NAVIGATION

API Manual

VERSION 1.00

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ABBREVIATIONS

Abbreviation	Description
AHRS	Attitude Heading Reference System
BIN Message	Binary Message
CEP	Circular Error Probability
CSEP	Calculated Separation
IMU	Inertial Measurement Unit
INS	Inertial Navigation System
MSEP	Measured Separation
N/A	Not Available
N/C	Not Connected
RMS	Root Mean Square
TBD	To Be Determined
UKF	Unscented Kalman Filter
VG	Vertical Gyro

1. INTRODUCTION

1.1. API Overview

The navigation API (Application Programming Interface) is a set of commands that any Host controller can use to communicate with a connected navigation device to set the working configuration of the navigation device or to receive data messages. Communication with the navigation device is via RS232/RS422 serial port channel.

Navigation devices with a GNSS receiver include a second RS232 serial port channel, dedicated to working directly with the GNSS device to configure and receive NMEA-0183 messages in parallel to the main navigation device channel. While GNSS device API commands are not the subject of this manual, NMEA-0183 messages structure and message fields are included.

This document describes:

- API commands that control the navigation device
- API General message structure and the fields in each data message
- Specific information on the dynamic field calibration procedures that you should follow to achieve more accurate navigation
- GPS direct NMEA 0183 message information

1.2. Port Interfaces

1.2.1. Navigation Device - Main Port Interface

The main port exists in all navigation platforms. They all share the same API structure and most of the API commands.

Table 1. Main Port Interface (Port-A)

Parameter	Value	Units	Status
Baud Rate	921600	BPS	Configurable
Start Bit	1	Bit	Constant
Byte Size	8	Bit	Constant
Stop Bit	1	Bit	Constant
Parity	None		Constant
HW Flow Control	None		Constant
SW Flow Control	None		Constant

1.2.2. GNSS Port Interface

A second port for direct communication is available for navigation platforms with a GNSS receiver.

Table 2. GNSS Port Interface (Port-B)

Parameter	Value	Units	Status
Baud Rate	115200	Bps	Configurable
Start Bit	1	Bit	Constant
Byte Size	8	Bit	Constant
Stop Bit	1	Bit	Constant
Parity	None		Constant
HW Flow Control	None		Constant
SW Flow Control	None		Constant

2. NAVIGATION MAIN PORT API

2.1. General Message Structure

All API instructions have the same basic message structure (Table 3). The *data* element in the API instruction is the only element whose length is not constant. It can even be omitted in some commands (particularly GET commands).

Table 3. General Message Structure

	Header	Length	Group/D.T	Command	Device ID	Data	CkSum
Bytes	2	1	1	1	1	N	2
Default	[>	5+N	< 0x80				

2.2. API Instruction Elements

Table 4 lists the API instruction fields and elements. An API command consists of three elements, each of which may contain one or more fields (shown in distinct colors in Table 4).

- The Packet Recognition element (blue) includes leading message information (the header and length) and the check sum calculation (the message footer).
- The Command Identity element (orange) contains the command elements.
- The Data element (yellow) includes command GET/SET parameter values.

Table 4. API Instruction Elements

Title	Expected	Bytes	Description
Header	[>	2	This header content starts/leads any command (Hex Values: 0x5b 0x3e)
Length	5+N	1	One byte value indicates the number of bytes to follow this byte (including the check-sum bytes) N = the number of Data bytes 5 = a fixed number of bytes that includes the Command Identity element and Checksum
Group/D.T	< 0x80	1	Indicates the parent group of commands. This field should be below 80Hex (128D) for all commands.

Title	Expected	Bytes	Description
Command		1	Command IDs are related to the specified Group.
Device-Id		1	When the Group ID indicates a sub-device: 0 = directs to all devices of the Group 1…i = directs to a specific device ID in the Group
Data		N	Command Data bytes (such as function parameters) For most GET commands, there are no data fields.
CkSum		2	The sum of all bytes from the Group field to last Data byte.

2.2.1. Packet Recognition Element

The API command reply from the device to the Host uses the same API command structure shown in Table 3 and Table 6.

The three blue fields in the API instruction structure – Header, Length, and CkSum – are required for instruction detection, verification and locking. Each instruction starts with a constant Header field "[>" (0x5b 0x3e) characters, followed by the Length field (a byte value that indicates the number of bytes in this frame that follow the Length field).

To lock onto an instruction packet:

1. Detect the Header characters from the incoming characters.
2. Collect all the instruction data bytes according to the Length field value.
1. Calculate the checksum (by adding the bytes between the Length field and the CkSum field) and verify the result with the instruction check-sum (CkSum) field that you receive.

2.2.2. Instruction Command Element

After locking onto an instruction packet, use the command element to parse the Data element information field, which may contain one or more bytes or several different data types (float, double, int32, and so on). The command element consists of three orange fields: Group/Device-Type, Command, and Device-ID.

The Group/Device-Type field indicates the command mechanism (work mode) to which you direct a SET/GET command in the Command-ID field (Table 5). The Command-ID field indicates the instruction number in the group of commands.

The Device-ID field is zero (0) for Groups/Device-Types below 0x20. If the Group/Device-Type is greater than, or equal to, 0x20, the Device-ID indicates the sub-device from type Group/Device-Type.

For example, if Group/Device-Type = 0x24 (Accelerometers), you can direct a command to all accelerometers using Device-ID = 0x00 or you can direct a command to Acc-X if Device-ID = 0x01, to Acc-Y if Device-ID =0x02, and so on.

Table 5. Available IDs for Group/D.T. Field

Group/D.T. Value	Group/D.T. Name	Description
0x01	Immediate	Instructions that can be sent in real-time mode.
0x10	Configuration	General settings registers to handle messages.
0x11	Calibration	General settings and instructions to handle dynamic calibration.
Devices		
0x00	System	Device specific Settings instruction that are system specific.
0x24	Acceleration	General settings registers relating to the Accelerometers.
0x25	Rate Gyro	General settings registers relating to the Rate Gyros.
0x2A	IMU	General settings registers relating to the IMU.
0x50	UKF	General setting registers relating to the algorithm.

You can learn more about the following specific work modes:

- **Immediate** mode (Section 3)
- **Configuration** mode (Section 3.1)
- **Calibration** mode (Section 3.2)

Note	The Group/Device-Type field can be used as: a) a Group in Real-Time mode, whose relevant IDs may be: 0x01 (Immediate), 0x10 (Configuration), 0x11(Calibration). b) a Device-Type in Configuration mode, whose field values may be: 0x00 (System) or a sub-device, such as 0x24 (Accelerometers). Table 5 lists the relevant IDs and values for both of the above uses.

2.2.3. Data Element

Depending upon the instructions used, the Data element may contain a variable number of fields or may be omitted.

- For SET commands, the Data element contains parameters to update the current settings.
  - The device replies to a SET Command with ACK reply.
- For GET commands, the Data element contains a register index or a list of registers from which to read values. The Data element is omitted for many GET commands.
  - The device replies to a GET command with the content of the register's information.

2.3. General Description of API SET Instructions

SET API instructions change a device's current setting registers.

When the host computer sends a SET Instruction to a connected device, the connected device returns an ACK reply to the host computer. This reply includes a Data element consisting of a single field to indicate whether the last SET command was received (OK).

The ACK reply instruction returns the SET instruction values in the Command Element field, to show to which SET command the ACK reply relates.

Table 6 shows the ACK reply structure. A value of 0x01 in the ACK Reply Data field indicates that the command was received successfully.

Table 6. ACK Reply Structure

	Header	Length	Group/D.T.	Command	Device ID	Data	CkSum
Bytes	2	1	1	1	1	1	2
Default	[>	6	As Sent	As Sent	As Sent	1 or 0	Calc. Val

2.4. General Description of API GET Instructions

GET API instructions read current values from the connected device's setting registers. It is advisable to read current values before and immediately after changing (writing new values) those values to verify that the intended changes were made.

When the host computer sends a GET Instruction to a connected device, the connected device returns a Command Reply instruction with the requested information in the Data element to the host computer.

Table 8. Command Reply Structure

	Header	Length	Group/D.T.	Command	Device ID	Data	CkSum
Bytes	2	1	1	1	1	1	2
Default	[>	5+N	As Sent	As Sent	As Sent	N	Calc. Val

3. IMMEDIATE GROUP INSTRUCTIONS

The instructions under Immediate group can be delivered to the connected device when the connected device is in: “Real-Time” mode. However, for all other group commands the connected device must be in a specific mode (for example, Configuration or Calibration).

The list of instructions under the Immediate group are minimal and are mainly for switching modes.

Table 7. Immediate Group Instructions

Index	Command	Description
0x01	Enter/Exit Configuration	Enters/exits configuration mode
0x02	Enter/Exit Calibration	Enters/exits Calibration mode
0x03	Get Device Name	Reads the Device Name without entering Configuration mode
0x04	Get Sample	Obtains device (predefined) active messages when sample mode is set to Polling

The Immediate group instructions are used mainly to change the current working mode to either Configuration, Calibration, or back to Real-Time (the default mode).

The Immediate group includes instructions to:

- Obtain the device name
- Pull a sample when configured in Polling mode instead of Continuous mode.

Table 8. Immediate Group Structure

	Header	Length	Group/D.T.	Command	Device ID	Data	CkSum
Bytes	2	1	1	1	1	1	2
Default	[>	5/6	0x01	(Table 7)	0x00	1/none	

Table 8 lists optional values used to build immediate instructions.

- The immediate instructions length field is 5 or 6 bytes, since either there is no Data element or the Data element consists of a single byte field.

Table 8 shows the Group/D.T. field, which indicates the Immediate Group index of 0x01

Table 7 lists the Command Index options.

The Device-ID should always be 0.

3.1. Enter/Exit Configuration Mode

Use this command to change the current mode from Real-Time mode (default after proper power-up sequence) to Configuration Mode. When the device enters Configuration Mode, the user can send the API instructions under the Configuration Group.

- You cannot send Configuration API instructions when the device is in Real-Time Mode.
- Sending Enter Configuration Mode command when the device is already in configuration mode has no meaning.
- Sending Exit Configuration Mode command when the device is already in "Real-Time" mode has no meaning.

The Data element is built from a single parameter that indicates whether the operation is “Exit” or “Enter” (Table 9).

Table 9. Enter/Exit Configuration Mode - Command Index 0x01

Field Index	Field Name	Field Type	Field Values
1	Enter/Exit Configuration Mode	uint8_t	0 – Exit Configuration mode 1 – Enter Configuration mode

In the following example, commas are not part of the command or the reply.

Command - Enter Configuration

0x5b, 0x3e, 0x6, 0x1, 0x1, 0x0, 0x1, 0x3, 0x0

ACK Reply

0x5b, 0x3e, 0x6, 0x1, 0x1, 0x0, 0x1, 0x3, 0x0

Command - Exit Configuration

0x5b, 0x3e, 0x6, 0x1, 0x1, 0x0, 0x0, 0x2, 0x0

ACK Reply

0x5b, 0x3e, 0x6, 0x1, 0x1, 0x0, 0x1, 0x3, 0x0

3.2. Enter/Exit Calibration Mode

Use this command to change the current mode from Real-Time mode (default after proper power-up sequence) to Calibration Mode. When the device enters Calibration Mode, you can send the API instructions under the Calibration Group.

You cannot send Calibration API instructions when the device is in Real-Time Mode.

- You cannot send Calibration API instructions when the device is in Real-Time Mode.
- Sending Enter Calibration Mode command when the device is already in calibration mode has no meaning.
- Sending Exit Calibration Mode command when the device is already in "Real-Time" mode has no meaning.

Calibration mode is used for dynamic calibrations (for example, Hard-Iron), which you handle in the field.

The Data element is built from a single parameter that indicates whether the operation is “Enter” or “Enter” (Table 10).

Table 10. Enter/Exit Calibration Mode - Command Index 0x02

Field Index	Field Name	Field Type	Field Values
1	Enter/Exit Calib. Mode	uint8_t	0 – Exit Calibration mode 1 – Enter Calibration mode

In the following example, commas are not part of the command or the reply.

Command - Enter Calibration mode

0x5b, 0x3e, 0x6, 0x1, 0x2, 0x0, 0x1, 0x4, 0x0

ACK Reply

0x5b, 0x3e, 0x6, 0x1, 0x2, 0x0, 0x1, 0x4, 0x0

Command - Exit Calibration mode

0x5b, 0x3e, 0x6, 0x1, 0x2, 0x0, 0x0, 0x3, 0x0

ACK Reply

0x5b, 0x3e, 0x6, 0x1, 0x2, 0x0, 0x1, 0x4, 0x0

3.3. Get Device Name

Use this command to identify a connected navigation device. This GET instruction reads the device name from the connected device when the device is in Real-Time Mode. You can use this command to verify that the connected device is the device with which you want to work with.

This GET command has no Data element and is therefore sent without an argument.

The optional return values are transmitted as a null terminated string (char*). The following tables show the return values for different connected platforms.

Table 11. Optional ExiguoLP (EXLP100/200/300) Return Values

Platform	Return Values
AHRS	EXIGUO_LP_AHRS
INS	EXIGUO_LP_INS
INS with 2 antennas	EXIGUO_LP_INS2ANT

Table 12. Optional gINS (gX100/200/300) Return Values

Platform	Return Values
AHRS	GINS_AHRS
INS	GINS_INS
INS with 2 antennas	GINS_INS2ANT

Table 13. Optional Exiguo (EX100/200/300) Return Values

Platform	Return Values
AHRS	EXIGUO_AHRS
INS	EXIGUO_INS
INS with 2 antennas	EXIGUO_INS2ANT

In the following example, commas are not part of the command or the reply.

Command - Get Device Name

0x5b, 0x3e, 0x5, 0x1, 0x3, 0x0, 0x4, 0x0

Command Reply

0x5b, 0x3e, 0xf, 0x1, 0x3, 0x0, 0x1, 0x3, 0x0, 0x45, 0x58, 0x49, 0x47, 0x55, 0x4F, 0x5F, 0x41, 0x48, 0x52, 0x53, 0x0, 0x66, 0x3

3.4. Get Sample

Use this command to acquire a sample from a connected device, when the device is configured to work in Polling mode, rather than in Continuous mode (the default).

This command includes an argument that indicates the field index of the message to acquire.

Table 14. Get Sample - Command Index 0x04

Field Index	Field Name	Field Type	Field Values
1	Message Index	uint8_t	Platform/Message dependent

In the following example, commas are not part of the reply (and there is no command reply).

Command - Get Sample IMU-2 message

0x5b, 0x3e, 0x06, 0x01, 0x04, 0x00, 0x21, 0x26, 0x00

Message Reply for IMU-2 as example

0x5b, 0x3e, 0x2b, 0x84, 0x21, 0x1f, 0x00, 0x00, 0x10, 0x00, 0x00, 0x00, 0x51, 0xab, 0xc4, 0x04, 0x96, 0xd3, 0x52, 0x42, 0xe3, 0x23, 0xa0, 0xbb, 0x2a, 0xa4, 0x7d, 0xbd, 0x9d, 0xc3, 0x71, 0xbf, 0x96, 0x73, 0x95, 0xbd, 0x4f, 0x0a, 0x71, 0x3f, 0x62, 0x9e, 0x05, 0xbf, 0xb6, 0x10

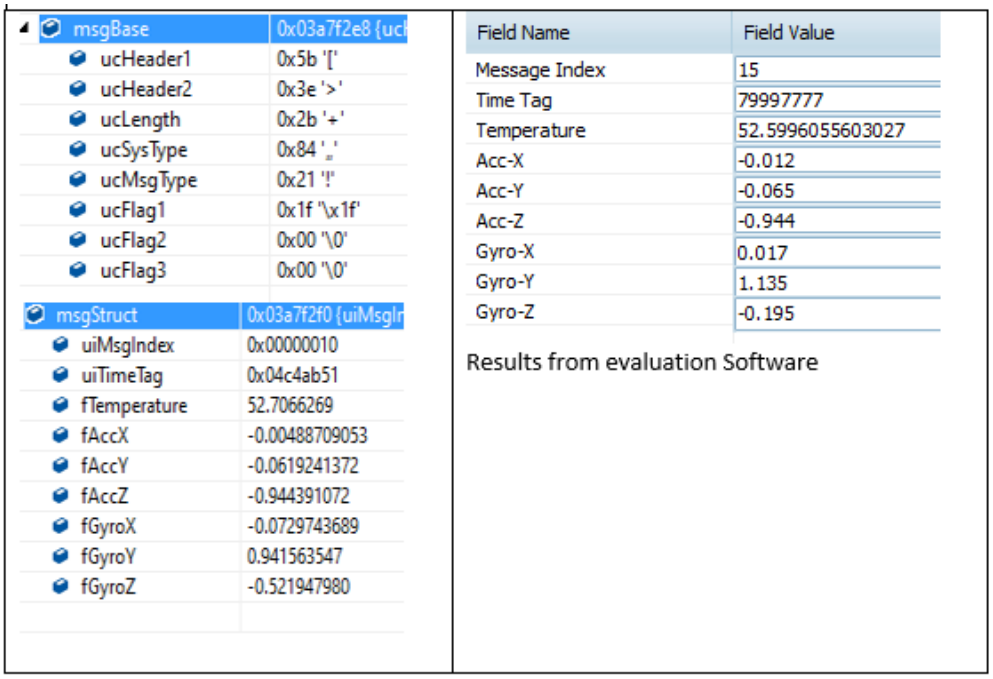


Figure 1. Sample Parsing

4. CONFIGURATION GROUP INSTRUCTIONS

The configuration instructions group contains many instructions that impact system behavior, including reading/writing full device information, controlling output messages to the host, output rate, and more (Table 15).

You must be in Configuration mode to use the Configuration group instructions.

Table 15. Configuration Group Instructions

Index	Command	Description
0x01	Reset To Factory	Resets all configuration changes to factory settings
0x02	Soft Reset	Resets the device
0x03	Burn To Flash	Burns current settings to flash for use as the default in the next powerup
0x04	Get HW Ver.	Reads the device hardware version
0x05	Get FW Ver.	Reads the device firmware version
0x06	Get Device Type	Reads the device type
0x07	Get Device Name	Reads the device name
0x08	Get Device Ver.	Reads the device version
0x09	Factory use only	
0x0A	Get Serial number	Reads the device serial number
0x0B	Set Frame Type and Rate	Sets the active frame rate for each frame type. Value of 0 - set the frame off
0x0C	Get Frame Type and Rate	Gets the active rate for each frame type
0x0D	Set Baud Rate	Sets a new Baud Rate for the Main communication channel
0x0E	Get Baud Rate	Gets the current Baud Rate of the Main communication channel
0x0F	Set Sample Mode	Sets whether Messages are sent on request or continuously.
0x10	Get Sample Mode	Gets the current selected sample mode
0x11	Set Operation Mode	Sets whether the system begins working immediately or starts with a bias estimation procedure.

Index	Command	Description
0x12	Get Operation Mode	Gets the user-selected operation mode
0x13-0x30	Factory use only	

Table 16. Configuration Group Structure with Optional Values

	Header	Length	Group/D.T.	Command	Device ID	Data	CkSum
Bytes	2	1	1	1	1	1	2
Default	[>	5+N	0x10	Table 15	0x00	N/none	Calc. Val

4.1. Reset to Factory

Use this command to restore the device's default factory settings, which are in a different memory location that you cannot change.

There is no Data element since this command has no arguments.

Table 17. Reset to Factory - Command Index 0x01

Field Index	Field Name	Field Type	Field Values

In the following example, commas are not part of the command or the reply.

Command - Soft Reset

0x5b, 0x3e, 0x5, 0x10, 0x1, 0x0, 0x11, 0x0

ACK Reply

0x5b, 0x3e, 0x6, 0x10, 0x1, 0x0, 0x1, 0x12, 0x0

4.2. Soft Reset

Use this command to reset the system without having to perform a power cycle. The soft reset will be executed only after you exit the Configuration mode.

There is no Data element since this command has no arguments.

Table 18. Soft Reset - Command Index 0x02

Field Index	Field Name	Field Type	Field Values

In the following example, commas are not part of the command or the reply.

Command - Soft Reset

0x5b, 0x3e, 0x5, 0x10, 0x2, 0x0, 0x12, 0x0

ACK Reply

0x5b, 0x3e, 0x6, 0x10, 0x2, 0x0, 0x1, 0x13, 0x0

4.3. Burn to Flash

Use this command to save all updated settings to the local flash to be used as default settings on the next powerup. When configuration instructions determine system behavior, all changes are temporary and influence the active registers in memory. Therefore, the settings must be saved if you plan to use them in the next powerup.

There is no Data element since this command has no arguments.

Table 19. Burn to Flash - Command Index 0x03

Field Index	Field Name	Field Type	Field Values

In the following example, commas are not part of the command or the reply.

Command – Burn to Flash

0x5b, 0x3e, 0x5, 0x10, 0x3, 0x0, 0x13, 0x0

ACK Reply

0x5b, 0x3e, 0x6, 0x10, 0x3, 0x0, 0x1, 0x14, 0x0

4.4. Get Device Information

Use this set of commands to read connected device information. While each command reads different information, all have the same structure and work in the same way.

The commands are:

- Get Hardware Version (0x04).
- Get Firmware Version (0x05).
- Get Device Type (0x06).
- Get Device Name (0x07).
- Get Device Version (0x08).
- Get Device Serial Number (0x0A).

Table 20. Get Device Information Commands

Command Index	0x04, 0x05, 0x06, 0x07, 0x08, 0x0A		
List of Arguments			
Field Index	**Field Name**	**Field Type**	**Field Values**

There is no Data element since these commands have no arguments.

Table 21 lists the reply structure of these commands. (Note that the return data is char* with up to 20 characters.)

Table 21. Reply structure for Get Device - Command Index 0x04, 0x05, 0x06, 0x07, 0x08, 0x0A

Command Index	0x04, 0x05, 0x06, 0x07, 0x08, 0x0A		
List of Arguments			
Field Index	**Field Name**	**Field Type**	**Field Values**
1	Device Info.	char*	Null Terminated string up to 20 characters

In the following examples, commas are not part of the command or the reply.

Command - Get Device Name AHRS

0x5b, 0x3e, 0x5, 0x10, 0x7, 0x0, 0x17, 0x0

Command Reply

0x5b, 0x3e, 0xf, 0x10, 0x7, 0x0, 0x45, 0x58, 0x49, 0x47, 0x55, 0x4f, 0x5f, 0x41, 0x48, 0x52, 0x53, 0x00, 0x75, 0x03

Command - Get HW Version

0x5b, 0x3e, 0x5, 0x10, 0x4, 0x0, 0x14, 0x0

Command Reply

0x5b, 0x3e, 0x12, 0x10, 0x4, 0x0, 0x45, 0x58, 0x49, 0x47, 0x55, 0x4f, 0x2d, 0x76, 0x31, 0x2e, 0x30, 0x30, 0x0, 0x47, 0x03

Command - Get FW Version

0x5b, 0x3e, 0x5, 0x10, 0x5, 0x0, 0x15, 0x0

Command Reply

0x5b, 0x3e, 0x14, 0x10, 0x5, 0x0, 0x76, 0x31, 0x2E, 0x30, 0x31, 0x5F, 0x62, 0x30, 0x30, 0x32, 0x33, 0xd1, 0x02

Command - Get Device Type

0x5b, 0x3e, 0x5, 0x10, 0x6, 0x0, 0x16, 0x0

Command Reply

0x5b, 0x3e, 0x10, 0x10, 0x6, 0x0, 0x4e, 0x61, 0x76, 0x69, 0x67, 0x61, 0x74, 0x69, 0x6f, 0x6e, 0x0, 0x26, 0x4

4.5. Set Frame Type and Rate

Use this command to control which device message is sent to the host controller and at what rate it is sent. To disable a message, set the rate value to 0. To enable a message, set the rate value to any value other than 0.

The total bandwidth that the messages occupy should not exceed the selected baud-rate.

For example, if you select a message that is 120 bytes long with frame-out rate of 100Hz, the baud rate must be greater than 120,000 bps, such as 230400 bps and above.

The command uses two parameters of single byte: Frame Type and Frame Rate.

Table 22. Set Frame Type and Rate - Command Index 0x0B

Field Index	Field Name	Field Type	Field Values
1	Frame Type	Uint8_t	Table 23
2	Frame Rate	Uint8_t	Table 24

Table 23. Frame Types

Index	Message	Platform
0x21	IMU 2 - 6Dof	All Platforms
0x22	IMU 3 - 9Dof	All Platforms
0x23	IMU 4 - Misc. Sensors	All Platforms
0x30	GPS 1 - LLA	INS platforms
0x31	GPS 2 - ECEF	INS platforms
0x32	GPS 3 - Statistic	INS platforms

Index	Message	Platform
0x33	GPS 4 - RTK	None
0x40	Tilt 1 – [R, P]	All Platforms
0x41	Tilt 2 – [R, P, Y]	All Platforms
0x42	Tilt 3 – [Quarter]	All Platforms
0x43	Tilt 4 – [DCM]	All Platforms
0x50	INS 1 – Tilt & Pos	INS Platforms
0x51	INS 2 – Tilt, Pos & Vel	INS Platforms
0x52	INS 3 – Tilt, Pos, Vel & Time	INS Platforms
0x53	INS 4 – FWD Lever ARM	INS 2 Antennas only

Table 24. Frame Rates

Index	Rate (Hz)	Message Types
0x00	Disable	All message types
0x01	1	All message types
0x02	2	All message types
0x03	5	All message types
0x04	10	All message types
0x05	25	All message types
0x06	50	All message types
0x07	100	All message types
0x08	200	IMU Message Types
0x09	250	IMU Message Types
0x0A	500	IMU Message Types
0x0B	1000	IMU Message Types
0x0C	2000	IMU Message Types for gINS Platforms only (gX100/200/300)

In the following examples, commas are not part of the command or the reply.

Command - Set IMU2 Message Rate to 0 => Disable message

0x5b, 0x3e, 0x7, 0x10, 0xb, 0x0, 0x21, 0x0, 0x3c, 0x0

ACK Reply

0x5b, 0x3e, 0x6, 0x10, 0xb, 0x0, 0x1, 0x1c, 0x0

Command - Set Tilt2 Message Rate => Enable message with 50Hz

0x5b, 0x3e, 0x7, 0x10, 0xb, 0x0, 0x31, 0x6, 0x52, 0x0

Ack/Command Reply

0x5b, 0x3e, 0x6, 0x10, 0xb, 0x0, 0x1, 0x1c, 0x0

4.6. Get Frame Type and Rate

Use this command to read the actual active rate of a selected message. The GET instruction is complementary to the instruction Set Frame-Type and Frame-Rate, as it provides the actual active rate of a selected message. The only argument is the desired Frame Type.

Table 25. Get Frame Type and Rate - Command Index 0x0C

Field Index	Field Name	Field Type	Field Values
1	Frame Type	Uint8_t	Table 23

Table 26 lists the reply structure fields for Get Frame Type and Rate.

Table 26. Reply structure for Get Frame Type and Rate - Command Index 0x0C

Command Index	0x0C		
List of Arguments			
Field Index	**Field Name**	**Field Type**	**Field Values**
1	Frame Rate.	Uint8_t	Table 24

In the following examples, commas are not part of the command or the reply.

Command - Get IMU2 - message rate

0x5b, 0x3e, 0x6, 0x10, 0xc, 0x0, 0x21, 0x3d, 0x0

Command Reply

0x5b, 0x3e, 0x7, 0x10, 0xc, 0x0, 0x21, 0x0, 0x3d, 0x0

Command - Get Tilt2 - message rate

0x5b, 0x3e, 0x6, 0x10, 0xc, 0x0, 0x41, 0x5d, 0x0

Command Reply

0x5b, 0x3e, 0x7, 0x10, 0xc, 0x0, 0x41, 0x6, 0x63, 0x0

4.7. Set Baud Rate

This SET command sets the channel communication baud rate, which should be broad enough to accommodate all selected messages.

The host controller and the device must operate at the same baud rate before you can set a new baud rate. The only argument is the new baud rate value.

Table 27. Set Baud Rate - Command Index 0x0D

Field Index	Field Name	Field Type	Field Values
1	Baud Rate	Uint32_t	Table 28

Table 28. Optional Communication Baud Rate Values

Index	Argument Baud Rate Values
1	115200
2	230400
3	460800
4	921600

In the following example, commas are not part of the command or the reply.

Command - Set Communication Baud Rate (921600)

0x5b, 0x3e, 0x9, 0x10, 0xd, 0x0, 0x0, 0x10, 0xe, 0x0, 0x3b, 0x0

ACK Reply

0x5b, 0x3e, 0x6, 0x10, 0xd, 0x0, 0x1, 0x1e, 0x0

4.8. Get Baud Rate

This GET command is complementary to the Set Baud Rate command and reads the current baud-rate. The host controller must operate at the correct baud rate.

There is no Data element since this command has no arguments.

Table 29. Get Baud Rate - Command Index 0x0E

Field Index	Field Name	Field Type	Field Values

The device reply structure for Get Baud Rate instruction is matched to the Set Baud Rate instruction (Table 27) with values shown in Table 28.

In the following example, commas are not part of the command or the reply.

Command - Get Communication Baud Rate

0x5b, 0x3e, 0x5, 0x10, 0xe, 0x0, 0x1e, 0x0

Command Reply

0x5b, 0x3e, 0x9, 0x10, 0xe, 0x0, 0x0, 0x10, 0xe, 0x0, 0x3c, 0x0

4.9. Set Sample Mode

This SET command determines how a connected device transmits data messages, either via continuous transmission (default mode for all systems) or via the Polling mode.

Table 30. Set Sample Mode - Command Index 0x0F

Field Index	Field Name	Field Type	Field Values
1	Sample Mode	Uint8_t	0 – Continuous 1 – Polling

In the following example, commas are not part of the command or the reply.

Command - Set Sample Mode

0x5b, 0x3e, 0x6, 0x10, 0xf, 0x0, 0x0, 0x1f, 0x0

ACK Reply

0x5b, 0x3e, 0x6, 0x10, 0xf, 0x0, 0x1, 0x20, 0x0

4.10. Get Sample Mode

This GET command is complementary to the Set Sample Mode and reads the Sample mode currently in use.

There is no Data element since this command has no arguments.

Table 31. Get Sample Mode - Command Index 0x10

Field Index	Field Name	Field Type	Field Values

The device reply structure for Get Sample Mode instruction is matched to the Set Sample Mode instruction (Table 30) with same values.

In the following example, commas are not part of the command or the reply.

Command - Get Sample Mode

0x5b, 0x3e, 0x5, 0x10, 0x10, 0x0, 0x20, 0x0

Command Reply

0x5b, 0x3e, 0x6, 0x10, 0x10, 0x0, 0x0, 0x20, 0x0

4.11. Set Operation Mode

This SET command determines if the system performs a Bias Estimation calibration on every powerup or if it uses the last saved Bias Estimation calibration. The default, for maximum accuracy, is to perform a bias estimation calibration on every powerup and software reset.

A register (which you can control) indicates how many values to collect before the Bias estimation calculation begins (Section 6.2.3 and Section 6.2.4 for more information how to set and read the number of samples).

Table 32. Set Operation Mode - Command Index 0x11

Field Index	Field Name	Field Type	Field Values
1	Operation Mode	Uint8_t	0 – Start Immediate 1 – Calc. Bias-Estimation

In the following example, commas are not part of the command or the reply.

Command - Set Operation Mode

0x5b, 0x3e, 0x6, 0x10, 0x11, 0x0, 0x1, 0x22, 0x0

ACK Reply

0x5b, 0x3e, 0x6, 0x10, 0x11, 0x0, 0x1, 0x22, 0x0

4.12. Get Operation Mode

This GET command complements the Set Operation Mode command and reads the current Operation mode.

There is no Data element since this command has no arguments.

Table 33. Get Operation Mode - Command Index 0x12

Field Index	Field Name	Field Type	Field Values

The device reply structure for Get Operation Mode instruction matches the Set Operation Mode instruction structure shown in Table 32.

In the following example, commas are not part of the command or the reply.

Command - Get Operation Mode

0x5b, 0x3e, 0x5, 0x10, 0x12, 0x0, 0x22, 0x0

Command Reply

0x5b, 0x3e, 0x6, 0x10, 0x12, 0x0, 0x00, 0x22, 0x0

5. CALIBRATION GROUP INSTRUCTIONS

The calibration instructions group contains all commands required to handle Bias Estimation calibration (on all platforms) and Hard-Iron Calibration (on INS and AHRS platforms). Factory calibration can always be restored. Table 34 lists the instructions available in the calibration group.

You can only use Calibration group instructions after entering Calibration mode successfully.

Table 34. Calibration Group Instructions

Index	Command	Description
0x01	Reset to Factory	Resets all calibration values to factory calibration
0x02	Burn to Flash	Saves Current calibration results in the Flash to be used from now on.
0x03	Start Bias Est.	Starts Bias Estimation calculation.
0x04	Stop Bias Est.	Stops Bias Estimation Calculation.
0x05	Get Bias Est. Cal.	Reads part A of the Bias Estimation calibration results.
0x06	Set Bias Est. Cal.	Writes part A of the Bias Estimation calibration results.
0x07	Get Bias Est. Extra Cal.	Reads part B of the Bias Estimation calibration results.
0x08	Set Bias Est. Extra Cal.	Writes part B of Bias Estimation calibration results.
0x09	Start HI Cal.	Starts Hard-Iron Calibration (magnetic calibration)
0x0A	Stop HI Cal.	Stops Hard-Iron Calibration.
0x0B	Get HI Cal.	Reads the Hard-Iron calibration results.
0x0C	Set HI Cal.	Writes the Hard–Iron calibration results.

Table 35. Calibration Group Structure

	Header	Length	Group/D.T.	Command	Device ID	Data	CkSum
Bytes	2	1	1	1	1	1	2
Default	[>	5+N	0x11	Table 34	0	N/none	Calc. Val

The length field in Table 35 can be quite large, due to the Data element for the Get and Set calibration functions.

5.1. Reset to Factory

This SET command restores the device's factory default calibration, which is in a different memory location that you cannot change. The command influence the immediate memory registers only; the user has to send the Burn to Fash command in order for the device to save the factory settings in the Flash.

There is no Data element since this command has no arguments.

Table 36. Reset to Factory - Command Index 0x01

Field Index	Field Name	Field Type	Field Values

In the following example, commas are not part of the command or the reply.

Command: Reset to Factory

0x5b, 0x3e, 0x05, 0x11, 0x01, 0x00, 0x12, 0x00

Ack/Cmnd Reply:

0x5b, 0x3e, 0x06, 0x11, 0x01, 0x00, 0x01, 0x13, 0x00

5.2. Burn to Flash

This SET command saves calibration values temporarily retained in the memory registers to the Flash memory for the next power-up.

There is no Data element since this command has no arguments.

Table 37. Burn to Flash - Command Index 0x02

Field Index	Field Name	Field Type	Field Values

In the following example, commas are not part of the command or the reply.

Command: Burn to Flash

0x5b, 0x3e, 0x05, 0x11, 0x02, 0x00, 0x13, 0x00

Ack/Cmnd Reply:

0x5b, 0x3e, 0x06, 0x11, 0x02, 0x00, 0x01, 0x14, 0x00

5.3. Bias Estimation Calibration Overview

A compensation algorithm compensates for sensor biases. By default, navigation systems perform the bias estimation calculation immediately after powerup in static conditions. The system retains the calibration in memory registers until the next power cycle.

If the bias estimation was not performed on power up, you can still calculate it by sending the start Bias Estimation instruction.

When a predefined number of samples have been collected (or when a Stop Bias Estimation command is sent to the system), the measurement collection process ends and the bias calculation begins.

If the Bias Estimation calculation succeeds, the Burn to Flash command should be executed to save the new calibration values.

You can read calibration values, using the Get Bias estimation calculation (Two data structures). You can then save the results on the host controller and rewrite them if required, using the Set Bias Estimation Calculation and Set Bias Estimation Extra Calculation commands.

During the calibration process, the navigation system sends the following status messages (see more information on Status Message in Section:7.5)

1. smStartStaticCal - when the Start Bias Estimation Calculation command has been received
2. smInStaticCal – during data collection, the device sends the percentage of measurements processed
3. smDoneStaticCal - When the Bias Estimation calibration succeeds.
4. smStaticCalError - When the Bias Estimation calibration fails.

All platforms use the Bias Estimation.

Note	It is best practice to save the new calibration values since, when the system exits the Calibration mode and reverts to Real-Time mode, it undergoes an automatic Soft Reset. Bias estimation should always be under static conditions.

The bias estimation modes are shown in Figure 2 (default) and Figure 3 (manual) below.

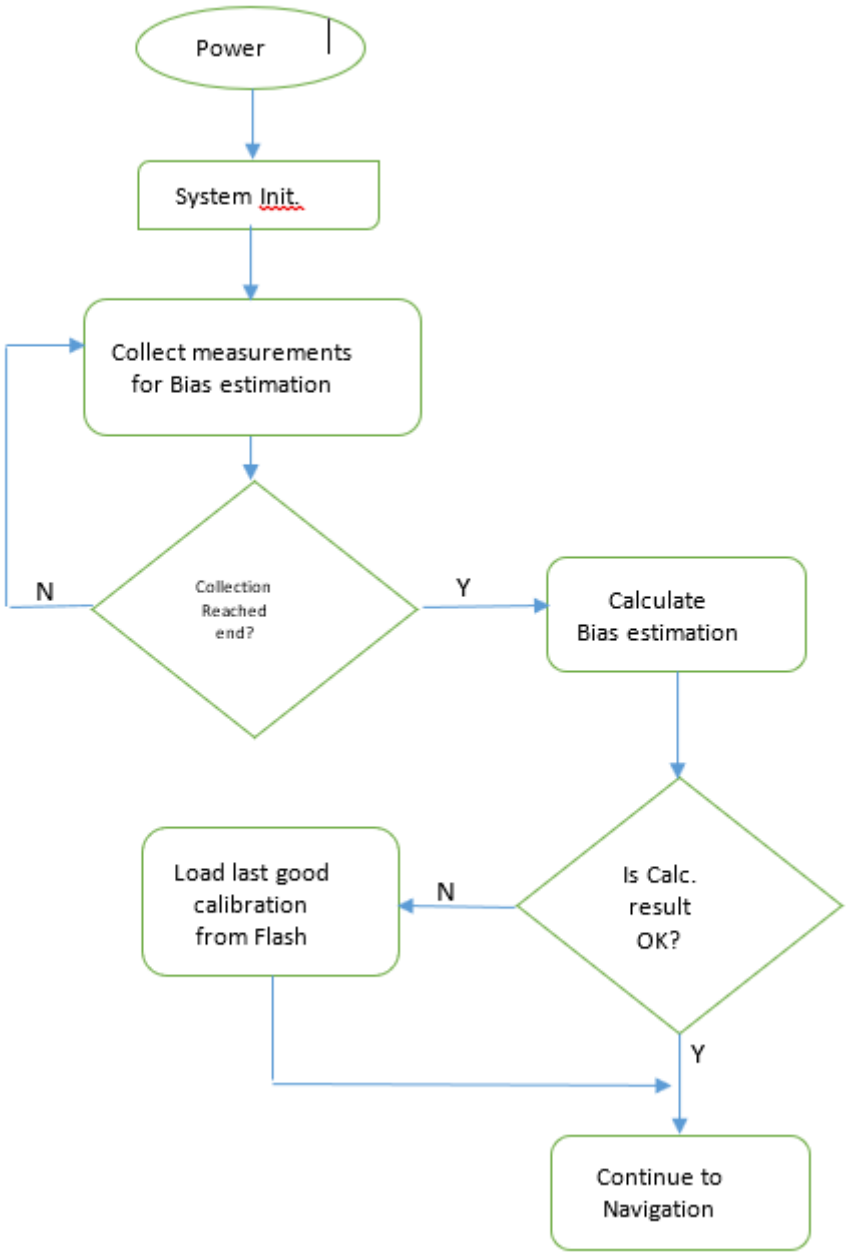


Figure 2. Bias Estimation Default Power-up Flow

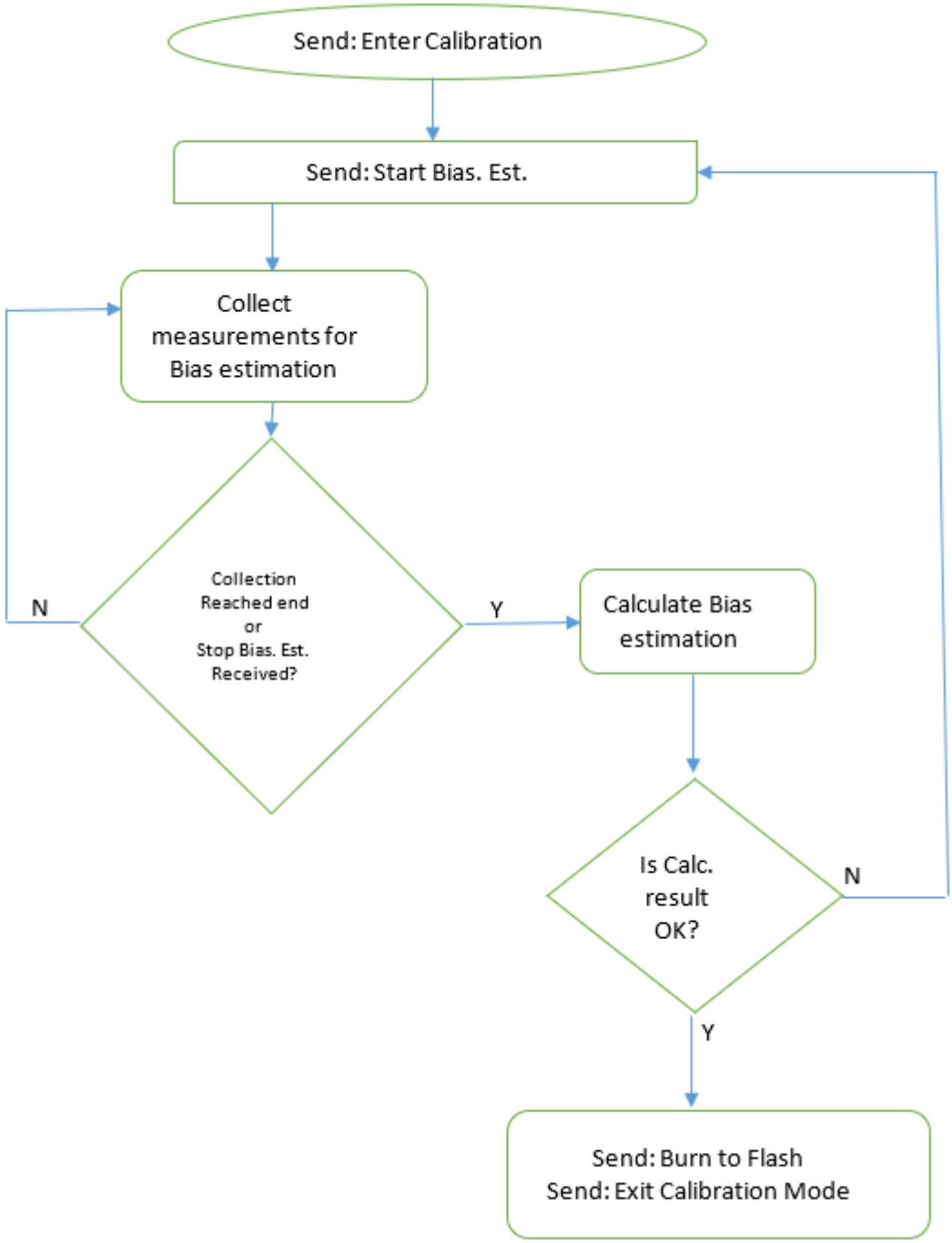


Figure 3. Manual Bias Estimation Flow

5.4. Start Bias Estimation

This SET command initiates a Bias Estimation calibration manually at any time (in static conditions) in Calibration mode.

There is no Data element since this command has no arguments.

Table 38. Start Bias Estimation - Command Index 0x03

Field Index	Field Name	Field Type	Field Values

In the following example, commas are not part of the command or the reply.

Command: Start Bias Estimation

0x5b, 0x3e, 0x05, 0x11, 0x03, 0x00, 0x14, 0x00

Ack/Command Reply:

0x5b, 0x3e, 0x06, 0x11, 0x03, 0x00, 0x01, 0x15, 0x00

5.5. Stop Bias Estimation

This SET command stops the bias estimation at any time before the predetermined number of measurements have been calculated.

By default, the bias estimation mechanism register indicates how many measurements to collect before the calculation begins (between 1000 to 9000 samples).

There is no Data element since this command has no arguments.

Table 39. Stop Bias Estimation - Command Index 0x04

Field Index	Field Name	Field Type	Field Values

In the following example, commas are not part of the command or the reply.

Command: Stop Bias-Estimation

0x5b, 0x3e, 0x05, 0x11, 0x04, 0x00, 0x15, 0x00

Ack/Command Replay:

0x5b, 0x3e, 0x06, 0x11, 0x04, 0x00, 0x01, 0x16, 0x00

5.6. Get Bias Estimation Calibration

This GET command reads the current Bias Estimation calibration from the memory of a connected device. Together with the Get Bias Estimation Extra Calibration command, it is possible to read the entire bias estimation calibration.

There is no Data element since this command has no arguments.

Table 40. Get Bias Estimation Calibration - Command Index 0x05

Field Index	Field Name	Field Type	Field Values

Table 41 contains the device reply structure for the Get Bias Estimation Calibration command.

Table 41. Reply for Get Bias Estimation Calibration - Command Index 0x05

Field Index	Field Name	Field Type	Field Values
1..27/28	CalibVals [1..27/28]	Float[27/28]	VG/AHRS – 27 float Fields INS/INS2ANT – 28 float Fields

5.7. Set Bias Estimation Calibration

This SET command complements the Get Bias Estimation Calibration and sends preloaded Bias Estimation Calibration to the connected device. You can use the Set Bias Estimation Calibration with Set Bias Estimation Extra Calibration to write the entire bias estimation calibration.

Table 42. Reply for Set Bias Estimation Calibration - Command Index 0x06

Field Index	Field Name	Field Type	Field Values
1..27/28	CalibVals [1..27/28]	Float[27/28]	VG/AHRS – 27 float Fields INS/INS2ANT – 28 float Fields

5.8. Get Bias Estimation Extra Calibration

This GET command reads the current Bias Estimation Extra calibration parameters from the memory of the connected device.

There is no Data element since this command has no arguments.

Table 43. Get Bias Estimation Extra Calibration - Command Index 0x07

Field Index	Field Name	Field Type	Field Values

Table 44 contains the device reply structure for the Get Bias Estimation Extra Calibration command.

Table 44. Reply for Get Bias Estimation Extra Calibration - Command Index 0x07

Field Index	Field Name	Field Type	Field Values
1..19	CalibVals [1..19]	Double[19]	Array of 19 values of type double

5.9. Set Bias Estimation Extra Calibration

This command complements the Get Bias Estimation Extra Calibration command and sends a preloaded Bias Estimation Extra Calibration to the connected device.

Table 45. Set Bias Estimation Extra Calibration - Command Index 0x08

Field Index	Field Name	Field Type	Field Values
1..19	CalibVals [1..19]	Double[19]	Array of 19 values of type double

5.10. Hard-Iron Calibration Overview

Navigation systems that use magnetometer sensors (AHRS, INS) must compensate for the magnetic environment surrounding the system, at least for the first installation.

The navigation system comes with instructions for performing, reading, and writing hard-iron calibration.

Hard-iron (H.I) calibration is a manual operation. In Calibration mode, send the Start H.I calibration command, rotate the navigation system platform at least 360 degrees (recommended 720 degrees) horizontally, and send the "Stop H.I calibration" Command. When the calibration succeeds, send the Burn to Flash command to save the current calibration results.

During the calibration process, the connected system should send the following status messages (see more information on Status Message in Section:7.5):

1. smStartHICal – When the Start H.I Calculation command has been received.
2. smInHiCal – during data collection, the device sends the percentage of measurements processed.
3. smDoneCal – when H.I calibration calculation succeeds
4. smHICalError – when H.I calibration calculation fails

The Get Hard-Iron Calibration command reads the results to the host controller and allows the user to save them on a file and rewrites them to the device if and when required, using the complementary Set Hard-Iron Calibration command.

Note	When you exit the Calibration mode, the connected navigation system performs a soft reset.

5.11. Start Hard-Iron Calibration

This SET command initiates a Hard-Iron calibration manually in Calibration mode.

There is no Data element since this command has no arguments.

Table 46. Start Hard-Iron Calibration - Command Index 0x09

Field Index	Field Name	Field Type	Field Values

In the following example, commas are not part of the command or the reply.

Command: Start Hard-Iron

0x5b, 0x3e, 0x05, 0x11, 0x09, 0x00, 0x1a, 0x00

Ack/Command Reply:

0x5b, 0x3e, 0x06, 0x11, 0x09, 0x00, 0x01, 0x1b, 0x00

5.12. Stop Hard-Iron Calibration

This SET command stops the Hard-Iron Calibration" command.

There is no Data element since this command has no arguments.

Table 47. Stop Hard-Iron Calibration - Command Index 0x0A

Field Index	Field Name	Field Type	Field Values

In the following example, commas are not part of the command or the reply.

Command: Stop Hard-Iron

0x5b, 0x3e, 0x05, 0x11, 0x0a, 0x00, 0x1b, 0x00

Ack/Command Reply:

0x5b, 0x3e, 0x06, 0x11, 0x0a, 0x00, 0x01, 0x1c, 0x00

5.13. Get Hard-Iron Calibration

This GET command reads the current Hard-Iron calibration from the memory of the connected device.

There is no Data element since this command has no arguments.

Table 48. Get Hard-Iron Calibration - Command Index 0x0B

Field Index	Field Name	Field Type	Field Values

Table 49 contains the device reply structure for the Get Hard-Iron Calibration command.

Table 49. Reply for Get Hard-Iron Calibration - Command Index 0x0B

Field Index	Field Name	Field Type	Field Values
1..12	CalVal[1..12]	Float[12]	Array of 12 values of type float

5.14. Set Hard-Iron Calibration

This command complements the Get Hard-Iron Calibration and sends the preloaded Hard-Iron Calibration back to the connected device.

Table 50. Set Hard-Iron Calibration - Command Index 0x0C

Field Index	Field Name	Field Type	Field Values
1..12	CalVal[1..12]	Float[12]	Array of 12 values of type float

6. DEVICE-SPECIFIC GROUPS INSTRUCTIONS

6.1. Device-Specific Groups Overview

The API instructions for all navigation products include a set of instructions dedicated to navigation sub-devices.

Since the Device Specific set of instructions is quite lengthy, this chapter covers only instructions relevant to user settings.

The system must be in Configuration mode to configure any of the available device specific groups, which must have an entry in the Group/D.T. field.

6.2. UKF Device Group (0x2A)

In the UKF Device Group, you can configure several parameters, based on the commands provided in Table 51.

Table 51. UKF Device Group

Index	Command	Description
0x03	Set IMU Orientation	Sets the way the IMU is installed on the platform
0x04	Get IMU Orientation	Gets the way the IMU is installed on the platform
0x05	Set number of static samples	Sets the number of samples to collect for the Bias Estimation calculation
0x06	Get number of static samples	Gets the number of samples to collect for the Bias Estimation calculation
0x07	Set IIR Filter Status	Enables or Disables the IIR filter on the IMU Raw date
0x08	Get IIR Filter Status	Gets the IIR filter status (Enabled/Disabled)
0x09-0x0A	Reserved	
0x0B	Set RPY Offset	Sets manually offset for Roll, Pitch & Yaw
0x0C	Get RPY Offset	Gets Last offset values for Roll, Pitch & Yaw
0x0D	Set Lever-ARM	Lever-Arm: Sets the location of the GPS primary antenna with relation to the IMU location.
0x0E	Get Lever-ARM	Lever-Arm: Gets the location of the GPS primary antenna with relation to the IMU location.

Index	Command	Description
0x0F	Set Antennas separation	Sets the distance between antennas
0x10	Get Antennas separation	Gets the last value entered for distance between antennas
0x11	Set GPS position manually	Sets the starting point GPS position
0x12	Get GPS position	Gets the last starting point entered for GPS position

Table 52. Immediate Group Structure

	Header	Length	Group/D.T.	Command	Device ID	Data	CkSum
Bytes	2	1	1	1	1	1	2
Default	[>	5+N	0x2A	Table 51	0x00	N/none	Calc. Val

6.2.1. Device Set IMU Orientation

This command identifies how the IMU has been installed on a platform and is critical for the Unscented Kalman Filter (UKF).

Table 53. Device Set IMU Orientation - Command Index 0x03

Field Index	Field Name	Field Type	Field Values
1	Orientation	Uint8_t	Table 54

In the following example, commas are not part of the command or the reply.

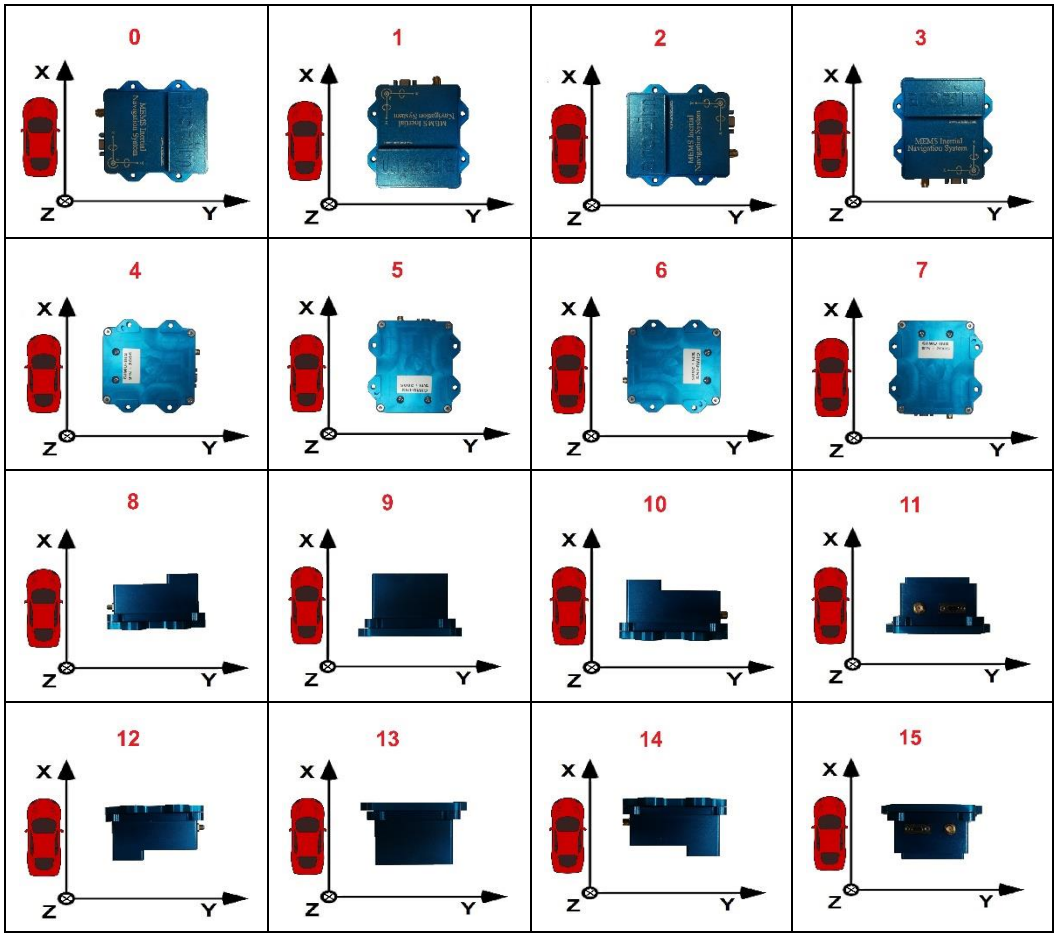
Command - Set UKF - IMU Orientation

0x5b, 0x3e, 0x6, 0x50, 0x3, 0x0, 0x0, 0x53, 0x0

ACK Reply

0x5b, 0x3e, 0x6, 0x50, 0x3, 0x0, 0x1, 0x54, 0x0

Table 54. Available IMU Orientation Positions



6.2.2. Device Get IMU Orientation

This GET command complements the Set IMU Orientation command and reads the actual orientation of the IMU defined for the UKF.

There is no Data element since this command has no arguments.

Table 55. Device Get IMU Orientation - Command Index 0x04

Field Index	Field Name	Field Type	Field Values

Table 56. Reply for Device Get IMU Orientation - Command Index 0x04

Field Index	Field Name	Field Type	Field Values
1	Orientation	Uint8_t	Table 54

In the following example, commas are not part of the command or the reply.

Command - Get UKF - IMU orientation

0x5b, 0x3e, 0x5, 0x50, 0x4, 0x0, 0x54, 0x0

Command Reply

0x5b, 0x3e, 0x6, 0x50, 0x4, 0x0, 0x0, 0x54, 0x0

6.2.3. Device Set Number of Static Samples

This SET command sets the number of samples (between 1000 and 9000) to collect for the Bias Estimation calculation.

The command includes a single argument of type uint16_t.

Table 57. Device Set Number of Static Samples - Command Index 0x05

Field Index	Field Name	Field Type	Field Values
1	Number of Samples	uint16_t	1000 - 9000

In the following example, commas are not part of the command or the reply.

Command - Set UKF - Number of static samples for Static calibration (i.e: 2000 samples):

0x5b, 0x3e, 0x7, 0x50, 0x5, 0x0, 0xd0, 0x7, 0x2c, 0x1

ACK Reply

0x5b, 0x3e, 0x6, 0x50, 0x5, 0x0, 0x1, 0x56, 0x0

6.2.4. Device Get Number of Static Samples

This GET command complements the Set Amount of Static Samples command and reads the actual number of static samples.

There is no Data element since this command has no arguments.

Table 58. Device Get Number of Static Samples - Command Index 0x06

Field Index	Field Name	Field Type	Field Values

Table 59. Reply for Device Get Number of Static Samples - Command Index 0x06

Field Index	Field Name	Field Type	Field Values
1	Number of Samples	uint16_t	1000 - 9000

In the following example, commas are not part of the command or the reply.

Command - Get UKF - Number of Samples to use for static calibration

0x5b, 0x3e, 0x5, 0x50, 0x6, 0x0, 0x56, 0x0

Command Reply (2000 samples = 0x07D0)

0x5b, 0x3e, 0x7, 0x50, 0x6, 0x0, 0xd0, 0x7, 0x2d, 0x1

6.2.5. Device Set IIR Filter Status

This SET command enables/disables the IIR LPF on the IMU raw data. When the filter is enabled a latency of three samples are included in the results.

The command includes a single argument of type uint8_t.

Table 60. Device Set IRR Filter Status - Command Index 0x07

Field Index	Field Name	Field Type	Field Values
1	IIR Status	Uint8_t	0 – disabled 1 - enabled

In the following example, commas are not part of the command or the reply.

Command - Set UKF - IIR Filter Status to: Disabled

0x5b, 0x3e, 0x6, 0x50, 0x7, 0x0, 0x0, 0x57, 0x0

ACK Reply

0x5b, 0x3e, 0x6, 0x50, 0x7, 0x0, 0x1, 0x58, 0x0

6.2.6. Device Get IIR Filter Status

This command complements the Set IIR filter Status command and reads the actual status of the IIR Filter (enable or disabled).

There is no Data element since this command has no arguments.

Table 61. Device Get IIR Filter Status - Command Index 0x08

Field Index	Field Name	Field Type	Field Values

Table 62. Reply for Device Get IIR Filter Status - Command Index 0x08

Field Index	Field Name	Field Type	Field Values
1	IIR Status	Uint8_t	0 – disabled 1 - enabled

In the following example, commas are not part of the command or the reply.

Command - Get UKF - IIR Filter Status (Disabled/Enabled)

0x5b, 0x3e, 0x5, 0x50, 0x8, 0x0, 0x58, 0x0

Command Reply

0x5b, 0x3e, 0x6, 0x50, 0x8, 0x0, 0x0, 0x58, 0x0

6.2.7. Device Set Manual RPY Offset

This SET command is essentially the same as, but more tuned than, Set IMU Orientation, which can only handle 90-degree assembly.

The first argument of this command indicates whether or not the device should use the manual offset values. The remaining arguments are the offset corrections for Roll, Pitch and Yaw.

Table 63. Device Set Manual RPY Offset - Command Index 0x0B

Field Index	Field Name	Field Type	Field Values
1	Use manual bias remove	Uint8_t	0 – Disable use 1 – Enable use
2	Roll Bias correction	Float	
3	Pitch Bias correction	Float	
4	Yaw Bias correction	Float	

In the following example, commas are not part of the command or the reply.

Command – Set UKF – Manual Bias Remove (set to Enable, Roll=5.3, Pitch=4.8, Yaw=0.00)

0x5b, 0x3e, 0x12, 0x50, 0x0b, 0x0, 0x01, 0x9a, 0x99, 0xa9, 0x40, 0x9a, 0x99, 0x99, 0x40, 0x00, 0x00, 0x00, 0x00, 0x84, 0x04

ACK Reply

0x5b, 0x3e, 0x6, 0x50, 0xb, 0x0, 0x1, 0x5c, 0x0

6.2.8. Device Get Manual RPY Offset

This GET command complements the Set manually RPY offset command and reads the current offset values and indicates whether to use or not to use these offset values (enabled or disabled).

There is no Data element since this command has no arguments.

Table 64. Device Get Manual RPY Offset - Command Index 0x0C

Field Index	Field Name	Field Type	Field Values

Table 65. Reply for Device Get RPY Offset - Command Index 0x0C

Field Index	Field Name	Field Type	Field Values
1	Use manual bias remove	Uint8_t	0 – Disable use 1 – Enable use
2	Roll Bias correction	Float	
3	Pitch Bias correction	Float	
4	Yaw Bias correction	Float	

In the following example, commas are not part of the command or the reply.

Command – Get Device Bias Remove Values

0x5b, 0x3e, 0x05, 0x50, 0x0c, 0x0, 0x5c, 0x00

Command Reply

0x5b, 0x3e, 0x12, 0x50, 0x0c, 0x00, 0x01, 0x9a, 0x99, 0xa9, 0x40, 0x9a, 0x99, 0x99, 0x40, 0x00, 0x00, 0x00, 0x00, 0x85, 0x04

6.2.9. Device Set Lever-ARM

This SET command should be used when the primary GPS antenna location is away from the IMU location. The user will need to feed the position of the GPS primary antenna with respect to the IMU position in meters. The IMU position is: 0X, 0Y, 0Z.

If the antenna is above the IMU, the Z distance is negative.

If the antenna is in front of the IMU X axis, the X distance is positive.

If the antenna is in front of the IMU Y axis, the Y distance is positive.

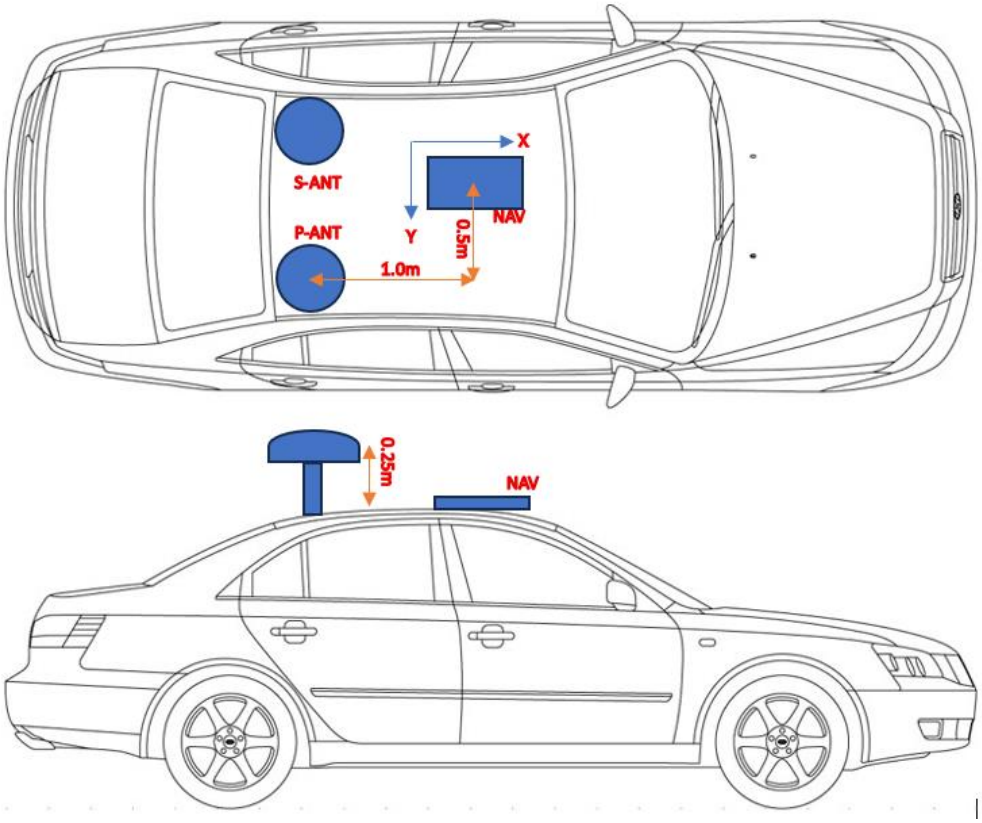


Figure 4. Primary Antenna Location

In Figure 4:

- The primary antenna is in the negative direction of the navigation X-axis, X-distance = -1.0m.
- The navigation Y-axis points to the primary antenna location, Y-distance = +0.5m.
- The primary antenna is above the navigation platform, Z-distance = -0.25m

This command's first argument indicates whether or not to use the Lever-ARM position information. The remaining arguments indicate the distance of the primary antenna from the IMU in the X, Y, Z positions.

Table 66. Device Set Lever-ARM (Primary Antenna Position) - Command Index 0x0D

Field Index	Field Name	Field Type	Field Values
1	Use Lever-Arm info	Uint8_t	0 – Disable use 1 – Enable use
2	Distance in X Axis	Float	

Field Index	Field Name	Field Type	Field Values
3	Distance in Y Axis	Float	
4	Distance in Z Axis	Float	

In the following example, commas are not part of the command or the reply.

Command – Set UKF – Lever-ARM (enable, x=5.3, y=4.8, z=132.5)

0x5b, 0x3e, 0x12, 0x50, 0x0d, 0x00, 0x01, 0x9a, 0x99, 0xa9, 0x40, 0x9a, 0x99, 0x99, 0x40, 0x00, 0x80, 0x04, 0x43, 0x4d, 0x05

ACK Reply

0x5b, 0x3e, 0x06, 0x50, 0x0d, 0x00, 0x01, 0x5e, 0x00

6.2.10. Device Get Lever-ARM

This GET command complements the Set Lever-ARM command and reads the values entered for the primary antenna location and indicates whether the device activates the Lever ARM calculations.

There is no Data element since this command has no arguments.

Table 67. Device Get Lever-ARM - Command Index 0x0D

Field Index	Field Name	Field Type	Field Values

Table 68. Reply for Device Get Lever-ARM - Command Index 0x0C

Field Index	Field Name	Field Type	Field Values
1	Use Lever-Arm info	Uint8_t	0 – Disable use 1 – Enable use
2	Distance in X Axis	Float	
3	Distance in Y Axis	Float	
4	Distance in Z Axis	Float	

In the following example, commas are not part of the command or the reply.

Command – Set UKF – Lever-ARM (enable, x=5.3, y=4.8, z=132.5)

0x5b, 0x3e, 0x05, 0x50, 0x0e, 0x00, 0x5e, 0x00

ACK Reply

0x5b, 0x3e, 0x12, 0x50, 0x0e, 0x00, 0x01, 0x9a, 0x99, 0xa9, 0x40, 0x9a, 0x99, 0x99, 0x40, 0x00, 0x80, 0x04, 0x43, 0x4e, 0x05

6.2.11. Device Set Antenna Separation

This SET command is currently only relevant for the ArSys2 platform.

The command's first argument indicates whether to use the manual antenna separation value, while the second argument indicates the distance between the antennas in meters.

Table 69. Device Set Antenna Separation - Command Index 0x0F

Field Index	Field Name	Field Type	Field Values
1	Use Antenna Separation	Uint8_t	0 – Disable use 1 – Enable use
2	Antennas Separation	Float	meters

In the following example, commas are not part of the command or the reply.

Command – Set UKF – Antennas Separation (Enable, distance=5.33)

0x5b, 0x3e, 0x0a, 0x50, 0x0f, 0x00, 0x01, 0x5c, 0x8f, 0xaa, 0x40, 0x35, 0x02

ACK Reply

0x5b, 0x3e, 0x06, 0x50, 0x0f, 0x00, 0x01, 0x60, 0x00

6.2.12. Device Get Antenna Separation

This GET command is currently only relevant for the Arsys2 platform.

It complements the Set Antennas separation command and reads the last antenna separation value and determines whether the device was configured to use this value.

There is no Data element since this command has no arguments.

Table 70. Device Get Antenna Separation - Command Index 0x10

Field Index	Field Name	Field Type	Field Values

Table 71. Reply for Device Get Antenna Separation - Command Index 0x10

Field Index	Field Name	Field Type	Field Values
1	Use Antenna Separation	Uint8_t	0 – Disable use 1 – Enable use

Field Index	Field Name	Field Type	Field Values
2	Antennas Separation	Float	meters

In the following example, commas are not part of the command or the reply.

Command – Get UKF – Antennas Separation (Enable, dist=5.33)

0x5b, 0x3e, 0x05, 0x50, 0x10, 0x00, 0x60, 0x00

Command Reply:

0x5b, 0x3e, 0x0a, 0x50, 0x10, 0x00, 0x01, 0x5c, 0x8f, 0xaa, 0x40, 0x36, 0x02

6.2.13. Device Set GPS Manual Start Position

This SET command allows you to manually set the GPS position when GPS data reception is unavailable. When the system is turned on (with default settings) it calculates biases for the IMU sensors and preserves the GPS position. If GPS data reception is unavailable, the Bias Estimation on power up should be disabled and the GPS position set manually. If you use zeros for the GPS position, the system automatically calculates the position on the basis of the last bias estimation.

This command's three arguments are Latitude and Longitude (in degrees) and Altitude (in meters).

Table 72. Device Set GPS Manual Start Position - Command Index 0x11

Field Index	Field Name	Field Type	Field Values
1	Latitude	Double	+/-90deg
2	Longitude	Double	+/-180deg
3	Altitude	Float	meters

In the following example, commas are not part of the command or the reply.

Command – Set UKF – GPS Manual Start Position (lat=32.4, lon=34.5, alt=80.2)

0x5b, 0x3e, 0x19, 0x50, 0x11, 0x00, 0x33, 0x33, 0x33, 0x33, 0x33, 0x33, 0x40, 0x40, 0x00, 0x00, 0x00, 0x00, 0x00, 0x40, 0x41, 0x40, 0x66, 0x66, 0xa0, 0x42, 0x82, 0x04

ACK Reply

0x5b, 0x3e, 0x06, 0x50, 0x11, 0x00, 0x01, 0x62, 0x00

6.2.14. Device Get GPS Manual Start Position

This command complements the Set GPS manual start position and reads the values entered as the starting point for GPS outage on powerup.

There is no Data element since this command has no arguments.

Table 73. Device Get GPS Manual Start Position - Command Index 0x12

Field Index	Field Name	Field Type	Field Values

Table 74. Reply for Device Get GPS Manual Start Position - Command Index 0x12

Field Index	Field Name	Field Type	Field Values
1	Latitude	Double	+/-90deg
2	Longitude	Double	+/-180deg
3	Altitude	Float	meters

In the following example, commas are not part of the command or the reply.

Command – Get UKF – GPS manual start position (lat=32.4, lon=34.5, alt=80.2)

0x5b, 0x3e, 0x05, 0x50, 0x12, 0x00, 0x62, 0x00

ACK Reply

0x5b, 0x3e, 0x19, 0x50, 0x12, 0x00, 0x33, 0x33, 0x33, 0x33, 0x33, 0x33, 0x40, 0x40, 0x00, 0x00, 0x00, 0x00, 0x00, 0x40, 0x41, 0x40, 0x66, 0x66, 0xa0, 0x42, 0x83, 0x04

7. API DATA MESSAGES

7.1. Overview

This chapter lists the messages available for the navigation systems and indicates which are global and which are system-specific. Each message (frame out) includes a list of fields and their types.

You can select messages with same or different frame rates as long as the total bandwidth does not exceed the communication link baud rate in use.

7.2. General Message Structure

All messages have the same basic structure, and only the Data element varies in size. The Message general structure is similar to the API instruction structure and has the same mechanism for packet recognition and message identification.

Table 75. General Message Structure

	Header	Length	Platform/ Sys.Type	Msg. Type	Flags	Data	CkSum
Bytes	2	1	1	1	3	N	2
Default	[>	7+N	>= 0x80				Calc. Val

7.3. Message Fields and Elements

Table 76 lists the message structure fields and elements, each of which has a distinct color and may contain one or more fields.

Table 76. Message Fields and Elements

Title	Expected	Bytes	Description
Header	[>	2	Constant Header 0x5b 0x3e
Length	7+N	1	Number of bytes to follow this location N is the number of bytes in the Data element
Platform/ Sys.Type	>= 0x80	1	Platform Identification value
Msg. Type		1	Platform dependent. **0x00 – 0x10 - Reserved for Status Messages**

Title	Expected	Bytes	Description
			>=0x20 - Platform Messages
Flags		3	1st byte - TBD 2nd byte - TBD 3rd byte - TBD
Data		N	Variable number of fields.
CkSum		2	Sum of all bytes from Platform/Sys.Type field up to the last Data element byte (Total of: Length – 2).

7.3.1. Packet Recognition Element

To lock an arriving instruction correctly, use the three blue fields in the API instruction structure: Header, Length, and CkSum. Each instruction starts with Header "[>" (0x5b 0x3e) characters followed by a Length field that indicates the number of bytes to follow that field. After collecting all the instruction Data bytes according to the Length field value, calculate the checksum (CkSum) and verify the result with the instruction CkSum field that you receive.

The CkSum is a simple two-byte summation of all bytes between the Length field and the CkSum field.

7.3.2. Identification Element

After locking on a message packet correctly, the Identification Element indicates how to parse the Data element, which may contain different field types. The Identification element consists of the Platform field and the Message ID field (both orange or bright yellow).

The Platform field indicates the current connected platform. Each platform will use a unique platform index in the platform field (Table 77).

The Message Index field indicates the message ID, which is the same for all relevant platforms (Table 78).

Table 77. Platform Indexes and Names

Platform Index	Platform Name
0x82	EX100 (Exiguo AHRS)
0x83	EX200 (Exiguo INS single antenna)
0x84	EX300 (Exiguo INS dual antenna)
0x86	gX100 (gINS AHRS)

Platform Index	Platform Name
0x87	gX200 (gINS INS single antenna)
0x88	gX300 (gINS INS dual antenna)
0x89	Arsys2
0x8C	EXLP100 (ExiguoLP AHRS)
0x8D	EXLP200 (ExiguoLP INS single antenna)
0x8E	EXLP300 (ExiguoLP INS dual antenna)

Table 78. Data Message Indexes and Names

Message Index	Message Name	Platforms
0x21	IMU2-6DOF	All Platforms
0x22	IMU3-9DOF	All Platforms
0x23	IMU4-Misc.	Not active at the moment
0x30	GPS1-LLA	AHRS, INS, INS2ANT
0x31	GPS2-ECEF	AHRS, INS, INS2ANT
0x32	GPS3-Statistic	AHRS, INS, INS2ANT
0x33	GPS4-RTK	To be implemented
0x34	GPS5-Sat. Info	To be implemented
0x40	Tilt1 – [R, P]	All Platforms
0x41	Tilt2 – [R, P, Y]	All Platforms
0x42	Tilt3 – [Quarter]	All Platforms
0x43	Tilt4 – [DCM]	All Platforms
0x50	INS1 – Tilt & Pos.	INS, INS2ANT
0x51	INS2 – Tilt, Pos. & Vel.	INS, INS2ANT
0x52	INS3 – Tilt, Pos., Vel. & Time	INS, INS2ANT
0x53	INS4 – FWD Lever ARM	EX300 - Exiguo INS 2 antennas

In addition to Data messages, the navigation platforms also sends Status messages (such as the current mode) or messages about a specific condition to be fulfilled (during Bias-Estimation or Hard-Iron). Alarm status messages include information about deviations from working boundaries defined for the system (for example, above or below temperature or power ranges (Table 79).

Table 79. Information/Status Message Indices and Names

Message Index	Message Name	Platforms
0x00	Done MCU Init	All Platforms
0x01	Start Static Cal.	All Platforms
0x02	In Static Cal.	All Platforms
0x03	Done Static Cal.	All Platforms
0x04	Static Cal. Error	All Platforms
0x05	Start HI Cal.	AHRS, INS, INS2ANT
0x06	In HI Cal.	AHRS, INS, INS2ANT
0x07	Done HI Cal.	AHRS, INS, INS2ANT
0x08	HI Cal. Error	AHRS, INS, INS2ANT
0x09	Wait for GPS Loc.	INS, INS2ANT
0x0A	GPS Loc. Exist	INS, INS2ANT
0x0B	Wait for GPS Heading	INS2ANT
0x0C	GPS Heading Exist	INS2ANT
0x0D	Inform Alarm	All Platforms
0x0E	In Calibration	All Platforms
0x0F	In Configuration	All Platforms
0x10	In Real-Time	All Platforms

7.3.3. Data Element

The Data element consists of Flags and Data fields, where the Flags has a constant length of three bytes and the Data field has a variable length which is message dependent. Section 7.4 contains additional information.

7.4. Data Messages

7.4.1. Data Flags

The data flags consist of three registers, each consisting of one byte and containing specific information about all platforms (although not necessarily relevant to all platforms).

The first flag register contains general information, relevant to all platforms.

Table 80. Data Flag-1 –Bit Structure Information

Bit	Flag Name	Description
0	MCU OK	Power up – BIT – Set to 1 when all HW finished initialization OK
1	Flash CkSum OK	Power up – BIT – Set to 1 when flash check sum is OK
2	GPS connected OK	Power up – BIT – Set to 1 when Bi-directional communication with GPS Tested OK
3	IMU Connected OK	Power up – BIT – Set to 1 when Bi-directional communication with IMU Tested OK
4	Temp OK	Continues – BIT – Set to 1 when Temperature is in defined borders.
5	Supply In OK	Continues – BIT – Set to 1 when Supply in is in defined borders.
6	Work Supply OK	Continues – BIT – Set to 1 when working supply is in defined borders
7	Reserved	

The second flag register contains information relevant to systems using a GPS receiver.

Table 81. Data Flag-2 – Bit Structure Information

Bit	Flag Name	Description
0	GPS PPS	Software IO indication for PPS signal – should blink
1	GPS ANT1 SHORT	Continues – BIT – Set to 1 when short detected on Antenna – 1 Relevant for EX200 and EX300 only
2	GPS ANT1 OPEN	Continues – BIT – Set to 1 when Antenna load is detected Relevant for EX200 and EX300 only
3	GPS ANT2 SHORT	Continues – BIT – Set to 1 when short detected on Antenna – 2 Relevant for EX200 and EX300 only
4	GPS ANT2 OPEN	Continues – BIT – Set to 1 when Antenna load is detected Relevant for EX200 and EX300 only
5	GPS position lock	Continues – Set to 1 when GPS position is available
6	GPS heading lock	Continues – Set to 1 when GPS heading is available Relevant for EX300, EXLP300, gX300 and Arsys2
7	Reserved	

The third flag register contains values that vary per system and includes the Static or Dynamic nature of the platform.

Table 82. Data Flag-3 – Bit Structure Information for VG Platform

Value	Value Indication	Description
0	Non-Moving	System detected static condition
1	Moving	System has detected dynamic condition

Table 83. Data Flag-3 – Bit Structure Information for AHRS Platform

Value	Value Indication	Description
0	Non-Moving	System has detected static condition (magnetometers = active)
1	Non-Moving	System has detected static condition (magnetometers = not active)
2	Moving	System has detected dynamic condition (magnetometers = active)
3	Moving	System has detected dynamic condition (magnetometers = not active)

Table 84. Data Flag-3 – Bit Structure Information for INS Platform

Value	Value Indication	Description
0	Non-Moving	System has detected static condition (Pos = active, VelTH = 0, Magnetometers = active)
1	Non-Moving	System has detected static condition (Pos = active, VelTH = 0, Magnetometers = not active)
2	Non-Moving	System has detected static condition (Pos = not active, VelTH = 0, Magnetometers = active)
3	Non-Moving	System has detected static condition (Pos = not active, VelTH = 0, Magnetometers = not active)
4	Moving	System has detected dynamic condition (Pos = active, VelTH = (+) Sog > Th, Magnetometers = active)
5	Moving	System has detected dynamic condition

Value	Value Indication	Description
		(Pos = active, VelTH = (+), Magnetometers = not active)
6	Moving	System has detected dynamic condition (Pos = active, VelTH = (+) Sog <= Th, Magnetometers = active)
7	Moving	System has detected dynamic condition (Pos = active, VelTH = (-), Magnetometers = not active)
8	Moving	System has detected dynamic condition (Pos = not active, VelTH = 0, Magnetometers = active)
9	Moving	System has detected dynamic condition (Pos = not active, VelTH = 0, Magnetometers = not active)

Table 85. Data Flag-3 – Bit Structure Information for INS2ANT Platform

Value	Value Indication	Description
0	Non-Moving	System has detected static condition (wPVT, wHDT, wMag, woVel)
1	Non-Moving	System has detected static condition (wPVT, wHDT, woMag, woVel)
2	Non-Moving	System has detected static condition (wPVT, woHDT, wMag, woVel)
3	Non-Moving	System has detected static condition (wPVT, woHDT, woMag, woVel)
4	Non-Moving	System has detected static condition (woPVT, woHDT, wMag, woVel)
5	Non-Moving	System has detected static condition (woPVT, woHDT, woMag, woVel)
6	Moving	System has detected dynamic condition (wPVT, wHDT, wMag, Vel>Th)
7	Moving	System has detected dynamic condition (wPVT, wHDT, woMag, wVel)

Value	Value Indication	Description
8	Moving	System has detected dynamic condition (wPVT, woHDT, wMag, wVel)
9	Moving	System has detected dynamic condition (wPVT, woHDT, woMag, wVel)
10	Moving	System has detected dynamic condition (wPVT, wHDT, wMag, Vel<Th)
11	Moving	System has detected dynamic condition (wPVT, wHDT, woMag, woVel)
12	Moving	System has detected dynamic condition (wPVT, woHDT, wMag, woVel)
13	Moving	System has detected dynamic condition (wPVT, woHDT, woMag, woVel)
14	Moving	System has detected dynamic condition (woPVT, woHDT, wMag, woVel)
15	Moving	System has detected dynamic condition (woPVT, woHDT, woMag, woVel)

7.4.2. Data Information

7.4.2.1. IMU Message Data

Table 86. Data Message - IMU-2 - 6DOF

Message Name:	IMU_MSG_2		**Ver: 1.0**	**Date: 4/9/19**
Msg. Type ID:	0x21			
Field Name	**Field Type**	**Source Message**	**Description**	
Message Index	Uint32	System	Message Index	
Time Tag	Uint32	System	Time Tag [uSec]	
Temperature	Float	System	Temperature [Deg/C]	
ACC. X	Float	IMU	Scaled to g units by defaults	
ACC. Y	Float	IMU		
ACC. Z	Float	IMU		
Gyro X	Float	IMU	Scaled to deg/sec by defaults	
Gyro Y	Float	IMU		
Gyro Z	Float	IMU		

Table 87. Data Message - IMU-3 - 9DOF

Message Name:	IMU_MSG_3		**Ver: 1.0**	**Date: 4/9/19**
Msg. Type ID:	0x22			
Field Name	**Field Type**	**Source Message**	**Description**	
Message Index	Uint32	System	Message Index	
Time Tag	Uint32	System	Time Tag [uSec]	
Temperature	Float	System	Temperature [Deg/C]	
ACC. X	Float	IMU	Scaled to g units by default	
ACC. Y	Float	IMU		
ACC. Z	Float	IMU		
Gyro X	Float	IMU	Scaled to deg/sec by default	
Gyro Y	Float	IMU		
Gyro Z	Float	IMU		
Mag. X	Float	IMU	Scaled to Gauss by default	
Mag. Y	Float	IMU		
Mag. Z	Float	IMU		

Table 88. Data Message - IMU-4 - Miscellaneous Sensors

Message Name:	IMU_MSG_4		**Ver: 1.0**	**Date: 4/9/19**
Msg. Type ID:	0x23			
Field Name	**Field Type**	**Source Message**	**Description**	
Message Index	Uint32	System	Message Index	
Time Tag	Uint32	System	Time Tag	
Temperature	Float	System	Temperature	
Baro	Float			
Odo	Float			
Pito	Float			
Humidity	Float			

7.4.2.2. GPS Message Data

Table 89. Data Message - GPS-1 - LLA

Message Name:	GPS_MSG_1 - LLA		**Ver: 1.0**	**Date: 4/9/19**
Msg. Type ID:	0x30			
Field Name	**Field Type**	**Source Message**	**Description**	
Message Index	Uint32	System		
Time Tag	Uint32	System		
Temperature	Float	System		
Date	Uint32	GPS	YYYYMMDD (fields: 4,5,6)	
Time	Double	GPS	HHMMSS.SS (fields: 7,8,9)	
Latitude	Double	GPS		
Longitude	Double	GPS		
Altitude	Float	GPS		
Lat_Sigma	Float	GPS		
Lon_Sigma	Float	GPS		
Alt_Sigma	Float	GPS		
Velocity_N	Float	GPS		
Velocity_E	Float	GPS		
Velocity_U	Float	GPS		
Vel_N_Sigma	Float	GPS		
Vel_E_Sigma	Float	GPS		
Vel_U_Sigma	Float	GPS		
Heading	Float	GPS		
CSEP	Float	GPS		
Heading_Status	Uint8	GPS	0: ineffective, 4: Fix solution, 5: float solution	
Position Qual.	Uint8	GPS	0: ineffective, 1: Single Point, 2: Pseudo-Range, 4: Fix Solution, 5: Float Solution	
GPS Fix	Uint8	GPS	1: no fix, 2: 2D fix, 3: 3D fix	
Reserved_2	Uint8			

Table 90. Data Message - GPS-2 - ECEF

Message Name:	GPS_MSG_2 - ECEF		**Ver: 1.0**	**Date: 4/9/19**
Msg. Type ID:	0x31			
Field Name	**Field Type**	**Source Message**	**Description**	
Message Index	Uint32	System		
Time Tag	Uint32	System		
Temperature	Float	System		
Date	Uint32	GPS	YYYYMMDD (fields: 4,5,6)	
Time	Double	GPS	HHMMSS.SS (fields: 7,8,9)	
ECEF_X	Double	GPS		
ECEF_Y	Double	GPS		
ECEF_Z	Double	GPS		
ECEF_X_Sigma	Float	GPS		
ECEF_Y_Sigma	Float	GPS		
ECEF_Z_Sigma	Float	GPS		
Velocity_N	Float	GPS		
Velocity_E	Float	GPS		
Velocity_U	Float	GPS		
Vel_N_Sigma	Float	GPS		
Vel_E_Sigma	Float	GPS		
Vel_U_Sigma	Float	GPS		
Heading	Float	GPS		
CSEP	Float	GPS		
Heading_Status	Uint8	GPS	0: ineffective, 4: Fix solution, 5: float solution	
Position Qual.	Uint8	GPS	0: ineffective, 1: Single Point, 2: Pseudo-Range, 4: Fix Solution, 5: Float Solution	
GPS Fix	Uint8	GPS	1: no fix, 2: 2D fix, 3: 3D fix	
Reserved_2	Uint8			

Table 91. Data Message - GPS-3 - Statistic

Message Name:	GPS_MSG_3 - Statistic		**Ver: 1.0**	**Date: 4/9/19**
Msg. Type ID:	0x32			
Field Name	**Field Type**	**Source Message**	**Description**	
Message Index	Uint32	System		
Time Tag	Uint32	System		
Temperature	Float	System		
Date	Uint32	GPS	YYYYMMDD (fields: 4,5,6)	
Time	Double	GPS	HHMMSS.SS (fields: 7,8,9)	
Num. GPS Sat.	Uint8	GPS		
Num. GLO Sat.	Uint8	GPS		
Num. BDS Sat.	Uint8	GPS		
Num. GAL Sat.	Uint8	GPS		
Num Sat. Tracked	Uint8	GPS		
Num. Sat. in Use	Uint8	GPS		
Num. Sat. Above elevation mask	Uint8	GPS		
Num. Sat Above elevation mask L2	Uint8	GPS		
Solution Status	Uint8	GPS	0: solution computed, 1: Insufficient observation, 2: No Convergence, 4: Covariance trace exceeds maximum (field: 2)	
Ext. Solution Status	Uint8	GPS	Bit 0: 0 = not verified, 1= verified	

Message Name:	GPS_MSG_3 - Statistic		**Ver: 1.0**	**Date: 4/9/19**
Msg. Type ID:	0x32			
Field Name	**Field Type**	**Source Message**	**Description**	
			Bit 1-3: 0=unknown, 1=Broadcase, 2=SBAS Broadcase, 3=Multi Freq Correction, 4=PSRDiff Correction (field: 16)	
Sig mask	Uint8	GPS	Bit 0: Gps L1 used in solution Bit 1: Gps L2 used in solution Bit 2: Gps L5 used in solution Bit 3: BD2 B3 used in solution Bit 4: Glo L1 used in solution Bit 5: Glo L2 used in solution Bit 6: BD2 B1 used in solution Bit 7: BD2 B2 used in solution (field: 18)	
Reserved_1	Uint8			

Currently, this message is inactive but may be available in the future.

Table 92. Data Message - GPS-4 - RTK

Message Name:	GPS_MSG_4 - RTK		**Ver: 1.0**	**Date: 4/9/19**
Msg. Type ID:	0x33			
Field Name	**Field Type**	**Source Message**	**Description**	
Message Index	Uint32	MCU	Message Index	
Time Tag	Uint32	MCU	Time Tag	
Temperature	Float	MCU	Temperature	
Date	Uint32	GPS	YYYYMMDD (fields: 4,5,6)	
Time	Double	GPS	HHMMSS.SS (fields: 7,8,9)	
RTK Status	Uint8	GPS	1=Single point, 4=Fix solution, 5=float solution	
Heading Status	Uint8	GPS	4=Fix solution, 5=Float solution	
Baseline_N	Float	GPS	From base to rover	
Baseline_E	Float	GPS	From base To rover	
Baseline_U	Float	GPS	From base To rover	
Baseline_N_std	Float	GPS		
Baseline_E_std	Float	GPS		
Baseline_U_std	Float	GPS		
Base Lat.	Double	GPS		
Base Lon.	Double	GPS		
Base Alt.	Float	GPS		

Currently, this message is inactive but may be available in the future.

Table 93. Data Message - GPS-5 - Satellite Information

Message Name:	GPS_MSG_5 - Satellite Information		**Ver: 1.0**	**Date: 4/9/19**
Msg. Type ID:	0x34			
Field Name	**Field Type**	**Source Message**	**Description**	
Message Index	Uint32	System	Message Index	
Time Tag	Uint32	System	Time Tag	
Temperature	Float	System	Temperature	
Date	Uint32	GPS	YYYYMMDD	
Time	Double	GPS	HHMMSS.SS	
Const. Type	Uint8	GPS	Constellation: GPS/Glonass/Etc…	
Num Sat.	Uint8	GPS	Indicates amount of SV's Tracked	
SV PRN	**Uint8**	GPS	This field will repeat according to the value in field 'Num Sat.'	
SV Elevation	**Uint8**	GPS		
SV Azimuth	**Uint16**	GPS		
SV SNR	**Uint8**	GPS		
SV Used in Calc	**Uint8**	GPS		

7.4.2.3. VG & AHRS Tilt Data Information

Table 94. Data Message - Tilt-1 - [R, P]

Message Name:	Tilt_MSG_1		**Ver: 1.0**	**Date: 4/9/19**
Msg. Type ID:	0x40			
Field Name	**Field Type**	**Source Message**	**Description**	
Message Index	Uint32	System	Message Index	
Time Tag	Uint32	System	Time Tag	
Temperature	Float	System	Temperature	
Roll	Float	Calculated	[Deg]	
Pitch	Float	Calculated	[Deg]	

Table 95. Data Message - Tilt-2 - [R, P, Y]

Message Name:	Tilt_MSG_2		**Ver: 1.0**	**Date: 4/9/19**
Msg. Type ID:	0x41			
Field Name	**Field Type**	**Source Message**	**Description**	
Message Index	Uint32	System	Message Index	
Time Tag	Uint32	System	Time Tag	
Temperature	Float	System	Temperature	
Roll	Float	Calculated	[Deg]	
Pitch	Float	Calculated	[Deg]	
Yaw	Float	Calculated	[Deg]	

Table 96. Data Message - Tilt-3 - [Quarter]

Message Name:	Tilt_MSG_3		**Ver: 1.0**	**Date: 4/9/19**
Msg. Type ID:	0x42			
Field Name	**Field Type**	**Source Message**	**Description**	
Message Index	Uint32	System	Message Index	
Time Tag	Uint32	System	Time Tag	
Temperature	Float	System	Temperature	
Qu_1	Float	Calculated		
Qu_2	Float	Calculated		
Qu_3	Float	Calculated		
Qu_4	Float	Calculated		

Table 97. Data Message - Tilt-4 - [DCM]

Message Name:	GPS_MSG_4		**Ver: 1.0**	**Date: 4/9/19**
Msg. Type ID:	0x43			
Field Name	**Field Type**	**Source Message**	**Description**	
Message Index	Uint32	System	Message Index	
Time Tag	Uint32	System	Time Tag	
Temperature	Float	System	Temperature	
DCM_1	Float	Calculated		
DCM_2	Float	Calculated		
DCM_3	Float	Calculated		
DCM_4	Float	Calculated		
DCM_5	Float	Calculated		
DCM_6	Float	Calculated		
DCM_7	Float	Calculated		
DCM_8	Float	Calculated		
DCM_9	Float	Calculated		

7.4.2.4. INS Data

Table 98. Data Message - INS-1 - Tilt & Position

Message Name:	INS_MSG_1		**Ver: 1.0**	**Date: 4/9/19**
Msg. Type ID:	0x50			
Field Name	**Field Type**	**Source Message**	**Description**	
Message Index	Uint32	System	Message Index	
Time Tag	Uint32	System	Time Tag	
Temperature	Float	System	Temperature [Deg/C]	
Roll	Float	Calculated	[Deg]	
Pitch	Float	Calculated	[Deg]	
Yaw	Float	Calculated	[Deg]	
Lat.	Double	Calculated	[Deg]	
Lon.	Double	Calculated	[Deg]	
Alt.	Float	Calculated	[Meters]	

Table 99. Data Message - INS-2 - Tilt, Position & Velocity

Message Name:	INS_MSG_2		**Ver: 1.0**	**Date: 4/9/19**
Msg. Type ID:	0x51			
Field Name	**Field Type**	**Source Message**	**Description**	
Message Index	Uint32	System	Message Index	
Time Tag	Uint32	System	Time Tag	
Temperature	Float	System	Temperature [Deg/C]	
Roll	Float	Calculated	[Deg]	
Pitch	Float	Calculated	[Deg]	
Yaw	Float	Calculated	[Deg]	
Lat.	Double	Calculated	[Deg]	
Lon.	Double	Calculated	[Deg]	
Alt.	Float	Calculated	[meters]	
Vel. N	Float	Calculated	[meter/Sec]	
Vel. E	Float	Calculated	[meter/Sec]	
Vel. U	Float	Calculated	[meter/Sec]	

Table 100. Data Message - INS-3 - Tilt, Position, Velocity & Time

Message Name:	INS_MSG_3		**Ver: 1.0**	**Date: 4/9/19**
Msg. Type ID:	0x52			
Field Name	**Field Type**	**Source Message**	**Description**	
Message Index	Uint32	System	Message Index	
Time Tag	Uint32	System	Time Tag	
Temperature	Float	System	Temperature [Deg/C]	
Roll	Float	Calculated	[Deg]	
Pitch	Float	Calculated	[Deg]	
Yaw	Float	Calculated	[Deg]	
Lat.	Double	Calculated	[Deg]	
Lon.	Double	Calculated	[Deg]	
Alt.	Float	Calculated	[meters]	
Vel. N	Float	Calculated	[meters/Sec]	
Vel. E	Float	Calculated	[meters/Sec]	
Vel. U	Float	Calculated	[meters/Sec]	
Time	Double	Calculated	Synced with PPS	
Date	Uint32	GPS		

7.5. Information/Status Messages

The navigation platforms sends status messages to the host controller about the current system status or active mode. These messages all have the same structure as the general data messages, except that the Data element is fixed.

Table 101.General Message Structure

	Header	Length	Platform/ Sys.Type	Msg. Type	Flags	Data	CkSum
Bytes	2	1	1	1	3	4	2
Default	[>	7+N	>= 0x80	0x00 - 0x10			Calc. Val

7.5.1. Status Messages without Parameters

Most Status messages do not contain a valid argument but have four bytes of o values. The message index identifies the status information.

Table 102. Status Messages without Parameters

Message Index	Message Name
0x00	Done MCU Init
0x01	Start Static Cal.
0x03	Done Static Cal.
0x04	Static Cal. Error
0x05	Start HI Cal.
0x07	Done HI Cal.
0x08	HI Cal. Error
0x09	Wait for GPS Loc.
0x0A	GPS Loc. Exist
0x0B	Wait for GPS Heading
0x0C	GPS Heading Exist
0x0E	In Calibration

Message Index	Message Name
0x0F	In Configuration
0x10	In Real-Time

7.5.2. Status Messages with Parameters

Table 103 lists the status messages with data information.

Table 103. Status Messages with Parameters

Message Index	Message Name
0x02	In Static Cal.
0x06	In HI Cal.
0x0D	Inform Alarm

7.5.2.1. In Static Calibration

The "In Static Calibration" status message lists the percentage of measurements collected by a certain point in time, calculated based on the measurements to be collected before the Bias Estimation calculation.

This information is sent once a second during the process.

Table 104. In Static Calibration - Command Index 0x02

Field Index	Field Name	Field Type	Field Values
1	Percent	Uint32_t	0 - 100

7.5.2.2. In Hard-Iron Calibration

The "In Hard-Iron Calibration" status message lists the number (a counter) of measurements collected.

The information is sent once a second during the process.

Table 105. In Hard-Iron Calibration - Command Index 0x06

Field Index	Field Name	Field Type	Field Values
1	Amount	Uint32_t	

7.5.2.3. Inform Alarm

The "Inform Alarm" status message indicates when an environmental condition exceeds pre-defined boundaries for the working temperature, the supply in, and the working supply.

The information is sent once a second while the current status is still out of range.

Table 106. Inform Alarm - Command Index 0x0D

Field Index	Field Name	Field Type	Field Values
1	Alarm Type	Uint8_t	Table 107
2	Hi Range Exceeded	Uint8_t	0 - did not exceed 1 - Exceeded
3	Lo Range Exceeded	Uint8_t	0 - did not exceed 1 - Exceeded

Table 107. Optional Alarm Types

Index	Alarm Type
0	Temperature
1	Vin
3	VDD

7.5.3. Status Messages with Respect to Powerup

The navigation platform power-up mode requires bias-estimation calculation on power-up or Power-up mode that uses pre-saved bias-estimation coefficients so system startup occur right away.

Figure 5 and Figure 6 show when to expect status messages in each Power-up mode.

7.5.4. Status messages for power up with bias estimation enabled

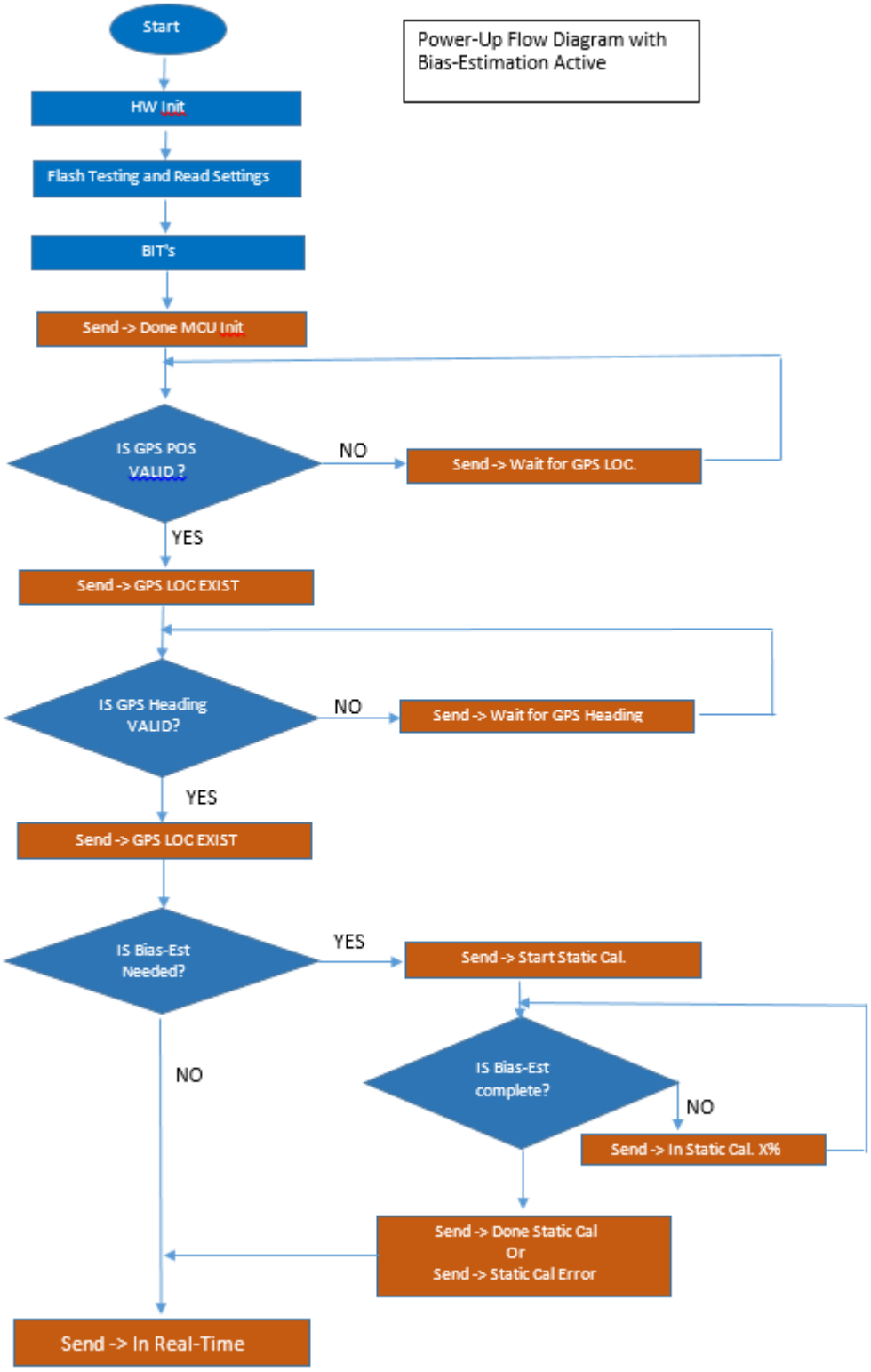


Figure 5. Status Messages for INS 2 Antennas on Power-up with Bias Estimation Enabled

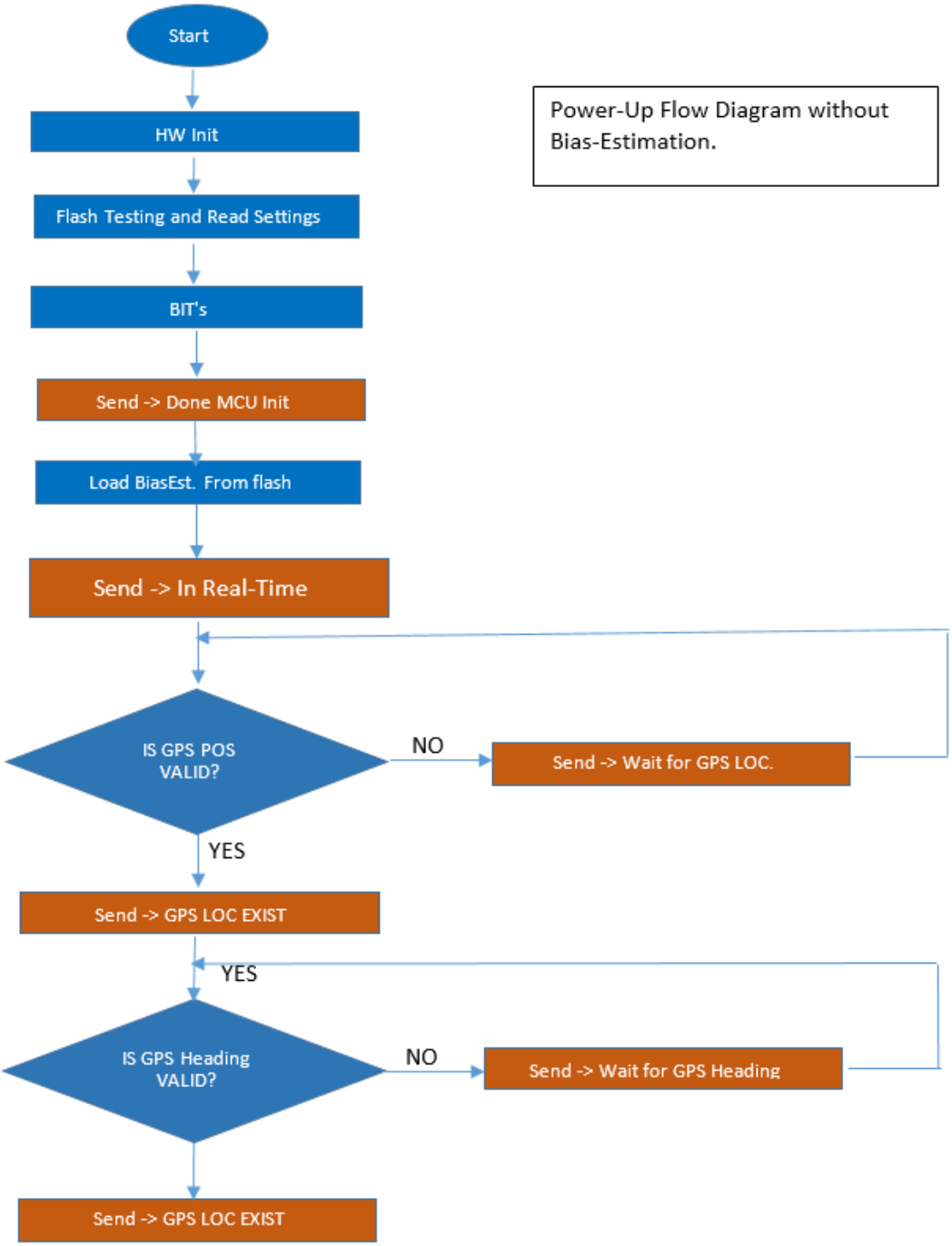


Figure 6. Status Messages for INS 2 Antennas on Power-up with Bias Estimation Disabled

8. API COMMANDS

This chapter contains API commands and structures to configure internal GPS settings.

TBD

Currently, you can only configure the GPS in accordance with the evaluation software supplied with the product.

9. NMEA MESSAGES

9.1. Overview

NMEA 0183 is a communication standard established by the National Marine Electronics Association (NMEA). NMEA 0183 provides data definitions for a variety of navigation instruments and related equipment such as gyro-compasses, Loran receivers, echo sounders and GPS receivers.

NMEA 0183 functionality is virtually standard on all GPS equipment available. NMEA 0183 has an ASCII character format so you can read data via a receiving device with terminal software.

9.2. Generic NMEA 0183 Message Structure

All data messages are transmitted in sentence form with printable ASCII characters.

Table 108. NMEA Generic Message Structure

Parameter	Header	Talker Field	Message Code	Delimiter	Data Field	Pre-CkSum	Check sum	Footer
Value	**$**	**GP**	**ZZZ**	**,**		*****	**CC**	**<CR><LF>**
Bytes	1	2	3	1	X	1	2	2

Each sentence starts with a "$" sign and ends with <CR><LF> characters. The GPS talker follows the header (for example, "GP" for GPS characters) for all messages. The message code follows the GPS talker code (ZZZ) and is written together with the GPS talker.

A comma delimiter (",") follows the message code field and separates the data fields, which may contain characters or numbers. The numbers may be integers or floats (in which case a dot (".") is part of the data field.

An asterisk ("*"), after the data field information indicates that the following characters represent the checksum.

The checksum includes all characters between, but not including, the "$" and "*".

9.3. NMEA 0183 Messages

Table 109 contains a list of the messages that currently can be configured.

Table 109. NMEA 0183 Messages

Message Code	Defaults	Max Rate [Hz]	Description
GSA	Off	1	GPS DOP and active satellite information
GST	Off	1	GNSS pseudo-range error statistics
GSV	Off	1	GNSS satellite in view
ZDA	Off	10	UTC time and date information
GGA	10	10	Detailed GPS position information
GLL	Off	10	Latitude and Longitude data
RMC	Off	10	Recommended minimum specific GNSS data
VTG	Off	10	Course overground and ground speed
HDT	10	10	True heading of the vessel

9.4. Message Fields Information

The following sections list the message data fields currently available for each GPS message.

9.4.1. GGA Messages

Table 110 lists the GGA data fields.

Table 110.GGA Data Fields

Message	GGA
Description	Detailed GPS position information
Rates [Hz]	0,1,2,3,4,10,20
Message Format	
$GPGGA,HHMMSS.SS,DDMM.MMMMM,S,DDDMM.MMMMM,S,N,QQ,PP.P, AAAA.AA,M,±XX.XX,M, SSS,AAAA*CC<CR><LF>	
Message Field	Description
HHMMSS.SS	UTC time in Hours [HH], Minutes [MM] and seconds [SS.SS] of GPS Position
DDMM.MMMMM	Latitude in degrees, minutes and decimal minutes

Message	GGA
Description	Detailed GPS position information
Rates [Hz]	0,1,2,3,4,10,20
Message Format	
$GPGGA,HHMMSS.SS,DDMM.MMMMM,S,DDDMM.MMMMM,S,N,QQ,PP.P, AAAA.AA,M,±XX.XX,M, SSS,AAAA*CC<CR><LF>	
Message Field	Description
S	S => N (North Latitude) or S (South latitude)
DDDMM.MMMMM	Longitude in degrees, minutes and decimal minutes
S	S => E (East longitude) or W (West longitude)
N	Quality indicator
•	0 = no position
•	1 = un-differentially corrected position (autonomous)
•	2 = differentially corrected position
QQ	Number of satellites used in position computation
PP.P	Horizontal dilution of precision (HDOP), ranging 0.0 to 9.9
AAAA.AA	Antenna altitude
M	Altitude units in meters
+/-XX.XX	Geoidal separation (needs geoidal height option)
M	Geoidal separation units, in meters
SSS	Age of differential corrections, in seconds
AAAA	Reference station identification
*CC	Checksum
<CR>	Carriage return
<LF>	Line feed

9.4.2. GLL Messages

Table 111 lists the GLL data fields.

Table 111. GLL Data Fields

Message	GLL
Description	Latitude and Longitude Data
Rates [Hz]	0,1,2,10,20
Message Format	
$GPGLL,DDMM.MMMMM,S,DDDMM.MMMMM,S,HHMMSS.SS,S*CC<CR><LF>	
Message Field	Description
DDMM.MMMMM	Latitude in degrees, minutes and decimal minutes
S	S = N (North Latitude) or S = S (South latitude)
DDDMM.MMMMM	Longitude in degrees, minutes and decimal minutes
S	S = E (East longitude) or S = W (West longitude)
HHMMSS.SS	UTC time in Hours [HH], Minutes [MM] and seconds [SS.SS] of GPS Position
S	Status S = A (valid) or S = V (invalid)
*CC	Checksum
<CR>	Carriage return
<LF>	Line feed

9.4.3. GSA Messages

Table 112 lists the GSA data fields.

Table 112. GSA Data Fields

Message	GSA
Description	GPS DOP and active satellite information. Only satellites used in the position computation are present in this message. Null fields are present when data is unavailable due to the number of satellites tracked.
Rates [Hz]	0,1
Message Format	
$GPGSA,A,B,CC ... OO,P.P,Q.Q,R.R*CC<CR><LF>	
Message Field	Description
A	Satellite acquisition mode (M = manually forced to 2D or 3D, A = automatic swap between 2D and 3D)
B	Position mode (1 = fix not available, 2 = 2D fix, 3 = 3D fix)
CC … OO	Satellites used in the position solution; a null field occurs if a channel is unused
P.P	Position Dilution of Precision (PDOP) = 1.0 to 9.9
Q.Q	Horizontal Dilution of Precision (HDOP) 1.0 to 9.9
R.R	Vertical Dilution of Precision (VDOP) = 1.0 to 9.9
*CC	Checksum
<CR>	Carriage return
<LF>	Line feed

9.4.4. GST Messages

Table 113 lists the GST data fields.

Table 113. GST Data Fields

Message	GST
Description	GNSS pseudo-range error statistics and position accuracy
Rates [Hz]	0,1
Message Format	
$GPGST,HHMMSS.SS,A.A,B.B,C.C,D.D,E.E,F.F,G.G*CC<CR><LF>	
Message Field	Description
HHMMSS.SS	UTC time in Hours [HH], Minutes [MM] and seconds [SS.SS] of GPS Position
A.A	Root mean square (rms) value of the standard deviation of the range inputs to the navigation process. Range inputs include pseudo-ranges and differential GNSS (DGNSS) corrections.
B.B	Standard deviation of semi-major axis of error ellipse, in meters
C.C	Standard deviation of semi-minor axis of error ellipse, in meters
D.D	Error in Eclipse's semi major axis origination, in decimal degrees, true north
E.E	Standard deviation of latitude error, in meters
F.F	Standard deviation of longitude error, in meters
G.G	Standard deviation of altitude error, in meters
*CC	Checksum
<CR>	Carriage return
<LF>	Line feed

9.4.5. GSV Messages

Table 114 lists the GSV data fields.

Table 114. GSV Data Fields

Message	GSV
Description	GNSS satellite in view Null fields occur where data is unavailable due to the number of satellites tracked.
Rates [Hz]	0,1
Message Format	
$GPGSV,T,M,N,II,EE,AAA,SS,…II,EE,AAA,SS*CC<CR><LF>	
Message Field	Description
T	Total number of messages
M	Message number (1 to 3)
N	Total number of satellites in view
II	Satellite number
EE	Elevation, in degrees (0 to 90)
AAA	Azimuth (true), in degrees (0 to 359)
SS	Signal strength, in dB-Hz (0 - 99)
*CC	Checksum
<CR>	Carriage return
<LF>	Line feed

9.4.6. RMC Messages

Table 115 lists the RMC data fields.

Table 115. RMC Data Fields

Message	RMC
Description	Contains recommended minimum specific GNSS data
Rates [Hz]	0,1, 2, 10
Message Format	
$GPRMC,HHMMSS.SS,A,DDMM.MMM,N,DDDMM.MMM,W,Z.Z,Y.Y,DDMMYY,D.D,V*CC<CR><LF>	
Message Field	Description
HHMMSS.SS	UTC time in Hours [HH], Minutes [MM] and seconds [SS.SS] of GPS Position
A	Status: A = Valid, V = Invalid
DDMM.MMM	Latitude in degrees, minutes and decimal minutes
N	Latitude location: N = North, S = South
DDDMM.MMM	Longitude in degrees, minutes and decimal minutes
W	Longitude location: E = East, W = West
Z.Z	Ground Speed, in knots
Y.Y	Track made good, reference to true north
DDMMYY	UTC date of position fix in day, month, and year
D.D	Magnetic Variation, in degrees
V	Variation sense (E = East, W = West)
*CC	Checksum
<CR>	Carriage return
<LF>	Line feed

9.4.7. VTG Messages

Table 116 lists the VTG data fields.

Table 116. VTG Data Fields

Message	VTG
Description	Course overground and ground speed
Rates [Hz]	0,1, 2, 10, 20
Message Format	
$GPVTG,TTT,T,MMM,M,NNN.NN,N,KKK.KK,K,X*CC<CR><LF>	
Message Field	Description
TTT	True course overground (COG) in degrees (000 to 359)
T	True course over ground indicator (always 'T')
MMM	Magnetic course over ground in degrees (000 to 359)
M	Magnetic course overground indicator (always 'M')
NNN.NN	Speed over ground in knots
N	Speed over ground in knots indicator (always 'N')
KKK.KK	Speed over ground in km/h
K	Speed overground in km/h indicator (always 'K')
X	Mode A = Autonomous mode D = Differential mode E = Estimated (dead reckoning) mode M = Manual input mode S = Simulator mode N = Data not valid
*CC	Checksum
<CR>	Carriage return
<LF>	Line feed

9.4.8. ZDA Messages

Table 117 lists the ZDA data fields.

Table 117. ZDA Data Fields

Message	ZDA
Description	UTC time and date information
Rates [Hz]	0,1, 2, 10, 20
Message Format	
$GPZDA,HHMMSS.SS,DD,MM,YYYY,XX,YY*CC<CR><LF>	
Message Field	Description
HHMMSS.SS	UTC time in Hours [HH], Minutes [MM] and seconds [SS.SS] of GPS Position
DD	Day (0 to 31)
MM	Month (1 to 12)
YYYY	Year
XX	Local zone description in hours (-13 to 13)
YY	Local zone description in minutes (0 to 59)
*CC	Checksum
<CR>	Carriage return
<LF>	Line feed

9.4.9. HDT Messages

Table 118 lists the HDT data fields.

Table 118. HDT Data Fields

Message	HDT
Description	True heading of the vessel This is the direction that the vessel (antennas) is pointing and is not necessarily the direction of vessel motion (the course over ground).
Rates [Hz]	0,1, 2, 10, 20
Message Format	
$GPHDT,x.x,T*CC<CR><LF>	
Message Field	Description
x.x	Current Heading, in degrees
T	Indicates true heading (always T)
*CC	Checksum
<CR>	Carriage return
<LF>	Line feed

AUTHORIZATION TABLE

Document Information			
Document:	<Document Name>	**Site:**	<SITE NAME>
Purpose:	<Operational Document/Acceptance Document/Technical Reference Document>		
Authorization			

	Role	**Name**	**Approval Date**	**Signature**
Approved by:				

TABLE OF REVISIONS

Ver. #	Description	Author/s	Date
<0.0>			<DAY> <MONTH> <YEAR>