

# BLE Communication Guide 20190205

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## **StretchSense Development Kit Bluetooth Low Energy Interface**

## **Terminology**

**BLE** - Bluetooth Low Energy

**StretchSense board** – The board designed by StretchSense connected to the sensors

SSB - StretchSense board

Central - BLE master electronics

Peripheral – BLE slave electronics

## **General Specifications**

Parameter	VALUE	
StretchSense boards compatible (peripheral)	SPI to BLE shield, Arduino101 (BLE mode), TinyTile (BLE mode)	
StretchSense solutions to receive BLE (central)	Android, iOS, Raspberry Pi	
Transmission speed (10 channels)	25Hz	
Resolution / channel	16bits	
Average power consumption (SPI to BLE shield)	15mA	



Author: JL, TG, AD Version: 1.2 Rev. Date: 05/02/19

#### Introduction

The SPI-to-BLE module is a wireless solution provided by StretchSense to communicate the sensor output to a remote device such as a smartphone or any BLE-enabled electronics.

Bluetooth Low Energy (BLE) is a low energy protocol of wireless communication between two BLE-enabled devices. Each device is defined by a role, it can be either Central or Peripheral. To enable the communication, you need one Central device and at least one Peripheral device.

The Peripheral device can be put in 3 main states: Idle, Connected and Advertising.

- Idle mode consists of powering the system without being connected, and without Advertising for a connection. Typical current consumption in this state is several hundred nanoamps.
- Connected mode means a connection between the Central and Peripheral device has been established and the devices have exchanged and agreed to the parameters of the connection, in particular how frequently the Peripheral device will connect and transmit data to the Central device. A connection will regularly be made according to the parameters even if no new data is available to ensure the connection is kept alive.
- Advertising mode means the device is searching for a Central device. It is broadcasting identifying information that can be received by a Central device and used to determine if a connection should be initiated. Advertising mode uses the highest power consumption.

#### StretchSense BLE Protocol

Once the Peripheral device and Central are connected, the Generic Attributes (GATT) of the Peripheral is discoverable and accessible. The GATT profile defines the profile of the data transfer. Each device has a hierarchical organized data divided in section called Services and sub-section called Characteristics.

A BLE Service groups all the data with the same purpose. In the StretchSense SPI-to-BLE module, only one Service is used. This service is named StretchSense, and contains several Characteristics related to communicating with and controlling the StretchSense sensing electronics.

Table 1: StretchSense SPI-to-BLE Module GATT Definition

GATT TYPE	NAME	UUID	PEMISSION	ТҮРЕ
Service	StretchSense	000017 <mark>01</mark> -7374-7265-7563-6873656e7365	Read/Write	
Charact.	Capacitances	000017 <mark>02</mark> -7374-7265-7563-6873656e7365	Read	Hex
Charact.	Private	000017 <mark>03</mark> -7374-7265-7563-6873656e7365	Read/Write	Bool
Charact.	Private	000017 <mark>04</mark> -7374-7265-7563-6873656e7365	Read/Write	Bool
Charact.	Frequency	000017 <mark>05</mark> -7374-7265-7563-6873656e7365	Read/Write	Hex
Charact.	Filtering	000017 <mark>06</mark> -7374-7265-7563-6873656e7365	Read/Write	Hex

**NOTE**: The UUID displayed in Table 1 is an example for the default UUID for a StretchSense SPI-to-BLE shield. Custom applications may include unique UUIDs according to the following convention:



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#### AAABBBXX-7374-7265-7563-6873656e7365

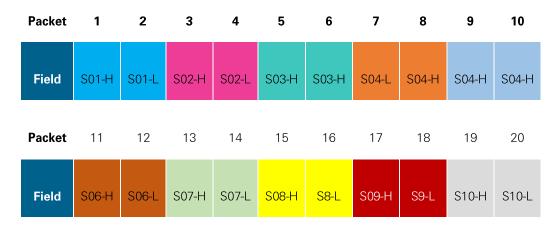
With: AAA the Peripheral device ID, BBB Circuit Type ID, and XX the GATT type number

## **Characteristic: Capacitances**

This Characteristic contains all the output of the StretchSense sensors.

The general packet structure of the Characteristic has a fixed length of 20 bytes. These 20 bytes are divided into 10x 2-byte groups. Each sensor output is packed into 2 bytes, the upper byte representing the most significant byte of the sensor reading, and the lower byte representing the least significant byte of the sensor reading.

Table 2: Packet Structure of StretchSense Capacitance Characteristic



In this example, only the sensor on the Channel 1 is used. To calculate the capacitance, you will need to cast the two packets together and convert it to decimal. By default, the capacitance is output in units of 0.1pF. Custom configurations may use different units. This example packet therefore corresponds to a sensor 1 output of:

$$Hex(06A5) = Dec(1701)$$

## **Characteristic: Frequency**

The frequency of BLE connection events is governed by the following equation for the time in milliseconds between connection events:

Time between BLE connection events = 40ms\*(input+1) = 40ms (default = 0)

INPUT	FREQUENCY	
0-FF	Determines the frequency of connection events	



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## **Characteristic: Filtering**

The SPI-to-BLE Module can be used to set the width of the moving average filter on the sensing electronics connected to the module. The default value is 1 = 1pt filter.

INPUT	FILTER
1-FF	Filter length

### **Characteristic: Private**

<u>\*Warning\*:</u> This characteristic is for StretchSense use only. It should not be use without StretchSense support as it will affect the firmware with no return possible.



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