StretchSense™

BLE Communication Guide

20190205

Contents

StretchSense Limited
114 Rockfield Road, Penrose, Auckland 1061, New Zealand
Ph: +64 9 634 1927 (NZ) I Ph: +1 415 800 1003 (US) I sales@stretchsense.com
www.stretchsense.com

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

StretchSense Limited
114 Rockfield Road, Penrose, Auckland 1061, New Zealand
Ph: +64 9 634 1927 (NZ) I Ph: +1 415 800 1003 (US) I sales@stretchsense.com
www.stretchsense.com

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	TYPE
Service	StretchSense	00001701-7374-7265-7563-6873656e7365	Read/Write	
Charact.	Capacitances	00001702-7374-7265-7563-6873656e7365	Read	Hex
Charact.	Private	00001703-7374-7265-7563-6873656e7365	Read/Write	Bool
Charact.	Private	00001704-7374-7265-7563-6873656e7365	Read/Write	Bool
Charact.	Frequency	00001705-7374-7265-7563-6873656e7365	Read/Write	Hex
Charact.	Filtering	00001706-7374-7265-7563-6873656e7365	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:

StretchSense Limited
114 Rockfield Road, Penrose, Auckland 1061, New Zealand
Ph: +64 9 634 1927 (NZ) I Ph: +1 415 800 1003 (US) I sales@stretchsense.com
www.stretchsense.com

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

Packet	1	2	3	4	5	6	7	8	9	10
Field	S01-H	S01-L	S02-H	S02-L	S03-H	S03-H	S04-L	S04-H	S04-H	S04-H

Packet	11	12	13	14	15	16	17	18	19	20
Field	S06-H	S06-L	S07-H	S07-L	S08-H	S8-L	S09-H	S9-L	S10-H	S10-L

Example: [06 – A5 – 0 – 0– 0 – 0– 0 – 0– 0 – 0– 0 – 0 – 0 – 0– 0 – 0 – 0 – 0 – 0 – 0]

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)

1701 * 0.1= 170.1pF

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

StretchSense Limited
114 Rockfield Road, Penrose, Auckland 1061, New Zealand
Ph: +64 9 634 1927 (NZ) I Ph: +1 415 800 1003 (US) I sales@stretchsense.com
www.stretchsense.com

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

Warning: 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.

StretchSense Limited
114 Rockfield Road, Penrose, Auckland 1061, New Zealand
Ph: +64 9 634 1927 (NZ) I Ph: +1 415 800 1003 (US) I sales@stretchsense.com
www.stretchsense.com

Intellectual Property And Licensing

Version 20190121B

DISCLAIMER

All resources including technical information, statements and recommendations are based on information StretchSense believes to be reliable, but the accuracy or completeness is not guaranteed. StretchSense is not liable for any loss of profit, revenue, savings, business, use, data (including data and design inputs), and/or goodwill or consequential, indirect, incidental or special damage or loss of any kind under or in connection with these resources.

INTELLECTUAL PROPERTY (IP)

StretchSense owns all IP related to StretchSense sensing elements (including technology and IP relating to sensing element design, physical placement, arrays, cabling, connectors, tracks and termination points); the sensing algorithm and all embedded firmware used to control the acquisition, processing, and/or transmission of raw sensor data generated by the StretchSense sensing elements and circuits; systems, materials and methods in relation to the manufacture and/or quality control of the foregoing, including mechanical, electronic or adhesive materials, systems and methods for attaching StretchSense sensing elements and circuits to a structure. Any source code relating to training, machine learning or calibration of StretchSense technology, or any software application source code related to interfacing with StretchSense technology, or any electronic hardware reference design is owned by StretchSense and provided to you under the terms of an MIT License. All pre-existing IP remains the property of its original owner. For StretchSense's intellectual property policies, please refer to our website at https://www.stretchsense.com/legal/#ss-panel-1

LICENSING

StretchSense has licensed technology from Parker Hannifin Corporation and from Auckland UniServices Limited:

Parker Hannifin Corporation

StretchSense products that utilise certain dielectric electro-active polymer (DEAP) technology are manufactured and supplied under licence from the Quick Coupling Division of Parker Hannifin Corporation, Minneapolis, MN, USA ("Parker"). Such licence enables StretchSense to manufacture and supply Parker DEAP transducer products generally for evaluation and application validation purposes, and commercially for consumer electronics, motion capture and augmented/virtual reality, and sports and fitness industries. Commercial use in other industries is subject to Parker's prior consent.

Auckland UniServices Limited

StretchSense products that utilise certain sensor and dielectric elastomer generator technologies are manufactured and supplied under license from Auckland UniServices Limited in Auckland, New Zealand ("UniServices"). These licensed technologies originally being created by the Biomimetics Lab at the Auckland Bioengineering Institute. Such license enables StretchSense to manufacture and supply sensor and dielectric elastomer generator products for evaluation, application validation, and commercial purposes for all fields.

StretchSense Limited
114 Rockfield Road, Penrose, Auckland 1061, New Zealand
Ph: +64 9 634 1927 (NZ) I Ph: +1 415 800 1003 (US) I sales@stretchsense.com
www.stretchsense.com