**PRELIMINARY**

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Maker PowerTM

Power Monitor API

**Overview**

This document describes the Application Programming Interface (API) for both the USB and BTLE interfaces.

**USB API (API Level 2)**

The USB interface is a standard HID interface. The Power Monitor will negotiate the interface with the Operating System and provide the transport mechanism.

The commands are sent as packets in the following format:

|  |  |  |
| --- | --- | --- |
| Byte | Content | Description |
| 1 | 0xFF | Header |
| 2 | 0xFF | Header |
| 3 | 0x$$ | Command (see list) |
| 4 | 0x$$ | Packet Size |
| .. | 0x$$ | Data |
| .. | 0x$$ | Data |
| .. | 0x$$ | Data |
| n | 0xFE | End of Packet Marker |
|  |  |  |

Header: The first two bytes are 0xFF and construct the header of the packet

Command: Single byte value of 0x01 – 0xFD ( see command list)

Packet Size: Single byte value of 0x01 – 0x20 of how many bytes of data there are.

Data: Sequence of bytes as indicated in the packet size value.

EOP Marker: Single byte value of 0xFE to indicate the end of packet.

Note: The USB path will return string data that is outside of the packet format. These are generally Printf type strings indicating that certain commands have been completed. While every effort has been made to suppress these, we cannot guarantee we found them all.

**USB Command List:**

Reserved 0x1E

NVMDumpMemory 0x1F

SetDataRate 0x30

Run 0x31

Stop 0x32

SendPortData 0x33

SendMiscData 0x34

SetCurrentScale 0x35

SetStandAloneCFG 0x36

GetStandAloneCFG 0x37

TxLocalData 0x38

FxLocalData 0x39

Calibrate 0x3A

GetCalData 0x3B

Reserved 0x3C

SendLTPortData 0x40

SendLTMiscData 0x41

SetLTAmps 0x42

FWUpdate 0xEC

Reserved 0xED

Reserved 0xEE

RestoreDefaults 0xEF

ACK 0xF0

NAK 0xF1

GetAPILevel 0xF3

GetFirmwareVer 0xF4

GetSerialNumber 0xF5

Reserved 0xF6

BoardID 0xF7

Reserved 0xFB

Reserved 0xFC

Reserved 0xFD

Reserved 0xFE

Reserved 0xFF

**CAUTION**

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

**NVM Dump Memory (0x1F)**

Command will transmit 256 bytes of internal memory, either the factory configuration memory or the 32Mbit FLASH local configuration/data memory.

Tx Packet Size: 2

Rx packet Size: variable

Tx Data:

Byte Description

1 Memory to be displayed

 0x00 – factory configuration memory

 0x01 – local configuration/data memory

2 Which 256 bytes in the local configuration/data memory

 0x00 – configuration memory 0

 0x01 – configuration memory 1

 0x02 – configuration memory 2

 0x03 – configuration memory 3

 0x04 – data memory 0

 0xx5 – data memory 1

RxData: 16 Packets of 16 bytes will be sent in sequence

**Set Data Rate (0x30)**

Command sets the data collection rate (or interval) for the power monitor.

Tx Packet Size: 3

Rx packet Size: no returned data

Tx Data:

Byte Description

1 Byte value to select the data collection rate

 0x00 – Reserve

 0x01 – 200 msec

 0x02 – 500 msec

 0x03 – 1 sec

 0x04 – 2 sec

 0x05 – 5 sec

 0x06 – 10 sec

 0x07 – 30 sec

 0x08 – 1 min

 0x0F – custom rate (see next two bytes)

 all other values are invalid

2-3 Unsigned 16 bit value that constitutes a custom data rate. Byte #2 is the upper byte and Byte #3 is the lower byte of the unsigned 16 bit value. The value multiplied by 25 msec will be the data collection interval. Values less than 8 are not valid.

 Example: value = 100, collection interval = 2.5 sec

RxData: No Rx Data.

**Run (0x31)**

Command starts the data collection process in the local 32Mbit memory. Parameters that were sent with the Set Standalone CFG (0x36) are loaded into the device and the collection process begins.

Tx Packet Size: 1

Rx packet Size: no returned data

Tx Data: Any value between 0x01 and 0xEF, value is not used

RxData: No Rx Data.

**Stop (0x32)**

Command stops the data collection process in the local 32Mbit memory. The Record Count, data rate are stored in local memory and the collection process stops.

Tx Packet Size: 1

Rx packet Size: no returned data

Tx Data: Any value between 0x01 and 0xEF, value is not used

RxData: No Rx Data.

**Send Port Data (0x33)**

This is a receive command only. When the Power Monitor is not in Run Mode (0x31), the Power Monitor will send voltage and amperage data at the current data rate. If it is in Run Mode, then all data is sent to the local FLASH memory and this command will not be sent.

Tx Packet Size: N/A

Rx packet Size: variable

Tx Data: N/A

Rx Data:

Connected to a Monitor Module the Rx Packet Size will be 8 bytes. The packet data contains 4 unsigned 16 bit values. The first byte is the upper byte followed by the lower byte of the unsigned 16 bit value. The four 16 bit values contain the voltage and amperage data for each of the 4 ports as follows:

Bits Description

D15 type identifier

 0 – Amperage port

 1 – Voltage port

D14 – D12 port identifier

 0x0 – Port #1

 0x1 – Port #2

 0x2 – Port #3

 0x3 – Port #4

 0x4 – Port #5 (Port#5 – Port#8 only available on the Power Chassis)

 0x5 – Port #6

 0x6 – Port #7

 0x7 – Port #8

D11 – D0 unsigned 12 bit value representing the voltage or amperage

Connected to a Power Chassis the Rx Packet Size will be 12 bytes. The packet data contains 6 unsigned 16 bit values. The first byte is the upper byte followed by the lower byte of the unsigned 16 bit value. The six 16 bit values contain the voltage and amperage data for each of the 6 ports and follow the same format as the Monitor Module.

Voltage Conversion – each count is 13.99mV which gives a range of 0-57.3 volts.

Amperage Conversion – value is dependent on the selected scale

 Scale 8A – each count is 2.15mA which gives a range of 0-8800mA

 Scale 2A – each count is 0.54mA which gives a range of 0-2200mA

 Scale 1A – each count is 0.27mA which gives a range of 0-1100mA

**WARNING**

Maximum voltage and amperage values shown here exceed the maximum allowed values in the data sheet. These numbers do **NOT** override the maximum permissible values in the data sheet.

**Send Misc Data (0x34)**

This is a receive command only. When the Power Monitor is not in Run Mode (0x31), the Power Monitor will send miscellaneous data at the current data rate. If it is in Run Mode, then all data is sent to the local FLASH memory and this command will not be sent.

Tx Packet Size: N/A

Rx packet Size: variable

Tx Data: N/A

Rx Data:

Connected to a Monitor Module the Rx Packet Size will be 8 bytes. The packet data contains 4 unsigned 16 bit values. The first byte is the upper byte followed by the lower byte of the unsigned 16 bit value. The four 16 bit values contain the miscellaneous data for each of the 4 ports as follows:

Bits Description

D15 type identifier

 0 – Reserved

 1 – Temperature port

D14 – D12 port identifier

 0x0 – Port #1

 0x1 – Port #2

 0x2 – Port #3

 0x3 – Port #4

 0x4 – Port #5 (Port#5 – Port#8 only available on the Power Chassis)

 0x5 – Port #6

 0x6 – Port #7

 0x7 – Port #8

D11 – D0 signed 12 bit value representing the temperature (only 9 bits are significant)

Connected to a Power Chassis the Rx Packet Size will be 12 bytes. The packet data contains 6 unsigned 16 bit values. The first byte is the upper byte followed by the lower byte of the unsigned 16 bit value. The six 16 bit values contain the miscellaneous data for each of the 6 ports and follow the same format as the Monitor Module.

Temperature Conversion – each count is 0.48°C, however only the range of -40°C to +125°C is valid. The measured temperature is of the power monitoring IC and can be used to adjust or calibrate the voltage and amperage measurements if needed.

**Set Current Scale (0x35)**

Command sets the current scale that will be used in all amperage port data sent back (0x33) for the power monitor.

Tx Packet Size: 1

Rx packet Size: no returned data

Tx Data:

Byte Description

1 Byte value to select the current scale

 Scale 8A – 0x00

 Scale 2A – 0x01

 Scale 1A – 0x02

RxData: No Rx Data.

**Set Standalone CFG (0x36)**

Command sets the configuration that will be used in the standalone collection mode where data is recorded on the local 32Mbit FLASH memory. The only available configuration is the data rate. Amperage data is collected at the last set current scale or Scale 8A if power is cycled. This command will erase the local 32Mbit FLASH memory.

Tx Packet Size: 11

Rx packet Size: no returned data

Tx Data:

Byte Description

1 Byte value to select the data collection rate (see 0x30 for values)

2-3 unsigned 16 bit value for custom interval (see 0x30 for explanation)

4-7 unsigned 32 bit value for record count (set to zero for configuration)

8-11 unsigned 32 bit value for next location in 32Mbit FLASH ( set to zero for configuration)

RxData: No Rx Data.

**Get Standalone CFG (0x37)**

Command gets the configuration that was be used in the standalone collection mode where data is recorded on the local 32Mbit FLASH memory.

Tx Packet Size: 1

Rx packet Size: 11

Tx Data: Any value between 0x01 and 0xEF, value is not used

RxData:

Byte Description

1 Byte value to indicate the data collection rate (see 0x30 for values)

2-3 unsigned 16 bit value to indicate custom interval (see 0x30 for explanation)

4-7 unsigned 32 bit value for records collected, byte #4 is highest order byte, followed by byte #5, byte#5 and byte#7 which is the lowest order byte.

8-11 unsigned 32 bit value for next location in 32Mbit FLASH, byte #4 is highest order byte, followed by byte #5, byte#5 and byte#7 which is the lowest order byte.

**Tx Local Data (0x38)**

Command starts the process of downloading the data collected in the 32Mbit FLASH memory. This command only needs to sent once to start the download process. The first data transmitted by the Power Module is a the Fx Local Data (0x39) command to indicate that the download is beginning. This is followed by the data packets as described below. Once all the collected data is sent, another Fx Local Data (0x39) command will be sent by the Power Module to indicate that all the collected data has been sent.

Tx Packet Size: 1

Rx packet Size: variable

Tx Data: Any value between 0x01 and 0xEF, value is not used

RxData:

Connected to a Monitor Module the Rx Packet Size will be 9 bytes. The data contained will depend on the first byte of the packet.

Byte Description

1 Type of data

 0x00 – Header information

 0x01 – Port voltages

 0x02 – Port currents

 0x03 – Port temperatures

Header information

2-3 reserved

4-7 unsigned 32 bit value that indicates time

8-9 reserved

Port Voltages (see 0x33 for byte packing)

2-3 unsigned 16 bit value for Port #1

4-5 unsigned 16 bit value for Port #2

6-7 unsigned 16 bit value for Port #3

8-9 unsigned 16 bit value for Port #4

Port Currents (see 0x33 for byte packing)

2-3 unsigned 16 bit value for Port #1

4-5 unsigned 16 bit value for Port #2

6-7 unsigned 16 bit value for Port #3

8-9 unsigned 16 bit value for Port #4

Port Temperatures (see 0x34 for byte packing)

2-3 unsigned 16 bit value for Port #1

4-5 unsigned 16 bit value for Port #2

6-7 unsigned 16 bit value for Port #3

8-9 unsigned 16 bit value for Port #4

Connected to a Power Chassis the Rx Packet Size will be 17 bytes. The data contained will depend on the first byte of the packet.

Byte Description

1 Type of data

 0x00 – Header information

 0x01 – Port voltages

 0x02 – Port currents

 0x03 – Port temperatures

Header information

2-3 reserved

4-7 unsigned 32 bit value that indicates time

8-17 reserved

Port Voltages (see 0x33 for byte packing)

2-3 unsigned 16 bit value for Port #1

4-5 unsigned 16 bit value for Port #2

6-7 unsigned 16 bit value for Port #3

8-9 unsigned 16 bit value for Port #4

10-11 unsigned 16 bit value for Port #5

12-13 unsigned 16 bit value for Port #6

14-15 unsigned 16 bit value for Port #7

16-17 unsigned 16 bit value for Port #8

Port Currents (see 0x33 for byte packing)

2-3 unsigned 16 bit value for Port #1

4-5 unsigned 16 bit value for Port #2

6-7 unsigned 16 bit value for Port #3

8-9 unsigned 16 bit value for Port #4

10-11 unsigned 16 bit value for Port #5

12-13 unsigned 16 bit value for Port #6

14-15 unsigned 16 bit value for Port #7

16-17 unsigned 16 bit value for Port #8

Port Temperatures (see 0x34 for byte packing)

2-3 unsigned 16 bit value for Port #1

4-5 unsigned 16 bit value for Port #2

6-7 unsigned 16 bit value for Port #3

8-9 unsigned 16 bit value for Port #4

10-11 unsigned 16 bit value for Port #5

12-13 unsigned 16 bit value for Port #6

14-15 unsigned 16 bit value for Port #7

16-17 unsigned 16 bit value for Port #8

**Fx Local Data (0x38)**

This is a receive only command and indicates the start and finish of the collected data download. The Power Module will not respond to this command.

Tx Packet Size: N/A

Rx packet Size: 1

Tx Data: N/A

RxData:

Byte Description

1 Start/Stop marker

 0x01 – start of the download, all packets (0x38) that follow are part of the download.

 0x02 – end of the download.

**Calibrate (0x3A)**

Command starts the calibration process for the selected current scale. Once complete, the calibration data in the local memory is updated.

Tx Packet Size: 1

Rx packet Size: 1

Tx Data:

Byte Description

1 Byte value to select current scale to calibrate

 Scale 8A – 0x00

 Scale 2A – 0x01

 Scale 1A – 0x02

RxData: Always returns 0x00 to indicate calibration is complete.

**Get Cal Data (0x3B)**

Command retrieves the calibration data stored in local memory for the selected current scale.

Tx Packet Size: 1

Rx packet Size: variable

Tx Data:

Byte Description

1 Byte value to select current scale to calibrate

 Scale 8A – 0x00

 Scale 2A – 0x01

 Scale 1A – 0x02

RxData:

Byte Description

1-2 unsigned 16 bit value for Port #1

3-4 unsigned 16 bit value for Port #2

5-6 unsigned 16 bit value for Port #3

7-8 unsigned 16 bit value for Port #4

9-10 unsigned 16 bit value for Port #5 (Port#5 - #8 only available on the Power Chassis)

11-12 unsigned 16 bit value for Port #6

13-14 unsigned 16 bit value for Port #7

15-16 unsigned 16 bit value for Port #8

**Send Load Test Port Data (0x40)**

**Send Load Test Misc Data (0x41)**

**Set Load Test Port Amperage (0x42)**

Commands to implement the load test feature on the Power Chassis.

**Firmware Update (0xEC)**

Command places the device in the Firmware update mode.

Tx Packet Size: 1

Rx packet Size: no returned data

Tx Data: Any value between 0x01 and 0xEF, value is not used

RxData: No Rx Data.

**Restore Defaults (0xEF)**

Command erases any locally updated calibration data and restores the factory default calibration data.

Tx Packet Size: 1

Rx packet Size: no returned data

Tx Data: Any value between 0x01 and 0xEF, value is not used

RxData: No Rx Data

**ACK (0xF0)**

This is a receive command only. Currently not used, but would indicate that a command was accepted and acted upon.

Tx Packet Size: N/A

Rx packet Size: 1

Tx Data: N/A

RxData: Byte value returned is dependent on the command the ACK is sent for.

**NAK (0xF1)**

This is a receive command only. Currently not used, but would indicate that a command was accepted, but failed.

Tx Packet Size: N/A

Rx packet Size: 1

Tx Data: N/A

RxData: Byte value returned is dependent on the command the NAK is sent for.

**Get API Level (0xF3)**

Command returns the API Level for both the USB interface and the BTLE interface.

Tx Packet Size: 1

Rx packet Size: 2

Tx Data: Any value between 0x01 and 0xEF, value is not used

RxData:

Byte Description

1 Byte value indicating the supported USB API Level. Valid values are 0x02.

2 Byte value indicating the supported BTLE API Level. Valid values are 0x02.

**Get Firmware Version(0xF4)**

Command returns the devices firmware version.

Tx Packet Size: 1

Rx packet Size: 2

Tx Data: Any value between 0x01 and 0xEF, value is not used

RxData:

Byte Description

1 Major version number

2 Minor version number

**Get Serial Number (0xF5)**

Command returns the Board serial number.

Tx Packet Size: 1

Rx packet Size: variable

Tx Data: Any value between 0x01 and 0xEF, value is not used

RxData: String containing the serial number.

**Board ID (0xF7)**

Command returns the Board ID and a string containing the Board Name, depending on whether it is connected to a Monitor Module or a Power Chassis.

Tx Packet Size: 1

Rx packet Size: variable

Tx Data: Any value between 0x01 and 0xEF, value is not used

RxData:

Connected to a Monitor Module will return 0x09 followed by the string “USB-BT Monitor”

Connected to a Power Chassis will return 0x0A followed by the sting “Power Chassis”

**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 = **f18e901a-f325-4dfd-8cdb-68506676dc08**

Control02 UUID = **9bac1d28-9fc1-4db0-97c4-896089ad26bb**

Control03 UUID = **39bb1bf9-17ec-41d2-b5e4-b78551b45740**

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

**Heartbeat Characteristic**

This characteristic establishes a heartbeat signal between the Power Monitor device and the BTLE device.

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. Once the notification is enabled, the Power Monitor device will update the characteristic with a new value at the interval set in the configuration. (See Control01 for details). The value will alternate between 0x0035 and 0x0041. You may disable the Heartbeat by disabling the characteristic notification. Also if the connection between the Power Monitor device and the BTLE device is broken or disabled by any means, the Heartbeat characteristic notification will be disable.

**Control01 Characteristic**

This characteristic is used to set/get the Power Monitor device configuration and control the Power Monitor.

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 byte is the command byte and the following commands are defined.

D31-D24 Commands

0x70 Get Configuration

0x71 Set Configuration

0x72 Start Recording

0x73 Stop Recording

0x7E Set BTLE LEDs

0x7F Factory Reset

Get Configuration (0x70)

Bits Description

D31-D24 Command byte (0x70)

D23-D16 BTLE API level (0x02)

D15-D12 Type of fixture

 0x00 - reserved

 0x01 - monitor module

 0x02 - Power Chassis

D11-D8 Current Scale

 0x00 - 8A

 0x01 - 4A

 0x02 – 1A

D7-D4 Heartbeat Rate

 0x00 – No Heartbeat

 0x01 – 1 sec

 0x02 – 2 sec

 0x03 – 5 sec

D3-D0 Data Rate (see USB command 0x30 for values)

Set Configuration (0x71)

Bits Description

D31-D24 Command byte (0x71)

D23-D12 Reserved (set to all zeros)

D11-D8 Current Scale

 0x00 - 8A

 0x01 - 4A

 0x02 - 1A

D7-D4 Heartbeat Rate

 0x00 – No Heartbeat

 0x01 – 1 sec

 0x02 – 2 sec

 0x03 – 5 sec

D3-D0 Data Rate (only fixed data rates are available, see USB command 0x30)

Start Recording (0x72)

Bits Description

D31-D24 Command byte (0x72)

D23-D0 Reserved (set to all zeros)

Stop Recording (0x73)

Bits Description

D31-D24 Command byte (0x73)

D23-D0 Reserved (set to all zeros)

Set BTLE LEDs (0x7E)

Bits Description

D31-D24 Command byte (0x7E)

D23-D8 Reserved (set to all zeros)

D7-D0 Set LED State

 0x00 – Red LED off

 0x01 – Red LED on

 0x00 – Blue LED off

 0x02 – Blue LED on

 0x00 – Green LED off

 0x04 – Green LED on

 0x10 – Red LED selected (these bits select the LED for change)

 0x20 – Blue LED selected

 0x40 – Green LED selected

Factory Reset (0x7F)

Bits Description

D31-D24 Command byte (0x7F)

D23-D0 Reserved (set to all zeros)

**Control02 Characteristic**

This characteristic is used to retrieve Power Monitor data.

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 bit defines the data type and are defined as follows.

*Read Value*

Bits Description

D31 0 – Misc data

 1 – Volt/Amp data

D30-D28 Port # (0-7)

D27-D16 Port current value (unsigned 12 bit value, see USB command 0x33 for conversion formula)

D15

D14-D12 Port # (0-7)

D11-D0 Port voltage value (unsigned 12 bit value, see USB command 0x33 for conversion formula)

*Write Value*

Bits Description

D31-D24 Port to read

 0x00 – Port #1

 0x01 – Port #2

 0x02 – Port #3

 0x03 – Port #4

 0x04 – Port #5 (Port#5 - #8 only available on the Power Chassis)

 0x05 – Port #6

 0x06 – Port #7

 0x07 – Port #8

D23-D0 Reserved (set to all zeros)

Once the configuration is set, this characteristic is used to read port data. First write to this characteristic with the value shown above (Write Value) for the port that data is required. Then read from the characteristic the unsigned 32 bit value and decode as required.

**Control03 Characteristic**

This characteristic is reserved for future use.