GOBIUS C (Continuous measurement)
BLUETOOTH PROTOCOL & FUNCTIONAL DESCRIPTION

History

Issue	Date	Issuer	Changed
1	2022-08-27	Anders Remar	First issue. Software version 1.0.0
2	2023-06-03	Anders Remar	Second issue. Software version 2.0.0. Major improvements for fuel measurement
3	2023-08-08	Anders Remar	Third issue. Parts of the document are hidden.

1 INTRODUCTION

1.1 SCOPE

This document describes the operation of the GOBIUS C sensor which is based on continuous measurement radar technology. The sensor has Bluetooth communication and can be controlled from a Bluetooth Master (BTM), for example a mobile phone. The function of the sensor including the Bluetooth protocol is described.

1.2 ABBREVIATIONS

BIM	Boot Image Manager
BLE	Bluetooth Low Energy
BTM	Bluetooth Master (App)
CFAR	Constant False Alarm Rate
GATT	Generic ATTribute (Bluetooth)
LED	Light Emitting Diode
N/A	Not Applicable
OAD	Over-the-Air-Download
RMS	Root Mean Squared
SDK	Software Development Kit
TBC	To Be Confirmed
TBD	To Be Determined
UUID	Universally Unique Identifier (Bluetooth)

1.3 SOFTWARE VERSIONS

Version number	Description
1.0.0	• Microprocessor CC2642 chip revision C • Gobius C hardware revision V2 • TI SDK: 4.10.00.78 • Code Composer Studio version 10 • Workspace: GOBIUS_C_1_0_0 • Object file: GOBIUS_C_1_0_0_oad.bin • BIM Workspace: GOBIUS_C_BIM_1 • BIM object file: GOBIUS_C_BIM_1.out Untested functions: • The data logging function
2.0.0	• Microprocessor CC2642 chip revision C • Gobius C hardware revision V2 • TI SDK: 4.10.00.78 • Code Composer Studio version 10 • Workspace: GOBIUS_C_2_0_0 • Object file: GOBIUS_C_2_0_0_oad.bin • BIM Workspace: GOBIUS_C_BIM_1 • BIM object file: GOBIUS_C_BIM_1.out • XM122 module software: Version 2.12.0 Changes since previous version: • Temperature compensation of calibration data • Improved algorithms for measurement of fuel

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2 HARDWARE DESCRIPTION

2.1 BLOCK DIAGRAM

The hardware consists of the following parts according to Figure 1:

- A voltage converter that converts a nominal input voltage between 12 to 24 V to the output voltages 3.3V and 5V. The voltage 3.3V is used for the processor, while 5V is used for the analog parts and for the radar sensor board.
- Processor with built-in Bluetooth and temperature sensor
- A radar module XM122 from Acconeer.
- Two separate digital drive stages that can drive loads connected to the supply voltage 12/24V. The voltage value on the outputs can be read back by the processor for self-test
- A galvanically isolated output for current loop 4-20 mA. The galvanically isolated electronics are powered by the current loop.
- An output that can simulate a resistance for connecting an external instrument of type 10-180 Ω or 240-30 Ω. (Or arbitrary resistance within a given range)
- An adapter with analog output signal 0-5V.
- An accelerometer with a digital interface to the processor.
- A separate FLASH memory for storing software transferred via Bluetooth and storing calibration data.
- A LED that shows the sensor's status to the user
- A JTAG connector in the form of a pin strip. The connector is used for software development and for programming the FLASH memory in the processor.

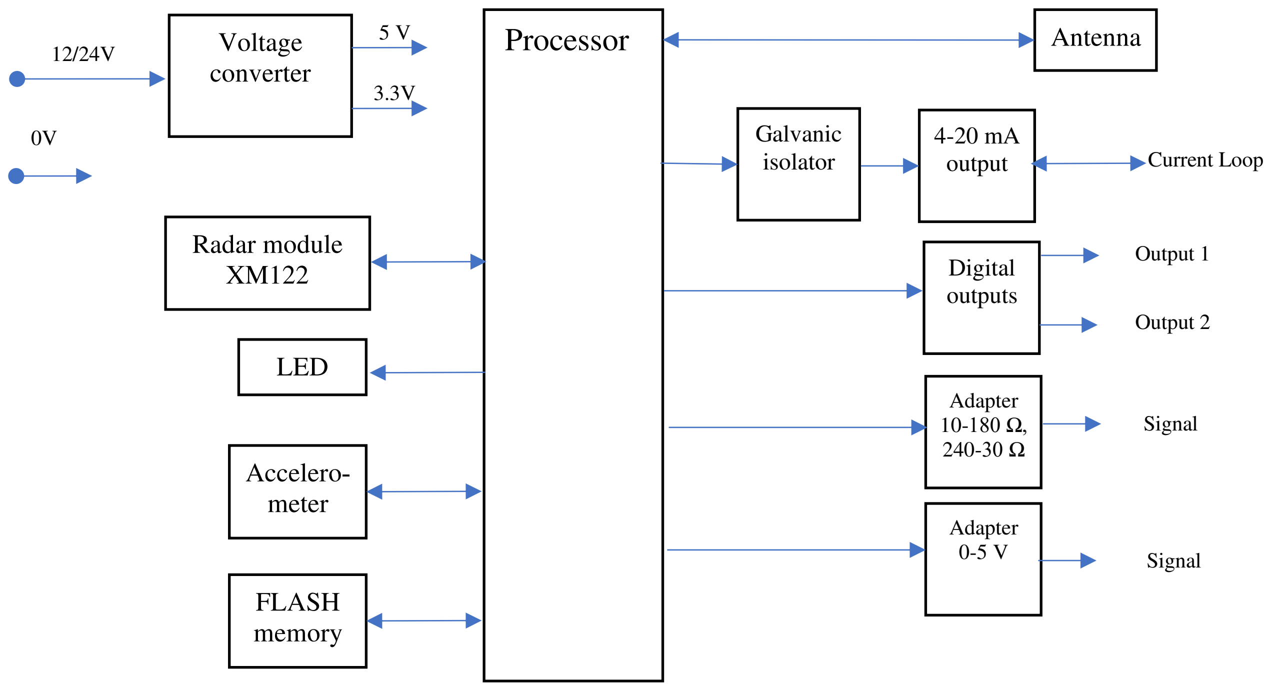

Figure 1: Gobius C block diagram

<u>Technical data:</u>

- Radar sensor:
  - Measuring range: 30-2000 mm
  - Resolution: 2 mm
  - Accuracy: +/- 10 mm
- Maximum inclination: +/- 5 ° (TBC)
- Input voltage. 9-28V DC
- Power consumption:
  - 10 mA with measurement disabled (And all outputs disabled)
  - 25 mA in operation (And all outputs disabled)
- Digital output signals:
  - Max voltage: 30 V
  - Max current: 500 mA
- Current loop:
  - Minimum loop voltage: 8 V

  - Max loop voltage: 40 V
- Resistance output:
  - Minimum resistance: 15 Ω
  - Maximum resistance: 500 Ω
  - Maximum voltage: 13.2 V
  - Maximum current: 120 mA
- Output 0-5V
  - Voltage: 0.1-4.9V
  - Output resistance: 100 Ω
- Operating temperature range: 0°C to +50°C

2.2 DIGITAL OUTPUT SIGNALS

The two digital outputs can be separately configured for:

- Not activated
- Always activated
- Activated when the level is below a certain value
- Activated when the level is above a certain value

2.3 ANALOG OUTPUT SIGNALS

2.3.1 General

There are three separate analog outputs that can be used simultaneously:

- A resistive output for connecting a standard indicating instruments (10-180 Ω or 240-33 Ω)
- A voltage output 0-5V.
- A current loop 4-20 mA.

2.3.2 Resistive output

The resistive output is configured in User Config with minimum and maximum resistance respectively.

Minimum resistance is internally restricted to 15 Ω (The User Config minimum value may be less but is internally restricted).

If minimum and maximum resistance are set to 0, the output will be disabled.

2.3.3 Voltage output 0-5V

The voltage output is configured in User Config with minimum and maximum voltage respectively.

Due to limitations in the electronics, the output voltage is limited to the range 0.1V to 4.9V.

If minimum and maximum voltages are set to 0, the output will be disabled (Voltage out ≈ 0)

2.3.4 Current loop 4-20 mA

The current loop is designed according to industry standards where the loop is driven by an external unit. The current loop can be disabled in User Config (Gives slightly lower power consumption)
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3 MEASUREMENT OVERVIEW

For a thorough tutorial of the operation of the A111 pulsed coherent radar chip from Acconeer AB, see www.acconeer.com. The following describes the usage in the Gobius C sensor.

See Figure 2. Four measurement ranges are defined as listed in Table 1.

Table 1: Radar measurement ranges

Range	Description
Zero Range	This is the range at the sensor chip itself. The radar sensor is configured for maximum attenuation. Background rejection (calibration) must be used if measurements shall be performed
Near Range	This is the range starting approximately at the sensor enclosure edge. The radar sensor is configured for minimum gain. Background rejection (calibration) should be used.
Mid Range	This range starts further away where the radar signal is assumed to not be affected by static obstacles near the sensor. Used for measurements up to approximately 800 mm.
Far Range	This range starts further away than the Mid Range. Used for measurements from approximately 800 mm up to the 2000 mm.

The sensor measures one range at a time starting with Zero Range until the fluid level is found within the distance for tank empty indication. Note that the ranges must overlap each other.

The measurement time is dependent on how many ranges are used and the extent of the radar signal processing.

It is important that the distance for tank empty indication is set up a short distance (3-5 cm) above the tank bottom, otherwise may the fluid level not be accurately determined due to the radar reflection from the tank bottom.

Note that the shortest distance that can be measured is approximately 30 mm.

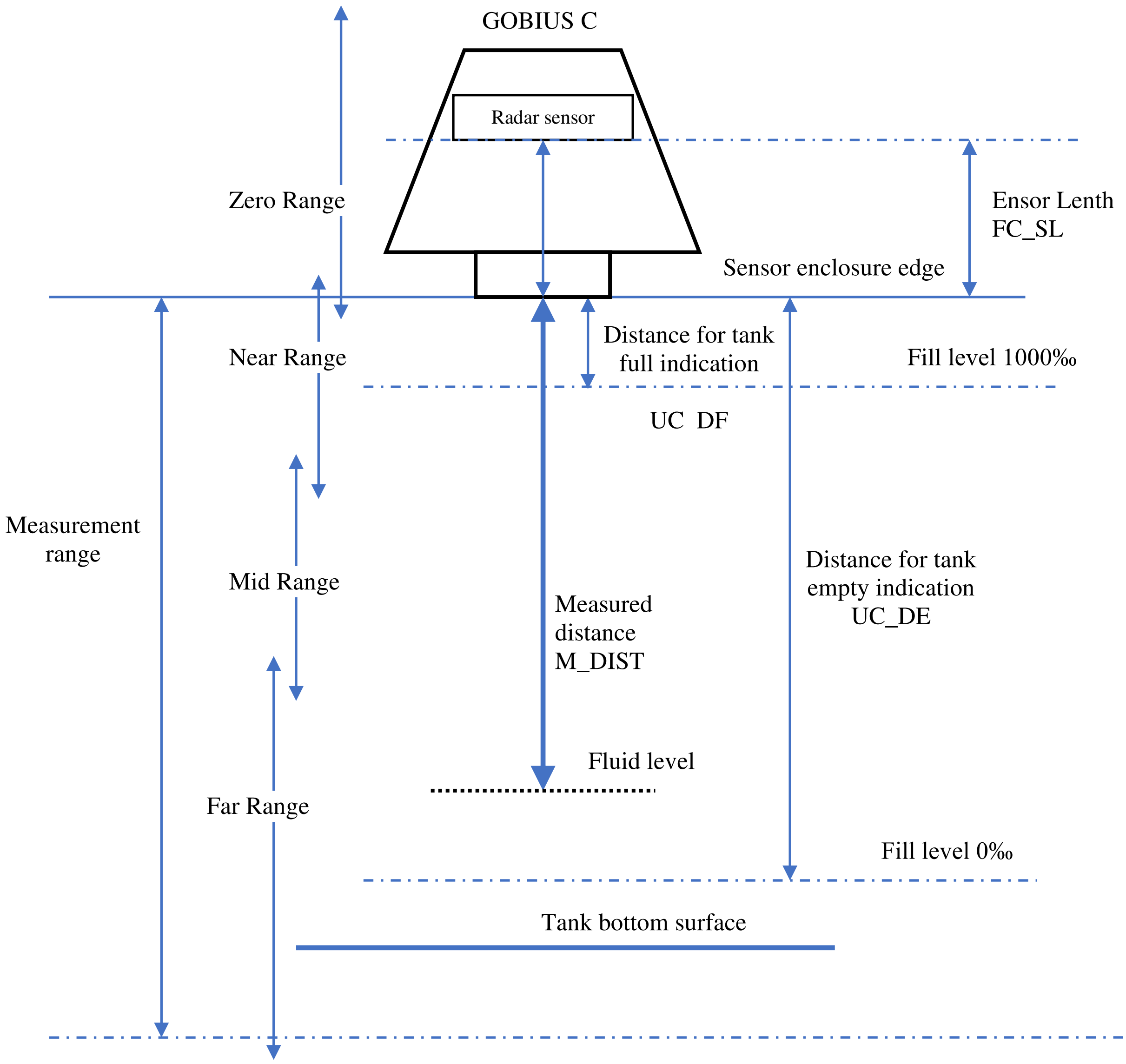

Figure 2: Radar measurement definitions

4 BLUETOOTH PROTOCOL OVERVIEW

4.1 GATT Registers

The Bluetooth Low Energy GATT protocol for Gobius C defines a number of registers that can be read and written. An overview is shown in Table 2. See section 8.2.4 for details.

Table 2: Bluetooth GATT overview

GATT UUID	Name (User description)	Read/ Write	Description
0xFFE1	”System Configuration”	R/W	System parameters that are normally not changed.
0xFFE2	"Factory Config Zero Range"	R/W	Configuration parameters for the Zero Range
0xFFE3	"Factory Config Near Range"	R/W	Configuration parameters for the Near Range
0xFFE4	"Factory Config Mid Range"	R/W	Configuration parameters for the Mid Range
0xFFE5	"Factory Config Far Range"	R/W	Configuration parameters for the Far Range
0xFFE6	"User Config"	R/W	User-specific configuration parameter
0xFFE7	"Command"	W	Command with optional parameters
0xFFE8	"Status"	R	Shows the current status of the sensor
0xFFE9	"Measurement"	R+Notify	Shows the current measurement result
0xFFEA	"Password"	W	Writing of password for information security
0xFFEB	"Info 1"	R/W	Arbitrary data stored by the user, part 1
0xFFEC	"Info 2"	R/W	Arbitrary data stored by the user, part 2
0xFFED	"Info 3"	R/W	Arbitrary data stored by the user, part 3
0xFFEE	"Logdata 1"	R	Measurement logging data, if activated
0xFFEF	"Logdata 2"	R+Notify	Measurement logging data, if activated
0xFFF0	”Tank Linearization”	R/W	Tank volume linearization table
0xFFF1	”Radar Envelope”	R+Notify	Read-out of radar envelope data

4.2 Commands

The sensor accepts the commands listed in Table 3. Some commands are valid only in certain states as shown in the table. For coding of the commands, see Table 25.

Table 3: Commands

Command	Validity in State				Action
	Uninit	Uncalibrated	Active	Error	
					General Commands
"Initialize"	X	X	X	X	The configuration memory is initialized whereby the sensor is set as uncalibrated. Any ongoing measurement is terminated. Transition takes place to the state Uncalibrated. See section **Fel! Hittar inte referenskälla.**
"Calibrate"	-	X	X	X	Calibration is performed. See section **Fel! Hittar inte referenskälla.**
"Stop Measuring"	-	-	X	-	After any measurement in progress has ended (without any result being reported), further measurements are stopped.
"Start Measuring"	-	-	X	-	Measurement is started (If not already running)
"Set Advertise Mode Normal"	-	X	X	X	Sets "Advertise Mode" to "Advertise Normal". Updates the configuration memory. See section 7.5.
"Set Advertise Mode Off"	-	X	X	X	Sets "Advertise Mode" to "Advertise Off". Updates the configuration memory. See section 7.5.
"Write Info"	-	X	X	X	Writes the current value of Info 1-3 to the configuration memory. See section 7.4
					Information security commands
"Set Secure Mode"	-	X	X	X	Sets the sensor in Secure Mode. The password is saved in the configuration memory. The state is set to Unprotected. See section 0.
"Set Unsecure Mode"	-	X	X	X	Sets the sensor in Unsecure Mode. The password is deactivated (Set to 0 and saved in the configuration memory). The state is set to Unprotected. See section 0.
					Test/debug commands
"Production Test"	X	X	X	X	Production Test is performed . See section **Fel! Hittar inte referenskälla.**
"Hardware Test"	-	X	X	X	Hardware Test is performed . See section **Fel! Hittar inte referenskälla.**
"Set envelope address"	-	-	X	-	Sets the radar envelope address. See section 7.11
					Logging commands
"Erase Log Data"	-	X	X	X	Erases the logging data in the external FLASH memory. See section 7.7
"Start Logging"	-	X	X	X	Sets the log period time and starts the logging. See section 7.7
"Stop Logging"	-	X	X	X	Stops the logging. See section 7.7
"Set Block Number to Read"	-	X	X	X	Sets the log number of the log block that shall be read. See section 7.7

4.3 Bluetooth Register Write Operation

Table 4 describes the sensor action when a BTM writes to one of the writable registers.

Table 4: Bluetooth register write

Register written	Sensor action
”System Configuration”	The data is saved in the configuration memory. The parameters written will affect the sensor at the next measurement or calibration ***Note that it may be necessary to re-calibrate the sensor***
”Factory Config”	The data is saved in the configuration memory. The parameters written will affect the sensor at the next measurement or calibration The scan parameters (Scan Start and Scan End) are checked for validity. If invalid, the whole data block is discarded. See section 4.5 ***Note that it may be necessary to re-calibrate the sensor***
”User Config”	The data is saved in the configuration memory. The parameters written will affect the sensor at the next measurement.
”Command”	The command is executed
"Password"	The password is temporarily saved There is no effect in Unsecure Mode, In Secure Mode and if the password is correct, the state will be set to Unprotected
"Info"	The data is saved temporarily. The user has to issue a "Write Info" command to save the data
”Tank Linearization”	The data is saved in the configuration memory. The parameters written will affect the sensor at the next measurement

4.4 Recommended command sequence

The following sequence is recommended to set up the sensor:

1) Issue command ”Initialize” to set the sensor to factory configuration.
2) Wait until the state is “Uncalibrated”
3) Write desired configuration to “User Config”
4) If needed, write to “Factory Config”
5) Issue command ”Calibrate”
6) Wait until state is “Active”
7) The sensor is now measuring

4.5 Checked parameters in “Factory Config”

The sensor checks some of the parameters when a BTM writes to “Factory Config”. If invalid, the data written has no effect and no error is reported.

The following parameters are checked:

1) “Scan Start” must be less than “Scan End”
2) “Scan End” – “Scan Start” must be at least 10 mm.
3) The maximum value of the range (Given by “Scan End” – “Scan Start”) depends on the downsampling factor as given in Table 5

Table 5: Scan limits

Downsampling Factor	Approximate maximum value of “Scan End” – “Scan Start”
1	480 mm
2	960 mm
4	1920 mm

5 STATE DIAGRAM

5.1 Overview

The sensor can be in the following states with respect to the Gobius function:

Table 6: Sensor states

State	Description
Start-Up	First state after the power is turned on
Self-Test	The sensor performs an automatic self-test of the hardware
Uninit	The sensor is uninitialized
Production-Test	Production test of the sensor is in progress
Error	An error has been detected which means that measurement cannot be performed
Uncalibrated	The sensor is uncalibrated, measurement cannot be performed
Calibration	Calibration is in progress
Active	The sensor is active, measurement of the level is performed continuously
HW-Test	User-commanded test of the hardware.

Possible state transitions are shown in Figure 3: Main state diagram.

The following Bluetooth commands directly affect Gobius functionality:

- "Initiate"
- "Calibrate"
- "Start production test" (Not for users)
- "Test"

In addition, the following configurations can be made via Bluetooth:

- Change of system configuration ("Factory Configuration" according to section 8.2.4)
- Change of user-specific configuration ("User Configuration" according to section 8.2.4)
- Linearization of the measured value for tanks with deviating shape towards rectangular (Section 7.12)
- Activation/deactivation of automatic shutdown of the Bluetooth communication according to section 7.5
- Activation/deactivation of logging according to section 7.7
- Arbitrary data (Info) can be saved in the sensor via Bluetooth according to section 7.4.

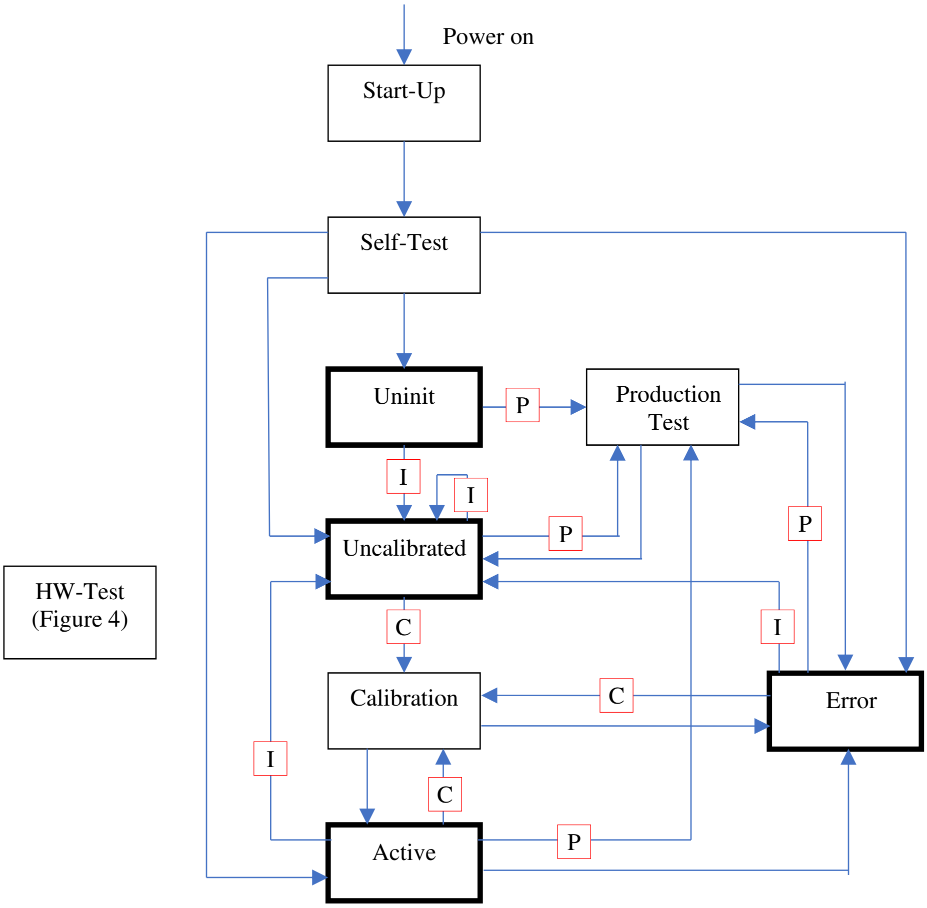

Figure 3: Main state diagram

I = Command ”i” (Initialize)
P = Command ”p” (Start Production Test)
C = Command ”c” (Calibrate)

The states in bold are "stationary" states, i.e. the sensor can be in these states for a long time. Other states are "transient", i.e. the sensor is in these states briefly while a function is performed.

The state "HW-Test" can only be accessed from the states that are stationary. See Figure 4 for possible state transitions for these.

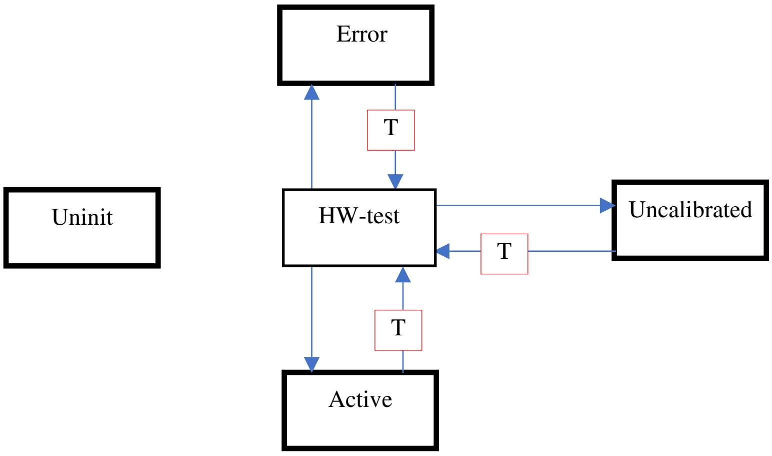

Figure 4: State diagram ”HW-test”

T = Command ”t” (HW-Test)
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6 INFORMATION SECURITY

6.1 General

The sensor can be in two modes with respect to information security:

- Unsecure Mode
- Secure Mode

In Secure Mode, unauthorized persons cannot affect the sensor's function (Can, however, read out data). In Secure Mode, the BTM can give the command "Set unsecure mode" to change to Unsecure Mode.

The sensor is initially in Unsecure Mode. To change to Secure Mode, the BTM must write a password to a register and give the command "Set Secure Mode".

The status register shows whether the sensor is in Unsecure or Secure Mode.

Current mode is indicated by the password saved in the sensor's FLASH memory:

- If the password = 0, the sensor is in Unsecure Mode
- If the password ≠ 0, the sensor is in Secure Mode

There is a "secret" master password that can be used by the BTM to unlock a sensor.

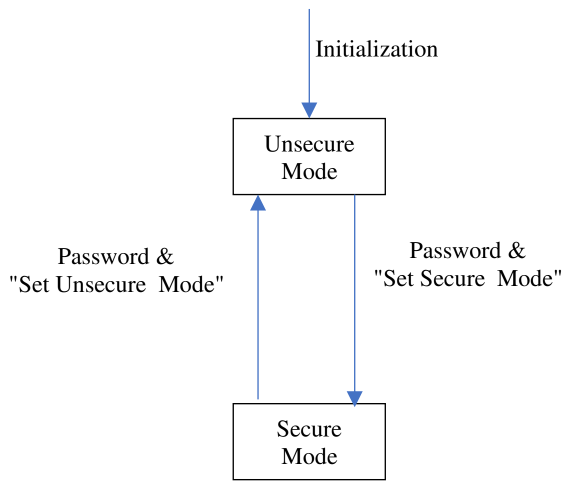

Figure 5: Mode transitions, Secure/Unsecure Mode

6.2 Operation in Unsecure Mode

Normal operation, the BTM has full access to all Bluetooth registers.

The sensor is in the Unprotected state.

6.3 Operation in Secure Mode

When the sensor is in Secure Mode, it can be in the Protected or Unprotected state.

Normally the sensor is in the Protected state whereby all writable registers are protected.

The BTM must enter a password into the sensor before the BTM can issue a command or change any settings in the sensor.

The password must not be zero.

However, the BTM can always read everything without having to provide a password.

A bit in a status register shows whether the sensor is unlocked (Unprotected) or not (Protected), i.e. shows whether the correct password has been given to the sensor or not.

The sensor remains in the Unprotected state until the Bluetooth communication with the BTM is terminated or interrupted. It then enters the Protected state.

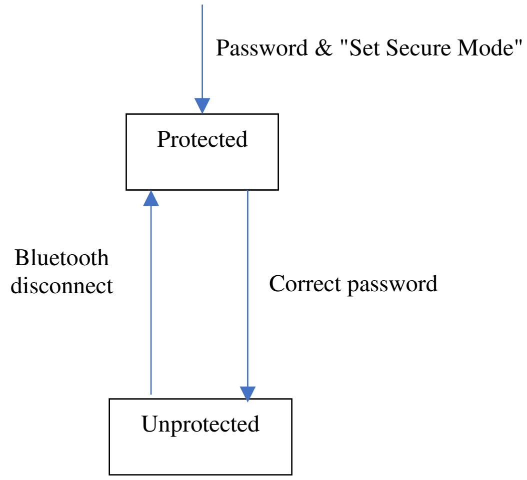

Figure 6: State transitions, Protected/Unprotected State

6.4 Sequence of events to set the sensor in Secure Mode

1. BTM connects to the sensor
2. BTM writes the desired password to the sensor
3. BTM writes the command "Set Secure Mode" to the sensor
4. The sensor saves the password in the internal FLASH memory and sets mode to Secure and permission to Unprotected
5. BTM now has full access to the sensor's registers
6. When BTM is disconnected from the sensor, the sensor goes into the Protected state.

6.5 Sequence of events to grant access to a sensor that is in Secure Mode

1. The sensor is initially in the Protected state
2. BTM connects to the sensor
3. BTM writes the password to the sensor
4. The sensor is now in the Unprotected state
5. BTM now has full access to the sensor's registers
6. When BTM is disconnected from the sensor, the sensor goes into the Protected state.

6.6 Sequence of events to software-wise put the sensor in Unsecure Mode

1. The sensor is initially in the Protected State
2. BTM connects to the sensor
3. BTM writes the password to the sensor
4. The sensor is now in the Unprotected State
5. BTM writes the command "Set Unsecure" to the sensor. The sensor sets the password to 0 and saves it in the FLASH memory. The sensor is now unsecure.

6.7 Sequence of events to hardware-wise put the sensor in Unsecure Mode

1. Turn off the power to the sensor
2. Interconnect the two digital outputs (Must not be connected to anything else)
3. Turn on the power of the sensor.
4. The sensor detects that the outputs are connected and sets the state to Unprotected
5. BTM connects to the sensor
6. BTM writes the command "Set Unsecure" to the sensor. The sensor sets the password to 0 and saves it in the FLASH memory. The sensor is now unsecure.

7 MISCELLANEOUS FUNCTIONS

7.1 Configuration Memory

Part of the processor's internal FLASH memory is used as configuration memory. This memory stores values that need to be saved permanently.

After initial programming of the processor's memory, the configuration memory will be uninitialized.

The memory is initialized by a Bluetooth command for production test or initialization.

Figure 7 shows an overview of the memory's content, which consists of blocks that can be updated independently of each other. The contents of most blocks are described in section 8.2.4.

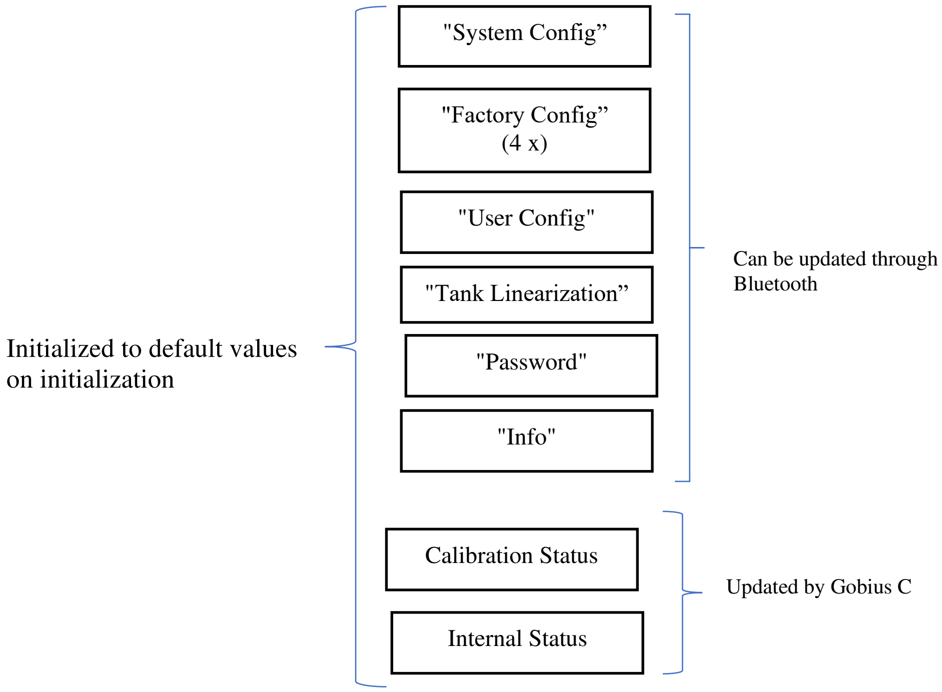

Figure 7: Microprocessor configuration memory

7.2 Storage of Calibration Data

The calibration data itself (Radar envelope) is stored in the external FLASH memory with a sector of 4096 bytes per measurement range (4 units). With 2 bytes per data point, 2000 points can be stored per measurement range. That the data is valid is checked with a checksum that is stored in "Calibration Status"

7.3 Storage of Logging Data

Logging data is stored in the external FLASH memory in 12 sectors of 4096 bytes each.

7.4 Storage of user data in the sensor

Three data blocks (Info 1, Info 2 and Info 3) are available where the user can store data. The data can be in any format and is not interpreted by the sensor. When initializing the sensor, the data blocks are initialized to default values.

BTM can read and write these data blocks in the sensor. However, a save to the sensor's FLASH memory only takes place when the BTM has given the "Write Info" command.

7.5 Automatic shutdown of Bluetooth communication

Bluetooth communication can be turned off automatically after a period of inactivity. This is controlled by "Advertise Mode" which can have two states:

- "Advertisement Normal"
- "Advertise Off"

In "Advertise Normal" mode, Bluetooth communication works normally.

In "Advertise Off" mode, Bluetooth communication is turned off after inactivity for a certain period of time. The time is counted from when the sensor is powered on or from when the BTM has been disconnected.

State selection is done via two commands.

The time delay is configured in User Config. Minimum time is 10 seconds. Maximum time is 255 seconds

The selected state is saved in the sensor's FLASH memory.

The default setting is "Advertise Normal".

Current state is displayed in "Status"

7.6 Watchdog

The processor's internal watchdog is activated with a time period of 30 s.

7.7 Logging of data to the external FLASH

Data can be logged to the external FLASH memory. Data for 1024 logging blocks can be saved.

The following data is saved in each block:

- Time (Relative sensor power-on)
- Sensor state
- Sensor status
- Sensor inclination
- Measurement validity flag
- Measurement distance

The following commands are available:

- Erase log data
- Start logging
- Stop logging
- Set block number to read

The following status can be read by the BTM during ongoing logging:

- Number of blocks logged
- Logging on/off.
- Log full
- Error on external FLASH

Event list to use the logging function:

1) Give command to erase the log data
2) Give command to start logging. The log start command shall include the desired periodicity of the logging (In increments of 10 seconds)

Event list to read out log data

1) Issue command to stop logging.
2) Read out the number of data blocks
3) Give command to set the number of the block that shall be read. 0 is the first block.
4) Read 2 data blocks
5) Repeat steps 3) and 4) until all data is read

7.8 Error Handling

In the event of an error, the sensor switches to the "Error" state.

The errors listed in Note: Multi-byte data is organized as “Big-Endian” (Most significant byte first)

Table 10, Table 11 and Table 12 can be detected.

7.9 The LED Indicator

The LED shows the status of the sensor as follows:

Table 7: LED indicator

Display	**Description**
Off	The sensor does not start
Steady light	Normal operation, uncalibrated
Steady light that goes out briefly	Normal operation, measurement in progress. The LED turns off briefly between measurements
Slow flashing light	Calibration, Hardware test or Production Test in progress
Fast flashing light	Error detected. The sensor is in the “Error” state

7.10 Radar Sensor testing and supervision

Testing of the radar sensor takes place through use, i.e. that the communication is error-free and that reasonable data is received. If the radar sensor hangs and does not respond to the communication, a restart (reset) and reinitialization is performed.

7.11 Readout of radar envelope data

The envelope of the radar signal and calibration data can be read in the "Radar Envelope".

The radar signal consists of a table for each measurement area (Zero, Near, Mid and Far) whose size depends on the current configuration. Segments of 10 values at a time (of 16 bits) can be read. The current size of the data can be read in "Measurement".

To read, the BTM must first stop the measurements with a command and then enter the address of the segment to be read, see Table 8. The sensor then presents 10 values and notifies the BTM (With notification).

Event list:

1) BTM stops the measurements by giving the command 'a'
2) BTM reads size of envelope in "Measurement"
3) BTM gives the command ”Set Envelope Address” with a parameter for the address.
4) The sensor presents data in "Radar Envelope" (With Notify)
5) BTM reads the data
6) BTM continues at step 3) until all data is read
7) BTM finishes by restarting the measurements with the command 'b'.

Table 8: Radar envelope readout address map

Address range	Data
0-999	Envelop Zero Range
1000-1999	Envelop Near Range
2000-2999	Envelop Mid Range
3000-3999	Envelop Far Range
4000-4999	Calibration envelope Zero Range
5000-5999	Calibration envelope Near Range
6000-6999	Calibration envelope Mid Range
7000-7999	Calibration envelope Far Range

7.12 Tank volume linearization

If the tank has a shape where the volume does not change linearly with the liquid level, a linearization table can be activated. The table translates from the sensor's measured value 0-1000 ‰ to presented measured value 0-1000 ‰. The table has 20 values where each step corresponds to 50‰. Note that there is no table element for the level 1000‰ i.e. full tank. The sensor interpolates between the table values.

Table 9: Linearization Table

Table position	Description	Example circular tank [‰]	Values in the Bluetooth table for circular tank (Scale factor 1/5)
1	Level at measured level 0‰	0	0
2	Level at measured level 5‰	20	4
3	Level at measured level 10‰	50	10
4	Level at measured level 15‰	90	18
5	Level at measured level 20‰	140	28
6	Level at measured level 25‰	200	40
7	Level at measured level 30‰	250	50
8	Level at measured level 35‰	310	62
9	Level at measured level 40‰	370	74
10	Level at measured level 45‰	440	88
11	Level at measured level 50‰	500	100
12	Level at measured level 55‰	560	112
13	Level at measured level 60‰	630	126
14	Level at measured level 65‰	690	138
15	Level at measured level 70‰	750	150
16	Level at measured level 75‰	800	160
17	Level at measured level 80‰	860	172
18	Level at measured level 85‰	910	182
19	Level at measured level 90‰	950	190
20	Level at measured level 95‰	980	196

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8 BLUETOOTH PROTOCOL

8.1 Version

Bluetooth version 5 is used.

The protocol is according to Bluetooth Low Energy specification (BLE).

Gobius C is a GATT Server

8.2 Generic Attribute Profile (GATT)

8.2.1 GATT Device Information 0x180A

UUID	**Description**	**Value**	**Comment**
0x2A24	Model Number String	"Gobius C"	Optional
0x2A27	Hardware Revision String	"V2"	Hardware rev. 1 med CC2642 revision E Optional
0x2A28	Software Revision String	”2.0.0”	Optional
0x2A29	Manufacturer Name String	"Gobius Sensor Tech"	Optional

8.2.2 GATT Generic Access 0x1800

UUID	**Description**	**Value**	**Comment**
0x2A00	Device Name	”Gobius C”	Mandatory
0x2A01	Appearance	"UNKNOWN"	Mandatory
0x2A04	Peripheral Preferred Connection Parameters	0x50 00 A0 00 00 00 E8 03 0x0050 = Minimum Connection Interval * 1.25 ms 0x00A0 = Maximum Connection Interval * 1.25 ms 0x0000 = Slave latency 0x03E8 = Connection Supervision Timeout Multiplier	Optional
0x2AA6	Central Address Resolution	0x01 = Address resolution is supported	Mandatory
0x2AC9	Resolvable Private Address	0x00 = Only Resolvable Private Addresses will be used as local addresses after bonding	Mandatory

8.2.3 GATT Generic Attribute 0x1801

UUID	**Description**	**Value**	**Comment**
	Primary Service		

8.2.4 GATT Custom Service

Note: Multi-byte data is organized as “Big-Endian” (Most significant byte first)

Table 10: General error code (ST_ER1)

Error	Occurrence	Error Code (Bit mask)
None	-	0x00
Hardware error. See Table 11and Table 12 for details	Self-Test, Production-Test or HW-Test	0x01
Reserved		0x02
Reserved		0x04
Reserved		0x08
Reserved		0x10
Reserved		0x20
Reserved		0x40
Reserved		0x80

Table 11: Hardware Error Code (ST_ER2)

Error	Occurrence	Error Code (Bit mask)
None		0x00
Accelerometer error	Self-Test or Production-Test	0x01
Radar sensor error	Self-Test or Production-Test or normal operation	0x02
Error in the resistive output OR the current loop	Production-Test	0x04
Error in 0-5V voltage output	Production-Test	0x08
Error in digital output #1	Production-Test	0x10
Error in digital output #2	Production-Test	0x20
Error in the internal FLASH memory	During normal operation	0x40
Error in the internal FLASH memory	Self-Test or Production-Test or normal operation	0x80

Table 12: Extended Hardware Error Code (ST_ER3)

Error	Occurrence	Error Code (Bit mask)
None		0x00
Error in the reading of the supply voltage	Production-Test	0x01
Reserved		0x02
Reserved		0x04
Reserved		0x08
Reserved		0x10
Reserved		0x20
Reserved		0x40
Reserved		0x80

Table 13: Factory Config Configuration Bits FC_CB1

Bit mask	Bit Coding	Description
0000000X	0 = Profile 1 1 = Profile 2	XM122 Profile
000000X0	0 = Background rejection disabled 1 = Background rejection enabled	Background rejection
00000X00	0 = Maximize signal attenuation disabled 1 = Maximize signal attenuation enabled	XM122 Signal attenuation
000XX000	00 = Downsampling Factor = 1 01 = Downsampling Factor = 2 10 = Downsampling Factor = 4 11 = Reserved	XM122 Downsampling factor
00X00000	0 = Noise level normalization disabled 1 = Noise level normalization enabled	XM122 Noise level normalization
XX000000	00 = Pure mean value 01 = Pure max. value 10 = Max. value combined with mean value filtering 11 = Reserved	Inter-envelope filtering

Table 14: Factory Config Configuration Bits FC_CB2

Bit mask	Bit Coding	Description
000000XX	00 = Do not use CFAR detection 01 = Use CFAR detection left 10 = Use CFAR detection right 11 = Use CFAR detection symmetric	CFAR detection mode
0000XX00	00 = Do not use Delta detection 01 = Use Delta detection left 10 = Use Delta detection right 11 = Use Delta detection symmetric	Delta detection mode
000X0000	0 = Do not use threshold detection 1 = Use threshold detection	Threshold detection mode
0XX00000	00 = Do not measure background noise 01 = Calculate threshold based on the signal RMS noise 10 = Calculate threshold based on the signal mean noise 11 = Calculate threshold based on the signal peak noise	Background noise calculation mode
X0000000	0 = The delta midpoint can have any value 1 = The delta midpoint must be positive	Delta midpoint mode

Table 15: Factory Config Configuration Bits FC_CB3

Bit mask	Bit Coding	Description
0000000X	0 = Do not use noise as threshold for CFAR detection 1 = Use noise as threshold for CFAR detection	CFAR detection submode: Use of noise threshold
000000X0	0 = Do not use noise as threshold for Delta detection 1 = Use noise as threshold for Delta detection	Delta detection submode: Use of noise threshold
00000X00	0 = Do not use noise as threshold for Threshold detection 1 = Use noise as threshold for Threshold detection	Threshold detection submode: Use of noise threshold
0000X000	0 = Use CFAR peak with highest amplitude 1 = Use CFAR peak with highest quotient	CFAR submode peak
000X0000	0 = Use Delta peak with highest amplitude 1 = Use Delta peak with highest delta	Delta submode peak
XXX00000	000 = 1:CFAR - 2: Delta – 3:Threshold 001 = 1: CFAR – 2: Threshold – 3: Delta 010 = 1: Delta – 2: CFAR – 3: Threshold 011 = 1: Delta – 2: Threshold – 3: CFAR 100 = 1: Threshold – 2: CFAR – 3: Delta 101 = 1: Threshold – 2: Delta – 3: CFAR 110 = Reserved 111 = Reserved	Detection method priority Determines in which order the different detection methods shall be used

Table 16: Status bits ST_SB

Bit mask	Bit Coding	Description
0000000X	0 = Unsecure mode 1 = Secure mode	Sensor security mode, see section 0
000000X0	0 = Unprotected state 1 = Protected state	Sensor security state, see section 0
00000X00	0 = Advertise Mode Normal 1 = Advertise Mode Off	See section 7.5
0000X000	0 = Uncalibrated 1 = Calibrated	See sections **Fel! Hittar inte referenskälla.**, REF _Ref130922476 \r \h * MERGEFORMAT **Fel! Hittar inte referenskälla.** and 7.2
000X0000	0 = Logging is off 1 = Logging is on	See section 7.7
00X00000	0 = Log memory is not full 1 = Log memory is full	See section 7.7
0X000000	0 = No log FLASH error 1 = Log FLASH error	See section 7.7
X0000000	0 = Measurements are enabled 1 = Measurements are disabled	See sections 4.2 and 7.11

Table 17: User Config UC_BITS

Bit mask	Bit Coding	Description
000000XX	00 = No activation 01 = Always activated 10 = Activate output when level is below threshold 11 = Activate output when level is above threshold	Output 1 mode
0000XX00	00 = No activation 01 = Always activated 10 = Activate output when level is below threshold 11 = Activate output when level is above threshold	Output 2 mode
000X0000	0 = No linearization 1 = Linearization enabled	Linearization enable
00X00000	0 = Disabled 1 = Enabled	Enable of 4-20 mA output
0X000000	Reserved	
X0000000	Reserved	

Table 18: UUID = 0xFFE1, User Description = ”System Configuration”

Byte offset	Size [bytes]	R/W	ID	Description	Default Water	Default Fuel
--	20	R/W		”System Configuration”		
0	1	R/W	SC_SL	Sensor Length. Radar length of sensor [mm]: Unsigned integer	53	53
1	1	R/W	SC_CEL	Calibration Envelope Length. Length of active part of calibration envelope in Zero Range. Relative to range start FC_SS. [mm]. Unsigned integer	80	80
2	2	R/W	SC_SWP	Number of sweeps when calibrating. Unsigned integer	100	100
4	1	R/W	SC_HWA	HardWare Accelerated average samples Unsigned integer. Valid for all ranges.	20	20
5	1	R/W	SC_GALT	Gain Adjustment Lower Threshold in‰. Used for automatic gain control (AGC). The current gain is set to zero if it is less than this value. Unsigned integer [10-1000] (Scaling 10 x)	1	1
6	2	R/W	SC_GAA	Gain Adjustement Amplitude.The automatic gain function (AGC) will increase the gain if the envelope amplitude at the peak found is less than this value. Unsigned integer	3000	3000
8	1	R/W	SC_GAIF	Gain Adjustment Increase Factor (In %) for the automatic gain control (AGC). The current gain is multiplied by this factor. Unsigned integer	120	120
9	1	R/W	SC_GADF	Gain Adjustment Decrease Factor (In %) for the automatic gain control (AGC). The current gain is multiplied by this factor. Unsigned integer	70	70
10	1	R/W	SC_NLP	Filter constant in % for noise low pass filtering [0..99] Unsigned integer (Note: A value of 0 disables filtering)	95	95
11	1	R/W	SC_CLP	Filter constant in % for calibration factor low pass filtering [0..99] (Note: A value of 0 disables filtering)	90	90
12	1	R/W	SC_BR	XM122 module baud rate. 0 = 115200 1 = 230400 2 = 250000 3 = 460800 4 = 921600 5 = 1000000	5	5
13	1	R/W	SC_TTC	Threshold Table Cell size for table created from envelope Unsigned integer. Shall be a multiple of 2. See section **Fel! Hittar inte referenskälla.**	20	20
14	2	R/W	SC_TCP	Time period between temperature compensation updates if Zero Range is not used for measurements.The resolution is 10 seconds. A value of zero gives maximum update rate. Unit = [s] .Unsigned integer.	60	60
16	1	R/W	SC_TCZ	Zero Range measuring disable. 0 = Zero Range is used for measuring. 1 = Zero Range is not used for measuring. Temperature compensation is performed with a time interval set by SC_TCP	1	1
17-19	3	R/W		Reserved		

Table 19: UUID = 0xFFE2, User Description = ”Factory Config Zero Range”

Byte offset	Size [bytes]	R/W	ID	Description	Default Water	Default Fuel
--	20	R/W		"Factory Config Zero Range”		
0	2	R/W	FC_SS	Scan Start [mm]: Integer (May be negative)	-40	-40
2	2	R/W	FC_SE	Scan End [mm]: Integer	50	50
4	1	R/W	FC_MSO	Measurement Start Offset relative to scan start [mm]: Unsigned integer	0	0
5	1	R/W	FC_MEO	Measurement End Offset relative to range end (Is subtracted from FC_SE) [mm]: Unsigned integer	0	0
6	1	R/W	FC_CB1	See Table 13: Factory Config Configuration Bits FC_CB1	00001110	00001110
7	1	R/W	FC_CB2	See Table 14: Factory Config Configuration Bits FC_CB2	10000000	10000000
8	1	R/W	FC_CB3	See Table 15: Factory Config Configuration Bits FC_CB3	00000000	00000000
9	1	R/W	FC_SW	Number of sweeps [1..255]: Unsigned integer *When envelope filtering is ”Max. value combined with mean value filtering”, the number of max. value envelopes is √(value) and the number of mean value calculations are √(value).*	100	100
10	1	R/W	FC_G	Initial gain Unsigned integer [0-1000] (Scaling 10 x)	0	0
11	1	R/W	FC_ITM	Bits 7-4: Number of maximum iterations for each measurement [1..15] Bits 3-0:Number of required successful iterations for a valid measurements for this range [1..15]	1 1	1 1
12	1	R/W	FC_THF	Fixed amplitude threshold. Used for Threshold and CFAR detection. Unsigned integer. (Scaling 50 x)	0	0
13	1	R/W	FC_CTH	CFAR Relative threshold (Scaling 0.1 x) [1.0—25.5]	0	0
14	1	R/W	FC_DTH	Delta relative threshold. Unsigned integer. (Scaling 50 x)	0	0
15	1	R/W	FC_THM	Threshold multiplier when using a threshold based on the signal noise (Scaling 0.1 x) [0.1—25.5]	0	0
16	1	R/W	FC_CF1	Bits 7-4: CFAR cell width in number of radar samples [1..15] Bits 3-0: CFAR number of sample cells [2-15]	0 0	0 0
17	1	R/W	FC_CF2	Bits 7-4: CFAR Number of background cells [1-15] Bits 3-0: CFAR Number of guard cells [1-15]	0 0	0 0
18	1	R/W	FC_DT1	Bits 7-4: Delta cell width in number of radar samples [1..15] Bits 3-0: Delta number of sample cells [2-15]	0 0	0 0
19	1	R/W	FC_DT2	Bits 7-4: Delta Number of background cells [1-15] Bits 3-0: Delta Number of guard cells [1-15]	0 0	0 0

Table 20: UUID = 0xFFE3, User Description = ”Factory Config Near Range”

Byte offset	**Size [bytes]**	**R/W**	**ID**	**Description**	**Default Water**	**Default Fuel**
--	20	R/W		"Factory Config Near Range”		
0	2	R/W	FC_SS	Scan Start [mm]: Integer (May be negative)	50	50
2	2	R/W	FC_SE	Scan End [mm]: Integer	180	180
4	1	R/W	FC_MSO	Measurement Start Offset relative to scan start [mm]: Unsigned integer	20	20
5	1	R/W	FC_MEO	Measurement End Offset relative to range end (Is subtracted from FC_SE) [mm]: Unsigned integer	0	0
6	1	R/W	FC_CB1	See Table 13: Factory Config Configuration Bits FC_CB1	10001010	10001010
7	1	R/W	FC_CB2	See Table 14: Factory Config Configuration Bits FC_CB2	11110100	11110100
8	1	R/W	FC_CB3	See Table 15: Factory Config Configuration Bits FC_CB3	10100110	10100110
9	1	R/W	FC_SW	Number of sweeps [1..255]: Unsigned integer *When envelope filtering is ”Max. value combined with mean value filtering”, the number of max. value envelopes is √(value) and the number of mean value calculations are √(value).*	100	100
10	1	R/W	FC_G	Initial gain Unsigned integer [0-1000] (Scaling 10 x)	0	0
11	1	R/W	FC_ITM	Bits 7-4: Number of maximum iterations for each measurement [1..15] Bits 3-0:Number of required successful iterations for a valid measurements for this range [1..15]	5 3	5 3
12	1	R/W	FC_THF	Fixed amplitude threshold. Used for Threshold and CFAR detection. Unsigned integer. (Scaling 50 x)	60	20
13	1	R/W	FC_CTH	CFAR Relative threshold (Scaling 0.1 x) [0.1—25.5]	0	0
14	1	R/W	FC_DTH	Delta relative threshold. Unsigned integer. (Scaling 50 x)	20	10
15	1	R/W	FC_THM	Threshold multiplier when using a threshold based on the signal noise (Scaling 0.1 x) [0.1—25.5]	10	10
16	1	R/W	FC_CF1	Bits 7-4: CFAR cell width in number of radar samples [1..15] Bits 3-0: CFAR number of sample cells [2-15]	0 0	0 0
17	1	R/W	FC_CF2	Bits 7-4: CFAR Number of background cells [1-15] Bits 3-0: CFAR Number of guard cells [1-15]	0 0	0 0
18	1	R/W	FC_DT1	Bits 7-4: Delta cell width in number of radar samples [1..15] Bits 3-0: Delta number of sample cells [2-15]	5 2	5 2
19	1	R/W	FC_DT2	Bits 7-4: Delta Number of background cells [1-15] Bits 3-0: Delta Number of guard cells [1-15]	1 3	1 3

Table 21: UUID = 0xFFE4, User Description = ”Factory Config Mid Range”

Byte offset	Size [bytes]	R/W	ID	Description	Default Water	Default Fuel
--	20	R/W		"Factory Config Mid Range”		
0	2	R/W	FC_SS	Scan Start [mm]: Integer (May be negative)	120	120
2	2	R/W	FC_SE	Scan End [mm]: Integer	950	950
4	1	R/W	FC_MSO	Measurement Start Offset relative to scan start [mm]: Unsigned integer	20	20
5	1	R/W	FC_MEO	Measurement End Offset relative to range end (Is subtracted from FC_SE) [mm]: Unsigned integer	0	0
6	1	R/W	FC_CB1	See Table 13: Factory Config Configuration Bits FC_CB1	10110000	10110000
7	1	R/W	FC_CB2	See Table 14: Factory Config Configuration Bits FC_CB2	00000001	00000001
8	1	R/W	FC_CB2	See Table 15: Factory Config Configuration Bits FC_CB3	00000000	00000000
9	1	R/W	FC_SW	Number of sweeps [1..255]: Unsigned integer *When envelope filtering is ”Max. value combined with mean value filtering”, the number of max. value envelopes is √(value) and the number of mean value calculations are √(value).*	49	49
10	1	R/W	FC_G	Initial gain Unsigned integer [0-1000] (Scaling 10 x)	100	100
11	1	R/W	FC_ITM	Bits 7-4: Number of maximum iterations for each measurement [1..15] Bits 3-0:Number of required successful iterations for a valid measurements for this range [1..15]	5 3	5 3
12	1	R/W	FC_THF	Fixed amplitude threshold. Used for Threshold and CFAR detection. Unsigned integer. (Scaling 50 x)	10	10
13	1	R/W	FC_CTH	CFAR Relative threshold (Scaling 0.1 x) [0.1—25.5]	20	20
14	1	R/W	FC_DTH	Delta relative threshold. Unsigned integer. (Scaling 50 x)	0	0
15	1	R/W	FC_THM	Threshold multiplier when using a threshold based on the signal noise (Scaling 0.1 x) [0.1—25.5]	0	0
16	1	R/W	FC_CF1	Bits 7-4: CFAR cell width in number of radar samples [1..15] Bits 3-0: CFAR number of sample cells [2-15]	3 2	3 2
17	1	R/W	FC_CF2	Bits 7-4: CFAR Number of background cells [1-15] Bits 3-0: CFAR Number of guard cells [1-15]	2 3	2 3
18	1	R/W	FC_DT1	Bits 7-4: Delta cell width in number of radar samples [1..15] Bits 3-0: Delta number of sample cells [2-15]	0 0	0 0
19	1	R/W	FC_DT2	Bits 7-4: Delta Number of background cells [1-15] Bits 3-0: Delta Number of guard cells [1-15]	0 0	0 0

Table 22: UUID = 0xFFE5, User Description = ”Factory Config Far Range”

Byte offset	**Size [bytes]**	**R/W**	**ID**	**Description**	**Default Water**	**Default Fuel**
--	20	R/W		"Factory Config Far Range”		
0	2	R/W	FC_SS	Scan Start [mm]: Integer (May be negative)	800	800
2	2	R/W	FC_SE	Scan End [mm]: Integer	2200	2200
4	1	R/W	FC_MSO	Measurement Start Offset relative to scan start [mm]: Unsigned integer	20	20
5	1	R/W	FC_MEO	Measurement End Offset relative to range end (Is subtracted from FC_SE) [mm]: Unsigned integer	0	0
6	1	R/W	FC_CB1	See Table 13: Factory Config Configuration Bits FC_CB1	10110001	10110001
7	1	R/W	FC_CB2	See Table 14: Factory Config Configuration Bits FC_CB2	00000001	00000001
8	1	R/W	FC_CB2	See Table 15: Factory Config Configuration Bits FC_CB3	00000000	00000000
9	1	R/W	FC_SW	Number of sweeps [1..255]: Unsigned integer *When envelope filtering is ”Max. value combined with mean value filtering”, the number of max. value envelopes is √(value) and the number of mean value calculations are √(value).*	49	49
10	1	R/W	FC_G	Initial gain Unsigned integer [0-1000] (Scaling 10 x)	100	100
11	1	R/W	FC_ITM	Bits 7-4: Number of maximum iterations for each measurement [1..15] Bits 3-0:Number of required successful iterations for a valid measurements for this range [1..15]	5 3	5 3
12	1	R/W	FC_THF	Fixed amplitude threshold. Used for Threshold and CFAR detection. Unsigned integer. (Scaling 50 x)	10	10
13	1	R/W	FC_CTH	CFAR Relative threshold (Scaling 0.1 x) [0.1—25.5]	20	20
14	1	R/W	FC_DTH	Delta relative threshold. Unsigned integer. (Scaling 50 x)	0	0
15	1	R/W	FC_THM	Threshold multiplier when using a threshold based on the signal noise (Scaling 0.1 x) [0.1—25.5]	0	0
16	1	R/W	FC_CF1	Bits 7-4: CFAR cell width in number of radar samples [1..15] Bits 3-0: CFAR number of sample cells [2-15]	5 2	5 2
17	1	R/W	FC_CF2	Bits 7-4: CFAR Number of background cells [1-15] Bits 3-0: CFAR Number of guard cells [1-15]	2 4	2 4
18	1	R/W	FC_DT1	Bits 7-4: Delta cell width in number of radar samples [1..15] Bits 3-0: Delta number of sample cells [2-15]	0 0	0 0
19	1	R/W	FC_DT2	Bits 7-4: Delta Number of background cells [1-15] Bits 3-0: Delta Number of guard cells [1-15]	0 0	0 0

Table 23: UUID = 0xFFE6 User Description = "User Config"

Byte offset	Size [bytes]	R/W	ID	Description	Default Water	Default Fuel
--	20	R/W		"User Config"		
0	2	R/W	UC_DE	Distance for tank empty indication [mm] Unsigned integer [20-2000]	2000	2000
2	2	R/W	UC_DF	Distance for tank full indication [mm] Unsigned integer [20-2000]	75	75
4	1	R/W	UC_LPN	Low pass filter size (N = Number of measurements) N=0 disables filtering Unsigned integer [0..100]	3	3
5	1	R/W	UC_LPK	Low pass filter threshold constant [1-100] in percent of meaurement distance value M_DIST	10	10
6	1	R/W	UC_BITS	Configuration bits, see Table 17	00011011	00011011
7	1	R/W	UC_O1T	Output 1 threshold level in % Unsigned integer 8 bits [0-100]	80	80
8	1	R/W	UC_O1H	Output 1 hysteresis in % Unsigned integer 8 bits [0-100]	5	5
9	1	R/W	UC_O2T	Output 2 threshold in % Unsigned integer 8 bits [0-100]	20	20
10	1	R/W	UC_O2H	Output 2 hysteresis in %: Unsigned integer 8 bits [0-100]	5	5
11	1	R/W	UC_R0	Resistive output Ω value for 0% fill level (0 = disable)	Table 24	Table 24
12	1	R/W	UC_R25	Resistive output Ω value for 25% fill level (0 = disable)	Table 24	Table 24
13	1	R/W	UC_R50	Resistive output Ω value for 50% fill level (0 = disable)	Table 24	Table 24
14	1	R/W	UC_R75	Resistive output Ω value for 75% fill level (0 = disable)	Table 24	Table 24
15	1	R/W	UC_R100	Resistive output Ω value for 100% tank (0 = disable)	Table 24	Table 24
16	1	R/W	UC_VE	Voltage output value for empty tank. Unit = 25 mV. [0..200] 0 = disable 4 = enable output of 0.1V	0	0
18	1	R/W	UC_VF	Voltage output value for full tank. Unit = 25 mV [0..200] 0 = disable 196 = enable output of 4.9V	0	0
18	1	R/W	UC_AOF	”Advertise Off” time 10-255 seconds	30	30
19	1			Reserved		

Table 24: Resistive output values

ID	Fill level	Resistance 10-180 Ω	Resistance 240-33 Ω
UC_R0	0%	10	240
UC_R25	25%	52	142
UC_R50	50%	95	105
UC_R75	75%	137	67
UC_R100	100%	180	33

Table 25: UUID = 0xFFE7, User Description = "Command"

Byte offset	Size [bytes]	R/W	ID	Description
--	3	W		"Command"
0	1			General commands: 'i' (0x69, 105_{10}) = "Initialize" 'c' (0x63, 99_{10}) = "Calibrate" 'a' (0x61, 97_{10}) = "Stop Measuring" 'b' (0x62, 98_{10})= "Start Measuring" 'n' (0x6E), 110_{10}) = "Set Advertise Mode Normal" 'o' (0x6F), 111_{10}) = "Set Advertise Mode Off" 'w' (0x77, 119_{10}) = "Write Info" Information security commands: 's' (0x73, 115_{10}) = "Set Secure Mode" 'u' (0x75, 117_{10}) = "Set Unsecure mode" Test/debug commands: 'p' (0x70, 112_{10}) = "Production Test" 't' (0x74, 116_{10}) = "Hardware Test" 'r' (0x72, 114_{10}) = "Set Envelope Address" Logging commands: 'e' (0x64, 101_{10}) = "Erase Log Data" 'x' (0x78,120_{10}) = "Start Logging" 'y' (0x79,121_{10})= "Stop logging" 'z' (0x7A,122_{10})= "Set Block Number to Read"
2	2			Radar envelope buffer address for command 'r' Log period [s] for command 'x' Log block number for command 'z' Unsigned integer

Table 26: UUID = 0xFFE8, User Description = "Status"

Byte offset	Size [bytes]	R/W	ID	Description
--	20	R		"Status"
0	1		ST_ST	State: 0x00 = Start-Up 0x01 = Self-Test 0x02 = Uninit 0x03 = Uncalibrated 0x04 = Calibration 0x05 = Active 0x06 = Error 0x07 = Production-Test 0x08 = HW-Test
1	1		ST_SB	Status Bits. See Table 16: Status bits ST_SB
2	4		ST_T	Time since power-on [s]
6	1		ST_ER1	General error code: Table 10
7	1		ST_ER2	Hardware Error Code: See Table 11
8	1		ST_T	Processor temperature: -128 to +127 °C
9	2		ST_V	Supply voltage [mV]
11	6		ST_ID	Sensor ID (MAC BLE address)
17	1		ST_ER3	Extended Hardware Error Code. See Table 12
18	1		ST_ERR	Radar sensor (XM122) communication error counter
19	1		ST_RNG	Current measurement range 0 = Zero Range 1 = Near Range 2 = Mid Range 3 = Far RAnge

Table 27: UUID = 0xFFE9, User Description = "Measurement"

Byte offset	Size [bytes]	R/W	ID	Description
--	20	R+ Notify		"Measurement"
0	1		M_ST	State (Copy from "Status" ST_ST)
1	1		M_SB	Status Bits. See Table 16: Status bits ST_SB
2	1		M_VD	Level measurement validity 0x00 = Level is invalid 0x01 = Level is valid
3	2		M_FL	Tank fill level in ‰ [0-1000] Integer
5	1		M_INC	Sensor inclination [0-90 degrees]: Integer
6	2		M_DIST	Distance from sensor enclosure interface [mm] Integer
8	2		M_SZR	Radar envelope size Zero Range Integer
10	2		M_SNR	Radar envelope size Near Range Integer
12	2		M_SMR	Radar envelope size Mid Range Integer
14	2		M_SFR	Radar envelope size Far Range Integer
16-19	4			Reserved

Table 28: UUID = 0xFFEA, User Description = "Password"

Byte offset	Size [bytes]	R/W	ID	Description
--	4	W		"Password"
0	4			Password Unsigned integer 32 bits

Table 29: UUID = 0xFFEB, User Description = "Info 1"

Byte offset	Size [bytes]	R/W	ID	Description	Default
--	20	R/W		"Info 1"	
0	20			Data "Info" part 1. ASCII or binary data.	0x20, 0x20, ...

Table 30: UUID = 0xFFEC, User Description = "Info 2"

Byte offset	Size [bytes]	R/W	ID	Description	Default
--	20	R/W		"Info 2"	
0	20			Data "Info" part 2. ASCII or binary data.	0x20, 0x20, ...

Table 31: UUID = 0xFFED, User Description = "Info 3"

Byte offset	Size [bytes]	R/W	ID	Description	Default
--	20	R/W		"Info 3"	
0	20			Data "Info" part 3. ASCII or binary data.	0x20, 0x20, ...

Table 32: UUID = 0xFFEE, User Description = "Logdata 1"

Byte offset	Size [bytes]	R/W	ID	Description	Default
--	20	R		"Logdata 2"	
0	2			Number of log blocks [0..1024]	0
2-19	18			Reserved	0

Table 33: UUID = 0xFFEF, User Description = "Logdata 2"

Byte offset	Size [bytes]	R/W	ID	Description	Default
--	20	R Notify		"Logdata 1"	
0	*4*			(Block n) Time stamp [s]	0
4	*1*			(Block n) State (Copy of M_ST)	0
5	*1*			(Block n) Status Bits.(Copy of M_SB)	0
6	*1*			(Block n) Level measurement validity (Copy of M_VD)	0
7	*1*			(Block n) Sensor inclination (Copy pf M_INC)	0
8	*2*			(Block n) Distance from sensor enclosure interface (Copy of M_DIST)	0
10	4			(Block n+1) Time stamp [s]	0
14	1			(Block n+1) State (Copy of M_ST)	0
15	1			(Block n+1) Status Bits.(Copy of M_SB)	0
16	1			(Block n+1) Level measurement validity (Copy of M_VD)	0
17	1			(Block n+1) Sensor inclination (Copy pf M_INC)	0
18	2			(Block n+1) Distance from sensor enclosure interface	0

Table 34: UUID = 0xFFF0, User Description = ”Tank Linearization”

Byte offset	Size [bytes]	R/W	ID	Description	Default
--	20	R/W		”Tank Linearization”	
0	1		LIN_0	Linearization value at 0 ‰ measurement Unsigned integer [0-200]. Scale factor = 5 ‰	0
1	1		LIN_1	Linearization value at 50 ‰ measurement Unsigned integer [0-200]. Scale factor = 5 ‰	10
….	….		….	……	
19	1		LIN_19	Linearization value at 950 ‰ measurement Unsigned integer [0-200]. Scale factor = 5 ‰	190

Table 35: UUID = 0xFFF1, User Description = ”Radar Envelope”

Byte offset	**Size [bytes]**	**R/W**	**ID**	**Description**	**Default**
	20	R Notify		”Radar Envelope”	
0	2	R	RE_E0	Envelope value relative index 0. Integer	0
2	2	R	RE_E1	Envelope value relative index 1. Integer	0
….	….	….			…
16	2	R	RE_E8	Envelope value relative index 8. Integer	0
18	2	R	RE_E9	Envelope value relative index 9. Integer	0