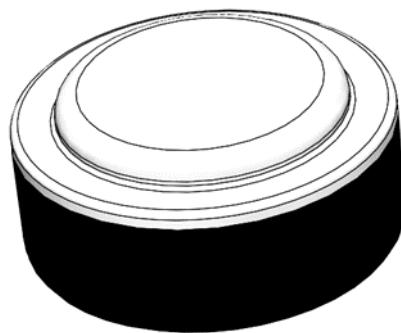


**TMS-AF-01**

**MICHELIN TIRE MOUNTED SENSOR**

**DATASHEET**



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## 1.1 GLOSSARY

TERM	MEANING
<b>AD</b>	Advertising Data
<b>BLE</b>	Bluetooth Low Energy
<b>CRC</b>	Cyclic Redundancy Check
<b>GenFSK</b>	Generic Frequency Shift-Keying
<b>MAC</b>	Media Access Control
<b>PDU</b>	Protocol Data Unit
<b>RF</b>	Radio Frequency
<b>TMS</b>	Tire Mounted Sensor

## 1.2 DOCUMENT CHANGE HISTORY

MODIFICATIONS	ISSUE
INITIAL ISSUE	01

## 2 INTRODUCTION

### 2.1 PURPOSE

This specification describes the functional requirements, and the operation of the Michelin Tire Mounted Sensor. The information is important for the design and integration with the vehicle monitoring system.

### 2.2 SCOPE

This document applies to the Michelin TMS. This document does not intend to restrict or specify any hardware or software. The intent is only to specify the functionality and advanced features of the TMS.

### 3 TIRE MOUNTED SENSOR

#### 3.1 MAJOR FUNCTIONS

The main functions are:

- Detect if wheel is in motion (rotation) or not.
- Identify Tire type with an ID.
- Monitor and transmit temperature and battery voltage.
- Data will be transmitted using Bluetooth Low Energy 4.2 advertisement.

#### 3.2 TMS-AF-01 BLOCK DIAGRAM

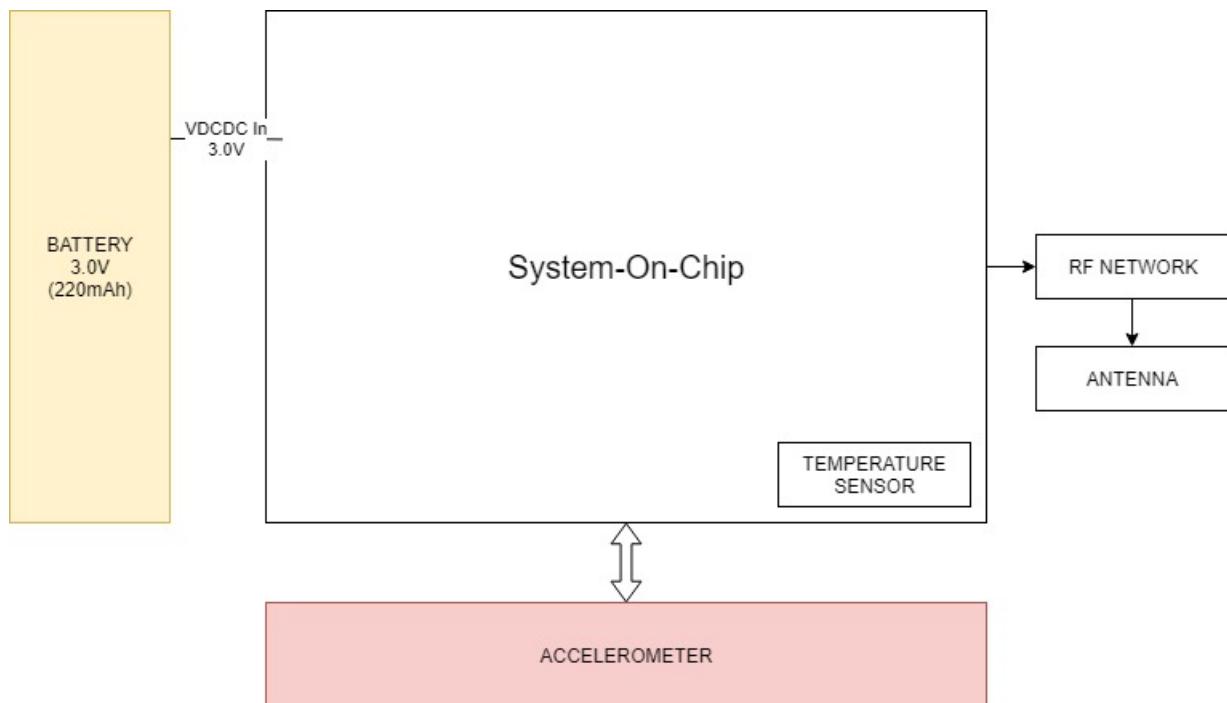


Figure 1 - Block Diagram

#### 3.3 TMS-AF-01 LIFETIME

The sensor has been designed to meet the 3-years lifetime target.

## 4 TMS-AF-01 SYSTEM MODES

### 4.1 TMS-AF-01 MODE EXPLANATION

#### 4.1.1 STATIONARY MODE

Stationary mode is used when the TMS is not in motion. There is no transmission to conserve battery life.

#### 4.1.2 ADVERTISING MODE

Advertising mode is used when the TMS detects continuous motion. This mode has a regular transmission at the interval of 1 sec. Each block contains 3 frames. Please refer to section 4.3 for more details on RF transmission.

If motion stop for more than 30 seconds, it will return to stationary mode.

## 4.2 RADIO TRANSMISSIONS

### 4.2.1 BLUETOOTH LOW ENERGY

RF transmissions are done using BLE 4.2 advertisements. When the device transmits data, it sends a single frame (as described below in section 4.2.2 BLE FRAME FORMAT) on the 3 standard BLE advertising channels 37, 38 and 39 (respectively 2402MHz, 2426MHz and 2480MHz), one after the other.

The device does not handle BLE scan requests nor BLE connection establishment.

### 4.2.2 ADVERTISING INTERVAL

When the device detects continuous motion, it starts sending regular BLE advertisements.

During that time, the device sends one BLE advertising frames (on each three channels in a row) every 1000ms (+ a pseudo random delay of 0 to 10ms).

### 4.2.3 BLE FRAME FORMAT

TMSAF01 RF frames shall have the structure below:

Preamble	Access Address	Advertising PDU				CRC
0xAA	0x8E89BED6	Header		Payload		3 bytes
		PDU type (1 byte)	Payload length	Advertising Address (6 bytes)	Advertising Data	

The modulation method used is GenFSK.

#### 4.2.3.1 PREAMBLE

The preamble of each frame is 0xAA as described in the BLE 4.2 specification.

#### 4.2.3.2 ACCESS ADDRESS

The access address of each frame is 0x8E89BED6 as described in the BLE 4.2 specification.

#### 4.2.3.3 ADVERTISING PDU – HEADER

PDU type used is ADV\_NONCONN\_IND (0x02), which means that the advertisement is non-connectable and undirected according to the BLE 4.2 specification.

#### 4.2.3.4 ADVERTISING PDU – PAYLOAD

The advertising PDU payload contains both the advertising address and the advertising data

#### 4.2.3.5 ADVERTISING PDU – PAYLOAD – ADVERTISING ADDRESS

Each device has a unique BLE MAC address as described in the BLE 4.2 specification which is included in the frames.

#### 4.2.3.6 ADVERTISING PDU – PAYLOAD – ADVERTISING DATA

Flags			Complete Local Name			Manufacturer Specific Data			
0x02	0x01	0x06	0x0E	0x09	"MICHELIN TIRE"				
Length	AD Type	Flags	Length	AD Type	Local Name				

#### 4.2.3.7 FLAGS

Each message will start with a flag field.

Flags		
0x02	0x01	0x06
Length	AD Type	Flags

#### 4.2.3.8 COMPLETE LOCAL NAME

Each message will contain complete local name.

Complete Local Name		
0x0E	0x09	"MICHELIN TIRE"
Length	AD Type	Local Name

#### 4.2.3.9 MANUFACTURER SPECIFIC DATA

Each message will contain Michelin company ID.

Manufacturer Specific Data									
0x0C	0xFF	0x0828	0x01	0x01	1 byte	1 byte	0x43 0x55 0x50 ("CUP")	0x01	1 byte
Length	AD type	Michelin Company ID	TMS Beacon flag	Frame type	Temp (°C) -60 .. 195	Vbatt (V) 1 .. 3,55	Tire type ID	Active flag	Overall cycle counter

TMS Beacon Flag is hardcoded to 0x01

Frame Type is hardcoded to 0x01

#### 4.2.3.10 TEMPERATURE BYTE

The temperature value is one byte of data. The transmitted temperature is in the range as given in table below:

Temperature Value	Description
0x00 to 0xFF	Valid temperature range: -60°C to 195°C

#### 4.2.3.11 BATTERY VALUE BYTE

The battery value is one byte of data. The transmitted value is in the range as given in table below:

Battery Value	Description
0x00 to 0xFF	Valid battery value: 1V to 3.55V

#### 4.2.3.12 *TIRE TYPE ID*

The Tire type ID is a 3 bytes hardcoded value set to “0x43 0x55 0x50”.

#### 4.2.3.13 *CYCLE COUNTER VALUE BYTE*

The cycle counter value is one byte of data. The transmitted value is in the range as given in table below:

Cycle Counter Value	Description
<b>0x00 to 0xFF</b>	Valid cycle counter value: 0 to 255