

## **BLUEGIGA I/O PROFILE**

### **iWRAP APPLICATION NOTE**

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Version 1.4



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## VERSION HISTORY

Version	Comment
1.0	First version
1.1	Fixed wrong packet length in "ADC set event interval" event
1.2	Fixed several response codes
1.3	Added information about unit of ADC event interval
1.4	Editorial changes

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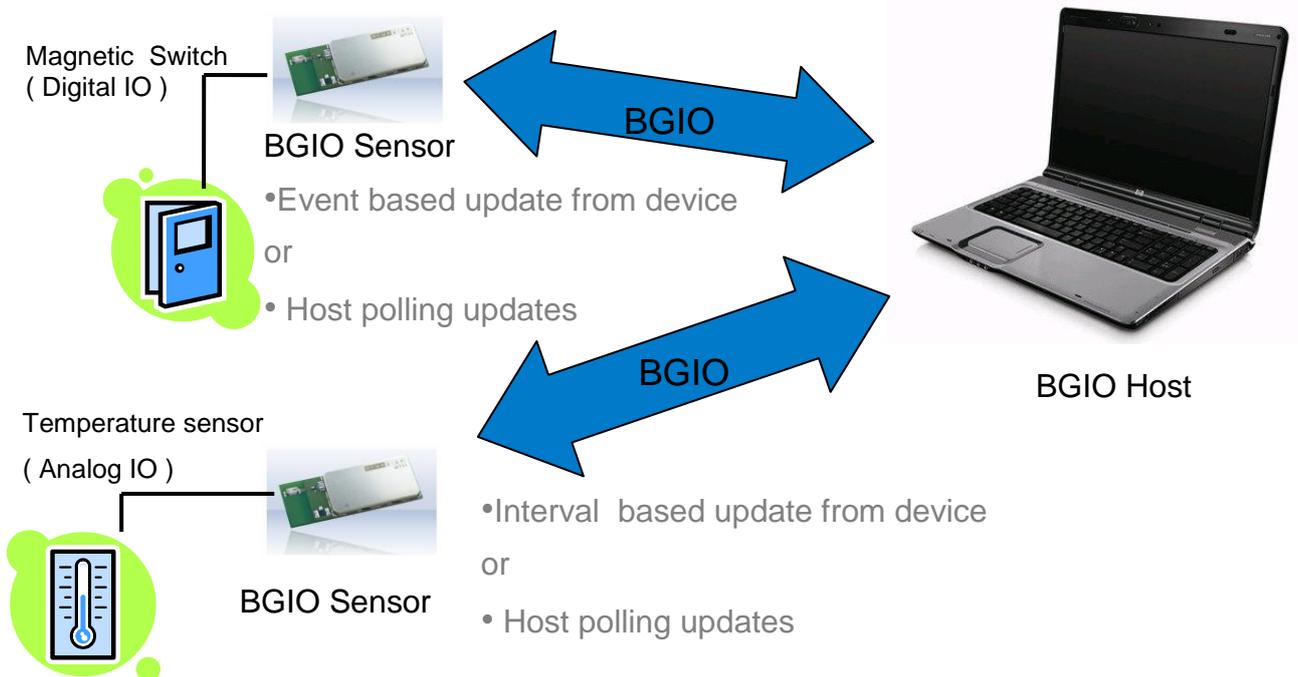
# 1 Introduction

This application note discusses Bluegiga I/O (BGIO) Profile's advantages and how the profiles can be utilized. Also practical examples are given how the BGIO can be used with the iWRAP firmware.

Bluegiga I/O profile is a proprietary profile which main purpose is to allow reading and setting of WT modules I/Os remotely over Bluetooth connection. This makes possible to build sensors which do not have host controller but instead only WT module and sensor component which can be for example a temperature meter.

BGIO defines two roles, that of a Sensor and Host:

- BGIO Sensor is the device who's GPIOs and/or AIOs are connected to sensors
- BGIO Host is the device which receives the measurements sent by the BGIO Sensor



## 2 iWRAP firmware overview

iWRAP is an embedded firmware running entirely on the RISC processor of WT12, WT12 and WT32 modules. It implements the full *Bluetooth* protocol stack and many *Bluetooth* profiles as well. All software layers, including application software, run on the internal RISC processor in a protected user software execution environment known as a Virtual Machine (VM).

The host system can interface to iWRAP firmware through one or more physical interfaces, which are also shown in the figure below. The most common interfacing is done through the UART interface by using the ASCII commands that iWRAP firmware supports. With these ASCII commands, the host can access *Bluetooth* functionality without paying any attention to the complexity, which lies in the *Bluetooth* protocol stack. GPIO interface can be used for event monitoring and command execution. PCM, SPDIF, I2S or analog interfaces are available for audio. The available interfaces depend on the used hardware.

The user can write application code to the host processor to control iWRAP firmware using ASCII commands or GPIO events. In this way, it is easy to develop *Bluetooth* enabled applications.

On WT32 there is an extra DSP processor available for data/audio processing.

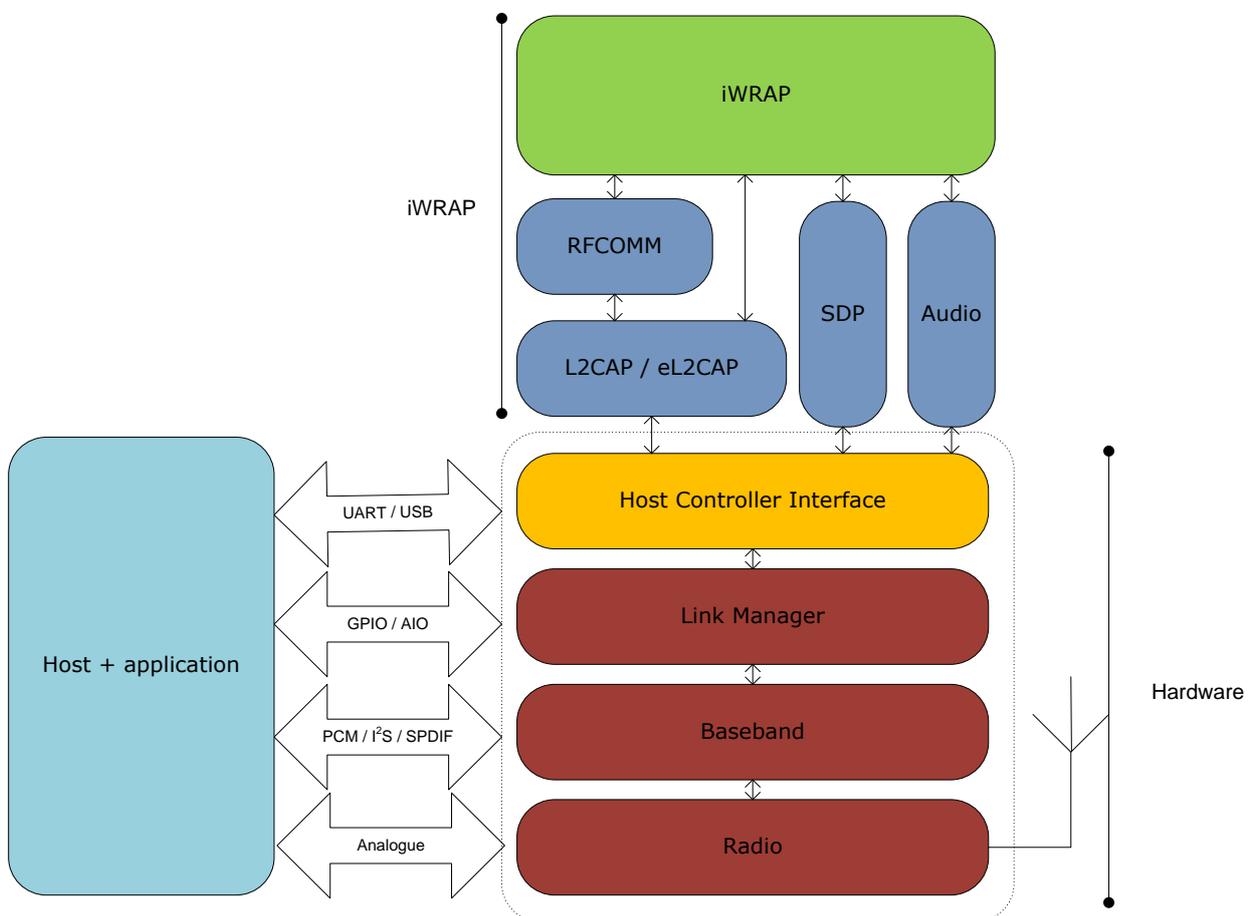


Figure 1: iWRAP Stack

In the figure above, a WRAP THOR *Bluetooth* module with iWRAP firmware could be connected to a host system for example through the UART interface. The options are:

- If the host system has a processor, software can be used to control iWRAP by using ASCII based commands or GPIO events.
- If there is no need to control iWRAP, or the host system does not need a processor, iWRAP can be configured to be totally transparent and autonomous, in which case it only accepts connections or automatically opens them.
- GPIO lines that WRAP THOR modules offer can also be used together with iWRAP to achieve additional functionality, such as Carrier Detect or DTR signaling.
- Audio interfaces can be used to transmit audio over a *Bluetooth* link.

### 3 Using BGIO with iWRAP

This chapter instructs the BGIO usage and configuration with the iWRAP firmware.

#### 3.1 Configuration

##### 3.1.1 BGIO Sensor

BGIO Sensor is enabled with command “**SET PROFILE BGIO {service\_name}**”

<b>service_name</b>	This parameter configures user friendly description of the device. Neither special characters nor white spaces are allowed. Service name <b>ON</b> enables the profile with the default name.
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A reset is needed to for the BGIO profile to become active.

Below is an example how to enable BGIO Sensor mode.

```
SET PROFILE BGIO ON
RESET
```

##### 3.1.2 BGIO Host

BGIO Host doesn't require any pre-configurations to be made.

#### 3.2 Service discovery

Bluetooth technology enables wireless service discovery, so you can find out the capabilities the remote device supports. Wireless service discovery uses the Bluetooth Service Discovery Profile (SDP).

With iWRAP the service discovery is performed with command: “**SDP {bd\_addr} {uuid}**”.

<b>bd_addr</b>	Bluetooth device address of the remote device.
<b>uuid</b>	Universally unique identifier. Refers to the Bluetooth profile one wants to discover. For BGIO the <b>uuid</b> is af5c7d47-350b-45f6-bdf6-b403441edb77.

Below is an example how to perform a service discovery for BGIO Sensor device.

```
SDP 00:07:80:93:0c:aa af5c7d47-350b-45f6-bdf6-b403441edb77
SDP 00:07:80:93:0c:aa < I SERVICENAME S "Bluegiga IO" > < I PROTOCOLDESCRIPTORLIST < < U
L2CAP > < U RFCOMM I 05 > > >
SDP
```

**Bluegiga IO** = Service name

**05** = RFCOMM channel for BGIO

### 3.3 Connection establishment

To create BGIO connection to BGIO Sensor the BGIO Host needs to open connection using UUID af5c7d47-350b-45f6-bdf6-b403441edb77.

If the host device is iWRAP connection can be opened with **CALL** command:

**“CALL {bd\_addr} af5c7d47-350b-45f6-bdf6-b403441edb77 RFCOMM”**

**bd\_addr** Bluetooth device address of the device.

If connection establishment was successful you should receive CONNECT event:

**“CONNECT {link\_id} RFCOMM {channel} {bd\_addr}”**

**link\_id** Local identifier for connection

**channel** Service channel on the remote device where connection was made

**bd\_addr** Bluetooth device address of the device.

```
CALL 00:07:80:ff:ff:ff af5c7d47-350b-45f6-bdf6-b403441edb77 RFCOMM
CONNECT 0 RFCOMM 1 00:07:80:ff:ff:ff
```

### 3.4 Connection termination

Closing connection to the BGIO Sensor can be done by just closing the Bluetooth connection. If you are using iWRAP as the BGIO Host device you can do this with iWRAP command **“CLOSE {link\_id}”**

**link\_id** Numeric connection identified

BGIO connection termination.

```
CLOSE 0
NO CARRIER 0 ERROR 0
```

## 3.5 General BGIO information

This chapter contains general information and tips about the iWRAP and BGIO profile for the implementers.

### 3.5.1 BGIO protocol

BGIO uses a binary protocol that allows data transactions to be as short as possible, which allows more aggressive power saving methods to be used. There are three types of packets used in BGIO profile. Command packets are used by the Host to control the Sensor. Every command packet results a return packet sent by the Sensor back to the Host. Additionally, there are event packets which can be sent by the Sensor if it is configured to do so.

Byte	Function	Explanation
0	Packet Type	0x00      command 0x01      return 0x02      event
1	Packet Length	Combined length of "Command ID" and "Command Data" bytes
2	Command ID	0x00      ADC read 0x01      Reserved 0x02      ADC set event interval 0x03      PIO read 0x04      PIO write 0x05      PIO set event 0x06      PIO get direction 0x07      PIO set direction 0x08      PIO get bias 0x09      PIO set bias
3-	Command Data	Command specific data

**Table 1:** BGIO protocol syntax table

### 3.5.2 ADC read

Command **ADC read** gets readings from defined ADCs. Essentially does the same as **ADC set event interval**, but measurement events from each ADC come only once at the time the command is received by the BGIO Sensor.

Synopsis:	
<b>0x00 0x02 0x00 [source_mask]</b>	

Description:	
<b>source_mask</b>	<b>8bit</b> Bit mask describing ADC from which a reading is required. For ADCs 1 and 2 you would use mask 0x03

Response:	
<b>0x01 0x02 0x00 [ error_code ]</b>	Return packet (ACK)

Description:	
<b>error_code</b>	<b>8bit</b> 0x00 - OK, command completed successfully 0x01 - Fail, parameters OK but executing command failed 0x02 - Syntax error, parameter length is wrong 0x03 - Unknown command

Events:	
<b>{ 0x02 0x04 0x00 [ source_id ][ value ] }</b>	Reading from 1st ADC defined by source_mask
<b>{ 0x02 0x04 0x00 [ source_id ][ value ] }</b>	Reading from 2nd ADC defined by source_mask
...	etc.

Description:	
<b>source_id</b>	<b>8bit</b> Bit mask describing (single) ADC from which measurement was read
<b>value</b>	<b>10bit</b> reading (will be contained in <b>2 separate bytes</b> )

### 3.5.3 ADC set event interval

Command **ADC set event interval** sets how often updated measurement information is sent by the Sensor to the Host from defined ADCs.

<b>Synopsis:</b>	
<b>0x00 0x06 0x02 [source_mask] [ interval ]</b>	

<b>Description:</b>	
<b>source_mask</b>	<b>8bit</b> Bit mask describing ADC from which a reading is required
<b>interval</b>	<b>32bit</b> Value in milliseconds describing the interval between measurement updates

<b>Response:</b>	
<b>0x01 0x02 0x02 [ error_code ]</b>	Return packet (ACK)

<b>Description:</b>	
<b>error_code</b>	<b>8bit</b> <b>0x00</b> - OK, command completed successfully <b>0x01</b> - Fail, parameters ok but executing command failed <b>0x02</b> - Syntax error, parameter length is wrong <b>0x03</b> - Unknown command

<b>Events:</b>	
<b>{ 0x02 0x04 0x02 [ source_id ] [ value ] }</b>	Reading from 1st ADC defined by source_mask
<b>{ 0x02 0x04 0x02 [ source_id ] [ value ] }</b>	Reading from 2nd ADC defined by source_mask
...	etc.

<b>Description:</b>	
<b>source_id</b>	<b>8bit</b> Bit mask describing (single) ADC from which measurement was read
<b>value</b>	<b>10bit</b> reading (will be contained in <b>2 separate bytes</b> )

### 3.5.4 PIO read

Command **PIO read** gets status of defined remote digital GPIOs.

#### Synopsis:

**0x00 0x03 0x03 [source\_mask]**

#### Description:

<b>source_mask</b>	<b>16bit</b> Bit mask describing PIOs from which a reading is required
--------------------	------------------------------------------------------------------------

#### Response:

<b>0x01 0x04 0x03 [ error_code ] [ value ]</b>	Return packet with PIO statuses from PIOs defined by <b>source_mask</b>
------------------------------------------------	-------------------------------------------------------------------------

#### Description:

<b>error_code</b>	<b>8bit</b> 0x00 - OK, command completed successfully 0x01 - Fail, parameters ok but executing command failed 0x02 - Syntax error, parameter length is wrong 0x03 - Unknown command
<b>value</b>	<b>16bit</b> reading

### 3.5.5 PIO write

Command **PIO write** sets status of defined remote digital GPIOs.

Synopsis:	
<b>0x00 0x05 0x04 [source_mask] [ status ]</b>	

Description:	
<b>source_mask</b>	<b>16bit</b> Bit mask describing PIOs whose status needs to be changed
<b>status</b>	<b>16bit</b> new status (what is the example value for setting a GPIO high)

Response:	
<b>0x01 0x02 0x04 [ error_code ]</b>	Return packet (ACK)

Description:	
<b>error_code</b>	<b>8bit</b> 0x00 - OK, command completed successfully 0x01 - Fail, parameters ok but executing command failed 0x02 - Syntax error, parameter length is wrong 0x03 - Unknown command

### 3.5.6 PIO set event

Command **ADC set event** sets which remote digital GPIO causes information about its status transition to be sent.

<b>Synopsis:</b>	
<b>0x00 0x03 0x05 [source_mask]</b>	

<b>Description:</b>	
<b>source_mask</b>	<b>16bit</b> Bit mask describing PIOs which trigger event sending upon change of its state

<b>Response:</b>	
<b>0x01 0x02 0x05 [ error_code ]</b>	Return packet (ACK)

<b>Description:</b>	
<b>error_code</b>	<b>8bit</b> 0x00 - OK, command completed successfully 0x01 - Fail, parameters ok but executing command failed 0x02 - Syntax error, parameter length is wrong 0x03 - Unknown command

<b>Events:</b>	
<b>0x02 0x05 0x05 [ pio_status ] [ pio_change ]</b>	

<b>Description:</b>	
<b>pio_status</b>	<b>16bit</b> current status of PIOs masked with <b>source_mask</b>
<b>pio_change</b>	<b>16bit</b> PIOs whose state change caused this event to be sent

### 3.5.7 PIO get direction

Command **PIO get direction** gets direction of defined PIOs.

Synopsis:	
<b>0x00 0x03 0x06 [source_mask]</b>	

Description:	
<b>source_mask</b>	<b>16bit</b> Bit mask describing PIOs from which a reading is required

Response:	
<b>0x01 0x04 0x06 [ error_code ] [ value ]</b>	Return packet with PIO directions from PIOs defined by <b>source_mask</b>

Description:	
<b>error_code</b>	<b>8bit</b> 0x00 - OK, command completed successfully 0x01 - Fail, parameters ok but executing command failed 0x02 - Syntax error, parameter length is wrong 0x03 - Unknown command
<b>value</b>	<b>16bit</b> reading ( 1 = Output, 0 = Input )

### 3.5.8 PIO set direction

Command **PIO set direction** sets direction of defined PIOs.

<b>Synopsis:</b>	
<b>0x00 0x05 0x07 [source_mask] [ direction ]</b>	

<b>Description:</b>	
<b>source_mask</b>	<b>16bit</b> Bit mask describing PIOs whose direction needs to be changed
<b>direction</b>	<b>16bit</b> new PIO directions ( 1 = Output, 0 = Input )

<b>Response:</b>	
<b>0x01 0x02 0x07 [ error_code ]</b>	Return packet (ACK)

<b>Description:</b>	
<b>error_code</b>	<b>8bit</b> 0x00 - OK, command completed successfully 0x01 - Fail, parameters ok but executing command failed 0x02 - Syntax error, parameter length is wrong 0x03 - Unknown command

### 3.5.9 PIO get bias

Command **PIO get bias** gets bias of defined PIOs.

<b>Synopsis:</b>	
<b>0x00 0x03 0x08 [source_mask]</b>	

<b>Description:</b>	
<b>source_mask</b>	<b>16bit</b> Bit mask describing PIOs from which bias reading is needed

<b>Response:</b>	
<b>0x01 0x04 0x08 [ error_code ] [ value ]</b>	Return packet with PIO directions from PIOs defined by <b>source_mask</b>

<b>Description:</b>	
<b>error_code</b>	<b>8bit</b> 0x00 - OK, command completed successfully 0x01 - Fail, parameters ok but executing command failed 0x02 - Syntax error, parameter length is wrong 0x03 - Unknown command
<b>value</b>	<b>16bit</b> reading ( 1 = Strong pull up/down, 0 = weak pull up/down )

### 3.5.10 PIO set bias

Command **PIO set direction** sets direction of defined PIOs.

Synopsis:	
<b>0x00 0x05 0x09 [source_mask] [ direction ]</b>	

Description:	
<b>source_mask</b>	<b>16bit</b> Bit mask describing PIOs whose bias needs to be changed
<b>direction</b>	<b>16bit</b> new PIO biases ( 1 = Output, 0 = Input )

Response:	
<b>0x01 0x02 0x09 [ error_code ]</b>	Return packet (ACK)

Description:	
<b>error_code</b>	<b>8bit</b> 0x00 - OK, command completed successfully 0x01 - Fail, parameters ok but executing command failed 0x02 - Syntax error, parameter length is wrong 0x03 - Unknown command

### 3.5.11 Power saving

iWRAP offers two power saving options. Sniff mode, which can be used to save power for active Bluetooth connections and deep sleep mode which puts the internal processor into a reduced duty cycle mode. Please refer to iWRAP user guide for more information about sniff and deep sleep modes.

One should also know that when Bluetooth connections are in active mode i.e. no power saving in use the master device uses 3-4 times less power than a slave device. Therefore for battery powered applications it might be useful to configure the device as a master rather than a slave. Look at following commands in iWRAP user guide: **SET {link\_id} MASTER** or **SET {link\_id} SLAVE** and **SET BT ROLE**.

## 4 Contact information

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