MGC3130 GestIC® Library Interface Description User's Guide

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Preface

NOTICE TO CUSTOMERS

All documentation becomes dated, and this manual is no exception. Microchip tools and documentation are constantly evolving to meet customer needs, so some actual dialogs and/or tool descriptions may differ from those in this document. Please refer to our web site (www.microchip.com) to obtain the latest documentation available.

Documents are identified with a "DS" number. This number is located on the bottom of each page, in front of the page number. The numbering convention for the DS number is "DSXXXXXA", where "XXXXX" is the document number and "A" is the revision level of the document.

For the most up-to-date information on development tools, see the MPLAB® IDE on-line help. Select the Help menu, and then Topics to open a list of available online help files.

INTRODUCTION

This chapter contains general information that will be useful to know before using the MGC3130 GestIC® Library Interface. Items discussed in this chapter include:

- Document Layout
- Conventions Used in this Guide
- Warranty Registration
- Recommended Reading
- The Microchip Web Site
- Development Systems Customer Change Notification Service
- Customer Support
- Document Revision History

DOCUMENT LAYOUT

This document describes the MGC3130 GestIC Library and is organized as follows:

- **Chapter 1. Introduction**
- **Chapter 2. MGC3130 Host Interface**
- **Chapter 3. GestIC Library Message Interface**
- **Chapter 4. GestIC Library Message Reference**
- **Chapter 5. Messages for GestIC Library Update**

CONVENTIONS USED IN THIS GUIDE

This manual uses the following documentation conventions:

DOCUMENT CONVENTIONS

Description	Represents	Examples
Arial font:		
Italic characters	Referenced books	*MPLAB IDE User's Guide*
	Emphasized text	...is the *only* compiler...
Initial caps	A window	the Output window
	A dialog	the Settings dialog
	A menu selection	select Enable Programmer
Quotes	A field name in a window or dialog	"Save project before build"
Underlined, italic text with right angle bracket	A menu path	<u>*File>Save*</u>
Bold characters	A dialog button	Click **OK**
	A tab	Click the **Power** tab
N'Rnnnn	A number in verilog format, where N is the total number of digits, R is the radix and n is a digit.	4'b0010, 2'hF1
Text in angle brackets < >	A key on the keyboard	Press <Enter>, <F1>
Courier New font:		
Plain Courier New	Sample source code	`#define START`
	Filenames	`autoexec.bat`
	File paths	`c:\mcc18\h`
	Keywords	`_asm, _endasm, static`
	Command-line options	`-Opa+, -Opa-`
	Bit values	`0, 1`
	Constants	`0xFF, 'A'`
Italic Courier New	A variable argument	*`file`*`.o`, where *`file`* can be any valid filename
Square brackets [ ]	Optional arguments	`mcc18 [options]` *`file`* `[options]`
Curly brackets and pipe character: { | }	Choice of mutually exclusive arguments; an OR selection	`errorlevel {0|1}`
Ellipses...	Replaces repeated text	`var_name [, var_name...]`

	Represents code supplied by user	`void main (void)`
		`{ ...`
		`}`

WARRANTY REGISTRATION

Please complete the enclosed Warranty Registration Card and mail it promptly. Sending in the Warranty Registration Card entitles users to receive new product updates. Interim software releases are available at the Microchip web site.

RECOMMENDED READING

This user's guide describes how to use MGC3130 GestIC Library Interface. Other useful documents are listed below. The following Microchip documents are available and recommended as supplemental reference resources.

- *"MGC3130 Single-Zone 3D Gesture Controller Data Sheet"* (DS40001667) – Consult this document for information regarding the MGC3130 3D Tracking and Gesture Controller.
- *"MGC3130 Aurea Graphical User Interface User's Guide"* (DS40001681) – Describes how to use the MGC3130 Aurea Graphical User Interface.
- *"MGC3130 GestIC® Design Guide"* (DS40001716) – This document describes the MGC3130 system characteristic parameters and the design process. It enables the user to generate a good electrode design and to parameterize the full GestIC system.

THE MICROCHIP WEB SITE

Microchip provides online support via our web site at www.microchip.com. This web site is used as a means to make files and information easily available to customers. Information about GestIC technology and MGC3130 can be directly accessed via http://www.microchip.com/gestic.

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- **Emulators** – The latest information on Microchip in-circuit emulators.This includes the MPLAB® REAL ICE™ and MPLAB ICE 2000 in-circuit emulators.
- **In-Circuit Debuggers** – The latest information on the Microchip in-circuit debuggers. This includes MPLAB ICD 3 in-circuit debuggers and PICkit™ 3 debug express.
- **MPLAB IDE** – The latest information on Microchip MPLAB IDE, the Windows Integrated Development Environment for development systems tools. This list is focused on the MPLAB IDE, MPLAB IDE Project Manager, MPLAB Editor and MPLAB SIM simulator, as well as general editing and debugging features.
- **Programmers** – The latest information on Microchip programmers. These include production programmers such as MPLAB REAL ICE in-circuit emulator, MPLAB ICD 3 in-circuit debugger and MPLAB PM3 device programmers. Also included are nonproduction development programmers such as PICSTART® Plus and PICkit 2 and 3.

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- Field Application Engineer (FAE)
- Technical Support

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Technical support is available through the web site at:

http://www.microchip.com/support.

DOCUMENT REVISION HISTORY

Revision A (August 2013)

- Initial release of the document.

Revision B (November 2013)

- Updated Chapters 1, 2, 3 and 4; Added Chapter 5; Updated content for GestIC Library V1.0 and later.

Revision C (May 2014)

- Updated Section 3.5.2 (Payload Extraction), Section 4.2 (`Request_Message`), Section 4.4 (`Set_Runtime_Parameter`) and Section 4.5 (`Sensor_Data_Output`); Updated Tables 3-7, 3-12, 3-13, 3-14, 5.2, 5-4 and 5-6; Added Appendix A (I^2C™ Command Examples).

Chapter 1. Introduction

1.1 PURPOSE OF THIS DOCUMENT

This document is the interface description of the MGC3130's GestIC Library. It outlines the function of the Library's I^{2}C™ message interface, and contains the complete message reference to control and operate the MGC3130 system.

The main sections covered are:

- Description of the message interface and data protocol
- Message reference of the GestIC Library

The parameterization of the Colibri Suite is not covered in this document. That is only possible via Aurea PC software. Please refer to *"MGC3130 Aurea Graphical User Interface"* (DS40001681).

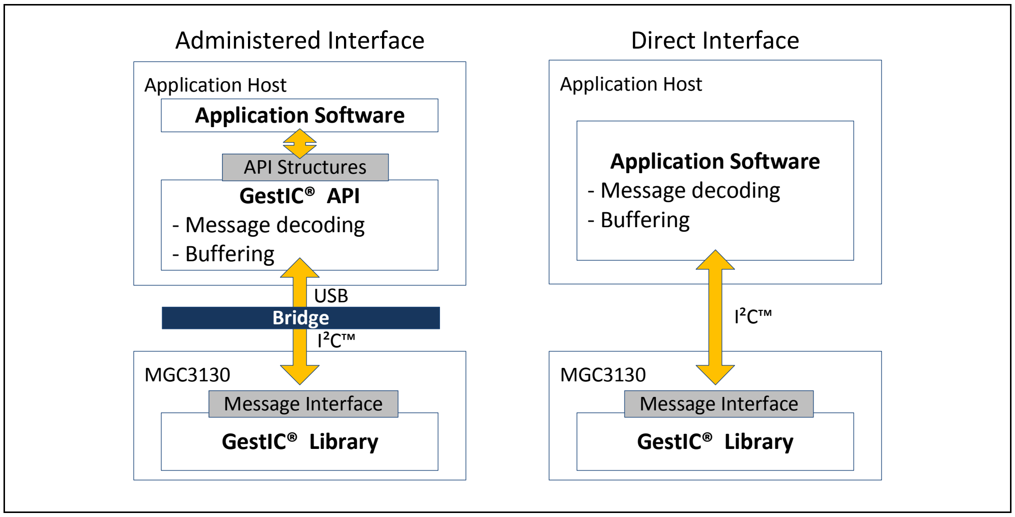
1.2 MGC3130 SOFTWARE ARCHITECTURE

A MGC3130 system can be accessed at two software levels:

- by direct I^{2}C access via message interface of GestIC Library (direct interface)
- by GestIC API as an abstraction layer of the messages (administered interface)

Examples for the two principal options are shown in Figure 1-1.

FIGURE 1-1: EXAMPLES FOR MGC3130 SOFTWARE ACCESS



The direct interface is the simplest way to access MGC3130, but it requires the user to receive and decode all I^{2}C messages and validate received data. Direct access is recommended if a reduced set of sensor data are used by the application (e.g., gestures only, position only). The administered interface via GestIC API provides decoded and validated sensor data, which can be immediately used in the application. Typically, GestIC API runs in PC applications or OS drivers, which provide data to the application software.

The following sections give a brief description of the building blocks of the two interface modes.

1.3 GestIC® LIBRARY

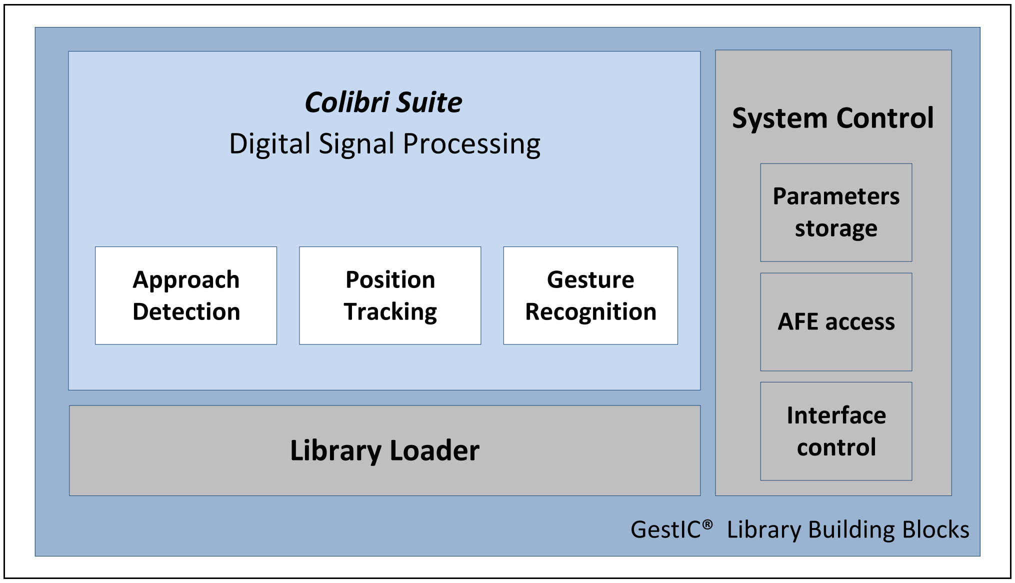
The GestIC Library is embedded firmware stored on the MGC3130's internal Flash memory. It contains:

- the Colibri Suite with the digital signal processing algorithms for GestIC features (i.e., GestIC core features Approach Detection, Position Tracking and Gesture Recognition)
- the System Control block providing full control of host interfaces, parameter storage and AFE access
- the Library Loader for updates of GestIC Library

The main building blocks are shown in Figure 1-2.

The GestIC Library incorporates a message-based interface that allows the configuration of the chip and the streaming of sensor data to the host application.

FIGURE 1-2: BUILDING BLOCKS OF GestIC® LIBRARY



1.4 BRIDGE

An additional hardware bridge is needed if the application host does not support a native I^{2}C interface. The bridge converts the I^{2}C hardware protocol to USB/UART.

If a bridge hardware is incorporated, the application host may need an additional device driver to register the interface and provide MGC3130 data within the operating system.

Examples are:

- Windows® CDC driver to send MGC3130 data to a virtual COM port. In this case, the driver is not aware of the MGC3130 data format.
- HID driver to use the MGC3130 data directly as USB HID classes within the operating system. Such driver must decode MGC3130 messages and, thus, the GestIC API reference code is recommended to be part of it.

1.5 GestIC API

As an abstraction layer for MGC3130 messages, Microchip developed the GestIC API to provide a simplified user interface which can be easily integrated into the customer's application.

GestIC API comes along with a C reference code which includes message buffer, decoder and event handler to make the interface independent from the low-level protocol and its timing constraints.

1.6 APPLICATION SOFTWARE

The sensor output is used in a user's application which integrates context-driven actions based on the user's hand movements.

Typically, the application software provides a graphical user interface (GUI) to visualize the MGC3130 control options, like Aurea, which is delivered within the MGC3130 evaluation and development kits.

Chapter 2. MGC3130 Host Interface

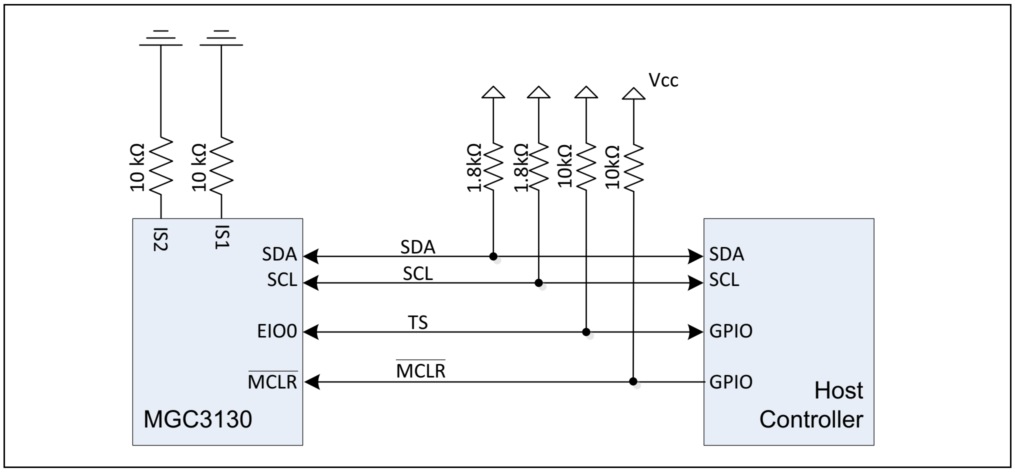
2.1 MGC3130 HARDWARE INTERFACE

Communication with the MGC3130 is accomplished via a two-wire I^{2}C compatible serial port, which allows the user to read the sensor data and to send control messages to the chip. It communicates via the serial interface with a master controller, which operates at speeds up to 400 kHz. One pin (IS2) is available for address selection and enables the user to connect up to two MGC3130 devices on the same bus without address conflict.

> **Note:** The MGC3130 I^{2}C™ addresses are 0x42 and 0x43. They are given as device addresses without the R/$\overline{\text{W}}$ bit. Please compare to the *"MGC3130 Single-Zone 3D Gesture Controller Data Sheet"* (DS40001667).

In addition, MGC3130 requires a dedicated transfer status line (TS), which features a data transfer status function. It is used by both I^{2}C Master and Slave to control the data flow. I^{2}C SCL, I^{2}C SDA and TS lines require an open-drain connection on MGC3130 and the connected host controller. To function properly, I^{2}C SCL and I^{2}C SDA need to be pulled up to VCC with 1.8 kΩ resistors and the TS line needs to be pulled up to VCC with a 10 kΩ resistor.

FIGURE 2-1: HARDWARE INTERFACE TO HOST CONTROLLER



In order to complete the control options for MGC3130, it is recommended that the host controller controls the MGC3130 $\overline{\text{MCLR}}$ line. In particular, the hardware reset is necessary for the update procedure of the GestIC Library.

2.2 USAGE OF TRANSFER STATUS LINE (TS)

The transfer status line is used to check if I^2C data are valid and if they can be sent from MGC3130 to the host controller.

The MGC3130 (I^2C Slave) uses this line to inform the host controller (I^2C Master) that there is data available which can be transferred. The host controller uses the TS line to indicate that data are being transferred and prevents MGC3130 from updating its data buffer.

Table 2-1 shows how the TS line is used in the different states of communication.

MGC3130 can update the I^2C buffer only when TS is released by both chips, and a data transfer can only be started when MGC3130 pulls TS low.

This procedure secures that:

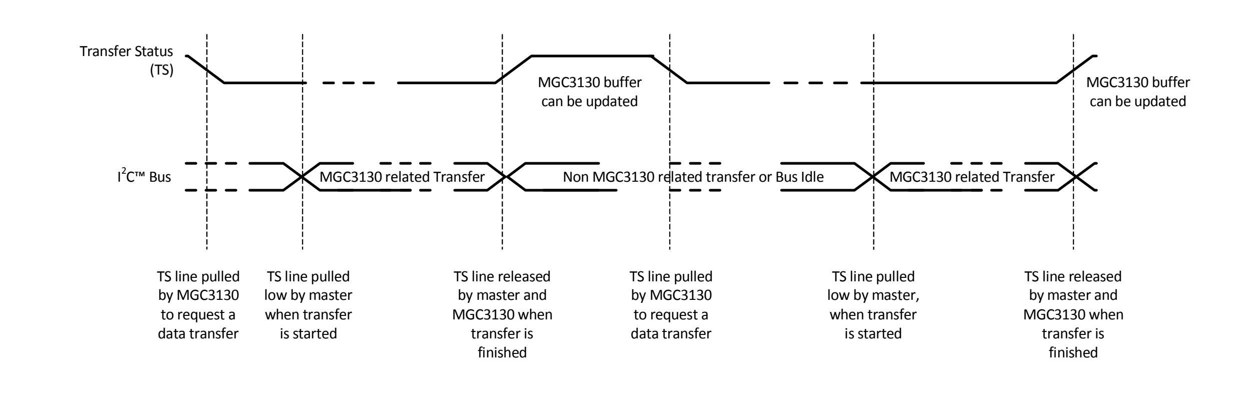
- the host is always informed when new sensor data are available
- buffer updates in MGC3130 are always completed before data are sent to the I^2C bus

Figure 2-2 shows the complete communication protocol.

TABLE 2-1: USAGE OF TRANSFER STATUS LINE

MGC3130	Host Controller	TS Line	Status
Released (H)	Released (H)	High	Host finished reading data (Transfer end). No more data to be transferred to the host. MGC3130 is allowed to update the data buffer.
Asserted (L)	Released (H)	Low	Data from MGC3130 is available to be sent, but the host has not yet started reading. If the host is busy and did not start reading before the next data update (5 ms), the MGC3130 will assert the TS line high while updating the data buffer.
Asserted (L)	Asserted (L)	Low	Host starts reading. MGC3130 data buffer will not be updated until the end of transfer (host releases TS high).
Released (H)	Asserted (L)	Low	MGC3130 is ready to update the data buffer, but the host is still reading the previous data. MGC3130 is allowed to update the data only when the host releases the TS high.

FIGURE 2-2: MGC3130 COMMUNICATION PROTOCOL


Transfer Status (TS)
MGC3130 buffer can be updated
MGC3130 buffer can be updated
I2C™ Bus
MGC3130 related Transfer
Non MGC3130 related transfer or Bus Idle
MGC3130 related Transfer
TS line pulled by MGC3130 to request a data transfer
TS line pulled low by master when transfer is started
TS line released by master and MGC3130 when transfer is finished
TS line pulled by MGC3130 to request a data transfer
TS line pulled low by master, when transfer is started
TS line released by master and MGC3130 when transfer is finished

> **Note 1:** The Stop condition after an I^{2}C™ data transmission is generated by the host controller (I^{2}C™ Master) after the data transfer is completed. Thus, it is recommended to verify the amount of bytes to be read in the message header (Size field).
>
> **2:** Transfer Status is only needed for data transfer from MGC3130 to the host controller. Writing to MGC3130 does not require the additional TS signal.

2.3 CODING EXAMPLE

In addition to the standard I^{2}C interface, the communication between MGC3130 and the host controller requires a proper handling of the Transfer Status. For an easier integration, the requirements are put into the code examples below.

EXAMPLE 2-1: CODE IMPLEMENTATION IN HOST CONTROLLER

```
I2C™ Read Function - requires TS:
I2C™ Master read loop:
    Read TS
    If TS == 0:
       Assert TS
       Send I2C™ start condition
       Send I2C™ device address + read indication
       Receive I2C™ payload (the GestIC® Library message)
       Send I2C™ stop condition
       Release TS
    Wait 200 µs (to assure that MGC3130 released TS line, too)
I2C™ Write Function - does not require TS:
I2C™ Master write loop:
       Send I2C™ start condition
       Send I2C™ device address + write indication
       Send I2C™ payload (the GestIC® Library message)
       Send I2C™ stop condition
```

Chapter 3. GestIC Library Message Interface

3.1 MESSAGES OVERVIEW

GestIC Library messages are defined for providing sensor data to the host application and for controlling MGC3130 and its embedded features. They are sent as the payload of the I^2C packets.

TABLE 3-1: MESSAGES FOR SYSTEM CONTROL

ID	Name	Page
0x15	System_Status	25
0x06	Request_Message	27
0x83	Fw_Version_Info	28
0xA2	Set_Runtime_Parameter	29

TABLE 3-2: MESSAGE FOR SENSOR DATA OUTPUT

ID	Name	Page
0x91	Sensor_Data_Output	38

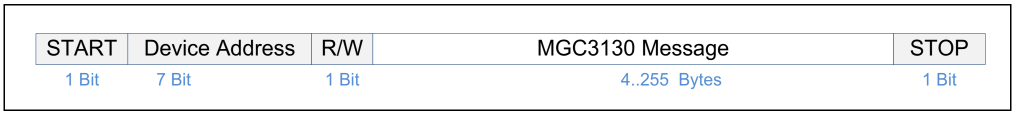
TABLE 3-3: MESSAGES FOR GestIC® LIBRARY UPDATE

ID	Name	Page
0x80	Fw_Update_Start	42
0x81	Fw_Update_Block	43
0x82	Fw_Update_Completed	45

3.2 MESSAGE FORMAT

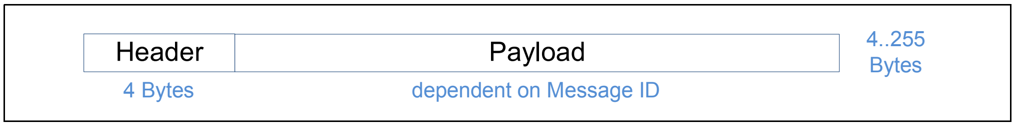
A message is the container to exchange data between GestIC Library and the application host. Each message has a length minimum of 4 bytes and a maximum of 255 bytes, and fits into the data packets of the communication interface (e.g., I^2C). Each frame transports a single message (see Figure 3-1).

FIGURE 3-1: MGC3130 MESSAGE EMBEDDED IN THE I^2C™ FRAME



Messages consist always of a 4-byte header and a variable payload. The format is shown in Figure 3-2.

FIGURE 3-2: MGC3130 MESSAGE FORMAT



3.3 MESSAGE HEADER

The GestIC Library message header is fixed and has a length of 4 bytes. It contains four data fields shown in Figure 3-3 and explained in Table 3-4.

FIGURE 3-3: MGC3130 MESSAGE HEADER

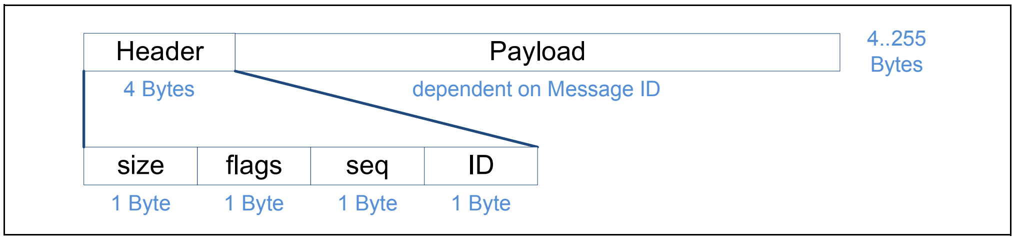


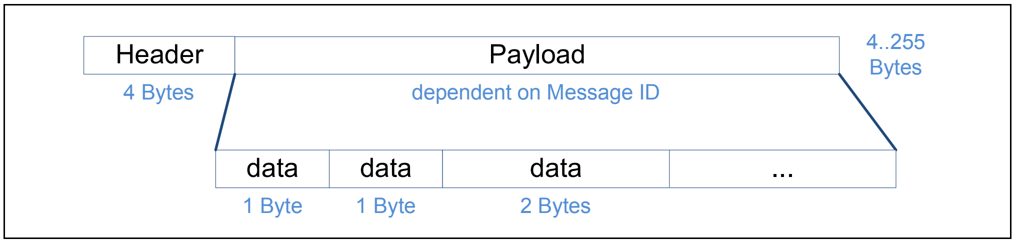
TABLE 3-4: DATA FIELDS OF MGC3130 MESSAGE HEADER

Field	Size (in bytes)	Description
Msg. Size	1	Complete size of the message in bytes including the header.
Flags	1	Reserved for future use.
Seq.	1	Sequence number which is increased for each message sent out by MGC3130. Range is 0…255. The host controller can use that information to verify if the messages got lost during I^2C™ transmission. MGC3130 ignores the sequence number in the received messages.
ID	1	ID of the message. For each ID, the GestIC® Library holds a dedicated structure containing the message direction, its payload elements and possible reply actions.

3.4 MESSAGE PAYLOAD

The message payload has a variable length and consists of one or more payload elements that contain the information to be exchanged. Depending on the content, these elements can be numerical values or dedicated numbers.

FIGURE 3-4: MGC3130 MESSAGE PAYLOAD



> **Note:** Payload elements are exchanged in little endian format. This means that the Lowest Significant Byte is written first.
>
> Example: Element of 4 bytes: [Byte0]:[Byte1]:[Byte2]:[Byte3]

The structure and content of the payload elements is given in **Chapter 4. "GestIC Library Message Reference"**.

3.5 MESSAGE CODING AND DECODING

GestIC Library messages can be read as a row of hexadecimal values. In order to decode them, the header and payload elements need to be extracted and mapped to the definition in the message reference (see **Chapter 4. "GestIC Library Message Reference"**).

As an example message, ID `0x83, FW_Version_Info` is decoded in the following section.

EXAMPLE 3-1: HEXADECIMAL REPRESENTATION OF MESSAGE 0x83

```
84 00 00 83 AA 63 80 E6 0C 64 15 20 31 2E 30 2E 30 3B 70 3A 48 69 6C 6C 73 74 61 72
56 30 31 3B 44 53 50 3A 49 44 39 30 30 30 72 31 38 34 39 3B 69 3A 42 3B 66 3A 32 32
35 30 30 3B 6E 4D 73 67 3B 73 3A 42 65 74 61 32 72 31 30 34 30 3A 31 30 34 39 3A 4D
4F 3B 63 3A 4D 4B 49 3B 74 3A 32 30 31 33 2F 31 31 2F 30 38 20 31 33 3A 30 33 3A 30
00 10 00 00 55 AA 90 65 20 20 80 0F FF 00 FF 00 E1 EA 00 00
```

3.5.1 Header Extraction

EXAMPLE 3-2: MESSAGE HEADER

```
84 00 00 83 AA 63 80 E6 0C 64 15 20 31 2E 30 2E 30 3B 70 3A 48 69 6C 6C 73 74 61 72
56 30 31 3B 44 53 50 3A 49 44 39 30 30 30 72 31 38 34 39 3B 69 3A 42 3B 66 3A 32 32
35 30 30 3B 6E 4D 73 67 3B 73 3A 42 65 74 61 32 72 31 30 34 30 3A 31 30 34 39 3A 4D
4F 3B 63 3A 4D 4B 49 3B 74 3A 32 30 31 33 2F 31 31 2F 30 38 20 31 33 3A 30 33 3A 30
00 10 00 00 55 AA 90 65 20 20 80 0F FF 00 FF 00 E1 EA 00 00
```

The message header contains the following information:

- *Size:* *`0x84`* *Message including header is 132 bytes long*
- *Flags:* *`0x00`* *Flags are not set*
- *Seq.:* *`0x00`* *The message has been sent out with a sequence number of 0*
- *ID:* *`0x83`* *The message ID is `0x83`, `Fw_Version_Info`*

3.5.2 Payload Extraction

EXAMPLE 3-3: MESSAGE PAYLOAD

```
84 00 00 83 AA 63 80 E6 0C 64 15 20 31 2E 30 2E 30 3B 70 3A 48 69 6C 6C 73 74 61 72 56
30 31 3B 44 53 50 3A 49 44 39 30 30 30 72 31 38 34 39 3B 69 3A 42 3B 66 3A 32 32 35 30
30 3B 6E 4D 73 67 3B 73 3A 42 65 74 61 32 72 31 30 34 30 3A 31 30 34 39 3A 4D 4F 3B 63
3A 4D 4B 49 3B 74 3A 32 30 31 33 2F 31 31 2F 30 38 20 31 33 3A 30 33 3A 30 00 10 00 00
55 AA 90 65 20 20 80 0F FF 00 FF 00 E1 EA 00 00
```

According to **Section 4.3 “Fw_Version_Info”**, Fw_Version_Info holds seven payload elements:

- **FwValid** Status of GestIC Library (1 byte)
- **HwRev** HW revision information (2 bytes)
- **ParameterStartAddr** Start address of parameter (1 byte)
- **LibraryLoaderVersion** GestIC Library loader version (2 bytes)
- **LibraryLoaderPlatform** GestIC Library loader platform (1 byte)
- **FwStartAddr** Start address of GestIC Library(1 byte)
- **FwVersion** Version information of GestIC Library if valid (120 bytes)

The values can now be converted and mapped to the description of the payload elements:

FwValid = AA (170): A valid GestIC Libary is available

HwRev = 63 80 (read as 0x63 0x80): HW revision is 99.128

ParameterStartAddr = 0xE6 (230x128=29440): Start address of parameter is 29440

LibraryLoaderVersion = 0C 64 (read as 0x64 0x0C): Library Loader version is 100.12

LibraryLoaderPlatform = 15 (read as 0x15): Library Loader Platform is 21

FwStartAddr = 0x20 (32x128=4096): Start address of GestIC Library is 4096

FwVersion = 31 2E 30 2E 30 3B 70 3A 48 69 6C 6C 73 74 61 72 56 30 31 3B 44 53 50 3A 49 44 39 30 30 30 72 31 38 34 39 3B 69 3A 42 3B 66 3A 32 32 35 30 30 3B 6E 4D 73 67 3B 73 3A 42 65 74 61 32 72 31 30 34 30 3A 31 30 34 39 3A 4D 4F 3B 63 3A 4D 4B 49 3B 74 3A 32 30 31 33 2F 31 31 2F 30 38 20 31 33 3A 30 33 3A 30 00 10 00 00 55 AA 90 65 20 20 80 0F FF 00 FF 00 E1 EA 00 00

The version string is interpreted by ASCII characters. It is a semicolon-separated string, always starting with the version number itself, followed by different tags:

```
1.0.0;p:HillstarV01;DSP:ID9000r1849;i:B;f:22500;nMsg;s:Beta2r10
40:1049:MO;c:MKI;t:2013/11/08 13:03:0;...
```

3.6 MESSAGE CONTROL FLOW AND CODING EXAMPLES

3.6.1 Message Control Flow

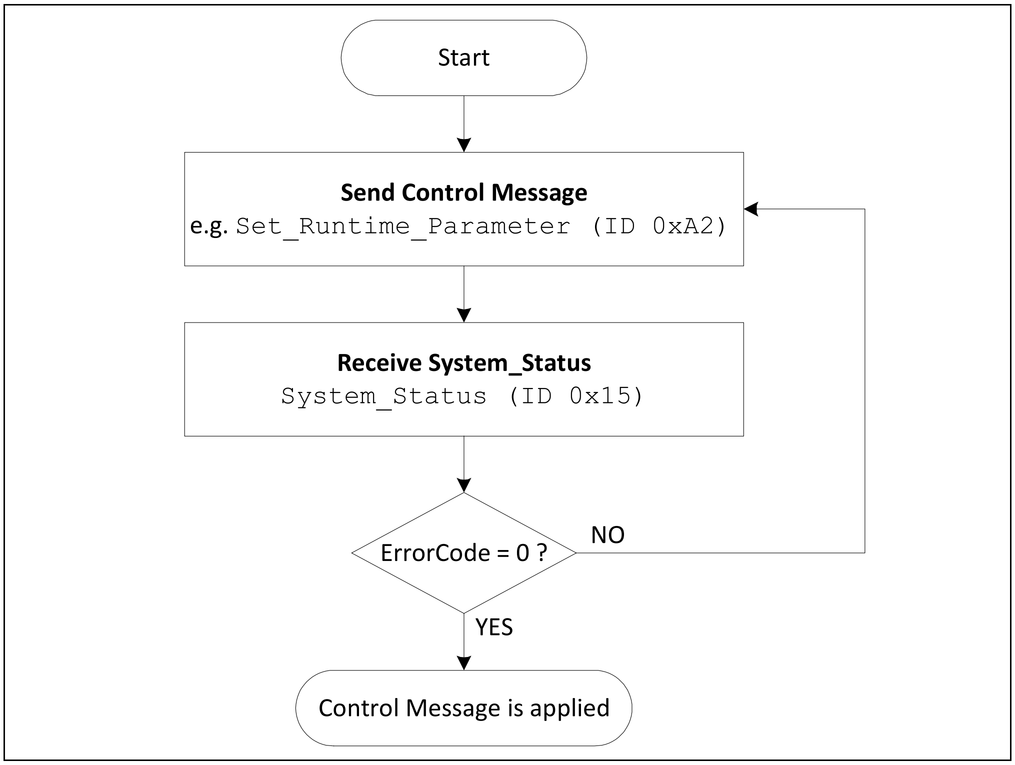
The control of MGC3130 GestIC Library is done through the following messages:

- `Set_Runtime_Parameter (ID 0xA2)`
- `Request_Message (ID 0x06)`

MGC3130 acknowledges each control message by a `System_Status (ID 0x15)` which contains the original message ID and a 2-byte error code. If the error code is ‘`0`’, the message is applied correctly to MGC3130.

The message control flow from the point of view of the application host is shown in Figure 3-5.

FIGURE 3-5: APPLICATION HOST MESSAGE CONTROL



> **Note:** The Hillstar and Sabrewing I^{2}C to USB bridge prefixes every I^{2}C packet with `0xFEFF` before it is sent out via UART emulation on USB. That is done to allow a frame separation inside the data stream of the PC. For messages sent to MGC3130 from a terminal program (e.g., Hterm), the prefix has to be added, as well.

3.6.2 Read GestIC Library Version

After Power-on or Reset, MGC3130 runs the Library Loader and sends out the message `Fw_Version_Info (0x83)`. The application host can receive this message as a first communication check. After a time-out of 200 ms, the GestIC Library Processing mode is started automatically.

The application host can request the `FW_Version_Info` during runtime by using `Request_Message (0x06)`.

3.6.2.1 EXAMPLE: REQUEST FW VERSION INFO

The following example shows how the `Request_Message (0x06)` is used to request a `FW_Version_Info (0x83)` message.

TABLE 3-5: MESSAGE FROM HOST TO MGC3130: `REQUEST_MESSAGE (0X06)`

Raw Message	0C 00 00 06 83 00 00 00 00 00 00 00		
Payload Element	MessageID	Reserved	Parameter
Hex in little endian	83	00 00 00	00 00 00 00
Hex decoded	0x83	n.a.	n.a.
Description	FW_Version_Info	n.a.	n.a.

MGC3130 replies with message `FW_Version_Info (0x83)` followed by `System_Status (0x15)`, containing the error code.

TABLE 3-6: MESSAGE FROM MGC3130 TO HOST: `FW_VERSION_INFO (0X83)`

Raw Message	84 00 01 83 AA 00 00 FF 00 00 00 20 31 2E 30 2E 30 3B 70 3A 48 69 6C 6C 73 74 61 72 56 30 31 3B 44 53 50 3A 49 44 39 30 30 30 72 31 38 34 39 3B 69 3A 42 3B 66 3A 32 32 35 30 30 3B 6E 4D 73 67 3B 73 3A 42 65 74 61 32 72 31 30 34 30 3A 31 30 34 39 3A 4D 4F 3B 63 3A 4D 4B 49 3B 74 3A 32 30 31 33 2F 31 31 2F 30 38 20 31 33 3A 30 33 3A 30 38 3B 00 00 00 00 00 00 00 00 00 00 00 00 00 00 E1 EA 00 00					
Payload Element	FWValid	HWRev	Parameter-StartAddr	LibraryLoad-erVersion	FWStartAddr	FWVersion
Hex in little endian	AA	00 00	FF	00 00 00	20	...
Hex decoded	0xAA	n.a.	n.a.	n.a.	0x20	...
Description	170 ValidFW	Only valid after MGC3130 start-up	Only valid after MGC3130 start-up	Only valid after MGC3130 start-up	Start address of GestIC® Library	Please see below

`FWVersion` interpreted as ASCII characters:

```
1.0.0;p:HillstarV01;DSP:ID9000r1849;i:B;f:22500;nMsg;s:Beta2r10
40:1049:MO;c:MKI;t:2013/11/08 13:03:08;…
```

• GestIC Library Version:	1.0.0
• Plattform:	HillstarV01
• Colibri Suite Version:	ID9000r1849
• Build Time:	2013/11/08 13:03:08

3.6.3 Run-Time Control

A dedicated set of run-time control options is provided within the message Set_Runtime_Parameter (0xA2). It can be used to control the active feature set and sensor data output and, thus, it allows the build-up of a context-sensitive operation of MGC3130. For a detailed message description, please refer to **Section 4.4 "Set_Runtime_Parameter"**.

The following examples show how to set relevant runtime parameters.

3.6.3.1 EXAMPLE: ENABLE APPROACH DETECTION

This example shows how to enable the Approach Detection mode by using the message Set_Runtime_Parameter (0xA2).

TABLE 3-7: MESSAGE FROM HOST TO MGC3130: SET_RUNTIME_PARAMETER (0XA2)

Raw Message	10 00 00 A2 97 00 00 00 01 00 00 00 01 00 00 00			
Payload Element	RuntimeParameterID	Reserved	Argument0	Argument1
Hex in little endian	97 00	00 00	01 00 00 00	01 00 00 00
Hex decoded	0x0097	n.a.	0x00000001	0x00000001
Description	ApproachDetection	n.a.	Enable Approach Detection mode	Mask for Approach Detection bit

MGC3130 replies with message System_Status (0x15), containing the error code.

TABLE 3-8: MESSAGE FROM MGC3130 TO HOST: SYSTEM_STATUS (0X15)

Raw Message	10 00 08 15 A2 34 00 00 00 00 00 00 00 00 00 00				
Payload Element	MsgID	MaxCmdSize	ErrorCode	Reserved	Reserved
Hex in little endian	A2	34	00 00	00 00 00 00	00 00 00 00
Hex decoded	0xA2	0x34	0x0000	n.a.	n.a.
Description	Acknowledge to ID 0xA2	n.a.	No error	n.a.	n.a.

3.6.3.2 EXAMPLE: ENABLE ALL GESTURES

This example shows how to enable all gestures (Flicks and Circles) by using the message Set_Runtime_Parameter (0xA2).

TABLE 3-9: MESSAGE FROM HOST TO MGC3130: SET_RUNTIME_PARAMETER (0XA2)

Raw Message	10 00 00 A2 85 00 00 00 7F 00 00 00 7F 00 00 00			
Payload Element	RuntimeParameterID	Reserved	Argument0	Argument1
Hex in little endian	85 00	00 00	7F 00 00 00	7F 00 00 00
Hex decoded	0x0085	n.a.	0x0000007F	0x0000007F
Description	despGestureMask	n.a.	Enable gestures 0...6	Mask for Enable gestures 0...6 bits

MGC3130 replies with message System_Status (0x15). Refer to Table 3-8.

3.6.3.3 EXAMPLE: ENABLE DATA OUTPUT

This example shows how to enable the sensor data output of Gesture Data, Touch Data, AirWheel Data and Position Data. Please refer to **Section 4.4.5.4 "Data Output Enable Mask"**.

TABLE 3-10: MESSAGE FROM HOST TO MGC3130: `SET_RUNTIME_PARAMETER (0XA2)`

Raw Message	`10 00 00 A2 A0 00 00 00 1E 00 00 00 FF FF FF FF`			
Payload Element	`RuntimeParameterID`	`Reserved`	`Argument0`	`Argument1`
Hex in little endian	`A0 00`	`00 00`	`1E 00 00 00`	`FF FF FF FF`
Hex decoded	`0xA0`	`0x0000`	`0x0000001E`	`0xFFFFFFFF`
Description	`DataOutputEnableMask`	n.a.	Enable bit 1...bit 4; disable all other bits	Overwrite existing configuration

MGC3130 replies with message `System_Status (0x15)`. Refer to Table 3-8.

3.6.3.4 EXAMPLE: LOCK DATA OUTPUT

This example shows how to lock the sensor data output of Gesture Data, Touch Data, AirWheel Data and Position Data. Please refer to **Section 4.4.5.5 "Data Output Lock Mask"**.

TABLE 3-11: MESSAGE FROM HOST TO MGC3130: `SET_RUNTIME_PARAMETER (0XA2)`

Raw Message	`10 00 00 A2 A1 00 00 00 1E 00 00 00 FF FF FF FF`			
Payload Element	`RuntimeParameterID`	`Reserved`	`Argument0`	`Argument1`
Hex in little endian	`A1 00`	`00 00`	`1E 00 00 00`	`FF FF FF FF`
Hex decoded	`0x00A1`	`0x0000`	`0x0000001E`	`0xFFFFFFFF`
Description	`DataOutputLockMask`	n.a.	Enable bit 1...bit 4; disable all other bits	Overwrite existing configuration

MGC3130 replies with message `System_Status (0x15)`. Refer to Table 3-8.

3.6.4 Sensor Data Output

The GestIC Library processes sensor data with a default update rate of 5 ms. That means the I^{2}C message buffer is regularly updated in that time interval. Whenever new data are available, MGC3130 pulls the TS line to request the I^{2}C master to transfer this data. Sensor data sent from MGC3130 to the host are included in the message `Sensor_Data_Output (0x91)`.

The content of the sensor data output can be configured via the message `Set_Runtime_Parameter (0xA2)`.

3.6.4.1 EXAMPLE: READ SENSOR DATA OUTPUT

In the following examples the sensor data output is configured according to **Section 3.6.3.3 "Example: Enable Data Output"** and **Section 3.6.3.4 "Example: Lock Data Output"**.

TABLE 3-12: MESSAGE FROM MGC3130 TO HOST: FLICK EAST TO WEST

Raw Message	18 08 FF 91 1E 01 57 8C 03 10 04 00 00 00 00 00 00 00 00 00 00 00 00 00				
Payload Element	SystemInfo	GestureInfo	TouchInfo	Air-WheelInfo	xyzPosition
Hex in little endian	8C	03 10 04 00	00 00 00 00	00 00	00 00 00 00 00 00
Hex decoded	0x8C	0x00041003	0x00000000	0x0000	0x000000000000
Description	Bit 2: RawDataValid Bit 3: NoisePowerValid Bit 7: DSPRunning	Flick East to West	No touch	No AirWheel	No Position Data available

TABLE 3-13: MESSAGE FROM MGC3130 TO HOST: TOUCH OF CENTER ELECTRODE

Raw Message	18 08 3B 91 1E 01 38 8D 00 00 00 00 10 00 00 00 00 00 5A A6 12 53 6B 0A				
Payload Element	SystemInfo	GestureInfo	TouchInfo	Air-WheelInfo	xyzPosition
Hex in little endian	8D	00 00 00 00	10 00 00 00	00 00	5A A6 12 53 6B 0A
Hex decoded	0x8D	0x00000000	0x00000010	0x0000	Byte 1 and 2: 0xA65A Byte 3 and 4: 0x5312 Byte 5 and 6: 0x0A6B
Description	Bit 0: PositionValid Bit 2: RawDataValid Bit 3: NoisePowerValid Bit 7: DSPRunning	No Gesture Detected	Touch on Center Electrode	No AirWheel Data	x: 42586 y: 21266 z: 2667

TABLE 3-14: MESSAGE FROM MGC3130 TO HOST: POSITION

Raw Message	18 08 44 91 1E 01 41 8D 00 00 00 00 00 00 00 00 00 00 2F B2 E7 87 6A 35				
Payload Element	SystemInfo	GestureInfo	TouchInfo	Air-WheelInfo	xyzPosition
Hex in little endian	8D	00 00 00 00	00 00 00 00	00 00	2F B2 E7 87 6A 35
Hex decoded	0x8D	0x00000000	0x00000000	0x0000	Byte 1 and 2: 0xB22F Byte 3 and 4: 0x87E7 Byte 5 and 6: 0x356a
Description	Bit 0: PositionValid Bit 2: RawDataValid Bit 3: NoisePowerValid Bit 7: DSPRunning	No Gesture Detected	Touch on Center Electrode	No AirWheel Data	x: 45615 y: 34791 z: 13674

Chapter 4. GestIC Library Message Reference

4.1 SYSTEM_STATUS

System_Status is used to acknowledge the reception of messages from the host. This message holds the error code and is used to confirm the transmission of the following messages:

- Request_Message (0x06)
- Set_Runtime_Parameter (0xA2)
- Fw_Update_Start (0x80)
- Fw_Update_Block (0x81)
- Fw_Update_Completed (0x82)

Direction: MGC3130 to Host

TABLE 4-1: MESSAGE OVERVIEW

Header				Payload				
Msg. Size	Flags	Seq.	ID	MsgID	MaxCmdSize	ErrorCode	Reserved	Reserved
1 Byte	*1 Byte*	*1 Byte*	*1 Byte*	*1 Byte*	*1 Byte*	*2 Bytes*	*4 Bytes*	*4 Bytes*
0x10	n.a.	n.a.	0x15	see description below				

TABLE 4-2: PAYLOAD ELEMENTS

Element	Element Size (in bytes)	Description
MsgID	1	Holds the Message ID which System_Status corresponds to ***Structure***: 1 byte ***Range***: (0x00..0xFF)
MaxCmdSize	1	Holds the maximum I^{2}C™ packet size GestIC® Library accepts (including header) ***Structure***: 1 byte ***Range***: (0..0xFF)
ErrorCode	2	Error code, returned for the previous message. ***Structure***: 16-bit word containing dedicated values (see list below) Possible values: These error codes are sent by the Library Loader, Library Loader Updater and Library 0x0000 NoError — OK 0x0001 UnknownCommand — Message ID is unknown These error codes are sent by the Library Loader 0x0002 InvalidSessionId — Session ID is invalid or does not match (0x0 is not allowed) (message FwUpdateStart, FwUpdateCompleted) 0x003 InvalidCrc — CRC is invalid thrown by commands: FwUpdateBlock, FwUpdateStart,FwUpdateCompleted 0x0004 InvalidLength — Length is invalid (message FwUpdateBlock) 0x0005 InvalidAddress — Address is invalid (message FwUpdateBlock) 0x0006 InvalidFunction — Function-id is invalid (message FwUpdateStart, FwUpdateBlock, FwUpdateCompleted) 0x0008 ContentMismatch — The VerifyOnly function found a mismatch between content and Flash memory (message: FwUpdateBlock) 0x000B WrongParameterAddr — Parameter Start address, contained in the new Library FW to be loaded, does not match Library Loader assumption. The Library Update is therefore aborted. (message: FwUpdateStart) These error codes are sent by the Library 0x0014 WrongParameterValue — The value of the Argument/Parameter of a RuntimeParameter command is out of the valid range (message: Request Message and Set_Runtime_Parameter) 0x0015 UnknownParameterID — The MessageID or RuntimeParameterID is unknown or out of the valid range (message: Request Message and Set_Runtime_Parameter) 0x001A WakeupHappend — A wake-up by Host was detected These error codes are sent by the Library Loader Updater 0x0080 LoaderUpdateStarted — The Library Loader update started 0x0081 LoaderUpdateFinished — The Library Loader update finished

TABLE 4-2: PAYLOAD ELEMENTS

Element	Element Size (in bytes)	Description
Reserved	4	Reserved
Reserved	4	Reserved

4.2 REQUEST_MESSAGE

Request_Message forces GestIC Library to reply to the message with the requested ID.

Direction: Host to MGC3130

TABLE 4-3: MESSAGE OVERVIEW

Header				Payload		
Msg. Size	Flags	Seq.	ID	MessageID	Reserved	Param.
1 Byte	*1 Byte*	*1 Byte*	*1 Byte*	*1 Byte*	*3 Bytes*	*4 Bytes*
0x0C	n.a.	n.a.	0x06	see description below		

TABLE 4-4: PAYLOAD ELEMENTS

Element	Element Size (in bytes)	Description
MessageID	1	Request the Message with ID MessageID from GestIC® Library. GestIC® Library shall answer with the requested message or stay silent. ***Structure***: Single byte read as a hexadecimal value ***Range:*** (0x00..0xFF)
Reserved	3	Reserved, write as ‘0’.
Param.	4	Optional, parameter can be used to specify the kind of return. Example: Requesting message SetRuntimeParameter, param. specifies the RuntimeParameterId to read-back the parameter. ***Structure***: 32-bit word, containing dedicated values or bit fields. ***Range:*** (0x00000000..0xFFFFFFFF)

Note 1: The Request_Message command can only be used with MessageID 0x83 and 0xA2.

2: The TransFreqSelect runtime parameter is a write only parameter and could not be requested with message Request_Message.

3: For the complete list of the Request_Message command examples please refer to Table A-1.

4.3 FW_VERSION_INFO

At start-up, MGC3130 sends `Fw_Version_Info` message to the host interface to show that the chip is alive and ready for operation. `Fw_Version_Info` can also be requested using `Request_Message (0x06)`.

> **Note:** The payload elements `HWRev`, `ParameterStartAddr` and `LibraryLoaderVersion` are only valid after MGC3130 start-up.

Direction: MGC3130 to Host.

TABLE 4-5: MESSAGE OVERVIEW

Header				Payload					
Msg. Size	Flags	Seq.	ID	FwValid	HwRev	ParameterStartAddr	LibraryLoaderVersion	FwStartAddr	FwVersion
1 Byte	*1 Byte*	*1 Byte*	*1 Byte*	*1 Byte*	*2 Bytes*	*1 Byte*	*3 Bytes*	*1 Byte*	*120 Bytes*
0x84	n.a.	n.a.	0x83	see description below					

TABLE 4-6: PAYLOAD ELEMENTS

Element	Element Size (in bytes)	Description
FwValid	1	Status of GestIC® Library. ***Structure***: Single byte containing dedicated values (see list below) ***Possible values***: 0x00 `Empty` No valid GestIC® Library could be located 0x0A `InvalidFW` An invalid GestIC® Library was stored, or the last update failed 0xAA `ValidFW` A valid GestIC® Library is available
HwRev	2	Hardware revision information ***Structure***: Vector of 2 bytes interpreted as decimal values in format `xx.xx` ***Range***: (`0x00..0xFF, 0x00..0xFF`)
ParameterStartAddr	1	Parameter start address as supported by the Image address = 128 * value of `ParameterStartAddr` ***Structure***: 1 byte interpreted as hex value ***Range***: (`0x00..0xFF`)
LibraryLoaderVersion	3	GestIC® Library loader version information ***Structure***: Vector of 3 bytes interpreted as decimal values in format `xx.xx.xx` ***Range***: (`0x00..0xFF, 0x00..0xFF,0x00..0xFF`)
FwStartAddr	1	Start address of GestIC® Library as supported by the Bootloader, start address = 128 * value of `FwStartAddr` ***Structure***: 1 byte interpreted as hex value ***Range***: (`0x00..0xFF`)
FwVersion	120	Version information of GestIC® Library if valid (`FwValid` is not `0x00`). The version string is interpreted as ASCII characters. It is a semicolon-separated string, always starting with the Version Number itself, followed by different tags. **Supported Tags**: p Platform (e.g., HillstarVxx) DSP Colibri Suite Version (e.g., ID45r -1167) s Reserved c Reserved t Build time (e.g., 2013/04/24 14:24:50) ***Structure***: Vector of 120 bytes interpreted as string (ASCII characters) ***Range***: (`0x00..0xFF, 0x00..0xFF, 0x00..0xFF, ...`)

4.4 SET_RUNTIME_PARAMETER

This message is used to set runtime parameters within the GestIC Library. It supports parameters for AFE parameterization, feature configuration and sensor data output. A special value is defined for a persistent saving of parameters to the Flash memory. Parameters which can be made persistent are grouped into three categories:

- **Analog Front End (AFE) Category**
- **Digital Signal Processing (DSP) Category**
- **System Category**

Direction: Host to MGC3130.

TABLE 4-7: MESSAGE OVERVIEW

Header				Payload			
Msg. Size	Flags	Seq.	ID	`RuntimeParameterID`	`Reserved`	`Argument0`	`Argument1`
1 Byte	*1 Byte*	*1 Byte*	*1 Byte*	*2 Bytes*	*2 Bytes*	*4 Bytes*	*4 Bytes*
`0x10`	n.a.	n.a.	0xA2	see description below			

TABLE 4-8: PAYLOAD ELEMENTS

Element	Element Size (in bytes)	Description
`RuntimeParameterID`	2	ID of runtime parameter. Please refer to **Section 4.4.1 “Trigger”** through **Section 4.4.5.5 “Data Output Lock Mask”**. ***Structure***: 16-bit word interpreted as hex value ***Range:*** (`0x0000..0xFFFF`)
`Reserved`	2	write as ‘`0`’
`Argument0`	4	Argument values, depending on runtime parameter ID. If not used, `Argument0` should be provided as ‘`0`’. ***Structure***: 32-bit word: `Argument0` ***Range***: depends on runtime parameter
`Argument1`	4	Argument values, depending on runtime parameter ID. If not used, `Argument1` should be provided as ‘`0`’. ***Structure***: 32-bit word: `Argument1`. ***Range***: depends on runtime parameter.

4.4.1 Trigger

This parameter forces a trigger defined in `Argument0`.

`RuntimeParameterID` `0x1000 Trigger` Parameter forces a trigger.

`Argument0` `0x00000000`: Force recalibration

`0x00000002`: Enter Deep Sleep 1: The wake-up sources from Deep Sleep 1 are I2C0 Start bit detection or MCLR Reset. The system will resume from Deep Sleep on any I^{2}C messages sent on the bus and the first I^{2}C message will be lost.

`0x00000003`: Enter Deep Sleep 2: The wake-up source from Deep Sleep 2 is a falling edge on External Interrupt (IRQ0) or MCLR Reset. The IRQ0 (EIO2) should be tied to high when this command is sent unless the MGC3130 will resume directly after receiving it.

Range: (`0x00000000, 0x00000002, 0x00000003`)

`Argument1` Not used

4.4.2 Make Persistent

Use this ID to make the parameter set defined in Argument0 persistent (store to Flash memory).

RuntimeParameterID	0xFF00 MakePersistent Stores parameter in Flash.
Argument0	0x00000000: Store RTPs for AFE Category 0x00000001: Store RTPs for DSP Category 0x00000002: Store RTPs for System Category ***Range***: (0x00000000, 0x00000001, 00000002)
Argument1	Not used

4.4.3 Analog Front End (AFE) Category

4.4.3.1 SIGNAL MATCHING

Signal matching parameters are used to adjust the Rx signal level at the sampling point.

RuntimeParameterID	0x50	afeRxAtt_S	Signal matching parameter for South electrode
	0x51	afeRxAtt_W	Signal matching parameter for West electrode
	0x52	afeRxAtt_N	Signal matching parameter for North electrode
	0x53	afeRxAtt_E	Signal matching parameter for East electrode
	0x54	afeRxAtt_C	Signal matching factor for Center electrode
Argument0	Contains the value ***Range***: (0x00000000..0x000000FF)		
Argument1	Not used		

4.4.3.2 ELECTRODE MAPPING

The physical channel number assigned to the electrodes. These parameters represent the physical connection of the electrodes to MGC3130 Rx channels. For the correct function, the mapping has to be looked up in the circuitry design.

`RuntimeParameterID`	`0x65`	`Channelmapping_S`	Physical channel assigned to the South Electrode
	`0x66`	`Channelmapping_W`	Physical channel assigned to the West Electrode
	`0x67`	`Channelmapping_N`	Physical channel assigned to the North Electrode
	`0x68`	`Channelmapping_E`	Physical channel assigned to the East Electrode
	`0x69`	`Channelmapping_C`	Physical channel assigned to the Center Electrode

`Argument0` Contains the number of physical receive channels (Rx0, Rx1, Rx2, Rx3, Rx4)

Range: (`0x00000000`, `0x00000001`, `0x00000002`, `0x00000003`, `0x00000004`)

`Argument1` Not used.

4.4.4 Digital Signal Processing (DSP) Category

4.4.4.1 TRANSMIT FREQUENCY SELECTION

Sets the amount of used transmitter frequencies and the order in which they are tested for the frequency hopping.

`RuntimeParameterID` `0x82` `TransFreqSelect` Parameter to set the used frequencies IDs

`Argument0` Amount of used Tx frequencies. This parameter can be 1, 2, 3, 4 or 5.

`Argument1` This determines in what order the transmitter frequencies are tested. The indexes numbered 0 to 4 represent respective transmitter frequencies:

- Frequency ID 0 corresponds to 115 kHz
- Frequency ID 1 corresponds to 103 kHz
- Frequency ID 2 corresponds to 88 kHz
- Frequency ID 3 corresponds to 67 kHz
- Frequency ID 4 corresponds to 44 kHz

These indexes have to be provided in nibbles.

Example: e.g., `Argument0` = `0x04` in combination with

`Argument1` = `0x3104` means that frequencies with the index 4, 0, 1 and 3 are used and tested in this specific order.

e.g., Index – Default Frequency Mapping (`Argument 0` = `0x5`, `Argument 1` = `0x43210`)

Frequency ID 0 – Transmitter Frequency: 115 kHz

Frequency ID 1 – Transmitter Frequency: 103 kHz

Frequency ID 2 – Transmitter Frequency: 88 kHz

Frequency ID 3 – Transmitter Frequency: 67 kHz

Frequency ID 4 – Transmitter Frequency: 44 kHz

> **Note:** The `TransFreqSelect` runtime parameter is a write-only parameter and could not be requested with message `REQUEST_MESSAGE` (`0x06`).

4.4.4.2 TOUCH DETECTION

This parameter enables/disables Touch Detection.

`RuntimeParameterID` `0x97` `dspTouchConfig` Parameter to enable/disable Touch Detection

`Argument0` Set `Argument0` to ‘`0x08`’ to enable and set `Argument0` to ‘`0x00`’ to disable Touch Detection

Note: If `Argument1` is not set correctly the system will show malfunctions.

`Argument1` `0x08`

4.4.4.3 APPROACH DETECTION

This parameter enables/disables Approach Detection mode.

`RuntimeParameterID` `0x97dspApproachDetectionMode` Parameter to enable/disable Approach Detection Mode

`Argument0` Set `Argument0` to `0x01` to enable and set `Argument0` to `0x00` to disable Approach Detection

Note: If `Argument1` is not set correctly the system will show malfunctions.

`Argument1` `0x01`

Note: On earlier versions than V1.0, the Approach Detection `RuntimeParameterID` was `0x81` with the same definition of `Argument0` and `Argument1`. This RTC is no longer supported on V1.1 and later. Aurea PC Software still uses this RTC for legacy purposes.

4.4.5 System Category

4.4.5.1 AIRWHEEL

This parameter enables/disables AirWheel.

`RuntimeParameterID`	`0x90` `dspAirWheelConfig` Parameter to enable/disable AirWheel
`Argument0`	Set `Argument0` to ‘`0x20`’ to enable and set `Argument0` to ‘`0x00`’ to disable AirWheel **Note:** If `Argument1` is not set correctly the system will show malfunctions.
`Argument1`	`0x20`

4.4.5.2 GESTURE PROCESSING (HMM)

This parameter enables the in-built gestures. Disabling one gesture will increase the recognition probability of the others.

If a bit in Argument0 is set to ‘`1`’, the respective Gesture will be enabled. If a bit in Argument0 is set to ‘`0`’, the respective Gesture will be disabled.

`RuntimeParameterID`	`0x85` `dspGestureMask` Parameter to enable/disable gestures
`Argument0`	Bit 0: Garbage model Bit 1: Flick West to East Bit 2: Flick East to West Bit 3: Flick South to North Bit 4: Flick North to South Bit 5: Circle clockwise Bit 6: Circle counter-clockwise
`Argument1`	Acts as a mask, set appropriate bits to ‘`1`’ to change the flag. All other flags are kept unchanged.

4.4.5.3 CALIBRATION OPERATION MODE

This parameter enables/disables the selected auto-calibration feature.

If a bit in `Argument0` is set to ‘`0`’, the respective auto-calibration feature will be enabled.

If a bit in `Argument0` is set to ‘`1`’ the respective auto-calibration feature will be disabled.

`RuntimeParameterID`	`0x80` `dspCalOpMode` Parameter to enable/disable auto-calibration
`Argument0`	Bit 0: Enable/disable start-up calibration Bit 1: Enable/disable gesture-triggered calibration Bit 2: Enable/disable negative calibration Bit 3: Enable/disable idle calibration Bit 4: Enable/disable invalidity value calibration, if values are completely out of range Bit 5: Enable/disable calibration triggered by AFA
`Argument1`	Acts as a mask, set appropriate bits to ‘`1`’ to change the flag. All other flags are kept unchanged.

4.4.5.4 DATA OUTPUT ENABLE MASK

This parameter determines the data output of the message `Sensor_Data_Output (0x91)`. If a bit in `Argument0` is set to ‘`1`’, the respective payload element will be part of the message `Sensor_Data_Output (0x91)`. If a bit in `Argument0` is set to ‘`0`’, the payload element will not be part of the message `Sensor_Data_Output (0x91)`.

Use `DataOutputEnableMask` to optimize the sensor data output in terms of I^2C utilization and efficiency of the host code.

Please mind that enabling all payload elements might lead to malfunctions due to bandwidth limitations on the I^2C bus.

`RuntimeParameterID`	`0xA0 DataOutputEnableMask` Parameter determining the data output.
`Argument0`	Bit 0: DSP Status Bit 1: Gesture Data Bit 2: Touch Data Bit 3: AirWheel Data Bit 4: Position Data Bit 5: Noise Power Bits 6...10: These bits are reserved and must be set to ‘`0`’. Bit 11: Uncalibrated Signal (CIC) Data. Bit 12: Signal Deviation (SD) Data. Bits 13...15: These bits are reserved and must be set to ‘`0`’.
`Argument1`	Acts as a mask, set appropriate bits to ‘`1`’ to change the flag. All other flags are kept unchanged.

4.4.5.5 DATA OUTPUT LOCK MASK

This parameter determines the data output of the message `Sensor_Data_Output (0x91)`. If a bit in `Argument0` is set to '`1`', the respective payload element will be part of the message `Sensor_Data_Output (0x91)` no matter whether there is new data or not (payload element is "locked").

If a bit in `Argument0` is set to '`0`', the payload element will only be part of the message `Sensor_Data_Output (0x91)` when the data is updated (payload element is variable).

`RuntimeParameterID`	`0xA1`	`DataOutputLockMask`	Parameter determining the data output.
`Argument0`	Bit 0: DSP Status Bit 1: Gesture Data Bit 2: Touch Data Bit 3: AirWheel Data Bit 4: Position Data Bit 5: Noise Power Bits 6...10: These bits are reserved and must be set to '`0`'. Bit 11: Uncalibrated Signal (CIC) Data. Bit 12: Signal Deviation (SD) Data. Bit 13...15: These bits are reserved and must be set to '`0`'.		
`Argument1`	Acts as a mask, set appropriate bits to '`1`' to change the flag. All other flags are kept unchanged.		

4.4.5.6 DATA OUTPUT REQUEST MASK

This parameter determines the data output only of the next message `Sensor_Data_Output` (`0x91`). If a bit in `Argument0` is set to '`1`', the respective payload element will be part of the next message `Sensor_Data_Output` (`0x91`).

If a bit in `Argument0` is set to '`0`', the payload element will not be part of the next message `Sensor_Data_Output` (`0x91`) when the data is updated.

This will force the MGC3130 to send a new message `Sensor_Data_Output` (`0x91`) even if there were no valid events and data. This message will contain data according to the `Argument0` selection. Then the `Sensor_Data_Output` (`0x91`) will be sent according to the Data Output Enable and Lock masks only on valid events and data.

`RuntimeParameterID`	`0xA2 DataOutputRequestMask` Parameter determining the next data output.
`Argument0`	Bit 0: DSP Status Bit 1: Gesture Data Bit 2: Touch Data Bit 3: AirWheel Data Bit 4: Position Data Bit 5: Noise Power Bits 6...10: These bits are reserved and must be set to '`0`'. Bit 11: Uncalibrated Signal (CIC) Data. Bit 12: Signal Deviation (SD) Data. Bit 13...15: These bits are reserved and must be set to '`0`'.
`Argument1`	Acts as a mask, set appropriate bits to '`1`' to change the flag. All other flags are kept unchanged.

4.4.5.7 GESTURE IN PROGRESS FLAG CONTROL

This parameter determines whether the gesture in progress output will be part of the GestureInfo data output of the message `Sensor_Data_Output` (`0x91`). If `Argument0` is set to `0x1`, the gesture in progress will be output in the GestureInfo field (bit 31) from the message `Sensor_Data_Output` (`0x91`).

If `Argument0` is set to `0x0`, the gesture in progress will not be output in the GestureInfo field (bit 31) from the message `Sensor_Data_Output` (`0x91`).

For more details please refer to **Section 4.5 "Sensor_Data_Output"**.

`RuntimeParameterID`	`0xA3 DataOutputGestureInProgress` Parameter enabling or disabling the gesture in progress output in the GestureInfo field.
`Argument0`	`0x00000000`: Gesture in progress output disabled `0x00000001`: Gesture in progress output enabled
`Argument1`:	`0x00000001`

> **Note:** For the complete list of the `Set_Runtime_Parameter` command examples please refer to Table A-2.

4.5 SENSOR_DATA_OUTPUT

This message contains the sensor data output of the MGC3130. The content of the message can be configured via bit mask (refer to DataOutputEnableMask and DataOutputLockMask in **Section 4.4 "Set_Runtime_Parameter"**).

The elements DataOutputConfigMask, TimeStamp and SystemInfo are always part of the message. The inclusion of further payload elements depends on the configuration and the actual configuration can be read from the payload element DataOutputConfigMask.

Direction: MGC3130 to Host

TABLE 4-9: MESSAGE OVERVIEW

Header				Payload			
Size	Flags	Seq.	ID	DataOutputConfigMask	TimeStamp	SystemInfo	Variable Depending on DataOutputConfigMask
1 Byte	*1 Byte*	*1 Byte*	*1 Byte*	*2 Bytes*	*1 Byte*	*1 Byte*	Variable Depending on DataOutputConfigMask
variable	n.a.	n.a.	0x91	see description below			

TABLE 4-10: PAYLOAD ELEMENTS

Element	Element size (in bytes)	Description
DataOutputConfig-Mask	2	Bit mask indicating which data is part of the message. The following bits are used: Bit 0: DSPStatus field. Bit 1: GestureInfo field. Bit 2: TouchInfo field. Bit 3: AirWheelInfo field. Bit 4: xyzPosition field. Bit 5: NoisePower field. Bit 6: This bit is reserved. Bit 7: This bit is reserved. Bit 8...10: ElectrodeConfiguration 000: ChCnt = 4, four electrode configuration w/o Center electrode 001: ChCnt = 5, five electrode configuration with Center electrode Bit 11: CICData field with chCnt entries. Bit 12: SDData field with chCnt entries. Bit 13...15: These bits are reserved. ***Structure***: 16-bit word read as a bit mask. ***Range***: (0x0000..0xFFFF)
TimeStamp	1	8-Bit Counter of 200 Hz (Sample Interval) 200 Hz counter value wraps around after 256 ticks. This indicates when an event has taken place and allows measuring the elapsed time between two events as long as it is below approximately 1.25 seconds. ***Structure***: 8-bit word read as decimal value. ***Range***: (0x00..0xFF)
SystemInfo	1	Bit mask indicating if the respective sensor data is valid. In an application, the sensor data output should only be further processed if the respective bits are set to '1'. The following bits are used: Bit 0: PositionValid, if set indicates that the position in the xyzPosition field is valid. Bit 1: AirWheelValid, if set indicates that the AirWheel is active and the data in the AirWheelInfo field is valid. Bit 2: RawDataValid, if set indicates that the data of the CICData and SDData fields are valid. Otherwise those fields must be ignored. Bit 3: NoisePowerValid, if set indicates that the NoisePower field is valid. Bit 4: EnvironmentalNoise, if set indicates that environmental noise has been detected. Bit 5: Clipping, if set indicates that the ADCs are clipping. Bit 6: This bit is reserved. Bit 7: DSPRunning, if set indicates that the system is currently running. If not set, the system is about to go to sleep. ***Structure***: 8-bit word read as a bit mask. ***Range***: (0x00..0xFF) **Note:** Position Data is disabled from the sensor data output and AirWheel is enabed: Position Valid will be set and sent with SystemInfo and a new message will be sent when AirWheel detection starts.

TABLE 4-10: PAYLOAD ELEMENTS (CONTINUED)

Element	Element size (in bytes)	Description
DSPStatus	2	This element consists of two bytes. The first byte contains information about calibration events. The second byte indicates the Tx frequency currently used. Bit 0: This bit is reserved. Bit 1: CalibrationInfo: Forced calibration (by Host) Bit 2: CalibrationInfo: Start-up calibration Bit 3: CalibrationInfo: Gesture triggered Bit 4: CalibrationInfo: Negative value Bit 5: CalibrationInfo: Idle calibration Bit 6: CalibrationInfo: Invalid value calibration Bit 7: CalibrationInfo: calibration triggered by AFA Bits 8…15: Tx Frequency in kHz gesture as decimal value (44..115) ***Structure***: 2 bytes, first byte read as a bit mask second byte as decimal. ***Range***: (0x00..0xFF; 44..115)
GestureInfo	4	This field contains the 32-bit gesture information word. ***Recognized Gestures***: The recognized gestures are results of the HMM classification. Edge detection can be used to further classify where the gesture has been done (Edge Flicks). Furthermore, gesture attributes give information about the direction of the flick. The gesture information is given as a bit field and can be decoded as follows: Bits 0...7: Recognized gesture as decimal number 0: No gesture 1: Garbage model 2: Flick West to East 3: Flick East to West 4: Flick South to North 5: Flick North to South 6: Circle clockwise (only active if AirWheel disabled) 7: Circle counter-clockwise (only active if AirWheel disabled) Bits 8...11: These bits must not be interpreted. Bits 12…15: Gesture Class read as a decimal number 0: Garbage model 1: Flick gesture 2: Circular gesture Bit 16: Edge flick – is 1 if flick gesture is classified as edge flick Bits 17...30: These bits are reserved. Bit 31: Gesture recognition in progress. This bit is set when the Gesture Recognizer is active and reset when the gesture is recognized and the Recognizer is off. 0: Gesture recognition not in progress 1: Gesture recognition in progress ***Structure***: 32-bit word read as a bit mask ***Range***: (0x00000000..0xFFFFFFFF)
TouchInfo	4	Contains touch information The following bits are used to indicate a touch event on the respective electrodes: Bit 0: Touch South electrode Bit 1: Touch West electrode Bit 2: Touch North electrode Bit 3: Touch East electrode Bit 4: Touch Center electrode Bit 5: Tap South electrode Bit 6: Tap West electrode Bit 7: Tap North electrode Bit 8: Tap East electrode Bit 9: Tap Center electrode Bit 10: Double Tap South electrode Bit 11: Double Tap West electrode Bit 12: Double Tap North electrode Bit 13: Double Tap East electrode Bit 14: Double Tap Center electrode Bit 15: This bit is reserved. Bits 16...23: Touch Counter: 8-bit counter. This counter determines the period between the time when the hand starts moving to touch until it is detected. This period is equal to [Touch Counter Value] x 5 (ms). The counter starts counting when the minimum approach speed required to detect a touch event is exceeded until the touch is detected. After each touch detection, the counter is reset. Bits 24...31: These bits are reserved. ***Structure***: 32-bit word read as a bit mask ***Range***: (0x00000000xx0xFFFFFFFF)
AirWheelInfo	2	The first byte contains a counter which indicates how far the AirWheel rotation has progressed. Incrementing values indicate a clockwise rotation. Decrementing values indicate counter clockwise rotation. An increment of 32 approximates one full rotation. AirWheelInfo is only valid if the AirWheelValid bit in the element SystemInfo is '1'. The second byte is reserved. ***Structure***: Vector of two 8-bit words read as a decimal value ***Range***: (0x0000..0x00FF)

TABLE 4-10: PAYLOAD ELEMENTS (CONTINUED)

Element	Element size (in bytes)	Description
xyzPosition	6	This element contains x, y and z position data. Two bytes are used for each of the positions x, y and z. Bytes 1 and 2: x position Bytes 3 and 4: y position Bytes 5 and 6: z position The position information is only valid if the PositionValid bit in the element SystemInfo is '1'. The data give the position of the user's hand in the Cartesian coordinate system. Position data of [0,0,0] represent the origin of the coordinate system and data of [65535, 65535, 65535] are the maximum dimension of the sensing space. The origin is defined as the lower left corner of the sensitive space (South-West) at the surface of the system. ***Structure***: Vector of three16-bit words read as a decimal value for each position x, y, z ***Range***: (0x0000..0xFFFF) for each position x, y, z
NoisePower	4	Noise Power of the GestIC® system. NoisePower is only valid if the NoisePowerValid bit in the element SystemInfo is '1'. ***Structure***: 32-bit word read as a float value ***Range***: (0..3.402823e+38)
CICData	4xChCnt	Uncalibrated Sensor Data (CIC Data) Element size depends on ChCnt indicated in payload element DataOutputConfigMask bits 8...10. CICData are only valid if the RawDataValid bit in the element SystemInfo is '1'. ***Structure***: Vector of four, respectively five, 32-bit words interpreted as float values in format xxxx.xxxx.xxxx.xxxx.xxxx (South.West.North.East.Center) ***Range***: (-3.402823e+38..3.402823e+38) for each channel
SDData	4xChCnt	Signal Deviation (SD) Element size depends on ChCnt indicated in payload element DataOutputConfigMask bits 8...10. SDData are only valid if the RawDataValid bit in the element SystemInfo is '1'. ***Structure***: Vector of four, respectively five, 32-bit words interpreted as float values in format xxxx.xxxx.xxxx.xxxx.xxxx (South.West.North.East.Center) ***Range***: (-3.402823e+38...3.402823e+38) for each channel
Reserved	—	Reserved: Additional payload elements can be added in the future or for debug purposes.

Note: For the examples list of the Sensor_Data_Output command please refer to Table A-3.

Chapter 5. Messages for GestIC Library Update

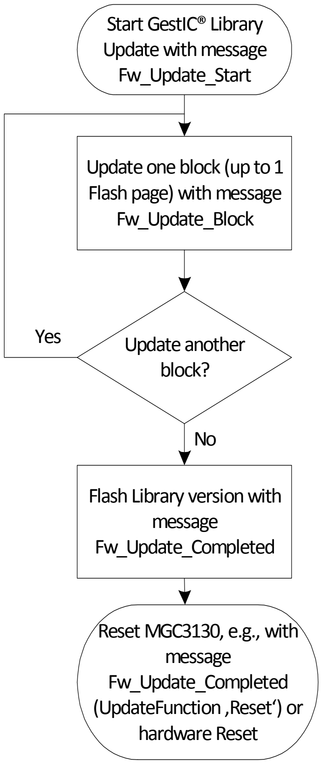
5.1 LIBRARY LOADER UPDATE PROCEDURE

The general library update process is shown in Figure 5-1. Please note that only libraries provided by Microchip Technology can be updated on the MGC3130. Furthermore, an Application Note which describes the library update process in detail can be delivered by Microchip by request only.

For the library update process, three different messages are required:

- `Fw_Update_Start` (Message ID – `0x80`)
- `Fw_Update_Block` (Message ID – `0x81`)
- `Fw_Update_Completed` (Message ID – `0x82`)

FIGURE 5-1: LIBRARY UPDATE FLOWCHART


Start GestIC® Library Update with message Fw_Update_Start
Update one block (up to 1 Flash page) with message Fw_Update_Block
Update another block?
Yes
No
Flash Library version with message Fw_Update_Completed
Reset MGC3130, e.g., with message Fw_Update_Completed (UpdateFunction ‚Reset‘) or hardware Reset

5.2 FW_UPDATE_START

This message starts the update session of the MGC3130 device.

Direction: Host to MGC3130

TABLE 5-1: MESSAGE OVERVIEW

Header				Payload				
Msg. Size	Flags	Seq.	ID	Crc	SessionID	IV	UpdateFunction	Reserved
1 Byte	*1 Byte*	*1 Byte*	*1 Byte*	*4 Bytes*	*4 Bytes*	*14 Bytes*	*1 Byte*	*1 Byte*
0x1C	n.a.	n.a.	0x80	see description below				

TABLE 5-2: PAYLOAD ELEMENTS

Field	Size (in bytes)	Description
Crc	4	A CRC32 (Ethernet, polynomial: 0x04C11DB7) calculated across the rest of the message (20 bytes) ***Structure***: 32-bit word ***Range***: (0x00000000..0xffffffff)
SessionId	4	The SessionID is a random number generated by the Host. It has to be resent in the Fw_Update_Completed message or else the session will be invalid. 0x00000000 is an invalid SessionID and is used to force the device in a wait loop. In this case, the remaining information in this message is discarded. ***Structure***: 32-bit word ***Range***: (0x00000000..0xffffffff)
IV	14	14-byte value which is used to encrypt the data. ***Structure***: Vector of 14 bytes ***Range***: (0x00..0xFF, 0x00..0xFF, 0x00..0xFF, ...)
UpdateFunction	1	The UpdateFunction sets the mode of the whole update session: - If the Session mode is set ProgramFlash, the Payloads of the following Fw_Update_Block messages are written to Flash. - If the Session mode is set VerifyOnly, the code is only verified (comparison between Flash content and decrypted payload of Fw_Update_Block messages), but not written to Flash. If a mismatch between decrypted payload and Flash is found, a System_Status message with an Error 8 (ContentMismatch) is returned **Note:** The following Fw_Update_Block messages also contain an UpdateFunction field. That field defines the mode for the single Update Blocks. However: - if the mode of the session is set to ProgramFlash via Fw_Update_Start, the UpdateFunction of the single Fw_Update_Blocks can be set to ProgramFlash or to VerifyOnly. - if the mode of the session is set to VerifyOnly via Fw_Update_Start, the UpdateFunction of the single Fw_Update_Blocks can only be set to VerifyOnly. ***Structure***: Single byte containing dedicated values (see list below) ***Possible values***: 0 Program Flash 1 VerifyOnly
Reserved	1	Reserved

5.3 FW_UPDATE_BLOCK

This message updates one block of the Flash. The size of one block can be up to 128 bytes.

Direction: Host to MGC3130

TABLE 5-3: MESSAGE OVERVIEW

Header				Payload				
Msg. Size	Flags	Seq.	ID	Crc	Address	Length	UpdateFunction	Payload
1 Byte	*1 Byte*	*1 Byte*	*1 Byte*	*4 Bytes*	*2 Bytes*	*1Byte*	*1 Byte*	*128 Bytes*
0x8C	n.a.	n.a.	0x81	see description below				

TABLE 5-4: PAYLOAD ELEMENTS

Field	Size (in bytes)	Description
`Crc`	4	`CRC32` (Ethernet, polynomial: `0x04C11DB7`) value, calculated across the rest of the message (132 bytes) ***Structure***: 32-bit word ***Range***: (`0x00000000..0xffffffff`)
`Address`	2	The Flash address of the block which will be programmed/verified. If the block is smaller than 128 bytes, it has to be aligned at the end of each page. So, if the next update block is a full 128-byte block, it can be Flash-page aligned again. **Note:** The lower 4 KB are reserved for the Library Loader and cannot be updated. If a value lower than the 4 KB is used, a `System_Status` message with the `Error 5` (`InvalidAddress`) is returned. ***Structure***: 16-bit word ***Range***: (`0x1000..0x7fff`)
`Length`	1	The length of the content of the block which will be updated: ***Structure***: Single byte ***Range***: (0x00..0x80)

`UpdateFunction`	1	The `UpdateFunction` sets the mode for this single Update Block.
		- If the mode is set `ProgramFlash`, the decrypted Payload is written to Flash.
		- If the Session mode is set `VerifyOnly`, the code is only verified (comparison between Flash content and decrypted payload, but not written to Flash. If a mismatch between decrypted payload and Flash is found, a `System_Status` message with `Error 8` (`ContentMismatch`) is returned.
		Note: If the mode of the whole session was set to `VerifyOnly` in the `Fw_Update_Start` message, only `VerifyOnly` can be set in the `Fw_Update_Block`; otherwise, a `System_Status` message with `Error 6` (`InvalidFunction`) is returned.
		Structure: Single byte containing dedicated values (see list below)
		Possible values:
		`0 ProgramFlash`
		`1 VerifyOnly`

`Payload`	128	The `Payload` contains the encrypted content of the block which will be updated. **Note:** Its length is always 128. If the length of the content is smaller than 128, it will be filled with zeros. The Crc is then calculated over the entire 128-byte Payload. ***Structure***: Vector of 120 bytes interpreted as String (ASCII characters) ***Range***: (`0x00..0xFF, 0x00..0xFF, 0x00..0xFF, . ..`)

5.4 FW_UPDATE_COMPLETED

This message finalizes the update session of the MGC3130.

Direction: Host to MGC3130

TABLE 5-5: MESSAGE OVERVIEW

Header				Payload				
Msg. Size	Flags	Seq.	ID	Crc	SessionID	UpdateFunction	FwVersion	Reserved
1 Byte	*1 Byte*	*1 Byte*	*1 Byte*	*4 Bytes*	*4 Bytes*	*1 Byte*	*120 Bytes*	*3 Bytes*
0x88	n.a.	n.a.	0x82	see description below				

TABLE 5-6: PAYLOAD ELEMENTS

Field	Size (in bytes)	Description
Crc	4	CRC32 (Ethernet, polynomial: 0x04C11DB7) value, calculated across the rest of the message (128 bytes) ***Structure***: 32-bit word ***Range***: (0x00000000..0xffffffff)
SessionID	4	The SessionID is the same random number as used for the Fw_Update_Start. 0x00000000 is an invalid SessionID and forces the device into a restart. In this case, the remaining information in this message is discarded. **Structure**: 32-bit word ***Range***: (0x00000000..0xffffffff)
UpdateFunction	1	The UpdateFunction defines how the update session is finalized. - If the session was started as ProgramFlash session, it has to be finalized with the ProgramFlash session. If not, the library version is not stored and the library is not valid. If ProgramFlash is used in a VerifyOnly session, a System_Status message with Error 6 (InvalidFunction) is returned. - If Restart is used, the device will restart. FwVersion and SessionID are included in Crc calculation, but content is ignored. ***Structure***: Single byte containing dedicated values (see list below) ***Possible values***: 0 ProgramFlash Program Flash 1 3 Restart
FwVersion	120	It contains the library version. Only libraries with IDs other than 0 are valid. ***Structure***: Vector of 120 bytes interpreted as String (ASCII characters) ***Range***: (0x00..0xFF, 0x00..0xFF, 0x00..0xFF, . ..)
Reserved	3	Reserved

Appendix A. I²C™ Command Examples

TABLE A-1: REQUEST_MESSAGE COMMAND EXAMPLES

Requested Function			Request Message												Comment
			Header				Payload								
			Msg. Size	Flags	Seq.	ID	Msg. ID	Reserved			Parameter				
—	FW version (0x83)		0x0C	0x0	0x0	0x06	0x83	0x00	0x00	0x00	0x00	0x00	0x00	0x00	Fixed command.
Get Runtime Parameters	Trigger (0x1000)		0x0C	0x0	0x0	0x06	0xA2	0x00	0x00	0x00	0x00	0x10	0x00	0x00	Fixed command.
	Signal Matching (0x0050, 0x0051, 0x0052, 0x0053, 0x0054)	AFERXATT_S	0x0C	0x0	0x0	0x06	0xA2	0x00	0x00	0x00	0x50	0x00	0x00	0x00	Fixed command.
		AFERXATT_W	0x0C	0x0	0x0	0x06	0xA2	0x00	0x00	0x00	0x51	0x00	0x00	0x00	
		AFERXATT_N	0x0C	0x0	0x0	0x06	0xA2	0x00	0x00	0x00	0x52	0x00	0x00	0x00	
		AFERXATT_E	0x0C	0x0	0x0	0x06	0xA2	0x00	0x00	0x00	0x53	0x00	0x00	0x00	
		AFERXATT_C	0x0C	0x0	0x0	0x06	0xA2	0x00	0x00	0x00	0x54	0x00	0x00	0x00	
	Electrode Mapping (0x0065, 0x0066, 0x0067, 0x0068, 0x0069)	Channelmapping_S	0x0C	0x0	0x0	0x06	0xA2	0x00	0x00	0x00	0x65	0x00	0x00	0x00	Fixed command.
		Channelmapping_W	0x0C	0x0	0x0	0x06	0xA2	0x00	0x00	0x00	0x66	0x00	0x00	0x00	
		Channelmapping_N	0x0C	0x0	0x0	0x06	0xA2	0x00	0x00	0x00	0x67	0x00	0x00	0x00	
		Channelmapping_E	0x0C	0x0	0x0	0x06	0xA2	0x00	0x00	0x00	0x68	0x00	0x00	0x00	
		Channelmapping_C	0x0C	0x0	0x0	0x06	0xA2	0x00	0x00	0x00	0x69	0x00	0x00	0x00	
	Touch Detection (0x0097) and Approach Detection (0x0097)		0x0C	0x0	0x0	0x06	0xA2	0x00	0x00	0x00	0x97	0x00	0x00	0x00	Fixed command.
	Approach Detection (0x0081)		0x0C	0x0	0x0	0x06	0xA2	0x00	0x00	0x00	0x81	0x00	0x00	0x00	Fixed command.
	AirWheel (0x0090)		0x0C	0x0	0x0	0x06	0xA2	0x00	0x00	0x00	0x90	0x00	0x00	0x00	Fixed command.
	Gesture Processing HMM (0x0085)		0x0C	0x0	0x0	0x06	0xA2	0x00	0x00	0x00	0x85	0x00	0x00	0x00	Fixed command.
	Calibration Operation Mode (0x0080)		0x0C	0x0	0x0	0x06	0xA2	0x00	0x00	0x00	0x80	0x00	0x00	0x00	Fixed command.
	Data Output Enable Mask (0x00A0)		0x0C	0x0	0x0	0x06	0xA2	0x00	0x00	0x00	0xA0	0x00	0x00	0x00	Fixed command.
	Data Output Lock Mask (0x00A1)		0x0C	0x0	0x0	0x06	0xA2	0x00	0x00	0x00	0xA1	0x00	0x00	0x00	Fixed command.
	Data Output Request Mask (0x00A2)		0x0C	0x0	0x0	0x06	0xA2	0x00	0x00	0x00	0xA2	0x00	0x00	0x00	Fixed command.
	Gesture in progress flag control (0x00A3)		0x0C	0x0	0x0	0x06	0xA2	0x00	0x00	0x00	0xA3	0x00	0x00	0x00	Fixed command.

TABLE A-2: SET_RUNTIME_PARAMETER COMMAND EXAMPLES

Requested Function			Set_Runtime_Parameter																Comment
			Header				Payload												
			Msg. Size	Flags	Seq.	ID	Runtime Parameter ID		Reserved		Argument0				Argument1				
Common Category	Trigger (0x1000)	Force Calibration	0x10	0x0	0x0	0xA2	0x00	0x10	0x00	0x00	0x00	0x00	0x00	0x00	0x00	0x00	0x00	0x00	Fixed command.
		Enter Deep Sleep 1	0x10	0x0	0x0	0xA2	0x00	0x10	0x00	0x00	0x02	0x00	0x00	0x00	0x00	0x00	0x00	0x00	Fixed command.
		Enter Deep Sleep 2	0x10	0x0	0x0	0xA2	0x00	0x10	0x00	0x00	0x03	0x00	0x00	0x00	0x00	0x00	0x00	0x00	Fixed command.
	MakePersistent (0xFF00)	Store RTPs for AFE	0x10	0x0	0x0	0xA2	0x00	0xFF	0x00	0x00	0x00	0x00	0x00	0x00	0x00	0x00	0x00	0x00	Fixed command.
		Store RTPs for DSP	0x10	0x0	0x0	0xA2	0x00	0xFF	0x00	0x00	0x01	0x00	0x00	0x00	0x00	0x00	0x00	0x00	Fixed command.
		Store RTPs for System	0x10	0x0	0x0	0xA2	0x00	0xFF	0x00	0x00	0x02	0x00	0x00	0x00	0x00	0x00	0x00	0x00	Fixed command.
Analog Front-End Category	Signal Matching (0x0050, 0x0051, 0x0052, 0x0053, 0x0054)	AFERXATT_S	0x10	0x0	0x0	0xA2	0x50	0x00	0x00	0x00	0x98	0x00	0x00	0x00	0x00	0x00	0x00	0x00	Argument0 (8-bit) defines the signal matching value for each electrode. These values are just examples.
		AFERXATT_W	0x10	0x0	0x0	0xA2	0x51	0x00	0x00	0x00	0x96	0x00	0x00	0x00	0x00	0x00	0x00	0x00	
		AFERXATT_N	0x10	0x0	0x0	0xA2	0x52	0x00	0x00	0x00	0x98	0x00	0x00	0x00	0x00	0x00	0x00	0x00	
		AFERXATT_E	0x10	0x0	0x0	0xA2	0x53	0x00	0x00	0x00	0x91	0x00	0x00	0x00	0x00	0x00	0x00	0x00	
		AFERXATT_C	0x10	0x0	0x0	0xA2	0x54	0x00	0x00	0x00	0xD9	0x00	0x00	0x00	0x00	0x00	0x00	0x00	
	Electrode Mapping (0x0065, 0x0066, 0x0067, 0x0068, 0x0069)	Channelmapping_S	0x10	0x0	0x0	0xA2	0x65	0x00	0x00	0x00	0x03	0x00	0x00	0x00	0x00	0x00	0x00	0x00	Argument0 (8-bit) defines the respective Rx Channel for each electrode. This value can be '0' for Rx0, '1' for Rx1, '2' for Rx2, '3' for Rx3 or '4' for Rx4. These values are just examples.
		Channelmapping_W	0x10	0x0	0x0	0xA2	0x66	0x00	0x00	0x00	0x01	0x00	0x00	0x00	0x00	0x00	0x00	0x00	
		Channelmapping_N	0x10	0x0	0x0	0xA2	0x67	0x00	0x00	0x00	0x02	0x00	0x00	0x00	0x00	0x00	0x00	0x00	
		Channelmapping_E	0x10	0x0	0x0	0xA2	0x68	0x00	0x00	0x00	0x04	0x00	0x00	0x00	0x00	0x00	0x00	0x00	
		Channelmapping_C	0x10	0x0	0x0	0xA2	0x69	0x00	0x00	0x00	0x00	0x00	0x00	0x00	0x00	0x00	0x00	0x00	

TABLE A-2: SET_RUNTIME_PARAMETER COMMAND EXAMPLES (CONTINUED)

Requested Function			Set_Runtime_Parameter																Comment
			Header				Payload												
			Msg. Size	Flags	Seq.	ID	Runtime Parameter ID		Reserved		Argument0				Argument1				
Digital Signal Processing	TransFreqSelect (0x0082)	Five frequencies	0x10	0x0	0x0	0xA2	0x82	0x00	0x00	0x00	0x05	0x00	0x00	0x00	0x10	0x32	0x04	0x00	This is an example for 5 frequencies used in the following order (0x43210): 115kHz, 103kHz, 88kHz, 67kHz and then 44kHz
		Two frequencies	0x10	0x0	0x0	0xA2	0x82	0x00	0x00	0x00	0x02	0x00	0x00	0x00	0x42	0x00	0x00	0x00	This is an example for 2 frequencies used in the following order (0x42): 103kHz and then 44kHz
	Touch Detection (0x0097)	Enable	0x10	0x0	0x0	0xA2	0x97	0x00	0x00	0x00	0x08	0x00	0x00	0x00	0x08	0x00	0x00	0x00	Fixed command.
		Disable	0x10	0x0	0x0	0xA2	0x97	0x00	0x00	0x00	0x00	0x00	0x00	0x00	0x08	0x00	0x00	0x00	Fixed command.
	Approach Detection (0x0097)	Enable	0x10	0x0	0x0	0xA2	0x97	0x00	0x00	0x00	0x01	0x00	0x00	0x00	0x01	0x00	0x00	0x00	Fixed command.
		Disable	0x10	0x0	0x0	0xA2	0x97	0x00	0x00	0x00	0x00	0x00	0x00	0x00	0x01	0x00	0x00	0x00	Fixed command.
	Approach Detection (0x0081)	Enable	0x10	0x0	0x0	0xA2	0x81	0x00	0x00	0x00	0x01	0x00	0x00	0x00	0x01	0x00	0x00	0x00	Fixed command. This command is not anymore supported starting from V1.0 release. Please use the 0x97 ID instead.
		Disable	0x10	0x0	0x0	0xA2	0x81	0x00	0x00	0x00	0x00	0x00	0x00	0x00	0x01	0x00	0x00	0x00	Fixed command. This command is not anymore supported starting from V1.0 release. Please use the 0x97 ID instead.

TABLE A-2: SET_RUNTIME_PARAMETER COMMAND EXAMPLES (CONTINUED)

Requested Function			Set_Runtime_Parameter																Comment
			Header				Payload												
			Msg. Size	Flags	Seq.	ID	Runtime Parameter ID		Reserved		Argument0				Argument1				
System Category	AirWheel (0x0090)	Enable	0x10	0x0	0x0	0xA2	0x90	0x00	0x00	0x00	0x20	0x00	0x00	0x00	0x20	0x00	0x00	0x00	Fixed command.
		Disable	0x10	0x0	0x0	0xA2	0x90	0x00	0x00	0x00	0x00	0x00	0x00	0x00	0x20	0x00	0x00	0x00	Fixed command.
	Gesture Processing HMM (0x0085)	Enable All Gestures	0x10	0x0	0x0	0xA2	0x85	0x00	0x00	0x00	0x7F	0x00	0x00	0x00	0x7F	0x00	0x00	0x00	The Argument 0 (8-bit) defines which Gestures need to be configured. The Argument 1 defines the mask for the Gestures which need to be configured.These values are just examples.
		Enable Only Flick Gestures	0x10	0x0	0x0	0xA2	0x85	0x00	0x00	0x00	0x1F	0x00	0x00	0x00	0x7F	0x00	0x00	0x00	
		Enable in Addition Circles	0x10	0x0	0x0	0xA2	0x85	0x00	0x00	0x00	0x60	0x00	0x00	0x00	0x60	0x00	0x00	0x00	
	Calibration Operation Mode (0x0080)	Enable	0x10	0x0	0x0	0xA2	0x80	0x00	0x00	0x00	0x00	0x00	0x00	0x00	0x3F	0x00	0x00	0x00	Fixed command.
		Disable	0x10	0x0	0x0	0xA2	0x80	0x00	0x00	0x00	0x3F	0x00	0x00	0x00	0x3F	0x00	0x00	0x00	Fixed command.
	Data Output Enable Mask (0x00A0)	Enable All Data	0x10	0x0	0x0	0xA2	0xA0	0x00	0x00	0x00	0x3F	0x18	0x00	0x00	0x3F	0x18	0x00	0x00	The Argument 0 defines which Data need to be enaled or disabled. The Argument 1 defines the mask for the Data which need to be configured.These values are just examples.
		Enable DSP, Gestures and Noise Power	0x10	0x0	0x0	0xA2	0xA0	0x00	0x00	0x00	0x23	0x00	0x00	0x00	0x3F	0x18	0x00	0x00	
		Enable Only Data: Noise (others not changed)	0x10	0x0	0x0	0xA2	0xA0	0x00	0x00	0x00	0x10	0x00	0x00	0x00	0x10	0x00	0x00	0x00	
		Disable Only Data: CIC (others not changed)	0x10	0x0	0x0	0xA2	0xA0	0x00	0x00	0x00	0x00	0x00	0x00	0x00	0x00	0x08	0x00	0x00	
	Data Output Lock Mask (0x00A1)	Lock All Data	0x10	0x0	0x0	0xA2	0xA1	0x00	0x00	0x00	0x3F	0x18	0x00	0x00	0x3F	0x18	0x00	0x00	The Argument 0 defines which Data need to be locked or unlocked. The Argument 1 defines the mask for the Data which need to be configured.These values are just examples.
		Lock DSP, Gestures and Noise Power	0x10	0x0	0x0	0xA2	0xA1	0x00	0x00	0x00	0x23	0x00	0x00	0x00	0x3F	0x18	0x00	0x00	
		Lock Only Data: Noise (others not changed)	0x10	0x0	0x0	0xA2	0xA1	0x00	0x00	0x00	0x10	0x00	0x00	0x00	0x10	0x00	0x00	0x00	
		UnLock Only Data: CIC (others not changed)	0x10	0x0	0x0	0xA2	0xA1	0x00	0x00	0x00	0x00	0x00	0x00	0x00	0x00	0x08	0x00	0x00	
	Data Output Request Mask (0x00A2)	Request All Data	0x10	0x0	0x0	0xA2	0xA2	0x00	0x00	0x00	0x3F	0x18	0x00	0x00	0x3F	0x18	0x00	0x00	The Argument 0 defines which Data need to be requested. This is only valid for the next message. The Argument 1 defines the mask for the Data which need to be configured.These values are just examples.
		Request DSP, Gestures and Noise Power	0x10	0x0	0x0	0xA2	0xA2	0x00	0x00	0x00	0x23	0x00	0x00	0x00	0x3F	0x18	0x00	0x00	
		Request Only Data: Noise	0x10	0x0	0x0	0xA2	0xA2	0x00	0x00	0x00	0x10	0x00	0x00	0x00	0x10	0x00	0x00	0x00	
	Gesture in Progress Flag Control (0x00A3)	Enable	0x10	0x0	0x0	0xA2	0xA3	0x00	0x00	0x00	0x01	0x00	0x00	0x00	0x01	0x00	0x00	0x00	Fixed command.
		Disable	0x10	0x0	0x0	0xA2	0xA3	0x00	0x00	0x00	0x00	0x00	0x00	0x00	0x01	0x00	0x00	0x00	Fixed command.

TABLE A-3: SENSOR_DATA_OUTPUT COMMAND EXAMPLES

Requested Function	User Action	Sensor_Data_Output												Comment
		Header				Payload								
		Msg. Size	Flags	Seq.	ID	Data Output Config. Mask		Time Stamp	System Info	Parameter				
Data Output contains only DSPStatus field (configured using the Set_Runtime_Parameter command: 10 00 00 A2 A0 00 00 00 01 00 00 00 FF FF FF FF)	No action	0x0A	0x08	0x26	0x91	0x01	0x01	0x5D	0x80	0x10	0x73	—	—	Negative Calibration.
		0x0A	0x08	0x27	0x91	0x01	0x01	0x5E	0x80	0x00	0x73	—	—	Calibration finished.
		0x0A	0x08	0x28	0x91	0x01	0x01	0x5D	0x80	0x20	0x73	—	—	Idle Calibration.
		0x0A	0x08	0x29	0x91	0x01	0x01	0x5E	0x80	0x00	0x73	—	—	Calibration finished.
Data Output contains only Gesture Data field (configured using the Set_Runtime_Parameter command: 10 00 00 A2 A0 00 00 00 02 00 00 00 FF FF FF FF)	Flick East to west	0x0C	0x08	0x31	0x91	0x02	0x01	0x82	0x80	0x03	0x10	0x00	0x00	0x03: Flick East to West 0x10: Flick Gesture
		0x0C	0x08	0x32	0x91	0x02	0x01	0x83	0x80	0x00	0x00	0x00	0x00	
	Flick North to South	0x0C	0x08	0x33	0x91	0x02	0x01	0x13	0x80	0x05	0x10	0x04	0x00	0x05: Flick North to South 0x10: Flick Gesture
		0x0C	0x08	0x34	0x91	0x02	0x01	0x14	0x80	0x00	0x00	0x00	0x00	
	Flick South to North	0x0C	0x08	0x35	0x91	0x02	0x01	0x53	0x80	0x04	0x10	0x04	0x00	0x03: Flick South to North 0x10: Flick Gesture
		0x0C	0x08	0x36	0x91	0x02	0x01	0x54	0x80	0x00	0x00	0x00	0x00	
	Flick West to East	0x0C	0x08	0x37	0x91	0x02	0x01	0x5D	0x80	0x02	0x10	0x00	0x00	0x03: Flick West to East 0x10: Flick Gesture
		0x0C	0x08	0x38	0x91	0x02	0x01	0x5E	0x80	0x00	0x00	0x00	0x00	

TABLE A-3: SENSOR_DATA_OUTPUT COMMAND EXAMPLES (CONTINUED)

Requested Function	User Action	Sensor_Data_Output												Comment
		Header				Payload								
		Msg. Size	Flags	Seq.	ID	Data Output Config. Mask		Time Stamp	System Info	Parameter				
Data Output contains only Gesture Data field (configured using the `Set_Runtime_Parameter` command: 10 00 00 A2 A0 00 00 00 02 00 00 00 FF FF FF FF) Gesture in Progress is activated using the `Set_Runtime_Parameter` command: 10 00 00 A2 A3 00 00 00 01 00 00 00 FF FF FF FF)	Flick East to West	0x0C	0x08	0x3A	0x91	0x02	0x01	0x19	0x81	0x00	0x00	0x00	0x80	Gesture Recognizer started
		0x0C	0x08	0x3B	0x91	0x02	0x01	0x45	0x81	0x03	0x10	0x00	0x00	Gesture recognized (Flick East to West)
		0x0C	0x08	0x3C	0x91	0x02	0x01	0x46	0x81	0x00	0x00	0x00	0x00	
	Just move hand	0x0C	0x08	0x3D	0x91	0x02	0x01	0x47	0x81	0x00	0x00	0x00	0x80	Gesture Recognizer started
		0x0C	0x08	0x3E	0x91	0x02	0x01	0x6E	0x81	0x01	0x00	0x00	0x00	Garbage recognized
		0x0C	0x08	0x3F	0x91	0x02	0x01	0x6F	0x81	0x00	0x00	0x00	0x00	
	Flick East to West	0x0C	0x08	0x40	0x91	0x02	0x01	0x83	0x81	0x00	0x00	0x00	0x80	Gesture Recognizer started
		0x0C	0x08	0x41	0x91	0x02	0x01	0xAC	0x80	0x03	0x10	0x04	0x00	Gesture recognized (Flick East to West)
		0x0C	0x08	0x42	0x91	0x02	0x01	0xAD	0x80	0x00	0x00	0x00	0x00	
	Flick North to South	0x0C	0x08	0x43	0x91	0x02	0x01	0x67	0x81	0x00	0x00	0x00	0x80	Gesture Recognizer started
		0x0C	0x08	0x44	0x91	0x02	0x01	0x8A	0x80	0x05	0x10	0x04	0x00	Gesture recognized (Flick North to South)
		0x0C	0x08	0x45	0x91	0x02	0x01	0x8B	0x80	0x00	0x00	0x00	0x00	
	Flick South to North	0x0C	0x08	0x46	0x91	0x02	0x01	0x67	0x81	0x00	0x00	0x00	0x80	Gesture Recognizer started
		0x0C	0x08	0x47	0x91	0x02	0x01	0x8E	0x80	0x04	0x10	0x04	0x00	Gesture recognized (Flick South to North)
		0x0C	0x08	0x48	0x91	0x02	0x01	0x8F	0x80	0x00	0x00	0x00	0x00	
	Flick West to East	0x0C	0x08	0x49	0x91	0x02	0x01	0x6E	0x81	0x00	0x00	0x00	0x80	Gesture Recognizer started
		0x0C	0x08	0x4A	0x91	0x02	0x01	0x9A	0x80	0x02	0x10	0x02	0x00	Gesture recognized (Flick West to East)
		0x0C	0x08	0x4B	0x91	0x02	0x01	0x9B	0x80	0x00	0x00	0x00	0x00	
	Clockwise Circle	0x0C	0x08	0x4C	0x91	0x02	0x01	0x81	0x80	0x00	0x00	0x00	0x80	Gesture Recognizer started
		0x0C	0x08	0x4D	0x91	0x02	0x01	0xD6	0x80	0x00	0x00	0x00	0x00	Circle Gesture not recognized because AirWheel is On
	Counter Clockwise Circle	0x0C	0x08	0x4E	0x91	0x02	0x01	0x05	0x80	0x00	0x00	0x00	0x80	Gesture Recognizer started
		0x0C	0x08	0x4F	0x91	0x02	0x01	0x56	0x80	0x00	0x00	0x00	0x00	Circle gesture not recognized because AirWheel is On

TABLE A-3: SENSOR_DATA_OUTPUT COMMAND EXAMPLES (CONTINUED)

Requested Function	User Action	Sensor_Data_Output												Comment
		Header				Payload								
		Msg. Size	Flags	Seq.	ID	Data Output Config. Mask		Time Stamp	System Info	Parameter				
Data Output contains only Touch Data field (configured using the Set_Runtime_Parameter command: 10 00 00 A2 A0 00 00 00 04 00 00 00 FF FF FF FF)	Touch Center Electrode	0x0C	0x08	0x45	0x91	0x04	0x01	0x51	0x81	0x10	0x00	0x09	0x00	Center Touch detected and the touch counter = 0x09
		0x0C	0x08	0x46	0x91	0x04	0x01	0x52	0x81	0x10	0x00	0x00	0x00	Touch Counter Reset
		0x0C	0x08	0x47	0x91	0x04	0x01	0x5D	0x81	0x00	0x02	0x00	0x00	Tap on Center electrode detected
		0x0C	0x08	0x48	0x91	0x04	0x01	0x5E	0x81	0x00	0x00	0x00	0x00	

Appendix B. Glossary

TABLE B-1: GLOSSARY

Term	Definition
AFE	Analog front end
Application Host	PC or embedded controller which controls the MGC3130
Aurea	MGC3130 PC control software with graphical user interface
Colibri Suite	Embedded DSP suite within the GestIC® Library
Deep Sleep	MGC3130 Power-Saving mode
E-field	Electrical field
Frame Electrodes	Rectangular set of four electrodes for E-field sensing
GestIC® Technology	Microchip’s patented technology providing 3D free-space gesture recognition utilizing the principles of electrical near-field sensing
GestIC® Library	Includes the implementation of MGC3130 features and is delivered as a binary file preprogrammed on the MGC3130
Gesture Recognition	Microchip’s stochastic HMM classifier to automatically detect and classify hand movement patterns
Gesture Set	A set of provided hand movement patterns
Hand Brick	Copper coated test block (40x40x70 mm)
Hillstar	MGC3130 Development Kit
HMM	Hidden Markov Model
MGC3130	Single-Zone 3D Gesture Sensing Controller
Position Tracking	GestIC® technology feature
Sabrewing	MGC3130 evaluation board
Self Wake-up	MGC3130 Power-Saving mode
Sensing Area	Area enclosed by the four frame electrodes
Sensing Space	Space above sensing area
Signal Deviation	Term for the delta of the sensor signal on approach of the hand versus non-approach
Spacer Brick	Spacer between the sensor layer and hand brick (Styrofoam block 40x40xh mm) with h= 1 / 2 / 3 / 5 / 8 / 12 cm
SPU	Signal Processing Unit
Approach Detection	GestIC® technology feature: Power-Saving mode of the MGC3130 with approach detection

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