



Ingenuity Design
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Bluetooth API Definition

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1 Introduction

1.1 General

This document describes the implementation of an API to be used on the Pokit project.

The API will be used for communication between Pokit devices and control applications via Bluetooth®.

1.2 Definitions

1.2.1 Acronyms

The following abbreviations are used in this document:

BLE	Bluetooth® Low Energy
ACK	Acknowledge
NAK	Not Acknowledge
OTA	Over-The-Air
DFU	Device Firmware Update

1.2.2 Terms

The following terms are used in this document:

Shall, Must	Indicates a mandatory requirement.
Should	Indicates a recommendation.
Will	Indicates a non-mandatory provision with a declaration of intent.
May	Indicates a permission.
Can	Indicates a possibility or a capability
Note	Used to designate additional information intended to provide guidance, understanding and/or clarification

1.3 Reference Documents

The following documents are referenced in this report.

Ref.	Title	Doc No.	Author	Rev	Date

2 Embedded API

2.1 Protocol Overview

The communication protocol is based on Generic Attributes (GATT) services, which are collections of characteristics that are used to access different public attributes of the device allowing reading and writing operations.

Pokit consists of 6 GATT services in total. Each service contains a certain number of characteristics that are consisted of one or more attributes.

Every characteristic has its own UUID (used as an identifier), properties (read/write/notify) and attributes.

Characteristics that have single attributes can be retrieved directly whereas characteristics that have multiple attributes need to be parsed as byte arrays, respecting each attribute type, size and order as presented in this document.

2.2 API Version

The information provided in this section refers to API version **1.0**.

2.3 MM Service

The MM Service allows access to Pokit's Multimeter Mode. This mode is used to perform measurements of AC/DC Voltage, AC/DC Current, Resistance, Diode, Continuity or Temperature.

To start MM acquisitions, the application needs to set the attributes of the **Settings** characteristic. After initialised, the MM will notify every new measurement through its **Reading** characteristic automatically.

UUID: e7481d2f-5781-442e-bb9a-fd4e3441dadcd

2.3.1 Settings Characteristic

Description:

Defines the operation mode, range and update interval of Pokit's Multimeter Mode.

After receiving a valid request on this characteristic, an ACK will be replied and Pokit will start measuring using the selected **Mode** and **Range** using the given **Update Interval**.

In case of receiving invalid values on any attribute, a NAK will be replied and Pokit will be set to IDLE mode.

UUID: 53dc9a7a-bc19-4280-b76b-002d0e23b078

Properties: Write

Size: 6 bytes

Attributes:

Attribute Name	Type	Description	Possible Values
Mode	uint8	Desired operation mode.	0 – IDLE 1 – DC Voltage 2 – AC Voltage

			3 – DC Current 4 – AC Current 5 – Resistance 6 – Diode 7 – Continuity 8 – Temperature
Range	uint8	Desired range.	IDLE Mode: N/A AC/DC Voltage Modes: 0 – 0V to 300mV 1 – 300mV to 2V 2 – 2V to 6V 3 – 6V to 12V 4 – 12V to 30V 5 – 30V to 60V 255 – Auto Range AC/DC Current Modes: 0 – 0A to 10mA 1 – 10mA to 30mA 2 – 30mA to 150mA 3 – 150mA to 300mA 4 – 300mA to 3A 255 – Auto Range Resistance Mode: 0 – 0Ω to 160Ω 1 - 160Ω to 330Ω 2 - 330Ω to 890Ω 3 - 890Ω to 1K5Ω 4 – 1K5Ω to 10KΩ 5 – 10KΩ to 100KΩ 6 – 100KΩ to 470KΩ 7 – 470KΩ to 1MΩ 255 – Auto Range Diode Mode: N/A Continuity Mode: N/A Temperature Mode: N/A
		Ranges vary according to each operation Mode.	
Update Interval	uint32	Desired update interval in milliseconds.	–

2.3.2 Reading Characteristic

Description:

The reading characteristic contains information regarding the last MM acquisition. This characteristic is notified automatically but it can also be read any time by reading requests.

UUID: 047d3559-8bee-423a-b229-4417fa603b90

Properties: Read/Notify

Size: 7 bytes

Attributes:

Attribute Name	Type	Description	Possible Values
Status	uint8	Current MM status. The possible status varies according to each operation mode.	AC/DC Voltage, AC/DC Current, Resistance: 0 – Auto Range Off 1 – Auto Range On 255 – Error Continuity: 0 – No continuity 1 – Continuity 255 – Error Temperature, Diode: 0 – OK 255 – Error
Value	float	Last acquired value.	–
Mode	uint8	Current operation mode.	0 – IDLE 1 – DC Voltage 2 – AC Voltage 3 – DC Current 4 – AC Current 5 – Resistance 6 – Diode 7 – Continuity 8 – Temperature
Range	uint8	Current range. Ranges vary according to each operation mode.	IDLE Mode: N/A AC/DC Voltage Modes: 0 – 0V to 300mV 1 – 300mV to 2V 2 – 2V to 6V 3 – 6V to 12V 4 – 12V to 30V 5 – 30V to 60V 255 – Auto Range AC/DC Current Modes: 0 – 0A to 10mA 1 – 10mA to 30mA 2 – 30mA to 150mA 3 – 150mA to 300mA 4 – 300mA to 3A 255 – Auto Range Resistance Mode: 0 – 0Ω to 160Ω

1 - 160Ω to 330Ω
 2 - 330Ω to 890Ω
 3 - 890Ω to 1K5Ω
 4 – 1K5Ω to 10KΩ
 5 – 10KΩ to 100KΩ
 6 – 100KΩ to 470KΩ
 7 – 470KΩ to 1MΩ
 255 – Auto Range

Diode Mode: N/A

Continuity Mode: N/A

Temperature Mode: N/A

2.4 DSO Service

The DSO Service allows access to Pokit's DSO Mode. This mode converts Pokit into a digital oscilloscope allowing capture of Voltage or Current waveforms at up to 10M samples per second.

To start DSO acquisitions, the application needs to set the attributes of the **Settings** characteristic. After initialised, the DSO will start acquiring data and once it is finished, the data will be notified through its **Reading** characteristic automatically. Extra information about the last acquisition is notified over the **Metadata** characteristic, and the same can be retrieved any time by reading requests.

UUID: 1569801e-1425-4a7a-b617-a4f4ed719de6

2.4.1 Settings Characteristic

Description:

Defines the main settings required to allow DSO acquisitions.

After receiving a valid request on this characteristic, an ACK will be replied and Pokit will start measuring using the selected **Mode** and **Range** using the given **Sampling Window** and **Number of Samples**. **Trigger Value** will be ignored depending on the selected **Command** attribute.

In case of receiving invalid values on any attribute, a NAK will be replied and Pokit will be set to IDLE mode.

UUID: a81af1b6-b8b3-4244-8859-3da368d2be39

Properties: Write

Size: 13 bytes

Attributes:

Attribute Name	Type	Description	Possible Values
Command	uint8	Custom operation request.	0 – Free Running 1 – Rising Edge Trigger
		This attribute defines whether the DSO will operate in free running	2 – Falling Edge Trigger 3 – Resend data

		mode or wait for a Rising/Falling edge to happen.	
		It is also used to resend the last acquired data. In this case, all other attributes will be ignored.	
Trigger Level	float	Trigger threshold level in Volts or Amperes, depending on the operation mode.	–
		Note: This field is required only if Command is set to <i>Rising/Falling Edge Trigger</i> . It will be ignored otherwise.	
Mode	uint8	Desired operation mode.	0 – IDLE 1 – Voltage (DC Coupling) 2 – Voltage (AC Coupling) 3 – Current (DC Coupling) 4 – Current (AC Coupling)
Range	uint8	Desired range.	IDLE Mode: N/A
		Ranges vary according to each operation Mode.	Voltage Mode: 0 – 0V to 300mV 1 – 300mV to 2V 2 – 2V to 6V 3 – 6V to 12V 4 – 12V to 30V 5 – 30V to 60V Current Mode: 0 – 0A to 10mA 1 – 10mA to 30mA 2 – 30mA to 150mA 3 – 150mA to 300mA 4 – 300mA to 3A
Sampling Window	uint32	Desired sampling window in microseconds.	–
Number of Samples	uint16	Desired number of samples to acquire.	1 to 8192

2.4.2 Metadata Characteristic

Description:

Contains general information regarding the last DSO acquisition.

This characteristic is notified automatically after each request, but it can also be read any time by reading requests.

UUID: 970f00ba-f46f-4825-96a8-153a5cd0cda9

Properties: Read/Notify

Size: 17 bytes

Attributes:

Attribute Name	Type	Description	Possible Values
Status	uint8	Current DSO status.	0 – Done 1 – Sampling 255 – Error
Scale	float	Acquired data points are always converted to values between -2048 and 2047 so better throughput can be achieved. Due to that reason, a scale factor is generated so the application can reconstruct the real values afterwards.	–
Mode	uint8	Operation mode used during the last acquisition.	0 – IDLE 1 – Voltage (DC Coupling) 2 – Voltage (AC Coupling) 3 – Current (DC Coupling) 4 – Current (AC Coupling)
Range	uint8	Range used during the last acquisition. Ranges vary according to each operation Mode.	IDLE Mode: N/A Voltage Mode: 0 – 0V to 300mV 1 – 300mV to 2V 2 – 2V to 6V 3 – 6V to 12V 4 – 12V to 30V 5 – 30V to 60V Current Mode: 0 – 0A to 10mA 1 – 10mA to 30mA 2 – 30mA to 150mA 3 – 150mA to 300mA 4 – 300mA to 3A
Sampling Window	uint32	Sampling window used during the last acquisition (in microseconds).	–
Number of Samples	uint16	Number of samples used during the last acquisition.	1 to 8192
Sampling Rate	uint32	Sampling rate used during the last acquisition (in Hertz).	1 to 10000000 (Hz)
<p>Note: The <i>Sampling Rate</i> is calculated based on the requested <i>Sampling Window</i> and <i>Number of Samples</i>.</p>			

2.4.3 Reading Characteristic

Description:

The reading characteristic is used to transmit all stored data values sequentially to the application. This characteristic is notified automatically after the acquisition is finished or whenever a *resend* command is requested.

UUID: 98e14f8e-536e-4f24-b4f4-1debfed0a99e

Properties: Notify

Size: Up to 20 bytes

Attributes:

Attribute Name	Type	Description	Possible Values
Samples [10]	int16	Acquired data points transmitted in sequence. The whole data frame is fragmented and transmitted in packages of up to 10 samples each time. The transmission is done sequentially. To achieve better throughput, the transmission is done without sequence validation, but the application can verify the expected amount of data by reading the <i>Number of Samples</i> attribute of the Metadata characteristic. Note: Values are converted to int16. The <i>Scale</i> attribute needs to be applied over each sample in order to reconstruct the real values.	-2048 to 2047

2.5 Data Logger Service

The Data Logger Service allows access to Pokit's Data Logger Mode. This mode converts Pokit into a logger tool allowing capture of low frequency Voltage or Current signals over long periods of time.

To start Data Logger acquisitions, the application needs to set the attributes of the **Settings** characteristic. After initialised, Pokit will start acquiring data periodically according to a given interval. All captured data points can be retrieved via the *Refresh* command and are then notified through its **Reading** characteristic. Extra information about the current Logger configuration is notified over the **Metadata** characteristic, after each *Refresh* command and the same can be retrieved any time by reading requests.

UUID: a5ff3566-1fd8-4e10-8362-590a578a4121

2.5.1 Settings Characteristic

Description:

Defines the main settings required to start Data Logger acquisitions.

After receiving a valid start request on this characteristic, an ACK will be replied and Pokit will start measuring using the selected **Mode** and **Range** using the given **Update Interval**. **Trigger Value** will be ignored depending on the selected **Command** attribute.

In case of receiving invalid values on any attribute, a NAK will be replied and Pokit will be set to IDLE mode.

Stop and *Refresh* requests are also achieved via this characteristic. In those cases, all attributes but *Command* are ignored.

UUID: 5f97c62b-a83b-46c6-b9cd-cac59e130a78

Properties: Write

Size: 11 bytes

Attributes:

Attribute Name	Type	Description	Possible Values
Command	uint8	Custom operation request. This attribute is used to request Pokit to start or stop acquiring data. It is also used to request the stored data to be notified through the Reading characteristic.	0 – Start 1 – Stop 2 – Refresh
Arguments	uint16	Reserved to be used along <i>Commands</i> in the future.	–
Mode	uint8	Desired operation mode.	0 – IDLE 1 – Voltage (DC Coupling) 2 – Voltage (AC Coupling) 3 – Current (DC Coupling) 4 – Current (AC Coupling)
Range	uint8	Desired range. Ranges vary according to each Operation Mode.	IDLE Mode: N/A Voltage Mode: 0 – 0V to 300mV 1 – 300mV to 2V 2 – 2V to 6V 3 – 6V to 12V 4 – 12V to 30V 5 – 30V to 60V Current Mode: 0 – 0A to 10mA 1 – 10mA to 30mA 2 – 30mA to 150mA 3 – 150mA to 300mA 4 – 300mA to 3A

Update Interval	uint16	Desired logging interval in seconds.	–
Timestamp	uint32	Custom timestamp reflecting the logging start time that can be retrieved from the Metadata characteristic afterwards. This is useful for application internal control.	–

2.5.2 Metadata Characteristic

Description:

Contains general information regarding the current logging parameters.

This characteristic is notified automatically after each start request, but it can also be read any time by reading requests.

UUID: 9acada2e-3936-430b-a8f7-da407d97ca6e

Properties: Read/Notify

Size: 15 bytes

Attributes:

Attribute Name	Type	Description	Possible Values
Status	uint8	Current Data Logger status.	0 – Done 1 – Sampling 2 – Buffer Full 255 – Error
Scale	float	Acquired data points are always converted to values between -2048 and 2047 so better throughput can be achieved. Due to that reason, a scale factor is generated so the application can reconstruct the real values afterwards.	–
Mode	uint8	Current operation mode being used.	0 – IDLE 1 – Voltage (DC Coupling) 2 – Voltage (AC Coupling) 3 – Current (DC Coupling) 4 – Current (AC Coupling)
Range	uint8	Current range being used. Ranges vary according to each Operation Mode.	IDLE Mode: N/A Voltage Mode: 0 – 0V to 300mV 1 – 300mV to 2V 2 – 2V to 6V 3 – 6V to 12V 4 – 12V to 30V 5 – 30V to 60V Current Mode: 0 – 0A to 10mA

			1 – 10mA to 30mA 2 – 30mA to 150mA 3 – 150mA to 300mA 4 – 300mA to 3A
Update Interval	uint16	Current logging interval being used (in microseconds).	–
Number of Samples	uint16	Number of acquired samples.	1 to 6192
Timestamp	uint32	Timestamp stored at the beginning of current logging section.	–

2.5.3 Reading Characteristic

Description:

The reading characteristic is used to transmit all stored data values sequentially to the application. This characteristic is notified automatically after a *stop* or *refresh* command is requested.

UUID: *3c669dab-fc86-411c-9498-4f9415049cc0*

Properties: *Notify*

Size: *Up to 20 bytes*

Attributes:

Attribute Name	Type	Description	Possible Values
Samples [10]	int16	Acquired data points transmitted in sequence.	-2048 to 2047
		The whole data frame is fragmented and transmitted in packages of up to 10 samples each time. The transmission is done sequentially.	
		To achieve better throughput, the transmission is done without sequence validation, but the application can verify the expected amount of data by reading the <i>Number of Samples</i> attribute of the Metadata characteristic.	
		Note: Values are converted to int16. The <i>Scale</i> attribute needs to be applied over each sample in order to reconstruct the real values.	

2.6 Pokit Status Service

The Pokit Status Service allows access to Pokit's general information and status.

UUID: 57d3a771-267c-4394-8872-78223e92aec4

2.6.1 Device Characteristics

Description:

This characteristic is read only and contains basically general information related to the device characteristics.

UUID: 6974f5e5-0e54-45c3-97dd-29e4b5fb0849

Properties: Read

Size: 20 bytes

Attributes:

Attribute Name	Type	Description	Possible Values
Version Major	uint8	Firmware version major.	0 – 255
Version Minor	uint8	Firmware version minor.	0 – 255
Max Voltage	uint16	Device max input voltage.	60 (V)
Max Current	uint16	Device max input current.	2 (A)
Max Voltage	uint16	Device max input resistance.	1000 (K Ω)
Max Sampling Rate	uint16	Device max sampling rate.	1000 (KHz)
Sampling Buffer Size	uint16	Device sampling buffer size.	8192
Capability Mask	uint16	Reserved.	–
Mac Address [6]	uint8	Device's Mac Address.	–

2.6.2 Status Characteristic

Description:

This characteristic is read only and contains general information regarding current Pokit status and battery voltage.

UUID: 3dba36e1-6120-4706-8dfd-ed9c16e569b6

Properties: Read

Size: 5 bytes

Attributes:

Attribute Name	Type	Description	Possible Values
Status	uint8	Current Pokit status.	0 – IDLE 1 – MM meas. DC Voltage 2 – MM meas. AC Voltage 3 – MM meas. DC Current 4 – MM meas. AC Current 5 – MM meas. Resistance 6 – MM meas. Diode

			7 – MM meas. Continuity 8 – MM meas. Temperature 9 – DSO Mode (Sampling) 10 – Logger Mode (Sampling)
Battery Voltage	float	Current battery voltage level.	0.0 - 3.3 (V)

2.6.3 Device Name Characteristic

Description:

This characteristic allows read and write access to the device name.

UUID: 7f0375de-077e-4555-8f78-800494509cc3

Properties: Read/Write

Size: Up to 11 bytes

Attributes:

Attribute Name	Type	Description	Possible Values
Device Name [11]	uint8	Device name.	From 1 to 11 alphanumeric characters.
Battery Voltage	float	Current battery voltage level.	0.0 - 3.3 (V)

2.6.4 Flash LED Characteristic

Description:

This characteristic allows LED flashing control.

UUID: ec9bb1f3-05a9-4277-8dd0-60a7896f0d6e

Properties: Write

Size: 1 byte

Attributes:

Attribute Name	Type	Description	Possible Values
LED	uint8	LED flashing control. Writing the number 1 to this attribute will cause the LED to flash twice. Note: Any value other than 1 will be ignored.	1

2.7 Device Info Service

The Device Info Service is a standard BLE service used to access general device information.

UUID: 180A

2.7.1 Manufacturer Name String Characteristic

Description:

This standard BLE characteristic is read only and contains the manufacturer name in string format.

UUID: 2A29

Properties: Read

Size: 16 bytes

Attributes:

Attribute Name	Type	Description	Possible Values
Manufacturer Name	utf8	Manufacturer name.	Ingenuity Design

2.7.2 Model Number String Characteristic

Description:

This standard BLE characteristic is read only and contains the model number in string format.

UUID: 2A24

Properties: Read

Size: 5 bytes

Attributes:

Attribute Name	Type	Description	Possible Values
Model Number	utf8	Model number.	XX.XX

2.7.3 Firmware Revision String Characteristic

Description:

This characteristic is read only and contains the firmware revision in string format.

UUID: 2A26

Properties: Read

Size: 5 bytes

Attributes:

Attribute Name	Type	Description	Possible Values
Firmware Revision	utf8	Firmware revision.	XX.XX

2.7.4 Software Revision String Characteristic

Description:

This standard BLE characteristic is read only and contains the API version in string format.

UUID: 2A28

Properties: Read

Size: 5 bytes

Attributes:

Attribute Name	Type	Description	Possible Values
API Version	utf8	API version.	XX.XX

2.7.5 Hardware Revision String Characteristic

Description:

This standard BLE characteristic is read only and contains the hardware revision in string format.

UUID: 2A27

Properties: Read

Size: 5 bytes

Attributes:

Attribute Name	Type	Description	Possible Values
Hardware Revision	utf8	Hardware revision.	XX.XX

2.8 Generic Access Service

The Generic Access Service is a standard BLE service used to access general device information.

UUID: 1800

2.8.1 Device Name Characteristic

Description:

This standard BLE characteristic can be used to read or write the device name in string format.

UUID: 2A00

Properties: Read/Write

Size: Up to 11 bytes

Attributes:

Attribute Name	Type	Description	Possible Values
Device Name	utf8	Device name.	From 1 to 11 alphanumeric characters.

2.8.2 Appearance Characteristic

Description:

This standard BLE characteristic is read only and contains the appearance code for this device type.

UUID: 2A01

Properties: Read

Size: 4 bytes

Attributes:

Attribute Name	Type	Description	Possible Values
Appearance	uint16	Device appearance code. Note: Code 0 represents "Unknown Appearance"	0