2
TIS-B with Self-assigned address	3
Surface Vehicle	4
Ground State Beacon	5

6.15 Miscellaneous Indicators

The Miscellaneous Indicator field contains the following indicator bits that apply to the Ownship Report. Bits 1 and 0 describe the type of data conveyed in the "Track/Heading" field. Bit 2

describes whether the report is updated from an ADS-B message reception or is extrapolated from a previous report. Bit 3 gives the Air/Ground state of the traffic.

Bit 3	Bit 2	Bit 1	Bit 0	Meaning
-	-	0	0	“Track/Heading” not valid
-	-	0	1	“Track/Heading” True Track Angle
-	-	1	0	“Track/Heading” Heading (Magnetic)
-	-	1	1	“Track/Heading” Heading (True)
-	0	-	-	Report is updated
-	1	-	-	Report is extrapolated
0	-	-	-	On Ground
1	-	-	-	Airborne

6.16 Integrity (NIC) and Accuracy (NACp)

The Integrity and Accuracy of the traffic is reported using a 4-bit value for each field. At the transmitting source, NIC is encoded by the Containment Radius (typically HPL). NACp is encoded using the Estimated Position Uncertainty (typically HFOM)

Value	NIC (HPL)	NACp (HFOM)
0	Unknown	Unknown
1	< 20.0 NM	< 10.0 NM
2	< 8.0 NM	< 4.0 NM
3	< 4.0 NM	< 2.0 NM
4	< 2.0 NM	< 1.0 NM
5	< 1.0 NM	< 0.5 NM
6	< 0.3 NM	< 0.3 NM
7	< 0.2 NM	< 0.1 NM
8	< 0.1 NM	< 0.05 NM
9	< 75 m	< 30 m
10	< 25 m	< 10 m
11	< 7.5 m	< 3 m

6.17 Emitter Category

The Emitter Category as a binary value within the range 0 to 39.

Description	Value
No aircraft type information	0
Light (ICAO) < 15 500 lbs	1
Small - 15 500 to 75 000 lbs	2
Large - 75 000 to 300 000 lbs	3
High Vortex Large (e.g., aircraft such as B757)	4
Heavy (ICAO) - > 300 000 lbs	5
Highly Maneuverable > 5G acceleration and high speed	6
Rotorcraft	7
Unassigned	8
Glider/sailplane	9

Lighter than air	10
Parachutist/sky diver	11
Ultra light/hang glider/paraglider	12
Unassigned	13
Unmanned aerial vehicle	14
Space/trans atmospheric vehicle	15
Unassigned	16
Surface vehicle — emergency vehicle	17
Surface vehicle — service vehicle	18
Point Obstacle (includes tethered balloons)	19
Cluster Obstacle	20
Line Obstacle	21
Reserved	22-39

6.18 Emergency/Priority Code

The Emergency Priority Code is a 4-bit value that provides status information about the traffic.

Description	Value
No emergency	0
General emergency	1
Medical emergency	2
Minimal fuel	3
No communication	4
Unlawful interference	5
Downed aircraft	6

6.19 Hardware Identification

Description	Value
Ping200s	0x09
Ping20s	0x0A
Ping200C	0x18
Ping200z/Ping200X	0x26
Ping20Z	0x27

6.20 Serial Port Baud Rate

Description	Value
1200 bps	0
2400 bps	1
4800 bps	2
9600 bps	3
19200 bps	4
38400 bps	5
57600 bps	6
115200 bps	7

921600 bps	8

6.21 Aircraft Air-Ground State

Description	Value
Aircraft is Airborne and Subsonic	0
Aircraft is Airborne and Supersonic (Vgs > 1024knots)	1
Aircraft is on the ground	2

6.22 Latitude and Longitude

Latitude and longitude values are stored in 24-bit fields, both encoded over a range of ±180 degrees. Valid latitude values are limited to +90 through -90 degrees, with northern values being positive. Valid longitude values are +(180 minus LSB) through -180 degrees, with eastern values being positive.

Example	Value
0 N or 0 E degrees	0x000000
0 + LSB N or E degrees	0x000001
0 – LSB S or W degrees	0xFFFFFF
45 N or E degrees	0x200000
45 S or W degrees	0xE00000
-180 degrees	0x800000
Maximum longitude (180 – LSB)	0x7FFFFF

6.23 Altitude

Altitude values contain pressure altitude referenced to 29.921 inHg, encoded using 25-foot resolution and offset by 1,000 feet. Valid altitude values range from -1000 to 101,350 feet, with 0xFFF indicating invalid or unavailable.

Example	Value
-1000 feet	0x000
0 feet	0x028
10,000 feet	0x1B8
101,350 feet	0xFFE
Invalid or unavailable	0xFFF

6.24 Firmware Identification

Description	Value
Ping200s	0x11
Ping20s	0x11
Ping200C	0x26
Ping200z/Ping200X	0x33
Ping20Z	0x34

6.25 Request Message Id

Description	Value
Identification Message (Msg ID = 3710)	0x25
Transponder Configuration (Msg ID = 4310)	0x2B

6.26 Control Message Validity Bitmask

Bit	Description
0	ICAO address
1	SIL (Source Level Integrity)
2	SDA (System Design Assurance)
3	Barometer Altitude Source
4	Aircraft Maximum Speed
5	Test Mode
6	ADS-B IN Capability
7	Aircraft Length and Width
8	GNSS Antenna Lateral Offset
9	GNSS Antenna Longitudinal Offset
10	Aircraft Registration
11	Aircraft Stall Speed (cm/s)
12	Aircraft Emitter Type
13	Default 1090ES TX Mode
14	Default Mode S Reply Mode
15	Default Mode C Reply Mode
16	Default Mode A Reply Mode
17	Serial Port Baud Rate
18	Default Mode A (squawk) code
19-31	Reserved