

Bluetooth API of Cosmoids

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1. About

This document describes the Bluetooth Smart (BLE) interface of Cosmoids. It is intended to be used by Application Developers who want to integrate Cosmoids into their own system. Only the bluetooth services that are necessary for such a system integration are described in this document. The rest of the BLE services are used internally by Filisia for administration and maintenance purposes.

2. Integration Requirements

To communicate with a Cosmoid, a Bluetooth Central device that supports Bluetooth Smart (V4.2 and above) is necessary. Examples of such devices are smartphones, tablets and modern personal computers. The application developer has to be familiar with using Bluetooth Smart Services and the way those can be accessed on the chosen development platform.

3. General Description

Cosmoids have an analog force sensor that can measure the force applied on the device and an RGB LED that can illuminate with configurable color and variable intensity. The input from the sensor can be read via the bluetooth interface. The LED luminosity can be configured to either follow the force sensor or to be controlled directly via Bluetooth.

4. Bluetooth Smart Services

4.1. Standard Services

This section describes the standard services provided by the device.

4.1.1. Device Information Service (0X180A)

Characteristic	UUID	Properties	Example Value
Manufacturer Name String	2A29	Read	"Filisia Interfaces"
Serial Number String	2A25	Read	"CM.3.1020.001"
Hardware Revision	2A27	Read	"14.00"
Firmware Revision	2A26	Read	"3.6.02"

4.1.2. Battery Service (0X180F)

Characteristic	UUID	Properties	Range	Description
Battery Level	2A19	Read	0-100	Remaining Battery charge (%)

4.2. Custom Services

4.2.1. Cosmo Service (00001523-1212-EFDE-1523-785FEABCD123)

This service exposes all the interfaces needed for an application to use Cosmoid's functions. An extensive description of the control protocol characteristics can be found later in this document.

Characteristic	UID	Properties	Size (bytes)	Short Description
Sensor Value (Analog)	1524	Read, Notify	1	Current Force Sensor value (0-255)
Button Status (Digital)	1525	Read, Notify	1	Pressed value = 0X00 (Sensor Value > 0) Released value = 0XFF (Sensor Value = 0)
Senor Raw Value	1526	Read, Notify	2	Force sensor raw value - Not to be used by applications
Command Queue Status	1527	Read, Notify	1	Execution status of Control Protocol Command
Command Write	1528	Write	1-7	Execute Control Protocol Command

5. Control Protocol

5.1. Introduction

Using the "Command Write" characteristic of the "Cosmo Service", a Bluetooth Central can send commands to the device. There are multiple types of commands and each one has its own format. All commands first enter a FIFO queue before being executed. This queue has space for up to 40 commands, and the Bluetooth Central can continue sending commands while the device fetches and executes commands from the queue. The "Command Queue Status" characteristic can be used to monitor the queue status. If an application sends multiple commands to the device to generate a light pattern that takes time to complete, this characteristic can be used to get a notification when all commands have been executed.

5.2. Commands

To send a command to the device, the "Command Write" characteristic has to be written with an array of bytes. The first byte of the array is the command code, and the rest are the command parameters. For commands that have parameters, all parameters must be written (the commands have fixed length)

5.2.1. Set Luminosity (Code 0X01)

This command sets the luminosity of the LED. The transition time interval from current luminosity to the one set by the command can be defined from 0 to 2550 ms in 10ms increments.

Offset	Argument	Range	Comments
0	Luminosity	0 - 64	
1	Interval	0 - 255	The interval in ms divided by 10 For example a value of 5 equals $5 \times 10 = 50\text{ms}$

5.2.2. Set Color (Code 0X02)

This command sets the Color of the LED. The default color of the LED is white (R=4, G=4, B=4). The color setting resets to default on device disconnection from BLE Central.

Offset	Argument	Range
0	Red	0 - 4
1	Green	0 - 4
2	Blue	0 - 4
3	Log	0 - Logarithmic scale, 1 - linear scale

5.2.3. Set Parameters (Code 0X03)

This command sets the device parameters. The parameters are explained in a later section of this document. A value of 0XFF for any of the parameters will leave the corresponding parameter unaffected. This makes it easier to use a single command to set either one or multiple parameters. Please note that all the parameters are cleared after the device disconnects from the BLE Central. The table below shows the default values after power on or disconnection.

Offset	Argument	Range	Default Value	Comments
0	Sensor Threshold	5-250	5	Sensor values below this threshold will be ignored
1	LED luminosity multiplier	1 - 250	20	Sets the luminosity multiplier multiplied by 10. (Ex. A value of 15 sets a multiplier of 1.5)
2	Auto calibration	0-1	1	0 - Disables autocalibration 1 - Enables autocalibration
3	LED Mode	0-4	1	0 - None 1 - Analog 2 - Analog Inverted 3 - Button 4 - Button Inverted
4	Enable Sensor Value Notification	0-1	1	0 - Disables notifications for "Sensor Value" Characteristic 1 - Enables the notification
5	Enable Sensor Raw Value Notification	0-1	1	0 - Disables notifications for "Sensor Raw Value" 1 - Enables the notification
6	Button Mode	0-1	0	0 - Button in normal mode 1 - Button in toggle mode
7	Sounder Mode	0-3	0	0 - Off 1 - Low 2 - Mid 3 - High

5.2.4. Clear Queue (Code 0X04)

This command is used to clear the command queue. If any command is being executed while the queue is being cleared, the execution will be interrupted and the device will become idle. This command is executed immediately (it does not enter the FIFO queue). The command has no parameters.

5.2.5. No Operation (Code 0X05)

This command suspends command execution for a time interval. It can be used as part of a series of commands to pause execution for the given time interval.

Offset	Argument	Range	Comments
0	interval LSB	1 - 65535	The interval in ms divided by 10 (ex. 10 -> 100ms)
1	interval MSB		

5.2.6. Set Persistent Parameters (Code 0X10)

This command sets device parameters that are persistent across power cycles (will be remembered by the device even after it is powered off). A value of 0XFF for any of the parameters will leave the corresponding parameter unaffected. This command will clear the command queue and stop any active LED operations so it is recommended that it is used early in the initialization of the device. Although the parameters are persistent, there is no issue with writing them every time the device is initialized. So if an app always needs the same parameters, there is no need for a special configuration menu or action, all the app has to do is to send this command every time the device is connected to it.

Offset	Argument	Range	Default Value	Comments
0	Disable Auto Power Off when not connected	0-1	0	With a value of 0 (default), the device will automatically power off after 5 minutes if it is not connected. With a value of 1, this feature will be disabled
1	Disable Auto Power Off with sensor inactivity	0-1	0	With a value of 0 (default), the device will automatically power off after 1 hour of sensor inactivity. With a value of 1, this feature will be disabled
2	Enable Full Functionality while Charging	0-1	0	With a value of 0 (default), the device will not be accessible via Bluetooth while charging and the LED will show the charging status. With a value of 1, the device will be fully functional while charging
3-7	Reserved	FF	N/A	Always write these reserved bytes to 0xFF

6. Device Parameters

This section explains the device parameters mentioned earlier in this document

6.1. Sensor Threshold

The default value for this parameter is used for maximum sensing sensitivity. If the device needs to be less sensitive this parameter can be increased. The sensor values below this threshold will be ignored which means that more force will need to be applied on the device for the "Sensor Value" characteristic to go above 0. Please note that the value of this parameter is subtracted from the output to "Sensor Value" Characteristic (The sensor value always starts at 0). Please also note that this threshold also affects the "Button Status" characteristic.

6.2. LED Luminosity Multiplier

This parameter is applicable to the 2 analog modes of the device. For these 2 modes, the sensor value will be multiplied by this parameter and the resulting value will be automatically applied as the luminosity value for the LED. Higher numbers to this parameter will result in higher sensitivity of the LED luminosity to applied force.

6.3. Auto Calibration (Enable/Disable)

The device has an automatic calibration function enabled by default. This function lets the device correct its "zero" value when resting on a table. If constant force is applied to the device and the sensor value is unchanged for a few seconds, this automatic calibration might be accidentally triggered. For this reason, disabling automatic calibration may be useful for some special use cases.

6.4. LED Mode

The LED supports 5 different modes of operation. In the first mode (None) the LED luminosity is completely independent of the sensor and controlled only by Bluetooth commands. This mode must be used when light patterns need to be generated via Bluetooth commands. In the Analog mode the LED luminosity is proportional to the sensor value multiplied by "Led Luminosity Multiplier". In the Analog Inverted mode the LED luminosity is inversely proportional to the same value. In the Button and Button Inverted modes the LED follows the "Button Status" Characteristic value so it acts as an indication of the digital state of the sensor.

6.5. Sensor Notifications (Enable/Disable)

These functions are used to temporarily disable the notifications for the analog sensing characteristics. These parameters are used for convenience when it is not easy for the application to unsubscribe from the corresponding notifications.

7. Troubleshooting

While sending commands to the device, you may see some unexpected behavior. Please check the following table for possible reasons:

Problem	Possible reasons
Commands Lost / Ignored	Queue limit is exceeded (limit is 40 commands)
	Parameter count for the command is incorrect
	Wrong command ID or parameter out of range
Device resets/disconnects	A parameter value in the executed command is out of range

8. Examples of Usage

In this section, a few examples of usage are explained. For all the examples we assume that the setup step follows a new connection to the device. Before starting application development, it is recommended that the developer uses a generic BLE scanner/reader application to experiment with the device services to better understand the following examples.

8.1. Use as a simple switch with custom color

In this example, we setup the cosmoid as a simple switch. The device will have the color yellow. It will have 1/3 of max luminosity when not pressed and full luminosity when the user presses it.

Setup Steps:

1) Write the following bytes to "Command Write" characteristic to set the color:

0X02 (Set Color Command)
0X04 (RED)
0X04 (GREEN)
0X00 (BLUE)

2) Write the following bytes to "Command Write" characteristic to set the button mode

0X03 (Set Parameters Command)
0XFF (Sensor Threshold unchanged)
0XFF (Luminosity Multiplier unchanged)
0XFF (Auto Calibration unchanged)
0X03 (LED MODE = Button)
0XFF (Sensor Value Notification unchanged)
0XFF (Sensor Raw Value Notification unchanged)
0XFF (Button mode unchanged)
0XFF (Sounder mode unchanged)

Usage:

After the described setup, the application can read the switch state from "Button Status" characteristic (A value of 0X00 will be read when it is pressed and 0XFF when it is released). The application can also subscribe for notifications on this characteristic.

8.2. Use as a switch with reduced sensitivity

In this example, we setup the cosmoid again as a simple switch but with reduced sensitivity and inverted LED function. The device will have the color blue. It will have full luminosity when released and 1/3 of max luminosity when pressed.

Setup Steps:

1) Write the following bytes to "Command Write" characteristic to set the color:

0X02 (Set Color Command)
0X00 (RED)
0X00 (GREEN)
0X04 (BLUE)

2) Write the following bytes to "Command Write" characteristic to set the button mode

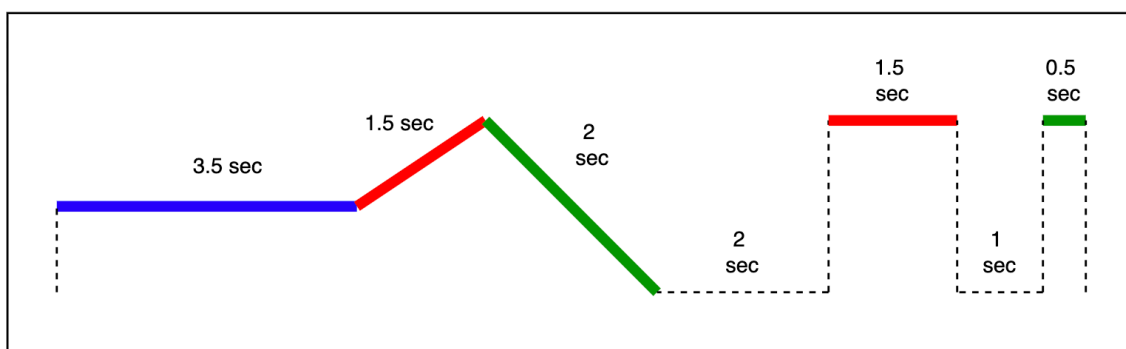
0X03 (Set Parameters Command)
0X30 (Sensor Threshold = 48)
0XFF (Luminosity Multiplier unchanged)
0XFF (Auto Calibration unchanged)
0X04 (LED MODE = Button Inverted)
0XFF (Sensor Value Notification unchanged)
0XFF (Sensor Raw Value Notification unchanged)
0XFF (Button mode unchanged)
0XFF (Sounder mode unchanged)

Usage:

The usage from the application side after setup is exactly the same as with the previous example.

8.3. Generate Light Pattern

In this example we use the LED independently of the sensor to generate a light pattern. Please note that the sensor status can still be read using the "Button Status" and "Sensor Value" characteristics. In the picture below, we see the example light pattern generated.



Setup:
Write

the following bytes to "Command Write" characteristic to set the button mode

0X03 (Set Parameters Command)
0XFF (Sensor Threshold unchanged)
0XFF (Luminosity Multiplier unchanged)

0XFF (Auto Calibration unchanged)

0X04 (LED MODE = None)

0XFF (Sensor Value Notification unchanged)

0XFF (Sensor Raw Value Notification unchanged)

0XFF (Button mode unchanged)

0XFF (Sounder mode unchanged)

Write the following commands to generate the light pattern (all bytes **in hex** format):

- 1) 02 00 00 04 - Set blue color
- 2) 01 20 00 - Set Luminosity to 32 immediately
- 3) 05 5E 01 - Pause execution for 3.5 sec ($3500/10 = 350 = 0X015E$)
- 4) 02 04 00 00 - Set red color
- 5) 01 40 96 - Set Luminosity to 64 in 1.5sec ($1500/10 = 150 = 0X96$)
- 6) 02 00 04 00 - Set green color
- 7) 01 00 C8 - Set Luminosity to 00 in 2sec ($2000/10 = 200 = 0XC8$)
- 8) 05 C8 00 - Pause execution for 2 sec ($2000/10 = 200 = 0X00C8$)
- 9) 02 04 00 00 - Set red color
- 10) 01 40 00 - Set Luminosity to 64 immediately
- 11) 05 96 00 - Pause execution for 1.5 sec ($1500/10 = 150 = 0X0096$)
- 12) 01 00 00 - Set Luminosity to 0 immediately
- 13) 05 64 00 - Pause execution for 1 sec ($1000/10 = 100 = 0X0064$)
- 14) 02 00 04 00 - Set green color
- 15) 01 40 00 - Set Luminosity to 64 immediately
- 16) 05 32 00 - Pause execution for 0.5 sec ($500/10 = 50 = 0X0032$)
- 17) 01 00 00 - Set Luminosity to 0 immediately

The commands should be sent all together immediately. They will enter the queue and will be executed sequentially. If the developer needs to know when the device actually finishes execution, the "Command Queue Status" characteristic can be used to get a notification for the completion.

8.4. Configure Persistent Parameters

In this example, the device will be configured to disable the power saving features and also be functional and accessible via bluetooth while charging.

Write the following bytes to "Command Write" characteristic:

0X10 (Set Persistent Parameters Command)
0X01 (Disable the Auto Power Off When Not Connected Feature)
0X01 (Disable the Auto Power OFF When Sensor Inactive Feature)
0X01 (Enable Full Functionality while Charging)
0XFF (Reserved)
0XFF (Reserved)
0XFF (Reserved)
0XFF (Reserved)
0XFF (Reserved)