GREASEBOSS.
Lubricate with confidence.

Endpoint Functional Specification

Exported on 14/12/2023

Unit 6, 1 Metier Linkway, Birtinya, QLD 4575 | Australia
Phone +61 7 3186 0203 | sales@greaseboss.com.au | www.greaseboss.io

Author	@Peter Condoleon
Version	1.6
Date	19 Jun 2023

1 Overview

Endpoints are wireless flow meters that measure and transmit flow data to a nearby gateway using Bluetooth Low Energy. This document describes the functionality of the Endpoint version 3 device.

1.1 Technical Specifications

Inlet and Outlet	1/4” BSPP
IP Rating	TBA
Maximum Operating Pressure	7500 PSI
Flow Meter Housing Material	Aluminium
Flow Meter Type	Oval Gear + Hall Effect Sensor
Housing Material	Glass Filled Nylon
Maximum Flow Rate	TBA
Back Pressure	TBA
Operating Temperature Range	-40°C to +85°C
Battery Type	1Ah CR2477N Coin Cell

Bluetooth Radio	Nordic nRF52833
Maximum Transmit Power	+8 dBm

2 Restricted Use Caution

GreaseBoss Endpoints are intended **for industrial use only**. These devices were designed to be installed in restricted industrial areas and operated by authorised persons. Examples of restricted areas include mine sites, refineries, processing plants, construction sites, utility plants and manufacturing facilities. Examples of authorised persons include mechanical fitters, electricians, service technicians and engineers. In such environments, the use of personal protective equipment (PPE) such as hard hat, safety glasses, high visibility clothing and protective footwear is expected. One safety consideration when installing Endpoints is the risk of dropping one when mounting it to a large machine such as that shown below.

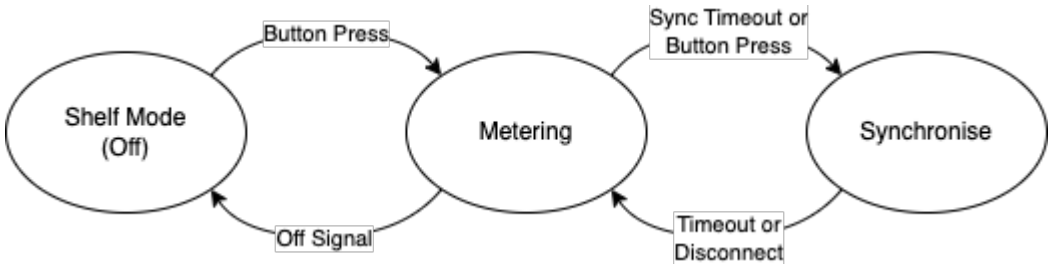
Example Operation Environment

As Endpoints can be mounted as various heights, the gravitational potential energy of an Endpoint is a hazard that must be considered when handling them. Another safety consideration to be aware of when operating Endpoints is the maximum operational pressure range. Endpoints are not to be over pressurised beyond that of the maximum pressure rating displayed on the device. It is the responsibility of Endpoint operators to ensure all precautionary measures are in place prior to handling and operating GreaseBoss Endpoints.

3 Operation

Endpoints are designed to be always metering flow with minimal power consumption. Periodically, an Endpoint will power on its Bluetooth Low Energy (BLE) radio, making itself visible to nearby Bluetooth gateways that can connect to the Endpoint and download its flow data. Endpoints are equiped with a user button and two status LEDs that allow user interaction for setup and inspection purposes.

Endpoint operation is illustrated in the following diagram.



- In shelf mode, the Endpoint does not meter flow or periodically synchronise. It may only exit shelf mode when the user button is pressed for 3 seconds.
- In the Metering state, an Endpoint uses minimal power consumption while counting flow. After a user defined period or a manual button press, the Endpoint will transition to the Synchronise state.
- In the Synchronise state, the Endpoint will make itself visible to a BLE gateway for downloading flow data. Once data transfer is complete or if the connection times out, the Endpoint will return to the Metering state. If flow occurs during synchronisation, the Endpoint will capture this data, but not report it until the next Synchronisation.

3.1 Flow Metering

There are two ways an Endpoint meters flow:

1. Cumulative Metering
2. Burst Metering

3.1.1 Cumulative Metering

Cumulative metering is an endless increasing count of flow through an Endpoint. It can be obtained by a BLE gateway when the Endpoint is advertising each period.

3.1.2 Burst Metering

Burst metering captures windows of volume flow. It is ideal for tracking the exact moments that a burst of volume passes through an Endpoint. Burst Metering works using three parameters:

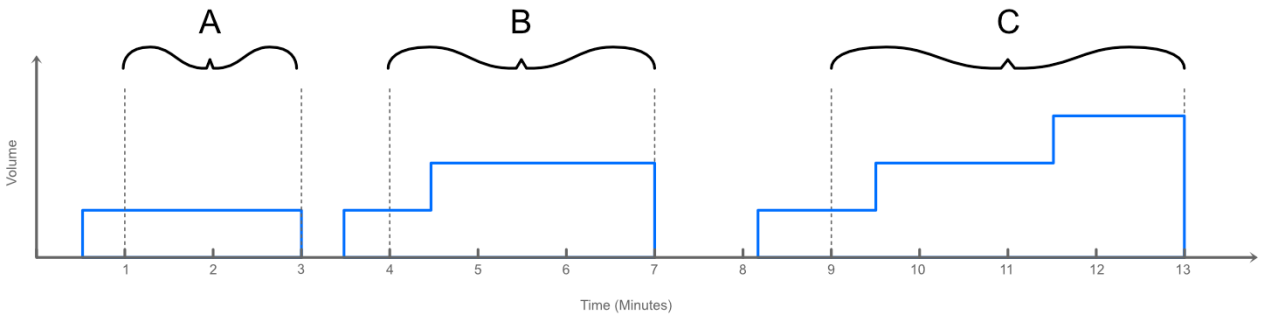
1. **Interval**: How often an endpoint checks for changes in volume
2. **Min Window Size**: The minimum amount of time that a volume is attributed to
3. **Max Window Size**: The maximum amount of time that a volume is attributed to

An Endpoint checks each interval for new volume and if new volume is detected, the Endpoint creates a window. A window increases in size (equal to the min window size) if more volume is detected at consecutive intervals. If no more volume is detected during an interval or the window reaches its maximum size, the recorded volume is packaged into a flow event timestamped to the window start time.

Example

The below chart illustrates 3 examples of burst metering with the following parameters

- Interval = 1 Minute
- Minimum Window Size = 2 Minutes
- Maximum Window Size = 4 Minutes



- Window A is created at interval 1 as a result of the volume increase that precedes it. As there are no further volume increases in this window, a flow event is created after the minimum window time has passed.
- Window B contains a volume increase within its window, causing the window to be extended. No further volume increases cause the window to close and a flow event created.
- Window C contains enough volume increases to reach its size to the maximum. A flow event is forcefully created.

3.2 Synchronisation

Endpoints periodically synchronise their data with a nearby BLE enabled gateway. The synchronisation period is based on the ***Sync Interval*** configuration parameter. When an Endpoint powers on its BLE radio for synchronisation, the ***Sync Timeout*** configuration parameter determines how long the Endpoint waits for a gateway to connect before giving up. If a sync fails or times out, the Endpoint can use the ***Sync Retry*** configuration parameter to specify the number of times it will re-attempt its sync at a random interval between 5 and 30 minutes.

3.2.1 Diagnostics

Before each time an Endpoint starts to sync, a special diagnostic event is generated that contains information such as battery voltage and device temperature.

3.2.2 Typical Synchronisation Process

Once a gateway successfully connects to an Endpoint, it will synchronise as shown in the following table.

Step	Action
1	Request serial number, firmware version, k-factor, clock and cumulative flow count.
2	If clock is out of sync, set the clock to the current time.

Step	Action
3	Subscribe to the GreaseBoss event attribute and read incoming events. Once the event stream has stopped, unsubscribe.
4	Disconnect.

3.3 User Interaction

The user button can be used to interact with an Endpoint and has various functions.

3.3.1 Powering On

If an Endpoint is powered off, it can simply be powered on by pressing the button for 3 seconds until the ✅ LED blinks 3 times.

3.3.2 Health Check

The status of an Endpoint can be quickly obtained by pressing and releasing the user button for less than 1 second. If the device is okay, the ✅ LED will blink once and if the device is not okay, the ⚠️ LED will blink once. If an Endpoint indicates that it is not okay, this may correspond to a low battery or in rare occasions an on board error.

3.3.3 User Function

The endpoint has a user function feature that allows field operators to trigger a custom notification from a specific endpoint. The functionality of this notification can be mapped to a function in GreaseCloud. E.g. a user function for single-point endpoints might be to indicate that a new canister was installed. To trigger a user function, the button may be pressed for 3 seconds (between 1 and 5 seconds). To indicate that a user function was triggered successfully, both the ✅ and ⚠️ LEDs will blink 3 times slowly.

3.3.4 Manual Synchronisation

A user may manually invoke a synchronisation with a nearby gateway by pressing the user button for 7 seconds (between 5 and 10 seconds). A sequence of LED blinks will follow with their meaning described in the following table.

[1] User Presses Button For 7 Seconds (5 to 10 Seconds)	
Endpoint will start pulsing both the ✅ and ⚠️ LEDs while searching for a gateway.	
[2A] Gateway is Found	[2B] Gateway is not Found
The Endpoint will start rapidly blinking the ✅ LED	⚠️ LED will blink slowly 3 times

[1] User Presses Button For 7 Seconds (5 to 10 Seconds)		
[3A] Synchronisation completed successfully	[3B] Synchronisation is unsuccessful	
✅ LED will go solid for a few seconds	⚠️ LED will go solid for a few seconds.	

4 Configuration

The Endpoint has a number of configuration parameters that affect how it operates. These are summarised in the following table.

Configuration Parameter	Description	Permissions
Serial Number	Endpoint unique Serial Number set at manufacture.	Read Only
K-Factor	Flow meter calibration factor set at manufacture. Can be updated to reflect new fluids, environments or if a recalibration occurred.	Read / Write
Burst Metering Interval	Interval in seconds between volume flow checks. Refer to Burst Metering for more information. **Default Value:** 60 Seconds (1 Minute) **Minimum Value:** 60 Seconds (1 Minute) **Maximum Value:** 86400 Seconds (1 Day)	Read / Write
Burst Metering Min Window Size	Minimum window size for volume aggregation. Refer to Burst Metering for more information. **Default Value:** 600 Seconds (10 Minutes) **Minimum Value:** Burst Metering Interval **Maximum Value:** 86400 Seconds (1 Day)	Read / Write
Burst Metering Max Window Size	Maximum window size for volume aggregation. Refer to Burst Metering for more information. **Default Value:** 1800 Seconds (30 Minutes) **Minimum Value:** Burst Metering Min Window Size **Maximum Value:** 86400 Seconds (1 Day)	Read / Write
Sync Interval	Time between device synchronisations. **Default Value:** 21600 Seconds (6 Hours) **Minimum Value:** 60 Seconds (1 Minute) **Maximum Value:** 31536000 Seconds (1 Year)	Read / Write
Sync Timeout	Time an Endpoint will advertise before it abandons trying to sync in the event no gateway is able to connect to it. **Default Value:** 30 Seconds **Minimum Value:** 10 Seconds **Maximum Value:** 900 Seconds (15 Minutes)	Read / Write

Configuration Parameter	Description	Permissions
Sync Retry	Whether an Endpoint will retry it's sync at some random interval after a failed sync. **Default Value:** 1 **Minimum Value:** 0 **Maximum Value:** 1	Read / Write
Transmit Power	The transmit power used by the bluetooth radio when synchronising. Can help extend wireless range at the cost of battery life. **Default Value:** 0 dBm **Minimum Value:** -40 dBm **Maximum Value:** +8 dBm	Read / Write

Various config parameters may be set via the bluetooth interface. See BLE Profile.

5 Appendix

5.1 User Button and LED Function Summary

Button Press	Function	LED Indicators
< 1 Second	Health Check	✅ LED blinks once if okay ⚠️ LED blinks once if problem Both ✅ and ⚠️ blink if the device is busy (e.g. syncing)
3 Seconds	User Function	Both ✅ and ⚠️ LEDs blink slowly 3 times to indicate that user function was triggered
7 Seconds	Manual Sync	✅ and ⚠️ pulse while endpoint is searching for gateway ⚠️ blinks slowly 3 times if unable to find gateway ✅ blinks fast if connected and is syncing ✅ goes solid for a few seconds if sync was successful ⚠️ goes solid for a few seconds if sync failed ⚠️ blinks slowly 3 times if sync incomplete due to timeout
15 Seconds or More	Maintenance Sync	No LEDs