**Title:** Bluetooth Communication Protocol

**Sensor:** ADS1292

**Date:** 8/04/2021

**Revision:** X01

**Compatible PCA:** PCA001

**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 |

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**ADS1292 Service:** CE:13:10:B0:F0:74:3E:A1:EE:45:30:38:**D9:8C**:AD:8A

-Instant ECG Characteristic: 12:1D:00:CE:13:10:B0:F0:74:3E:A1:EE:45:30:38:**B3:46**:AD:8A

Data type: uint8\_t [6]

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| CH #1 [0] | CH #1 [1] | CH #1 [2] | CH #2 [0] | CH #2 [1] | CH #2 [2] |

The voltage ECG measurements are 24-bit result registers in binary format. The data is encoded in two’s complement format.

**BLE Command Instructions**

1. Connect to Device.
   1. Device name: PCA**XXX**
   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 the SPI peripheral to communicate with the ADS1292. This only needs to be once when setting register values.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| BLUETOOTH HEADER | ADS1292 MODULE | ADS1292 ENABLE SPI COMMAND | 0 | 0 | 0 | 0 | 0 | 0 | BLUETOOTH FOOTER |
| 0xBA | 0x0A | 0x2E | 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. Wake the ADS1292 from standby mode. The ADS1292 is in standby mode by default.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| BLUETOOTH HEADER | ADS1292 MODULE | ADS1292 WAKEUP STANDBY COMMAND | 0 | 0 | 0 | 0 | 0 | 0 | BLUETOOTH FOOTER |
| 0xBA | 0x0A | 0x09 | 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. Set the sampling rate of the ADS1292. Default sampling rate is 125 samples per second.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| BLUETOOTH HEADER | ADS1292 MODULE | ADS1292 SET SAMPLES PER SECOND COMMAND | SAMPLING RATE | 0 | 0 | 0 | 0 | 0 | BLUETOOTH FOOTER |
| 0xBA | 0x0A | 0x17 | X | 0 | 0 | 0 | 0 | 0 | 0xBB |

\* The X values signify an input value. The sampling rate can be values from 125 to 8000 samples per second. 125 = 0x00, 250 = 0x01, 500 = 0x02, 1000 = 0x03, 2000 = 0x04, 4000 = 0x05, 8000 = 0x06

* 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 a channel for measurement of the ADS1292.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| BLUETOOTH HEADER | ADS1292 MODULE | ADS1292 SET CHANNEL OPERATING MODE COMMAND | CHANNEL | OPERATING MODE | 0 | 0 | 0 | 0 | BLUETOOTH FOOTER |
| 0xBA | 0x0A | 0x1A | X | X | 0 | 0 | 0 | 0 | 0xBB |

\* The X values signify an input value. There are two channels available on the ADS1292: 1 = 0x01, 2 = 0x02. Additionally, set the operating mode to 0x00 for normal operation or 0x01 for power down mode.

* 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 a channel of the ADS1292.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| BLUETOOTH HEADER | ADS1292 MODULE | ADS1292 SET CHANNEL PGA GAIN COMMAND | CHANNEL | PGA GAIN | 0 | 0 | 0 | 0 | BLUETOOTH FOOTER |
| 0xBA | 0x0A | 0x1B | X | X | 0 | 0 | 0 | 0 | 0xBB |

\* The X values signify an input value. There are two channels available on the ADS1292: 1 = 0x01, 2 = 0x02. Additionally, set the PGA gain on the channel to the following values: 1 = 0x01, 2 = 0x02, 3 = 0x03, 4 = 0x04, 6 = 0x00, 8 = 0x05, 12 = 0x06

* 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 channel input selection.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| BLUETOOTH HEADER | ADS1292 MODULE | ADS1292 SET CHANNEL INPUT COMMAND | CHANNEL | INPUT SELECTION | 0 | 0 | 0 | 0 | BLUETOOTH FOOTER |
| 0xBA | 0x0A | 0x1C | X | X | 0 | 0 | 0 | 0 | 0XBB |

\* The X values signify an input value. There are two channels available on the ADS1292: 1 = 0x01, 2 = 0x02. A channel input can be set to various selections. Normal electrode input = 0x00, Input shorted = 0x01. If you power down a channel, set the channel input to the input shorted selection.

* 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 Right Leg Drive Sense Selection for each enabled channel: Channel, Polarity, Connection

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| BLUETOOTH HEADER | ADS1292 MODULE | ADS1292 SET CHANNEL RLD INPUT COMMAND | CHANNEL | POLARITY | CONNECTION | 0 | 0 | 0 | BLUETOOTH FOOTER |
| 0xBA | 0x0A | 0x1F | X | X | X | 0 | 0 | 0 | 0xBB |

\* The X values signify an input value. There are two channels available on the ADS1292: 1 = 0x01, 2 = 0x02. There are two polarity settings: Positive = 0x01, Negative = 0x00. There are two connection settings: Not Connected = 0x00, Connected = 0x01.

* 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. Disable the SPI peripheral to communicate with the ADS1292. This only needs to be once all the register values have been properly set.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| BLUETOOTH HEADER | ADS1292 MODULE | ADS1292 DISABLE SPI COMMAND | 0 | 0 | 0 | 0 | 0 | 0 | BLUETOOTH FOOTER |
| 0xBA | 0x0A | 0x2F | 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. Set the ADS1292 to enter standby mode to save power.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| BLUETOOTH HEADER | ADS1292 MODULE | ADS1292 ENTER STANDBY COMMAND | 0 | 0 | 0 | 0 | 0 | 0 | BLUETOOTH FOOTER |
| 0xBA | 0x0A | 0x08 | 0 | 0 | 0 | 0 | 0 | 0 | 0xBB |

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

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

**To start data transfer of ECG data from the ADS1292, send the following command(s):**

1. Write the following command to the SETTINGS CHARACTERISTIC
   1. Start ADS1292 instant ECG data recording.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| BLUETOOTH HEADER | ADS1292MODULE | ADS1292 START DATA COLLECTION COMMAND | 0 | 0 | 0 | 0 | 0 | 0 | BLUETOOTH FOOTER |
| 0xBA | 0x0A | 0x14 | 0 | 0 | 0 | 0 | 0 | 0 | 0xBB |

\* This command will start the data collection recording to collect data from the previously set channels.

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

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

* 1. The previous command will be implemented. After implementing the following command, the response will be sent to indicate that the ADS1292 ECG data collection has started.

|  |  |  |  |
| --- | --- | --- | --- |
| 0x00 | 0x00 | 0x00 | 0x10 |

**To stop data transfer of ECG data from the ADS1292, send the following commands:**

1. Write the following command to the SETTINGS CHARACTERISTIC
   1. Stop ADS1292 instant ECG data recording.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| BLUETOOTH HEADER | ADS1292 MODULE | ADS1292 STOP DATA COLLECTION COMMAND | 0 | 0 | 0 | 0 | 0 | 0 | BLUETOOTH FOOTER |
| 0xBA | 0x0A | 0x15 | 0 | 0 | 0 | 0 | 0 | 0 | 0xBB |

\* This command will stop the data collection recording.

* 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 | 0x11 |