SLOC Productivity

API

Version: 1.8

www.sloc.one

Table of Contents

1. Components

Name	Description
SPR–203	Smart SLOC - Device, which is mounted on the industrial truck (e.g. riding on the attachment of the forklift) and advertises its information via BLE (Bluetooth Low Energy) (see chapter Advertise format). Needs a setup.
SPR-203 Reference	Smart SLOC - Device on the truck, which is needed as reference for the SPR-203 to determine the lifting height. The calibration of the two SLOCs is first performed manually by the user, then automatically. No setup necessary. Must only be mounted on the truck and woken up by magnet.
SBC-203	Smart SLOC - Device, which can be used in combination with the SPR-203 to determine position. This SLOC continuously advertises its MAC address via BLE (Beacon - functionality) and is recognized by the SPR-203 as soon as it is in close proximity (approx. 10m). Does not need a setup. Only needs to be mounted at desired locations and woken up by a magnet (see figure 1).
SDM[1]-App	This app is used to configure a SLOC.
SLOC Demo-App	This SLOC - App visualizes the data, which are advertised by the SLOC SPR-203 via BLE.

[1] SDM = SLOC Device Management

2. Description of function – SPR-203

The SPR-203 can provide the following information via BLE Advertisement:

- Loading condition
- Lifting height
- Distance to measuring object
- G-forces
- Battery level
- Position (Beacon MAC)

These values are continuously updated and advertised via BLE.

2.1. Energy saving mode

If the SLOC is not moved for five minutes, an energy saving mode is activated in which no more data is transmitted. By moving the SLOC slightly, this mode is deactivated again and the SLOC starts transmitting data again.

2.2. Transport mode

To reduce energy consumption during storage and transport, the SLOC can be set to a transport mode via the SLOC Device Management App. In this mode the SLOC can be stored for a longer period with very low battery consumption.

By holding a magnet over the magnet symbol on the SLOC housing, the transport mode is deactivated again. (see Figure 1).

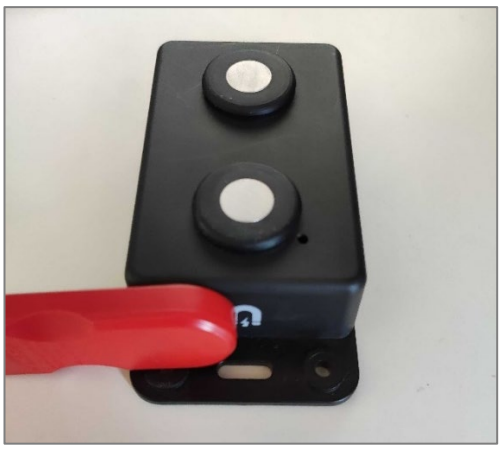


Figure 1: Magnetic sensor

© SLOC GmbH 2020

2.3. Battery change

The SLOC can be opened by loosening the 4 screws (Torx 10) at the bottom of the housing. Then the batteries can be changed and the SLOC can be screwed back on. To ensure optimum function and battery life, only batteries provided by SLOC should be used.

When closing the housing, its correct orientation must be observed – the magnet symbol must be on the left-hand side of the SLOC (see Figure 2).

Figure 2: Housing cover orientation

2.4. Loading condition

SLOC Productivity determines the loading condition by measuring the distance to objects at a distance of 10 cm up to 2 meters. To ensure a reliable distance measurement, the SLOC must not be touched by the object. A distance between object and SLOC of at least 2 cm is recommended.

The ultrasonic sensor used for distance measurement has a beam angle of approx. 40 degrees in all directions. Thus, objects can be detected even from the side of the SLOC. Therefore, it is recommended to mount the sensor as centered as possible to the objects (e.g. in the middle of the attachment) of the industrial truck. If the SLOC Productivity measures a distance smaller than 30cm the loading status changes from "*unloaded*" to "*loaded*".

Via setup you can set the distance to the object from which the loaded state is to be detected and the time intervals at which the loading state is to be redetermined.

The measuring and advertising of the loading status can also be completely activated and deactivated in the setup.

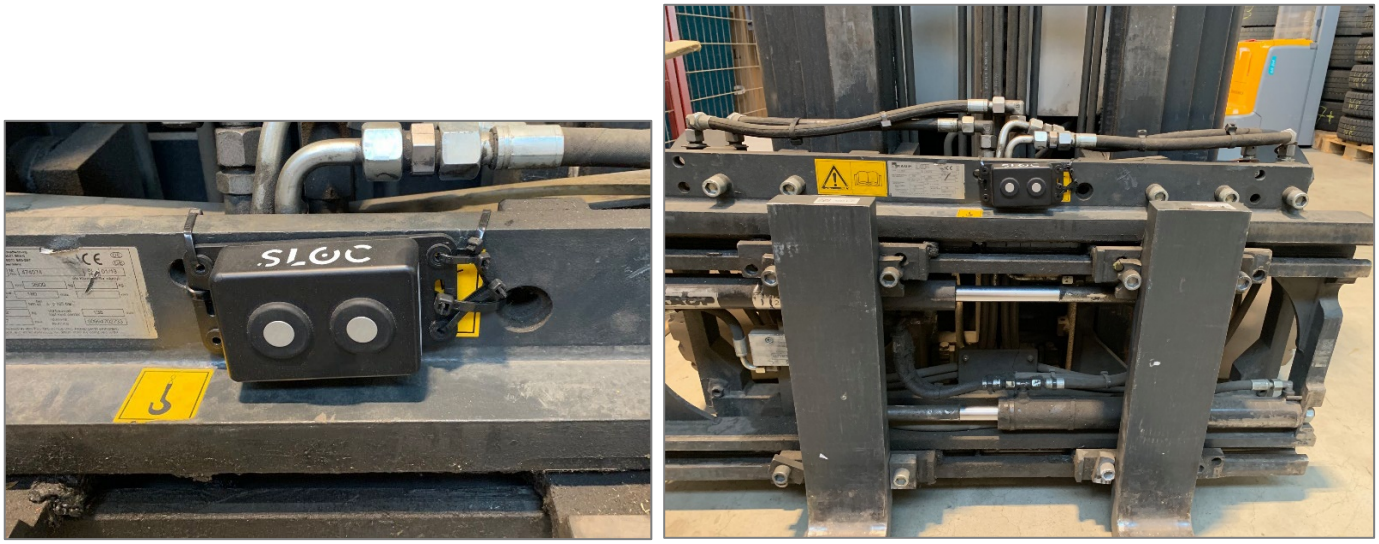


Figure 3: Mounting example

2.5. Lift height measurement

To measure the lifting height a second SLOC is necessary, which serves as a reference. The following steps are necessary to ensure correct function:

- Mounting the SPR-203 Reference (reference SLOC) at a fixed height on the vehicle
- Move the SPR-203 (SLOC Productivity on the attachment of the vehicle) to zero position (lift height 0)
- Hold magnet on magnet symbol of SPR-203 for 5 seconds (see Figure 1)
- Check the calculated lifting height with the SLOC Live - APP

If the lifting height is not determined correctly (accuracy: approx. +- 20cm), it is recommended to wait five minutes and repeat the calibration.

2.5.1. Automatic calibration

In the setup the parameter "Calibration Interval" can be set. This interval defines the time the SLOC must be quiet without movement and vibration for the SLOC to calibrate to 0mm.

If the actual measured lifting height of the SLOC is more than 500mm, the double interval is waited until the SLOC is referenced to 0mm.

The entire determination of the lifting height as well as the automatic calibration can be activated and deactivated in the setup.

2.6. Position determination

The SPR-203 continuously scans for BLE advertisements within range. If one or more SBR-203 (SLOC Beacons) are in range, the beacon with the best signal quality is set as the current position and its Mac is indicated as the position in the SPR-203's advertisement.

If no beacon is in range, SLOC advertises the MAC 00:00:00:00:00

The position determination can be activated and deactivated in the setup.

3. Setup SPR-203

The setup for the SPR-203 is divided into two setup pages:

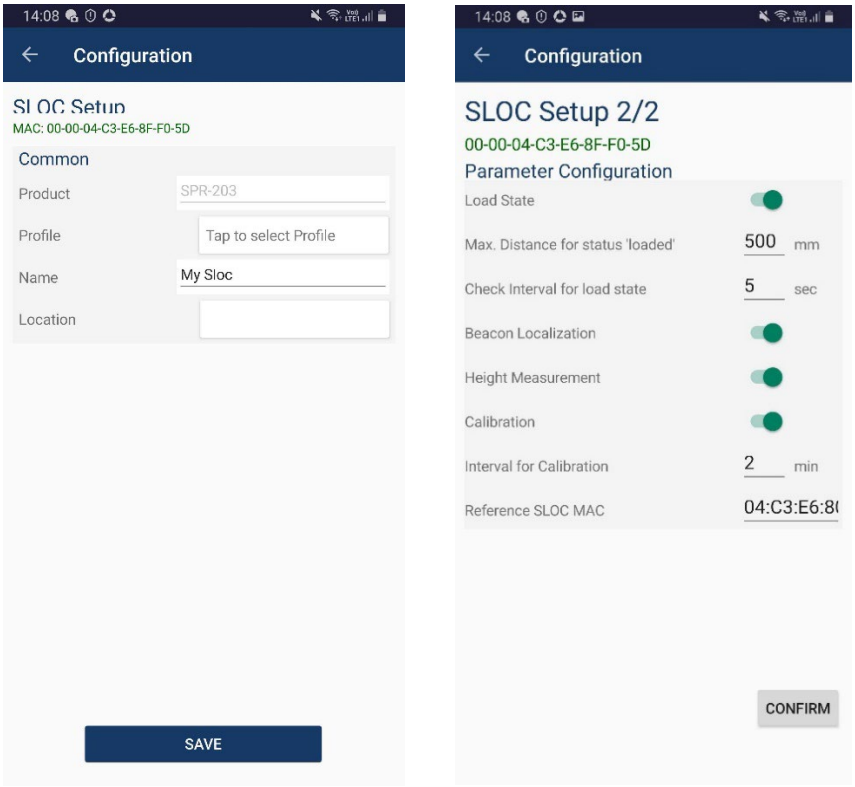


Figure 4: Mounting example

On the first setup page only the name for the SLOC should be given.

The following parameters must be set on the second page:

- Load State: Activate / deactivate measuring and advertising of the loading status.
- Max. Distance for status ‘loaded’: Distance from which the state "unloaded" is measured
- Check Interval for load state: Time between measurements of the loading condition
- Beacon Localization: Activate / deactivate the location determination by means of SBC localization
- Height Measurement: Activating / deactivating the lifting height measurement
- Calibration: Enable / disable the automatic recalibration of the lifting height during longer standstill
- Interval for Calibration: Time the SLOC must be completely at rest to calibrate the lift height to 0.0mm. If the measured lifting height during standstill is more than 500mm, twice the time must be waited for calibration.

4. Advertisement format

In this chapter the structure of the advertisement package, which the SLOC sends via BLE, is described in detail.

4.1. Package structure

Byte	Value
0 to 6	HEADER
7 to 12	MAC address
13	Type - 0x08
14	Status-Flags (e.g. load state)
15	Reserved
16 to 17	Lifting height
18 to 19	Distance
20 to 21	Acceleration (shock)
22 to 23	Last calibration
24	Battery status in percent
25 to 30	MAC of the Location Beacon

Except for the own MAC address (Byte 7 to 12) all data types are transmitted in Big Endian format.

Example - Complete BLE package including header:

Adv PDU Type	Adv PDU Header				AdvA	AdvData
	Type	TxAdd	RxAdd	PDU-Length		
ADV_IND	0	0	0	37	0x04C3E68015AF	02 01 05 1B FF FF FF AF 15 80 E6 C3 04 05 01 01 00 00 00 3C 3F 64 77 BE 00 04 C3 E6 8F F0 52

4.2. MAC - Address

For compatibility reasons with the SLOC configuration - APP the MAC address is also transferred in the payload.

Example – MAC 04:C3:E6:80:15:AF

AdvData

02 01 05 1B FF FF FF **AF 15 80 E6 C3 04** 05 01 01
00 00 00 3C 3F 64 77 BE 00 04 C3 E6 8F F0 52

4.3. Type

The type depends on the SLOC product used. The SPR-203 described in this document uses type 0x08.

Data type: uint8

Example – Type 0x08:

AdvData

```
02 01 05 1B FF FF FF 4B F0 8F E6 C3 04 08 03 00
00 00 00 0A 00 B6 00 7D 64 00 00 00 00 00 00
```

4.4. Status-Flags

In this byte several flags are given, whereby the different bits of the byte stand for individual status values of the SLOC, which are explained in more detail in the subchapters of this chapter.0… Unloaded

Bit	Value
0	Load state
1	Movement state
2	Reference state
3	Reserved
4	Reserved
5	Reserved
6	Reserved
7	Reserved

Example – Loaded (0x01):

AdvData

```
02 01 05 1B FF FF FF 4B F0 8F E6 C3 04 08 03 00
00 00 00 0A 00 B6 00 7D 64 00 00 00 00 00 00
```

Byte value 0x03 = 0b00000011

Means that load state and movement state are 1 and reference state is 0.

4.4.1. Load state

The first bit of the status flag byte stands for the load state.

If an object is detected on the fork, the status changes to Loaded.

0... Unloaded

1... Loaded

Data type: bool

4.4.2. Movement state

The second bit of the status flag byte stands for the motion state.

When the SLOC changes its movement state, the motion state changes.

0... Standstill

1... Movement

Data type: bool

4.4.3. Reference state

The third bit of the status flag byte stands for the reference state.

If the Reference SLOC is detected for calibration, the status changes to Detected.

0... Not detected

1... Detected

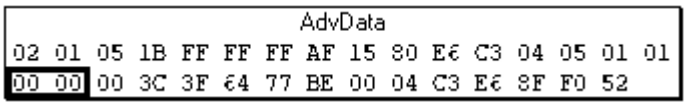
Data type: bool

4.5. Lifting height

The lifting height is transmitted in millimeters (mm). If the SLOC does not support lifting height measurement 0x0000 is always transmitted. If the reference SLOC cannot be reached, 0x8000 is transmitted.

Data type: int16

Example – 0mm (0x0000):

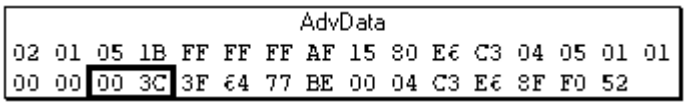


4.6. Distance in mm

The distance measurement to the object is transmitted in millimeters (mm).

Data type: uint16

Example – 60mm (0x003C):

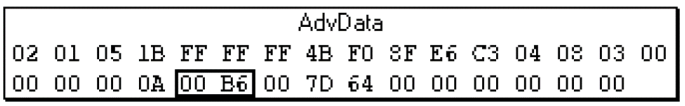


4.7. Acceleration (shock)

The maximum acceleration that has occurred within the last 5 seconds is given in mG.

Data type: int16

Example - 182 mG (0x00B6)



4.8. Last calibration

The time in seconds that has elapsed since the last calibration.

Data type: UInt16

Example – 125 sec (0x007D)

AdvData

```
02 01 05 1B FF FF FF 4B F0 8F E6 C3 04 08 03 00
00 00 00 0A 00 B6 00 7D 64 00 00 00 00 00 00
```

4.9. Battery status in percent

The charge level of SLOC batteries in percent.

Data type: uint8

Example – Battery level 82% (0x52):

AdvData

```
02 01 05 1B FF FF FF AF 15 80 E6 C3 04 05 01 01
00 00 00 3C 3F 64 77 BE 52 04 C3 E6 8F F0 52
```

For the SLOC Beacon and the SPR-203 Reference the battery level can be read out in the same way as in this example of an SPR-203.

Only the advertisement type differs.

4.10. Current position

MAC address of a recognized SBC-203. If several SLOC - Beacons are recognized at the same time, the one with the largest signal strength is selected. If no SLOC beacon is detected, 00:00:00:00:00:00 is advertised.

Data type: 6 Byte

Example – Beacon MAC 00:00:00:00:00:00 (since no beacon was detected)

AdvData

```
02 01 05 1B FF FF FF 4B F0 8F E6 C3 04 08 03 00
00 00 00 0A 00 B6 00 7D 64 00 00 00 00 00 00
```

5. Examples of implementation

This chapter explains how to read the advertisement in sample applications. For this purpose, code examples are illustrated and explained so that other users have a guide when implementing.

5.1. Implementation in C# with Unity

In this section, the implementation of the BLE Library BluetoothLE, which can be purchased from the Unity Asset Store, is explained in more detail. This includes how the scan process is performed and how advertiseten bytes are handled.

```
BluetoothLEHardwareInterface.ScanForPeripheralsWithServices(null, null, (address, dev_name, rssi, bytes) =>
{
```

In the sample code above, we scan for BLE devices in the environment. The function BluetoothLEHardwareInterface.ScanForPeripheralsWithServices(null, null, (address, dev_name, rssi, bytes) is used to start the scan. This function returns a callback with the following parameters from the library:

- address (MAC address of the device)
- dev_name (device name)
- rssi (signal strength)
- bytes (data which are present in the advertisement)

In the next step the data which are advertised by the SLOC are analyzed more closely.

```
if(bytes.Length > 25 && bytes[8] == 5)
```

First the advertisement type (at the 9th position of the bytes) is read, if it is 5 and the length of the bytes is greater than 25 it is a valid SLOC SPR - 203 advertisement and the parsing of the data can be started. Here an example of the reading of the stroke height is attached:

```
byte[] heightBytes = new byte[2];
Array.Copy(bytes, 11, heightBytes, 0, 2);
Array.Reverse(heightBytes);
Int16 height = BitConverter.ToInt16(heightBytes, 0);
```