**PRELIMINARY**



Maker PowerTM

DUST Device (Temperature) API

**Overview**

This document describes the Application Programming Interface (API) for the BTLE interface.

**BTLE API (Level 3)**

All communication across the BTLE link is through the MyMakerTools service and associated characteristics.

MyMakerTools Service UUID = **3425a5cc-a676-4362-9592-a88e132b8b52**

There are 4 characteristics that are used

Heartbeat UUID = **b67e3a3b-15c9-41b6-a9f2-fbf379418d12**

Control01 UUID = **770cf444-06ed-4360-9f16-7c53109481f4**

Control02 UUID = **7f1206ba-6145-43f7-adcd-7935dbfb389b**

Control03 UUID = **58a77551-2dbc-4d4b-a435-a6aaaba204e2**

The BTLE device will connect with the DUST device first through the MyMakerTools service. Once the connection is established, the BTLE device can query the characteristics and use as described below.

**CAUTION**

Using a reserved command may cause the device to lock up or become unusable. Do NOT use RESERVED commands.

**Heartbeat Characteristic**

This characteristic establishes a heartbeat signal between the DUST device and the BTLE device. Additionally, it is used as a background channel to update some parameters as shown below.

**NOTE**

This command may be deprecated in future releases. The notification data can interrupt other data being sent, so care must be taken with this feature.

The characteristic property is set to:

Notify

Read

Data Size 2 bytes.

To use the Heartbeat characteristic, the characteristic notification must be enabled through the BTLE programming mechanism you are using.

**NOTE**

Only the BTLE device you are using to control the DUST device can initiate this characteristic. The DUST device will not initiate this feature.

Once the notification is enabled, the DUST device will update the characteristic with a new heartbeat value at a 2 second interval. The value will alternate between 0x0035 and 0x0041. You may disable the Heartbeat by disabling the characteristic notification. Also if the connection between the DUST device and the BTLE device is broken or disabled by any means, the Heartbeat characteristic notification will be disable and must be re-started on the next connection.

The following parameters are updated via this characteristic. In the two byte value that is sent bits D15-D8 are the command and D7-D0 are the payload value.

D15-D8 Commands

0x00 Heartbeat

0x35 – Heartbeat low value

0x41 – Heartbeat high value

0x55 – DUST device has gone to sleep

0x20 Reserved

0x21 Reserved

**Control01 Characteristic**

This characteristic is used to get the DUST (Temperature) device temperature value. The DUST(Temperature) device will return the last retrieved temperature as determined by the collection sample rate.

The characteristic property is set to:

Read

Write without response

Data Size 4 bytes.

The four bytes are considered a contiguous unsigned 32 bit value, with the upper byte being D31-D24 continuing down to the lower byte being D7-D0. Writing to this characteristic has no effect. Reading from the characteristic will retrieve the current temperature value. The upper 16 bits (D31-D16) are RESERVED and the lower 16 bits (D15-D0) represent the temperature in integer format in degrees Celsius. The format is as follows

Bits Description

D15-D8 integer value of temperature

D7-D4 fractional value of temperature

D3-D0 set to 0x00

The following pseudo code will convert the integer into a floating point temperature value, TempData is the 16 bit integer representation of the temperature data.

TemperatureInt = (TempData intdiv 16) // eliminate bottom 4 bits, but keep sign

TemperatureFloat = TemperatureInt / 16 // divide by 16 to get decimal value

if TemperatureFloat < -40 then TemperatureFloat = -40; // cant go below -40C

**Control02 Characteristic**

This characteristic is used to retrieve/set DUST data, options and configuration. In order to set an option/configuration, write the 32 bit value to the characteristic. When retrieving data, you must first set the read pointer by writing to the characteristic and then immediately read the characteristic as many times as is necessary to retrieve the data. Once the read sequence is complete, the read pointer is set to zero unless otherwise noted below.

The characteristic property is set to:

Read

Write without response

Data size 4 bytes.

The four bytes are considered a contiguous unsigned 32 bit value, with the upper byte being D31-D24 continuing down to the lower byte being D7-D0. The upper bits define the command/data type and are defined as follows.

D31-D24 Write

0x64 Reserved

0x65 Reserved

0x66 Set Heartbeat State

0x67 Set Configuration

0x68 Get API version

0x69 Set RN4020 LEDs

0x6A Get Status

0x6B Reserved

0x6C Get Memory Dump

0x6D Reset

0x6E Erase Memory

0x6F Factory Reset

0x70 Reserved

0x71 Set Sample Rate

0x72 Set FLASH Address

0x73 Get Directory Entries

0x74 Get Temperature Data Entry

0x75 Start Download

0x76 Get Used FLASH

0x80 Start Recording

0x90 Stop Recording

0xA0 Sleep

D31-D24 Read

0x00 Complete

0x01 Continue

0x07 Configuration

0x08 API Version

0x09 Reserved

0x0A Status

0x0B Reserved

0x0C Memory Dump

0x10 Sample Rate

0x11 Temperature Data

0x12 Return Download data

0x13 Used FLASH

0xB0 Directory Data

*Set Heartbeat State (0x66)*

Will override the heartbeat command from Heartbeat Characteristic. Default state is on. State cannot be read back and thus is a write only command.

Write Characteristic

Bits Description

D31-D24 Command byte (0x66)

D23-D08 Reserved (set to all zeroes)

D07-D00 State

0x00 OFF

0x01 ON

Read Characteristic

No corresponding read data

*Get/Set Configuration (0x67)*

Will set the configuration or read the configuration. This is unimplemented in this version.

Write Characteristic

Bits Description

D31-D24 Command byte (0x67)

D23 Get or Set Configuration

0x0 Set Configuration

0x1 Get Configuration

D22-D00 Reserved (set to all zeroes)

Read Characteristic

Bits Description

D31-D24 Command byte (0x07)

D23-D00 all zeroes

*Get API Version (0x68)*

Will retrieve the BTLE API version and the Hardware revision.

Write Characteristic

Bits Description

D31-D24 Command byte (0x68)

D23-D00 Reserved (set to all zeroes)

Read Characteristic

Bits Description

D31-D24 Command byte (0x08)

D23-D16 Hardware revision

D15-D08 reserved

D07-D00 BTLE API version

*Set RN4020 LEDs (0x69)*

Will override the default state of the LEDs of the RN4020. Once this is done, they will no longer indicate the status of the RN4020 (Blue LED) or the connection state (Green LED).

Write Characteristic

Bits Description

D31-D24 Command byte (0x69)

D23-D08 Reserved (set to all zeroes)

D07 0x00

D06 Green LED Selection

0x0 not selected

0x1 selected

D05 Red LED Selection

0x0 not selected

0x1 selected

D04 Blue LED Selection

0x0 not selected

0x1 selected

D03 0x00

D02 Green LED State

0x0 OFF

0x1 ON

D01 Red LED State

0x0 OFF

0x1 ON

D00 Blue LED State

0x0 OFF

0x1 ON

Read Characteristic

No corresponding read data

*Get Status (0x6A)*

Will retrieve the status on the next Read Characteristic.

Write Characteristic

Bits Description

D31-D24 Command byte (0x6A)

D23-D00 Reserved (set to all zeroes)

Read Characteristic

Bits Description

D31-D24 Command byte (0x0A)

D23-D08 all zeroes

D07-D00 Sample rate (see Sample Rate description below)

*Get Memory Dump (0x6C)*

Will setup the process to download 16 bit values from memory, either the internal EEPROM or the external FLASH memory. The download will continue as long the characteristic is read. The characteristic read pointer is not reset when using this command. The highest initial FLASH address that can be set is 0x003FFFFF, the maximum size of the 32Mbit memory. Setting the address higher will cause the address to wrap in memory.

Write Characteristic

Bits Description

D31-D24 Command byte (0x6C)

D23 EEPROM or FLASH

0x0 FLASH

0x1 EEPROM

D22-D00 address in FLASH memory to read from, forced to zero for EEPROM

Read Characteristic

Bits Description

D31-D24 Command byte (0x0C)

D23-D16 all zeroes

D15-D00 16 bit value of memory

*Reset (0x6D)*

Will execute a processor reset on the device.

Write Characteristic

Bits Description

D31-D24 Command byte (0x6D)

D23-D00 Reserved (set to all zeroes)

Read Characteristic

No corresponding read data

*Erase Memory (0x6E)*

Will erase memory as selected. Operational memory is all memory used by the application. When selecting operational memory the entire FLASH memory is erased, the memory pointers are reset and the EEPROM is updated to reflect a reset state.

Write Characteristic

Bits Description

D31-D24 Command byte (0x6E)

D23-D04 Reserved (set to all zeroes)

D03 All Memory – clears all memories, EEPROM and FLASH

0x00 not selected

0x01 selected

D02 Operational Memory

0x00 not selected

0x01 selected

D01 FLASH Memory – clears only the external FLASH memory

0x00 not selected

0x01 selected

D00 EEPROM Memory – clears only EEPROM memory in PIC processor

0x00 not selected

0x01 selected

Read Characteristic

No corresponding read data

*Factory Reset (0x6F)*

Will return the device to a factory new state and then cause a PIC microprocessor reset.

Write Characteristic

Bits Description

D31-D24 Command byte (0x6F)

D23-D00 Reserved (set to all zeroes)

Read Characteristic

No corresponding read data

*Set Sample Rate (0x71)*

Will retrieve the status on the next Read Characteristic.

Write Characteristic

Bits Description

D31-D24 Command byte (0x71)

D23 Get or Set Configuration

0x0 Set Configuration

0x1 Get Configuration

D22-D04 Reserved (set to all zeroes)

D03-D00 Reserved (set to all zeroes)

0x03 – 1 sec

0x04 – 2 sec

0x05 – 5 sec

0x06 – 10 sec

0x07 – 30 sec

0x08 – 1 min

0x09 – 5 min

0x0A – 10 min

0x0B – 30 min

0x0C – 60 min

all other values are Reserved

Read Characteristic

Bits Description

D31-D24 Command byte (0x1)

D23-D04 all zeroes

D03-D00 Current sample rate (see Sample Rate description above)

*Set FLASH Address (0x72)*

Will set the address for the next FLASH memory operation. This is unimplemented in this version.

Write Characteristic

Bits Description

D31-D24 Command byte (0x72)

D23-D00 Reserved (set to all zeroes)

Read Characteristic

No corresponding read data

*Get Directory Entries (0x73)*

Will start the process to download the directory entries. Each record start and stop command creates a directory entry in the FLASH memory. This directory entry is 12 bytes in size and uses the following format on the PIC microprocessor. The data is returned in 7 consecutive reads. The characteristic read pointer is not reset when using this command, unless there were no directory entries to retrieve.

Byte Description

0x0 Entry type

0x1 Start

0x2 Stop

0x1 Current Sample Rate – see sample rate above for settings

0x2-0x3 Reserved

0x4-0x7 address in FLASH memory, start address for a start entry and the next address for a stop entry

0x8-0xB time entry supplied by the calling program, the PIC firmware only records the information passed to it and does not process it in anyway. Only the lower 28 bits are useable.

Write Characteristic

Bits Description

D31-D24 Command byte (0x72)

D23-D00 Reserved (set to all zeroes)

Read Characteristic

To retrieve the entire directory entry requires 7 consecutive reads.

Read 1

Bits Description

D31-D28 Command byte (0xB)

D27-D24 Reserved

D23-D16 Directory Entry sequence number

D15-D08 Sample rate – see sample rate above for values

D07-D00 Directory entry count, if zero the operation is terminated

Read 2

Bits Description

D31-D28 Command byte (0xB)

D27-D08 Reserved

D07-D00 Directory entry type of start entry – see directory format above

Read 3

Bits Description

D31-D28 Command byte (0xB)

D27-D00 Start address in FLASH memory

Read 4

Bits Description

D31-D28 Command byte (0xB)

D27-D00 Start time as sent in the Start recording command

Read 5

Bits Description

D31-D28 Command byte (0xB)

D27-D08 Reserved

D07-D00 Directory entry type of stop entry – see directory format above

Read 6

Bits Description

D31-D28 Command byte (0xB)

D27-D00 Stop address in addres in FLASH Memory (will be next address to use)

Read 7

Bits Description

D31-D28 Command byte (0xB)

D27-D00 Stop time as sent in the Stop recording command

*Get Temperature Data Entry (0x74)*

Will retrieve Temperature Data starting at the specified address. The application shall perform consecutive characteristic reads until the required data is retrieved. Each entry requires two consecutive reads. The characteristic read pointer is not reset when using this command.

Write Characteristic

Bits Description

D31-D24 Command byte (0x74)

D23-D00 Address in FLASH to start retrieving data

Read Characteristic

This requires consecutive reads to download the required data. See Control01 Characteristic for temperature data format explanation.

Read Characteristic

Read 1

Bits Description

D31-D24 Command byte (0x11)

D23-D16 Sample Rate – see sample rate entry above for more information

D15-D8 integer value of temperature

D7-D4 fractional value of temperature

D3-D0 set to 0x00

Read 2

Bits Description

D31-D24 Command byte (0x11)

D23-D00 Count – incremental count so that an outside application can determine the relative time between any two entries using the count and the sample rate.

*Start Download (0x75)*

Will download all of the recorded data in the external FLASH memory.

The characteristic read pointer is not reset when using this command.

Write Characteristic

Bits Description

D31-D24 Command byte (0x75)

D23-D00 Address in FLASH to start retrieving data

Read Characteristic

This requires consecutive reads to download the required data. See Control01 Characteristic for temperature data format explanation.

Read Characteristic

Read 1

Bits Description

D31-D24 Command byte (0x11)

D23-D16 Sample Rate – see sample rate entry above for more information

D15-D8 integer value of temperature

D7-D4 fractional value of temperature

D3-D0 set to 0x00

Read 2

Bits Description

D31-D24 Command byte (0x11)

D23-D00 Count – incremental count so that an outside application can determine the relative time between any two entries using the count and the sample rate.

*Get Used FLASH (0x76)*

Will retrieve the used FLASH memory.

Write Characteristic

Bits Description

D31-D24 Command byte (0x76)

D23-D00 Reserved (set to all zeroes)

Read Characteristic

This requires two consecutive reads.

Read 1

Bits Description

D31-D24 Command byte (0x12)

D23-D00 Next available FLASH Address

Read 2

Bits Description

D31-D24 Command byte (0x12)

D23-D00 Starting FLASH Address

*Start Recording (0x80)*

Will start the recording process. A directory entry of start type will be created and the temperature data will be stored in FLASH memory at the sample rate previously set.

Write Characteristic

Bits Description

D31-D28 Command byte (0x8)

D27-D00 Start time as determined by the calling application (see directory entry for more information)

Read Characteristic

No corresponding read data

*Stop Recording (0x90)*

Will stop the recording process. A directory entry of type stop will be created and the recording process will stop.

Write Characteristic

Bits Description

D31-D28 Command byte (0x8)

D27-D00 Stop time as determined by the calling application (see directory entry for more information)

Read Characteristic

No corresponding read data

*Sleep (0xA0)*

Will place the device in sleep mode. The RN4020 Bluetooth module will be placed in deep sleep mode and the device will configure itself for lowest power mode. The device will wake on the sample rate and record the temperature and then return to the low power mode. The Mode switch will determine what happens on power cycles. If the MODE switch is in SLEEP, subsequent power cycles will cause a stop then start directory entry to be created. The time stamp will be all zeroes since the device has no sense of time. If the MODE switch is in NORMAL, then the device will create a stop directory entry, time stamp all zeroes, and then start normally. This allows for changes in power sources without disturbing the settings.

Write Characteristic

Bits Description

D31-D28 Command byte (0x8)

D27-D00 Sleep time as determined by the calling application (see directory entry for more information)

Read Characteristic

No corresponding read data

**Control03 Characteristic**

This characteristic is reserved for future use.