BRIC4 Bluetooth Protocol

Rev F

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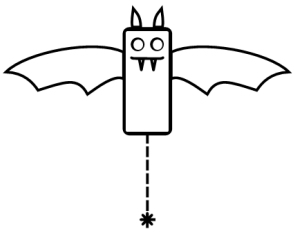

Overview:

This document describes the bluetooth communication protocol for the BRIC4 survey tool. The hardware implemented is a Laird BL652 module which uses Bluetooth Low Energy version 4.2. All communication is performed over BLE GATT/ATT using several standard and custom services:

- **Device Information Service:** Standard service to provide device name, serial number, firmware version, and more.
- **Battery Service:** Standard service to provide BRIC4 battery level.
- **Measurement Sync Service:** Custom service to send measurements and metadata to the client.
- **Device Control Service:** Custom service to allow client to control/adjust the BRIC4 device.

The “Device Information Service” and “Battery Service” will not be discussed in much detail since it is a standard service protocol. All data is transmitted in Little Endian per the BLE protocol standards. Bluetooth info and additional options can be found on the BRIC4, *Main Menu > Bluetooth.*

Pairing:

The BRIC4 will advertise while it is powered up and not connected. The device name advertised is “BRIC4_XXXX” where “XXXX” is the device serial number (example: “BRIC4_0039”). No encryption or pairing PIN numbers are implemented. The BRIC4 will remain connected while powered-down but will not respond or tend to any services. If the BRIC4 is connected, a bluetooth symbol will appear on the bottom right of the screen.

BLE Services

Device Information Service (UUID 0x180A)

The BRIC4 implements the standard “Device Information Service” which provides the following information:

- **Manufacturer Name String:** example: “Team Poseidon LLC”
- **Model Number String**: example: “BRIC4”
- **Serial Number String**: “0039”
- **Hardware Revision String**: “A”
- **Firmware Revision String:** BL652 Module Software, example “BL652:v28.6.2.0”
- **Software Revision String:** BRIC4 Software, example: “4.08”
- **System ID:** Not Implemented
- **IEEE 11073-20601 Regulator Certification Data List:** Not Implemented
- **PnP ID**: Not Implemented

Battery Service (UUID 0x180F)

The BRIC4 implements the standard “Battery Service” which provides the device battery level percentage from 0-100. For example a hex reading of 0x4E is equal to 78%.

Measurement Sync Service (UUID 0x58D0)

The BRIC4 implements the “Measurement Sync Service” which is a custom service designed to send survey measurements from the device to the client. Each measurement is transferred in 3 characteristics due to the 20-byte limit on BLE-Indicated characteristics: “Measurement Primary”, “Measurement MetaData”, and “Measurement Errors”. In addition there is a characteristic of “Last Time” which allow the client to roll back or forward the synchronization point if desired.
A “Sync Tracker” on the BRIC4 is used to track which measurements are in queue to be transmitted to the client. All measurements are stored on the SD card of the device, also accessible through the USB interface.

Measurement Sync Characteristics:

Measurements are only sent to the client if the “Measurement Primary” characteristic is subscribed by the client. When a measurement is sent to the client, first the “Measurement Primary” then “Measurement Metadata”, then “Measurement Errors” characteristics are BLE Indicated in that order. If the “Measurement Meta” or “Measurement Errors” characteristic are not subscribed, they will not be sent and the transfer will be considered a success.
If any of the measurement characteristics are subscribed and sent but fail for any reason, the BRIC4 device will wait 2 seconds and re-send everything again.

Measurement Primary Characteristic		
UUID:	0x58D1	Indicate
Byte	**Data Type**	**Description**
1	uint16_t	Year
2		
3	uint8_t	Month
4	uint8_t	Day (of month)
5	uint8_t	Hours
6	uint8_t	Minutes
7	uint8_t	Seconds
8	uint8_t	Centiseconds
9	float	Distance (meters)
10		
11		
12		
13	float	Azimuth (degrees, 0 to 360)
14		
15		
16		
17	float	Inclination (degrees, -90 to +90)
18		
19		
20		

Measurement Metadata Characteristic		
UUID:	0x58D2	Indicate
Byte	**Data Type**	**Description**
1	uint32_t	Reference Index (As shown on BRIC4 Display)
2		
3		
4		
5	float	Dip (Magnetic Dip above/below horizon, -90 to +90)
6		
7		
8		
9	float	Roll (Roll angle of instrument about laser axis, 0 to 360)
10		
11		
12		
13	float	Temperature (degrees Celsius)
14		
15		
16		
17	uint16_t	Samples (Magnetometer and Accelerometer Samples Averaged)
18		
19	uint8_t	Measurement Type (Defined in another section)
20		

Measurement Errors Characteristic		
UUID:	0x58D3	Indicate
Byte	**Data Type**	**Description**
1	uint8_t	Error Code 1
2	float	Error 1, Data 1
3		
4		
5		
6	float	Error 1, Data 2
7		
8		
9		
10	uint8_t	Error Code 2
11	float	Error 2, Data 1
12		
13		
14		
15	float	Error 2, Data 2
16		
17		
18		
19		
20		

Last Time Characteristic

The “Last Time” characteristic provides an optional method for the client to roll back or roll forward the sync point in the measurement service. For example, if a new client is paired with the BRIC4, the “Last Time” can be set to a past date and all measurements after that point will be sent to the device. In another example, if the BRIC4 has a large number of un-sent measurements and a new survey is started, the client can set the “Last Time” to the current date and avoid receiving unnecessary data.
After the BRIC4 has completed measurement synchronization, this characteristic will be updated with the time of the last measurement. If the client writes to this characteristic, the BRIC4 internal “Sync Tracker” will be updated as needed.

Last Time Characteristic		
UUID:	0x58D4	Read / Write
Byte	**Data Type**	**Description**
1	uint16_t	Year
2		
3	uint8_t	Month
4	uint8_t	Day (of month)
5	uint8_t	Hours
6	uint8_t	Minutes
7	uint8_t	Seconds
8	uint8_t	Centiseconds
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		

Device Control Service (UUID 0x58E0)

The BRIC4 implements the “Device Control Service” which is a custom service that allows the client to control or adjust the device. For example, this service can initiate “Scan Mode”, trigger a measurement, or adjust error sensitivity. The command is sent as a string up to 20 bytes long.

Device Control Characteristic		
UUID:	0x58E1	Read / Write
Byte	**Data Type**	**Description**
1	char	Command string, ASCII characters
2	char	
3	char	
4	char	
5	char	
6	char	
7	char	
8	char	
9	char	
10	char	
11	char	
12	char	
13	char	
14	char	
15	char	
16	char	
17	char	
18	char	
19	char	
20	char	

The available commands are shown below. This is expected to expand over time with additional capability added. All commands should be in lower-case. The string must contain the command but can contain additional characters since the C library “strstr” function is used to identify commands. For example, “AscanBCD” will be interpreted as the “scan” command.

String Command	**Hex Command**	**Description**
“scan”	0x 73 63 61 6e	Initiate scan mode where instrument takes continuous readings and streams them over the BLE connection. Typical rates are 1 Hz but can be higher if the distance is relatively stable. Measurement rate is limited by the laser rangefinder. While in scan mode, any other command reverts back to normal operation.
“shot”	0x 73 68 6f 74	If the laser is not already on, it will be turned on. If the laser is on, this immediately takes a measurement survey shot.
“laser”	0x 6c 61 73 65 72	Toggles the laser on or off
“power off”	0x 70 6f 77 65 72 20 6f 66 66	Turns-off the BRIC4 in the same way as holding down the main button. Note, the BRIC4 cannot be turned back on over BLE, yet.
“clear memory”	0x 63 6c 65 61 72 20 6d 65 6d 6f 72 79	Clears stored measurement data from the device. The reference index will be reset to 1. Display will be cleared. Note: The data will remain stored on the SD card in .csv files, accessible through USB storage.

Error Codes

Error Code (uint8)	Data 1 (float)	Data 2 (float)	Description
0	N/A	N/A	No error detected
1	Magnitude of vector	N/A	Accelerometer 1 high magnitude. Nominal is 1.
2	Magnitude of vector	N/A	Accelerometer 2 high magnitude. Nominal is 1.
3	Magnitude of vector	N/A	Magnetometer 1 high magnitude. Nominal is 1.
4	Magnitude of vector	N/A	Magnetometer 2 high magnitude. Nominal is 1.
5	Delta	Axis (1=X, 2=Y, 3=Z)	Accelerometer disparity error. Significant difference in single axis measurement value between both accelerometers.
6	Delta	Axis (1=X, 2=Y, 3=Z)	Magnetometer disparity error. Significant difference in single axis measurement value between both magnetometers.
7	N/A	N/A	Rangefinder calculation error. Target moved too fast.
8	N/A	N/A	Rangefinder weak signal. Target not reflective enough or too far away.
9	N/A	N/A	Rangefinder strong signal. Target too reflective.
10	N/A	N/A	Rangefinder Pattern Error. Communication error due to lack of 0xAA message identifier.
11	Timeout (seconds)	N/A	Rangefinder Response Timeout. Message not received in timeout period.
12	Rangefinder error code	N/A	Rangefinder unrecognized error.
13	Rangefinder message identifier	N/A	Rangefinder wrong message received. Communication error due to wrong message received.
14	Inclination delta		Inclination angle error. Inclination calculated using combinations of all 4 sensors and results compared. Differences in the calculated inclination over a threshold triggers this error.
15	Azimuth delta		Azimuth angle error. Azimuth calculated using combinations of all 4 sensors and results compared. Differences in the calculated azimuth over a threshold triggers this error.