Zone DPMX
Theory of operation. Revision 2
10th August 2016

Introduction

The device measures the power output of a cyclist. It is fitted to the cyclist's shoes. On each shoe there is a *pod* fixed to a *base* that is attached to the top of the shoe. Each base is attached by a cable to a *force sensor plate* underneath the shoe. The pod and the base communicate with each other via a 3 pin wired serial data interface.

Pod

The pod contains a microcontroller, motion sensors, a 2.4 GHz radio transceiver using ANT+, and a rechargeable battery.

In operation the two pods (one on each shoe) make regular force and motion sensor measurements, and calculate power, cadence and other appropriate values. The two pods communicate with each other via the radio transceivers, with one of the pods acting as master and the other pod as slave. The master pod merges its own data with the data from the slave pod, and transmits the merged data via the radio transceiver to a listening device for display and/or recording.

Radio

The radio system uses the standard ANT protocol to communicate between the two pods on a pair of shoes, with a short burst of data approximately 8 times per second. The master pod uses the standard ANT+ protocol (see www.thisisant.com) to send the data to any listening ANT+ device with a short burst of data approximately 4 times per second.

The radio transceiver in each pod is a Nordic Semiconductor nrf24AP2 chip, with antenna matching circuit and an *inverted-F* PCB trace antenna. The nrf24AP2 chip is pre-programmed by Nordic Semiconductor with all the ANT protocol behaviour. The chip has 78 software selectable radio channels from 2.403 GHz up to 2.480 GHz.

In operation, the software controls the radio to select only 2 of the radio channels. It selects 2.451 GHz for communication between a master pod and a slave pod, and it selects 2.457 GHz for communication between a master pod and a bike computer that is typically mounted on the handlebars of the bike.

The master pod transmits for 200 µS 4 times per second on 2.457 GHz. The slave pod transmits for 200 µS 8 times per second on 2.451 GHz.

Battery

The battery in the pod is a 3.75 V (nominal) 150 mAh rechargeable lithium-ion battery. To recharge it, the end user removes the pod from the base and inserts the pod into the charging dock.

User control

The only user control on the device is on/off via a press switch on the top of the pod.

A flashing LED visible on the top of the pod indicates that the device is on, and is used to indicate battery charge level and other operational states.

Base

The base contains a microcontroller and analogue amplifiers. It has a wired connection to the force sensor plate, and has a 3-pin interface to the pod for serial communications and power.

The analogue amplifiers receive analogue signals from the attached force sensor plate.

There are no user controls on the base.

Force sensor plate

The force sensor plate is connected by wire to the base. The sensor plate contains 4 piezoceramic force sensors. There are no electronic components in the sensor plate. The piezoceramic sensors provide very small current signals to the amplifiers in the base. The current signals are in the low nA range, and vary with the applied force.

Charging Dock

The charging dock is primarily for charging the batteries in the pods. It has a USB interface, a set of indicator LEDs, and two 3-pin connectors for two pods.

The charging dock is powered via the USB connector by any standard USB power source. It will automatically charge the battery of a pod, and will stop charging once the battery is fully charged.

The charging dock can also be used to update the firmware in a pod. To do this the user must run the *Zone Controller* software on a PC, connect the charging dock via USB to the PC, and insert the pods. In this mode the software on the PC will communicate with the charging dock via USB, and will provide updated firmware if it is available.

There are no user controls on the charging dock.