AN987: BLUEGIGA I/O PROFILE

iWRAP application note

Thursday, 06 April 2017

Version 1.5

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
1.5	PIO read updated

TABLE OF CONTENTS

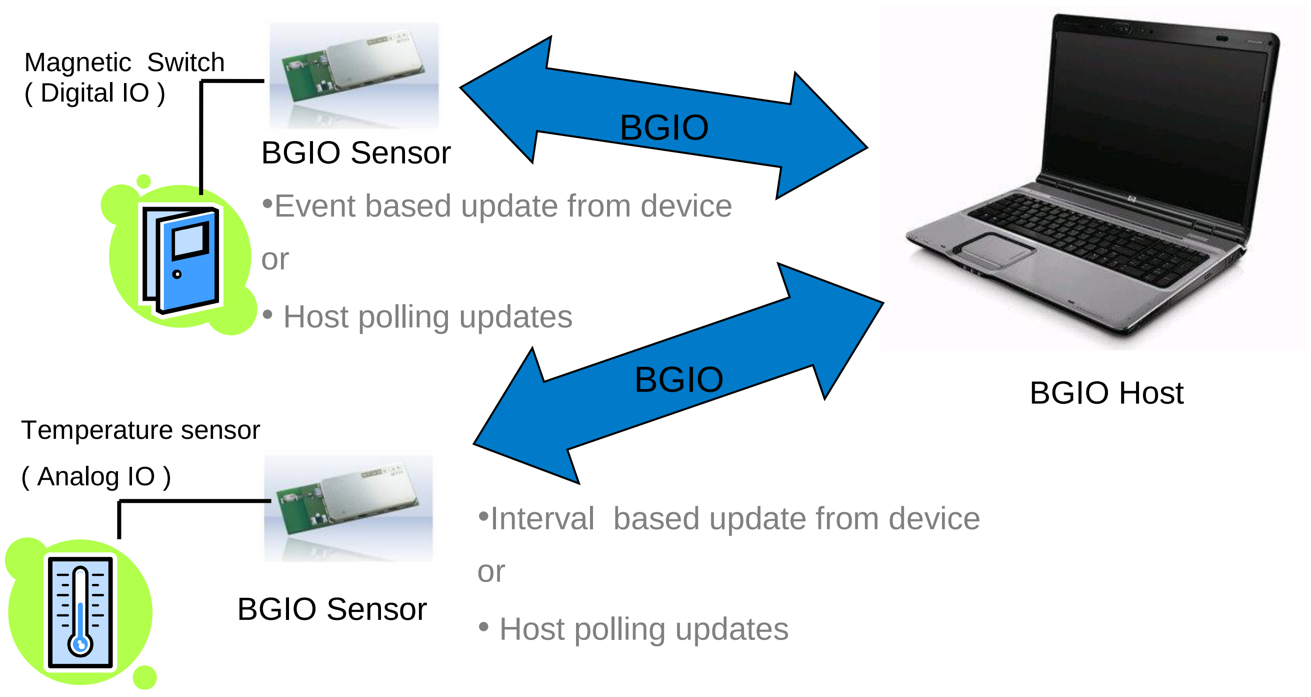
1 Introduction

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.

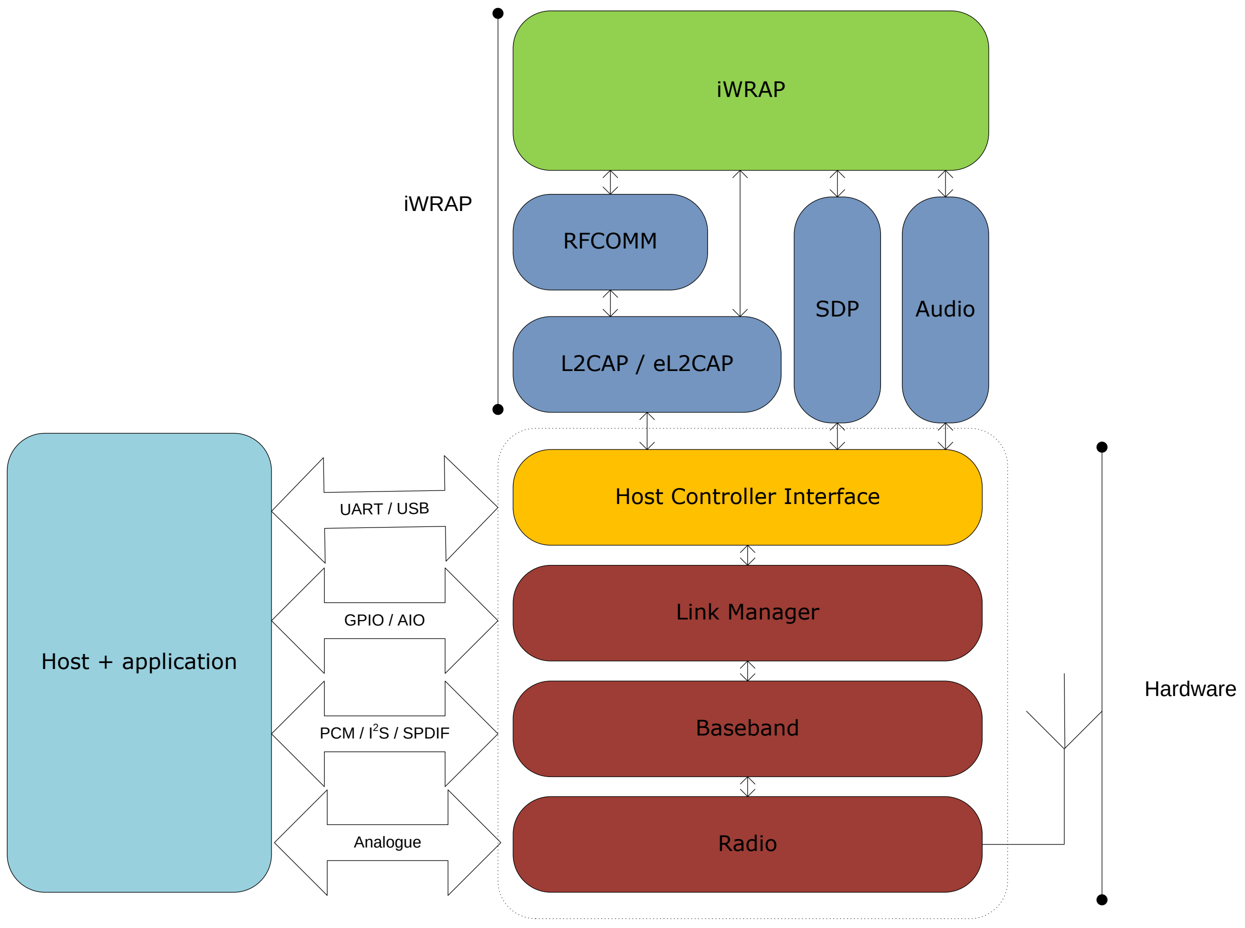


Figure 1: iWRAP Stack

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*}**"

service_name	This parameter configures user friendly description of the device. Neither special characters nor white spaces are allowed. Service name **ON** enables the profile with the default name.

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*}**".

bd_addr	Bluetooth device address of the remote device.
uuid	Universally unique identifier. Refers to the Bluetooth profile one wants to discover. For BGIO the ***uuid*** 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:
0x00 0x02 0x00 [source_mask]

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

Response:	
0x01 0x02 0x00 [error_code]	Return packet (ACK)

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

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

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

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.

Synopsis:
0x00 0x06 0x02 [source_mask] [interval]

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

Response:	
0x01 0x02 0x02 [error_code]	Return packet (ACK)

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

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

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

3.5.4 PIO read

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

Synopsis:
0x00 0x03 0x03 [source_mask]

Description:	
source_mask	**16bit** Bit mask describing PIOs from which a reading is required (obligatory parameter)

Response:	
0x01 0x04 0x03 [error_code] [value]	Return packet with PIO statuses from PIOs defined by **source_mask**

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

3.5.5 PIO write

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

Synopsis:
0x00 0x05 0x04 [source_mask] [status]

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

Response:	
0x01 0x02 0x04 [error_code]	Return packet (ACK)

Description:	
error_code	**8bit** 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.

Synopsis:
0x00 0x03 0x05 [source_mask]

Description:	
source_mask	**16bit** Bit mask describing PIOs which trigger event sending upon change of its state

Response:	
0x01 0x02 0x05 [error_code]	Return packet (ACK)

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

Events:	
0x02 0x05 0x05 [pio_status] [pio_change]	

Description:	
pio_status	**16bit** current status of PIOs masked with **source_mask**
pio_change	**16bit** 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:
0x00 0x03 0x06 [source_mask]

Description:	
source_mask	**16bit** Bit mask describing PIOs from which a reading is required

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

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

3.5.8 PIO set direction

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

Synopsis:
0x00 0x05 0x07 [source_mask] [direction]

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

Response:	
0x01 0x02 0x07 [error_code]	Return packet (ACK)

Description:	
error_code	**8bit** 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.

Synopsis:
0x00 0x03 0x08 [source_mask]

Description:	
source_mask	**16bit** Bit mask describing PIOs from which bias reading is needed

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

Description:	
error_code	**8bit** 0x00 - OK, command completed successfully 0x01 - Fail, parameters ok but executing command failed 0x02 - Syntax error, parameter length is wrong 0x03 - Unknown command
value	**16bit** 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:
0x00 0x05 0x09 [source_mask] [direction]

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

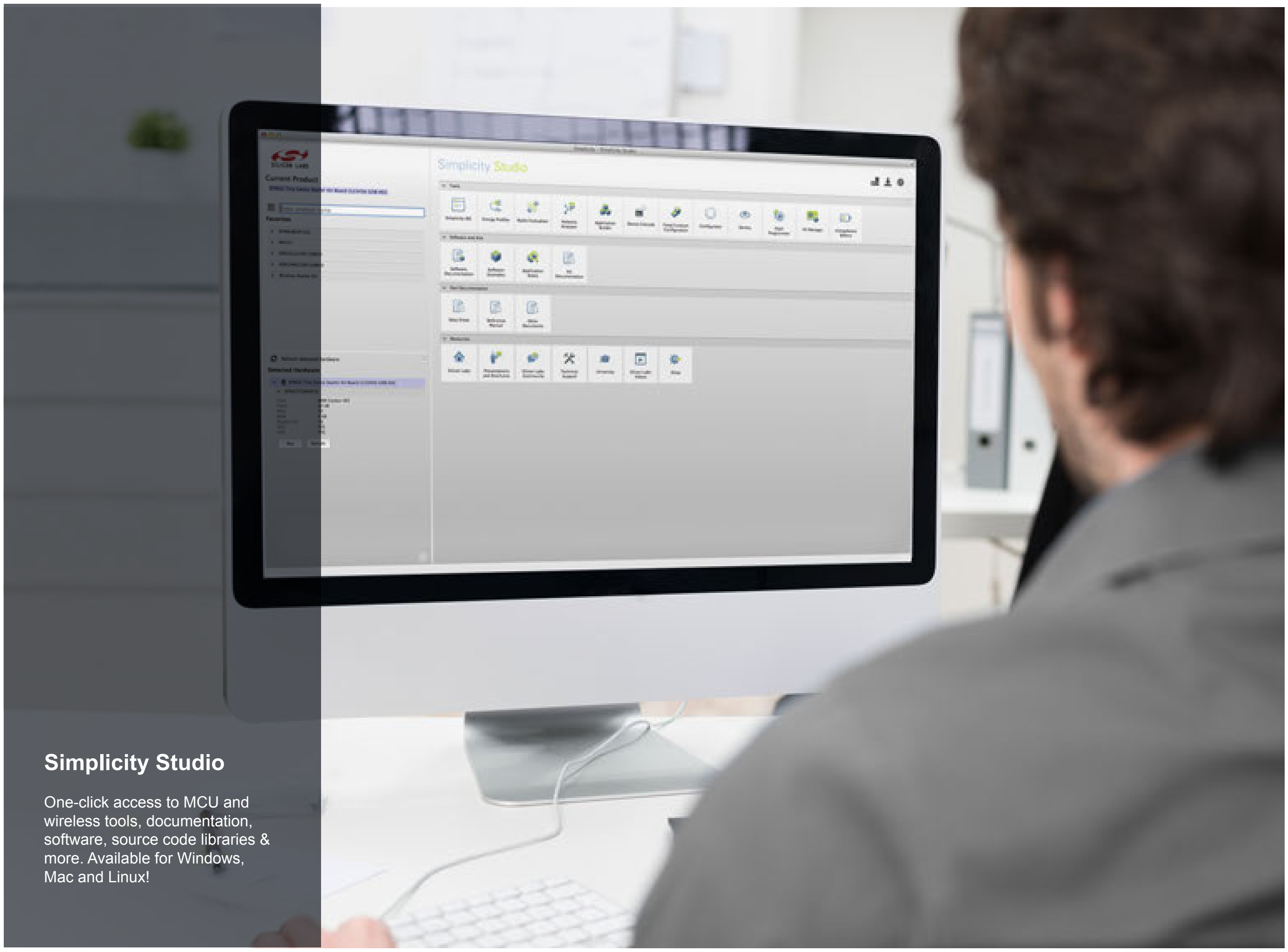
Response:	
0x01 0x02 0x09 [error_code]	Return packet (ACK)

Description:	
error_code	**8bit** 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 more 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 then a slave device. Therefore for battery powered applications it might be useful to configure the device as a master rather then a slave. Look at following commands in iWRAP user guide: **SET {link_id} MASTER** or **SET {link_id} SLAVE** and **SET BT ROLE**.



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