Ekinox AHRS/INS

Tactical Grade Inertial Systems

Firmware Reference Manual

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Revision history

Rev.	Date	Author	Information
1.2	Mar 17, 2014	Alexis Guinamard	Renamed GPS Omnistar solution type Removed SBG_ECOM_POS_OMNISTAR_G2 position solution type Added SBG_ECOM_POS_FIXED position type Updated heave output messages specifications Added new NMEA messages definition (GST, VBW)
1.1	Nov 15, 2013	Raphael Siryani	Added pitch field in GPS true heading data Added DVL support output logs Updated status definitions for DVL Added Teledyne PD0 and PRDID output logs Added CAN messages specifications
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1. Introduction

This firmware reference manual presents the input and output protocols supported by the Ekinox AHRS and Ekinox INS series.

With this manual, you will learn how to read data from the device and how to send some configuration commands or aiding data to the device.

1.1. Types definitions

1.1.1. Scalar types

When required, the following types will be used to describe variables format.

Type	Description
Mask	This type defines a bit within a larger size integer variable
Enum	This type defines a group of several bits defining a list of possible states. Each value corresponds to a state; This type has no pre-defined size and user should refer to each occurrence for corresponding size.
bool	8 bits boolean, 0x00 is FALSE, 0x01 is TRUE
uint8	8 bits unsigned integer
int8	8 bits signed integer
uint16	16 bits unsigned integer
int16	16 bits signed integer
uint32	32 bits unsigned integer
int32	32 bits signed integer
uint64	64 bits unsigned integer
int64	64 bits signed integer
float	32 bits single floating point, standard IEEE 754 format
double	64 bits double floating point, standard IEEE 754 format

1.2. Complex types

1.2.1. Vectors objects

Vectors are stored in a 1D array of float or double components.

$$V = \begin{pmatrix} V_0 \\ V_1 \\ V_2 \end{pmatrix}$$

This vector is stored in memory this way:

V_0	V_1	V_2

1.2.2. Matrix objects

Matrix are stored in a 1D array of float or double items. They are expressed in vector column format.

$$M_{3x3} = \begin{pmatrix} U_0 & V_0 & W_0 \\ U_1 & V_1 & W_1 \\ U_2 & V_2 & W_2 \end{pmatrix}$$

This matrix is stored this way:

U_0	U_1	U_2	V_0	V_1	V_2	W_0	W_1	W_2

1.3. Endianness

The Ekinox and all provided libraries use little endian data format. However, the sbgECom communication library should be compatible with big endian platforms.

For ASCII or NMEA messages, the platform endianness does not affect messages parsing or generation.

1.4. Conventions and units

The Ekinox uses the International System of Units (SI) when applicable. The device coordinate frame is defined as North East Down (NED).

Physical quantity	Unit description
Angle	Radians, roll, pitch, yaw.
Rotational speed	rad.s^-1
Acceleration	m.s^-2
Velocity	m.s^-1
Latitude	Degrees, positive North, negative South.
Longitude	Degrees, positive East, negative West.
Altitude	Meters, positive up, above Mean Sea Level, negative down.
Ship Motion	Surge positive forward, Sway positive right, Heave positive down expressed in meters.

2. Serial, Ethernet and Data-logger interfaces

In addition to common RS-232 or RS-422 ports, the Ekinox includes five Ethernet communication ports as well as an internal data-logger.

2.1. Low level interfaces

2.1.1. Serial interface Low level protocol

All serial ports use the following transmission format for communications:

- Available baudrates: 4800, 9600, 19200, 38400, 57600, 115200, 230400, 460800, 921600
- 8 bits data
- 1 stop bit
- No parity
- No control flow

2.1.2. Ethernet low level protocol

The Ekinox features five Ethernet virtual serial ports: ETH 0, ETH 1, ETH 2, ETH 3, ETH 4. Each port provides an input and output channel for full duplex operations.

Ethernet ports can be configured as virtual serial ports over TCP/IP (server or client) or UDP. The UDP option offers the best data throughput but doesn't guarantee that data are being sent or received correctly.

Note: All data that are transmitted over Ethernet are protected by a 32 bits CRC even for an UDP connection.

2.1.3. Data-logger interface

This interface is considered as a standard serial port and can be used to store any output data log. The data-logger acts exactly as if you have stored all the raw bytes coming from a serial port. The internal data-logger can thus log both binary logs and NMEA/ASCII messages.

2.2. sbgECom Binary Protocol description

2.2.1. General description

The sbgECom protocol has been designed for compact and secured communications thanks to its binary form and 16 bits CRC. It's therefore very efficient for inertial navigation related communications that requires high throughput and high data integrity.

In addition, the sbgECom binary protocol is the best way to access the device full features and accuracy. It's strongly recommended to use this protocol to ensure the best integration into a host system.

2.2.1.1. Commands vs logs input/output

The protocol philosophy can be summarized in two types of communications:

- Question / Answer mode. This mode is used mainly for some configuration operations. A setting command is sent to the Ekinox which provides, once the operation is performed, an appropriate answer. This type of communication is therefore a bi-directional communication.
- Continuous / Triggered mode. This mode is used for data input and output. Data computed by the Ekionx are sent in a uni-directional mode and require no answer from receiver side. In the same time, aiding data provided by third party equipments can be sent to the Ekinox. No answer will be sent by the Ekinox at such message reception.

2.2.1.2. Frame definition

All frames sent through the sbgECom protocol have a common format, which is described below:

Field	SYNC 1	SYNC 2	CMD	LEN	DATA	CRC	ETX
Size (bytes)	1	1	2	2	0 to 4086	2	1
Description	Sync. word	Sync. word	Command	Length of DATA section	Additional data	16 bit CRC	End of frame
Value	0xFF	0x5A	-	-	-	-	0x33

Note 1: The LEN field contains the DATA section size in bytes. A 0 LEN field implies that no DATA section is present. Maximum length value is 4086 so that maximum frame size is 4096.

Note 2: The whole protocol is defined in LITTLE endian, so LEN, CMD and CRC fields are written directly in little endian.

Note 3: Some third party frames are available on output and will not comply with this protocol format. A specific format will then be defined for each frame. It belongs to the user to decode the different formats if several protocols are used at the same time.

2.2.1.3. CRC definition

The sbgECom protocol uses a 16 bit CRC to detect corrupted messages. This CRC uses the following polynomial value: 0x8408

You can find in the sbgECom library source code, the C code used to compute this CRC in the file misc/sbgCrc.c. The sbgECom CRC implementation uses a lookup table to speed up the CRC computation.

In the C code below, you have a non optimized method to compute the 16 CRC.

```
/*!
 *    Compute a CRC for a specified buffer.
 *    \param[in]    pBuffer       Read only buffer to compute the CRC on.
 *    \param[in]    bufferSize    Buffer size in bytes.
 *    \return                     The computed 16 bit CRC.
 */
uint16 calcCRC(const void *pBuffer, uint16 bufferSize)
{
      const uint8 *pBytesArray =  (const uint8*)pBuffer;
      uint16 poly = 0x8408;
      uint16 crc = 0;
      uint8 carry;
      uint8 i_bits;
      uint16 j;

      for (j =0; j < bufferSize; j++)
      {
            crc = crc ^ pBytesArray[j];
            for (i_bits = 0; i_bits < 8; i_bits++)
            {
                  carry = crc & 1;
                  crc = crc / 2;
                  if (carry)
                  {
                        crc = crc^poly;
                  }
            }
      }

      return crc;
}
```

2.2.2. Transfer sub-protocol

Some commands from the sbgECom protocol involve data transmission. A transfer sub-protocol is in place to assure a reliable way to send large amount of data from and to the device.

This sub-protocol encapsulated into sbgECom protocol frames works in a master/slave communication scheme where the host acts as the master and the device the slave. The transfers are divided in 3 steps (initialization, data transmission, finalization) which is described below in case of emission and reception.

The following transfer sub-commands are available:

Name (transfer step)	Description
ECOM_TRANSFER_START (0x0000)	Initialization of the transfer
ECOM_TRANSFER_DATA (0x0001)	Data transmission
ECOM_TRANSFER_END (0x0002)	Finalization of the transfer

2.2.2.1. Sending data to the device

Initialization

To initiate a transfer, the host issue an ECOM_TRANSFER_START, followed by the total size of the transfer. The device will respond with an ACK if it was able to prepare for the reception, a NACK otherwise.

Field	TRANSFER CMD	DATA
Value	ECOM_TRANSFER_START (0x0000)	Transfer total size (uint32)
Size (bytes)	2	4

Data transmission

Once the transfer is successfully initialized, the host sends buffers sequentially beginning with an ECOM_TRANSFER_DATA sub command, the offset from the start of the transfer and the byte stream. It must wait for the device ACK before sending the next one. If the device responds with a NACK or does not respond, the host must try sending the buffer again.

Field	TRANSFER CMD	DATA	
Value	ECOM_TRANSFER_DATA (0x0001)	Offset from start (uint32)	Payload (byte stream)
Size (bytes)	2	4	n

Finalization

To end the transfer, after all the data has been sent, the host issues an ECOM_TRANSFER_END. The device will process the whole transfer and respond with an ACK or NACK whether it has validated the received data or not.

Field	TRANSFER CMD
Value	ECOM_TRANSFER_END (0x0002)
Size (bytes)	2

2.2.2.2. Receiving data from the device

Initialization

To initiate a transfer, the host issue an ECOM_TRANSFER_START. The device will prepare the data to send and respond with a transfer ECOM_TRANSFER_START followed by the total size of the transfer. If an error occurs, the device will issue an NACK.

Host request format:

Field	TRANSFER CMD
Value	ECOM_TRANSFER_START (0x0000)
Size (bytes)	2

Device response format:

Field	TRANSFER CMD	DATA
Value	ECOM_TRANSFER_START (0x0000)	Transfer total size (uint32)
Size (bytes)	2	4

Data transmission

Once the transfer is successfully initialized, the host requests buffers sequentially beginning with an ECOM_TRANSFER_DATA, the offset from the start of the transfer and the amount of data it requests. It must validate every buffer it receives before requesting the next one. If the device responds with a NACK or does not respond, the host must try requesting the buffer again.

Host request format:

Field	TRANSFER CMD	DATA	
Value	ECOM_TRANSFER_DATA (0x0001)	Offset from start (uint32)	Buffer size requested (uint32)
Size (bytes)	2	4	4

Device response format:

Field	TRANSFER CMD	DATA	
Value	ECOM_TRANSFER_DATA (0x0001)	Offset from start (uint32)	Payload (byte stream)
Size (bytes)	2	4	n

Finalization

To end the transfer, after all the data has been received, the host issues an ECOM_TRANSFER_END. The device will return in a non transfer state and respond with an ACK or an NACK if an error occurred.

Field	TRANSFER CMD
Value	ECOM_TRANSFER_END (0x0002)
Size (bytes)	2

2.2.3. Commands

The Ekinox series is a very advanced piece of technology with a lot of configuration options. All these options can be defined using the powerful embedded web interface. The sbgECom binary protocol hasn't been designed to configure the whole device.

Indeed, the sbgECom provides only the commands that should or can be used during the device operation or some commands that can ease the device configuration during production.

The following commands are available:

Name (command ID)	Description
SBG_ECOM_CMD_ACK (100)	Used to acknowledge a command.
SBG_ECOM_CMD_SAVE_SETTINGS (101)	Save current settings to the non volatile memory.
SBG_ECOM_CMD_IMPORT_SETTINGS (102)	Command used to upload a settings file onto the device.
SBG_ECOM_CMD_EXPORT_SETTINGS (103)	Command used to export settings from the device.
SBG_ECOM_CMD_SET_MAG_CALIB (110)	Upload a new magnetic calibration.

2.2.3.1. SBG_ECOM_CMD_ACK (100)

Most configuration commands will get an Acknowledge frame as answer. The ACK frame contains two fields, the first one is the command ID that is being acknowledged. The second one is the returned command status used to know if the command has been executed successfully or if an error has occurred.

Field	CMD	LEN	DATA	
Value	SBG_ECOM_CMD_ACK (100)	48	Acknowledged CMD ID (uint16)	Error code (uint16)
Size (bytes)	2	2	2	2

The following Error Codes may be produced by the Ekinox:

Error Code	Value	Description
SBG_NO_ERROR	0x00	The command has been properly executed
SBG_ERROR	0x01	Command could not be executed properly due to a generic error
SBG_NULL_POINTER	0x02	A pointer equaled NULL
SBG_INVALID_CRC	0x03	A frame with an invalid CRC has been received
SBG_INVALID_FRAME	0x04	The frame sent has an invalid format
SBG_TIME_OUT	0x05	A time out occurred before getting the answer
SBG_WRITE_ERROR	0x06	The device could not write some data
SBG_READ_ERROR	0x07	The device could not read some data
SBG_BUFFER_OVERFLOW	0x08	The buffer is too small to contain the whole frame
SBG_INVALID_PARAMETER	0x09	A parameter has a non valid value
SBG_NOT_READY	0x0A	The device is not ready for communication
SBG_MALLOC_FAILED	0x0B	Could not allocate memory
SBG_INCOMPATIBLE_HARDWARE	0x13	The command cannot be executed because of hardware incompatibility
SBG_INVALID_VERSION	0x14	The command cannot be executed because of version incompatibility

2.2.3.2. SBG_ECOM_CMD_SAVE_SETTINGS (101)

This function saves all Ekinox current parameters into the non-volatile memory.

Field	CMD	LEN
Value	SBG_ECOM_CMD_SAVE_SETTINGS (101)	0
Size (bytes)	2	2

This command has no parameter and the device should answer with an ACK if the settings have been saved successfully into the non volatile memory.

Note: The device will not restart after this command is issued.

2.2.3.3. SBG_ECOM_CMD_IMPORT_SETTINGS (102)

This command is used to send a buffer that contains a complete set of settings to the device. The device will then save these settings into the FLASH memory and reboot in order to use the new settings.

Thanks to this command, you can automate the device configuration for production proposes.

This command uses the transfer sub-protocol since the set of settings is too large to be sent in a unique sbgECom protocol frame. See 2.2.2 Transfer sub-protocol and more specifically 2.2.2.1 Sending data to the device for further information.

Field	CMD	LEN	DATA	
Value	SBG_ECOM_CMD_IMPORT_SETTINGS (102)	48	Transfer protocol command (uint16)	Transfer protocol payload
Size (bytes)	2	2	2	0-n

Note: The device will restart after this command is issued.

2.2.3.4. SBG_ECOM_CMD_EXPORT_SETTINGS (103)

You can export all the device settings to a buffer using this command. Use it in pair with the SBG_ECOM_CMD_IMPORT_SETTINGS (102) command to automate a device configuration.

This command uses the transfer sub-protocol since the set of settings is too large to be received in a unique sbgECom protocol frame. See 2.2.2 Transfer sub-protocol and more specifically 2.2.2.2 Receiving data from the device for further information.

Field	CMD	LEN	DATA	
Value	SBG_ECOM_CMD_EXPORT_SETTINGS (103)	48	Transfer protocol command (uint16)	Transfer protocol payload
Size (bytes)	2	2	2	0-n

2.2.3.5. SBG_ECOM_CMD_SET_MAG_CALIB (110)

This command sends a new magnetic calibration to the Ekinox. A magnetic calibration is composed of a magnetic offset vector used to compensate for hard iron effects and a 3x3 correction matrix that accounts for soft iron distortions.

Field	CMD	LEN	DATA	
Value	SBG_ECOM_CMD_SET_MAG_CALIB (110)	48	Offset x3 (float)	Matrix 3x3 (float)
Size (bytes)	2	2	12	36

Once the operation is performed, the Ekinox will answer with an ACK frame and the new magnetic calibration will be used automatically.

Note: After you have uploaded a new magnetic calibration, if you would like to keep it for the next device power up, don't forget to call the SBG_ECOM_CMD_SAVE_SETTINGS (101) command.

2.3. NMEA Protocol description

The Ekinox AHRS and Ekinox INS series provide a NMEA support for both aiding input and data output.

2.3.1. NMEA sentences format

The NMEA sentences implemented in the Ekinox are based on NMEA 0183 Version 4.1.

The following example is described in the table below:

```
$GPZDA,201530.00,04,07,2002,00,00*60<CR><LF>
```

Field	Value	Description	Example
Start of frame	$	All frames start with $	$
Talker ID	<XX>	GP for GPS GL for GLONASS...	GP
Sentence Formater	<XXX>	Type of message content	ZDA
[,value]		Data field are separated by a ',' Data field can vary even for a certain field	,201530.00,04,07,2002,00,00
Check-sum	*<Checksum>	Start with a '*' and consist of a 2 characters representing a 8 bits hex value. The checksum is the XOR of all previous values except '$' and '*'	*60
End of Frame	<CR><LF>	All frames end with a carriage return and line feed.	<CR><LF>

Note 1: For each output interface, the NMEA talker ID may be configured accordingly. When input NMEA data are sent to the Ekinox, the talker ID field is ignored.

Note 2: Each data field is comma separated. Sometimes, a field cannot be defined and can be left empty. In this case the frame may contain several blank fields such as in the following example:

$GPZDA,,,,,,*XX<CR><LF>

2.3.2. NMEA types conventions

To ease NMEA messages definitions, we define two conventions for both integers and decimal number format.

2.3.2.1. Integer numbers

Integer numbers are represented using the char 'i'. The number of 'i' chars define the maximum number of digits that can be used to represent this integer.

The char '-' is prepended to represent a negative integer number.

Example

The integer format iii could be used to represent the following integers: -234, 13, -3

2.3.2.2. Decimal numbers

Decimal numbers are represented by the char 'f'. The char '.' is used to separate the integer part from the decimal one. The number of 'f' chars define the maximum number of digits that can be used to represent both the integer and decimal part.

The char '-' is prepended to represent a negative decimal number.

Example

The decimal format ff.fff could be used to represent the following decimal numbers: -34.2, 1.205, 24.126

2.4. Output Logs

For best flexibility, the Ekinox provides many different outputs formats. Although the sbgECom protocol is the best suitable for new developments with the Ekinox, it may be desirable in some specific situations to use NMEA implementation or other third party protocols for quick integration.

Each interface can output at the same time any logs combination. For example, the Ekinox can send on the same serial port, both sbgECom binary logs and NMEA sentences.

2.4.1. sbgECom binary logs

Several Logs are defined and contain a fixed set of data. Each log stores coherent data that can be fully interpreted without any additional information.

In addition, a time stamp expressed in microseconds is included in each log. It can be used to synchronize the data carefully.

Finally, the sbgECom binary logs have been designed to ease post processing operations by including a status field to know how to interpret some specific logs.

Note: SBG Systems reserves the right to add at the end of logs new fields in future revision of the sbgECom protocol for upward compatibility. Therefore, user must consider the DATA sizes defined in this document as a minimum size.

The following output logs are available:

Name (log ID)	Description
SBG_ECOM_LOG_STATUS (01)	Status general, clock, com aiding, solution, heave
SBG_ECOM_LOG_IMU_DATA (03)	Includes IMU status, acc., gyro, temp delta speeds and delta angles values
SBG_ECOM_LOG_EKF_EULER (06)	Includes roll, pitch, yaw and their accuracies on each axis
SBG_ECOM_LOG_EKF_QUAT (07)	Includes the 4 quaternions values
SBG_ECOM_LOG_EKF_NAV (08)	Position and velocities in NED coordinates with the accuracies on each axis
SBG_ECOM_LOG_SHIP_MOTION_0/1/2/3 (09, 10, 11, 12), SBG_ECOM_SHIP_MOTION_HP_0/1/2/3 (32, 33, 34, 35)	Heave, surge and sway and accelerations on each axis for up to 4 points
SBG_ECOM_LOG_UTC_TIME (02)	Provides UTC time reference
SBG_ECOM_LOG_MAG (04)	Magnetic data with associated accelerometer on each axis
SBG_ECOM_LOG_MAG_CALIB (05)	Magnetometer calibration data (raw buffer)
SBG_ECOM_LOG_GPS1_VEL (13), SBG_ECOM_LOG_GPS2_VEL (16)	GPS velocities from primary or secondary GPS receiver
SBG_ECOM_LOG_GPS1_POS (14), SBG_ECOM_LOG_GPS2_POS (17)	GPS positions from primary or secondary GPS receiver
SBG_ECOM_LOG_GPS1_HDT (15), SBG_ECOM_LOG_GPS2_HDT (18)	GPS true heading from dual antenna system
SBG_ECOM_LOG_GPS1_RAW (31)	GPS 1 raw data for post processing.
SBG_ECOM_LOG_ODO_VEL (19)	Provides odometer velocity
SBG_ECOM_LOG_EVENT_A/B/C/D/E (24, 25, 26, 27, 28)	Event markers sent when events are detected on a sync in pin
SBG_LOG_DVL_BOTTOM_TRACK (29)	Doppler Velocity Log for bottom tracking data.
SBG_LOG_DVL_WATER_TRACK (30)	Doppler Velocity log for water layer data.

2.4.1.1. SBG_ECOM_LOG_STATUS (01)

This output combines all system status data, divided into six categories: General, Clock, Communications, Aiding, Solution and Heave.

This log is useful for advanced status information.

Field	Description	Unit	Format	Size	Offset
TIME STAMP	Time since sensor is powered up	µs	uint32	4	0
GENERAL STATUS	General status bitmask and enums	-	uint16	2	4
CLOCK STATUS	Clock model and UTC related status.	-	uint16	2	6
COM STATUS	Communication status bitmask and enums.	-	uint32	4	8
AIDING STATUS	Aiding equipments status bitmask and enums.	-	uint32	4	12
SOLUTION STATUS	Internal filter solution status and indicators.	-	uint32	4	16
RESERVED	Reserved field for future use	-	uint16	2	20
				Total size	22

GENERAL_STATUS definition

Provides general device status and information such as the power supplies (main, IMU, GNSS), settings, temperature and data-logger.

Bit	Name	Type	Description
0	SBG_ECOM_GENERAL_MAIN_POWER_OK	Mask	Set to 1 when main power supply is OK.
1	SBG_ECOM_GENERAL_IMU_POWER_OK	Mask	Set to 1 when IMU power supply is OK.
2	SBG_ECOM_GENERAL_GPS_POWER_OK	Mask	Set to 1 when GPS power supply is OK.
3	SBG_ECOM_GENERAL_SETTINGS_OK	Mask	Set to 1 if settings where correctly loaded
4	SBG_ECOM_GENERAL_TEMPERATURE_OK	Mask	Set to 1 when temperature is within specified limits.
5	SBG_ECOM_GENERAL_DATALOGGER_OK	Mask	Set to 1 when the data-logger is working correctly.

CLOCK_STATUS definition

Provide status on the clock stability, error and synchronization.

Bit	Name	Type	Description
0	SBG_ECOM_CLOCK_STABLE_INPUT	Mask	Set to 1 when a clock input can be used to synchronize the internal clock.
[1-4]	SBG_ECOM_CLOCK_STATUS	Enum	Define the internal clock estimation status (see the 1 below).
5	SBG_ECOM_CLOCK_UTC_SYNC	Mask	Set to 1 if UTC time is synchronized with a PPS
[6-9]	SBG_ECOM_CLOCK_UTC_STATUS	Enum	Define the UTC validity status (see the 2 below).

You can find below the values that each clock enumeration can have:

Value	Name	Description
0	SBG_ECOM_CLOCK_ERROR	An error has occurred on the clock estimation.
1	SBG_ECOM_CLOCK_FREE_RUNNING	The clock is only based on the internal crystal.
2	SBG_ECOM_CLOCK_STEERING	A PPS has been detected and the clock is converging to it.
3	SBG_ECOM_CLOCK_VALID	The clock has converged to the PPS and is within 500ns.

Table 1: Clock Status enumeration

Value	Name	Description
0	SBG_ECOM_UTC_INVALID	The UTC time is not known, we are just propagating the UTC time internally.
1	SBG_ECOM_UTC_NO_LEAP_SEC	We have received valid UTC time information but we don't have the leap seconds information.
2	SBG_ECOM_UTC_VALID	We have received valid UTC time data with valid leap seconds.

Table 2: UTC time status enumeration

COM_STATUS definition

Provide information on ports, tells is they are valid or saturated

Bit	Name	Type	Description
0	SBG_ECOM_PORTA_VALID	Mask	Set to 0 in case of low level communication error.
1	SBG_ECOM_PORTB_VALID	Mask	Set to 0 in case of low level communication error.
2	SBG_ECOM_PORTC_VALID	Mask	Set to 0 in case of low level communication error.
3	SBG_ECOM_PORTD_VALID	Mask	Set to 0 in case of low level communication error.
4	SBG_ECOM_PORTE_VALID	Mask	Set to 0 in case of low level communication error.
5	SBG_ECOM_PORTA_RX_OK	Mask	Set to 0 in case of saturation on PORT A input
6	SBG_ECOM_PORTA_TX_OK	Mask	Set to 0 in case of saturation on PORT A output
7	SBG_ECOM_PORTB_RX_OK	Mask	Set to 0 in case of saturation on PORT B input
8	SBG_ECOM_PORTB_TX_OK	Mask	Set to 0 in case of saturation on PORT B output
9	SBG_ECOM_PORTC_RX_OK	Mask	Set to 0 in case of saturation on PORT C input
10	SBG_ECOM_PORTC_TX_OK	Mask	Set to 0 in case of saturation on PORT C output
11	SBG_ECOM_PORTD_RX_OK	Mask	Set to 0 in case of saturation on PORT D input
12	SBG_ECOM_PORTD_TX_OK	Mask	Set to 0 in case of saturation on PORT D output
13	SBG_ECOM_PORTE_RX_OK	Mask	Set to 0 in case of saturation on PORT E input
14	SBG_ECOM_PORTE_TX_OK	Mask	Set to 0 in case of saturation on PORT E output
15	SBG_ECOM_ETH0_RX_OK	Mask	Set to 0 in case of saturation on PORT ETHA input
16	SBG_ECOM_ETH0_TX_OK	Mask	Set to 0 in case of saturation on PORT ETHA output
17	SBG_ECOM_ETH1_RX_OK	Mask	Set to 0 in case of saturation on PORT ETHB input
18	SBG_ECOM_ETH1_TX_OK	Mask	Set to 0 in case of saturation on PORT ETHB output
19	SBG_ECOM_ETH2_RX_OK	Mask	Set to 0 in case of saturation on PORT ETHC input
20	SBG_ECOM_ETH2_TX_OK	Mask	Set to 0 in case of saturation on PORT ETHC output
21	SBG_ECOM_ETH3_RX_OK	Mask	Set to 0 in case of saturation on PORT ETHD input
20	SBG_ECOM_ETH3_TX_OK	Mask	Set to 0 in case of saturation on PORT ETHD output
23	SBG_ECOM_ETH4_RX_OK	Mask	Set to 0 in case of saturation on PORT ETHE input
24	SBG_ECOM_ETH4_TX_OK	Mask	Set to 0 in case of saturation on PORT ETHE output
25	SBG_ECOM_CAN_RX_OK	Mask	Set to 0 in case of saturation on CAN Bus output buffer
26	SBG_ECOM_CAN_TX_OK	Mask	Set to 0 in case of saturation on CAN Bus input buffer
27-29	SBG_ECOM_CAN_BUS	Enum	Define the CAN Bus status (see the 3 below).

You can find below the values that each clock enumeration can have:

Value	Name	Description
0	SBG_ECOM_CAN_BUS_OFF	Bus OFF operation due to too much errors.
1	SBG_ECOM_CAN_BUS_TX_RX_ERR	Transmit or received error.
2	SBG_ECOM_CAN_BUS_OK	The CAN bus is working correctly.
3	SBG_ECOM_CAN_BUS_ERROR	A general error has occurred on the CAN bus.

Table 3: CAN Bus status enumeration

AIDING_STATUS definition

Tells which aiding data is received.

Bit	Name	Type	Description
0	SBG_ECOM_AIDING_GPS1_POS_RECV	Mask	Set to 1 when valid GPS 1 position data is received
1	SBG_ECOM_AIDING_GPS1_VEL_RECV	Mask	Set to 1 when valid GPS 1 velocity data is received
2	SBG_ECOM_AIDING_GPS1_HDT_RECV	Mask	Set to 1 when valid GPS 1 true heading data is received
3	SBG_ECOM_AIDING_GPS1_UTC_RECV	Mask	Set to 1 when valid GPS 1 UTC time data is received
4	SBG_ECOM_AIDING_GPS2_POS_RECV	Mask	Set to 1 when valid GPS 2 position data is received
5	SBG_ECOM_AIDING_GPS2_VEL_RECV	Mask	Set to 1 when valid GPS 2 velocity data is received
6	SBG_ECOM_AIDING_GPS2_HDT_RECV	Mask	Set to 1 when valid GPS 2 true heading data is received
7	SBG_ECOM_AIDING_GPS2_UTC_RECV	Mask	Set to 1 when valid GPS 2 UTC time data is received
8	SBG_ECOM_AIDING_MAG_RECV	Mask	Set to 1 when valid Magnetometer data is received
9	SBG_ECOM_AIDING_ODO_RECV	Mask	Set to 1 when Odometer pulse is received
10	SBG_ECOM_AIDING_DVL_RECV	Mask	Set to 1 when valid DVL data is received
11	SBG_ECOM_AIDING_USBL_RECV	Mask	Set to 1 when valid USBL data is received
12	SBG_ECOM_AIDING_EM_LOG_RECV	Mask	Set to 1 when valid EM Log data is received
13	SBG_ECOM_AIDING_DEPTH_RECV	Mask	Set to 1 when valid Depth sensor data is received
14	SBG_ECOM_AIDING_USER_POS_RECV	Mask	Set to 1 when valid user position data is received.
15	SBG_ECOM_AIDING_USER_VEL_RECV	Mask	Set to 1 when valid user velocity data is received.
16	SBG_ECOM_AIDING_USER_HEADING_RECV	Mask	Set to 1 when valid user heading data is received.

SOLUTION_STATUS definition

Provide information on the internal Kalman filter status such as which aiding data is used to compute the solution and the provided solution mode.

Bit	Name	Description
[0-3]	SBG_ECOM_SOLUTION_MODE	Defines the Kalman filter computation mode (see the table 4 below)
4	SBG_ECOM_SOL_ATTITUDE_VALID	Set to 1 if Attitude data is reliable (Roll/Pitch error < 0,5°)
5	SBG_ECOM_SOL_HEADING_VALID	Set to 1 if Heading data is reliable (Heading error < 1°)
6	SBG_ECOM_SOL_VELOCITY_VALID	Set to 1 if Velocity data is reliable (velocity error < 1.5 m/s)
7	SBG_ECOM_SOL_POSITION_VALID	Set to 1 if Position data is reliable (Position error < 10m)
8	SBG_ECOM_SOL_VERT_REF_USED	Set to 1 if vertical reference is used in solution (data used and valid since 3s)
9	SBG_ECOM_SOL_MAG_REF_USED	Set to 1 if magnetometer is used in solution (data used and valid since 3s)
10	SBG_ECOM_SOL_GPS1_VEL_USED	Set to 1 if GPS velocity is used in solution (data used and valid since 3s)
11	SBG_ECOM_SOL_GPS1_POS_USED	Set to 1 if GPS Position is used in solution (data used and valid since 3s)
12	SBG_ECOM_SOL_GPS1_COURSE_USED	Set to 1 if GPS Course is used in solution (data used and valid since 3s)
13	SBG_ECOM_SOL_GPS1_HDT_USED	Set to 1 if GPS True Heading is used in solution (data used and valid since 3s)
14	SBG_ECOM_SOL_GPS2_VEL_USED	Set to 1 if GPS2 velocity is used in solution (data used and valid since 3s)
15	SBG_ECOM_SOL_GPS2_POS_USED	Set to 1 if GPS2 Position is used in solution (data used and valid since 3s)
16	SBG_ECOM_SOL_GPS2_COURSE_USED	Set to 1 if GPS2 Course is used in solution (data used and valid since 3s)
17	SBG_ECOM_SOL_GPS2_HDT_USED	Set to 1 if GPS2 True Heading is used in solution (data used and valid since 3s)
18	SBG_ECOM_SOL_ODO_USED	Set to 1 if Odometer is used in solution (data used and valid since 3s)
19	SBG_ECOM_SOL_DVL_BT_USED	Set to 1 if DVL Bottom Tracking is used in solution (data used and valid since 3s)
20	SBG_ECOM_SOL_DVL_WT_USED	Set to 1 if DVL Water Layer is used in solution (data used and valid since 3s)
21	SBG_ECOM_SOL_USER_POS_USED	Set to 1 if user position is used in solution (data used and valid since 3s)
22	SBG_ECOM_SOL_USER_VEL_USED	Set to 1 if user velocity is used in solution (data used and valid since 3s)
23	SBG_ECOM_SOL_USER_HEADING_USED	Set to 1 if user course is used in solution (data used and valid since 3s)
24	SBG_ECOM_SOL_USBL_USED	Set to 1 if USBL / LBL is used in solution (data used and valid since 3s).

You can find below the different available solution modes:

Value	Name	Description
0	SBG_ECOM_SOL_MODE_UNINITIALIZED	The Kalman filter is not initialized and the returned data are all invalid.
1	SBG_ECOM_SOL_MODE_VERTICAL_GYRO	The Kalman filter only rely on a vertical reference to compute roll and pitch angles. Heading and navigation data drift freely.
2	SBG_ECOM_SOL_MODE_AHRS	A heading reference is available, the Kalman filter provides full orientation but navigation data drift freely.
3	SBG_ECOM_SOL_MODE_NAV_VELOCITY	The Kalman filter computes orientation and velocity. Position is freely integrated from velocity estimation.
4	SBG_ECOM_SOL_MODE_NAV_POSITION	Nominal mode, the Kalman filter computes all parameters (attitude, velocity, position). Absolute position is provided.

Table 4: Solution modes enumeration

2.4.1.2. SBG_ECOM_LOG_IMU_DATA (03)

Provides accelerometers, gyros, delta angles and delta velocities data directly from the IMU.

Field	Description	Unit	Format	Size	Offset
TIME_STAMP	Time since sensor is powered up	µs	uint32	4	0
IMU_STATUS	IMU Status bitmask	-	uint16	2	4
ACCEL_X	Filtered Accelerometer – X axis	m/s²	float	4	6
ACCEL_Y	Filtered Accelerometer – Y axis	m/s²	float	4	10
ACCEL_Z	Filtered Accelerometer – Z axis	m/s²	float	4	14
GYRO_X	Filtered Gyroscope – X axis	rad/s	float	4	18
GYRO_Y	Filtered Gyroscope – Y axis	rad/s	float	4	22
GYRO_Z	Filtered Gyroscope – Z axis	rad/s	float	4	26
TEMP	Internal Temperature	°C	float	4	30
DELTA_VEL_X	Sculling output – X axis	m/s²	float	4	34
DELTA_VEL_Y	Sculling output – Y axis	m/s²	float	4	38
DELTA_VEL_Z	Sculling output – Z axis	m/s²	float	4	42
DELTA_ANGLE_X	Coning output – X axis	rad/s	float	4	46
DELTA_ANGLE_Y	Coning output – Y axis	rad/s	float	4	50
DELTA_ANGLE_Z	Coning output – Z axis	rad/s	float	4	54
				Total size	58

IMU_STATUS definition:

Status used to know if sensors are working correctly and are in their measurement range.

Bit	Name	Description
0 (LSB)	SBG_ECOM_IMU_COM_OK	Set to 1 if the communication with the IMU is ok.
1	SBG_ECOM_IMU_STATUS_BIT	Set to 1 if internal IMU passes Built In Test (Calibration, CPU)
2	SBG_ECOM_IMU_ACCEL_X_BIT	Set to 1 if accelerometer X passes Built In Test
3	SBG_ECOM_IMU_ACCEL_Y_BIT	Set to 1 if accelerometer Y passes Built In Test
4	SBG_ECOM_IMU_ACCEL_Z_BIT	Set to 1 if accelerometer Z passes Built In Test
5	SBG_ECOM_IMU_GYRO_X_BIT	Set to 1 if gyroscope X passes Built In Test
6	SBG_ECOM_IMU_GYRO_Y_BIT	Set to 1 if gyroscope Y passes Built In Test
7	SBG_ECOM_IMU_GYRO_Z_BIT	Set to 1 if gyroscope Z passes Built In Test
8	SBG_ECOM_IMU_ACCELS_IN_RANGE	Set to 1 if accelerometers are within operating range
9	SBG_ECOM_IMU_GYROS_IN_RANGE	Set to 1 if gyroscopes are within operating range

2.4.1.3. SBG_ECOM_LOG_EKF_EULER (06)

Provides computed orientation in Euler angles format.

Field	Description	Unit	Format	Size	Offset
TIME_STAMP	Time since sensor is powered up	µs	uint32	4	0
ROLL	Roll angle	rad	float	4	4
PITCH	Pitch angle	rad	float	4	8
YAW	Yaw angle (heading)	rad	float	4	12
ROLL_ACC	1σ Roll angle accuracy	rad	float	4	16
PITCH_ACC	1σ Pitch angle accuracy	rad	float	4	20
YAW_ACC	1σ Yaw angle accuracy	rad	float	4	24
				Total size	28

2.4.1.4. SBG_ECOM_LOG_EKF_QUAT (07)

Provides orientation in quaternion format.

Field	Description	Unit	Format	Size	Offset
TIME_STAMP	Time since sensor is powered up	µs	uint32	4	0
Q0	First quaternion parameter (W)	-	float	4	4
Q1	Second quaternion parameter (X)	-	float	4	8
Q2	Third quaternion parameter (Y)	-	float	4	12
Q3	Forth quaternion parameter (Z)	-	float	4	16
ROLL_ACC	1σ Roll angle accuracy	rad	float	4	20
PITCH_ACC	1σ Pitch angle accuracy	rad	float	4	24
YAW_ACC	1σ Yaw angle accuracy	rad	float	4	28
				Total size	32

2.4.1.5. SBG_ECOM_LOG_EKF_NAV (08)

Provides velocity in NED coordinate system and position (Latitude, Longitude, Altitude), and associated accuracy parameters.

Field	Description	Unit	Format	Size	Offset
TIME_STAMP	Time since sensor is powered up	µs	uint32	4	0
VELOCITY_N	Velocity in North direction	m/s	float	4	4
VELOCITY_E	Velocity in East direction	m/s	float	4	8
VELOCITY_D	Velocity in Down direction	m/s	float	4	12
VELOCITY_N_ACC	1σ Velocity in North direction accuracy	m/s	float	4	16
VELOCITY_E_ACC	1σ Velocity in East direction accuracy	m/s	float	4	20
VELOCITY_D_ACC	1σ Velocity Down direction accuracy	m/s	float	4	24
LATITUDE	Latitude	°	double	8	28
LONGITUDE	Longitude	°	double	8	36
ALTITUDE	Altitude above Mean Sea Level	m	double	8	44
UNDULATION	Altitude difference between the geoid and the Ellipsoid.	m	float	4	52
LATITUDE_ACC	1σ Latitude accuracy	m	float	4	56
LONGITUDE_ACC	1σ Longitude accuracy	m	float	4	60
ALTITUDE_ACC	1σ Vertical Position accuracy	m	float	4	64
				Total size	68

2.4.1.6. SBG_ECOM_LOG_SHIP_MOTION_0/1/2/3 (09, 10, 11, 12), SBG_ECOM_SHIP_MOTION_HP_0/1/2/3 (32, 33, 34, 35)

Provides ship motion data such as surge, sway, heave, velocity and accelerations.

This output may come from a real time computation mode, or from a delayed shipMotionHP computation. In this case, the time stamp will be the actual data time of validity instead of current time.

Ship motions are computed at up to four monitoring points. Each monitoring point has it's own log.

Field	Description	Unit	Format	Size	Offset
TIME_STAMP	Time since sensor is powered up	µs	uint32	4	0
HEAVE_PERIOD	Main heave period in seconds.	s	float	4	4
SURGE	Surge at main location (positive forward)	m	float	4	8
SWAY	Sway at main location (positive right)	m	float	4	12
HEAVE	Heave at main location (positive down)	m	float	4	16
ACCEL_X	Longitudinal acceleration (positive forward)	$m.s^{-2}$	float	4	20
ACCEL_Y	Lateral acceleration (positive right)	$m.s^{-2}$	float	4	24
ACCEL_Z	Vertical acceleration (positive down)	$m.s^{-2}$	float	4	28
VEL_X	Longitudinal velocity (positive forward)	$m.s^{-1}$	float	4	32
VEL_Y	Lateral velocity (positive right)	$m.s^{-1}$	float	4	36
VEL_Z	Vertical velocity (positive down)	$m.s^{-1}$	float	4	40
STATUS	Ship motion output status	-	uint16	2	44
				Total size	46

STATUS definition

This field must be checked in order to know which fields are active in the output and to know if data is valid or not.

Bit	Name	Description
0	SBG_ECOM_HEAVE_VALID	Set to 1 after heave convergence time. Set to 0 in following conditions: • Turn occurred and no velocity aiding is available • Heave reached higher/lower limits • If a step is detected and filter has to re-converge • If internal failure
1	SBG_ECOM_HEAVE_VEL_AIDED	Set to 1 if heave output is compensated for transient accelerations
2	SBG_ECOM_HEAVE_SURGE_SWAY_INCLUDED	Set to 1 if surge and sway channels are provided in this output.
3	SBG_ECOM_HEAVE_PERIOD_INCLUDED	Set to 1 if the heave period is provided in this output
4	SBG_ECOM_HEAVE_PERIOD_VALID	Set to 1 if the returned heave period is assumed to be valid.

2.4.1.7. SBG_ECOM_LOG_UTC_TIME (02)

Provides UTC time reference. This frame also provides a time correspondence between Ekinox TIME_STAMP value and actual UTC Time.

Field	Description	Unit	Format	Size	Offset
TIME_STAMP	Time since sensor is powered up	µs	uint32	4	0
RESERVED	Reserved for future use	-	uint16	2	4
YEAR	Year	year	uint16	2	6
MONTH	Month in Year [1 ... 12]	month	uint8	1	8
DAY	Day in Month [1 ... 31]	d	uint8	1	9
HOUR	Hour in day [0 ... 23]	h	uint8	1	10
MIN	Minute in hour [0 ... 59]	min	uint8	1	11
SEC	Second in minute [0 ... 60] Note 60 is when a leap second is added.	s	uint8	1	12
NANOSEC	Nanosecond of second.	ns	uint32	4	13
GPS_TOW	GPS Time of week	ms	uint32	4	17
				Total size	21

2.4.1.8. SBG_ECOM_LOG_MAG (04)

Provides magnetometer data and associated accelerometer. In case of internal magnetometer used, the internal accelerometer is also provided.

Field	Description	Unit	Format	Size	Offset
TIME_STAMP	Time since sensor is powered up	µs	uint32	4	0
MAG_STATUS	Magnetometer status bitmask	-	uint16	2	4
MAG_X	Magnetometer output – X axis	a.u	float	4	6
MAG_Y	Magnetometer output – Y axis	a.u	float	4	10
MAG_Y	Magnetometer output – Z axis	a.u	float	4	14
ACCEL_X	Accelerometer output – X axis	m/s^2	float	4	18
ACCEL_Y	Accelerometer output – Y axis	m/s^2	float	4	22
ACCEL_Z	Accelerometer output – Z axis	m/s^2	float	4	26
				Total size	30

MAG_STATUS definition

Bit	Name	Description
0(LSB)	SBG_ECOM_MAG_MAG_X_BIT	Set to 1 if the magnetometer X has passed the self test.
1	SBG_ECOM_MAG_MAG_Y_BIT	Set to 1 if the magnetometer Y has passed the self test.
2	SBG_ECOM_MAG_MAG_Z_BIT	Set to 1 if the magnetometer Z has passed the self test.
3	SBG_ECOM_MAG_ACCEL_X_BIT	Set to 1 if the accelerometer X has passed the self test.
4	SBG_ECOM_MAG_ACCEL_Y_BIT	Set to 1 if the accelerometer Y has passed the self test.
5	SBG_ECOM_MAG_ACCEL_Z_BIT	Set to 1 if the accelerometer Z has passed the self test.
6	SBG_ECOM_MAG_MAGS_IN_RANGE	Set to 1 if magnetometer is not saturated
7	SBG_ECOM_MAG_ACCELS_IN_RANGE	Set to 1 if accelerometer is not saturated
8	SBG_ECOM_MAG_CALIBRATION_OK	Set to 1 if magnetometer seems to be calibrated

2.4.1.9. SBG_ECOM_LOG_MAG_CALIB (05)

This log provides a RAW buffer for magnetic calibration procedure.

Field	Description	Unit	Format	Size	Offset
BUFFER	Raw magnetic calibration buffer	-	12 bytes	12	0
				Total size	12

2.4.1.10. SBG_ECOM_LOG_GPS1_VEL (13), SBG_ECOM_LOG_GPS2_VEL (16)

Provides raw GNSS velocity from primary or secondary GNSS receiver.

The time stamp is not aligned on main loop but instead of that, it dates the actual GNSS velocity data.

Field	Description	Unit	Format	Size	Offset
TIME_STAMP	Time since sensor is powered up	µs	uint32	4	0
GPS_VEL_STATUS	GPS velocity fix and status bitmask	-	uint32	4	4
GPS_TOW	GPS Time of Week	ms	uint32	4	8
VEL_N	Velocity in North direction	m/s	float	4	12
VEL_E	Velocity in East direction	m/s	float	4	16
VEL_D	Velocity in Down direction	m/s	float	4	20
VEL_ACC_N	1σ Accuracy in North direction	m/s	float	4	24
VEL_ACC_E	1σ Accuracy in East direction	m/s	float	4	28
VEL_ACC_D	1σ Accuracy in Down direction	m/s	float	4	32
COURSE	True direction of motion over ground (0 to 360°)	°	float	4	36
COURSE_ACC	1σ course accuracy (0 to 360°).	°	float	4	40
				Total size	44

GPS_VEL_STATUS definition

Bit	Type	Name	Description
[0-5]	Enum	SBG_ECOM_GPS_VEL_STATUS	The raw GPS velocity status (see the 5 below).
[6-11]	Enum	SBG_ECOM_GPS_VEL_TYPE	The raw GPS velocity type (see the 6 below).

You can find below the GPS velocity status and type enumerations:

Value	Name	Description
0	SBG_ECOM_VEL_SOL_COMPUTED	A valid solution has been computed.
1	SBG_ECOM_VEL_INSUFFISENT_OBS	Not enough valid SV to compute a solution.
2	SBG_ECOM_VEL_INTERNAL_ERROR	An internal error has occurred.
3	SBG_ECOM_VEL_LIMIT	Velocity limit exceeded.

Table 5: Raw GPS velocity status enumeration

Value	Name	Description
0	SBG_ECOM_VEL_NO_SOLUTION	No valid velocity solution available.
1	SBG_ECOM_VEL_UNKNOWN_TYPE	An unknown solution type has been computed.
2	SBG_ECOM_VEL_DOPPLER	A Doppler velocity has been computed.
3	SBG_ECOM_VEL_DIFFERENTIAL	A velocity has been computed between two positions.

Table 6: Raw GPS velocity type enumeration

Note: Both the GPS velocity status and type should be tested to make sure that the outputted velocity is valid.

2.4.1.11. SBG_ECOM_LOG_GPS1_POS (14), SBG_ECOM_LOG_GPS2_POS (17)

Provides GNSS position from primary or secondary GNSS receiver.

The time stamp is not aligned on main loop but instead of that, it dates the actual GPS position data.

Field	Description	Unit	Format	Size	Offset
TIME_STAMP	Time since sensor is powered up	µs	uint32	4	0
GPS_POS_STATUS	GPS position fix and status bitmask	-	uint32	4	4
GPS_TOW	GPS Time of Week	ms	uint32	4	8
LAT	Latitude, positive Noth	°	double	8	12
LONG	Latitude, positive Noth	°	double	8	20
ALT	Altitude Above Mean Sea Level	m	double	8	28
UNDULATION	Altitude difference between the geoid and the Ellipsoid	m	float	4	36
POS_ACC_LAT	1σ Latitude Accuracy	m	float	4	40
POS_ACC_LONG	1σ Longitude Accuracy	m	float	4	44
POS_ACC_ALT	1σ Altitude Accuracy	m	float	4	48
				Total size	52

GPS_POS_STATUS definition

Bit	Type	Name	Description
[0-5]	Enum	SBG_ECOM_GPS_POS_STATUS	The raw GPS position status (see the 7 below).
[6-11]	Enum	SBG_ECOM_GPS_POS_TYPE	The raw GPS position type (see the 8 below).
12	Mask	SBG_ECOM_GPS_POS_GPS_L1_USED	Set to 1 if GPS L1 is used in the solution
13	Mask	SBG_ECOM_GPS_POS_GPS_L2_USED	Set to 1 if GPS L2 is used in the solution
14	Mask	SBG_ECOM_GPS_POS_GPS_L5_USED	Set to 1 if GPS L5 is used in the solution
15	Mask	SBG_ECOM_GPS_POS_GLO_L1_USED	Set to 1 if GLONASS L1 is used in the solution
16	Mask	SBG_ECOM_GPS_POS_GLO_L2_USED	Set to 1 if GLONASS L2 is used in the solution

You can find below the GPS position status and type enumerations:

Value	Name	Description
0	SBG_ECOM_POS_SOL_COMPUTED	A valid solution has been computed.
1	SBG_ECOM_POS_INSUFFISENT_OBS	Not enough valid SV to compute a solution.
2	SBG_ECOM_POS_INTERNAL_ERROR	An internal error has occurred.
3	SBG_ECOM_POS_HEIGHT_LIMIT	The height limit has been exceeded.

Table 7: Raw GPS position status enumeration

Value	Name	Description
0	SBG_ECOM_POS_NO_SOLUTION	No valid solution available.
1	SBG_ECOM_POS_UNKNOWN_TYPE	An unknown solution type has been computed.
2	SBG_ECOM_POS_SINGLE	Single point solution position.
3	SBG_ECOM_POS_PSRDIFF	Standard Pseudorange Differential Solution (DGPS).
4	SBG_ECOM_POS_SBAS	SBAS satellite used for differential corrections.
5	SBG_ECOM_POS_OMNISTAR	Omnistar VBS Position (L1 sub-meter).
6	SBG_ECOM_POS_RTK_FLOAT	Floating RTK ambiguity solution (20 cms RTK).
7	SBG_ECOM_POS_RTK_INT	Integer RTK ambiguity solution (2 cms RTK).
8	SBG_ECOM_POS_PPP_FLOAT	Precise Point Positioning with float ambiguities
9	SBG_ECOM_POS_PPP_INT	Precise Point Positioning with fixed ambiguities
10	SBG_ECOM_POS_FIXED	Fixed location solution position

Table 8: Raw GPS position type enumeration

Note 1: Both the GPS position status and type should be tested to make sure that the outputted position is valid.

Note 2: OmniStar, Terrastar, Veripos or other worldwide DGPS service provider are considered as Precise Point Positioning solutions.

2.4.1.12. SBG_ECOM_LOG_GPS1_HDT (15), SBG_ECOM_LOG_GPS2_HDT (18)

Provides raw GPS true heading data from a dual antenna GPS system.

The time stamp is not aligned on main loop but instead of that, it dates the actual GPS true heading data.

Field	Description	Unit	Format	Size	Offset
TIME_STAMP	Time since sensor is powered up	µs	uint32	4	0
GPS_HDT_STATUS	GPS True Heading status.	-	uint16	2	4
GPS_TOW	GPS Time of Week	ms	uint32	4	6
GPS_TRUE_HEADING	True heading angle (0 to 360°).	°	float	4	10
GPS_TRUE_HEADING_ACC	1σ True heading estimated accuracy (0 to 360°).	°	float	4	14
GPS_PITCH	Pitch angle from the master to the rover	°	float	4	18
GPS_PITCH_ACC	1σ pitch estimated accuracy	°	float	4	22
				Total size	26

GPS_HDT_STATUS definition

Bit	Type	Name	Description
[0-5]	Enum	SBG_ECOM_GPS_HDT_STATUS	The raw GPS true heading status (see the 9 below).

You can find below the GPS true heading status enumeration:

Value	Name	Description
0	SBG_ECOM_HDT_SOL_COMPUTED	A valid solution has been computed.
1	SBG_ECOM_HDT_INSUFFISENT_OBS	Not enough valid SV to compute a solution.
2	SBG_ECOM_HDT_INTERNAL_ERROR	An internal error has occurred.
3	SBG_ECOM_HDT_HEIGHT_LIMIT	The height limit has been exceeded.

Table 9: Raw GPS true heading status enumeration

2.4.1.13. SBG_ECOM_LOG_GPS1_RAW (31)

This special log is used to store raw GPS data for post processing purposes. This log can only be used for the internal GPS receiver of an Ekinox-N or an Ekinox-D. In addition, the Ekinox should have the RTK / RAW GPS option to be able to store RAW measurements.

> **Note:** The only good way to use this log is to trigger it on a new data only.

2.4.1.14. SBG_ECOM_LOG_ODO_VEL (19)

Provides raw Odometer velocity.

Time since reset is not aligned on main loop but instead of that, it dates the actual odometer velocity data.

Field	Description	Unit	Format	Size	Offset
TIME_STAMP	Time since sensor is powered up	µs	uint32	4	0
ODO_STATUS	Odometer velocity status bit-mask	-	uint16	2	4
ODO_VEL	Velocity in odometer direction	m/s	float	4	6
				Total size	10

ODO_VEL_STATUS definition

Bit	Name	Description
0 (LSB)	SBG_ECOM_ODO_REAL_MEAS	Set to 1 if this log comes from a real pulse measurement or from a timeout.

2.4.1.15. SBG_ECOM_LOG_EVENT_A/B/C/D/E (24, 25, 26, 27, 28)

The Ekinox can detect events markers at up to 1 kHz on Sync A, Sync B, Sync C, Sync D and Sync E input signals. For each input synchronization signal, the Ekinox can output a binary log that returns the time of each received event during the last past 5 milliseconds (the maximum output rate is 200 Hz).

The TIME_STAMP field dates the first event that has been received during the last 5 ms. Other events received during the same time slot (5ms) are dated using a time offset to reduce the log size.

Example

If three events are received during the last 5 ms, each event will be dated using the following rules:

- First received event time is directly stored in TIME_STAMP
- Second received event time is TIME_STAMP + TIME_OFFSET_0
- Thrid received event time is TIME_STAMP + TIME_OFFSET_1

The other time offset fields will be set to 0 and the EVENT_STATUS flag will reflect which time offset fields are valid.

Field	Description	Unit	Format	Size	Offset
TIME_STAMP	Measurement time since the sensor power up.	µs	uint32	4	0
EVENT_STATUS	Status bit mask	-	uint16	2	4
TIME_OFFSET_0	Time offset for the second received event.	µs	uint16	2	6
TIME_OFFSET_1	Time offset for the third received event.	µs	uint16	2	8
TIME_OFFSET_2	Time offset for the fourth received event.	µs	uint16	2	10
TIME_OFFSET_3	Time offset for the fifth received event.	µs	uint16	2	12
				Total size	14

EVENT_STATUS definition

Bit	Name	Description
0 (LSB)	SBG_ECOM_EVENT_OVERFLOW	Set to 1 if we have received events at a higher rate than 1 kHz.
1	SBG_ECOM_EVENT_OFFSET_0_VALID	Set to 1 if at least two events have been received.
2	SBG_ECOM_EVENT_OFFSET_1_VALID	Set to 1 if at least three events have been received.
3	SBG_ECOM_EVENT_OFFSET_2_VALID	Set to 1 if at least four events have been received.
4	SBG_ECOM_EVENT_OFFSET_3_VALID	Set to 1 if five events have been received.

Note: The Ekinox series supports events markers at up to 1 kHz. If too much events are sent, it may overload the internal CPU leading to decreased performance and reliability.

Warning: Never leave an activated Sync In signal unconnected as noise on the line may trigger spurious events at very high rates.

2.4.1.16. SBG_LOG_DVL_BOTTOM_TRACK (29)

Doppler Velocity Log for bottom tracking data.

Time since reset is not aligned on main loop but instead of that, it dates the actual DVL velocity data.

Field	Description	Unit	Format	Size	Offset
TIME_STAMP	Time since sensor is powered up	µs	uint32	4	0
DVL_STATUS	DVL velocity status bit-mask	-	uint16	2	4
VELOCITY_X	Velocity X expressed in the DVL instrument frame	m/s	float	4	6
VELOCITY_Y	Velocity Y expressed in the DVL instrument frame	m/s	float	4	10
VELOCITY_Z	Velocity Z expressed in the DVL instrument frame	m/s	float	4	14
VELOCITY_STD_X	1σ X velocity expressed in the DVL instrument frame	m/s	float	4	18
VELOCITY_STD_Y	1σ Y velocity expressed in the DVL instrument frame	m/s	float	4	22
VELOCITY_STD_Z	1σ Z velocity expressed in the DVL instrument frame	m/s	float	4	26
				Total size	30

DVL_STATUS definition

Bit	Name	Description
0 (LSB)	SBG_ECOM_DVL_VELOCITY_VALID	Set to 1 if the DVL equipment was able to measure a valid velocity.
1	SBG_ECOM_DVL_TIME_SYNC	Set to 1 if the data is accurately time stamped using a Sync In or Sync Out.

2.4.1.17. SBG_LOG_DVL_WATER_TRACK (30)

Doppler Velocity Log for water track data.

Time since reset is not aligned on main loop but instead of that, it dates the actual DVL velocity data.

Field	Description	Unit	Format	Size	Offset
TIME_STAMP	Time since sensor is powered up	µs	uint32	4	0
DVL_STATUS	DVL velocity status bit-mask	-	uint16	2	4
VELOCITY_X	Velocity X expressed in the DVL instrument frame	m/s	float	4	6
VELOCITY_Y	Velocity Y expressed in the DVL instrument frame	m/s	float	4	10
VELOCITY_Z	Velocity Z expressed in the DVL instrument frame	m/s	float	4	14
VELOCITY_STD_X	1σ X velocity expressed in the DVL instrument frame	m/s	float	4	18
VELOCITY_STD_Y	1σ Y velocity expressed in the DVL instrument frame	m/s	float	4	22
VELOCITY_STD_Z	1σ Z velocity expressed in the DVL instrument frame	m/s	float	4	26
				Total size	30

DVL_STATUS definition

Bit	Name	Description
0 (LSB)	SBG_ECOM_DVL_VELOCITY_VALID	Set to 1 if the DVL equipment was able to measure a valid velocity.
1	SBG_ECOM_DVL_TIME_SYNC	Set to 1 if the data is accurately time stamped using a Sync In or Sync Out.

2.4.2. NMEA Logs

The Ekinox can output standard NMEA 0183 version 4.1 logs for GPS drop in replacement and to ease integration with third party systems.

NMEA logs contain Kalman filtered navigation, velocity and attitude data. External NMEA aiding data are not used to generate these logs.

2.4.2.1. GGA message

The GGA log provides detailed Kalman filtered position, altitude and accuracy data.

Message format

```
$##GGA,hhmmss.ss,ddmm.mmmmm,N,ddd.mm.mmmmm,E,i,ii,ff.f,ffff.fff,M,fff.fff,M,,*cs<CR><LF>
```

Field	Name	Format	Description
0	$##GGA	string	Message ID – GGA frame
1	Time	hhmmss.ss	UTC Time, current time
2	Latitude	ddmm.mmmmm	Latitude: degree + minutes
3	N/S	char	North / South indicator
4	Longitude	dddmm.mmmmm	Longitude: degree + minutes
5	E/W	char	East / West indicator
6	Quality	i	Fix status (see definition below)
7	SV used	ii	Number of satellites used in solution
8	Horizontal DOP	ff.f	Horizontal dilution of precision, 1 (ideal) to > 20 (poor)
9	Altitude MSL	ffff.fff	Altitude above Mean Sea Level in meters
10	M	M	Altitude unit (Meters) fixed field.
11	Undulation	fff.fff	Geoidal separation between WGS-84 and MSL in meters).
12	M	M	Units for geoidal separation (Meters) fixed field.
13	Diff. Age	-	Age of differential corrections. Not filled by the device, always empty.
14	Diff. station ID	-	Differential station id. Not filled by the device, always empty.
15	Check sum	*cs	Xor of all previous bytes except $
16	End of frame	<CR><LF>	Carriage return and line feed

Quality indicators definition

The quality indicator is only computed using the estimated horizontal accuracy. You can find in the table below the position accuracy threshold for each quality value.

Value	Name	Description	Accuracy Threshold
0	NMEA_GGA_FIX_INVALID	Invalid solution.	>= 100 meters
1	NMEA_GGA_FIX_SINGLE	Standalone GPS fix.	>= 1 meter
2	NMEA_GGA_FIX_DGPS	Differential GPS fix.	>= 0.6 meters
3	NMEA_GGA_FIX_PPS	Precise Positioning System military fix.	N/A
4	NMEA_GGA_FIX_RTK	Real Time Kinematic integer with 2 cm accuracy.	< 0.2 meters
5	NMEA_GGA_FIX_FLOAT_RTK	Floating RTK.	>= 0.2 meters
6	NMEA_GGA_FIX_DEAD_RECKONING	Dead reckoning fix.	>= 10 meters
7	NMEA_GGA_FIX_MANUAL_INPUT	Manual input mode.	N/A
8	NMEA_GGA_FIX_SIMULATION	Simulation mode.	N/A

Horizontal Accuracy		100m		10m		1m		0.6m		0,2m	
GGA quality indicator	0		6		1		2		5		4

Message example

```
$GPGGA,000010.00,4852.10719,N,00209.42313,E,0,00,0.0,-44.7,M,0.0,M,,,*63<CR><LF>
```

2.4.2.2. RMC message

This is the "minimum recommended GNSS data" frame that contains Kalman enhanced 2D position, velocity and course over ground as well as quality indicators.

Message format

```
$##RMC,hhmmss.ss,A,ddmm.mmmmm,N,dddmm.mmmmm,E,fff.f,fff.f,ddmmyy,fff.ff,E,R,S*cs<CR><LF>
```

Field	Name	Format	Description
0	$##RMC	string	Message ID – RMC frame
1	time	hhmmss.ss	UTC Time, current time
2	status	char	Status field: A = Valid data. V = Invalid data.
3	latitude	ddmm.mmmmm	Latitude: degree + minutes
4	N/S	char	North / South indicator
5	longitude	dddmm.mmmmm	Longitude: degree + minutes
6	E/W	char	East / West indicator
7	speed	fff.f	Speed over ground in Knots
8	course	fff.f	Course over Ground in degrees [0; 360]
9	date	ddmmyy	UTC day, month, year
10	variation	fff.ff	Magnetic variation value in degrees [0; 180]
11	E/W	char	Direction of magnetic variation (East / West)
12	mode	char	Position mode indicator (see table below).

13	navStatus	char	Navigational status indicator (see table below).
14	Check sum	*cs	Xor of all previous bytes except $
15	End of frame	<CR><LF>	Carriage return and line feed

Position mode definition

The position mode is only computed using the estimated horizontal accuracy. You can find in the table below the position accuracy threshold for each quality value.

Value	Description	Accuracy Threshold
N	Invalid solution.	>= 100 meters
A	Standalone GPS fix.	>= 1 meter
D	Differential GPS fix.	>= 0.6 meters
P	Precise Positioning System military fix.	N/A
R	Real Time Kinematic integer with 2 cm accuracy.	< 0.2 meters
F	Floating RTK.	>= 0.2 meters
E	Dead reckoning fix.	>= 10 meters
S	Simulation mode.	N/A

Navigational status

This status is just used to know if the returned data are reliable enough to be used for navigation. This status is based on the Kalman filter internal quality status.

Value	Description
S	Safe
C	Caution
U	Unsafe
V	Not valid for navigation

Message example

```
$GPRMC,010802.26,A,4852.13326,N,00209.49001,E,0.2,195.49,290512,,,A*67<CR><LF>
```

2.4.2.3. ZDA message

This message contains UTC time and date information.

Message format

```
$##ZDA,hhmmss.ss,day,month,year,ltzh,ltzn*cs<CR><LF>
```

Field	Name	Format	Description
0	$##ZDA	string	Message ID – ZDA frame
1	Time	hhmmss.ss	UTC Time, current time
2	Day	dd	Day of month [01 - 31]
3	Month	mm	Month of year [01 - 12]
4	Year	yyyy	Year (4 digits)
5	Ltzh	0	Local zone hours (not supported, fixed 00)
11	Ltzh	0	Local zone minutes (not supported, fixed 00)
13	Check sum	*cs	Xor of all previous bytes except $
14	End of frame	<CR><LF>	Carriage return and line feed

Message example

```
$GPZDA,201530.00,04,07,2002,00,00*60<CR><LF>
```

2.4.2.4. HDT Message

The message output the Ekinox Kalman filtered true heading value. The true heading is the direction that the vehicle is pointing and is not necessarily the direction of travel (course over ground).

Message format

```
$##HDT,fff.ff,T*cs<CR><LF>
```

Field	Name	Format	Description
0	$##HDT	string	Message ID – HDT frame
1	Heading	fff.ff	True heading in degrees [0 - 360]
2	T	char	T means true heading
3	Check sum	*cs	Xor of all previous bytes except $
4	End of frame	<CR><LF>	Carriage return and line feed

Message example

```
$GPHDT,fff.ff,T*cs<CR><LF>
```

2.4.2.5. GST Message

The message output detailed position error statistics of the Kalman filtered position solution. Please keep in mind that the returned data reflects the estimated inertial position and not the GNSS quality fix directly.

Message format

```
$##GST,hhmmss.ss,,fff.fff,fff.fff,fff.ff,fff.fff,fff.fff,fff.fff*cs<CR><LF>
```

Field	Name	Format	Description
0	$##GST	string	Message ID – GST frame
1	Time	hhmmss.ss	UTC time of position fix
2	psrResidual	NULL	RMS value of pseudorange residuals. Always NULL, not supported.
3	sMajorAxisError	fff.fff	Error ellipse semi-major axis 1 sigma error, in meters
4	sMinorAxisError	fff.fff	Error ellipse semi-minor axis 1 sigma error, in meters
5	errorEllipseAng	fff.ff	Error ellipse orientation, degrees from true north [0 - 360]
6	latError	fff.fff	Latitude 1 sigma error, in meters
7	longError	fff.fff	Longitude 1 sigma error, in meters
8	altError	fff.fff	Height 1 sigma error, in meters
9	Check sum	*cs	Xor of all previous bytes except $
10	End of frame	<CR><LF>	Carriage return and line feed

Message example

```
$GPGST,172814.00,,0.023,0.020,273.62,0.023,0.015,0.031*46<CR><LF>
```

2.4.2.6. VBW Message

The message outputs Ground and Water speed from the Ekinox data fusion algorithm. The data are expressed in the Ekinox (body) frame.

This log can be filled correctly only if the Ekinox receives valid bottom tracking and water tracking DVL data. Bottom and water velocities are used by the Ekinox Kalman filter to estimate the water current and thus compute the water speed in the vessel coordinate frame.

Message format

```
$##VBW,fff.fff,fff.fff,A,fff.fff,fff.fff,A*cs<CR><LF>
```

Field	Name	Format	Description
0	$##VBW	string	Message ID – VBW frame
1	longWaterSpeed	fff.fff	Longitudinal water speed, knots (positive forward)
2	transvWaterSpeed	fff.fff	Transverse water speed, knots (positive right)
3	waterSpeedValid	char	Status: Water speed, A = Data valid, V = Invalid
4	longGroundSpeed	fff.fff	Longitudinal ground speed, knots (positive forward)
5	transvGroundSpeed	fff.fff	Transverse ground speed, knots (positive right)
6	groundSpeedValid	char	Status: Ground speed, A = Data valid, V = Invalid
7	Check sum	*cs	Xor of all previous bytes except $
10	End of frame	<CR><LF>	Carriage return and line feed

Message example

```
$GPVBW,0.312,0.910,A,0.410,0.950,A*55<CR><LF>
```

2.4.3. Third Party Logs

2.4.3.1. TSS1

Proprietary log used for marine survey applications that provides heave, roll, pitch, as well as sway and heave accelerations.

This log is affected by the heave measurement point configured for each output interface. You can thus output a TSS1 frame for the main heave measurement point on the Port A and an other TSS1 frame on the Port B that measures the heave at the second monitoring point.

> **Warning:** The TSS1 frame uses different conventions for surge, sway and heave measurements. In this frame, sway is when expressed positive left and heave is positive up.

Frame format

```
:XXAAAASMHHHHQMRRRRSMPPPP<CR><LF>
```

Field	Description
:	Start character
XX	Sway acceleration (hex value), in 3.835 cm/s^2, with a range from zero to 9.81 m/s^2
AAAA	Vertical acceleration (hex value - 2's complement), in 0.0625 cm/s^2, with a range of −20.48 to +20.48 m/s^2
S	Space character
M	Space if positive; minus if negative
HHHH	Heave measurement (ASCII value), in centimeters, with a range of −99.99 to +99.99 meters
Q	Status flag character (see table below)
M	Space if positive; minus if negative
RRRR	Roll, in units of 0.01 degrees (ex: 1000 = 10°), with a range of −99.99° to +99.99°
S	Space character
M	Space if positive; minus if negative
PPPP	Pitch, in units of 0.01 degrees (ex: 1000 = 10°), with a range of −99.99° to +99.99°
<CR><LF>	Carriage return, Line feed

TSS1 status flags

This flag is used to output status on algorithms used to compute the heave data. The Ekinox can use heading and velocity aiding data to improve the heave quality dramatically during ship maneuvers.

Value	Description
U	Unaided mode and stable measurements.
u	Unaided mode but unstable heave data.
G	Velocity aided mode and stable measurements.
g	Velocity aided mode but unstable data.
H	Heading aided mode and stable measurements.
H	Heading aided mode but unstable data.
F	Both velocity and heading aided mode and stable measurements.
f	Both velocity and heading aided mode but unstable measurements.

Frame example

```
:1A4770 -0016H 0429 -0680<CR><LF>
```

You can find below the explanation of each field:

- XX = 1A, Sway acceleration, which is 0.9971 m.s^-²
  (0x1A (hex) = 26 (decimal), multiplied by 0.03835 m.s^-² yields to 0.9971 m.s^-²)
- AAAA = 4770, Heave acceleration, which is 11.43 m.s^-²
  (0x4770 (hex) = 18288 (decimal), multiplied by 0.000625 m.s^-² yields to 11.43 m.s^-²)
- S = (space)
- M = (minus), meaning following heave value is negative
- HHHH = 0016, Heave value, which is 16 cm (-16 cm based on the M value)
- Q = H, status flag, which is stable heading aided mode
- M = (space), meaning following roll value is positive
- RRRR = 0429, roll, which is 4.29°
- S = (space)
- M = (minus), meaning following pitch value is negative
- PPPP = 0680, pitch, which is 6.80°

2.4.3.2. PD0

The PD0 binary frame is a Teledyne RDI proprietary log that output DVL data such as bottom tracking, water tracking and water profiling data. The Ekinox can output this log only if valid PD0 frames are sent by a DVL to the Ekinox. The PD0 frame is not altered or completed by the Ekinox and is just forwarded as it is.

This frame is very useful to store into the internal datalogger or output in real time water profiling data that can be parsed with a third party software. Please refer to the Teledyne RDI documentations for a detailed PD0 frame definition.

2.4.3.3. PRDID

This Teledyne RDI proprietary message outputs the vessel pitch, roll and true heading angles in degrees. It uses an NMEA style formatting.

Message format

```
$PRDID,+fff.ff,-fff.ff,fff.ff*cs<CR><LF>
```

Field	Name	Format	Description
0	$PRDID	string	Message ID – RDI proprietary heading, pitch and roll
1	Pitch	fff.ff	Signed vessel pitch in degrees, positive bow up.
2	Roll	fff.ff	Signed vessel roll in degrees, positive port up.
3	Heading	fff.ff	Vessel true heading in degrees [0 - 360]
4	Check sum	*cs	Xor of all previous bytes except $
5	End of frame	<CR><LF>	Carriage return and line feed

Message example

```
$PRDID,-012.39,+002.14,366.91*7A<CR><LF>
```

2.4.3.4. Simrad EM1000 & Simrad EM3000

Proprietary binary log from Kongsberg used to input attitude and heave data to an echo sounder. The Simrad attitude log provides roll, pitch, heading as well as heave measurements.

This log is affected by the heave measurement point configured for each output interface. You can thus output a Simrad 1000/3000 frame for the main heave measurement point on the Port A and an other Simrad 1000/3000 frame on the Port B that measures the heave at the second monitoring point.

This binary log is 10 bytes long and all fields are stored in Little Endian (LSB first). Signed data uses the 2's complement representation. A resolution of 0.01° is used for roll, pitch and heading angles and 1 cm for heave measurements.

The only difference between Simrad 1000 and 3000 frames is the first byte that is used as a synchronization byte for Simrad 1000 and as a status flag for Simrad 3000.

Warning: The Simrad 1000/3000 frame uses different conventions for heave measurements. In this frame, heave is positive up.

Frame format

Field	Description	Unit	Format	Size	Offset
Sync Byte 1 / Status	Sync Byte 1 = 0x00 or Status flag for EM3000	-	uint8	1	0
Sync Byte 2	Sync Byte 2 = 0x90	-	uint8	1	1
Roll	Roll is positive with port side up ±179.99°	0.01°	int16	2	2
Pitch	Pitch is positive with bow up ±89.99°	0.01°	int16	2	4
Heave	Heave measurement positive up ±99.99 meters	cm	int16	2	6
Heading	Heading is positive clockwise [0 to 359.99°]	0.01°	int16	2	8
				Total size	10

Simrad 3000 status flags

This flag is used to output status on algorithms used to compute the orientation and heave data. This flag is only available for the Simrad 3000 protocol. For Simrad 1000 outputs, the first byte is used as a synchronization byte and is always set to 0x00.

Value	Description
0x90	Valid measurements with full accuracy.
0x91	Valid measurements with reduced accuracy (unaided mode).
0x9A	Invalid measurements, the device is aligning and/or the heave filter is not settled.
0xA0	Report an error with the motion sensor.

2.5. Input logs

2.5.1. NMEA Protocol

This protocol is used as GPS aiding data in a read only mode.

Currently several sentences are required for proper operation:

- GGA is used to handle position aiding as well as vertical velocity
- RMC is used to handle horizontal velocity in NED frame aiding.
- HDT is used to get true heading from dual antenna systems.
- ZDA is used for UTC synchronization and it is usually sent at 1 Hz

Note: Please refer to the Ekinox NMEA integration manual to quickly connect a NMEA GNSS receiver to the Ekinox.

2.5.2. Novatel Binary Protocol

The Novatel protocol (binary form) can be used to provide best performance when connecting an external Novatel GNSS receiver to the Ekinox.

Currently several sentences are handled using Novatel Binary protocol:

- BESTPOS is used to handle position aiding.
- PSRXYZ is used to handle Doppler velocity with associated accuracy.
- HEADING is used to get true heading from dual antenna systems.
- TIME is used for UTC synchronization and is usually sent at 1 Hz

Note: Please refer to the Ekinox Novatel integration manual to quickly connect a Novatel GNSS receiver to the Ekinox.

2.5.3. Septentrio SBF binary protocol

The Ekinox implements Septentrio SBF binary protocol for GPS data aiding input. The following messages are used for Septentrio → Ekinox integration:

- PVTGeodetic: For position and velocity input
- PosCovGeodetic: For position advanced error management
- VelCovGeodetic: For velocity advanced error management
- AttEuler: Orientation for dual antenna systems
- AttCovEuler: Orientation accuracy
- ReceiverTime: Timing data
- xPPSOffset: Timing data

2.5.4. Teledyne RDI PD0 protocol

The PD0 binary frame is a Teledyne RDI proprietary log that output DVL data such as bottom tracking, water tracking and water profiling data.

It is accepted as input for DVL aiding purpose.

3. CAN protocol specifications

3.1. Introduction

The protocol described in this documentation is used to communicate with a Ekinox on a Controller-area network (CAN) bus.

The CAN bus is a message based protocol designed in a first time for automotive applications and used today in almost all industries.

The Ekinox CAN implementation supports both CAN 2.0A and CAN 2.0B standards in a very versatile manner.

This documentation contains all information needed to configure and integrate an Ekinox to a CAN bus.

3.1.1. Specifications

Following bitrates are supported:

- 1 000 kBit/s
- 500 kBit/s
- 250 kBit/s
- 200 kBit/s
- 125 kBit/s
- 100 kBit/s
- 50 kBit/s
- 25 kBit/s
- 20 kBit/s

A maximum of 8 bytes per frame are transmitted, both standard (11 bits) and extended (29 bits) identifiers are supported.

3.1.2. Message Identification

Every CAN message uses a unique identifier encoded on 11 bits for a CAN 2.0A standard message or on 29 bits for a CAN 2.0B extended message. In order to avoid incompatibilities with other materials, every CAN message id must be individually defined or even disabled using the following special id:

SBG_DISABLED_FRAME 0x000003FF

3.2. Output Logs

Following CAN messages are provided by the Ekinox.

Name (log ID)	Description
SBG_ECAN_LOG_STATUS_01 (0x100) SBG_ECAN_LOG_STATUS_02 (0x101) SBG_ECAN_LOG_STATUS_03 (0x102)	Status general, clock, com aiding, solution, heave
SBG_ECAN_LOG_IMU_INFO (0x120) SBG_ECAN_LOG_IMU_ACCEL (0x121) SBG_ECAN_LOG_IMU_GYRO (0x122) SBG_ECAN_LOG_IMU_DELTA_VEL (0x123) SBG_ECAN_LOG_DELTA_ANGLES (0x124)	Includes IMU status, acc., gyro, temp delta speeds and delta angles values
SBG_ECAN_LOG_EKF_INFO (0x130) SBG_ECAN_LOG_EKF_QUAT (0x131) SBG_ECAN_LOG_EKF_EULER (0x132) SBG_ECAN_LOG_EKF_ORIENTATION_ACC (0x133)	Includes roll, pitch, yaw, or quaternion output and their accuracies on each axis
SBG_ECAN_LOG_EKF_POS (0x134) SBG_ECAN_LOG_EKF_ALTITUDE (0x135) SBG_ECAN_LOG_EKF_POS_ACC (0x136) SBG_ECAN_LOG_EKF_VEL (0x137) SBG_ECAN_LOG_EKF_VEL_ACC (0x138)	Position and velocities in NED coordinates with the accuracies on each axis
SBG_ECAN_LOG_SHIP_MOTION_INFO (0x140), SBG_ECAN_LOG_SHIP_MOTION_HP_INFO (0x210) SBG_ECAN_LOG_SHIP_MOTION_x_0 (0x141, 0x142, 0x143, 0x144), SBG_ECAN_LOG_SHIP_MOTION_HP_x_0 (0x211, 0x212, 0x213, 0x214) SBG_ECAN_LOG_SHIP_MOTION_x_1 (0x145, 0x146, 0x147, 0x148), SBG_ECAN_LOG_SHIP_MOTION_HP_x_1 (0x215, 0x216, 0x217, 0x218)	Heave, surge and sway and accelerations on each axis for up to 4 points
SBG_ECAN_LOG_UTC_0 (0x110) SBG_ECAN_LOG_UTC_1 (0x111)	Provides UTC time reference
SBG_ECAN_LOG_MAG_0 (0x150) SBG_ECAN_LOG_MAG_1 (0x151) SBG_ECAN_LOG_MAG_2 (0x152)	Magnetic data with associated accelerometer on each axis
SBG_ECAN_LOG_GPS1_VEL_INFO (0x170), SBG_ECAN_LOG_GPS2_VEL_INFO (0x180) SBG_ECAN_LOG_GPS1_VEL (0x171), SBG_ECAN_LOG_GPS2_VEL (0x181) SBG_ECAN_LOG_GPS1_VEL_ACC (0x172) , SBG_ECAN_LOG_GPS2_VEL_ACC (0x182) SBG_ECAN_LOG_GPS1_COURSE (0x173), SBG_ECAN_LOG_GPS2_COURSE (0x183)	GPS velocities from primary or secondary GPS receiver
SBG_ECAN_LOG_GPS1_POS_INFO (0x174), SBG_ECAN_LOG_GPS2_POS_INFO (0x184) SBG_ECAN_LOG_GPS1_POS (0x175), SBG_ECAN_LOG_GPS2_POS (0x185) SBG_ECAN_LOG_GPS1_ALT (0x176), SBG_ECAN_LOG_GPS2_ALT (0x186) SBG_ECAN_LOG_GPS1_POS_ACC (0x177), SBG_ECAN_LOG_GPS2_POS_ACC (0x187)	GPS positions from primary or secondary GPS receiver
SBG_ECAN_LOG_GPS1_HDT_INFO (0x178), SBG_ECAN_LOG_GPS2_HDT_INFO (0x188) SBG_ECAN_LOG_GPS1_HDT (0x179), SBG_ECAN_LOG_GPS2_HDT (0x189)	GPS true heading from dual antenna system
SBG_ECAN_LOG_ODOMETER_INFO (0x160) SBG_ECAN_LOG_ODOMETER_VELOCITY (0x161)	Provides odometer velocity
SBG_ECAN_LOG_EVENT_INFO_A/B/C/D/E (0x200, 0x202, 0x204, 0x206, 0x208) SBG_ECAN_LOG_EVENT_TIME_A/B/C/D/E (0x201, 0x203, 0x205, 0x207, 0x209)	Event markers sent when events are detected on a sync in pin

3.2.1. General Status output

These outputs combine all system status data, divided into six categories: General, Clock, Communications, Aiding, Solution and Heave. This log is useful for advanced status information.

3.2.1.1. SBG_ECAN_LOG_STATUS_01 (0x100)

Field	Description	Unit	Format	Size	Offset
TIME_STAMP	Time since sensor is powered up.	µs	uint32	4	0
GENERAL_STATUS	Aiding status bit-mask.	-	uint16	2	4
CLOCK_STATUS	Clock status bit-mask.	-	uint16	2	6
				Total size	8

GENERAL_STATUS definition

Provides general device status and information such as the power supplies (main, IMU, GNSS), settings, temperature and data-logger.

Bit	Name	Type	Description
0	SBG_ECAN_GENERAL_MAIN_POWER_OK	Mask	Set to 1 when main power supply is OK.
1	SBG_ECAN_GENERAL_IMU_POWER_OK	Mask	Set to 1 when IMU power supply is OK.
2	SBG_ECAN_GENERAL_GPS_POWER_OK	Mask	Set to 1 when GPS power supply is OK.
3	SBG_ECAN_GENERAL_SETTINGS_OK	Mask	Set to 1 if settings where correctly loaded
4	SBG_ECAN_GENERAL_TEMPERATURE_OK	Mask	Set to 1 when temperature is within specified limits.
5	SBG_ECAN_GENERAL_DATALOGGER_OK	Mask	Set to 1 when the data-logger is working correctly.

CLOCK_STATUS definition

Provides status on the clock stability, error and synchronization.

Bit	Name	Type	Description
0	SBG_ECAN_CLOCK_STABLE_INPUT	Mask	Set to 1 when a clock input can be used to synchronize the internal clock.
[1-4]	SBG_ECAN_CLOCK_STATUS	Enum	Define the internal clock estimation status (see the table 10 below).
5	SBG_ECAN_CLOCK_UTC_SYNC	Mask	Set to 1 if UTC time is synchronized with a PPS
[6-9]	SBG_ECAN_CLOCK_UTC_STATUS	Enum	Define the UTC validity status (see the table 11 below).

You can find below the values that each clock enumeration can have:

Value	Name	Description
0	SBG_ECAN_CLOCK_ERROR	An error has occurred on the clock estimation.
1	SBG_ECAN_CLOCK_FREE_RUNNING	The clock is only based on the internal crystal.
2	SBG_ECAN_CLOCK_STEERING	A PPS has been detected and the clock is converging to it.
3	SBG_ECAN_CLOCK_VALID	The clock has converged to the PPS and is within 500ns.

Table 10: Clock Status enumeration

Value	Name	Description
0	SBG_ECAN_UTC_INVALID	The UTC time is not known, we are just propagating the UTC time internally.
1	SBG_ECAN_UTC_NO_LEAP_SEC	We have received valid UTC time but we don't have the leap seconds information.
2	SBG_ECAN_UTC_VALID	We have received valid UTC time data with valid leap seconds.

Table 11: UTC time status enumeration

3.2.1.2. SBG_ECAN_LOG_STATUS_02 (0x101)

Field	Description	Format	Size	Offset
COM_STATUS	Com status bit-mask.	uint32	4	0
AIDING_STATUS	Aiding status bit-mask.	uint32	4	4
			Total size	8

COM_STATUS definition

Provide information on ports, tells is they are valid or saturated

Bit	Name	Type	Description
0	SBG_ECAN_PORTA_VALID	Mask	Set to 0 in case of low level communication error.
1	SBG_ECAN_PORTB_VALID	Mask	Set to 0 in case of low level communication error.
2	SBG_ECAN_PORTC_VALID	Mask	Set to 0 in case of low level communication error.
3	SBG_ECAN_PORTD_VALID	Mask	Set to 0 in case of low level communication error.
4	SBG_ECAN_PORTE_VALID	Mask	Set to 0 in case of low level communication error.
5	SBG_ECAN_PORTA_RX_OK	Mask	Set to 0 in case of saturation on PORT A input
6	SBG_ECAN_PORTA_TX_OK	Mask	Set to 0 in case of saturation on PORT A output
7	SBG_ECAN_PORTB_RX_OK	Mask	Set to 0 in case of saturation on PORT B input
8	SBG_ECAN_PORTB_TX_OK	Mask	Set to 0 in case of saturation on PORT B output
9	SBG_ECAN_PORTC_RX_OK	Mask	Set to 0 in case of saturation on PORT C input
10	SBG_ECAN_PORTC_TX_OK	Mask	Set to 0 in case of saturation on PORT C output
11	SBG_ECAN_PORTD_RX_OK	Mask	Set to 0 in case of saturation on PORT D input
12	SBG_ECAN_PORTD_TX_OK	Mask	Set to 0 in case of saturation on PORT D output
13	SBG_ECAN_PORTE_RX_OK	Mask	Set to 0 in case of saturation on PORT E input
14	SBG_ECAN_PORTE_TX_OK	Mask	Set to 0 in case of saturation on PORT E output
15	SBG_ECAN_ETH0_RX_OK	Mask	Set to 0 in case of saturation on PORT ETHA input
16	SBG_ECAN_ETH0_TX_OK	Mask	Set to 0 in case of saturation on PORT ETHA output
17	SBG_ECAN_ETH1_RX_OK	Mask	Set to 0 in case of saturation on PORT ETHB input
18	SBG_ECAN_ETH1_TX_OK	Mask	Set to 0 in case of saturation on PORT ETHB output

Bit	Name	Type	Description
19	SBG_ECAN_ETH2_RX_OK	Mask	Set to 0 in case of saturation on PORT ETHC input
20	SBG_ECAN_ETH2_TX_OK	Mask	Set to 0 in case of saturation on PORT ETHC output
21	SBG_ECAN_ETH3_RX_OK	Mask	Set to 0 in case of saturation on PORT ETHD input
20	SBG_ECAN_ETH3_TX_OK	Mask	Set to 0 in case of saturation on PORT ETHD output
23	SBG_ECAN_ETH4_RX_OK	Mask	Set to 0 in case of saturation on PORT ETHE input
24	SBG_ECAN_ETH4_TX_OK	Mask	Set to 0 in case of saturation on PORT ETHE output
25	SBG_ECAN_CAN_RX_OK	Mask	Set to 0 in case of saturation on CAN Bus output buffer
26	SBG_ECAN_CAN_TX_OK	Mask	Set to 0 in case of saturation on CAN Bus input buffer
27-29	SBG_ECAN_CAN_BUS	Enum	Define the CAN Bus status (see the 12 below).

You can find below the values that each clock enumeration can have:

Value	Name	Description
0	SBG_ECAN_CAN_BUS_OFF	Bus OFF operation due to too much errors.
1	SBG_ECAN_CAN_BUS_TX_RX_ERR	Transmit or received error.
2	SBG_ECAN_CAN_BUS_OK	The CAN bus is working correctly.
3	SBG_ECAN_CAN_BUS_ERROR	A general error has occurred on the CAN bus.

Table 12: CAN Bus status enumeration

AIDING_STATUS definition

Tells which aiding data is received.

Bit	Name	Type	Description
0	SBG_ECAN_AIDING_GPS1_POS_RECV	Mask	Set to 1 when valid GPS 1 position data is received
1	SBG_ECAN_AIDING_GPS1_VEL_RECV	Mask	Set to 1 when valid GPS 1 velocity data is received
2	SBG_ECAN_AIDING_GPS1_HDT_RECV	Mask	Set to 1 when valid GPS 1 true heading data is received
3	SBG_ECAN_AIDING_GPS1_UTC_RECV	Mask	Set to 1 when valid GPS 1 UTC time data is received
4	SBG_ECAN_AIDING_GPS2_POS_RECV	Mask	Set to 1 when valid GPS 2 position data is received
5	SBG_ECAN_AIDING_GPS2_VEL_RECV	Mask	Set to 1 when valid GPS 2 velocity data is received
6	SBG_ECAN_AIDING_GPS2_HDT_RECV	Mask	Set to 1 when valid GPS 2 true heading data is received
7	SBG_ECAN_AIDING_GPS2_UTC_RECV	Mask	Set to 1 when valid GPS 2 UTC time data is received
8	SBG_ECAN_AIDING_MAG_RECV	Mask	Set to 1 when valid Magnetometer data is received
9	SBG_ECAN_AIDING_ODO_RECV	Mask	Set to 1 when Odometer pulse is received
10	SBG_ECAN_AIDING_DVL_RECV	Mask	Set to 1 when valid DVL data is received
11	SBG_ECAN_AIDING_USBL_RECV	Mask	Set to 1 when valid USBL data is received
12	SBG_ECAN_AIDING_EM_LOG_RECV	Mask	Set to 1 when valid EM Log data is received
13	SBG_ECAN_AIDING_DEPTH_RECV	Mask	Set to 1 when valid Depth sensor data is received
14	SBG_ECAN_AIDING_USER_POS_RECV	Mask	Set to 1 when valid user position data is received.
15	SBG_ECAN_AIDING_USER_VEL_RECV	Mask	Set to 1 when valid user velocity data is received.
16	SBG_ECAN_AIDING_USER_HEADING_RECV	Mask	Set to 1 when valid user heading data is received.

3.2.1.3. SBG_ECAN_LOG_STATUS_03 (0x102)

Field	Description	Format	Size	Offset
SOLUTION_STATUS	Solution status bit-mask.	uint32	4	0
HEAVE_STATUS	Heave status bit-mask.	uint16	2	4
			Total size	6

HEAVE_STATUS definition

Tells if the heave is valid and if the heave computation is aided by velocity and heading data.

Bit	Name	Description
0 (LSB)	SBG_ECAN_HEAVE_VALID	Set to 1 after heave convergence time. Set to 0 in following conditions: • Turn occurred and no velocity aiding is available • Heave reached higher/lower limits • If a step is detected and filter has to re-converge • If internal failure
1	SBG_ECAN_HEAVE_VEL_AIDED	Set to 1 if heave output is compensated for transient accelerations

SOLUTION_STATUS definition

Provides information on the internal Kalman filter status such as which aiding data is used to compute the solution and the provided solution mode.

Bit	Name	Description
[0-3]	SBG_ECAN_SOLUTION_MODE	Defines the Kalman filter computation mode (see the table 13 below)
4 (LSB)	SBG_ECAN_SOL_ATTITUDE_VALID	Set to 1 if Attitude data is reliable (Roll/Pitch error < 0,5°)
5	SBG_ECAN_SOL_HEADING_VALID	Set to 1 if Heading data is reliable (Heading error < 1°)
6	SBG_ECAN_SOL_VELOCITY_VALID	Set to 1 if Velocity data is reliable (velocity error < 1.5 m/s)
7	SBG_ECAN_SOL_POSITION_VALID	Set to 1 if Position data is reliable (Position error < 10m)
8	SBG_ECAN_SOL_VERT_REF_USED	Set to 1 if vertical reference is used in solution (data used and valid since 3s)
9	SBG_ECAN_SOL_MAG_REF_USED	Set to 1 if magnetometer is used in solution (data used and valid since 3s)
10	SBG_ECAN_SOL_GPS1_VEL_USED	Set to 1 if GPS velocity is used in solution (data used and valid since 3s)
11	SBG_ECAN_SOL_GPS1_POS_USED	Set to 1 if GPS Position is used in solution (data used and valid since 3s)
12	SBG_ECAN_SOL_GPS1_COURSE_USED	Set to 1 if GPS Course is used in solution (data used and valid since 3s)
13	SBG_ECAN_SOL_GPS1_HDT_USED	Set to 1 if GPS True Heading is used in solution (data used and valid since 3s)
14	SBG_ECAN_SOL_GPS2_VEL_USED	Set to 1 if GPS2 velocity is used in solution (data used and valid since 3s)
15	SBG_ECAN_SOL_GPS2_POS_USED	Set to 1 if GPS2 Position is used in solution (data used and valid since 3s)
16	SBG_ECAN_SOL_GPS2_COURSE_USED	Set to 1 if GPS2 Course is used in solution (data used and valid since 3s)
17	SBG_ECAN_SOL_GPS2_HDT_USED	Set to 1 if GPS2 True Heading is used in solution (data used and valid since 3s)
18	SBG_ECAN_SOL_ODO_USED	Set to 1 if Odometer is used in solution (data used and valid since 3s)
19	SBG_ECAN_SOL_DVL_BT_USED	Set to 1 if DVL Bottom Tracking is used in solution (data used and valid since 3s)
20	SBG_ECAN_SOL_DVL_WT_USED	Set to 1 if DVL Water Layer is used in solution (data used and valid since 3s)
21	SBG_ECAN_SOL_USER_POS_USED	Set to 1 if user position is used in solution (data used and valid since 3s)
22	SBG_ECAN_SOL_USER_VEL_USED	Set to 1 if user velocity is used in solution (data used and valid since 3s)
23	SBG_ECAN_SOL_USER_HEADING_USED	Set to 1 if user course is used in solution (data used and valid since 3s)
24	SBG_ECAN_SOL_USBL_USED	Set to 1 if USBL / LBL is used in solution (data used and valid since 3s).

You can find below the different available solution modes:

Value	Name	Description
0	SBG_ECAN_SOL_MODE_UNINITIALIZED	The Kalman filter is not initialized and the returned data are all invalid.
1	SBG_ECAN_SOL_MODE_VERTICAL_GYRO	The Kalman filter only rely on a vertical reference to compute roll and pitch angles. Heading and navigation data drift freely.
2	SBG_ECAN_SOL_MODE_AHRS	A heading reference is available, the Kalman filter provides full orientation but navigation data drift freely.
3	SBG_ECAN_SOL_MODE_NAV_VELOCITY	The Kalman filter computes orientation and velocity. Position is freely integrated from velocity estimation.
4	SBG_ECAN_SOL_MODE_NAV_POSITION	Nominal mode, the Kalman filter computes all parameters (attitude, velocity, position). Absolute position is provided.

Table 13: Solution modes enumeration

3.2.2. UTC time output

Provides UTC time reference. This frame also provides a time correspondence between Ekinox TIME_STAMP value and actual UTC Time.

3.2.2.1. SBG_ECAN_LOG_UTC_0 (0x110)

Field	Description	Unit	Format	Size	Offset
TIME_STAMP	Time since sensor is powered up.	µs	uint32	4	0
GPS_TOW	GPS Time of week.	ms	uint32	4	4
				Total size	8

3.2.2.2. SBG_ECAN_LOG_UTC_1 (0x111)

Field	Description	Scaling	Unit	Format	Size	Offset
YEAR	Year within the century (e.g. '10' means 2010)	1	year	uint8	1	0
MONTH	Month in Year [1 ... 12]	1	month	uint8	1	1
DAY	Day in Month [1 ... 31]	1	d	uint8	1	2
HOUR	Hour in day [0 ... 23]	1	h	uint8	1	3
MIN	Minute in hour [0 ... 59]	1	min	uint8	1	4
SEC	Second in minute [0 ... 60] Note 60 is when a leap second is added.	1	s	uint8	1	5
TENTHMS	Tenths of a millisecond in second.	10^{-4}	s	uint16	2	6
					Total size	8

3.2.3. *Inertial Data output*

3.2.3.1. SBG_ECAN_LOG_IMU_INFO (0x120)

Field	Description	Scaling	Unit	Format	Size	Offset
TIME_STAMP	Time since sensor is powered up.	1	µs	uint32	4	0
IMU_STATUS	IMU Status bit-mask.	-	-	uint16	2	4
TEMPERATURE	IMU Temperature.	10^{-2}	°C	int16	2	6
				Total size		8

IMU_STATUS definition:

Status used to know if sensors are working correctly and are in their measurement range.

Bit	Name	Description
0 (LSB)	SBG_ECAN_IMU_COM_OK	Set to 1 if the communication with the IMU is ok.
1	SBG_ECAN_IMU_STATUS_BIT	Set to 1 if internal IMU passes Built In Test (Calibration, CPU)
2	SBG_ECAN_IMU_ACCEL_X_BIT	Set to 1 if accelerometer X passes Built In Test
3	SBG_ECAN_IMU_ACCEL_Y_BIT	Set to 1 if accelerometer Y passes Built In Test
4	SBG_ECAN_IMU_ACCEL_Z_BIT	Set to 1 if accelerometer Z passes Built In Test
5	SBG_ECAN_IMU_GYRO_X_BIT	Set to 1 if gyroscope X passes Built In Test
6	SBG_ECAN_IMU_GYRO_Y_BIT	Set to 1 if gyroscope Y passes Built In Test
7	SBG_ECAN_IMU_GYRO_Z_BIT	Set to 1 if gyroscope Z passes Built In Test
8	SBG_ECAN_IMU_ACCELS_IN_RANGE	Set to 1 if accelerometers are within operating range
9	SBG_ECAN_IMU_GYROS_IN_RANGE	Set to 1 if gyroscopes are within operating range

3.2.3.2. SBG_ECAN_LOG_IMU_ACCEL (0x121)

Fully calibrated accelerometers values in meters per second squared.

Field	Description	Scaling	Unit	Format	Size	Offset
ACCEL_X	Acceleration X.	10^{-2}	$m.s^{-2}$	int16	2	0
ACCEL_Y	Acceleration Y.	10^{-2}	$m.s^{-2}$	int16	2	2
ACCEL_Z	Acceleration Z.	10^{-2}	$m.s^{-2}$	int16	2	4
				Total size		6

3.2.3.3. SBG_ECAN_LOG_IMU_GYRO (0x122)

Fully calibrated gyroscopes values in radians per second. Multiply each component by 10^{-3} to get the value in radians per second.

Field	Description	Scaling	Unit	Format	Size	Offset
GYRO_X	Rate of turn X.	10^{-3}	$rad.s^{-1}$	int16	2	0
GYRO_Y	Rate of turn Y.	10^{-3}	$rad.s^{-1}$	int16	2	2
GYRO_Z	Rate of turn Z.	10^{-3}	$rad.s^{-1}$	int16	2	4
				Total size		6

3.2.3.4. SBG_ECAN_LOG_IMU_DELTA_VEL (0x123)

1KHz Sculling integration output. Delivers delta velocities in body coordinate frame.

Field	Description	Scaling	Unit	Format	Size	Offset
DELTA_VEL_X	Delta velocity X.	10^{-2}	$m.s^{-2}$	int16	2	0
DELTA_VEL_Y	Delta velocity Y.	10^{-2}	$m.s^{-2}$	int16	2	2
DELTA_VEL_Z	Delta velocity Z.	10^{-2}	$m.s^{-2}$	int16	2	4
				Total size		6

3.2.3.5. SBG_ECAN_LOG_DELTA_ANGLES (0x124)

Coning integration output from the 1kHz gyroscopes integration. These values should be used as the gyroscopes values and should be multiplied by 10^{-3} to get the value in radians per second.

Field	Description	Scaling	Unit	Format	Size	Offset
DELTA_ANGLE_X	Coning integration X.	10^{-3}	$rad.s^{-1}$	int16	2	0
DELTA_ANGLE_Y	Coning integration Y.	10^{-3}	$rad.s^{-1}$	int16	2	2
DELTA_ANGLE_Y	Coning integration Z.	10^{-3}	$rad.s^{-1}$	int16	2	4
				Total size		6

3.2.4. EKF output

3.2.4.1. SBG_ECAN_LOG_EKF_INFO (0x130)

Field	Description	Unit	Format	Size	Offset
TIME_STAMP	Time since sensor is powered up.	µs	uint32	4	0
			Total size		4

3.2.4.2. SBG_ECAN_LOG_EKF_QUAT (0x131)

Device 3d orientation represented with a normalized quaternion (q0, q1, q2, q3) expressed using frac16 numbers (frac16: 1 sign bit, 15 fractional bits).

Field	Description	Scaling	Format	Size	Offset
Q0	Orientation quaternion, q0 component.	32768^{-1}	int16	2	0
Q1	Orientation quaternion, q1 component.	32768^{-1}	int16	2	2
Q2	Orientation quaternion, q2 component.	32768^{-1}	int16	2	4
Q3	Orientation quaternion, q3 component.	32768^{-1}	int16	2	6
			Total size		8

3.2.4.3. SBG_ECAN_LOG_EKF_EULER (0x132)

Provides computed orientation in Euler angles format.

Field	Description	Scaling	Unit	Format	Size	Offset
ROLL	Roll angle.	10^{-4}	rad	int16	2	0
PITCH	Pitch angle.	10^{-4}	rad	int16	2	2
YAW	Yaw angle.	10^{-4}	rad	int16	2	4
				Total size		6

3.2.4.4. SBG_ECAN_LOG_EKF_ORIENTATION_ACC (0x133)

Provides estimated orientation standard deviation accuracy in Euler angles format.

Field	Description	Scaling	Unit	Format	Size	Offset
ROLL_ACC	1σ Roll angle accuracy.	10^{-4}	rad	uint16	2	0
PITCH_ACC	1σ Pitch angle accuracy.	10^{-4}	rad	uint16	2	2
YAW_ACC	1σ Yaw angle accuracy.	10^{-4}	rad	uint16	2	4
					Total size	6

3.2.4.5. SBG_ECAN_LOG_EKF_POS (0x134)

Latitude and longitude enhanced using inertial data and expressed in the WGS84 format.

Field	Description	Scaling	Unit	Format	Size	Offset
LATITUDE	Latitude angle, positive north.	10^{-7}	°	int32	4	0
LONGITUDE	Longitude angle, positive east.	10^{-7}	°	int32	4	4
					Total size	8

3.2.4.6. SBG_ECAN_LOG_EKF_ALTITUDE (0x135)

Altitude in millimeters expressed either in height above ellipsoid or mean sea level according to the GPS configuration. Horizontal and vertical accuracies estimated by the Kalman filter are expressed in centimeters.

Field	Description	Scaling	Unit	Format	Size	Offset
ALTITUDE	Altitude above Mean Sea Level.	10^{-3}	m	int32	4	0
UNDULATION	Altitude difference between the geoid and the Ellipsoid.	0.005	m	int16	2	4
					Total size	6

3.2.4.7. SBG_ECAN_LOG_EKF_POS_ACC (0x136)

Position accuracy from internal Kalman filter.

Field	Description	Scaling	Unit	Format	Size	Offset
LATITUDE_ACC	1σ Latitude accuracy.	10^{-2}	m	uint16	2	0
LONGITUDE_ACC	1σ Longitude accuracy.	10^{-2}	m	uint16	2	2
ALTITUDE_ACC	1σ Vertical Position accuracy.	10^{-2}	m	uint16	2	4
					Total size	6

3.2.4.8. SBG_ECAN_LOG_EKF_VEL (0x137)

North, East and Down velocities, from Kalman filter output.

Field	Description	Scaling	Unit	Format	Size	Offset
VELOCITY_N	Velocity in North direction.	10^{-2}	$m.s^{-1}$	int16	2	0
VELOCITY_E	Velocity in East direction.	10^{-2}	$m.s^{-1}$	int16	2	2
VELOCITY_D	Velocity in Down direction.	10^{-2}	$m.s^{-1}$	int16	2	4
					Total size	6

3.2.4.9. SBG_ECAN_LOG_EKF_VEL_ACC (0x138)

North, East and Down velocity accuracy, from Kalman filter output.

Field	Description	Scaling	Unit	Format	Size	Offset
VELOCITY_ACC_N	1σ Velocity in North direction accuracy.	10^{-2}	$m.s^{-1}$	uint16	2	0
VELOCITY_ACC_E	1σ Velocity in East direction accuracy.	10^{-2}	$m.s^{-1}$	uint16	2	2
VELOCITY_ACC_D	1σ Velocity in Down direction accuracy.	10^{-2}	$m.s^{-1}$	uint16	2	4
				Total size		6

3.2.5. Heave output

3.2.5.1. SBG_ECAN_LOG_SHIP_MOTION_INFO (0x140), SBG_ECAN_LOG_SHIP_MOTION_HP_INFO (0x210)

Returns ship motion status as well as heave period at main monitoring point.

Field	Description	Scaling	Unit	Format	Size	Offset
TIME_STAMP	Time since sensor is powered up.	1	µs	uint32	4	0
PERIOD	Main heave period.	10^{-2}	s	uint16	2	4
STATUS	Ship motion status	-	-	uint16	2	6
				Total size		8

STATUS definition

This field must be checked in order to know which fields are active in the output and to know if data is valid or not.

Bit	Name	Description
0	SBG_ECOM_HEAVE_VALID	Set to 1 after heave convergence time. Set to 0 in following conditions: • Turn occurred and no velocity aiding is available • Heave reached higher/lower limits • If a step is detected and filter has to re-converge • If internal failure
1	SBG_ECOM_HEAVE_VEL_AIDED	Set to 1 if heave output is compensated for transient accelerations
2	SBG_ECOM_SURGE_SWAY_AVAILABLE	Set to 1 if surge and sway channels are provided in this output.
3	SBG_ECOM_PERIOD_AVAILABLE	Set to 1 if the swell period is provided in this output
4	SBG_ECOM_PERIOD_VALID	Set to 1 if the period returned is assumed to be valid or not.

3.2.5.2. SBG_ECAN_LOG_SHIP_MOTION_x_0 (0x141, 0x142, 0x143, 0x144), SBG_ECAN_LOG_SHIP_MOTION_HP_x_0 (0x211, 0x212, 0x213, 0x214)

Returns surge, sway & heave at monitoring point x (0 for main monitoring point, 1/2/3 for the others).

Field	Description	Scaling	Unit	Format	Size	Offset
SURGE	Surge motion (positive forward).	10^{-3}	m	int16	2	0
SWAY	Sway motion (positive right).	10^{-3}	m	int16	2	2
HEAVE	Heave motion (positive down).	10^{-3}	m	int16	2	4
				Total size		6

3.2.5.3. SBG_ECAN_LOG_SHIP_MOTION_x_1 (0x145, 0x146, 0x147, 0x148), SBG_ECAN_LOG_SHIP_MOTION_HP_x_1 (0x215, 0x216, 0x217, 0x218)

Returns ship accelerations at monitoring point x (0 for main monitoring point, 1/2/3 for the others).

Field	Description	Scaling	Unit	Format	Size	Offset
ACCEL_X	Longitudinal acceleration (positive forward).	10^{-2}	$m.s^{-2}$	int16	2	0
ACCEL_Y	Lateral acceleration (positive right).	10^{-2}	$m.s^{-2}$	int16	2	2
ACCEL_Z	Vertical acceleration (positive down).	10^{-2}	$m.s^{-2}$	int16	2	4
				Total size		6

3.2.5.4. SBG_ECAN_LOG_SHIP_MOTION_x_2(0x149, 0x14A, 0x14B, 0x14C), SBG_ECAN_LOG_SHIP_MOTION_HP_x_2 (0x219, 0x21A, 0x21B, 0x21C)

Returns ship velocity at monitoring point x (0 for main monitoring point, 1/2/3 for the others).

Field	Description	Scaling	Unit	Format	Size	Offset
VEL_X	Longitudinal velocity (positive forward).	10^{-2}	$m.s^{-1}$	int16	2	0
VEL_Y	Lateral velocity (positive right).	10^{-2}	$m.s^{-1}$	int16	2	2
VEL_Z	Vertical velocity (positive down).	10^{-2}	$m.s^{-1}$	int16	2	4
				Total size		6

3.2.6. Magnetometer output

3.2.6.1. SBG_ECAN_LOG_MAG_0 (0x150)

Field	Description	Unit	Format	Size	Offset
TIME_STAMP	Time since sensor is powered up.	µs	uint32	4	0
MAG_STATUS	Magnetometer status bit-mask.	-	uint16	2	4
				Total size	6

MAG_STATUS definition

Bit	Name	Description
0(LSB)	SBG_ECAN_MAG_MAG_X_BIT	Set to 1 if the magnetometer X has passed the self test.
1	SBG_ECAN_MAG_MAG_Y_BIT	Set to 1 if the magnetometer Y has passed the self test.
2	SBG_ECAN_MAG_MAG_Z_BIT	Set to 1 if the magnetometer Z has passed the self test.
3	SBG_ECAN_MAG_ACCEL_X_BIT	Set to 1 if the accelerometer X has passed the self test.
4	SBG_ECAN_MAG_ACCEL_Y_BIT	Set to 1 if the accelerometer Y has passed the self test.
5	SBG_ECAN_MAG_ACCEL_Z_BIT	Set to 1 if the accelerometer Z has passed the self test.
6	SBG_ECAN_MAG_MAGS_IN_RANGE	Set to 1 if magnetometer is not saturated
7	SBG_ECAN_MAG_ACCELS_IN_RANGE	Set to 1 if accelerometer is not saturated
8	SBG_ECAN_MAG_CALIBRATION_OK	Set to 1 if magnetometer seems to be calibrated

3.2.6.2. SBG_ECAN_LOG_MAG_1 (0x151)

Fully calibrated and normalized magnetometers values in arbitrary units. Multiply each component by 10^{-3} to get the value in the A.U. If well calibrated, the norm of the magnetic vector should equal 1.

Field	Description	Scaling	Unit	Format	Size	Offset
MAG_X	Magnetometer output, X axis.	10^{-3}	a.u.	int16	2	0
MAG_Y	Magnetometer output, Y axis.	10^{-3}	a.u.	int16	2	2
MAG_Z	Magnetometer output, Z axis.	10^{-3}	a.u.	int16	2	4
					Total size	6

3.2.6.3. SBG_ECAN_LOG_MAG_2 (0x152)

Provides associated accelerometer values, in case of internal magnetometer, internal accelerometer values are returned.

Field	Description	Scaling	Unit	Format	Size	Offset
ACC_X	Accelerometer output, X axis.	10^{-2}	$m.s^{-2}$	int16	2	0
ACC_Y	Accelerometer output, Y axis.	10^{-2}	$m.s^{-2}$	int16	2	2
ACC_Z	Accelerometer output, Z axis.	10^{-2}	$m.s^{-2}$	int16	2	4
					Total size	6

3.2.7. Odometer output

3.2.7.1. SBG_ECAN_LOG_ODOMETER_INFO (0x160)

Odometer status information and Time since reset. This time is not necessary aligned with main loop as it dates the actual odometer data.

Field	Description	Unit	Format	Size	Offset
TIME_STAMP	Time since sensor is powered up.	µs	uint32	4	0
ODO_STATUS	Odometer velocity status bit-mask.	-	uint16	2	4
			Total size		6

ODO_STATUS definition

Bit	Name	Description
0 (LSB)	SBG_ECAN_ODO_REAL_MEAS	Set to 1 if this log comes from a real pulse measurement or from a timeout.

3.2.7.2. SBG_ECAN_LOG_ODOMETER_VELOCITY (0x161)

Odometers raw velocities only computed using detected pulses and odometer pulses per meter setting.

Field	Description	Unit	Format	Size	Offset
VELOCITY	Velocity in odometer direction.	$m.s^{-1}$	float	4	0
			Total size		4

3.2.8. GPS 1 and 2 outputs

3.2.8.1. SBG_ECAN_LOG_GPS1_VEL_INFO (0x170), SBG_ECAN_LOG_GPS2_VEL_INFO (0x180)

The time stamp is not aligned on main loop but instead of that, it dates the actual GNSS velocity data.

Field	Description	Unit	Format	Size	Offset
TIME_STAMP	Time since sensor is powered up.	µs	uint32	4	0
GPS_VEL_STATUS	GPS velocity fix and status bit-mask.	-	uint32	4	4
			Total size		8

GPS_VEL_STATUS definition

Bit	Type	Name	Description
[0-5]	Enum	SBG_ECAN_GPS_VEL_STATUS	The raw GPS velocity status (see the 14 below).
[6-11]	Enum	SBG_ECAN_GPS_VEL_TYPE	The raw GPS velocity type (see the 15 below).

You can find below the GPS velocity status and type enumerations:

Value	Name	Description
0	SBG_ECAN_VEL_SOL_COMPUTED	A valid solution has been computed.
1	SBG_ECAN_VEL_INSUFFISENT_OBS	Not enough valid SV to compute a solution.
2	SBG_ECAN_VEL_INTERNAL_ERROR	An internal error has occurred.
3	SBG_ECAN_VEL_LIMIT	Velocity limit exceeded.

Table 14: Raw GPS velocity status enumeration

Value	Name	Description
0	SBG_ECAN_VEL_NO_SOLUTION	No valid velocity solution available.
1	SBG_ECAN_VEL_UNKNOWN_TYPE	An unknown solution type has been computed.
2	SBG_ECAN_VEL_DOPPLER	A Doppler velocity has been computed.
3	SBG_ECAN_VEL_DIFFERENTIAL	A velocity has been computed between two positions.

Table 15: Raw GPS velocity type enumeration

Note: Both the GPS velocity status and type should be tested to make sure that the outputted velocity is valid.

3.2.8.2. SBG_ECAN_LOG_GPS1_VEL (0x171), SBG_ECAN_LOG_GPS2_VEL (0x181)

Provide raw GNSS velocity from primary or secondary GNSS receiver.

Field	Description	Scaling	Unit	Format	Size	Offset
VEL_N	Velocity in North direction.	10^{-2}	$m.s^{-1}$	int16	2	0
VEL_E	Velocity in East direction.	10^{-2}	$m.s^{-1}$	int16	2	2
VEL_D	Velocity in Down direction.	10^{-2}	$m.s^{-1}$	int16	2	4
					Total size	6

3.2.8.3. SBG_ECAN_LOG_GPS1_VEL_ACC (0x172) , SBG_ECAN_LOG_GPS2_VEL_ACC (0x182)

Provide raw GNSS velocity accuracy from primary or secondary GNSS receiver.

Field	Description	Scaling	Unit	Format	Size	Offset
VEL_ACC_N	1σ Accuracy in North direction.	10^{-2}	$m.s^{-1}$	uint16	2	0
VEL_ACC_E	1σ Accuracy in East direction.	10^{-2}	$m.s^{-1}$	uint16	2	2
VEL_ACC_D	1σ Accuracy in Down direction.	10^{-2}	$m.s^{-1}$	uint16	2	4
					Total size	6

3.2.8.4. SBG_ECAN_LOG_GPS1_COURSE (0x173), SBG_ECAN_LOG_GPS2_COURSE (0x183)

Provide raw GNSS course data from primary or secondary GNSS receiver.

Field	Description	Scaling	Unit	Format	Size	Offset
COURSE	True direction of motion over ground (0 to 360°).	10^{-2}	°	uint16	2	0
COURSE_ACC	1σ course accuracy.	10^{-2}	°	uint16	2	2
					Total size	4

3.2.8.5. SBG_ECAN_LOG_GPS1_POS_INFO (0x174), SBG_ECAN_LOG_GPS2_POS_INFO (0x184)

The time stamp is not aligned on main loop but instead of that, it dates the actual GPS position data.

Field	Description	Unit	Format	Size	Offset
TIME_STAMP	Time since sensor is powered up.	µs	uint32	4	0
GPS_POS_STATUS	GPS position fix and status bit-mask.	-	uint32	4	4
				Total size	8

GPS_POS_STATUS definition

Bit	Type	Name	Description
[0-5]	Enum	SBG_ECAN_GPS_POS_STATUS	The raw GPS position status (see the table 16 below).
[6-11]	Enum	SBG_ECAN_GPS_POS_TYPE	The raw GPS position type (see the table 17 below).
12	Mask	SBG_ECAN_GPS_POS_GPS_L1_USED	Set to 1 if GPS L1 is used in the solution
13	Mask	SBG_ECAN_GPS_POS_GPS_L2_USED	Set to 1 if GPS L2 is used in the solution
14	Mask	SBG_ECAN_GPS_POS_GPS_L5_USED	Set to 1 if GPS L5 is used in the solution
15	Mask	SBG_ECAN_GPS_POS_GLO_L1_USED	Set to 1 if GLONASS L1 is used in the solution
16	Mask	SBG_ECAN_GPS_POS_GLO_L2_USED	Set to 1 if GLONASS L2 is used in the solution

You can find below the GPS position status and type enumerations:

Value	Name	Description
0	SBG_ECAN_POS_SOL_COMPUTED	A valid solution has been computed.
1	SBG_ECAN_POS_INSUFFISENT_OBS	Not enough valid SV to compute a solution.
2	SBG_ECAN_POS_INTERNAL_ERROR	An internal error has occurred.
3	SBG_ECAN_POS_HEIGHT_LIMIT	The height limit has been exceeded.

Table 16: Raw GPS position status enumeration

Value	Name	Description
0	SBG_ECAN_POS_NO_SOLUTION	No valid solution available.
1	SBG_ECAN_POS_UNKNOWN_TYPE	An unknown solution type has been computed.
2	SBG_ECAN_POS_SINGLE	Single point solution position.
3	SBG_ECAN_POS_PSRDIFF	Standard Pseudorange Differential Solution (DGPS).
4	SBG_ECAN_POS_SBAS	SBAS satellite used for differential corrections.
5	SBG_ECAN_POS_OMNISTAR	Omnistar VBS Position (L1 sub-meter).
6	SBG_ECAN_POS_RTK_FLOAT	Floating RTK ambiguity solution (20 cm RTK).
7	SBG_ECAN_POS_RTK_INT	Integer RTK ambiguity solution (2 cm RTK).
8	SBG_ECAN_POS_PPP_FLOAT	Precise Point Positioning with float ambiguities.
9	SBG_ECAN_POS_PPP_INT	Precise Point Positioning with fixed ambiguities.
10	SBG_ECAN_POS_FIXED	Fixed location solution position.

Table 17: Raw GPS position type enumeration

Note 1: Both the GPS position status and type should be tested to make sure that the outputted position is valid.

Note 2: OmniStar, Terrastar, Veripos or other worldwide DGPS service provider are considered as Precise Point Positioning solutions.

3.2.8.6. SBG_ECAN_LOG_GPS1_POS (0x175), SBG_ECAN_LOG_GPS2_POS (0x185)

Provide GNSS position from primary or secondary GNSS receiver.

Field	Description	Scaling	Unit	Format	Size	Offset
LATITUDE	Latitude, positive Noth.	10^{-7}	°	int32	4	0
LONGITUDE	Longitude, positive East.	10^{-7}	°	int32	4	4
					Total size	8

3.2.8.7. SBG_ECAN_LOG_GPS1_ALT (0x176), SBG_ECAN_LOG_GPS2_ALT (0x186)

Provide GNSS altitude from primary or secondary GNSS receiver.

Field	Description	Scaling	Unit	Format	Size	Offset
ALTITUDE	Altitude Above Mean Sea Level.	10^{-3}	m	int32	4	0
UNDULATION	Altitude difference between the geoid and the Ellipsoid.	0.005	m	int16	2	2
					Total size	6

3.2.8.8. SBG_ECAN_LOG_GPS1_POS_ACC (0x177), SBG_ECAN_LOG_GPS2_POS_ACC (0x187)

Provide GNSS position accuracy from primary or secondary GNSS receiver.

Field	Description	Scaling	Unit	Format	Size	Offset
LAT_ACC	1σ Latitude Accuracy.	10^{-2}	m	uint16	2	0
LONG_ACC	1σ Longitude Accuracy.	10^{-2}	m	uint16	2	2
ALT_ACC	1σ Altitude Accuracy.	10^{-2}	m	uint16	2	4
					Total size	6

3.2.8.9. SBG_ECAN_LOG_GPS1_HDT_INFO (0x178), SBG_ECAN_LOG_GPS2_HDT_INFO (0x188)

The time stamp is not aligned on main loop but instead of that, it dates the actual GPS true heading data.

Field	Description	Unit	Format	Size	Offset
TIME_STAMP	Time since sensor is powered up.	µs	uint32	4	0
GPS_HDT_STATUS	GPS True Heading status.	-	uint16	2	4
				Total size	6

GPS_HDT_STATUS definition

Bit	Type	Name	Description
[0-5]	Enum	SBG_ECAN_GPS_HDT_STATUS	The raw GPS true heading status (see the 18 below).

You can find below the GPS true heading status enumeration:

Value	Name	Description
0	SBG_ECAN_HDT_SOL_COMPUTED	A valid solution has been computed.
1	SBG_ECAN_HDT_INSUFFISENT_OBS	Not enough valid SV to compute a solution.
2	SBG_ECAN_HDT_INTERNAL_ERROR	An internal error has occurred.
3	SBG_ECAN_HDT_HEIGHT_LIMIT	The height limit has been exceeded.

Table 18: Raw GPS true heading status enumeration

3.2.8.10. SBG_ECAN_LOG_GPS1_HDT (0x179), SBG_ECAN_LOG_GPS2_HDT (0x189)

Provides raw GPS true heading data from a dual antenna GPS system.

Field	Description	Scaling	Unit	Format	Size	Offset
TRUE_HEADING	True heading angle (0 to 360°).	10^{-2}	°	uint16	2	0
TRUE_HEADING_ACC	1σ True heading estimated accuracy (0 to 360°).	10^{-2}	°	uint16	2	2
PITCH	Pitch angle from the master to the rover.	10^{-2}	°	int16	2	4
PITCH_ACC	1σ pitch estimated accuracy.	10^{-2}	°	uint16	2	6
					Total size	8

3.2.9. User log event

The Ekinox can detect events markers at up to 1 kHz on Sync A, Sync B, Sync C, Sync D and Sync E input signals. For each input synchronization signal, the Ekinox can output a binary log that returns the time of each received event during the last past 5 milliseconds (the maximum output rate is 200 Hz).

The TIME_STAMP field dates the first event that has been received during the last 5 ms. Other events received during the same time slot (5ms) are dated using a time offset to reduce the log size.

Example

If three events are received during the last 5 ms, each event will be dated using the following rules:

- First received event time is directly stored in TIME_STAMP
- Second received event time is TIME_STAMP + TIME_OFFSET_0
- Third received event time is TIME_STAMP + TIME_OFFSET_1

The other time offset fields will be set to 0 and the EVENT_STATUS flag will reflect which time offset fields are valid.

3.2.9.1. SBG_ECAN_LOG_EVENT_INFO_A/B/C/D/E (0x200, 0x202, 0x204, 0x206, 0x208)

Field	Description	Unit	Format	Size	Offset
TIME_STAMP	Time since sensor is powered up.	µs	uint32	4	0
EVENT_STATUS	Status bit-mask.	-	uint16	2	4
				Total size	6

EVENT_STATUS definition

Bit	Name	Description
0 (LSB)	SBG_ECAN_EVENT_OVERFLOW	Set to 1 if we have received events at a higher rate than 1 kHz.
1	SBG_ECAN_EVENT_OFFSET_0_VALID	Set to 1 if at least two events have been received.
2	SBG_ECAN_EVENT_OFFSET_1_VALID	Set to 1 if at least three events have been received.
3	SBG_ECAN_EVENT_OFFSET_2_VALID	Set to 1 if at least four events have been received.
4	SBG_ECAN_EVENT_OFFSET_3_VALID	Set to 1 if five events have been received.

3.2.9.2. SBG_ECAN_LOG_EVENT_TIME_A/B/C/D/E (0x201, 0x203, 0x205, 0x207, 0x209)

Field	Description	Unit	Format	Size	Offset
TIME_OFFSET_0	Time offset for the second received event.	µs	uint16	2	0
TIME_OFFSET_1	Time offset for the third received event.	µs	uint16	2	2
TIME_OFFSET_2	Time offset for the fourth received event.	µs	uint16	2	4
TIME_OFFSET_3	Time offset for the fifth received event.	µs	uint16	2	6
				Total size	8

Note: The Ekinox series supports events markers at up to 1 kHz. If too much events are sent, it may overload the internal CPU leading to decreased performance and reliability.

Warning: Never leave an activated Sync In signal unconnected as noise on the line may trigger spurious events at very high rates.

4. Support

Our goal is to provide the best experience to our customers. If you have any question, comment or problem with the use of your Ekinox, we would be glad to help you, so please feel free to contact us. Please do not forget to mention your Ekinox Device ID (written on your Ekinox' label).

You can contact us by:

- Email: support@sbg-systems.com
- Phone: +33 1 80 88 45 00