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# **TII492 Intelligent Transport Systems (ITS) Equipment Supply and Installation Framework**

## **Volume A: Works Requirements**

### **Part 3: Technical Specification Section 4: Traffic Monitoring Units**

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# 1. INTRODUCTION

## 1.1 Introduction and Scope

TMUs are the range of equipment used for detecting the presence of vehicles on the road network and measuring various parameters related to those vehicles and their passage.

TMUs utilise different technologies to detect and measure, including, embedded Inductive Loop Detectors.

TMU equipment shall be capable of monitoring, storing, processing and communicating traffic data collected by the equipment located across the road network. TMUs shall be located in roadside cabinets or other housings at locations across the road network. The TMUs shall communicate with and transmit data to TII's C2 Cloud data hosting service, Asset and Fault Management System (AFMS) and Associated Services.

The relevant TII standards shall be met, which include but are not limited to;

- CC-SCD-01530 - Installation Drawing TCC - Inductive Loop Test Certificate;
- The Contractor is responsible for ensuring AIDs comply to the TII standards. Where upon request, the evidence of compliance to the TII standards shall be provided:
- CC-SCD-01530 - Installation Drawing TCC - Inductive Loop Test Certificate;
- CC-SCD-01538 - Installation Drawing TCC - Loop (Inductive) - All Purpose Roads Details of Feeder Cable Slots;
- CC-SCD-01540 - Installation Drawing TCC - Loop (Inductive) - All Purpose Roads Details of Carriageway Chamber;
- CC-SCD-01539 - Installation Drawing TCC - Loop (Inductive) - All Purpose Roads Details of Entry to the Footway;
- CC-SCD-01541 - Installation Drawing TCC - Loop (Inductive) - All Purpose Roads Detail of Signal Duct Chamber;
- CC-SCD-01543 - Installation Drawing TCC - Loop (Inductive) All - Purpose Road Turning, Queue and Speed Measuring Loops -Sheet 1;
- CC-SCD-01544 - Installation Drawing TCC - Loop (Inductive) All - Purpose Road Speed Measuring Loops -Sheet 2;
- CC-SCD-01545 - Installation Drawing TCC - Loop (Inductive) All - Purpose Road Speed Measuring Loops -Sheet 3;
- CC-SCD-01542 - Installation Drawing TCC - Loop (Inductive) - All Purpose Roads Chevron Loops;
- CC-SCD-01547 - Installation Drawing TCC - Loop (Inductive) All - Purpose Road Mova Loops;
- CC-SCD-01546 - Installation Drawing TCC - Loop (Inductive) All - Purpose Road Typical Loop Configuration;
- CC-SCD-01538 - Installation Drawing TCC - Loop (Inductive) - All Purpose Roads Details of Feeder Cable Slots;
- CC-SCD-01540 - Installation Drawing TCC - Loop (Inductive) - All Purpose Roads Details of Carriageway Chamber.

The Contractor shall test and commission TMU in accordance with this specification and Volume A - Part 4: Testing and Commissioning Specification.

## **2. GENERAL REQUIREMENTS**

### **2.1 Date and Time**

All TMU equipment shall be configured to Greenwich Mean Time (GMT) or as specified by the Employer.

All TMUs shall be capable of automatic Daylight savings clock changes.

### **2.2 Data Format and Data Return**

The data format shall be agreed with the Employer.

The date and time of the data shall be clearly indicated by a timestamp, which shall be at the start or end of the time period, depending on the user configuration of the TMU.

The TMU shall upload all required data to TII's data hosting service and / or other designated systems to fulfil the requirements set out in this Section.

TMU shall be configurable to push data on a configurable time period.

Data to be returned must include individually identifiable and accessible Per Vehicle Records (PVR) and / or aggregated data as specified by the Employer.

Internal data storage shall be appropriately sized to allow for storage of PVR for a period of at least 90 days. Data from the internal storage shall be automatically retrievable for a period of 90 days and stored in non-volatile memory.

Overwritten data shall be on the basis of first in first out i.e. most recent 90 days shall remain intact.

The TMU shall support the separation of different configurable time bins and different configurable classification bins. These bins shall be definable by the Employer as required.

### **2.3 Site Setup**

Each TMU shall be equipped with a local interface to facilitate the Employer or the Contractor to test the correct operation of the TMU. The interface can be either wired or wireless. The Employer or the Contractor via the interface using a portable PC or similar shall be able to undertake the following tasks:

- Observe the operation of the detector in real time;
- Monitor the current flows;
- Monitor the current occupancy level;
- Access all stored flow levels;
- Monitor the speed of vehicles;
- Observe vehicle classification;
- Reconfigure device parameters;
- Re-set any equipment faults including self-resetting of the TMU itself; and
- Set the state of relay outputs (where available) for test purposes.

Each TMU shall be equipped with an interface to facilitate the Employer or the Contractor to establish remote communications with the TMU to facilitate;

- Monitor correct operation of the TMU;
- Data upload or download;
- Reconfigure device parameters;
- Observe the operation of the detector in real time; and
- Software / Firmware updates.

## **2.4 Power**

Internal setup parameters, including site specific details, date and time and other programmable data shall be maintained through a memory backup battery in the event of a power failure.

TMU units shall be equipped with a standby power source. In the event of power failure, or disconnection, the standby power source shall take over maintaining the full functionality of the unit under normal operating conditions for 120 hours. The 90-day saved memory shall be retained in the event of a power loss.

## **2.5 Processing**

The TMU shall be required to process and present data for transmission to the Employer.

## **2.6 CE Marking**

The Contractor shall ensure all TMU equipment has appropriate CE marking. Contractors should note The National Standards Authority of Ireland (NSAI) are the national certification authority for CE Marking in Ireland.

## **2.7 Detector Loops and Feeder Cables**

All loops shall be installed in accordance with, Series 1500 “Motorway Communications” of the Specification for Roadworks Volume 1 and specifically clause 1523 Detector Loops. Loops shall be installed at equipment locations identified in the drawings. For the purposes of this contract each TMU location shall operate using two loops per lane.

The change of inductance caused by a metal vehicle passing over the loops shall be monitored and a presence indicated when the change of inductance exceeds a sensitivity threshold.

### **2.7.1 Presence Events**

Presence events derived from the loops in each lane shall be monitored. Where there are two loops in a lane the passage of a vehicle shall only be registered if the events overlap (i.e. there is a period of concurrent presence). As each vehicle traverses the loop array and is computed by the TMU as a ‘valid vehicle’ it shall be assigned a vehicle number.

### **2.7.2 Vehicle Speed**

Where a valid vehicle is registered, the speed of a vehicle shall be determined from the arrival event at each loop and the distance between the leading edge of the upstream loop and the leading edge of the downstream loop.

The distance (i.e. the loop separation) shall be a configurable parameter which can be changed remotely or at the TMU interface at each specific site.

### **2.7.3 Headway**

The headway is defined as the time difference between the leading edge of the currently processed vehicle record and the leading edge of the previous vehicle. The measurement shall have a resolution of 100ms and shall have a maximum value of 3600 seconds. If the value exceeds 3600 seconds, then 3600 seconds shall be registered.

## **3. VEHICLE RECORDS**

### **3.1 Classification**

The vehicle classification shall be determined by the loop signature profile generated by a vehicle passing over the detector loops.

The vehicle classification system shall be capable of determining a minimum of 7 different vehicle classes.

The vehicle classification system shall determine the following 7 vehicle types with stated accuracy levels (or other vehicle classifications agreed with the Employer):

1. Motorbike;
2. Car; (accuracy 96% at 95% confidence threshold)
3. Light Goods Vehicle (LGV); (accuracy 90% at 95% confidence threshold)
4. Bus;
5. Heavy Goods Vehicle (HGV) rigid; (accuracy 90% at 95% confidence threshold)
6. HGV articulated; (accuracy 90% at 95% confidence threshold) and
7. Caravan – car or LGV pulling a trailer.

The count accuracy shall be 99% with 95% confidence threshold for vehicles crossing loop (or other sensors).

### **3.2 Vehicle Detection and Associated Data Records**

The TMU shall be capable of pushing time stamped, PVR information via TII's DNS service (currently [tmus.tii.ie](https://tmus.tii.ie)).

The TMU shall be capable of providing real time PVR locally at the roadside for SAT and Verification purposes.

The TMU shall be capable of storing data at the roadside for a minimum of 90 days irrespective of number of vehicles per day on any given site (the contractor shall programme the TMU to avail of this minimum storage requirement).

The TMU shall communicate with the C2 Cloud at predetermined time intervals and "push" the information to C2 Cloud. The data is currently sent every 10 minutes.

The TMU shall be capable of resending unsend data packages to C2 Cloud in the event of a break in communication.

The PVR record shall include;

- Site reference;
- Date;
- Time;
- Vehicle Speed in kilometres per hour (configurable);
- Vehicle Length in metres (configurable);

- Vehicle Classification in accordance with classification;
- Lane Number/Name;
- Direction of Travel (including 'reverse notification' for wrong direction vehicles);
- Headway (in seconds);
- Gap (in seconds);

The TMU shall have the capability to identify 'straddling' vehicles and thus shall include these vehicles in the correct traffic / lane count as required.

The TMU shall be capable of providing real time data records, both locally and returned to the Associated Services, regarding:

- Suspect flag;
- Fault information; and
- All incoming data from WIM Sites.

### **3.2.1 Per Vehicle Record (PVR) Data**

PVR data is required for in-depth data analysis of traffic patterns. In addition, the C2 cloud is required to aggregate and store the PVR information as detailed previously on a lane-by-lane basis in time 'bins' blocks/intervals.

These time intervals shall be configurable by the Employer as required.

### **3.2.2 Storage Capacity**

In relation to storage of records, the TMU shall have the capacity to store the following:

- capacity for 200,000 PVR records per day;
- capacity for 90 days storage (minimum) for both PVR and aggregated traffic statistics; and
- ability to expand storage capacity via upgrades of 50%, 100% or 200% memory.

It shall also be noted that if the TMU allocates memory on a day-by-day basis, then the user shall be able to configure / define the storage per day.

## **4. TMU EQUIPMENT REQUIREMENTS**

### **4.1 Core Performance Requirements**

The Contractor shall demonstrate that the TMU equipment supplied under the Contract has a mean time between failures of at least 50,000 hours.

The TMU shall be configured to:

- Provide fault reporting;
- Provide and hold a fault log detailing fault time and date;
- Produce a monthly report on all faults;
- Hold fault log in memory for retrieval up to 6 months; and
- Allow fault clearance by registered user following repair and update the fault monitoring systems to record the time the fault was repaired.

### **4.2 Inputs**

Inputs in relation to inductive loops are as follows:

- Two lanes of two loops per lane (minimum requirement);
- Four lanes of two loops per lane;
- Six lanes of two loops per lane;
- Eight lanes of two loops per lane; and
- Ten lanes of two loops per lane.

### **4.3 Telemetry**

Any telemetry options must be capable of allowing the unit to push the data to C2 and are to include an automated periodic data upload and data provision in response to a request from C2 Cloud, configurable by the user, dependent on location, number of daily records etc.

The telemetry shall include the following data:

- PVR data;
- Traffic statistics;
- Power details;
- Battery (batteries) voltage;
- Current TMU date and time;
- Storage used as percentage of capacity;
- TMU configuration; and
- Date and time of previous successful communications transmission.

The TMU shall provide data continuously or at intervals as directed by the Employer and shall be capable of both.

The TMU shall have the appropriate firmware to facilitate remote communications. This firmware shall enable remote on-line configuration and set up of the TMU as well as the ability to alter the clock timings and reset the device if so required.

#### **4.4 Loop sensitivity**

All loop boards shall allow the user to adjust the gain/sensitivity to suit local site conditions.

#### **4.5 Enclosure Construction and Operation**

TMU equipment shall be supplied in self-contained modular units.

TMU equipment shall be easily manageable by maintenance personnel, i.e. the mass and dimensions of each TMU shall not make it difficult to move/replace.

The TMU housing shall be passive in design to minimise impact in the case of collision.

The TMU housing shall be sufficiently insulated to remove the possibility of cold weather having an adverse impact on the performance of the equipment.

#### **4.6 Performance Criteria**

The following information relating to TMU performance criteria shall be provided by the Contractor;

- Battery life (by type/capacity of battery) both with communications in use 100% of each day polling once a minute and 100% of each day with the minimum polling period;
- Accuracy of readings - The Contractor shall provide a TMU that meets the following performance criteria in terms of classification;
  - Classify 99% of Cars (+/- 1%) at a 95% confidence level;
  - Classify 90% of LGVs (+/- 1%) at a 95% confidence level;
  - Classify 85% of HGVs (+/- 1%) at a 95% confidence level; and
  - Counts 96% of all Vehicles crossing the loop sensors in a 24-hour period (+/-1%) at a 95% confidence level.
- The Contractor shall provide statistics (percentage) on the accuracy of readings for classification/volume indicating that the above minimum requirements can be met.

#### **4.7 Hardware Equipment**

TMU equipment shall be supplied in both self-contained units and/or 3U 19" rack models.

Enclosure shall comply with the requirements of EN 60529 (Degrees of Protection Provided by Enclosures).

Modularity in Hardware and Software is required in view of the operation and maintenance requirements and future growth and enhancement of the Traffic Monitoring System.

TMU equipment elements supplied shall meet the following requirements:

- Industry Standard Interfaces and fixings shall be used throughout;

- Readily available from multiple manufacturers;
- Modular in design (as far as is reasonably practical);
- Flexible (allowing for enhancement of hardware / functional capabilities);
- Subject to low maintenance requirements;
- Easily serviceable;
- Not be restricted to one service provider in the case of Communications Equipment (Modem/Router); and
- Self-diagnostic to the greatest extent.

Electrical/electronic components supplied shall be provided by multiple suppliers and shall not be restricted to long lead times but instead be readily available.

In their Works Proposals, the Contractor shall provide details of any TMU components which have long lead times (greater than 7 days) and specify the lead in times for these components.

All equipment and its component parts shall be supplied new and manufactured from new apparatus.

## 5. COMMUNICATIONS

The TMUs shall communicate with local devices, in-station systems and data hosting services via one or more of the following (to accommodate both local and remote communications):

- RS232 serial or parallel communications;
- 10/100mbps network interface via RJ45 Ethernet connector;
- USB and Bluetooth;
- Fibre Optic Cable; or
- In-built integrated cellular communications.

The TMU shall be IP compatible and capable of transmitting data via the following communication mediums:

- 4/5G cellular (via TCP/IP);
- GPRS (via TCP/IP);
- GSM; and
- Fibre.

The Contractor following liaison with the Employer shall engage the network service provider.

Where a TMU has a SIM card installed it shall be the data only type (no voice). The Employer shall be able to switch network provider by replacement of the SIM card only. A change of network provider shall not require;

- The upgrade or reconfiguration of TMU hardware (other than replacement of SIM card);  
or
- The reconfiguration of any onboard firmware.

The TMUs shall be configurable to supply data to more than one destination if required.

Where an IP based system is used, IP addresses and network details will be provided by the Employer.

The TMU shall be fitted with a suitable interface to allow remote / local control of the TMU by means of a laptop PC.

The TMU shall be capable of being switched between remote and local / manual control.

The TMU shall be equipped with an interface for use by the Employer or maintenance personnel to check the correct operation of the TMU. The Contractor shall provide modems or other suitable connections and associated ancillaries to provide connectivity to C2 Cloud.

## 6. POWER

All proposed TMU sites shall be powered via one or a combination of the following sources:

- Renewable Power Source;
- Mains Power.

The Contractor shall install a backup battery system at all proposed TMU sites. The battery system shall be recharged by either the renewable power source or the mains power supply.

The TMU shall be designed to automatically switch between power sources without loss of data or performance.

The status of all power sources used within TMU equipment shall be relayed to C2 Cloud.

Where renewable power is the primary power source, the TMU shall remain fully operational all-year round using the solar and/or wind generators, with the battery providing the appropriate level of backup for winter months when day light is limited. The Contractor shall submit to the Employer details of the minimum battery life (by type/capacity of battery) with equipment in use 100% of each day.

Where directly connected to mains power, the equipment supplied shall have capability to operate from a single phase mains supply and operate correctly within a voltage of 230V over a frequency tolerance range of +10% to -10%.

The TMU shall be fitted with a means of isolation from all electrical supplies, to include for connections to alternative sources of power connections such as battery / solar power. Electrical supplies shall automatically be isolated in the event of a vehicle colliding with the cabinet.

Following a removal of the supply or a power failure, the TMU shall automatically restart itself without manual intervention within 6 minutes after mains power is restored.

Following power failure, the TMU shall automatically switch to alternative backup power sources capable of powering the TMU for a period in excess of 120 hours under normal operating conditions.

Power supply components shall be modular in nature to facilitate efficient upgrade or replacement in the case of component failure. Replacement or upgrade shall not be restricted by a system which necessitates components unique to one manufacturer.

Power supplies shall be designed to maximise efficiency whilst minimising ongoing maintenance requirements and both risk of and resistance to vandalism.

## 7. FAULT MONITORING AND ALERTS

The TMU shall be able to detect and report to C2 Cloud and/or the Employer's AFMS (as and when detected) the following fault and alert conditions. This shall relate to both PVR and traffic statistics data. Each fault/alert report shall be configurable and can be switched on/off by the Employer.

The TMU shall have the following fault identification and reporting functionality:

- Fault alert on detection of faulty loop (shorted or open circuit);
- Fault alert on comms when it is reestablished following a comms failure; and
- Fault alert on low battery (see power alert requirement below).

Detector fault information shall identify the detector and, if appropriate, channel(s). A 'suspect flag' shall be assigned to the traffic data for a lane or site if there is a loop fault on the associated lane or site (open circuit or short circuit).

In the event of a power related fault, information regarding this fault shall be communicated instantly to C2 Cloud and AFMS.

### 7.1 Faults

The TMU shall detect and communicate the following fault types:

- Power source has been 'lost' or restricted;
- Battery Low Voltage (below Employer configurable specified level);
- Loop / sensor fault per lane;
- Electronic Component Failure;
- Cabinet Door Open;
- Real-Time Clock Fault;
- Communication Error; and
- Tamper alert (if the feature is available with the TMU).