**Title:** Pressure Sensor App Communication Protocol and steps

**Date:** 5/5/2021

**Revision:** X02

**Compatible PCB:** Sensor\_Glove-X01

Diagram, schematic

Description automatically generated

**Turn-on Instructions:**

Supply a voltage potential of 3.4V to 5.5V between the VBAT+ and VBAT- connection points. The system is still off though. Voltage is supplied to the battery powered components, however, the nRF52 is not powered. To enable the linear regulator, you have to use the magnet on the popsicle stick to turn on the magnetic sensor. Hold the magnet over the magnetic sensor for a couple seconds. There will be an orange LED that will blink twice to notify the user that the patch is on and enabled. Now the system will begin advertising for three minutes. If the user does not connect to the patch within three minutes, the patch will shutdown requiring the user to use the magnet to connect to the patch again.

**BLE GATT Database:**

Configuration Service: CE:13:10:B0:F0:74:3E:A1:EE:45:30:38:D4:8C:AD:8A

-Settings Characteristic: 06:0D:00:CE:13:10:B0:F0:74:3E:A1:EE:45:30:38:AA:46:AD:8A

Data type: uint8\_t [10]

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Bluetooth Header | Module | Sub Message #1 | Sub Message #2 | Sub Message #3 | Sub Message #4 | Sub Message #5 | Sub Message #6 | Sub Message #7 | Bluetooth Footer |

-Response Characteristic: 12:0F:00:CE:13:10:B0:F0:74:3E:A1:EE:45:30:38:AB:46:AD:8A

Data type: uint8\_t [4]

|  |  |  |  |
| --- | --- | --- | --- |
| Response #1 | Response #2 | Response #3 | Response #4 |

Pressure Service: CE:13:10:B0:F0:74:3E:A1:EE:45:30:38:D7:8C:AD:8A

-Pressure Characteristic: 12:1D:00:CE:13:10:B0:F0:74:3E:A1:EE:45:30:38:B0:46:AD:8A

Data type: uint8\_t [12]

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| CIN #1 [0] | CIN #1 [1] | CIN #1 [2] | CIN #2 [0] | CIN #2 [0] | CIN #2 [1] | CIN #2 [2] | CIN #3 [0] | CIN #3 [1] | CIN #3 [2] | CIN #4 [0] | CIN #4 [1] | CIN #4 [2] |

The capacitance measurement are 24-bit result registers in binary format. The data is encoded in two’s complement format. The result of the measurement can be calculated using the following formula:

Capacitance (pF) = ((Two's Complement (measurement[23:0])) / 219) + CCAPDAC

**BLE Command Instructions**

1. Connect to Device.
   1. Device name: SG-P-X01
   2. Manufacturer name: GT-BITNG
2. Discover all attributes and services.
3. Enable all characteristic notifications.
4. Write the following command to the SETTINGS CHARACTERISTIC
   1. Enable Bluetooth Advertising after disconnection.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| BLUETOOTH HEADER | BLUETOOTH MODULE | BLUETOOTH ENABLE ADVERTISING AFTER DISCONNECTION COMMAND | 0 | 0 | 0 | 0 | 0 | 0 | BLUETOOTH FOOTER |
| 0XBA | 0X06 | 0X18 | 0 | 0 | 0 | 0 | 0 | 0 | 0XBB |

* 1. The Response Characteristic should read the following after the previous command:

|  |  |  |  |
| --- | --- | --- | --- |
| 0x00 | 0x00 | 0x00 | 0x01 |

1. Write the following command to the SETTINGS CHARACTERISTIC
   1. Enable the measurement channel for the FDC1004.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| BLUETOOTH HEADER | FDC1004 MODULE | FDC1004 ENABLE CHANNEL COMMAND | CHANNEL | 0 | 0 | 0 | 0 | 0 | BLUETOOTH FOOTER |
| 0XBA | 0X09 | 0X0C | X | 0 | 0 | 0 | 0 | 0 | 0XBB |

\* The X values signify an input value. The channel is a uint8\_t data type accepting numbers 1-4 corresponding to CIN1 - CIN4.

* 1. The Response Characteristic should read the following after the previous command:

|  |  |  |  |
| --- | --- | --- | --- |
| 0x00 | 0x00 | 0x00 | 0x01 |

1. Write the following command to the SETTINGS CHARACTERISTIC
   1. Set the offset capacitance measurement for the measurement channels used.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| BLUETOOTH HEADER | FDC1004 MODULE | FDC1004 SET CAPDAC COMMAND | CHANNEL | CAPDAC | 0 | 0 | 0 | 0 | BLUETOOTH FOOTER |
| 0XBA | 0X09 | 0X09 | X | X | 0 | 0 | 0 | 0 | 0XBB |

\* The X values signify an input value. The channel is a uint8\_t data type accepting numbers 1-4. The CAPDAC is a uint8\_t data type. This value sets the offset capacitance. This is the single-ended measurement capacitance offset: C\_offset = CAPDAC x 3.125 pF. This value needs to be tuned per pressure sensor. This value will vary as each pressure sensor is unique. Do this for each pressure sensor used.

* 1. The Response Characteristic should read the following after the previous command:

|  |  |  |  |
| --- | --- | --- | --- |
| 0x00 | 0x00 | 0x00 | 0x01 |

1. Write the following command to the SETTINGS CHARACTERISTIC
   1. Set the gain for each measurement channel used.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| BLUETOOTH HEADER | FDC1004 MODULE | FDC1004 SET GAIN CALIBRATION COMMAND | CHANNEL | INTEGER | DECIMAL MSB | DECIMAL  LSB | 0 | 0 | BLUETOOTH FOOTER |
| 0XBA | 0X09 | 0X04 | X | X | X | X | 0 | 0 | 0XBB |

\* The X values signify an input value. The channel is a uint8\_t data type accepting numbers 1-4. The integer is a uint8\_t data type containing 2 bits. This value sets the integer portion of the offset capacitance. This decimal is a uint8\_t [2] array containing 14 bits. The first sets the MSB and the second sets the LSB. This register contains a gain factor correction in the range of 0 to 4 that can be applied to each channel to remove gain mismatch due to external circuitry. I have found that a gain value of 0.5 works well. However, this value needs to be tuned per pressure sensor used.

* 1. The Response Characteristic should read the following after the previous command:

|  |  |  |  |
| --- | --- | --- | --- |
| 0x00 | 0x00 | 0x00 | 0x01 |

1. Write the following command to the SETTINGS CHARACTERISTIC
   1. Start instant pressure data recording transfer.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| BLUETOOTH HEADER | FDC1004 MODULE | FDC1004 START DATA COLLECTION COMMAND | 0 | 0 | 0 | 0 | 0 | 0 | BLUETOOTH FOOTER |
| 0XBA | 0X09 | 0X0E | 0 | 0 | 0 | 0 | 0 | 0 | 0XBB |

\* This command is to set internal variables to monitor the transmission of data from the FDC1004 to the nRF52.

* 1. The Response Characteristic should read the following after the previous command:

|  |  |  |  |
| --- | --- | --- | --- |
| 0x00 | 0x00 | 0x00 | 0x01 |

* 1. The previous command will be implemented. After implementation the following command, the response will be sent to indicate that the temperature data collection has finished.

|  |  |  |  |
| --- | --- | --- | --- |
| 0x00 | 0x00 | 0x00 | 0x0D |

1. Write the following command to the SETTINGS CHARACTERISTIC
   1. Change the sampling rate if you desire.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| BLUETOOTH HEADER | NRF52 MODULE | NRF52 RTC CLOCK COMMAND | NRF52 RTC SENSOR SET COUNTER | COUNTER[0] | COUNTER[1] | 0 | 0 | 0 | BLUETOOTH FOOTER |
| 0XBA | 0X01 | 0X04 | 0X08 | X | X | 0 | 0 | 0 | 0XBB |

The X values signify a byte in an unit16\_t data type. Counter[0] is the MSB and Counter[1] is the LSB. The counter / 8 = seconds per sample.

* 1. The Response Characteristic should read the following after the previous command:

|  |  |  |  |
| --- | --- | --- | --- |
| 0x00 | 0x00 | 0x00 | 0x01 |

1. Write the following command to the SETTINGS CHARACTERISTIC
   1. Start the internal timer to regulate the sampling rate.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| BLUETOOTH HEADER | NRF52 MODULE | NRF52 RTC CLOCK COMMAND | NRF52 RTC SENSOR START | 0 | 0 | 0 | 0 | 0 | BLUETOOTH FOOTER |
| 0XBA | 0X01 | 0X04 | 0X09 | 0 | 0 | 0 | 0 | 0 | 0XBB |

\* Only call this function once to start the timer to regulate the sampling rate.

Data is written to the pressure characteristic above at the desired sampling rate. After data is written to the characteristic, a notification is sent to the BLE Client.

* 1. The Response Characteristic should read the following after the previous command:

|  |  |  |  |
| --- | --- | --- | --- |
| 0x00 | 0x00 | 0x00 | 0x01 |

**To stop data transfer of pressure, send the following commands:**

1. Write the following command to the SETTINGS CHARACTERISTIC
   1. Stop instant pressure data recording.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| BLUETOOTH HEADER | FDC1004 MODULE | FDC1004 STOP DATA COLLECTION COMMAND | 0 | 0 | 0 | 0 | 0 | 0 | BLUETOOTH FOOTER |
| 0XBA | 0X09 | 0X0F | 0 | 0 | 0 | 0 | 0 | 0 | 0XBB |

\* This function only stops pressure data being transferred. It does not stop other types of data collection methods going on.

* 1. The Response Characteristic should read the following after the previous command:

|  |  |  |  |
| --- | --- | --- | --- |
| 0x00 | 0x00 | 0x00 | 0x01 |

* 1. The previous command will be implemented. After implementation the following command, the response will be sent to indicate that the pressure data collection has finished.

|  |  |  |  |
| --- | --- | --- | --- |
| 0x00 | 0x00 | 0x00 | 0x0E |

1. Write the following command to the SETTINGS CHARACTERISTIC
   1. Stop the internal timer that regulates the sampling rate.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| BLUETOOTH HEADER | NRF52 MODULE | NRF52 RTC CLOCK COMMAND | NRF52 RTC SENSOR STOP | 0 | 0 | 0 | 0 | 0 | BLUETOOTH FOOTER |
| 0XBA | 0X01 | 0X04 | 0X10 | 0 | 0 | 0 | 0 | 0 | 0XBB |

\* Only call this function once to stop all timer enabled sensor data collection.

* 1. The Response Characteristic should read the following after the previous command:

|  |  |  |  |
| --- | --- | --- | --- |
| 0x00 | 0x00 | 0x00 | 0x01 |

1. Write the following command to the SETTINGS CHARACTERISTIC
   1. Shutdown patch.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| BLUETOOTH HEADER | NRF52 MODULE | NRF52 COMMON COMMAND | NRF52 VCC LDO DISABLE | 0 | 0 | 0 | 0 | 0 | BLUETOOTH FOOTER |
| 0XBA | 0X01 | 0X06 | 0X07 | 0 | 0 | 0 | 0 | 0 | 0XBB |

* 1. The response characteristic should read the following after the previous command:

|  |  |  |  |
| --- | --- | --- | --- |
| 0x00 | 0x00 | 0x00 | 0x01 |