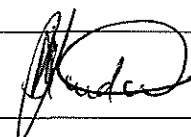
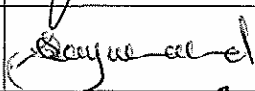
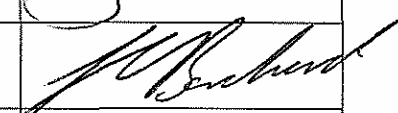


A division of Transnet limited

**TECHNICAL  
RAILWAY ENGINEERING  
SPECIFICATION**

**SYSTEM REQUIREMENT SPECIFICATION FOR  
DESIGN, SUPPLY, INSTALL, TEST AND  
COMMISSION AND MAINTENANCE OF THE  
THEFT DETECTION SYSTEM ON THE  
OVERHEAD TRACTION LINES**

|              |                      |             |   |
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Technology Management

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# TABLE OF CONTENTS

|  |           |
|--|-----------|
| <b>1. SCOPE .....</b>  | <b>4</b>  |
| <b>3. REFERENCES AND APPLICABLE DOCUMENTATION .....</b>            | <b>4</b>  |
| 3.1. SABS .....  | 4         |
| 3.2. OTHER .....   | 4         |
| 3.3. SPOORNET .....  | 4         |
| 3.4. DRAWINGS DETAILING OVERHEAD TRACTION LINE CONSTRUCTIONS ..... | 5         |
| <b>4. METHOD OF TENDERING.....</b>                                 | <b>6</b>  |
| <b>5. ENVIRONMENTAL CONDITIONS.....</b>                            | <b>6</b>  |
| <b>6. GENERAL SYSTEM DESCRIPTION.....</b>                          | <b>6</b>  |
| 6.1 GENERAL SYSTEM REQUIREMENTS .....                              | 7         |
| 6.2 SYSTEM DEFINITION .....  | 7         |
| 6.3 SYSTEM CONFIGURATION .....                                     | 8         |
| 6.4 SYSTEM CHARACTERISTICS .....                                   | 9         |
| 6.4.1 <i>Theft Detection and Alarm Generation</i> .....            | 9         |
| 6.4.2 <i>Tamper Detection and Alarm Generation</i> .....           | 9         |
| 6.4.3 <i>Theft Location</i> .....                                  | 9         |
| 6.4.4 <i>Alarm Notification</i> .....                              | 9         |
| 6.4.5 <i>Tracking and Escalation</i> .....                         | 10        |
| 6.4.6 <i>Visible Alarm Indications on FMU</i> .....                | 10        |
| 6.5 SYSTEM COMPONENT REQUIREMENTS.....                             | 10        |
| 6.5.1 <i>Component configuration and operation</i> .....           | 10        |
| 6.6 DATA COMMUNICATIONS NETWORK (DCN).....                         | 12        |
| 6.7 POWER SUPPLY REQUIREMENTS .....                                | 13        |
| 6.7.1 <i>FMU Power Supply</i> .....                                | 13        |
| 6.7.2 <i>SCU Power Supply</i> .....                                | 13        |
| 6.7.3 <i>NMS Power Supply</i> .....                                | 14        |
| 6.8 FMU/SCU COMMUNICATIONS .....                                   | 14        |
| 6.8.1 <i>Operating Frequency Band</i> .....                        | 14        |
| 6.8.2 <i>RF Power Output</i> .....                                 | 14        |
| 6.8.3 <i>RF Communications Protocol</i> .....                      | 14        |
| 6.8.4 <i>Communications Failures</i> .....                         | 14        |
| 6.8.5 <i>SCU/NMS Communications</i> .....                          | 15        |
| 6.9 PHYSICAL CHARACTERISTICS .....                                 | 15        |
| 6.9.1 <i>High Voltage Creepage Distances and Clearances</i> .....  | 15        |
| 6.9.2 <i>Enclosure requirements for the FMU</i> .....              | 15        |
| 6.9.3 <i>Installation</i> .....                                    | 15        |
| 6.10 SYSTEM MANAGEMENT REQUIREMENTS .....                          | 16        |
| 6.10.1 <i>System Operation</i> .....                               | 16        |
| 6.10.2 <i>Hardware Platforms</i> .....                             | 16        |
| 6.11 FUNCTIONAL REQUIREMENTS .....                                 | 16        |
| 6.11.1 <i>Fault Management</i> .....                               | 16        |
| 6.12 CONFIGURATION MANAGEMENT .....                                | 18        |
| 6.13 MAINTENANCE MANAGEMENT .....                                  | 18        |
| 6.14 SECURITY MANAGEMENT .....                                     | 19        |
| <b>7. DESIGN AND CONSTRUCTION .....</b>                            | <b>19</b> |
| 7.1 ENCLOSURE .....  | 19        |
| 7.2 ELECTROMAGNETIC COMPATIBILITY REQUIREMENTS .....               | 19        |
| 7.2.1 <i>Electromagnetic Compatibility (EMC)</i> .....             | 19        |

|       |  |    |
|-------|--|----|
| 7.3   | RELIABILITY .....  | 19 |
| 7.4   | MAINTAINABILITY .....                                    | 19 |
| 7.5   | AVAILABILITY .....                                       | 20 |
| 7.5.1 | <i>Failure of a Managed Section</i> .....                | 20 |
| 7.5.2 | <i>Failure of the NMS Server</i> .....                   | 20 |
| 7.5.3 | <i>Failure of a Remote Monitoring Workstation</i> .....  | 20 |
| 8.    | DOCUMENTATION .....                                      | 21 |
| 9.    | QUALITY ASSURANCE AND TYPE TESTING .....                 | 22 |
| 10.   | COMMISIONING, ACCEPTANCE AND IN-SERVICE EVALUATION ..... | 23 |
| 11.   | INSTALLATION TIME FRAME .....                            | 24 |
| 12.   | ANNEXURE 1 .....   | 25 |

## GLOSSARY

|      |                                       |
|------|---------------------------------------|
| DCN  | Data Communications Network           |
| FMU  | Field Monitoring Unit                 |
| ISM  | Industrial, Scientific and Medical    |
| NMS  | Network Management System             |
| OAU  | Officer Acknowledgement Unit          |
| PSTN | Public Switched Telephone Network     |
| SCU  | Section Controller Unit               |
| SMS  | Short Message Service                 |
| SU   | Sensing Unit                          |
| TTDS | Traction Line Theft Detection System  |
| UPS  | Un-interruptible Power Supply         |
| SLA  | Service Level Agreement               |
| ITU  | International Telecommunications Unit |

## 1. SCOPE

This specification defines the functional requirements of a high voltage overhead traction line theft detection and alarm system for Spoornet. The system will be evaluated on the 3kV DC traction line system, and should the technology be successful this type of system could also be deployed on the 25kV AC and 50kV AC traction lines and signaling cables of Spoornet. This alarm system is intended to detect cable theft attempts, determine the location of the theft attempt in progress and to alert the responsible operating and security personnel to enable them to take swift and rapid action to apprehend the suspects. The theft detection system thus has to be fully compatible with the above 3kV DC, 25 kV AC and 50 kV AC system voltages.

## 2. Background

Spoornet operates approximately 18000 km of electrified lines on national level. The power to these lines is supplied via copper and aluminum overhead conductors. These conductors however are being targeted by thieves who steal and then sell the metal back to the industry. These actions of theft present major problems to Spoornet in that trains are running late, pantograph hookups occur and clients are pursuing alternative methods of transporting their goods.

## 3. REFERENCES AND APPLICABLE DOCUMENTATION

Unless otherwise specified all material and equipment shall comply to the following standards, specifications, drawings and recommendations where applicable:

### 3.1. SABS

- SABS 1019 Standard voltages, currents and insulating levels for electrical supply
- SABS 1222 Enclosures for electrical equipment.

### 3.2. OTHER

- ♦ ETSI EN 300 683 "Electromagnetic compatibility and Radio spectrum Matters (ERM); Electromagnetic Compatibility (EMC) standard for Short Range Devices (SRD) operating on frequencies between 9kHz and 25 GHz"
- ♦ ETSI EN 300 220-1 "Electromagnetic compatibility and Radio spectrum Matters (ERM). Short range devices. Technical characteristics and test methods for radio equipment to be used in the 25MHz to 1000MHz frequency range with power levels ranging up to 500mW; Part 1: Parameters intended for regulatory purposes"

### 3.3. SPOORNET

- CSE 1154 001 Environmental specification for Spoornet railway signalling systems
- Electrical Safety Instructions – 1999
- CEE.0224 Drawings, Catalogues, Instruction Manuals and Spares Lists for Electrical Equipment Supplied under Contract.
- BBB 4728 version 1 Method for Testing and Evaluating a system Theft Detection System on the High Voltage Overhead Traction Lines

### 3.4. DRAWINGS DETAILING OVERHEAD TRACTION LINE CONSTRUCTIONS

Please note that only relevant drawings and diagrams have been supplied

- CEE-TMGC-0003 SHT 001.TIF
- CEE-TMGC-0014 SHT 001 AMD 05.TIF
- CEE-TMGC-0014 SHT 002 AMD 04.TIF
- CEE-TMGC-0017 AMD 03.TIF
- CEE-TMGC-0018 SHT 001 AMD 01.TIF
- CEE-TMGC-0018 SHT 002 AMD 01.TIF
- CEE-TMGC-0019 SHT 001 AMD 01.TIF
- CEE-TMGC-0019 SHT 002 AMD 01.TIF
- CEE-TMGC-0020 AMD 01.TIF
- CEE-TMGC-0021 SHT 001 AMD 01.TIF
- CEE-TMGC-0021 SHT 002 AMD 01.TIF
- CEE-TMGC-0027 AMD 01.TIF
- CEE-TMGC-0023 SHT 002 AMD 01.TIF
- CEE-TMGC-0023 SHT 001 AMD 01.TIF
- CEE-TMG-0049 AMD 05.TIF
- CEE-TMG-0053.TIF
- CEE-TMG-0056 SHT 001 AMD 01.TIF
- CEE-TMG-0058 SHT 001 AMD 02.TIF
- CEE-TMG-0058 SHT 002 AMD 03.TIF

#### 4. METHOD OF TENDERING

Tenderers shall indicate clause-by-clause compliance with the specification. This shall take the form of a separate document listing all the specification clause numbers indicating the individual statement of compliance or non-compliance. This document can be used by tenderers to elaborate on their response to a clause.

Tenderers shall motivate a statement of non-compliance.

Where equipment offered does not comply with standards or publications referred to in this specification, tenderers shall state which standards apply and submit a copy in English.

Tenderers shall submit descriptive literature consisting of detailed technical specifications, general constructional details and principal dimensions, together with clear illustrations of the equipment offered.

It should be noted that a compulsory site meeting will be scheduled. Should a tenderer not attend this site meeting, he will be precluded from the tender.

The Tenderer shall also tender and quote separately on the following deliverables:

- Development and supply of hardware in terms of this specification
- Development and supply of software in terms of this specification
- Installation and commissioning of the complete system onto site for evaluation
- Evaluation of components and the system in terms of Specification BBB 4278 version 1
- Full documentation in terms of clause 8 of this specification

#### 5. ENVIRONMENTAL CONDITIONS

The outdoor elements of the system shall be designed to meet the following environmental conditions:

- a. Temperature Range: -15 to 55 degrees Celsius.
- b. Humidity: as high as 86%
- c. Direct sunlight
- d. Vandalism (throwing of stones and shot with catapult)
- e. Lightning: 12 ground flashes/sq. km/annum

#### 6. GENERAL SYSTEM DESCRIPTION

The system called for is known as Spoornet's Traction Line Theft Detection System (TTDS).

## 6.1 GENERAL SYSTEM REQUIREMENTS

In order to reduce high operational costs, a radio communication based system is required. This implies that a system based on fiber optics, IR beams, reflection technology or any other technology based system, apart from a radio communication based system, will not be considered.

It is of utmost importance that the system's radio communication backbone will be accomplished by means of infrastructure that is fully Spoornet owned. This implies that the systems backbone radio communication will not be reliant upon infrastructure that is not owned by Spoornet and is solely used for the TTDS.

The system will comprise of some type of sensing device that detects the act of theft or attempted theft and then raises an alarm.

This alarm message then has to be communicated to a remote management system in order that some corrective action may be initiated.

To facilitate timeously response to this notification of theft the relevant information regarding the location as well as the time of the theft shall be communicated in the shortest time possible.

Simultaneously, the reaction force responsible for patrolling the particular area shall be notified of the incident. This reaction force may be remotely stationed and provision has to be made for this possibility.

The flow of events shall be tracked and logged for reference and further evaluation. This information must be made available in report (hard copy) format as well as all other information regarding events and actions.

## 6.2 SYSTEM DEFINITION

The main role of the TTDS is to continuously monitor Spoornets high voltage overhead traction lines, detect all attempts of theft and to alert the reaction forces in good time of verified attempts of theft to enable them to take swift and appropriate action.

The system and equipment shall be reliable (not raising false alarms), robust, cost-effective and maintenance friendly. Minimum human intervention shall be required for the reliable operation of the system.

The primary functional requirements of the system are:

- Theft detection and generation of associated alarms.
- Determination and identification of the location of the theft attempt.
- Immediate notification of the theft attempt to the system operator, the responsible reaction forces and responsible field officers.
- Monitoring and logging of reaction time (logging of the time when the responsible reaction force officer reaches the area of the attempted theft).
- Logging of all the alarms and events.
- Tracking and logging of initiated actions.
- Escalation of events based on operational procedures.

- Generation of detail management reports regarding all events and actions.
- Supervisory functions such as monitoring of the power supply and health status of the system elements.

### 6.3 SYSTEM CONFIGURATION

The architecture of the TTDS system is shown in Figure 6.3-1.

- Sensing Units (SUs)

The SUs shall be used to detect the theft incidents and communicate these messages to the FMUs.

- Field Monitoring Units (FMUs)

The FMUs will be deployed at regular intervals along the overhead traction lines to be protected. FMUs in a managed section will only communicate with the allocated SCUs for that specific section.

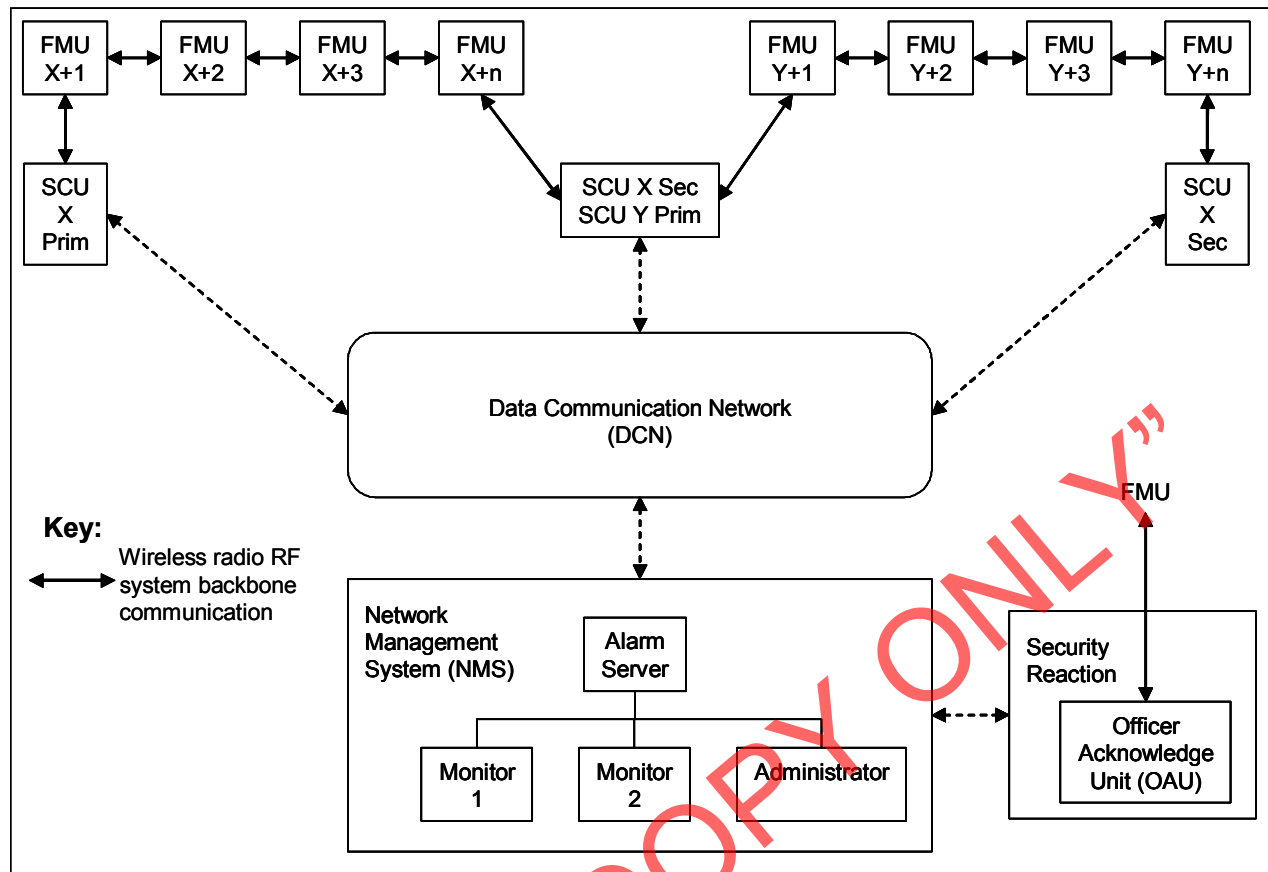
- Section Controller Units (SCUs)

The lines will be divided into managed sections and each managed section will be controlled by two SCUs, a main SCU and a secondary SCU. The SCUs will acquire and identify all the data (alarms, system alerts and telemetry data) received from its associated FMUs and then forward the data to the NMS via a reliable Data Communications Network (DCN).

- Officer Acknowledge Unit (OAU)
- Network Management System (NMS)

The DCN shall utilise various services (a private switched network, GSM, the PSTN and wireless data services) to ensure fast and reliable transfer of data to the NMS. At the NMS the data will be processed. System alerts will be forwarded to the system operator via the administrative workstation and alarm messages to the responsible reaction forces via the monitoring workstations. The responsible reaction force shall then dispatch field reaction officers to the identified site for visual inspection. When reaching the site the field reaction officers shall be able to log their presence at the site in order that the system automatically can verify and log that they have indeed visited and inspected the site identified by the system. The field reaction officer will use the Officer Acknowledge Unit (OAU) to acknowledge the identification of the alarm via the appropriate FMU. The OAU is a remote control unit (coded transmitter) that can communicate with a FMU, via radio communication, to acknowledge an alarm. The FMU will in turn send the alarm acknowledgement signal to the NMS via the other FMUs (in the same line segment with the SCU) and the appropriate SCUs. At the NMS the alarm acknowledgement signal will be logged for reporting purposes.





**Figure 6.3-1: Traction Line Theft Detection System (TTDS) Architecture**

## 6.4 SYSTEM CHARACTERISTICS

### 6.4.1 Theft Detection and Alarm Generation

The system shall be able to reliably (no false alarms) detect any theft attempts or tampering on any of the conductors constituting a typical traction line as depicted in various drawings listed in paragraph 3.4 (i.e. the Contact, the Catenaries and the Feeder conductor). The system shall then generate an appropriate alarm to signal the condition.

### 6.4.2 Tamper Detection and Alarm Generation

The system shall be able to reliably (no false alarms) detect any tampering with the FMU's and SCU's. The system shall then generate an appropriate alarm to signal the condition.

### 6.4.3 Theft Location

The system shall be able to pinpoint and unambiguously identify the location of a theft attempt of a traction line within at least a 900m segment of the line.

### 6.4.4 Alarm Notification

The system shall automatically notify the responsible reaction force of the theft attempt within 3 minutes after detecting a theft alarm. The field officer on duty of the responsible reaction force shall be notified of the assumed theft attempt and the location thereof.

#### 6.4.5 Tracking and Escalation

The system shall:-

- have the means and capability to automatically log all the alarms and events generated, and to track the actions taken by the system operators and the reaction forces to enable performance evaluation of the operators and reaction forces.
- be capable to automatically record the time it takes field officers to reach the identified area and to identify the field officer (by means of the OAU which is a coded transmitter issued to all on-duty field officers)
- automatically without operator assistance escalate the events according to operational procedures if required.

#### 6.4.6 Visible Alarm Indications on FMU

In the event of a theft, the FMU shall visually indicate the theft section so that it can be seen at night by a reaction force from a distance of at least 200m. This will enable the field officer to acknowledge the alarm by means of the OAU.

The visible alarm indication shall also show which high voltage line segment caused the alarm at the FMU. This implies that the visible alarm indication shall indicate which of the two high voltage line segments, monitored by that FMU, caused the alarm condition.

### 6.5 SYSTEM COMPONENT REQUIREMENTS

#### 6.5.1 Component configuration and operation

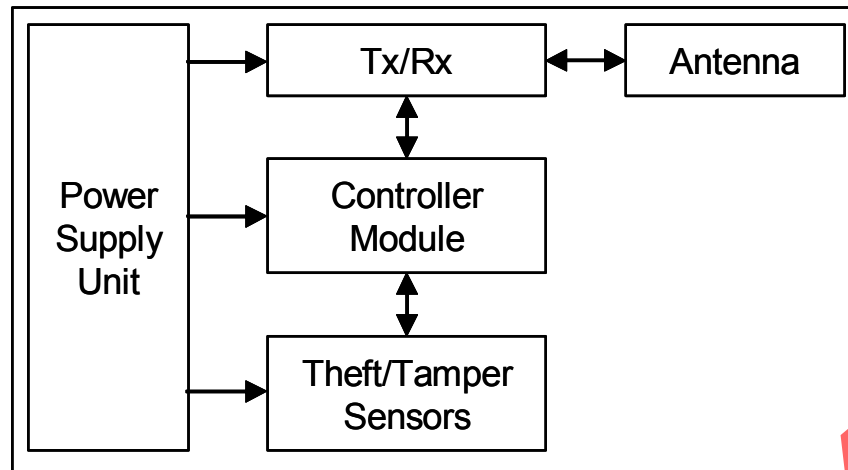
##### 6.5.1.1 Sensing Unit (SU)

The SU is typically a detector to determine the theft of assets, comprising a power supply, sensors and a low power radio transceiver with its antenna.

##### 6.5.1.2 Field Monitoring Unit (FMU)

The FMU will consist of a power supply module, anti-tamper sensors, a controller module and a low power radio transceiver with its antenna as shown in Figure 6.5-1. The FMUs shall be responsible to monitor the high voltage traction lines by means of suitable SU's sensors and to communicate the status of the SU's to the SCU on a regular basis. It shall also incorporate tamper sensors to detect any tampering with the unit or its SU's. Any tampering with the unit shall be communicated to the SCU. The operational status of the unit i.e. power availability and power usage shall be **communicated to the scu**.

The units shall be installed on the traction line infrastructure in such a way that it cannot easily be reached and/or damaged. The units shall be installed at regular intervals to meet the requirements for determination of the location of all theft attempts and reliable communications.



**Figure 6.5-1: Block Diagram of FMU**

### 6.5.1.3 Section Controller Unit (SCU)

The SCU will comprise a processor, a communications controller and a low power radio transceiver, dry contact monitoring and control relays, and a power supply unit as shown in Figure 6.5-2. The function of the SCU is to communicate on a regular basis with the FMUs via its low power transceiver within a selected managed section. Data received shall be processed and interpreted to determine the status of all the FMUs and if any theft attempt or tampering with a unit is identified. The SCU shall immediately notify the NMS via the DCN.

Equipment alarms e.g. power supply failures, and changes in the status information of the FMUs, as well as any telemetry data shall also be forwarded to the NMS. The SCU shall furthermore receive calls from the NMS with regard to the status of specific FMUs and respond with the required information. The power availability shall continuously be monitored and the status communicated to the SCU.

The SCU shall be responsible to determine if a FMU fails. This implies that the communications protocol between FMUs and the SCU shall be designed to make provision for a scenario when one or more FMUs fail. An unavailable FMU shall immediately be reported to the NMS.

Each managed section shall be controlled by two SCUs for redundancy to ensure reliable communications with the FMUs and to enhance the integrity of the alarm information received by the SCUs. When one or more FMUs fail and communication is lost with some of the FMUs due to the failure, the secondary SCU shall take over control of the FMUs that are isolated due to the FMU failure. When managed sections are deployed in tandem the primary SCU of a section can function as the secondary SCU of the neighbouring section. The NMS will be responsible to correlate and synchronize information received from the two SCU's of a managed section.

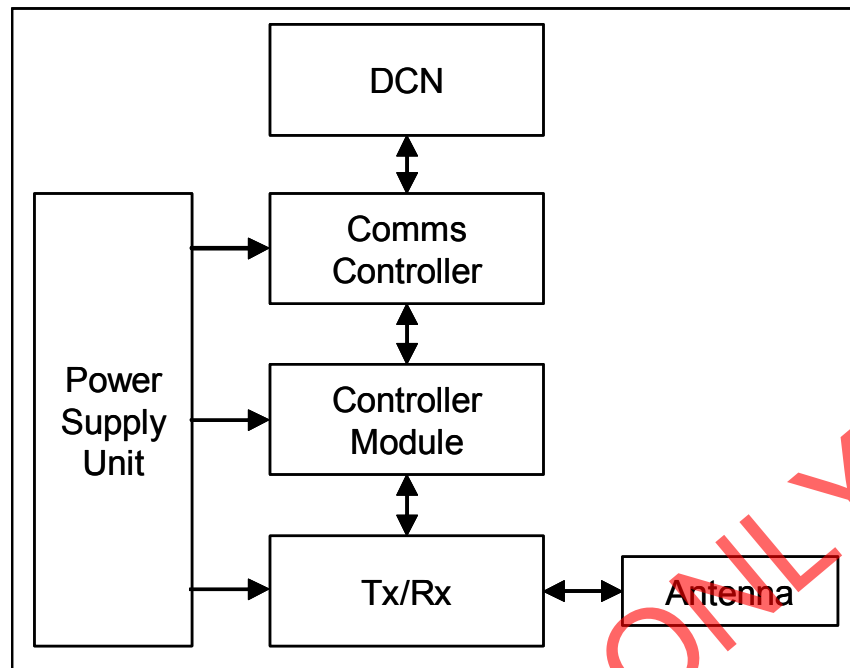


Figure 6.5-2: Block Diagram of SCU

#### 6.5.1.4 Officer Acknowledgement Unit (OAU)

The OAU is a battery powered remote control unit (coded transmitter) that can communicate with a FMU, via radio communication, to acknowledge an alarm. This unit is used by the field officer to acknowledge a FMU alarm condition. In order to ensure that the field officer is at the scene of the alarm condition the effective range of the OAU will be limited to a maximum of 30m.

#### 6.5.1.5 Network Management System (NMS)

The NMS shall be based on a client/server architecture with a communications interface to the Data Communications Network. The NMS shall incorporate a database, which shall reflect at all times the network configuration in terms of the FMUs and SCUs. The NMS shall receive messages from the SCUs, process the information and identify theft attempts and tampering. The NMS shall then be responsible to notify the responsible reaction forces and field officers via the PSTN, the cellular networks (voice and/or SMS) and/or a paging network. Provision shall also be made to communicate directly with delegate systems located at the control rooms of the responsible reaction forces.

### 6.6 DATA COMMUNICATIONS NETWORK (DCN)

The DCN shall facilitate reliable communication between the SCUs and the NMS by utilising various communication services i.e. the Public Switched Telephone Network (PSTN), Cellular networks, Transnet Data network or packet based data services (Swiftnet).

## 6.7 POWER SUPPLY REQUIREMENTS

### 6.7.1 FMU Power Supply

- The electrical energy for a FMU shall be supplied by a solar panel, which shall be of sufficient capacity to simultaneously charge a sealed lead acid battery and support the normal operation of the FMU.
- The battery shall be of sufficient capacity to provide minimum continuous operation of the FMU for 120 hours without charging.
- The condition of the battery i.e. State of Charge shall continuously be remotely monitored and communicated to the NMS via the SCU.
- Abnormal current drawn by the FMU elements, indicating potential fault conditions shall be detected and communicated to the NMS via the SCU.

### 6.7.2 SCU Power Supply

- The electrical power for a SCU shall be supplied by an UPS from the 230V 50 Hz Spoornet voltage supply. In the traction substation.
- The UPS shall be of sufficient capacity to ensure continuous use of the SCU of at least 4 hours in the event of mains failure. This UPS is to be supplied by the contractor as part of the TTDS. The UPS shall be designed to meet the following environmental conditions.

- The UPS shall operate within the limits laid down in this specification and shall be capable of withstanding all or a combination of the following environmental conditions:
- Environmental conditions:

Altitude: 0 to 1800 m above sea level.

Maximum altitude without derating shall be 1800m above sea level. The derating shall be in the order of not more than 2,0% for every 100m above 1800m.

Ambient temperature: Minus 5° C to plus 45° C.

Relative humidity: As high as 95% (non-condensing)

Lightning conditions: 11 flashes/km<sup>2</sup>/annum

Interference: severe switching surges and noise typical to heavy industrial environment.

The UPS permitted load shall be derated with continuous operation at high ambient temperature: 20% at 40°C.

- Electrical supply:

Input Voltage: 230V ± 10% Single Phase

Output Voltage: 230V ± 10% Single Phase

Frequency: 50Hz ± 5%

- Any failure of mains power shall be communicated to the NMS.

For typical voltage waveforms see Annexure 1 (ATTACHED).

### **6.7.3 NMS Power Supply**

- The electrical power for the NMS shall be supplied by UPS, using a single set of batteries.
- The UPS shall be of sufficient capacity to ensure continuous use of the NMS of at least 8 hours in the event of mains failure. This UPS is a client furnished item and will be available as part of the Spoornet infrastructure.
- Any failure of mains power shall be detected. The time without power shall be tracked and escalated over time.

## **6.8 FMU/SCU COMMUNICATIONS**

The communications between the FMUs and its associated SCUs shall be via wireless radio frequency communication.

The following requirements shall be met.

### **6.8.1 Operating Frequency Band**

The system shall operate in any one of the approved ISM frequency bands for ITU Region 1.

### **6.8.2 RF Power Output**

The power output of the FMU and SCU transceivers shall not exceed 100mW.

### **6.8.3 RF Communications Protocol**

The RF protocol shall ensure that the communications between FMUs, and FMU/SCU are reliable and not susceptible to interference and simultaneous transmissions of neighbouring FMUs. The communications protocol shall further ensure that an FMU fault can be identified to a specific individual FMU and that an alarm condition can be identified to a specific high voltage traction line segment.

### **6.8.4 Communications Failures**

The System shall be able to detect communication failures between FMUs and FMU/SCU and identify the faulty unit. In the event of a communication failure the NMS shall initialise an automatic restoring procedure.

## **6.8.5 SCU/NMS Communications**

### **6.8.5.1 DCN Communication Services**

The SCU/NMS communications shall be via an integrated DCN. The DCN shall be designed to utilise the following available communications services where applicable:

- Packet Data Services i.e. FastNet. Radio pads shall be used.
- Data services via the cellular networks using GSM modems (data or GPRS).
- Dialup data services via PSTN or the private switched network of Transnet using dial-up modems.

The SCUs and NMS shall be able to support all these services where applicable. At least two of these services will be available at each SCU site.

A Remote Access Server (RAS) with authentication capabilities shall be used at the NMS server side to handle large traffic volumes. (This is an operational system requirement, but is not included in the initial requirement for the evaluation system).

### **6.8.5.2 Least Cost Routing**

The system shall be able to support least cost routing algorithms to ensure that available communication services are used cost effectively.

### **6.8.5.3 Automatic Re-routing**

The system shall be able to automatically select one of the standby communication services, based on the least cost routing algorithm should the primary communication service be unavailable.

## **6.9 PHYSICAL CHARACTERISTICS**

### **6.9.1 High Voltage Creepage Distances and Clearances**

All equipment mounted on or in close proximity to high voltage equipment shall comply with the clearances and creepage distances as described in the Electrical Safety Instructions.

### **6.9.2 Enclosure requirements for the FMU**

The enclosure shall be such that it blends in with the Spoornet infrastructure. From the ground the solar panel shall not be visible, and shall form part of the enclosure.

### **6.9.3 Installation**

Provision shall be made to install the FMUs on all the different overhead traction line constructions (infrastructure) used by Spoornet. All the drawings that details the various constructions are listed in paragraph 3.4.

## **6.10 SYSTEM MANAGEMENT REQUIREMENTS**

### **6.10.1 System Operation**

The TTDS consists primarily of a network of FMUs that communicate via a token-based RF protocol with each other and the SCUs. The SCUs in turn communicate to the Network Management System (NMS) server via the DCN by one of three possible means: dialup modem, GSM modem or X25 radio pad (Fastnet). The NMS client workstations are in turn connected to the NMS via an Ethernet TCP/IP network.

The principle of operation is that the FMUs are connected to sensors that can determine whether and in which direction a cable has been cut. This alarm is then transmitted back to the two closest SCUs (one on either side), which then transmit to the NMS. The NMS then correlates both alarm signals and stores it as a single alarm, from where it is sent directly to a predefined Reaction Unit via SMS or Pager message. The Monitoring Client workstation then displays the alarm along with its location and reference data.

Besides alarm conditions, the systems status is also monitored on a regular basis. Each SCU polls the FMUs in its section for status data that gets sent back to the NMS, which is consequently displayed on the Admin Client workstation. Equipment failures can thus be clearly detected, so that in case of an FMU failure, polling of status data can continue uninterrupted via a secondary path.

Maintenance of the traction line cables in a particular section is also facilitated by virtue of disabling (masking) events from that section with the aid of the Admin Client workstation.

The NMS is a Regional Management System that is solely responsible for management of devices directly linked or connected to it within its own region. The incorporation of regional NMS servers into a National Management System is not required.

### **6.10.2 Hardware Platforms**

The NMS server platform shall be an Intel Pentium class computer with a Windows 2000 operating system. The Microsoft SQL Server database shall be used for the repository.

Client workstations shall be Pentium class computers with Windows 9x/NT/2000 operating systems.

The SCU will be a combined unit consisting of at least an embedded 386/486-computer board and an FMU transceiver connected via a serial port.

## **6.11 FUNCTIONAL REQUIREMENTS**

### **6.11.1 Fault Management**

#### **6.11.1.1 Alarm Interfaces**

The SCU will receive theft and tampering alarms from the FMUs in the form of fixed length frames, defined as Alarm Frames, through a serial RS232 port. These alarms are then processed and passed on to the NMS using the TCP/IP protocol stack, utilizing socket protocols.



### **6.11.1.2 Automatic Re-routing**

#### **6.11.1.2.1 Alarm Correlation**

Alarm correlation will be performed at the NMS server in order to eliminate duplicates of alarm instances and false alarm conditions.

#### **6.11.1.2.2 Alarm Delivery and Storage**

Processed alarms will be available for display at the operators terminal within 2 minutes of the alarm being detected at the FMU. As soon as an alarm is received, the operator will be informed at his/her terminal.

Capacity to store alarms for 30 days shall be provided.

Functionality for automatic archiving of alarm logs 30 days old or more shall be provided.

#### **6.11.1.2.3 Alarm Display**

All alarms received by the NMS server from the SCUs will be normalized and displayed in one of two ways, using a 'user friendly' Graphical User Interface (GUI).

- The first will be in an alarm list that displays most recent alarms first in a top – down fashion. This view may be filtered and sorted on time raised, alarm/event type etc.
- The second will be in a topological section diagram where the alarm will be represented as a red line segment.

The user will be notified as soon as a new alarm is received.

#### **6.11.1.2.4 Topology Display**

The network topology is to be represented as a highly visual graphical display of cable sections in the railway network.

The overhead track sections shall be depicted as lines between masts, which shall be displayed using symbols. Assuming that FMUs are mounted on the masts, the colour of the mast symbols shall reflect the current status of the related FMU.

The SCUs shall also be displayed as symbols.

#### **6.11.1.2.5 Trouble Ticketing**

Trouble tickets will be used to provide and monitor alarm notification to security and reaction units.

The trouble ticketing system will be able to process and store any queries, problems or comments provided by operators and end users.

Trouble tickets will include the following information:

- Time & date stamp of when ticket was raised
- Time & date when alarm was detected
- Ticket reference identifier

- Name, organisation and contact number of person raising the ticket
- Name and contact number of organisation that has been notified via SMS or pager
- Nature of alarm
- Location of alarm
- FMU identifier
- Action already taken/expected
- Priority of alarm (low, medium, high, immediate etc.)
- Status of trouble ticket (new, open, unresolved, closed etc.)
- Time & date stamp of when ticket was closed
- Escalation to supervisor when response time is exceeded. Mechanisms to be used are email and SMS.

Thirty-day storage capacity for trouble tickets shall be provided.

It will be possible to sort and filter the display of trouble tickets based on certain user stated parameters such as date raised, operator raising ticket, type of fault etc.

The NMS shall provide a facility for the management of Service Level Agreements (SLAs). Closed loop management of alarm notification through to acknowledgement and reaction will be implemented. This implies that the time of arrival of a field officer at an identified alarm area shall be time stamped and logged by the NMS for manage reporting.

An audit trail of user actions shall be maintained.

## 6.12 CONFIGURATION MANAGEMENT

Configuration data is defined as engineering, transmission and system parameters that are critical to the operation of the network devices.

The NMS platform shall be capable of receiving and interpreting configuration data from the FMUs and SCUs. The SCU will receive status from the FMUs in the form of fixed length frames, defined as Status Frames, through a serial RS232 port. These status frames are then processed and passed on to the NMS using the TCP/IP protocol stack, utilizing socket protocols. Typical equipment status will be battery state of charge, current consumption, FMU failure, etc.

The NMS platform will transfer configuration data to the SCUs.

Up to date FMU and SCU configuration information shall be stored in the NMS database.

## 6.13 MAINTENANCE MANAGEMENT

For the purposes of accommodating maintenance on the overhead track system, a maintenance scheduling module will allow user selectable sections to be disabled during allotted maintenance time intervals.

## **6.14 SECURITY MANAGEMENT**

Access to the NMS server and associated modules will be controlled on a user account & password basis. The customer IT manager will be able to control this.

Each user account will have a profile associated with it. The profile will define the modules and database areas that that particular user is authorized to access. The profiles will also state whether read/write or read only access is granted to that user or group of users.

Privileged actions will require a password before executing.

## **7. DESIGN AND CONSTRUCTION**

### **7.1 ENCLOSURE**

The FMU's and SU's of the system will be installed outdoors. The enclosures for these elements shall therefore meet the IP65 ratings as specified in SABS 1222 and shall be designed using materials to withstand the weather and sun radiation without degradation throughout its lifetime that shall exceed at least 10 years.

### **7.2 ELECTROMAGNETIC COMPATIBILITY REQUIREMENTS**

#### **7.2.1 Electromagnetic Compatibility (EMC)**

All the elements of the system that incorporates a radio transceiver shall meet the following requirements:

- a. ETSI EN 300 683 "Electromagnetic compatibility and Radio spectrum Matters (ERM); Electromagnetic Compatibility (EMC) standard for Short Range Devices (SRD) operating on frequencies between 9kHz and 25 GHz"
- b. ETSI EN 300 220-1 "Electromagnetic compatibility and Radio spectrum Matters (ERM). Short range devices. Technical characteristics and test methods for radio equipment to be used in the 25MHz to 1000MHz frequency range with power levels ranging up to 500mW; Part 1: Parameters intended for regulatory purposes"

### **7.3 RELIABILITY**

The system shall be robust and reliable to meet the availability requirement as stated in paragraph 7.5 below, taking into consideration that the Mean-Time-To-Repair (MTTR) will be less than 10 hours. During the TTDS industrialisation phase a reliability study shall be performed to demonstrate the achieved MTBF and to highlight possible hot spots.

### **7.4 MAINTAINABILITY**

The system shall be designed to be maintenance free excluding replacement of batteries in the SU's and the FMU's. Configuration of replaced faulty FMU's shall be done automatically and/or remotely by the system to enable the use of low skilled labour to implement unit replacements. All the FMU's shall incorporate facilities for easy upgrade of the software and charging of the batteries (if required) without removing the unit .

## **7.5 AVAILABILITY**

The availability of the system shall exceed 99.97%. The system shall be considered to be unavailable when any one of the following events occur:

### **7.5.1 Failure of a Managed Section**

A managed section shall be considered to have failed when any one of the following conditions occurs:

- a. Failure of the primary SCU.
- b. Failure of two or more FMUs in the one section.
- c. Loss of communications to the primary and secondary FMU.

### **7.5.2 Failure of the NMS Server**

If the NMS server fails due to a hardware failure or its communications and a back-up server is not available.

### **7.5.3 Failure of a Remote Monitoring Workstation**

Failure of any one of the remote monitoring workstations which will result in a region, comprising the monitoring of a number of managed sections at the responsible security and reaction force not being under surveillance.

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## 8. DOCUMENTATION

Detailed system documentation shall be provided. The documentation shall meet the requirements of CEE.0224 Drawings, Catalogues, Instruction Manuals and Spares Lists for Electrical Equipment Supplied under Contract and shall address the following:

- System description and operation
- Functional description of all the system elements and components.
- System drawings
- Installation procedures
- Configuration and set-up procedures
- Faultfinding and system maintenance procedures

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## **9. QUALITY ASSURANCE AND TYPE TESTING**

All the hardware components of the alarm system shall undergo type tests to ensure that it meets the requirements of the specification. Type tests certificates shall be provided for all type tests.

System acceptance tests shall be conducted in accordance with the specification BBB 4728 version 1 Method For Acceptance Testing And In-Service Evaluating Of A system Theft Detection System On The High Voltage Overhead Traction Lines.

Pre-deployment tests shall be conducted on a system prior to full-scale system deployment.

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## 10. COMMISSIONING, ACCEPTANCE AND IN-SERVICE EVALUATION

Once the alarm system has been installed on the designated site, commissioning of the hardware and software shall be done by the contractor.

Once functionality of the system been proved to SpoorNet's satisfaction, acceptance testing and in-service evaluation shall be carried out in accordance with specification BBB 4278 version 1.

The TTDS evaluation tests shall be performed to specification BBB...4278 version 1 Method For Acceptance Testing And In-Service Evaluating Of A SYSTEM Theft Detection System On The High Voltage Overhead Traction Lines

Method for Testing and Evaluating a Theft Detection System on the High Voltage Overhead Traction Lines.

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**11. INSTALLATION TIME FRAME**

The system alarm system shall be available for installation within three (3) months from placing business.

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## 12. ANNEXURE 1

A typical voltage waveform, which can be expected, is shown in figure 1 and its corresponding frequency spectrum (FFT) is shown in figure 2.

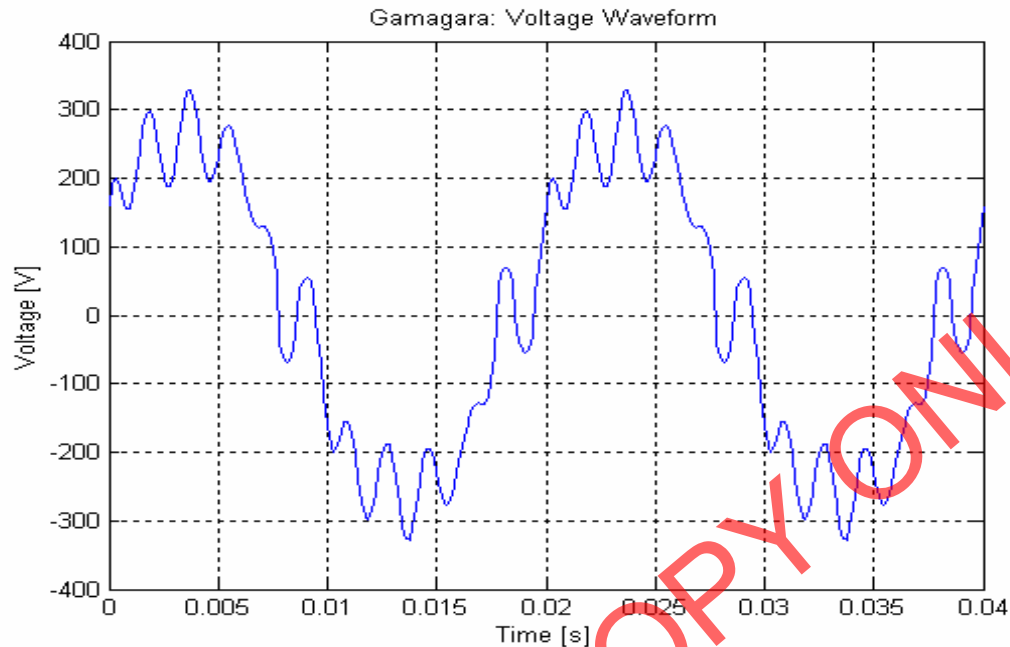
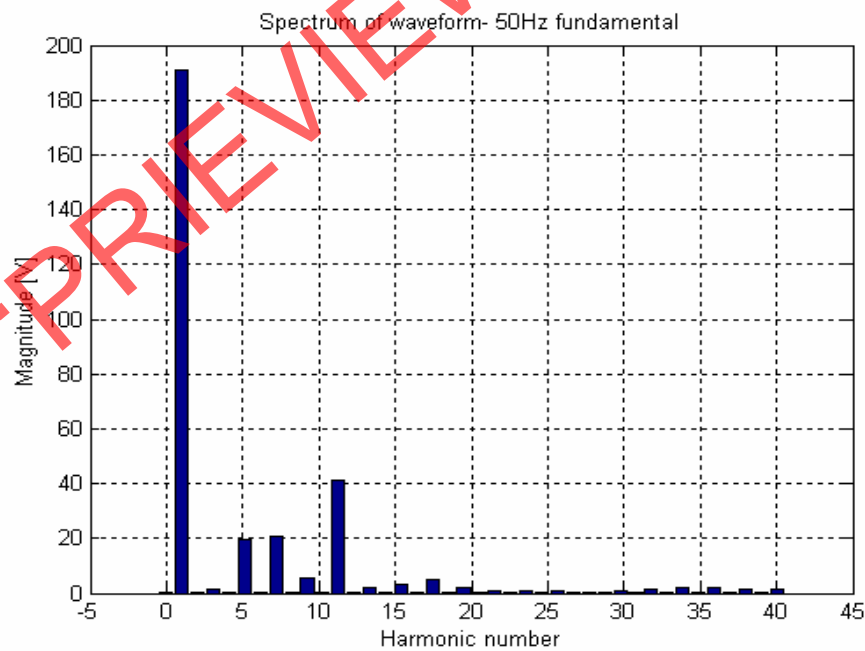


Figure 1: Voltage waveform under traction load ( $I_{\text{traction}} = 3000\text{A}$ )



**Figure 2: Frequency spectrum (FTT) of voltage waveform as shown in figure 1.**

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