TDM WP - Wireless Parking Control System

Technical Manual

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1 Foreword

TDM WP sensors can be integrated in parking systems to control the parking bays occupancy and therefore are proposed as an efficient alternative to the inductive loops.

The purpose of this system is to monitor parking spaces in real-time so as to create file archives containing important information for parking management. Data can be available to users in real time - for example via smart phones or variable message signs.

This kind of information, if appropriately processes, opens a possibility to provide different services, such as:

- **Real time information** about the number and the location of vacant parking spaces
- **Monitoring of restricted access areas**, in order to prevent and detect infringements
- **Monitoring of reserved areas**, e.g. disabled parking bays, loading zones, etc.
- **Reduction of checking operations**
- **Alert system for illegal occupancy** of pay parking spaces
- **Pay by phone services**
- **Advance booking of parking spaces**
- **Statistics** about occupancy rate, turnover, average occupancy time, parking distribution and revenues per day / week / month / year
- **Identification** of the most suitable fees based on supply and demand in each parking area

The TDM WP system is based on a low-consumption wireless sensor and on a patented detection technology. More precisely, the detection is based on **three different technologies**:

- **Variation in incident light (patent pending)**
- **Active infrared**
- **Magnetic field sensor**

The combination of three technologies guarantees a very high accuracy compared with conventional sensors based only on magnetic technology or ultrasounds.

Wireless transmission at 868 MHz enables a direct communication from sensors to the repeater even at great distances from the Access Points without wired connections, typical of inductive loops.

The main advantages of the TDM WP system are:

- **Quick and easy installation** - the wireless technology allows the installation of a sensor in about 15 minutes, using standard equipment and materials for road works

- **Completely independent power** - the sensor battery life is 10 years guaranteed
- **Easy maintenance** - the presence of an outer casing allows a simple and quick replacement of the sensor in less than 5 minutes
- **Excellent performance** - the vehicle detection efficiently uses the combination of three technologies

2 System architecture

2.1 Local transmission through serial port

The minimal system architecture configuration is set so that the sensor, which is installed in the road surface, will communicate the detected parking data to a repeater installed nearby, typically on a street pole at an height of at least 3 meters. The repeater forwards the data to a system hub.

The data about parking space occupancy are available through UART serial ports. Third-party companies can choose their own devices to interface and acquire data. The integration with third-party components is extremely simple, thanks to the data transfer and decoding protocols that we provide to system integrators, upon request.

The components of a basic configuration to monitor the parking spaces are:

- **TDM WP sensors - at least one for each parking bay**
- **TDM WP repeater - it can manage up to 50 sensors (max recommended distance between repeater and sensors is 100 m)**
- **TDM WP hub able to manage up to 10 repeaters**

2.2 Transmission to the server

The TDM WP system can be also configured to send data to a remote server. In this case the data can be processed and used as input for software and mobile applications. To do so, the hub is integrated into an Access Point placed in a suitable housing and powered by a solar panel (typ. 20/30 W) or directly through a 230Vac power supply. The Access Point can send data to the server via GPRS / 3G / 4G. See the example shown in Fig. 2.1.

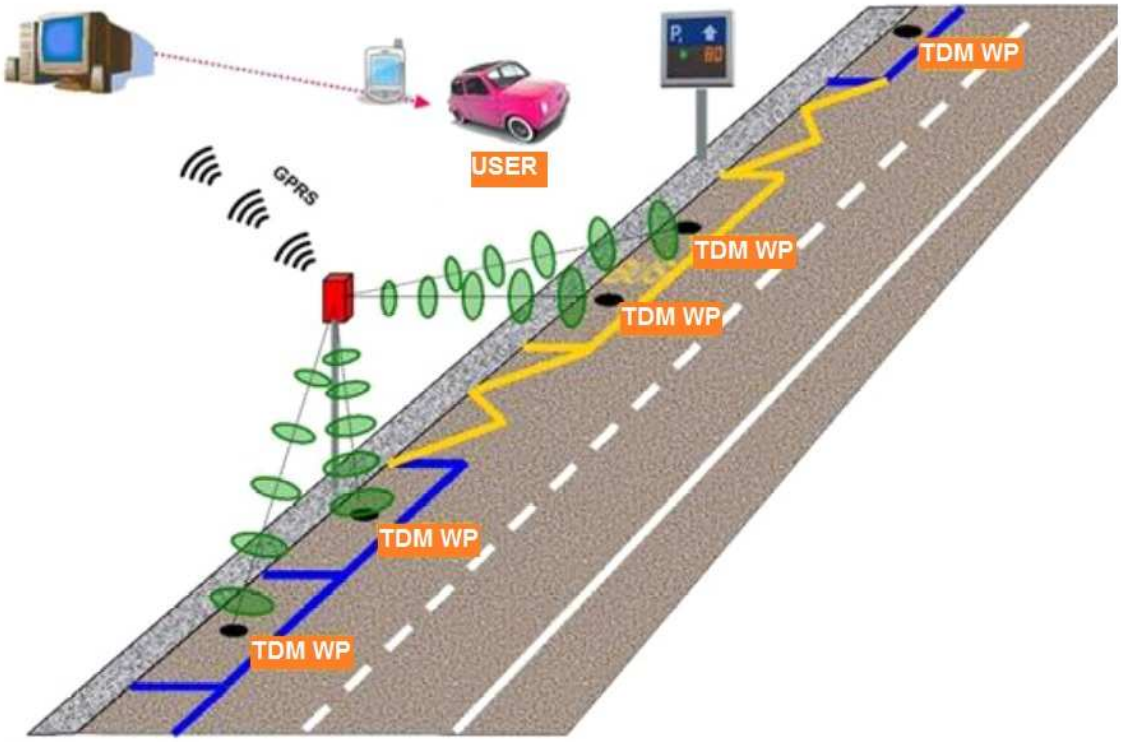

Fig. 2.1. *TDM WP - System Architecture for Parking Spaces Control*

3 System components

3.1 System Hub

The Hub is a concentrator for wireless data acquisition from the sensors.

It is really small (39 mm x 29 mm) and can manage up to 500 sensors (through 50 repeaters).

All the data about parking space occupancy are available through UART serial ports.

Third-party companies can choose their own devices to interface and acquire data directly from the Hub.

Fig. 3.1. *TDM WP - Hub*

3.2 Access Point

The Access Point collects data from all the sensors assigned to it (through repeaters). It features the data packaging and data transfer to the remote server via GPRS / 3G / 4G or IP link.

The Access Point is composed by 2 main units:

- The hub, operating as a concentrator for wireless data acquisition from sensors (868 MHz - max 10 repeaters)
- A data logger for data capture, storage and real-time transmission

The Access Point is typically placed in a IP65 housing which is installed on a street light pole. It can receive data up to great distances from repeaters - max 500 m - then granting an high

flexibility in the choice of the installation site, considering the presence of public power supply, orientation of solar panels, presence of obstacles, availability of IP data network, etc.

Power supply can be realized with simple Solar Panels (approx 20W) or using the public power supply grid and a 12V transformer.

Fig. 3.2. *Access Point installation*

3.3 Repeater

The repeater collects data from the sensors assigned to it and send them to the Hub or to the Access Point. The maximum recommended distance between sensor and repeater is 100 meters.

The repeater is placed in a waterproof housing and is typically installed on a lamppost at an height of at least 3 meters.

The repeater is battery powered and doesn’t need an external power supply.

Fig. 3.3. *Repeater*

3.4TDM WP sensor

The sensor is embedded in the asphalt in the center of a parking bay. The installation takes place in a short time using resins or cement and upon the removal of a asphalt core of 130 mm of diameter and a 80 mm depth.

After the placement, the sensor is able to auto calibrate itself without any intervention by the operator. TDM WP sensors have autonomous power supply with an high capacity and low discharge rate battery pack.

The housing is made to create a waterproof rigid volume which is able to protect the electronics from rainwater and from mechanical stresses caused by the passing vehicles. The features of these housings allow a simple extraction of the sensors, making possible a rapid maintenance work. See Fig. 3.4 and 3.5.

TDM WP sensors send data to the repeater via 868 MHz radio link.

Fig. 3.4. *TDM WP sensor*

Fig. 3.5. *Sensor installation*

Key features of the sensors are:

- **Real time vacancy detection** in both indoor and outdoor parking areas
- **Triple detection technology** (variation in incident light, IR detection, magnetic field changes detection) that guarantees an accuracy higher than 99%.
- **Self-calibration**
- **Quick and easy installation** (wireless technology reduces installation time)
- **Easy integration** with parking management systems, thanks to open protocols (available upon request).
- **Autonomous power supply** (sensor battery life is 10 years)
- **Easy maintenance** (the outer case helps to replace a sensor in less than 5 minutes)
- **Italian patent** n.0001379287 released on 30/08/2010

4 Technical specifications

4.1 Repeater

Physical characteristics

- Operating temperature: from -20 ~ +80°C
- Battery life: higher than 3 years
- Dimensions: 110 x 110 mm, H 66 mm
- Mounting: into a proper waterproof housing

Data transmission

- Data transfer protocol via radio: proprietary
- Working frequency: 868 MHz (ISM - unlicensed band)
- Receiver sensitivity: -110 dBm
- Radio range:
  - Repeater to Hub / Access Point: up to 500 m
  - Sensor to Repeater: up to 100 m

European Conformity (CE)

- Directive 1999/5/CE (R&TTE)
- ETSI EN 301 489-1 (Electromagnetic compatibility and Radio spectrum Matters - EMC standard for radio equipment and services-Common technical requirements)
- ETSI EN 301 489-3 (Electromagnetic compatibility and Radio spectrum matters - Specific conditions for SRD operating from 9KHz to 40GHz)
- EN 300 220-1 (Short Range Devices. Radio equipment used from 25 MHz to 1 GHz: technical characteristics and test method)
- CEI EN 55022 (radiated emissions)
- CEI EN 61000-4-2 (electrical discharge immunity)
- CEI EN 61000-4-3 (radiated electromagnetic field immunity)

4.2TDM WP sensor

Physical characteristics

- Operating temperature: -20 ~ +80°C
- External size: Ø 110 mm, H 85 mm
- Installation hole: Ø 130 mm
- Casing material: fiber reinforced nylon
- Weight: 1000 g
- Power supply: thionyl chloride battery (3,6 V - 19Ah)
- Battery life: 10 years
- Average consumption < 1mW

Data capture

- Detection mode: TRIPLE TECHNOLOGY:
  - Incident ambient light change (Italian patent n°0001379287)
  - Active Infrared
  - Magnetic field
- Sampling rate: 1 Hz

Data transmission

- Data transfer protocol via radio: proprietary TDMA, in compliance with IEEE802.15.4
- Working frequency: 868 MHz (ISM - unlicensed band)
- Transmitter power: 14dBm
- Receiver sensitivity: -110dBm
- Useful radio range (sensor to repeater): up to 100 m

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4.3 Access Point

Physical characteristics

- Operating temperature: from -15 ~ +70°C
- Data logger dimensions: 160 x 88 x 63 mm
- Power supply: 12-24 Vdc
- Average current consumption: 160 mA @ 12Vdc (GPRS included)
- Backup internal battery: lithium battery 3.7V 1400 mAh (2H and 20 min of autonomy)
- Mounting: into a proper waterproof housing

Data transmission

- Data transfer protocol via radio: proprietary TDMA
- Working frequency: 868 MHz (ISM - unlicensed band)
- Number of programmable channels: 10
- Individual channel width: 100 kHz
- Transmitter power: +14 dBm
- Receiver sensitivity: -110 dBm
- External antenna connector (868 Mhz): SMA 50 ohm
- Radio range (Repeater to Hub / Access Point): up to 500 m

Processing and storage module (AP)

- Operative system: embedded Linux
- CPU: AM335x, 1GHz ARM® Cortex-A8
- RAM 512 MB, flash 4 GB
- 1x micro SD card slot
- 1x USB 2.0 port
- 1x Ethernet 10/100 port
- 1x RS232 port
- 1x RS485 port
- GPRS module for remote data transmission
- External antenna connector GSM / GPRS: SMA 50 ohm

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