ADAMA SCIENCE AND TECHNOLOGY UNIVERSITY

SCHOOL OF ELECTRICAL ENGINEERING AND COMPUTING

DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

# GSM Based Automation of TV Program Delivery

# (A Case Study on ORTVO Transmitter Stations)

By

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Master of Science in Communication Engineering

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# GSM Based Automation of TV Program Delivery

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## Declaration

I hereby declare that the work which is being presented in the thesis entitled, *GSM Based Automated TV Program Delivery* (A Case Study on ORTVO Transmitter Stations), submitted to Adama Science and Technology University (ASTU) in partial fulfillment of the requirements for the degree of Master of Science in Communication Engineering, is the result of my own research carried out under the supervision of Dr. Sultan Fiesso and all materials used and reproduced have been properly referred.

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Date: ___________________

This is to declare that the above statement made by the candidate is correct and true to the best of my knowledge.

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## Abstract

Remote monitoring system is a very important communications tool that will be extremely valuable to a multitude of broadcasting stations as well as industrial applications. ORTVO is a broadcasting media that has terrestrial transmitters (TV, FM) and generators for power standby at different zones in Oromia region. Out of 16 zonal transmitter stations of ORTVO, 9 stations have generators, VHF TV and FM transmitters all together and the rest 7 stations have generators and VHF TV transmitters. The core idea of this study is to identify problems that cause generators to fail and transmitters' program disruption thereby providing integrated GSM based remote monitoring system from central monitoring station which further enables the central monitoring station to take actions prior to any failures and/ or program transmission interruption.

Broadcasting stations need constant monitoring and continuous power supply for consistent program delivery. If a power failure occurs the program will be disrupted and thereby leading to loss of audiences. My thesis focuses on the detection of generator power failure, transmitters' status and takes reflex action to solve the problem with help of modem communication using GSM which is installed in RDF. The Microcontroller inside GSM modem is designed to send SMS alerts from any integrated machine (generator, TV and/or FM transmitter) to central station server that archive the alerted SMS and resend it to the authorized persons' mobile number. The result has been done using Netpod software.


**Key words**: *Generators, GSM modem, Netpod software, RDF, Terrestrial transmitters, VHF.*

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## List of Acronyms

| | |
|---|---|
| AA | Addis Ababa |
| AC | Authentication Center |
| AT | Attention |
| ANSI | American National Standards Institute |
| ANT | Advanced Network Telemetry |
| AVR | Automatic Voltage Regulator |
| BSC | Base Station Controller |
| BSS | Base Station Subsystem |
| BTS | Base Transceiver Station |
| CDMA | Code Division Multiple Access |
| EDGE | Enhanced Data for GSM Evolution |
| EIR | Equipment Identity Register |
| ETSI | European Telecommunications Standards Institute |
| FFSK | Fast Frequency Shift Keying |
| FM | Frequency Modulation |
| FPGA | Field Programmable Gate Array |
| 3GPP | 3$^{rd}$ Generation partnership Project |
| GPRS | General Packet Radio Service |
| GSM | Global System for Mobile Communication |
| HLR | Home Location Register |
| IES | Internet Enhanced Service |
| IMEI | International Mobile Equipment Identity |
| IMSI | International Mobile Subscriber Identity |
| IP | Internet Protocol |

| | |
|---|---|
| ISDN | Integrated Services Digital Network |
| LAN | Local Area Network |
| LCD | Liquid Crystal Display |
| MCU | Micro-programmed Control Unit |
| ME | Mobile Equipment |
| MHS | Message Handling System |
| MMS | Multimedia Messaging Service |
| MS | Mobile Station |
| MSC | Mobile Switching Center |
| NMS | Network Management System |
| NSS | Network Switching Subsystem |
| OMS | Operation and Maintenance Subsystem |
| OMC | Operation and Maintenance Center |
| ORTVO | Oromia Radio and Television Organization |
| PC | Personal Computer |
| PDA | Personal Digital Assistant |
| RDF | Remote Data Front-end |
| PSTN | Public Switched Telephone Network |
| RF | Radio Frequency |
| SIM | Subscriber Identity Module |
| SMS | Short Message Service |
| SNMP | Simple Network Management Protocol |
| TCP | Transmission Control Protocol |
| TDMA | Time Division Multiple Access |
| TS | Technical Specification |
| TV | Television |
| UPS | Uninterruptible Power Supply |
| USB | Universal Serial Bus |

| | |
|---|---|
| VHF | Very High Frequency |
| VLR | Visitor Location Register |
| WSN | Wireless Sensor Network |

# CHAPTER ONE

## INTRODUCTION

### 1.1 Background

Remote monitoring system is a real-time monitoring system that monitors the system from a remote location. Wireless media has been undergoing a rapid innovation process in search for a reliable, simple and business-viable technology for fast, easy and inexpensive diagnosis of faults in different areas of applications. The term remote monitor describes the monitoring of physically separated parts. The use of GSM modem is to connect these physically separated parts globally and wirelessly thereby offering more precise and sophisticated control than ever before.

ORTVO as a broadcasting media has terrestrial TV and FM transmitters with generators for emergency power supply at different zones in Oromia region. Though the organization installed transmitters at different places, they have not yet been monitored remotely. The program transmission disruption which is raised from audiences [1] and the generators problems reported from technicians and data from daily logbooks of zonal stations indicate that there is poor monitoring system from central station. In fact, transmitters of today have become so sophisticated and digital circuitry so precise that monitoring and controlling can be done at microscopic levels never dreamed of by yesterday’s technology. Jointly remote monitoring of all parameters of generators that cause failures with both TV and FM transmitters is, of course, the point of interest of this thesis.

GSM technology which is an open, digital cellular technology used for transmitting mobile voice and data services, is the best solution for remote monitoring system. A GSM modem exposes an interface that allows applications such as NowSMS to send and receive messages over the modem interface. The mobile operator charges for this message sending and receiving as if it was performed directly on a mobile phone. To perform these tasks, a GSM modem must support an “extended AT command set” for sending/receiving SMS messages, as defined in the ETSI GSM 07.05 and 3GPP TS 27.005 specifications [4].

The status from machines (generator, TV and FM transmitters) will be connected to the Remote Data Front-end (RDF) to be converted and interpreted so that it can be sent through GSM modem to the central monitoring station and/ or to any mobiles of authorized members of maintenance department.

## 1.2 Objective of the study

### 1.2.1 General objective

The main objective of this thesis is to establish integrated GSM based remote monitoring system which delivers generator parameters, transmitters’ (TV and/or FM) status that results in program interruption through SMS to central data storage and to mobiles of any authorized persons

### 1.2.2 Specific objectives

The specific objectives of this thesis will be:

- To establish integrated GSM based remote monitoring system which delivers SMS to central monitoring station
- To monitor generator and transmitters’ status (alarms, warnings, power, etc. ) from center
- To give online supports when faults triggered by generator, transmitters exceed predefined limits, pre-alarms and alarms
- To enable the central monitoring station to take actions prior to any failures and/ or program transmission interruption

## 1.3 Statement of problems

Although ORTVO has different transmitter stations at different zones in Oromia region, it has not yet satisfied the need of its audiences due to program interruption. This is, of course, because of poor monitoring system. Sometimes technicians are not available at working place considering that transmitters will continue working by standby generator automatically, even if the main power has gone. But, if the status of generator is not thoroughly monitored, it not only interrupts the program ongoing but also damages the generator itself. In fact, the transmitters of today have come with many features to be operated locally or remotely. Though ORTVO has these days' transmitters, so far, they have not yet been monitored and/or controlled remotely. Inconsistent monitoring system will shorten the operating life of the machine as timely maintenance will increase the life of the machine. This thesis is, then, going to fill these gaps of both generator and transmitters by jointly monitoring them remotely using GSM technology.

## 1.4 Methodology

### 1.4.1 Description of the study area

The study area will be in zones of Oromia region that have transmitter stations and central monitoring station as depicted in table 1.1

Table1.1 ORTVO zonal transmitter stations description area

| No. | Name of station | Location (zone/city) | Description |
|---|---|---|---|
| 1. | Sire Ababune TV-FM station | East Shoa | Generator, TV and FM transmitters are available |
| 2. | Entoto TV-FM station | Finfine/AA area | Generator, TV and FM transmitters are available |
| 3. | Furi TV station | Finfine/AA area | Only TV transmitter is available |
| 4. | Wonchi TV station | South-west Shoa | Generator and TV transmitter are available |
| 5. | Chabir TV-FM station | Horro-guduru wollega | Generator, TV and FM transmitters are available |
| 6. | Nekemte TV station | East Wollega | Generator and TV transmitter are available |
| 7. | Gimbi TV station | West Wollega | Generator and TV transmitter are available |
| 8. | Dembi-dollo TV-FM station | Kellem Wollega | Generator, TV and FM transmitters are available |
| 9. | Gore TV station | Ilu Ababora | Generator and TV transmitter are available |
| 10. | Jimma TV-FM station | Jimma | Generator, TV and FM transmitters are available |
| 11. | Kuni TV-FM station | West Hararge | Generator, TV and FM transmitters are available |
| 12. | Hakim Gara TV-FM station | East Hararge (Harari region ) | Generator, TV and FM transmitters are available |

| | | | |
|---|---|---|---|
| 13. | Kersa TV-FM station | West Arsi | Generator, TV and FM transmitters are available |
| 14. | Goba TV station | Bale | Generator and TV transmitter are available |
| 15. | Anferara TV station | Guji | Generator and TV transmitter are available |
| 16. | Yabello TV-FM station | Borana | Generator, TV and FM transmitters are available |

### 1.4.2 Theoretical study

Many manufacturers of both broadcasting devices and emergency power develop manuals and software on their products. In order to understand the property of these products manuals, software, websites corresponding to their products are thoroughly studied.

There are a number of journals around the topic area of the thesis and are used as a reference in the development of this thesis.

In order to have a further understanding and in-depth knowledge on the background concept of remote monitoring systems, books are referred; online support and advice from manufacturer company experts are consulted.

### 1.4.3 Data collection

Getting correct and essential data is utmost has great importance for effective analysis of this thesis. Different sources are used to collect data; such as:

- Daily log sheet of technicians from each zonal station
- Daily log sheet of years from station monitoring and follow-up department
- Maintenance log sheet of different years from central maintenance department
- Manuals, software of the installer company (EUROTEL) and their expert advice are used as source of data.
- Additional information from ORTVO engineers and technicians are also used.

### 1.4.4 Data analysis

The collected data is analyzed in such a way that it meets the RDF and GSM modem requirements as well as any standard software (web browser or SNMP) that can be used at central monitoring station. It is then tested for each machine (generator, TV and FM) separately and jointly using RDF, GSM modem, SIM card, Mobile, PC (server) and any standard software, Netpod software is of my choice. Parameters/statuses of generator are customized using Netpod software from collected data in such a way that it will be integrated with TV and FM status in the RDF module. The following block diagrams show the integrated GSM based remote monitoring for ORTVO generator, TV and/FM transmitter stations from central and zonal monitoring stations.

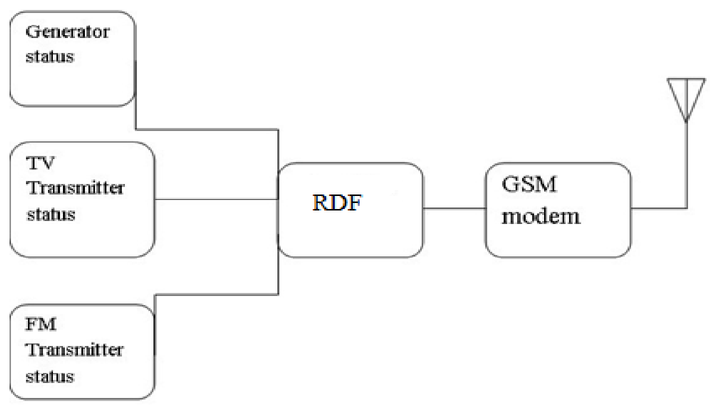


Fig.1.1. ORTVO zonal station integrated GSM based remote monitoring system

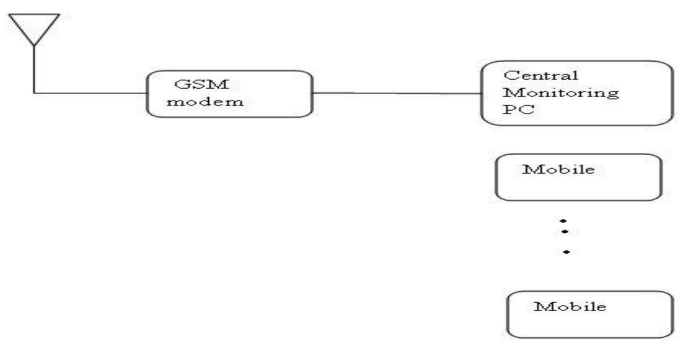


Fig.1.2. ORTVO central station integrated GSM based remote monitoring system

### 1.4.5 Material used

The following materials are used while conducting this research:

- Fastrack supreme modem

- SIM
- GSM antenna
- RDF (Remote data front ends)
- Sensors/probes
- Software

## 1.5 Scope of the study

The scope of this thesis will be from studying and identifying problems/faults of generators, TV and/or FM transmitters to establishing integrated system that monitor these machines remotely from center using GSM technology. The study will cover all ORTVO zonal transmitter stations in Oromia region including central monitoring station, Adama.

## 1.6 Significance of the study

The significance of this study is to monitor all ORTVO zonal transmitters and generators from central monitoring station/ maintenance department thereby:

- ✓ Providing consistent transmission of program to the audiences
- ✓ Establishing timely maintenance schedule to increase the operational life of machines
- ✓ To control technician at transmitter stations so that they are called to reset/ clean any triggered transmitter alarms, warning and for online technical support during machine problems/ faults occurred

Second, it is for optimal utilization of RDF and GSM modem as the primary focus of this thesis is remote monitoring of generator, TV and/ FM transmitters in integrated way using these devices.

## 1.7 Organization of the thesis

The remaining parts of the thesis are organized as follows: The literature review is discussed in the second chapter; the theoretical backgrounds of the thesis, related work as well as previous work are reviewed in detail. Chapter 3; deals with system modeling and implementation. While Chapter 4; describes presentation and analysis of the result. Finally conclusion and recommendation in addition to future research on the thesis work is given in chapter 5.

# CHAPTER TWO

## LITERATURE REVIEW

### 2.1 Introduction

The literature related to the research topic has been reviewed in order to find out better solution for problems identified in my entire study. There are many systems for remote monitoring and control designed as commercial products or experimental research platforms. It is noticed that most of the research carried out belongs to the following categories:

- Internet based Monitoring using Servers, GPRS modems, etc. with different approaches.
- GSM-SMS protocols using GSM module individually or in combination with Internet Technologies.
- Monitoring using Wireless Sensor Networks.
- Wireless Monitoring using Bluetooth, Wi-Fi, Zigbee and RF.

#### 2.1.1 Internet Based Monitoring

Internet monitoring is one of the common approaches for remote monitoring. Many researchers have worked in field of Internet based remote monitoring.

(Chen Chao et al., 2009) developed a remote wireless monitoring system for off grid Wind turbine based on the GPRS and the Internet. The remote monitoring system is made up of three parts: controlling terminal, central monitoring computer and communication network. Controlling terminal consists of microcontroller ARM7 LM3S1138, data acquisition module and GPRS communication module WAVECOM Q2406B connected to ARM7 system using serial port. GPRS module sends parameters relating wind turbine to central monitoring computer. The client can access central monitoring computer server through Internet and know parameters of different wind turbines.

(Kumari and Malleswaran, 2010) developed real time based equipment condition monitoring and controlling system using embedded web based technology which directly connects the equipment to network as a node. The embedded system consists of ARM7 based LPC 2148 microcontroller board, A/D, signal conditioning, sensors, and communications interface. The function of web based system is to collect the real time data information of the on-site equipment and remotely send the data in the form of user defined data transmission style. The remote Computer collects the data and running status through the network and provides the comparison on the historical data. If the parameter value is different from the original set value, the corrected signal is sent to the control unit. The embedded remote monitoring system completes the data Collection in the embedded platform and provides the data to remote host through the TCP/IP protocol from Web server. It creates condition to realize unattended management through providing Web-based graphical management interface for the Internet or LAN users.

(Hongping and Kangling, 2010) proposed the architecture of embedded remote monitoring system based on Internet. The system adopts embedded web server as a central monitoring node and results in improvement in stability and reliability of system. Moreover, utilization of dynamic monitoring web based on Java Applet improves the response capability and brings convenience for complex monitoring web design.

(Liu Zhong-xuan et al., 2010) designed wireless remote monitoring system based on the GPRS (General Packet Radio Service) and the MCU (Micro programmed Control Unit). System is based on 89C58 microcontroller and PIML GPRS-MODEM as the core, can collect data from eight sensors, control two-way Data Acquisition, in the local real-time display and support remote Internet monitoring. The data from sensors are encoded, sent to the WEB server (fixed IP address or fixed domain name website) through the GPRS channel. The system also accepts commands from remote monitoring Centre.

### 2.1.2 GSM-SMS Based Monitoring

With the wide spread use of cellular networks, this approach is also popular when small amount of data is to be transferred through the network. Extensive work has been carried out by researchers using this approach especially in medical field.

(Chen Peijiang and Jiang Xuehua, 2008) describe a remote monitoring system based on SMS of GSM. The system includes two parts which are the monitoring center and the remote monitoring station. The monitoring center consists of a computer and a TC35 GSM communication module. The computer and TC35 are connected by RS232. The remote monitoring station includes a TC35 GSM communication module, a MSP430F149 MCU, a display unit, various sensors, data gathering and processing unit.

(Jiang et al., 2008) proposed a system for early diagnosis of hypertension and other chronic diseases. The proposed design consists of three main parts: a wrist Blood Pressure (BP) measurement unit, a server unit and a terminal unit. Blood Pressure is detected using data acquired by sensors intelligently using DSP microchip. The data is then transmitted to the remote server unit located at Community Healthcare Centers/Points (CHC/P) by using Short Messaging Service (SMS), and notification information is sent to the terminal unit to inform users if patient's BP is abnormal.

(Xu Meihua et al., 2009) described a remote medical monitoring system based on GSM (Global System for Mobile communications) network. This system takes advantage of the powerful GSM network to implement remote communication in the form of short messages and uses FPGA as the control center to realize the family medical monitoring network. The system is made up of user terminal equipment, GSM network and hospital terminal equipment. Hospital terminal equipment can be a personal computer (connected with GSM modules) or other receiving equipment such as the mobile phone of the related doctor, while user terminal equipment are used to collect, demonstrate and transmit kinds of physiological parameters. User terminal devices include the temperature acquisition module, blood pressure/heart rate acquisition module, FPGA of Actel Fusion series, information-sending and information-receiving module -- Siemens TC35 GSM module, LCD displays and expansion modules.

(Yan Hongwei and Pan Hongxia, 2009) investigated the design and implementation of a remote data collection and monitoring system. The system communication is based on GSM short messages from cell phones using Siemens cell phone module TC35. The serial interface of TC35 is directly connected to the serial interface of PC computer. The system hardware includes remote client monitoring hardware, central monitoring module, and 0809 A/D converter. The central monitoring module sends commands via channel 1. Data collection commands are sent out through TC35 to collect all sorts of data. After data are collected they are processed by remote clients and sent back to the central monitoring module by GSM short messages via channel 2. Each monitoring module can connect up to 128 sensors and equipment within the range of 1000 meters via RS485 interface. The server hardware consists of 8031 microprocessor, 74LS373, one 8 kB 2764 E2PROM, one 2 kB 6116 extended memory, and one 8155 programmable serial interface chip. One 4×4 keyboard is connected to the PI port and 8 LED displays are connected to PA and PB ports of 8155.

Amit sachen et al at 2012 designed “Microcontroller Based Substation Monitoring and Control System with Gsm Modem” that have discussed the user can send commands in the form of SMS messages to read the remote electrical parameters. This system also can automatically send the real time electrical parameters periodically (based on time settings) in the form of SMS. This system can be designed to send SMS alerts whenever the Circuit Breaker trips or whenever the Voltage or Current exceeds the predefined limits. This project makes use of an onboard computer which is commonly termed as microcontroller [39].

Mallikarjun et al at 2013 proposed “The Load Monitoring and Protection on Electricity Power lines using GSM Network” system which is a specially designed computer system that is completely encapsulated by the device it controls. The embedded system has specific requirements and performs pre-defined tasks. The diesel generator is used when electricity is not readily available, or when power failures occur due to natural disasters such as typhoons or floods, or during other unexpected crises. Generally, the diesel generator operates in analog. The

analog type controller cannot be processed precisely due to the distortions and noises coming from the data. In order to increase data accuracy, the controller needs to be digitalized [40]
Vimalraj et al at 2013 designed "GSM Based Controlled Switching Circuit between Supply Mains and Captive Power Plant" has described a distribution transformers have a long service life if they are operated under good and rated conditions. However, their life is significantly reduced if they are overloaded, resulting in unexpected failures and loss of supply to a large number of customers thus effecting system reliability. This system provides flexible control of load parameters accurately and also provides effective means for rectification of faults if any abnormality occurs in power lines using SMS through GSM network [41].

Henrik Arleving at 2013 proposed system by using a cloud-based remote management solution with a communication gateway can help reduce costs, avoid fuel theft and improve power generator control. It can be difficult to focus on the right actions, simply because there isn't enough information on fuel levels, oil pressure or battery status for each generator. With a cloud-based remote management solution, we can have immediate access to generator parameters via a regular web browser being able to analyze each generator remotely enables you to better understand their health and more efficiently schedule field service visits and Fuel theft can be a significant problem[42].

Chetan Patil et al at 2013 discussed the design of BTS safety and fault management system the measures are taken to rectify these problems. The method makes use of GSM modem which gives the instant message about the each activity happening in the site. The temperature sensors will sense the temperature of the room and if it rises above the threshold value the GSM module will send the message to the master mobile which is already set in the system [43].

Y Jaganmohan Reddy et al in 2013 discussed the model of combination of Photo Voltaic (PV) cell System, Wind turbine system, Fuel cell (FC), and Battery systems for power generation, and to improve power quality they proposing Motor-Generator model instead of using static converters, and an energy management and control unit using Programmable Logic Controller (PLC). This system facilitates improvement in power quality, which ensures continuous and reliable supply to loads. The power transformer is regarded as the heart of any electrical transmission and distribution system. At the output of the generator, they are used for stepping up voltage for transmission [44].

A.P.Agalgaonkar et al at 2013 discussed the measurement and control of temperature, humidity and the other parameters at different places. The Data Acquisition is defined as the process of taking a real-world signal as input, such as a voltage or current any electrical input, into the computer, for processing, analysis, storage or other data manipulation or conditioning[45].

S. Boopathi, M. Jagadeeshraja, L. Manivannan, M. Dhanasu at 2015 developed “GSM Based Generator Monitoring System for Steel Melting Shop (SMS)” which focused on the detection of power failure and takes reflex action to solve the problem with help of GSM communication. The power failure will be detect by relay, and it communicates to Microcontroller to alerts the authorized person. In addition to that, parameters of Generator like Fuel level, Oil level, Temperature, battery status, etc., are monitored and communicated to authorized person. The acquired parameters are processed and recorded in the system memory. If there is any abnormality in their process, according to some predefined instruction and policies that are stored on the embedded system EEPROM then GSM alerts are sent to concerned person immediately [46].

### 2.1.3 Remote Monitoring using Wireless Sensor Networks (WSN)

Many Wireless Technologies like RF, Wi-Fi, Bluetooth and Zigbee have been developed and remote monitoring systems using these technologies are popular due to flexibility, low operating charges, etc. Today Wireless Sensor Network are used into an increasing number of commercial solutions, aimed at implementing distributed monitoring and control system in a great number of different application areas**.**

(Wijetunge et al., 2008) designed a general purpose controlling module designed with the capability of controlling and sensing up to five devices simultaneously. The communication between the controlling module and the remote server is done using Bluetooth technology. The server can communicate with many such modules simultaneously. The controller is based on ATMega64 microcontroller and Bluetooth communication TDK Blu2i (Class 1) module which provides a serial interface for data communication. The designed controller was deployed in a home automation application for a selected set of electrical appliances.

(Kanma et al., 2003) proposed a home appliance control system over Bluetooth with a cellular phone, which enables remote-control, fault-diagnosis and software-update for home appliances through Java applications on a cellular phone. The system consists of home appliances, a cellular phone and Bluetooth communication adapters for the appliances. The communication adapter hardware consists of a 20MHz 16bit CPU, SRAM and a Bluetooth module. The communication adapter board is connected to the home appliance and to the cellular phone through serial ports. The appliances can communicate with the cellular phone control terminal via Bluetooth SPP.

(Sung-Nien Yu and Jen-Chieh Cheng, 2005) proposed a wireless patient monitoring system which integrates Bluetooth and WiFi wireless technologies. The system consists of the mobile unit, which is set up on the patient's side to acquire the patient's physiological signals, and the monitor units, which enable the medical personnel to monitor the patient's status remotely. The mobile unit is based on AT89C51 microprocessor. The digitized vital-sign signals are transmitted to the local monitor unit using a Bluetooth dongle. Four kinds of monitor units, namely, local monitor unit, a control center, mobile devices (personal digital assistant; PDA), and a web page were designed to communicate via the WiFi wireless technology.

(Flammini et al., 2007) suggested a novel architecture for environmental tele-monitoring that relies on GSM for sampling point delocalization, while on-field nodes implement local subnets based on the DECT technology. Local subnets contain two major blocks; Acquisition Station (AS) where sensors and actuators are located and Transmitting Module (TM), i.e., the module that handles several measurement stations and sends data to the control center (CC). Each AS acts as a data logger, storing in its internal memory device field data; communications between AS and TM are cyclic (round robin), with a cycle time of about 1–10 min. On the contrary, communications between TM and CC occur once a day for data-logging purposes, while alarms or threshold crossings are communicated asynchronously by means of Short Message Service (SMS). Prototypes have been realized to interface with temperature ($T$, AD590 from analog devices), humidity (RH, HumirelHM1500), and carbon monoxide (CO, Figaro TGS2442) sensors. DECT Siemens module MD32 and GSM module MC35 were used. AS was based on

Microchip's PIC18F452 microcontroller and TM was designed using 32-bit ARM-based microcontroller from Samsung (S3F441FX).

(Yunseop Kim et al., 2008) described details of the design and instrumentation of variable rate irrigation, a wireless sensor network, and software for real-time in-field sensing and control of a site-specific precision linear-move irrigation system. Field conditions were site-specifically monitored by six in-field sensor stations distributed across the field based on a soil property map, and periodically sampled and wirelessly transmitted to a base station. An irrigation machine was converted to be electronically controlled by a programming logic controller (Siemens S7-226 with three relay expansion modules activated electric over air solenoids to control 30 banks of sprinklers) that updates geo-referenced location of sprinklers from a differential Global Positioning System (GPS) (17HVS, Garmin) and wirelessly communicates with a computer at the base station. Communication signals from the sensor network and irrigation controller to the base station were successfully interfaced using low-cost Bluetooth wireless radio communication through Bluetooth RS-232 serial adaptor (SD202, Initium Company).

(Bencini et al., 2009) developed state of the art WSN based system for monitoring a series of physiological parameters in the vineyard to prevent plant vine diseases. The different soil moistures in the same field is used to decide the correct amount of water for irrigation; sandy soils have very different behavior to irrigation in respect to clayey ones; water retention capacity is completely different and measuring it exactly where it is needed can help in controlling the irrigation system and saving water. Monitoring air temperature and humidity in different parts of a vine can help in preventing and fighting plants diseases, reducing the amount of pesticides only when and where they are necessary. Each node consists of MIDRA mote is equipped with 868 MHz radio transceiver, Chipcon CC1000TM. The master node of the Wireless Sensor Network is connected to a GPRS gateway board, forwarding data to a remote server, using the TCP-IP standard protocol. It included 11 nodes with a total of 35 sensors distributed on 1 hectare area; monitor common parameter using simple, unobtrusive, commercial and cheap sensors, forwarding their measurements by the means of a heterogeneous infrastructure, consisting of WSN technology, GPRS communication and ordinary Internet data transfer (TCP-IP protocol). Data coming from sensors are stored in a database that can be queried by users everywhere in world, only using a laptop or a PDA: the Smart User Interface also allows to read and to analyze data in an easy way.

(Harms et al., 2010) describe the emerging wireless sensor networks (WSN) for autonomous Structural Health monitoring SHM systems for bridges. In SmartBrick Network, the base station and sensor nodes collect data from the onboard and external sensors. The sensor nodes communicate their data from quasi-static sensors, e.g., temperature sensors, strain gauges and seismic detectors to the base station over the ZigBee connection. The base station processes these data and communicates them, along with any alerts generated, to a number of destinations over the GSM/GPRS link provided by the cellular phone infrastructure. The data are reported by email and FTP to redundant servers, via the Internet, at regular intervals or on an event-triggered basis. The alerts are sent directly by SMS text messaging and by email. Wireless sensor networks are the key enabler of the most reliable and durable systems for long-term SHM and have the potential to dramatically increase public safety by providing early warning of impending structural hazards.

(Mulyadi et al., 2009) implemented a wireless medical interface based on ZigBee and Bluetooth technology. The purpose is to acquire, process, and transfer raw data from medical devices to Bluetooth network. The Bluetooth network can be connected to PC or PDA for further processing. The interface comprises two types of device: MDIZ and MDIZB. MDIZ acquires data from medical device, processes them using microcontroller, and transmit the data through ZigBee network through UART. MDIZB receives data from several MDIZs and transmit them out to PC through Bluetooth network. MDIZB comprises of ZigBee module, two processors, RAM, and Bluetooth module. It receives data from ZigBee network through its ZigBee module. The data are then sent to processor 1. Processor 1 decides priority of MDIZs. In processor 1, the data frame is added with Start byte and End byte to mark the beginning and the end of data frame. After being processed in processor 1, the data are then sent to processor 2 through SPI (Serial Peripheral Interface). Processor 2 transmits data to PC through Bluetooth network. Processor 2 controls Bluetooth module. It also receives commands given by PC through Bluetooth network. The interface is connected with four different medical devices through UART and analog port at 42 kbps of data rate.

# CHAPTER THREE

## GSM SYSTEM OVERVIEW

### 2.1. GSM

GSM (Global System for Mobile communication), which originally stood for **Groupe Speciale Mobile**, is a digital mobile telephony system that is widely used in Europe and other parts of the world. GSM uses a variation of time division multiple access (TDMA) and is the most widely used of the three digital wireless telephony technologies (TDMA, GSM, and CDMA). GSM digitizes and compresses data, then sends it down a channel with two other streams of user data, each in its own time slot. It operates initially at either the 900 MHz or 1800 MHz frequency band and subsequently modified for the 850, 1800 and 1900MHz bands [2]. GSM is a circuit-switched system that divides each 200 kHz channel into eight 25 kHz timeslots.

GSM operates in the 900MHz and 1.8GHz bands in Europe and the1.9GHz and 850MHz bands in the US. The 850MHz band is also used for GSM and 3GSM in Australia, Canada and many South American countries. GSM supports data transfer speeds of up to 9.6 Kbit/s, allowing the transmission of basic data services such as SMS (Short Message Service). Another major benefit is its international roaming capability, allowing users to access the same services when traveling abroad as at home. This gives consumers seamless and same number connectivity in more than 210 countries. GSM satellite roaming has also extended service access to areas where terrestrial coverage is not available.

As the GSM standard continued to develop, it retained backward compatibility with the original GSM phones. For example, packet data capabilities were added in the Release ‘97 version of the standard, by means of GPRS. Higher speed data transmission has also been introduced with EDGE in the Release '99 version of the standard.

It is an open, digital cellular technology used for transmitting mobile voice and data services. GSM differs significantly from its predecessors in that both signaling and speech channels are Digital call quality, which means that it is considered as a second generation (2G) mobile phone system. This fact has also meant that data communication was built into the system from the Third Generation Partnership Project (3GPP).

## 2.2. GSM's Architecture and its Essential Components

GSM can be divided into two categories which are Mobile Subscribers and the fixed built infrastructure. The fixed built network is then sub-divided into Base Station Subsystem, Switching and Management Subsystem and Maintenance Subsystem. [2]

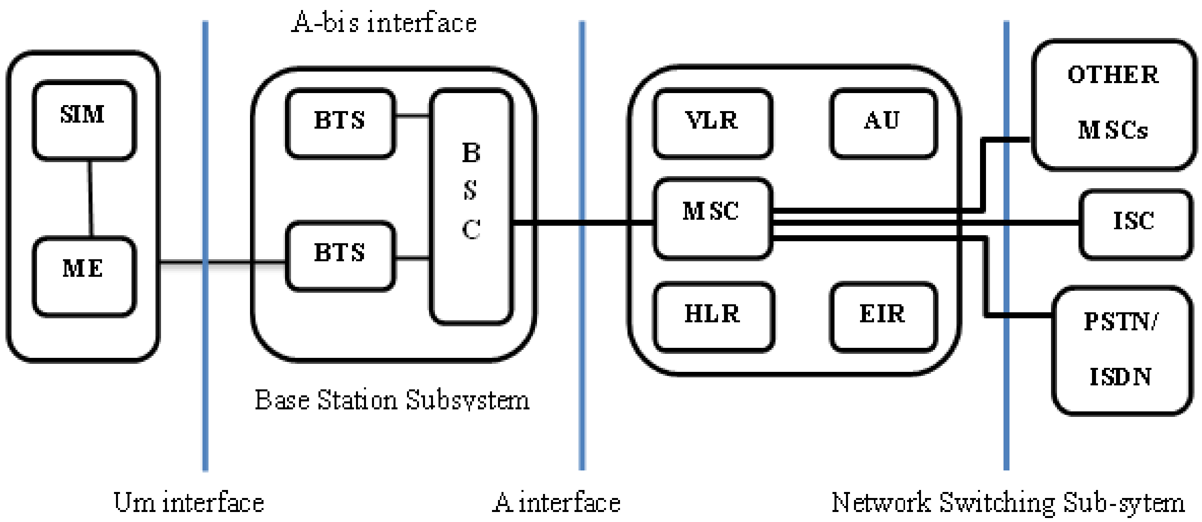


Fig 2.1.GSM's architecture

### a) Mobile Station (MS)

Mobile Station shortly is the combination of Mobile Equipment (ME) and Subscriber Identity Module (SIM). Together they provide various kinds of GSM services such as bearer services, tele-services and supplementary services. Each Mobile Equipment has its own unique identification which is known as International Mobile Equipment Identity (IMEI) while SIM has its own identification that is International Mobile Subscriber Identity (IMSI). [3, 18]

### b) International Mobile Station Equipment Identity (IMEI)

The International Mobile Station Equipment Identity distinguishes each unique Mobile Station from others and is assigned to each of the Mobile Station by the equipment manufacturer. Then, they are registered by network operator and store them in the Equipment Identity Register (EIR). Through this, any reported stolen MS, obsolete or nonfictional equipment can be identified abruptly and thus denying services provided to the MS.

**c) International Mobile Subscriber Identity (IMSI)**

Each and every subscriber of the mobile network service provider will receive a unique identifier which is known as International Mobile Subscriber Identity. IMSI is stored in SIM and used to identify SIM when MS is operated. This is to prevent SIM card from being duplicated by having only one unique IMSI subscribe to the network operator at one time. This is to ensure the privacy of the mobile subscriber and correct billing for the services. [3, 18]

**d) Mobile Subscriber ISDN Number (MSISDN)**

MSISDN is the “phone number” of a Mobile Station. Each SIM can have only one IMSI but can have multiple MSISDN (depending on the SIM) for the selection of different services (voice, data, fax and etc.) [3, 18]

**e) Base Station Subsystem (BSS)**

Base Station Subsystem is obligated for managing and maintaining the radio network and is controlled by an MSC. An MSC can control multiple BSS at a time. BSS covers a comparatively large geographical area which insides located many cells. BSS comprises of two, which is Base Transceiver Station (BTS) and Base Station Controller (BSC). BSS is providing the radio resources which are the radio channel allocation and quality of the radio connection. [3, 18]

**f) Base Station Controller (BSC)**

BSC is the central network component which controls the radio network. It establishes connection between the MS and the NSS (Network Switching Subsystem) and performs calling operation through the group switch of the BSC. Since the ME might changing from cells to cells, the BSC is responsible for most of the handovers, performing precise handover decision based on the calculations report sent by the MS during a call. The data from the BTS, Transcoders and BSC are collected in the BSC and forwarded to NMS to perform statistical calculations, and thus quality of network and status can be obtained. [3, 18]

**g) Base Transceiver Station (BTS)**

BTS is the hardware architecture responsible for managing the air interface and reducing the transmission problems since the air interface is very susceptible towards disturbances. Almost more than 120 parameters used in designing BTS to solve the problems such as handovers, paging, radio power level control, and identification of BTS. [3, 18]

**h) Network Switching Subsystem (NSS)**

Network Switching Subsystem is the switching Centre where databases store the data needed for routing and providing service such as call control, charging information, mobility management, signaling and subscriber data handling. It is the combination of different network elements such as MSC, VLR, HLR, AC and EIR. [3, 18]

**i) Mobile Switching Centre (MSC)**

MSC is responsible of all the switching functions of a fixed network switching node. It performs call origin and destination identification for mobile station or fixed line and for different type of call. Besides, MSC identifies the destination, the origin of a call and also the type of call. It is also responsible for setting up, supervising, and clearing connections for every call. It initiates paging to locate a particular MS in case of mobile terminate or moving to another cell. It collects the charging data too. [3, 18]

**j) Home Location Register (HLR)**

HLR is responsible for storing every entry of every subscriber. Each mobile subscriber ISDN number has their respective "home" which is HLR. HLR stores relevant temporary information and permanent data of all subscribers permanently registered in the HLR. Besides, HLR also periodically tracks the location of the subscribers. [3, 18]

**k) Visitor Location Register (VLR)**

VLR is a database responsible for storing information about the subscribers currently locating in the service are of the MSC/VLR such as identification numbers (IMEI, IMSI and etc.) of the subscribers and the services that be provided to the subscriber. The information of the subscribers at VLR is temporary and is held only when the subscriber is within its service area. The information stores temporary at VLR is such as the address to every subscriber's HLR. [3, 18]

**l) Authentication Centre (AC)**

For security purposes, AC is created to provide security information to the network in order to verify the SIM across the interfaces. [3, 18]

**m) Equipment Identity Register (EIR)**

EIR is responsible for IMEI checking. When performing this operation, the MS will provide the IMEI number which consists of type approval code, final assembly code and serial number of the MS. [3, 18]

**n) Operation and Maintenance Subsystem (OMSS)**

OMSS controls and maintains the ongoing network operation. OMC initiates and monitors network control functions.

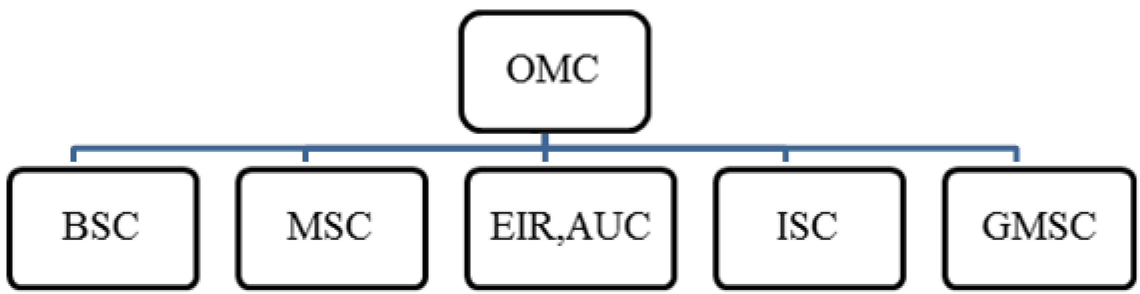


Fig.2.2. Operation and Maintenance Subsystem

Some of its functions are:

- Commercial and administration operation (end terminals, subscribers, charging, statistics)
- Security Management
- Network operation, configuration, and performance management
- Maintenance tasks [3, 18]

## 2.3. GSM Services

GSM Services can be categories into three parts which are bearer services, teleservices and supplementary services.

Bearer Services are a service which offers the fundamental technical capability for the transmission of binary data. GSM Bearer services can transport with circuit-switched or packet switched data rates of 300-9600 bit/s and 13kbit/s bearer service for voice. [3, 18]

Teleservices have many categorizes such as voice, fax transmission, Short Message Service, MHS access, Videotext access and Teletext transmission. [3, 18]

Supplementary Services are defined by GSM and are characterized as revenue-generating features. Partial listings of supplementary services are call forwarding, call barring, call waiting, call holding, multiparty service, etc.

## 2.4. GSM modem

A **GSM modem** is a specialized type of modem which accepts a SIM card, and operates over a subscription to a mobile operator, just like a mobile phone. When a GSM modem is connected to a computer, this allows the computer to use the GSM modem to communicate over the mobile network. It can also be used for sending and receiving SMS and MMS messages.

For the purpose of this document, the term GSM modem is used as a generic term to refer to any modem that supports one or more of the protocols in the GSM evolutionary family, including the 2.5G technologies GPRS and EDGE, as well as the 3G technologies .A GSM modem exposes an interface that allows applications such as Now-SMS to send and receive messages over the modem interface. To perform these tasks, a GSM modem must support an “extended AT command set” for sending/receiving SMS messages, as defined in the **ETSI GSM 07.05** and **3GPP TS 27.005** specifications [26].

# CHAPTER FOUR

## SYSTEM DESIGN AND IMPLEMENTATION

### 3.1 Introduction

ORTVO is a broadcasting media that has terrestrial TV, FM transmitters and generators for power standby at different zones in Oromia region. Out of 16 zonal transmitter stations of ORTVO, 15 stations have generators, 9 stations have FM transmitters, and all the stations have VHF TV transmitters. Data collected from archives of all stations and log books of the central station indicate that there is poor monitoring system of generators and transmitters which results in inconsistent program delivery. If a power failure occurs the program will be disrupted and thereby leading to loss of audiences. The core idea of this study is then identifying problems that cause generators to fail and transmitters' program disruption thereby providing integrated GSM based remote monitoring system from central monitoring station which further enables the central monitoring station to take actions prior to any failures and/ or program transmission interruption.

GSM Based Integrated Generator, Terrestrial TV and/or FM Transmitter/s Remote Monitoring for ORTVO Zonal Stations, as the name indicates, involve GSM technology and integration of devices. However, designing and implementing of the system is broader than the conceptual perspective as electronics designation, software designation, mechanical designation and other constraints are required to produce the whole system integration concept.

### 3.2 Conceptual Design

The aim of this thesis is to develop a transmitting system which can send SMS through the GSM network and develop another receiving system which can continuously read the modem's message, memory storage and display the incoming message on PC and send back to authorized personnel's mobiles. Station conceptual design has generator, TV transmitter and/or FM transmitter, Remote data front end (RDF) and GSM modem connected to GSM antenna as shown in fig.3.1.

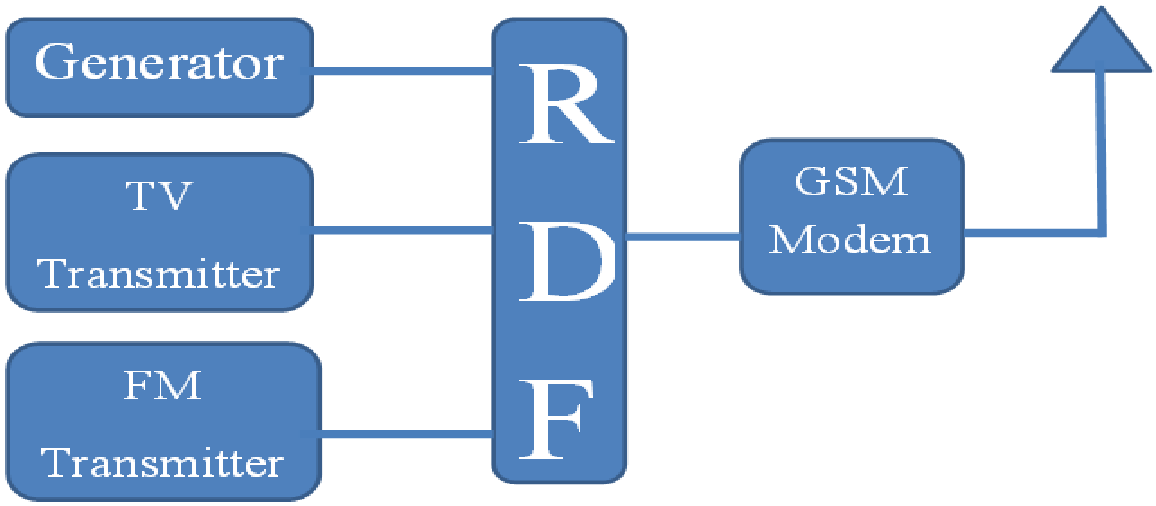


Fig.3.1. Conceptual design of remote stations

The central station which receives data from remote transmitting station and sends to authorized personnel has server-client PC (possibly separated), two GSM modems first one to receive data from every RDF and other one to send SMS alarms from the control center to the qualified users as shown in fig.3.2.

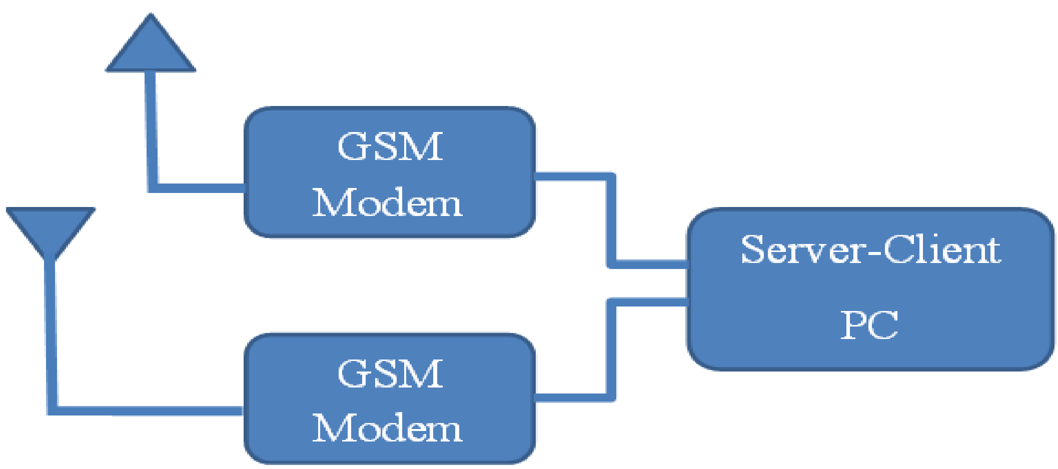


Fig.3.2. Conceptual design of central station

### 3.2.1 Generators

Generators are useful appliances that supply electrical power during a power outage and prevent discontinuity of daily activities or disruption of ongoing program especially in broadcasting media. But still there are some of the drawbacks encountered by the operators and the owners i.e., fuel theft, generator maintenance, capturing real time data, data collection and analysis issues and more over human dependencies becomes a vital issue. Continuous usage of the generator causes its various components to get heated up. It is essential to have a cooling and ventilation system to withdraw heat produced in the process. Daily follow up should be a mandatory.

### 3.2.2 Some important points to be considered for smooth operation of a generator

#### A. Fuel System

The fuel tank usually has sufficient capacity to keep the generator operational. The level of the fuel inside tank should be checked timely in order to sustain continual working of generator during outage of mains.

#### B. Cooling system

Continuous usage of the generator causes its various components to get heated up and results in rising up of temperature. It is essential to have a cooling and ventilation system to withdraw heat produced in the process. Raw/fresh water is sometimes used as a coolant for generator. Life extended coolant is the best. It is essential to check the coolant levels of the generator on a daily basis [24].

#### C. Lubricating system

Since the generator comprises moving parts in its engine, it requires lubrication to ensure durability and smooth operations for a long period of time. The generator's engine is lubricated by oil stored in a pump. One should check the level of lubricating oil, any leakages of lubricant and change the lubricating oil per schedule [24].

### D. Battery Charger

The start function of a generator is battery-operated. Battery is charged either from external main grid through transformer and rectifier or from generator itself during running by alternator (dynamo). The battery charger keeps the generator battery charged by supplying it with a precise 'float' voltage. If the float voltage is very low, the battery will remain undercharged. If the float voltage is very high, it will shorten the life of the battery. The DC output voltage of the battery charger is set at 2.33 Volts per cell, which is the precise float voltage for lead acid batteries [24].

### E. Sensors/probes

Sensors or probes are devices built to transform a physical measurement in an electrical reading. Example: a thermometer will more or less accurately change a temperature into some kind of electrical measurement readable from a device which does not have this capability. Generally sensors are very simple devices which most of the time take care of 'linearizing' the signal; otherwise this can be done in software.

### 3.2.3 Control panel

ORTVO has built generators in all the stations with control panel which is the user interface of the generator and contains provisions for electrical outlets and controls. Different manufacturers have varied features to offer in their control panel units. These features of control panel were built for ORTVO. Some of these are mentioned below:

- Automatically starts generator during a power outage, monitor the generator while in operation, and automatically shuts down the unit when no longer required
- Different gauges indicate important parameters such as oil pressure, temperature of coolant, battery voltage, engine rotation speed, and duration of operation. Constant measurement and monitoring of these parameters enables built-in shut down of the generator when any of these cross their respective threshold levels. The description of the existing control panel is shown in fig.3.3.
- The control panel also has meters for the measurement of output current and voltage, and operating frequency.

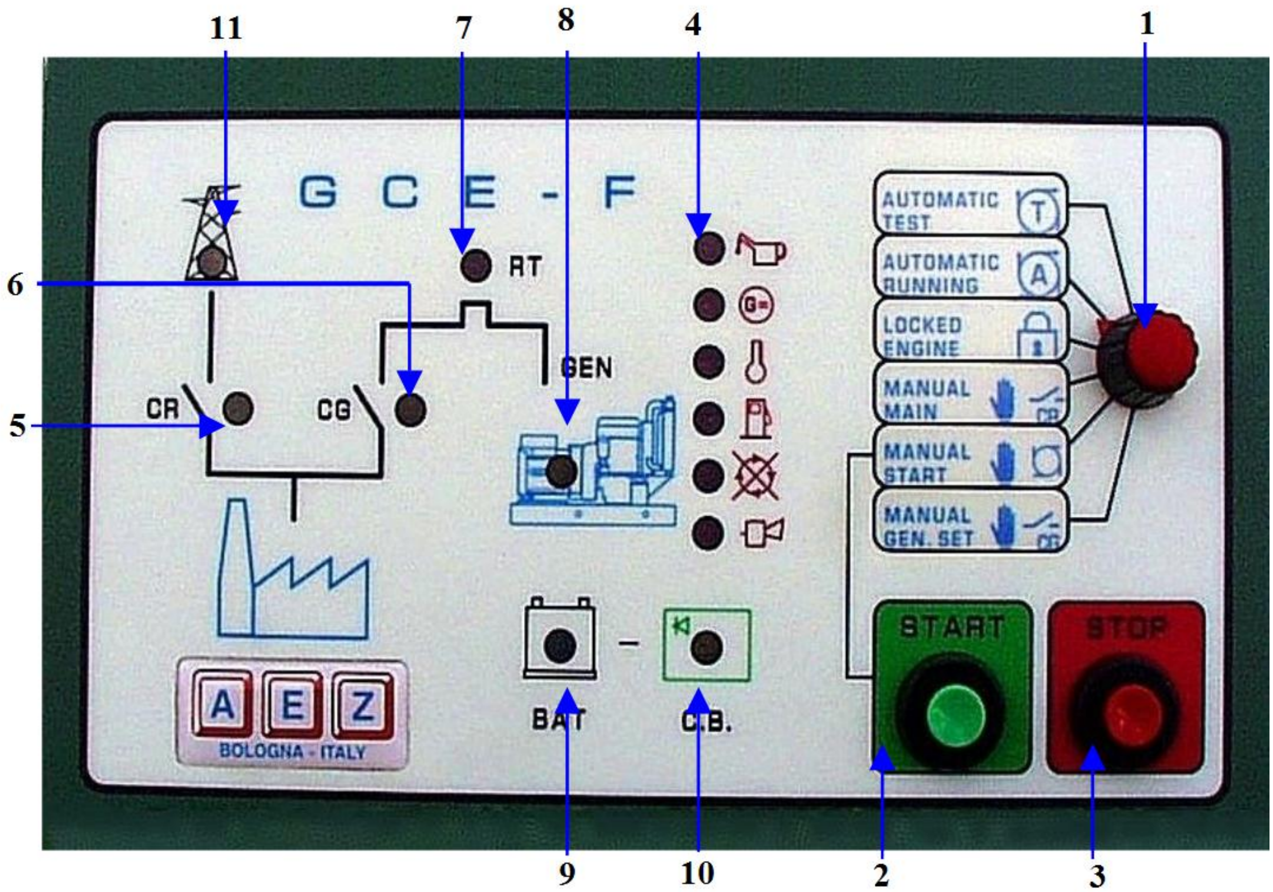


Fig.3.3. Control panel of ORTVO generators

Component description of control panel

1. All the commands are assembled on the programming switch placed on the right of the control panel that allows the followings functions:

    - automatic test
    - automatic running
    - locked engine
    - manual main
    - manual start
    - manual genset

2. start-up push button active only (1) in manual starting position
3. stop button

4. led for signaling an engine damage
5. led for signaling the main contactor closed and load supplies by main
6. led for signaling the genset contactor closed and load supplies by genset
7. led for signaling the overload protection intervention of the generator, it only can be reset manually
8. genset working on
9. card fed
10. battery active
11. led for signaling the main works in standard values

### 3.2.4 Advantage of remote monitoring of generator

The generator monitoring system is useful because of the following reasons:

- It gives awareness of the power stability and the behavior of power supply thus one can be able to deal with the problem of constant power outage by looking for Alternative means of power supply
- It records the time of the duration and in the process letting someone know in advance the effect of the damage caused by the power outage
- If one is far-away from the microcontroller based monitoring unit, with the facilities of reporting the failures to a central control via GSM module, one can be able to respond to the situation as soon as possible.

The Real-time point-to-point data reporting architecture is useful for remote surveillance and control, if communication network can be convenient to access. In the new age of technology, mobile phone redefines communication. The worldwide trend for wireless communication has elevated into wide band data instead of voice only. Sending written text messages is very popular among mobile phone users. We have used the embedded based control the generator plant from a remote area. Remotely the user can establish effective monitor and control via the mobile phone set by sending commands in the form of SMS. This system provides ideal solution to the problems caused in situations when main power outage occurs, warnings and alarms of the system occur and also when a wired connection between a remote device and the control unit might not be feasible.

Through the implementation of the Microcontroller with programmed chip the major difficulties on operating the generator can be minimized. This system becomes valuable when the power failures, interrupted supply of power, alarms on generator, etc., occurs. Sensors for each electrical parameter are set and it displays the situation of the generator instantly using the PIC controller. Relayed circuit is ensured for the tripping process on supply to the load to protect the load for being damaged when any type of fault occurred.

This thesis is backboned with the GSM technology, where all the instant data from the generator set is transmitted to the mobile phone through message service, where authorized person will handle with the information intimated him via mobile. Information like fuel level, temperature, oil level, battery voltage and etc. can be transmitted.

### 3.2.5 TV Transmitter

Transmitters of today have become so sophisticated and digital circuitry so precise that monitoring and controlling can be done at microscopic levels never dreamed of by yesterday's meter readers and maintenance engineers. Thanks to GSM technology, it's a reality today that nearly every modern transmission or broadcast infrastructure product comes with remote monitoring features offering more precise and sophisticated control than ever before.

Fig.3.4. Air cooled VHF B-III ORTVO station transmitter

ORTVO installed air cooled VHF band –III transmitters at 16 zones in oromia region which are provided with internal GSM monitoring and controlling system as requested option. This feature allows the operator to monitor the transmitter status via GSM command receiving SMS from transmitter unit about status and eventually failure states. Using GSM system, the operator can also send remote control to the transmitter unit.

The transmitters have come up with many features. It has a possibility to be monitored remotely by GSM modem in built in RDF module installed at station which is, of course, at software licensed level.

With reference to the general block diagram, fig.3.4, the output signal from the Exciter, at a nominal level of 4 W, reaches the Input low power divider, which splits the drive into 4 components of 1 W each. This system incorporates a step attenuator and a step phase shifter to adjust the slight differences of gain and phase of the four RF Amplifiers. The resultant signals drive the four RF Amplifiers to a nominal output of 500 W each. The Output power summer connected to the outputs of the two by two RF Amplifiers sums the output signals to a nominal level of 2 kW as shown in fig.3.4 [25].

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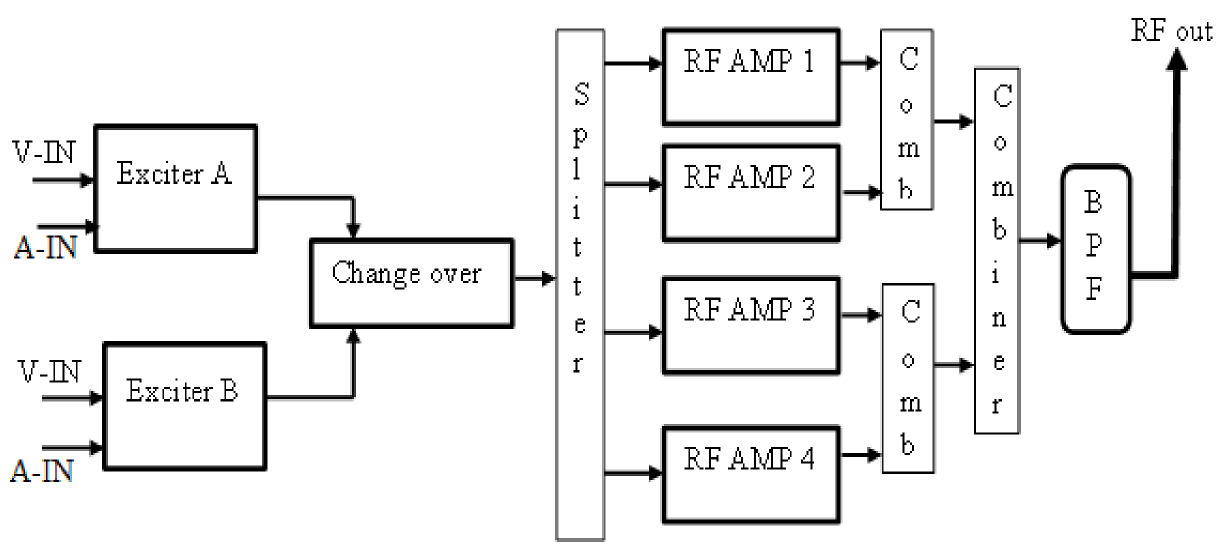



Fig.3.5. Block diagram of the existing VHF B-III ORTVO transmitter

At the output of the band pass filter a directional coupler collects samples of forward & reflected output power, which are sent to the 4 RF Amplifiers. Each power amplifier module has dedicated control and monitoring to support on/off functionality and alarms for reflected power, temperature and current over-loads. The transmitter control unit handles both internal and external communications and provides all control functions. All transmitter, cooling system, exciters and amplifiers parameters required for diagnostics can be retrieved locally as well as remotely from anywhere in the world via a standard (IP) protocol and standard software (web browser, SNMP).

The output directional coupler, which is equipped with built-in high sensitivity detectors for forward and reflected RF power, outputs D.C. samples to the Metering and Protection module.
The metering, alarm and protection module monitors: the peak and average RF output power, the peak reflected power and the temperature of the heat sinks. When any one of the pre-set values is exceeded, the module enters into a warning or into an alarm condition and reduces or disables the output of the power supplies. When in a disabled alarm condition, the amplifier is automatically recycled to continuously check the operating status. Once the warning or the alarm condition is removed, the metering, alarm and protection module returns the power supplies to the normal operating status.

The metering outputs of the metering, alarm and protection module feed an alphanumeric display, located on the front panel. This display provides all the significant electrical parameters: RF power, temperature, supply voltages and currents and other important information [25].
All significant operating parameters are provided on a standard RS-232 and RS-485 interface offering control of the equipment, such as commands to switch off, switch on, reset or change from exciter “A” to exciter “B,” for example. The RS-485 interfaces supervisor/control unit with RDF module in order for monitoring remotely. RDF output commands are fed to changeover switch through 15 pin D-SUB connector.

### 3.2.6 FM Transmitter

ORTVO has built 8 Air-Cooled FM transmitters from the same company with TV transmitter, EuroTel. These transmitters have come with many features of today's technology. They offer maximum on-air reliability, ease access to each module inside the cabinets, simplicity in its operation and maintenance procedure, and also high energy efficiency and outstanding configuration flexibility. The transmitter New LDMOS device technology delivers a high increase in power density, ensuring efficiency, compact design, high output power and lower operating costs that make FM transmitter Company ideal for all FM applications.

Fig.3.6. Air cooled FM of ORTVO station transmitter

Metering and protection circuit is provided to monitor all the amplifier parameter and manages potentially critical situation as over temperature, power failure, output reflection power and many others. The system has bidirectional interactive GSM monitoring and controlling system (option) [25]. It can possibly be integrated with that of TV transmitter RDF module.

## 3.3 Hardware used

There is a number of hardware used in this study.

### 3.3.1 Remote data front ends

Remote data front ends (RDF's) are devices that interface the main control center with the devices to control. They enclose embedded microcontroller systems running real time operating systems (they are NOT PC's). These machines are able to withstand harsh RF, temperature, and vibration, environments without particular problems.

Fig.3.7. Remote data front end (RDF)

**Multi-vector**

In each network it is possible to connect the RDFs to the server using different media. Radio FFSK, GSM, Phone and base-band Modem, TCP-IP, dedicated routers and satellite. Custom mixed networks with different vectors can normally be realized as well.

**Digital router**

RDF connected by radio has enormous potential: This configuration makes each RDF a digital router, passing data from one to each other based on a routing specification set by the control center. It is therefore sufficient to have a radio connection between two RDFs with the first within communication reach with the second, the second with the third and so on in a star and/or chain pattern through every RDF. The speed at which a package is routed is extremely low therefore being able to reach the destination even with many jumps in just a few seconds. Each RDF can connect directly to up to 12 RDF (star) and so on up to 255 per network, providing the possibility to create complex networks.

ANT uses a proprietary protocol that has been optimized and improved over the years on collision detention, error recovery, etc… In the event the packages cannot go through the Radio channel, the RDF when properly equipped will automatically try with alternative channels (modem, mobile phone, dedicated channel, etc).

**Alarms**

An alarm is a special event that is generated from the RDF. It is triggered from a digital or analog input. Each analog input is associated to up to 4 set points. If the electrical measurement, will, over or under run the set point, the alarm will trigger, sending a communication, to the control center. This is one of the few moments the RDF will spontaneously send a communication itself.

### 3.3.2 Modem- Fastrack Supreme

The Fastrack Supreme 10/20 is discrete, rugged cellular Plug & Play Wireless CPU offering state-of-the-art GSM/GPRS (and EGPRS for Fastrack Supreme 20) connectivity for machine to machine applications.

It offers an Internal Expansion Socket (IES) interface accessible for customer use. Expanding application features is easy without voiding the warrantee of the Fastrack Supreme by simply plugging in of an Internal Expansion Socket Module (IESM) board.

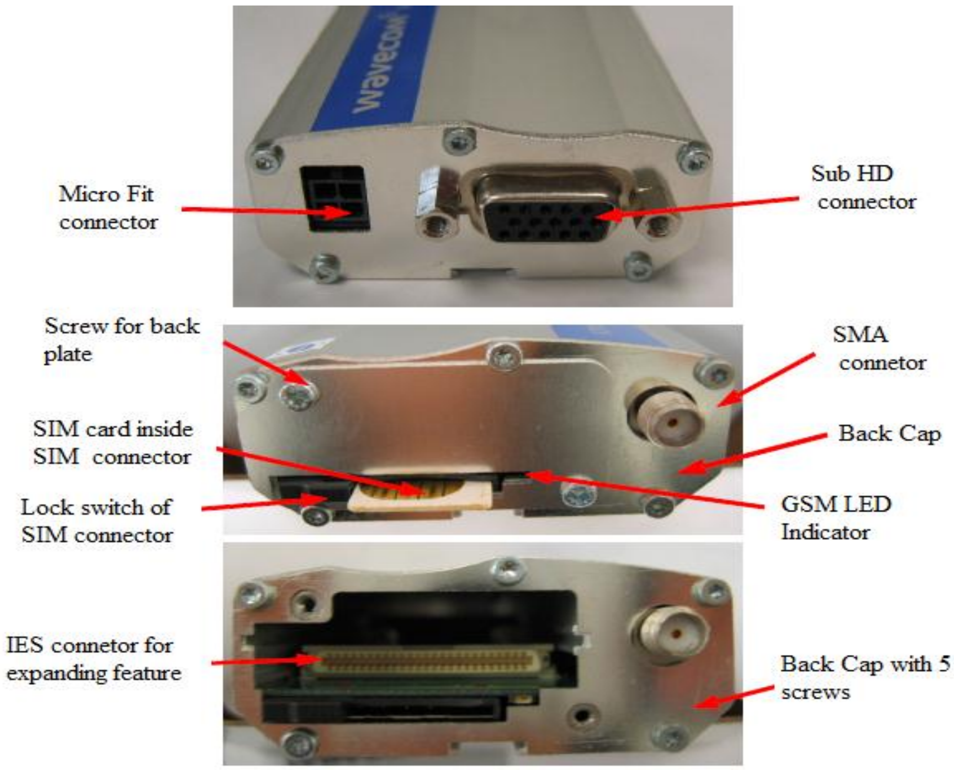



Fig.3.8. Fastrack Supreme description

It is supplied by an external DC voltage (V+BATTERY) from +5.5 V to +32 V at 2.2A and is also protected against voltage over +32 V.

The Fastrack Supreme is a quad band Plug & Play. It supports either EU bands (EGSM900/DCS1800) or US bands (GSM850/ PCS1900), depending on the band setting within the Plug & Play. Users are free to switch between EU bands and US bands by simple AT commands when the selected bands are supported [28]. GSM antenna, SIM card, interfacing cables and different types of connectors have been used in this thesis.

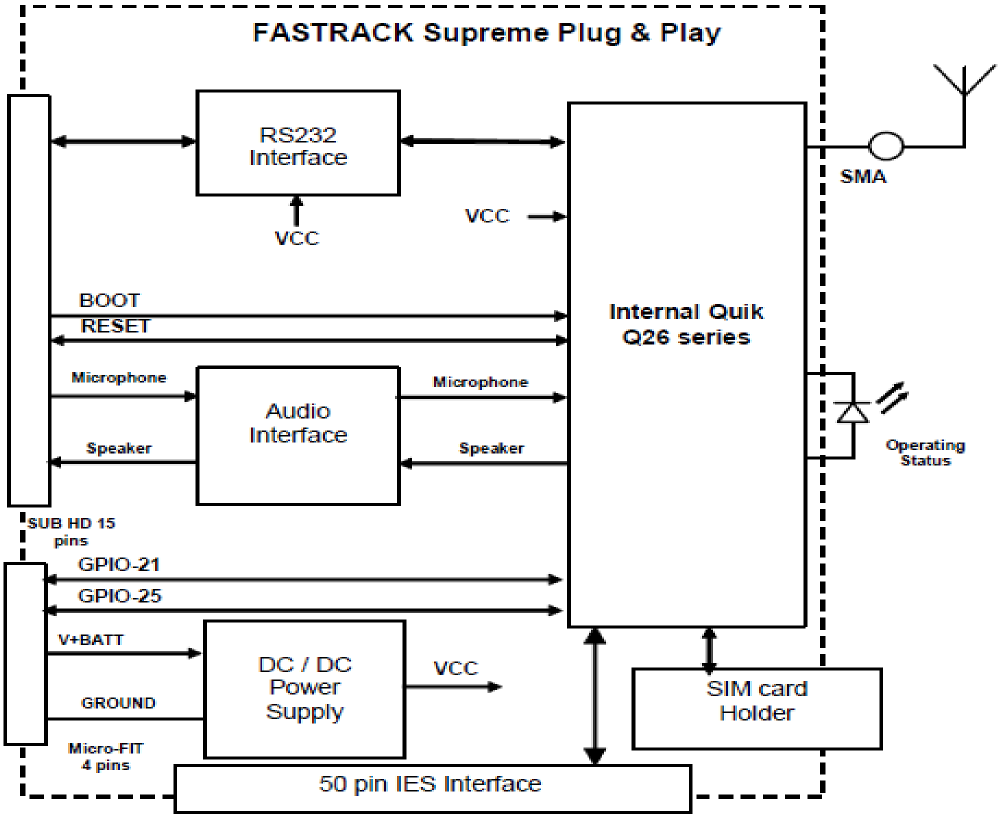



Fig.3.9. Fastrack supreme functional architecture

## 3.4 Software used

The software used to take this thesis into practical action is the so called "NetPod". I chose this software because of many reasons: the first reason is that I got licensed software from a transmitter installer company while consulting on this thesis. The other reason is that its compatibility and can be customized, to fit any network size and maintenance structure.

NetPOD is Garda Systems' control software designed to be future proof/futuristic and has got many benefits:

- It is an NMS software suite, based on a client-server concept.
- Improve efficiency and coordination of maintenance activities
- Optimize sites and equipment management thru the analysis of statistics, and enhance problem solving
- User-friendly and charming user interface
- Power and reliability, designed by people that know what broadcasters want.

- Any user can start with a very basic and easy to use system, and grow up to a very comprehensive and detailed surveillance system.
- It is a real multi-user system, with real time access available, that can also be split into areas, regions, and accessed according to hierarchical levels[ ].

### 3.4.1 NetPOD Manager

It is server application that runs as a system service and gathers information from the remote sites and Stores it all in the database. The data control engine automatically checks for connections with RDFs, Agent grabs incoming data, generates alarms, and creates statistics, sends email and SMS. It also takes care of managing client applications, connected to its services.

The NetPOD will collect data from all RDFs and SNMP agents inside equipment on the field, and send all commands to the remote equipment [ ].

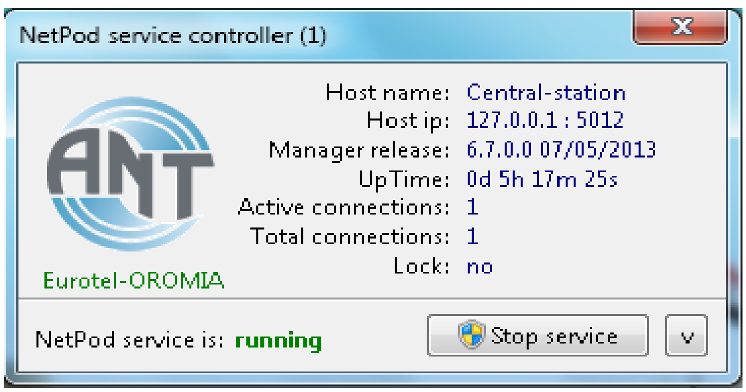



Fig.3.10.NetPOD Manager Software web-page

**Server application software**

The Server Software, Name=ANT125 Manager, is the heart of the system and is installed in a computer running 24/7/365 connected to devices that allow connection with the FRONT-ENDS and with the external world (Radio, RS232, TCP-IP, Modem PSTN, GSM, Satellite, etc). It manages all the communications, data computing, archiving and client servicing.

The control center is composed of a PC running a server application – NetPOD Manager -, with one or more network interfaces to communicate with the remote sites. The server application sends commands, collects data/events/alarms from the remote sites, and manages communication and database. Alarms are forwarded in real time to technicians and authorized/privileged persons via voice calls, SMS, email, etc.

### 3.4.2 NetPOD Supervisor

It is client application for the management and the supervision. TCP/IP connection enables fast performances.

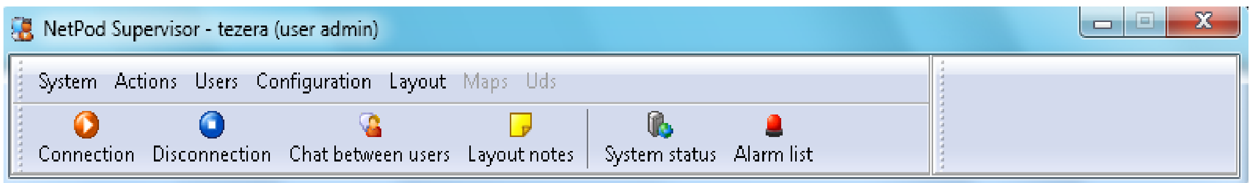



Fig.3.11. NetPOD Supervisor software web-page

**Client application software (GUI)**

The Client Software, Name=ANT125 Supervisor, is the user interface (GUI=Graphical user interface); it allows human interaction with the system. It communicates with the server through the network (local or internet). It is possible to simultaneously use more than one (as stated in the license) client application, even with different languages. Through this GUI all operations can take place. Authentication is done through username and password.

### 3.4.3 ANT Tool software

It is software used to test and/or setting up modems to be used with an RDF or server application (NetPOD manager). It also modifies address and user-id on the RDF, TCP parameters on the RDF, saves files to RDF firmware parameters before hardware replacement.

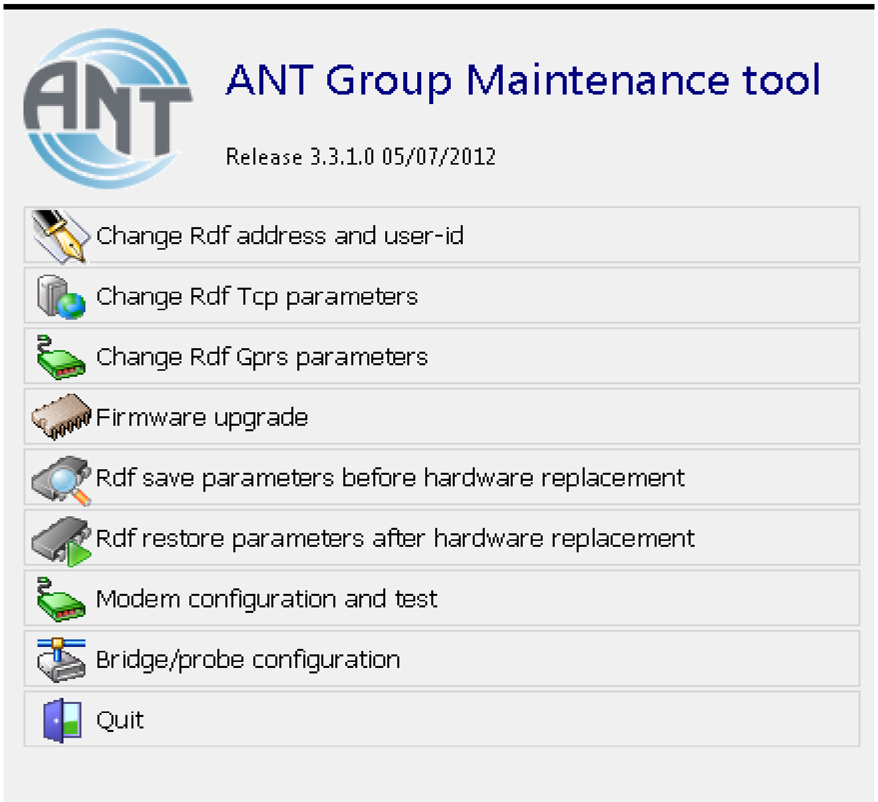



Fig.3.12. ANT tool software web-page

# CHAPTER FOUR

## ANALYSIS, DISCUSSION AND RESULT

### 4.1 Introduction

When there is need to reach key audiences with factual and trusted information, broadcasting media delivers. How offensive and unpleasant it is, if television transmission interrupted while watching hot, attractive and suspense program.  The use of generators for such a case is very mandatory now-a-days for the essential outcome of the load by giving the continuous and uninterrupted supply of power to the transmitting station. The Real-time point-to-point data reporting architecture is useful for remote surveillance and control, if communication network can be convenient to access. In the new age of technology, GSM modem redefines communication. Sending written text messages is very popular among mobile phone users. This thesis is backboned with the GSM technology, where all the instant data from the generator set is transmitted to the central station through message service, where authorized person will handle with the information intimated him via mobile. The thesis is then developed by identifying problems most frequently occurred in all ORTVO stations are embedded with TV and FM through RDF. Information like fuel level, temperature, battery voltage and oil level can be transmitted.

### 4.2 Generator parameters analysis, discussion and result

Common observed generator parameters are fuel level, temperature, battery voltage and oil level as shown in fig.4.1. All generator parameters listed are fed to RDF through control panel called GCEF.

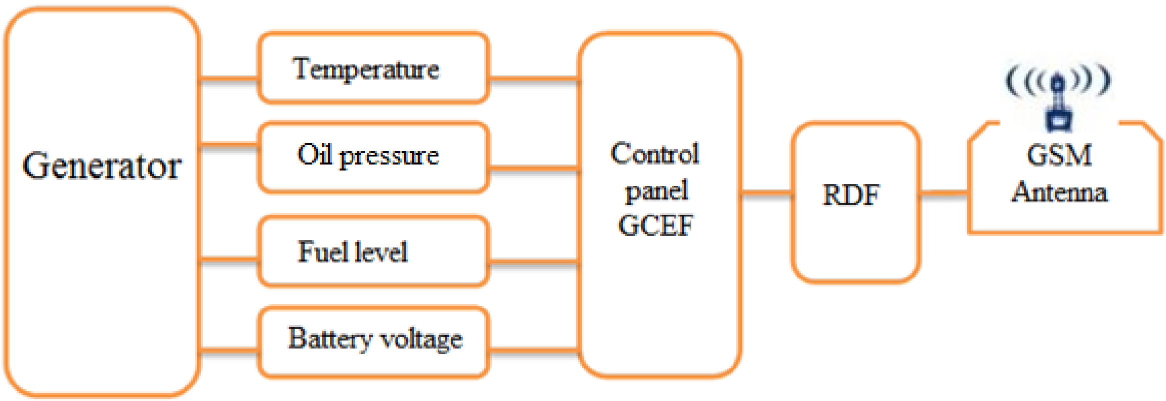



Fig 4.1 Generator system block diagram

The following table indicates generator parameters that most frequently result in failures that observed at each station during data collection.

Table 4.1 ORTVO generator input parameters

| Generator input parameters | | |
|---|---|---|
| **No.** | **Analog input** | **Digital input** |
| 1. | Temperature | Power supply |
| 2. | Oil pressure | Battery voltage |
| 3. | Fuel level | Battery charger |
| 4. | Battery voltage | Auxiliary fuse |
| 5. | | Mains |

The analog input parameters are from generator set and directly fed to RDF having minimum and maximum values for both pre-alarms and alarm as shown in table 4.2

Table 4.2 ORTVO generator input parameters with minimum and maximum values

| **Parameters** | **Pre-alarm values** | | **Alarm values** | |
|---|---|---|---|---|
| | Minimum | Maximum | Minimum | Maximum |
| Temperature | 20ºC | 85ºC | 15ºC | 95ºC |
| Oil pressure | 3bar | 8bar | 2bar | 10bar |
| Fuel level | 25% | 75% | 20% | 100% |
| Battery voltage | 10V | 12V | 8V | 12V |

The RDF module configured as per these parameters sends SMS when any pre-alarm and alarm is triggered.

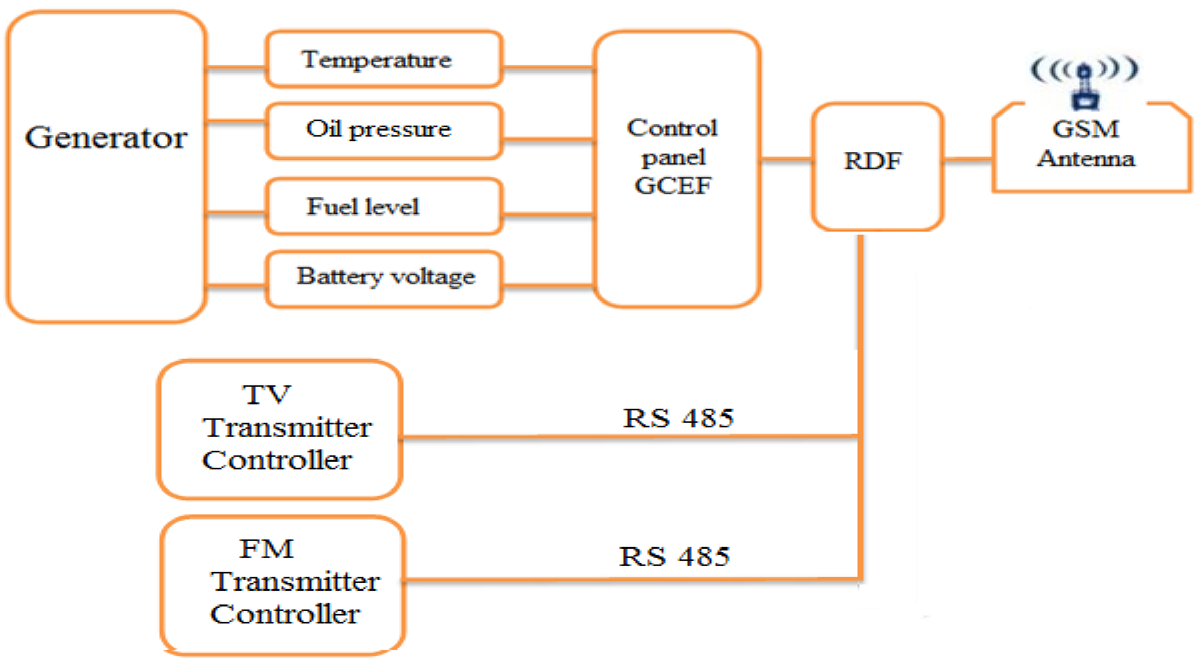



Fig 4.2 Generator, TV and FM embedded system block diagram

Any triggered alarms from transmitters are directly connected to RDF through RS 485. Each alarm of each parameter of generator is embedded and customized with parameters of TV and FM in the RDF module by using NetPOD software. The embedded signal is then sent to central monitoring station through GSM modem.

The software result of generator is shown in fig. 4.3

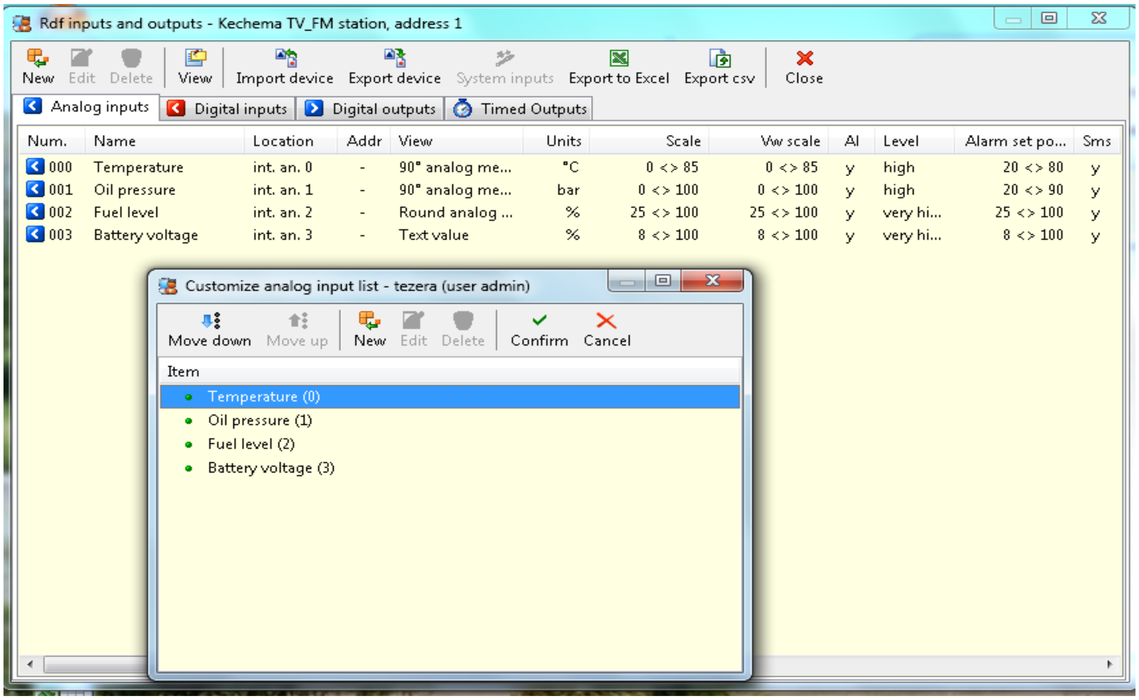



Fig.4.3 Rdf generator parameters analog inputs-Kechema TV-FM station

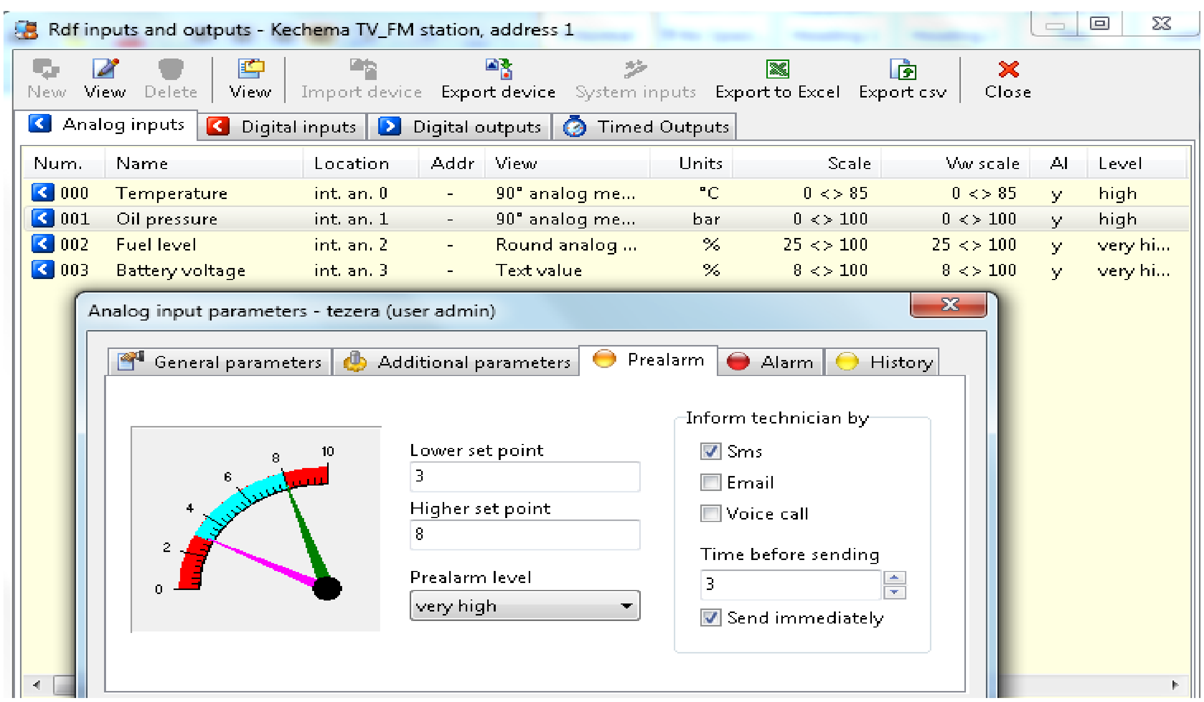



Fig.4.4 Rdf generator parameters analog inputs-Kechema TV-FM station

Digital input to the Rdf from control panel, GCEF is shown in fig. 4.3

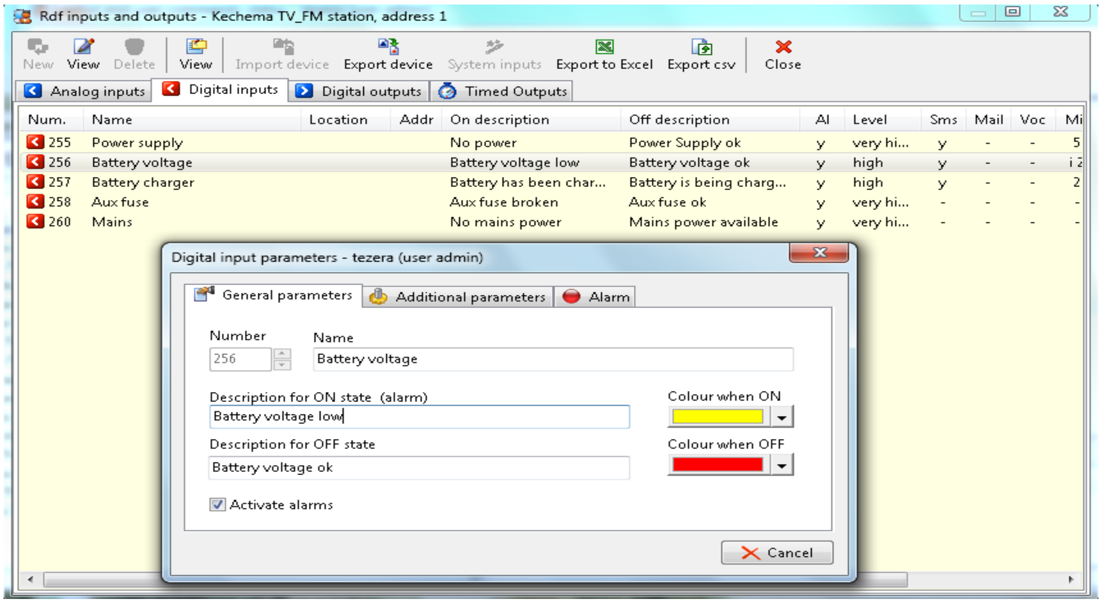



Fig.4.3 Rdf generator parameters digital inputs-Kechema TV-FM station

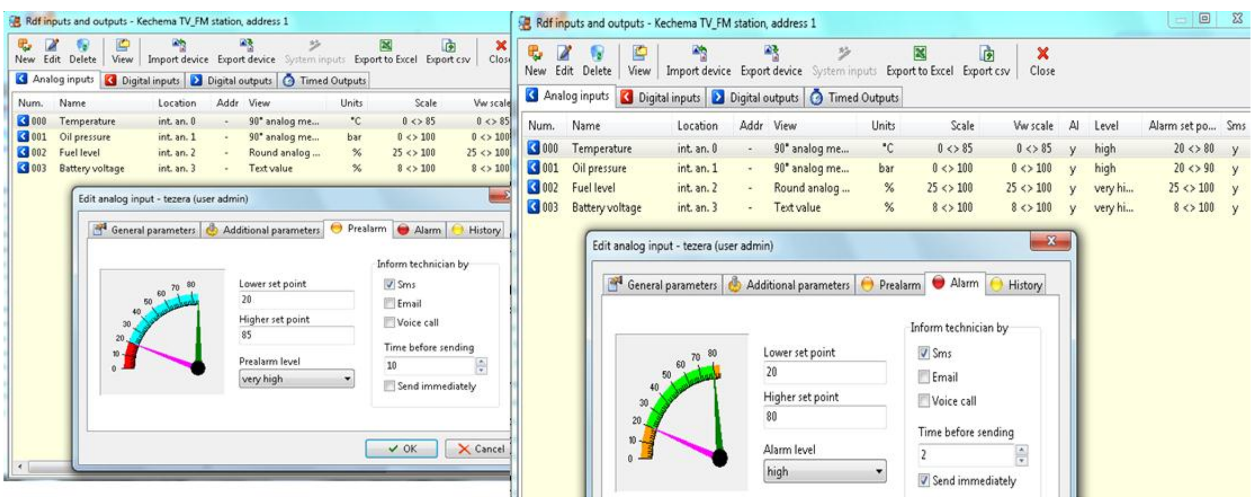



Fig.4.4 Rdf temperature pre-alarm and alarm setting-Kechema TV-FM station

The central station server is connected to 16 different Rdf of each station with the corresponding technician phone number. The server receives and archives any triggered alarms, pre-alarms to its central data storage and resends back to the pre-configured authorized phone numbers. Fig. 4.5 below indicates this.

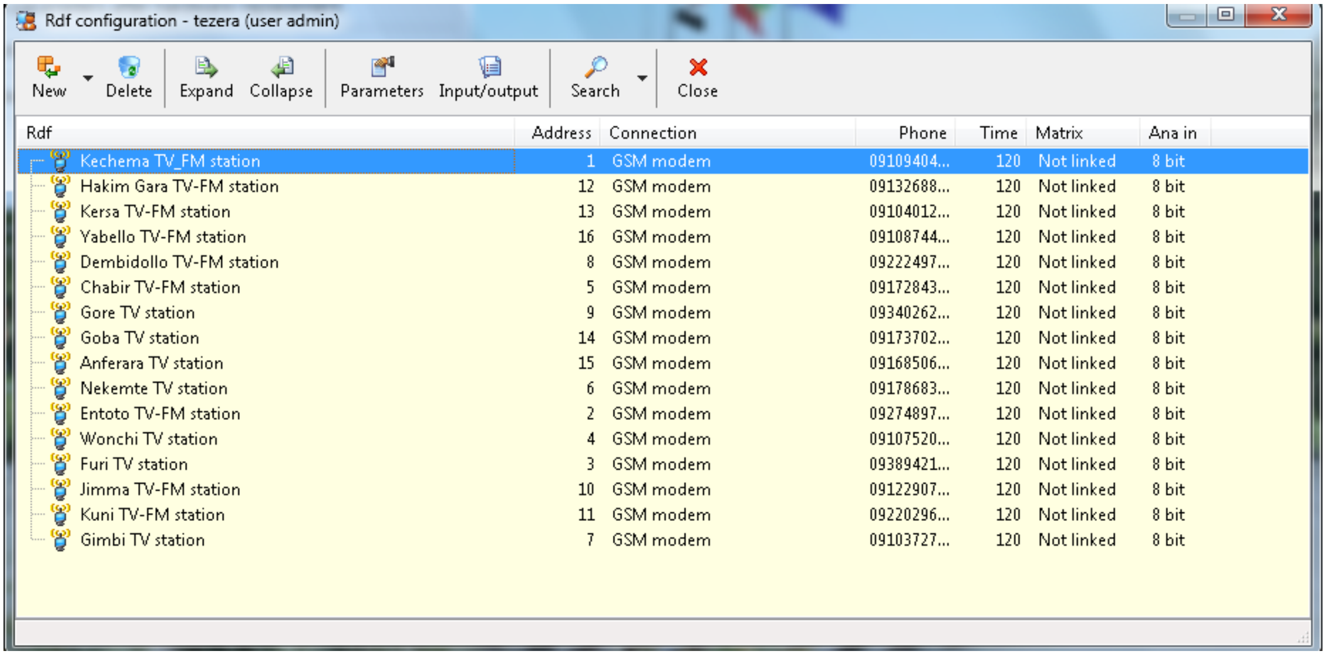



Fig.4.5 Rdf configuration for stations

Central station server technician archive for all the stations is shown in fig. 4.6. The archive includes schedules, phone numbers and station name in order to connect the station to the corresponding technician.

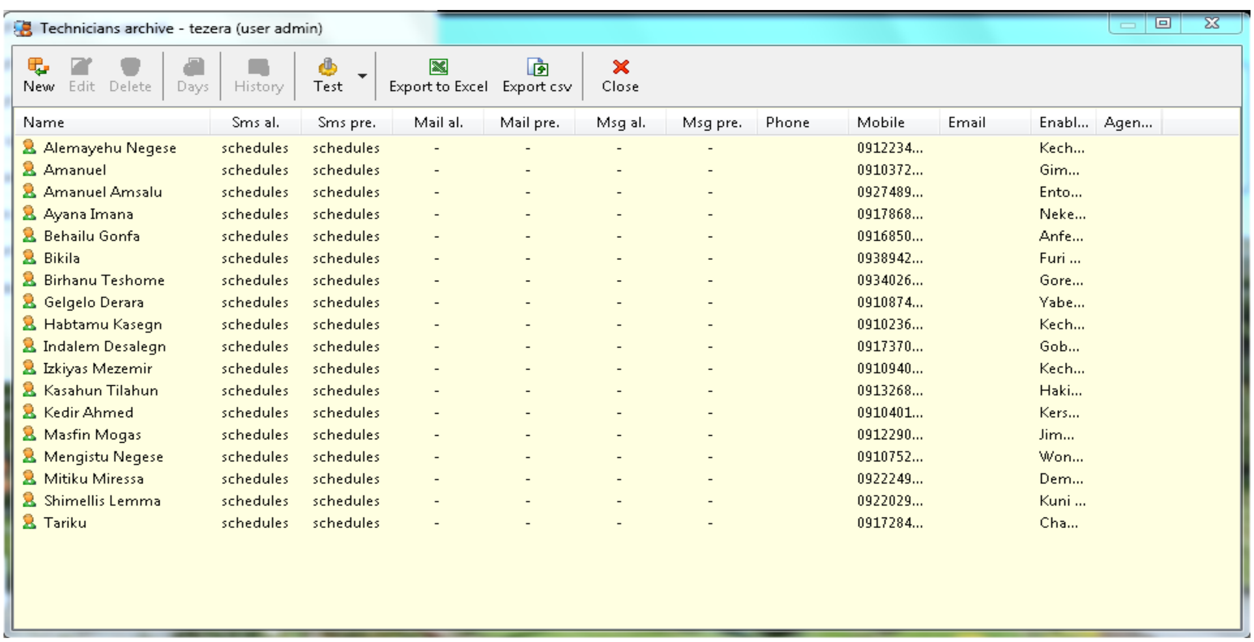



Fig.4.6. Central station server technician archive

Layout and user command status of the central server including all stations' names and their corresponding address, configuration, status, etc are depicted in fig.4.7 below.

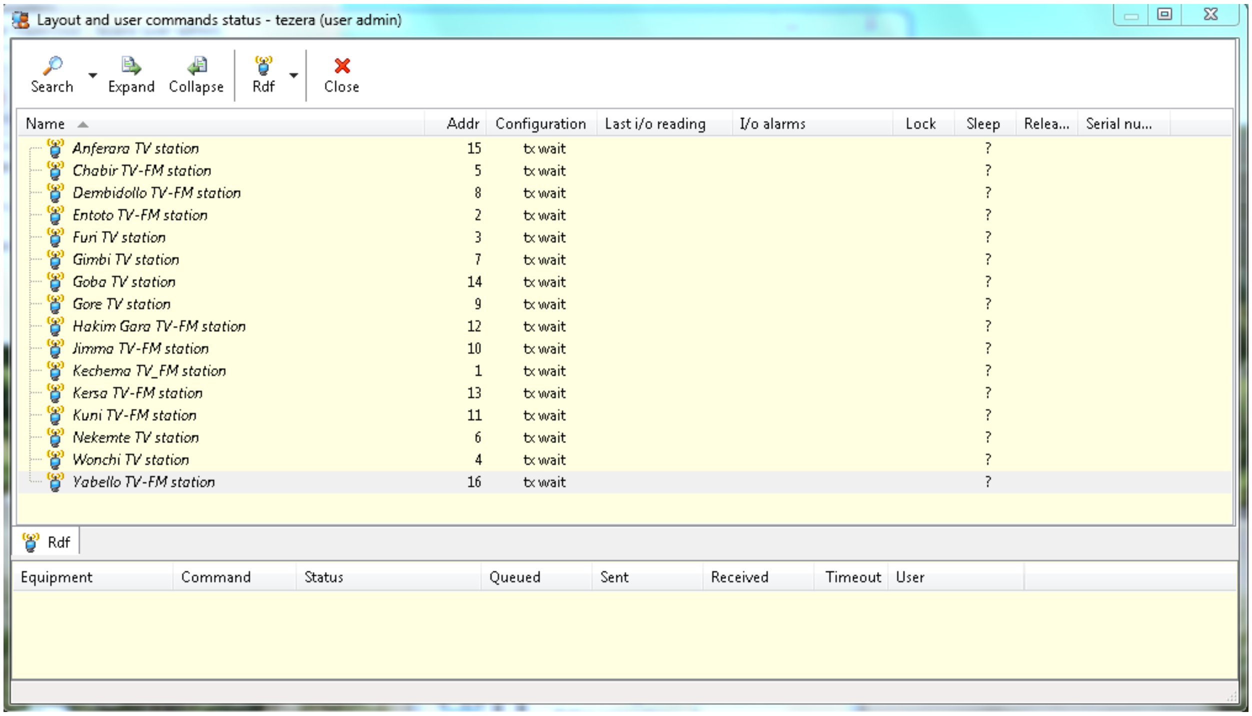



Fig.4.7. Central station server layout and user commands status

# CHAPTER FIVE

# CONCLUSION AND RECOMMENDATION

## 5.1 Conclusion

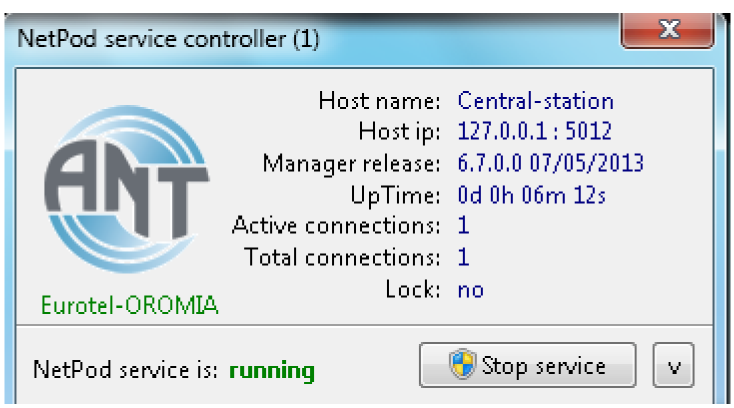
This thesis depicts constant and consistent monitoring of all ORTVO stations using GSM modem technology. The generator parameters that are thoroughly monitored are fuel level, temperature, and oil level and battery voltage. When these parameters and other faults triggered by generator exceed predefined limits, pre-alarms and alarms signaled by control panel directly go to RDF being embedded with TV and/or FM status inside the GSM module. The GSM module then sends a text message to the central station server where it is archived and resent back to the authorized personnel. The system provides the best solution to continuous power supply for consistent program delivery by remotely controlled benefits as long as GSM network coverage is available. Thus whenever the fault encoded by the controller kit the intimation to the mobile is sent immediately and the reflex action can be performed by the personnel to fix the problem to run the generator in a steady state and to clear any alarms triggered by TV and/or FM transmitters.

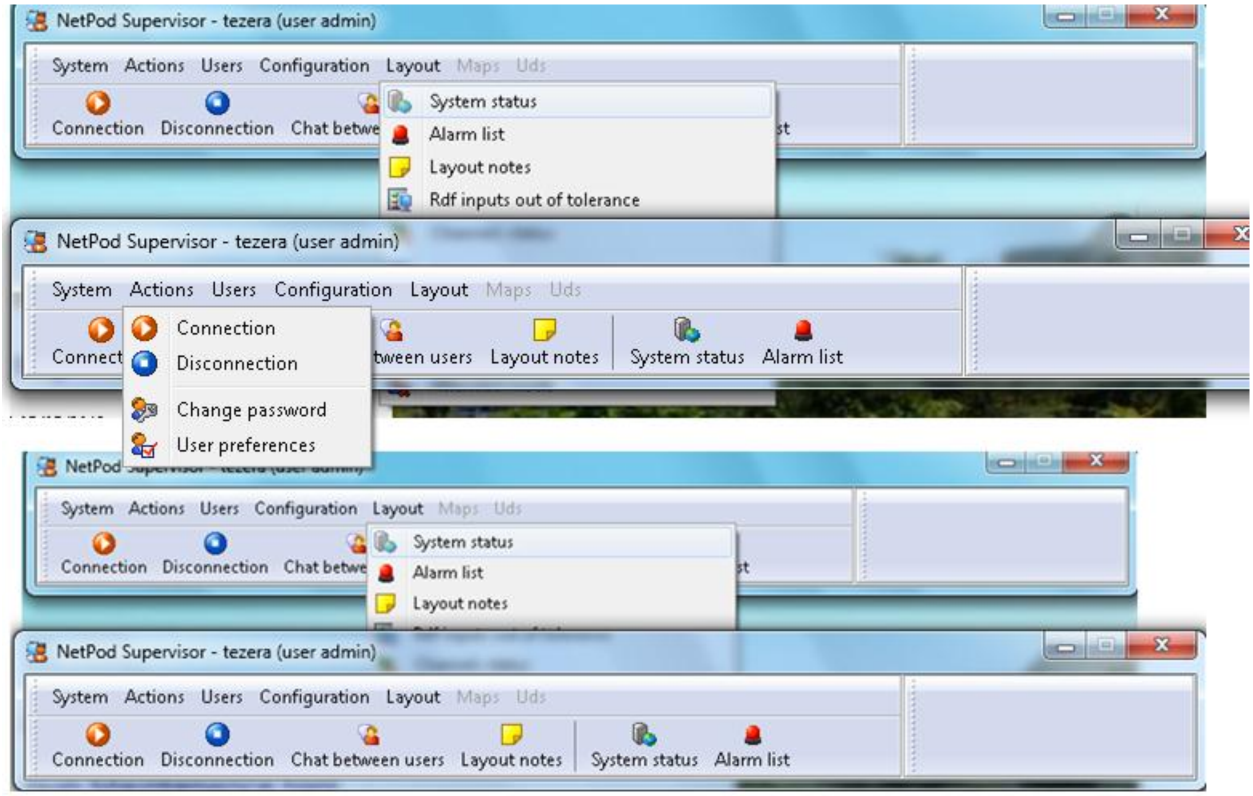
## 5.2 Recommendation

It is recommended that transmitter stations of ORTVO have different machineries like AVR, UPS which are directly interrelated with the systems. These devices also need monitoring as their failures also affect and disrupt the whole system. It is then recommended that adding plug in module (PIM) inside the RDF for any device in the station can feasibly solve the problem.

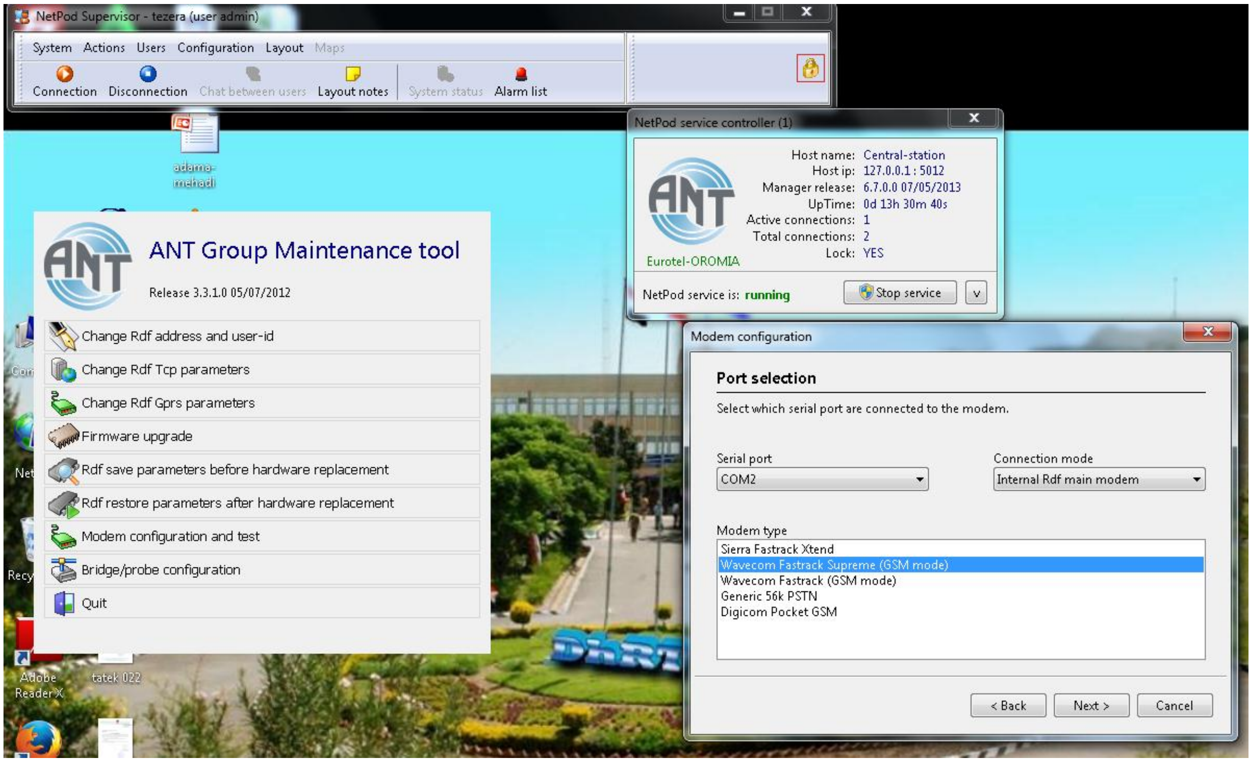
# Appendices

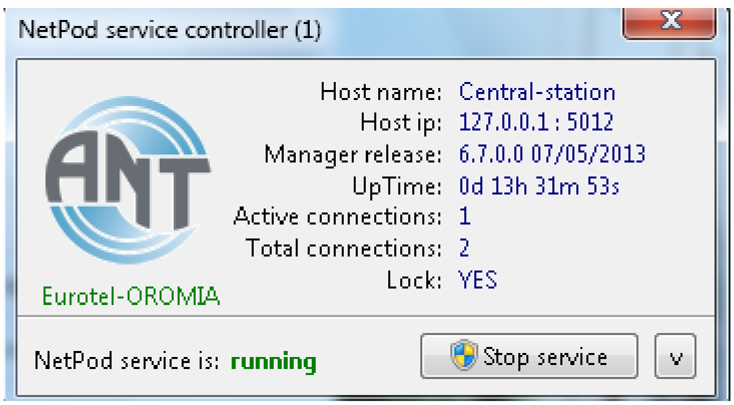
## A. Software used

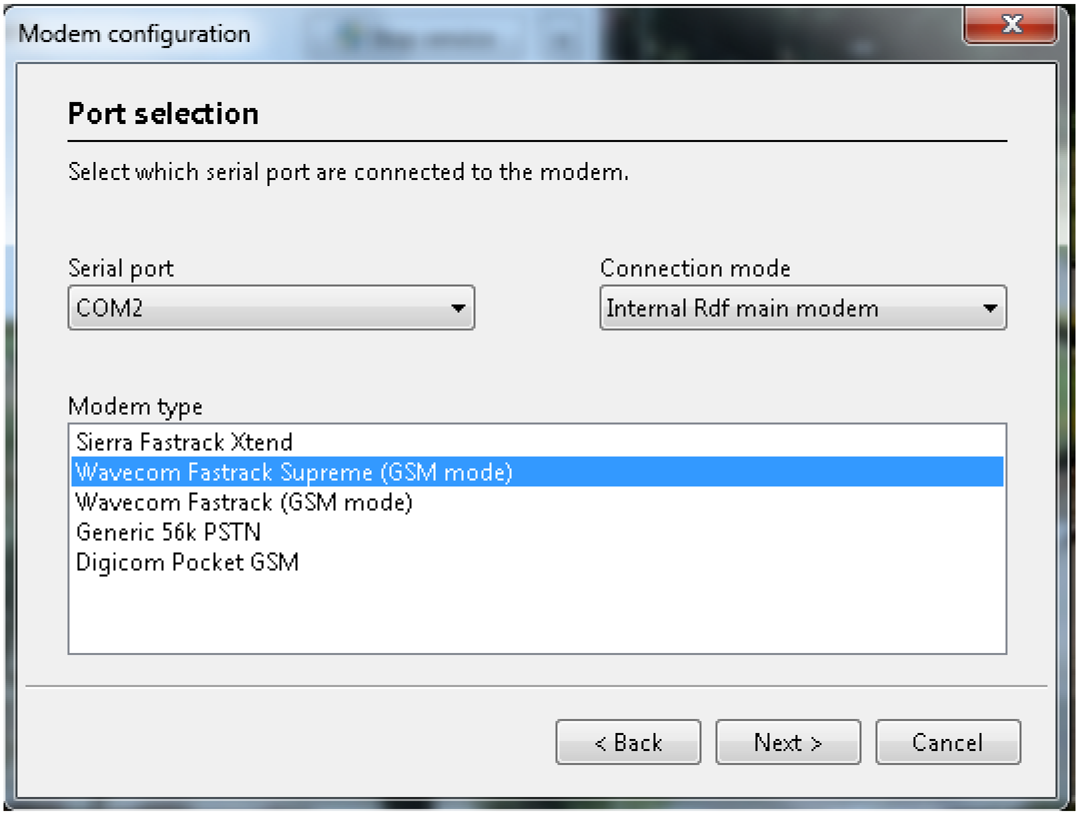



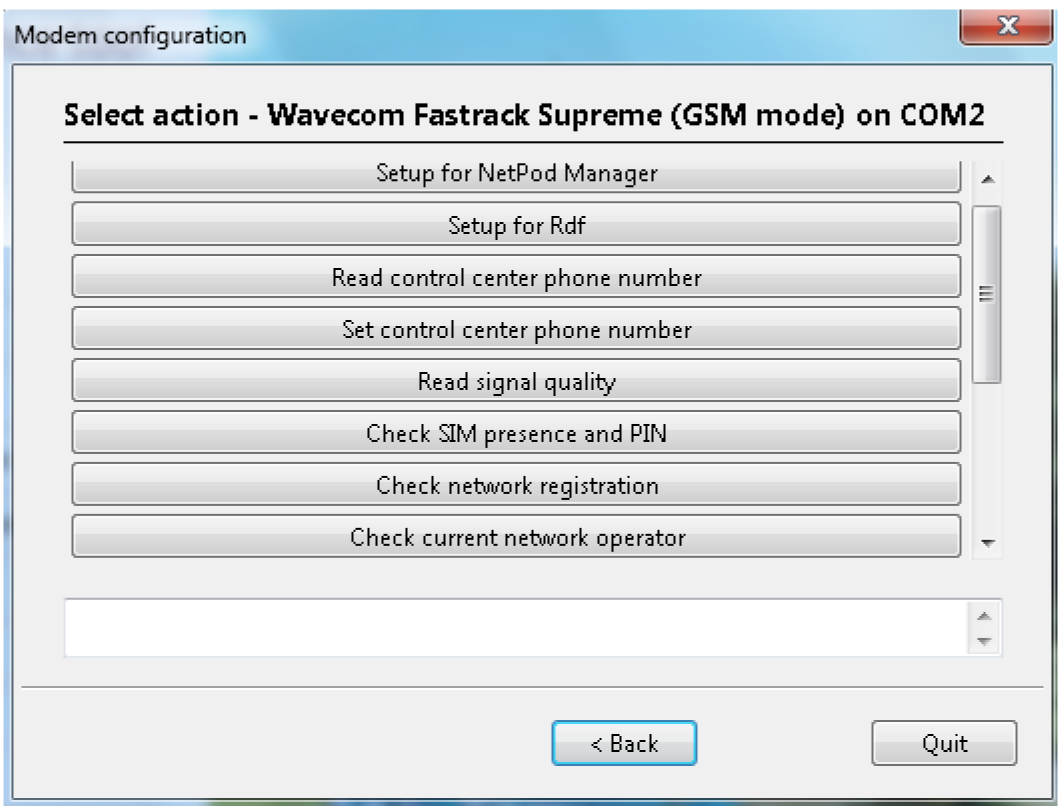

NetPod Supervisor - tezera (user admin)
System Actions Users Configuration Layout Maps Uds
Connection Disconnection Chat between users Layout notes System status Alarm list
System status
Alarm list
Layout notes
Rdf inputs out of tolerance
Connection
Disconnection
Change password
User preferences

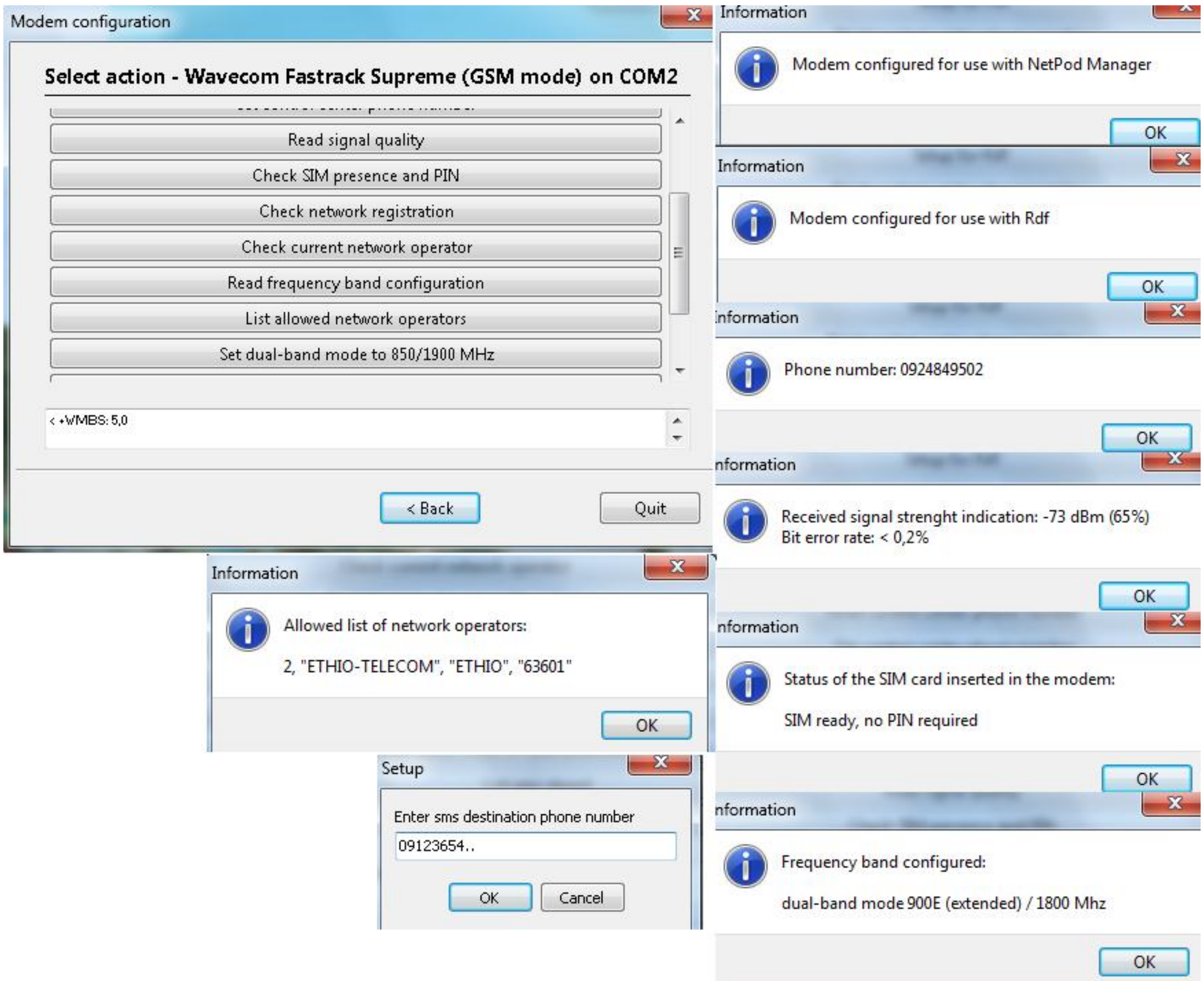

NetPod Supervisor - tezera (user admin)
System Actions Users Configuration Layout Maps Uds
Connection Disconnection Chat between users Layout notes System status Alarm list

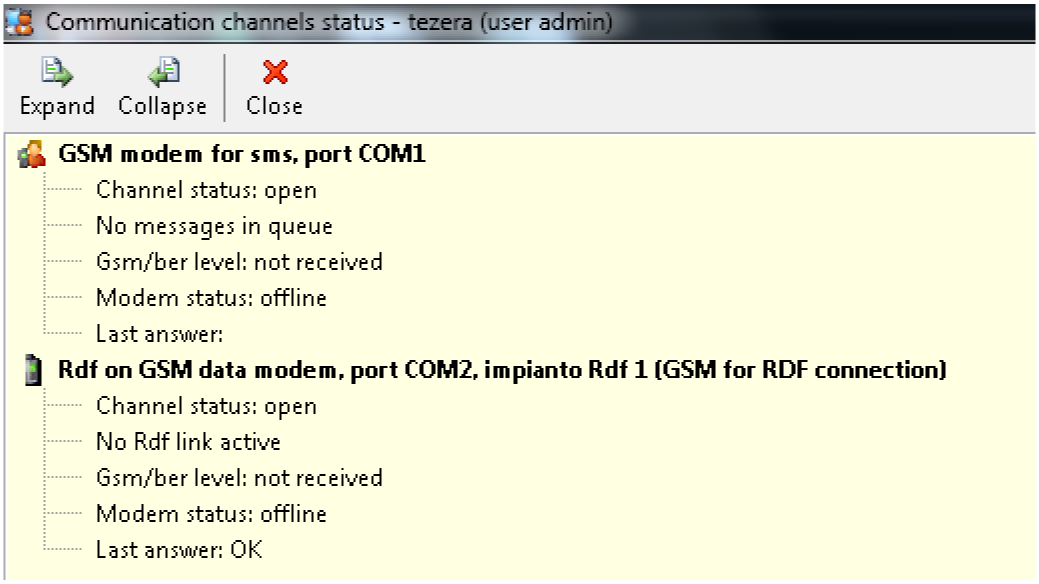

NetPod Supervisor - tezera (user admin)
System Actions Users Configuration Layout Maps
Connection Disconnection Chat between users Layout notes System status Alarm list
ANT Group Maintenance tool
Release 3.3.1.0 05/07/2012
Change Rdf address and user-id
Change Rdf Tcp parameters
Change Rdf Gprs parameters
Firmware upgrade
Rdf save parameters before hardware replacement
Rdf restore parameters after hardware replacement
Modem configuration and test
Bridge/probe configuration
Quit
NetPod service controller (1)
Host name: Central-station
Host ip: 127.0.0.1 : 5012
Manager release: 6.7.0.0 07/05/2013
UpTime: 0d 13h 30m 40s
Active connections: 1
Total connections: 2
Lock: YES
Eurotel-OROMIA
NetPod service is: running
Stop service
Modem configuration
Port selection
Select which serial port are connected to the modem.
Serial port
COM2
Connection mode
Internal Rdf main modem
Modem type
Sierra Fastrack Xtend
Wavecom Fastrack Supreme (GSM mode)
Wavecom Fastrack (GSM mode)
Generic 56k PSTN
Digicom Pocket GSM
< Back
Next >
Cancel

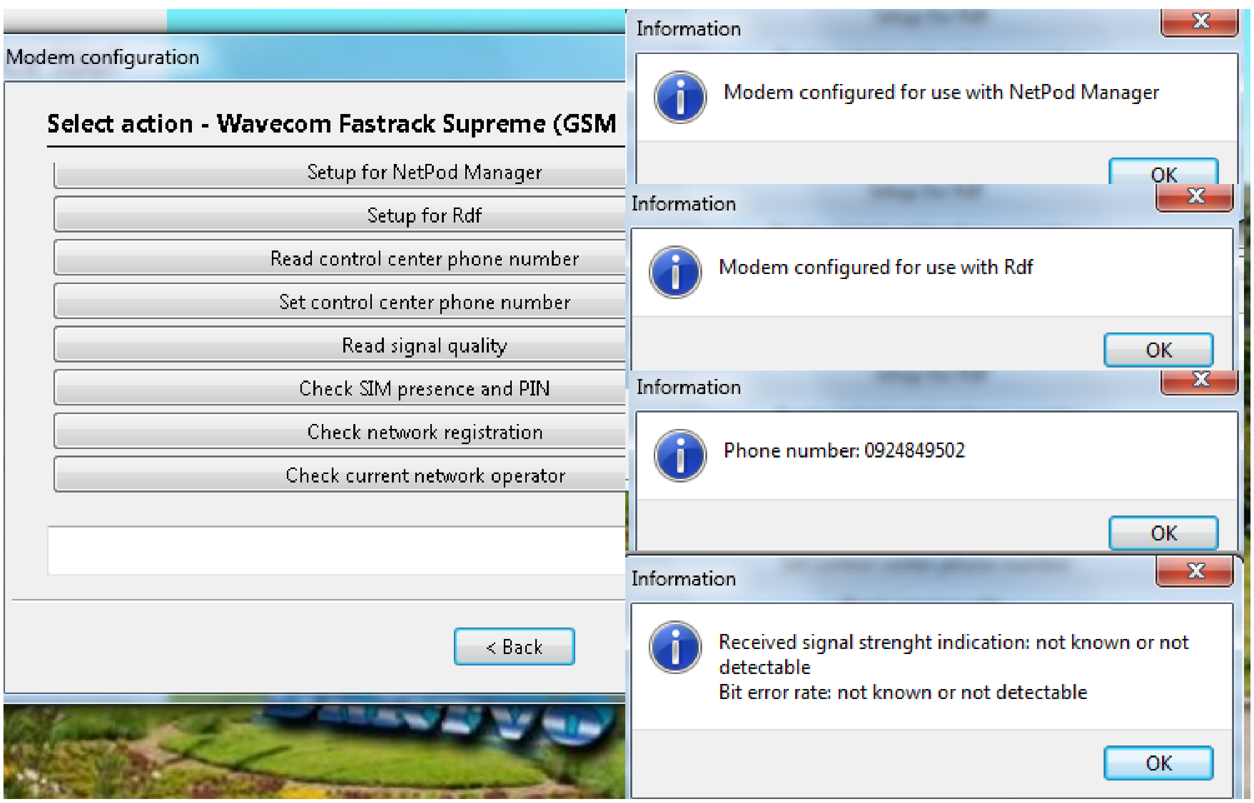

NetPod service controller (1)
Host name: Central-station
Host ip: 127.0.0.1 : 5012
Manager release: 6.7.0.0 07/05/2013
UpTime: 0d 13h 31m 53s
Active connections: 1
Total connections: 2
Lock: YES
Eurotel-OROMIA
NetPod service is: running
Stop service
v

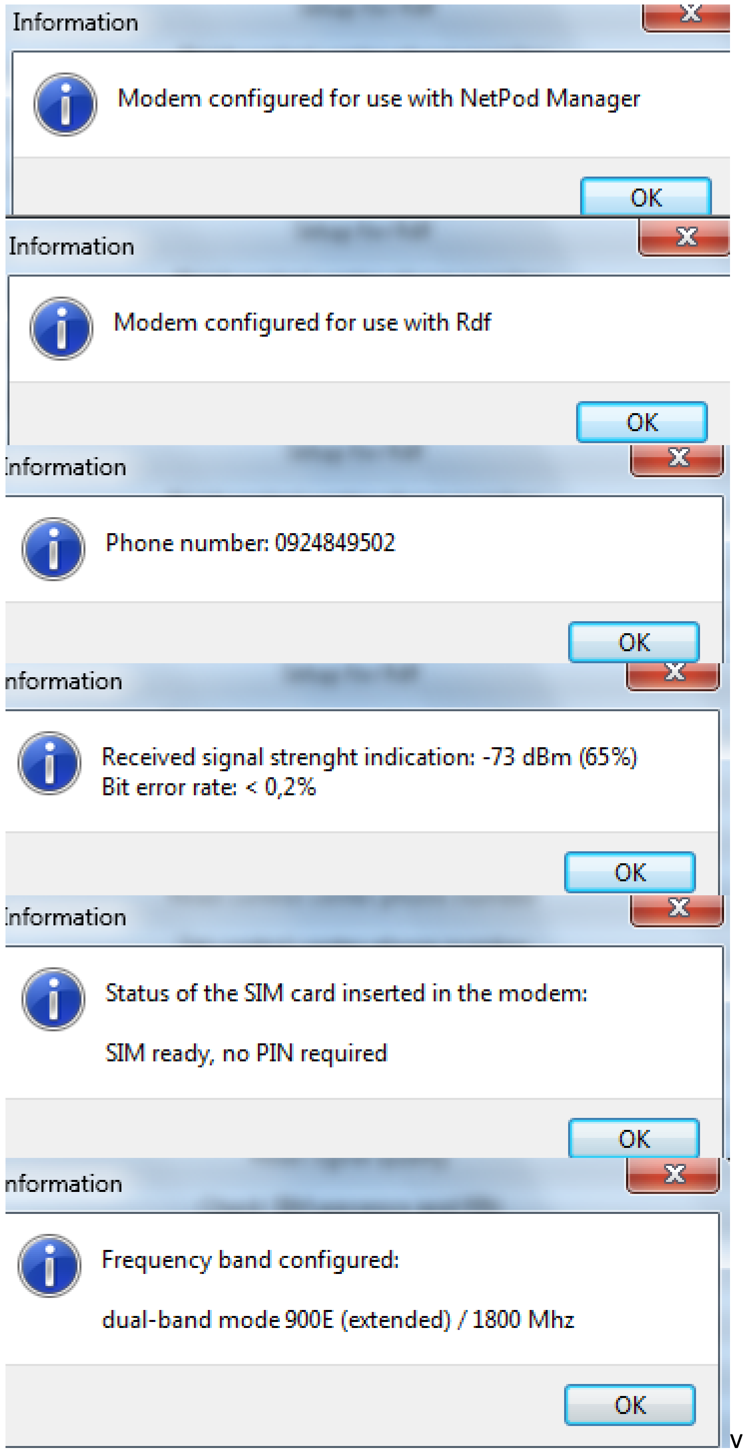

Modem configuration
Port selection
Select which serial port are connected to the modem.
Serial port
COM2
Connection mode
Internal Rdf main modem
Modem type
Sierra Fastrack Xtend
Wavecom Fastrack Supreme (GSM mode)
Wavecom Fastrack (GSM mode)
Generic 56k PSTN
Digicom Pocket GSM
< Back
Next >
Cancel

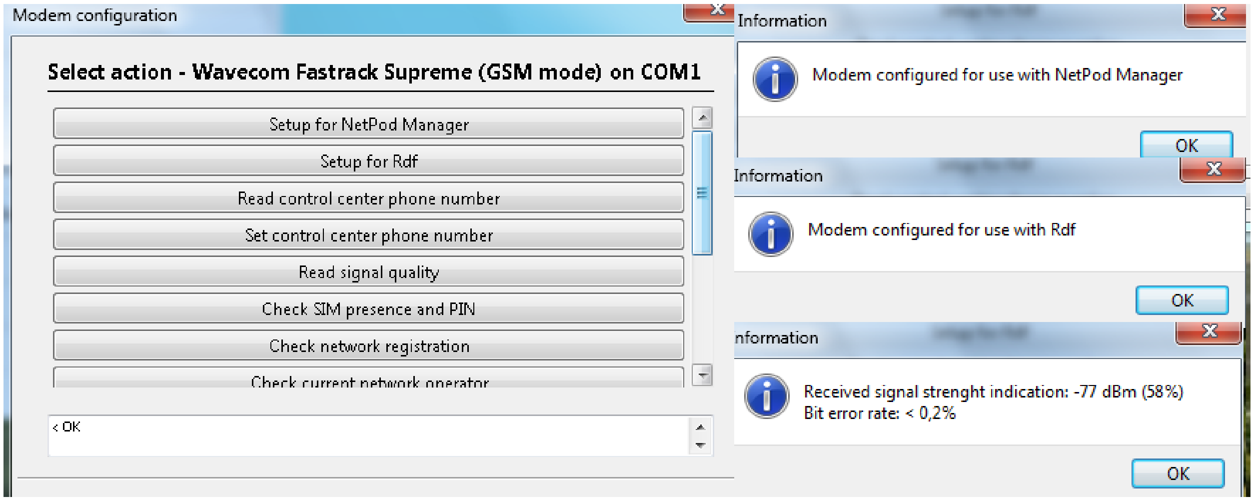

Modem configuration
Select action - Wavecom Fastrack Supreme (GSM mode) on COM2
Setup for NetPod Manager
Setup for Rdf
Read control center phone number
Set control center phone number
Read signal quality
Check SIM presence and PIN
Check network registration
Check current network operator
< Back
Quit


Modem configuration
Select action - Wavecom Fastrack Supreme (GSM mode) on COM2
Read signal quality
Check SIM presence and PIN
Check network registration
Check current network operator
Read frequency band configuration
List allowed network operators
Set dual-band mode to 850/1900 MHz
< +WMBS: 5,0
< Back
Quit
Information
Modem configured for use with NetPod Manager
OK
Information
Modem configured for use with Rdf
OK
Information
Phone number: 0924849502
OK
Information
Received signal strenght indication: -73 dBm (65%)
Bit error rate: < 0,2%
OK
Information
Allowed list of network operators:
2, "ETHIO-TELECOM", "ETHIO", "63601"
OK
Information
Status of the SIM card inserted in the modem:
SIM ready, no PIN required
OK
Setup
Enter sms destination phone number
09123654..
OK
Cancel
Information
Frequency band configured:
dual-band mode 900E (extended) / 1800 Mhz
OK

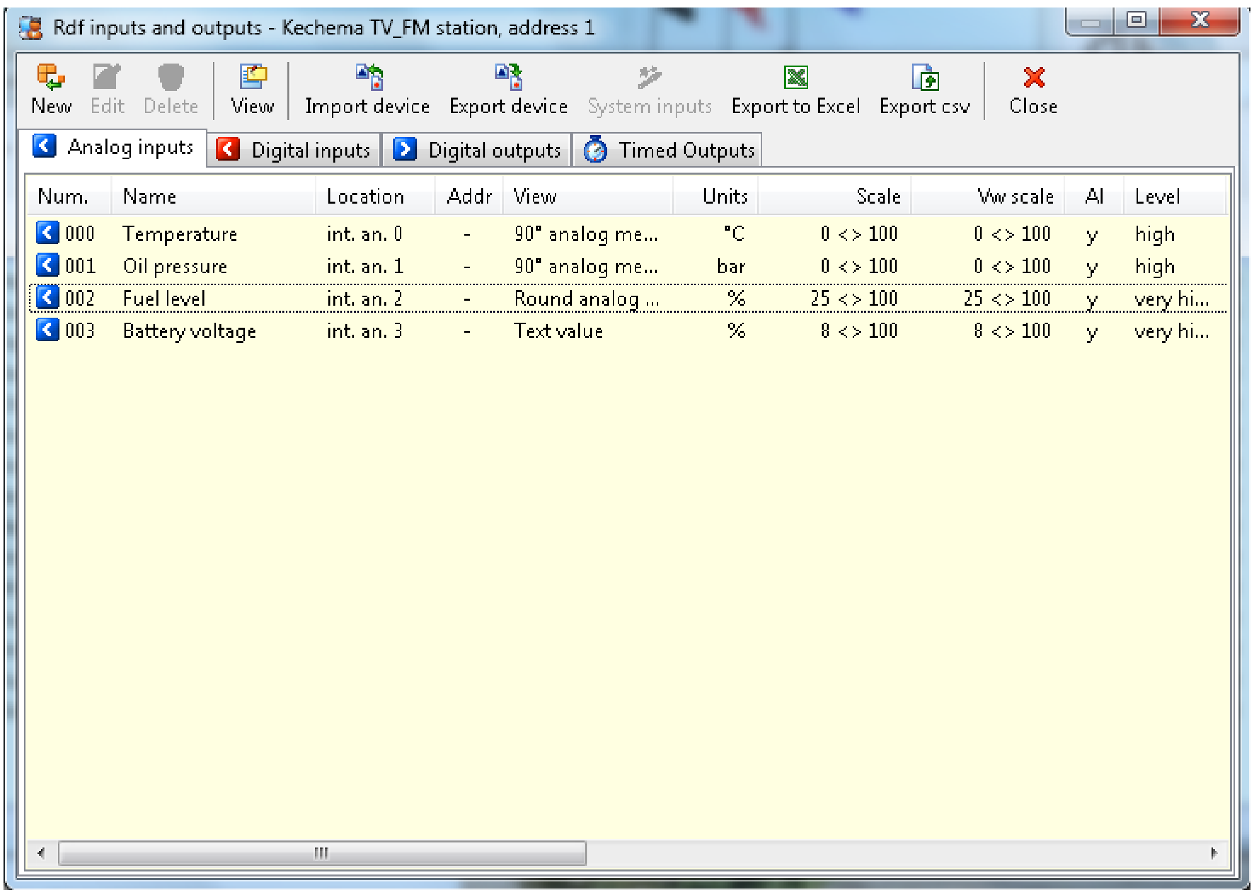

Communication channels status - tezera (user admin)
Expand
Collapse
Close
GSM modem for sms, port COM1
Channel status: open
No messages in queue
Gsm/ber level: not received
Modem status: offline
Last answer:
Rdf on GSM data modem, port COM2, impianto Rdf 1 (GSM for RDF connection)
Channel status: open
No Rdf link active
Gsm/ber level: not received
Modem status: offline
Last answer: OK

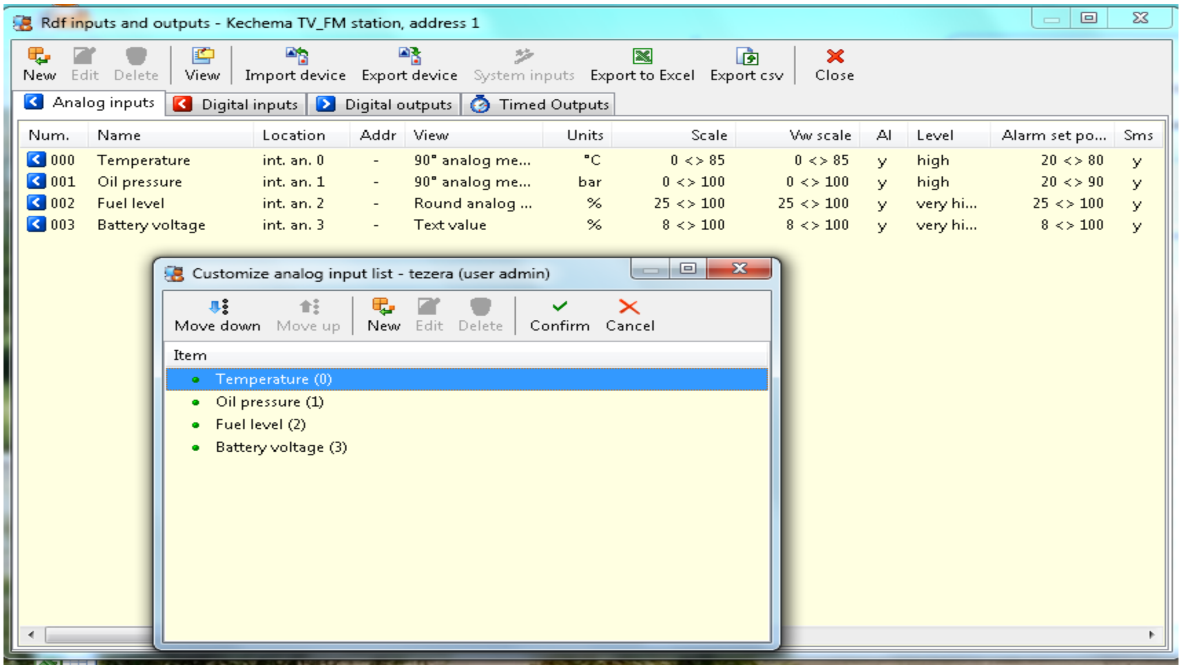

Modem configuration
Select action - Wavecom Fastrack Supreme (GSM
Setup for NetPod Manager
Setup for Rdf
Read control center phone number
Set control center phone number
Read signal quality
Check SIM presence and PIN
Check network registration
Check current network operator
< Back
Information
Modem configured for use with NetPod Manager
OK
Information
Modem configured for use with Rdf
OK
Information
Phone number: 0924849502
OK
Information
Received signal strenght indication: not known or not detectable
Bit error rate: not known or not detectable
OK

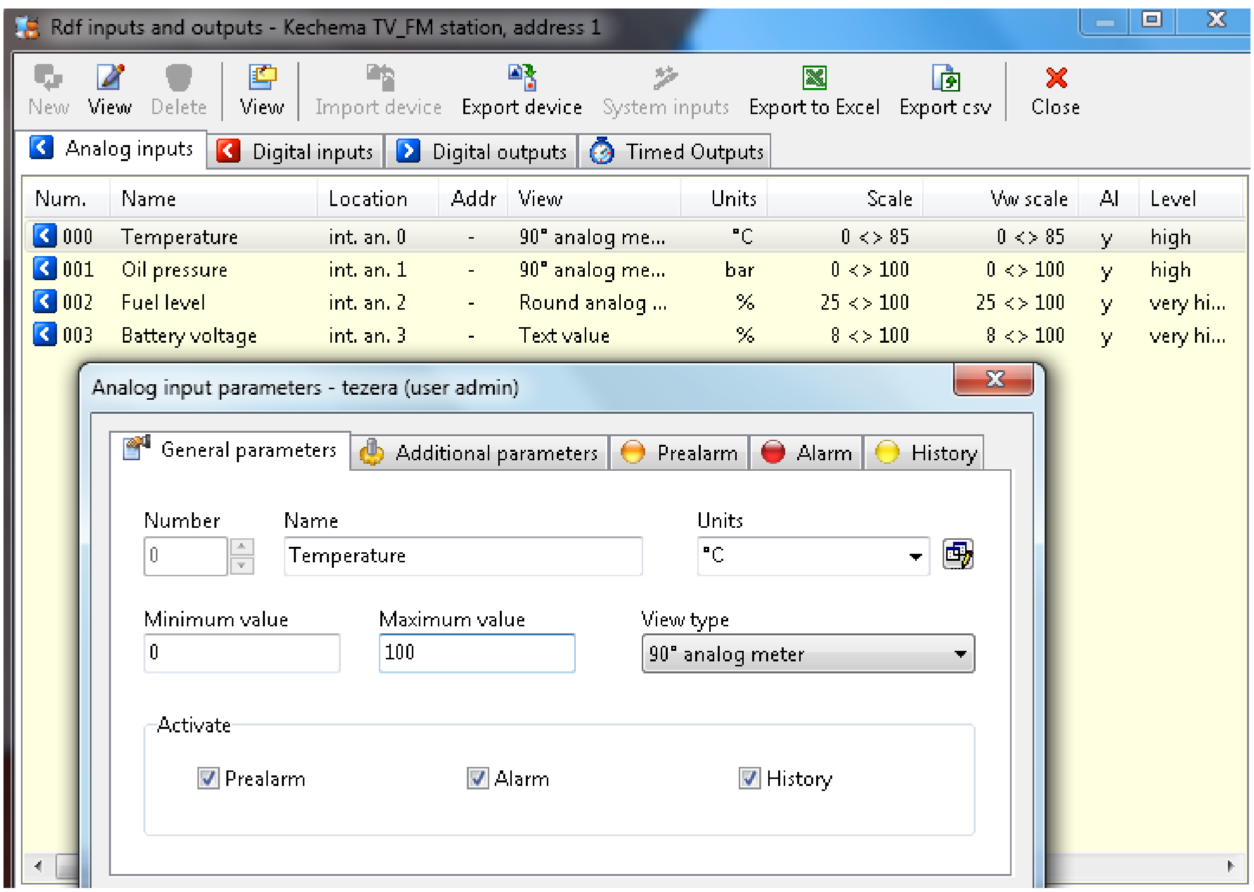

Information
Modem configured for use with NetPod Manager
OK
Information
Modem configured for use with Rdf
OK
Information
Phone number: 0924849502
OK
Information
Received signal strenght indication: -73 dBm (65%)
Bit error rate: < 0,2%
OK
Information
Status of the SIM card inserted in the modem:
SIM ready, no PIN required
OK
Information
Frequency band configured:
dual-band mode 900E (extended) / 1800 Mhz
OK

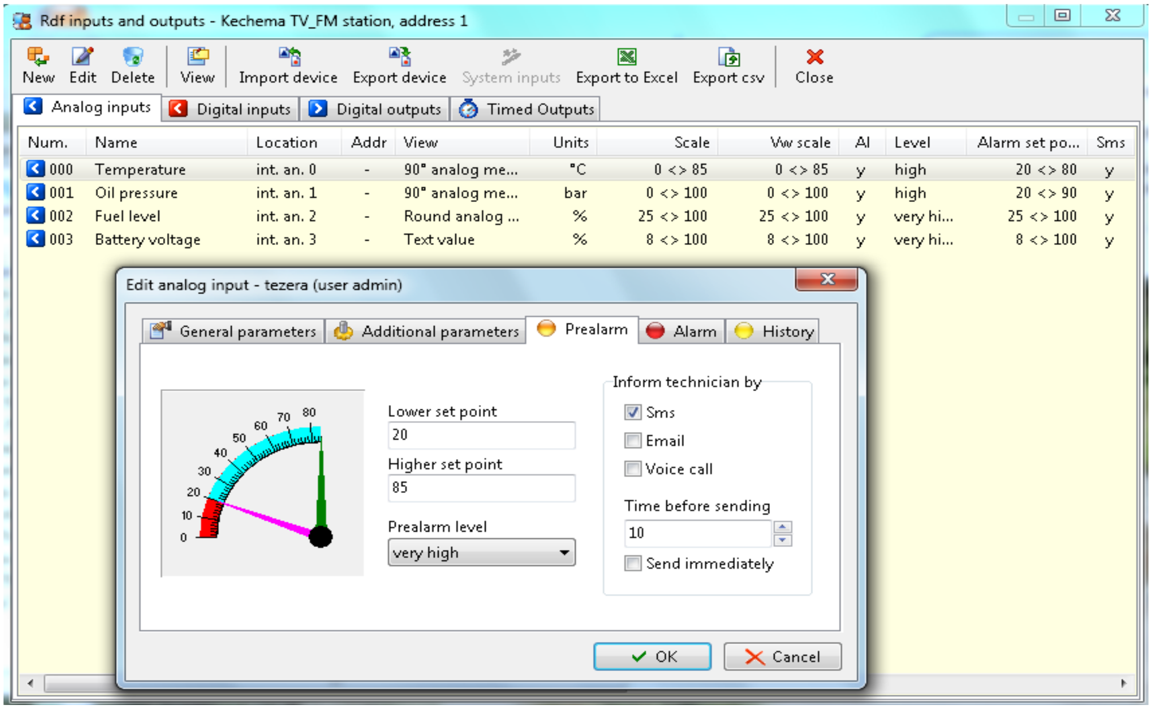


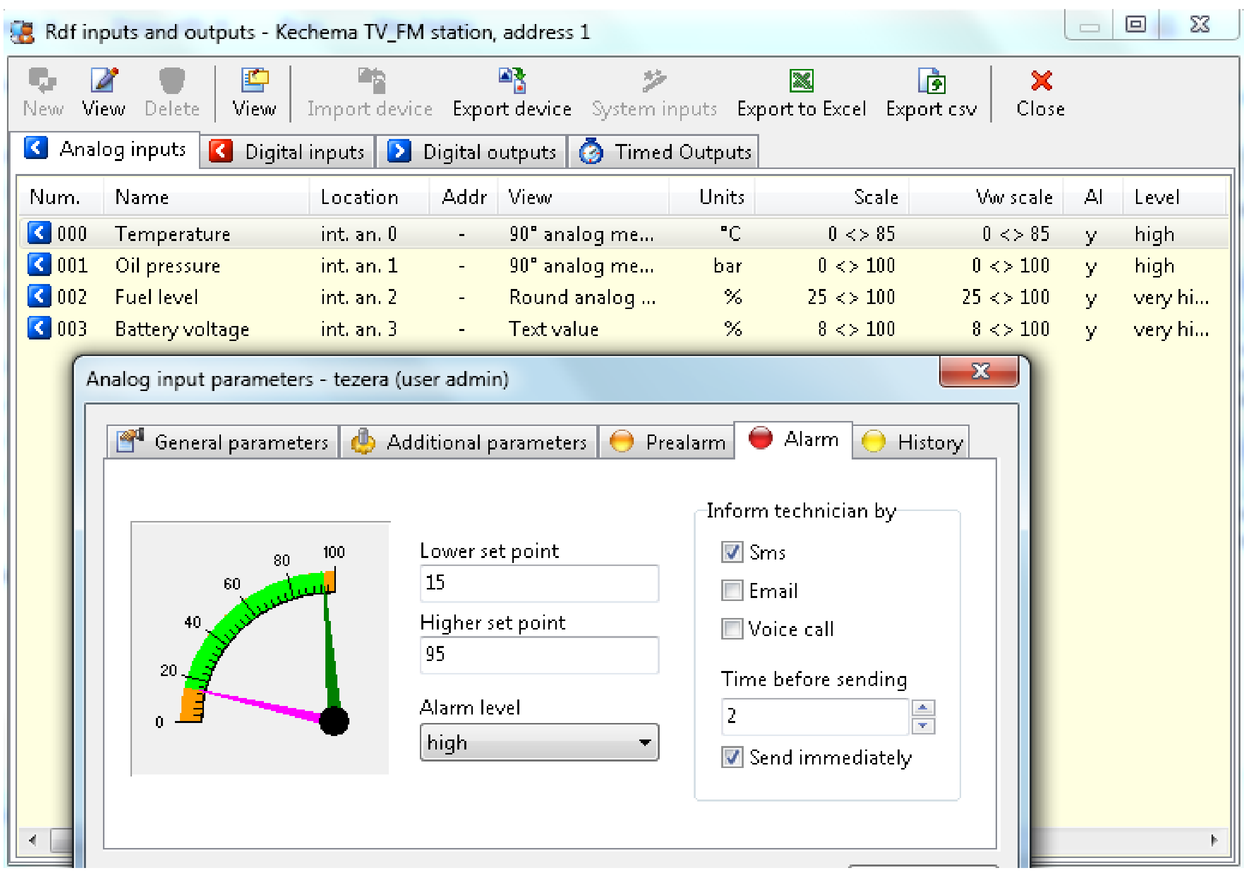

## B. Software result of remote station to central station GSM connection

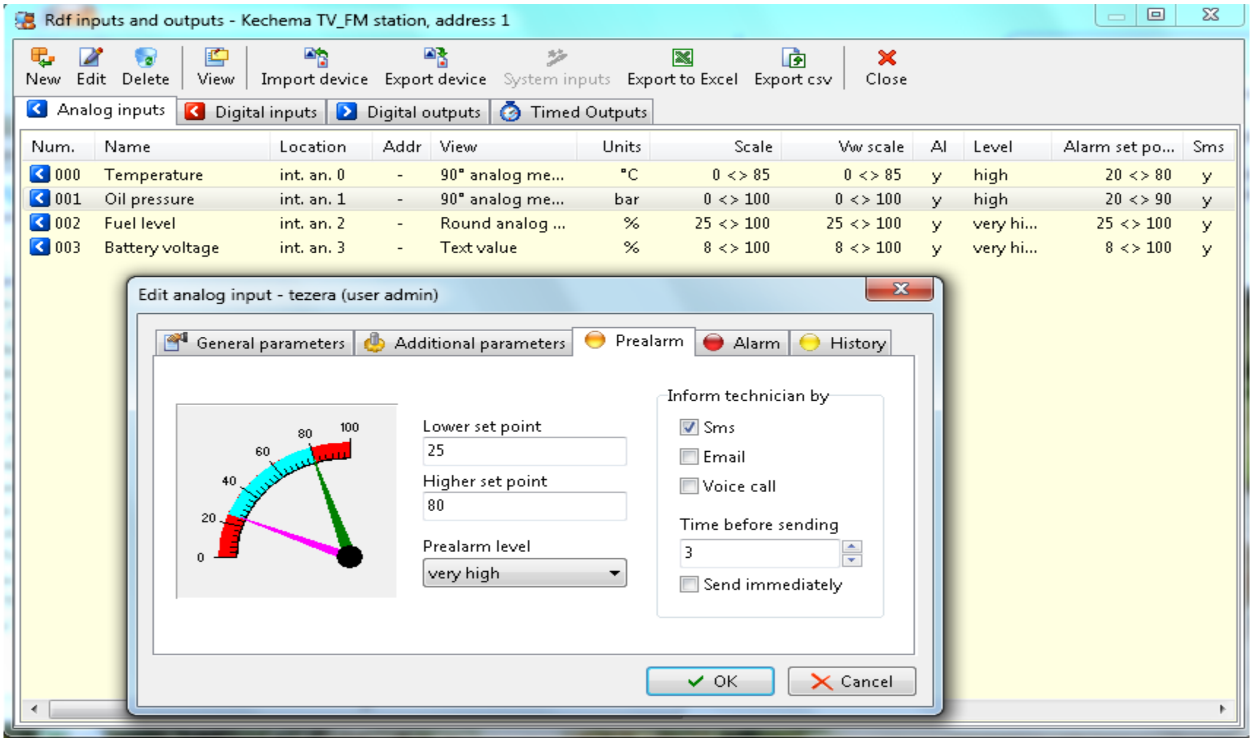


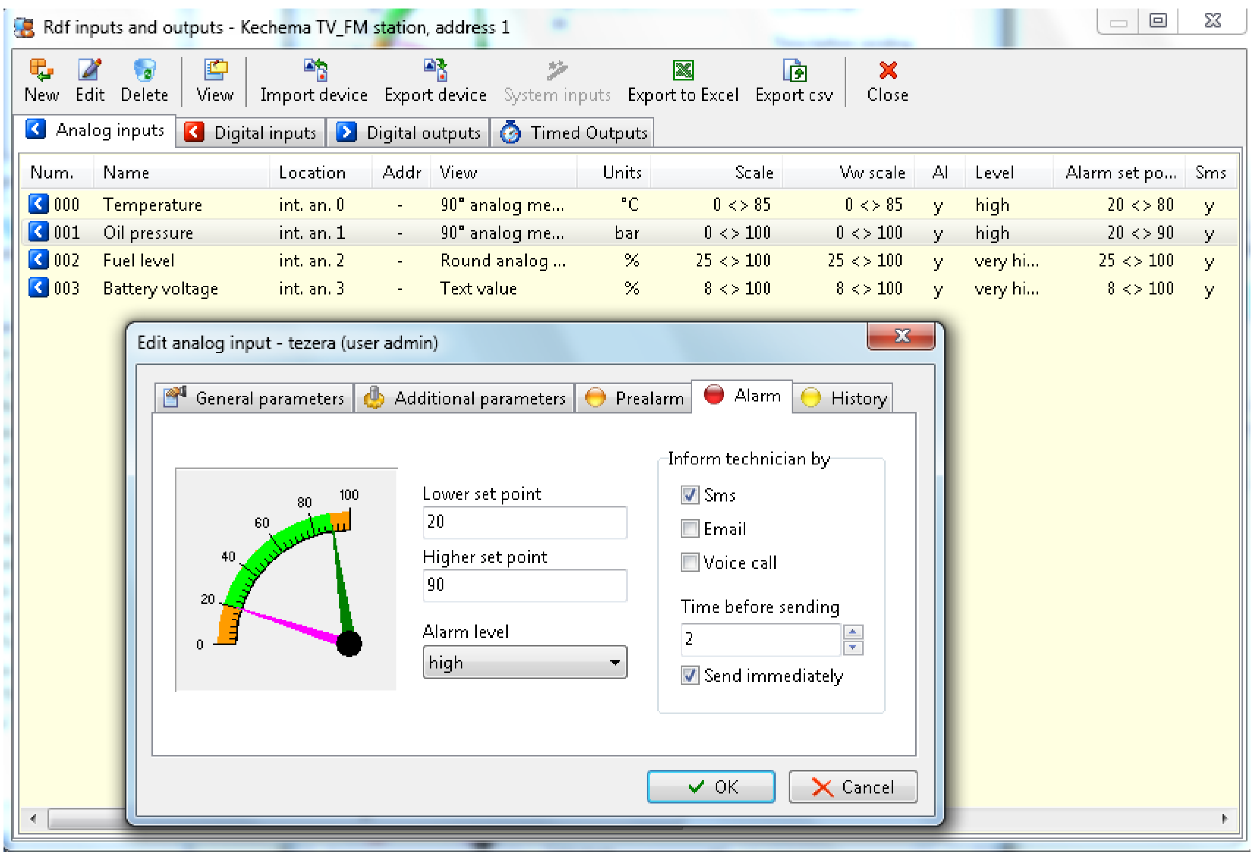

Rdf inputs and outputs - Kechema TV_FM station, address 1
New Edit Delete View Import device Export device System inputs Export to Excel Export csv Close
Analog inputs Digital inputs Digital outputs Timed Outputs
Num. Name Location Addr View Units Scale Vw scale Al Level Alarm set po... Sms
000 Temperature int. an. 0 - 90° analog me... °C 0 <> 85 0 <> 85 y high 20 <> 80 y
001 Oil pressure int. an. 1 - 90° analog me... bar 0 <> 100 0 <> 100 y high 20 <> 90 y
002 Fuel level int. an. 2 - Round analog ... % 25 <> 100 25 <> 100 y very hi... 25 <> 100 y
003 Battery voltage int. an. 3 - Text value % 8 <> 100 8 <> 100 y very hi... 8 <> 100 y
Customize analog input list - tezera (user admin)
Move down Move up New Edit Delete Confirm Cancel
Item
Temperature (0)
Oil pressure (1)
Fuel level (2)
Battery voltage (3)

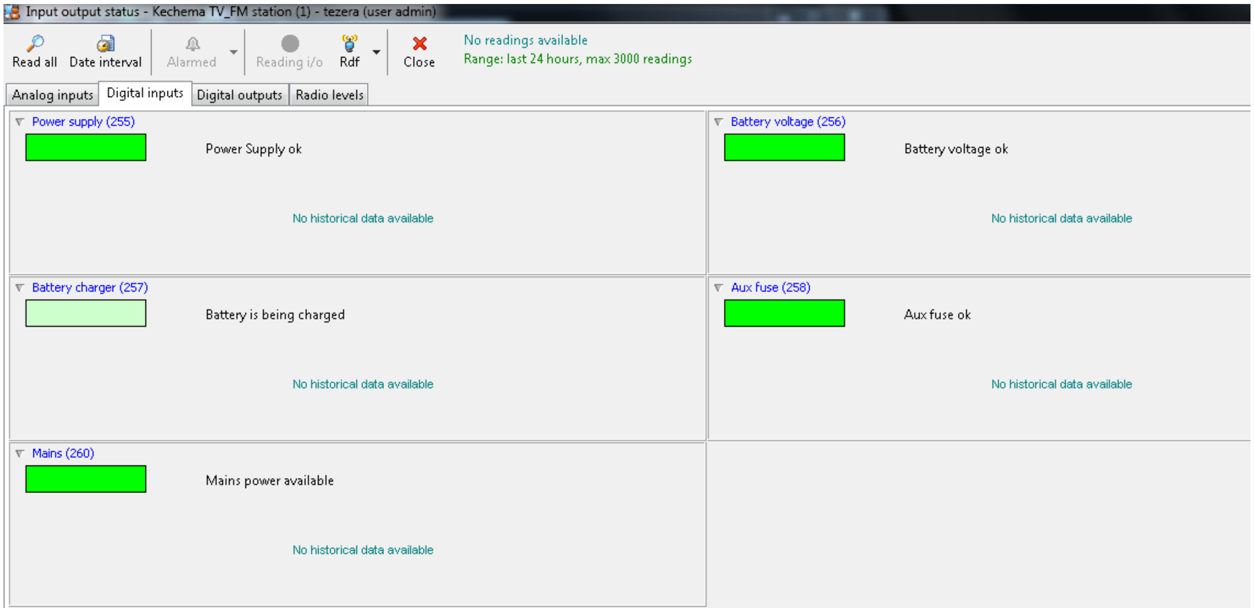

Rdf inputs and outputs - Kechema TV_FM station, address 1
New View Delete View Import device Export device System inputs Export to Excel Export csv Close
Analog inputs Digital inputs Digital outputs Timed Outputs
Num. Name Location Addr View Units Scale Vw scale Al Level
000 Temperature int. an. 0 - 90° analog me... °C 0 <> 85 0 <> 85 y high
001 Oil pressure int. an. 1 - 90° analog me... bar 0 <> 100 0 <> 100 y high
002 Fuel level int. an. 2 - Round analog ... % 25 <> 100 25 <> 100 y very hi...
003 Battery voltage int. an. 3 - Text value % 8 <> 100 8 <> 100 y very hi...
Analog input parameters - tezera (user admin)
General parameters Additional parameters Prealarm Alarm History
Number Name Units
0 Temperature °C
Minimum value Maximum value View type
0 100 90° analog meter
Activate
Prealarm Alarm History

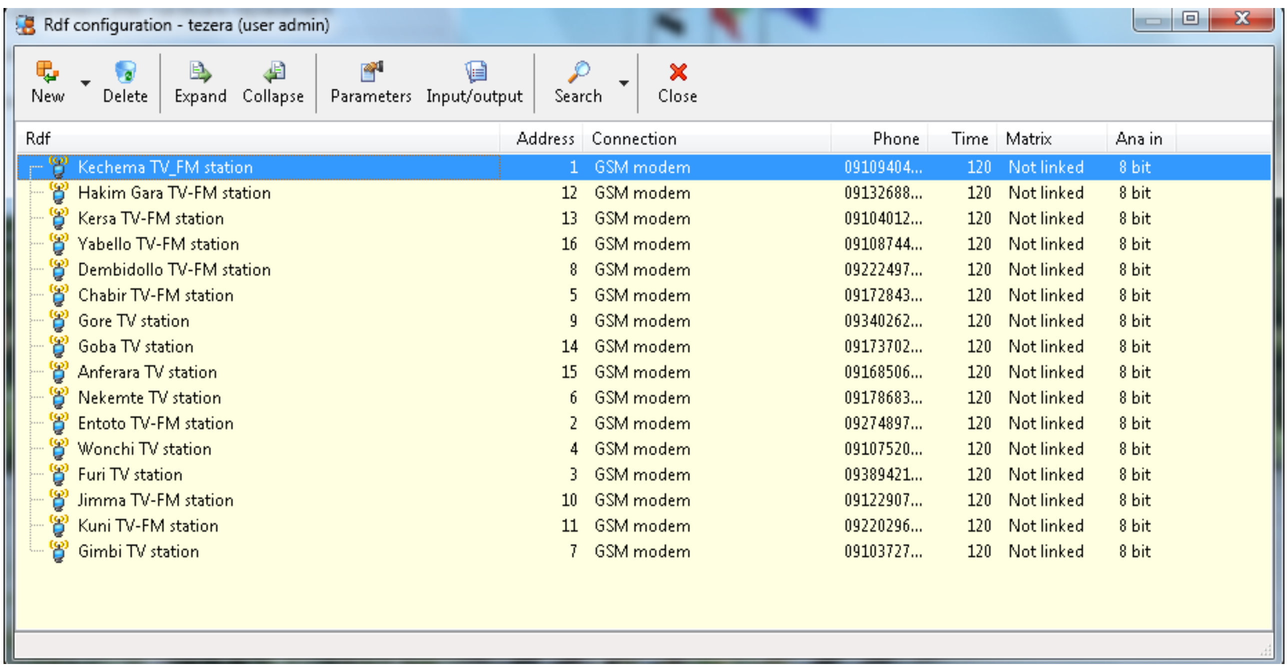

Rdf inputs and outputs - Kechema TV_FM station, address 1
New
Edit
Delete
View
Import device
Export device
System inputs
Export to Excel
Export csv
Close
Analog inputs
Digital inputs
Digital outputs
Timed Outputs
Num. Name Location Addr View Units Scale Vw scale Al Level Alarm set po... Sms
000 Temperature int. an. 0 - 90° analog me... °C 0 <> 85 0 <> 85 y high 20 <> 80 y
001 Oil pressure int. an. 1 - 90° analog me... bar 0 <> 100 0 <> 100 y high 20 <> 90 y
002 Fuel level int. an. 2 - Round analog ... % 25 <> 100 25 <> 100 y very hi... 25 <> 100 y
003 Battery voltage int. an. 3 - Text value % 8 <> 100 8 <> 100 y very hi... 8 <> 100 y
Edit analog input - tezera (user admin)
General parameters
Additional parameters
Prealarm
Alarm
History
Lower set point
20
Higher set point
85
Prealarm level
very high
Inform technician by
Sms
Email
Voice call
Time before sending
10
Send immediately
OK
Cancel

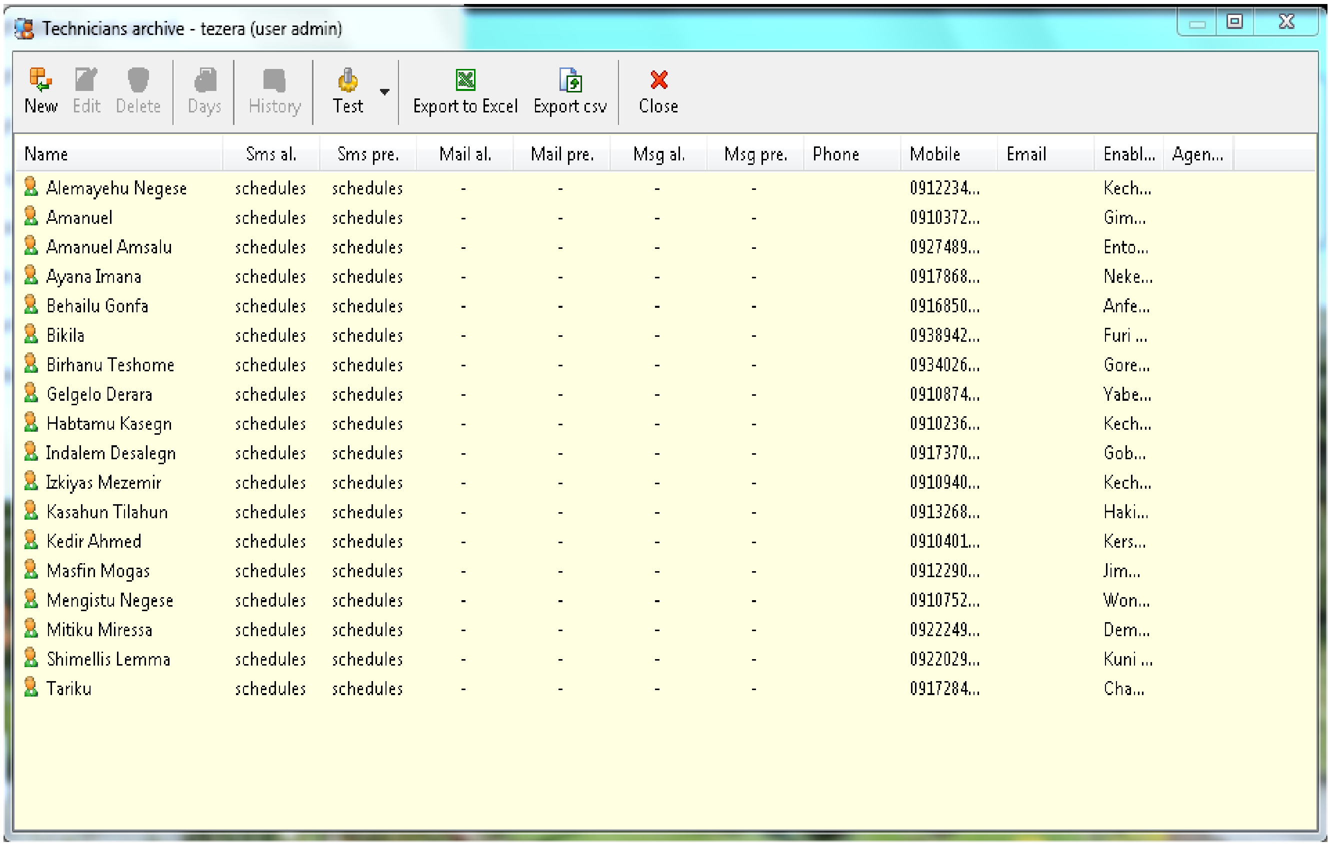

Rdf inputs and outputs - Kechema TV_FM station, address 1
New
View
Delete
View
Import device
Export device
System inputs
Export to Excel
Export csv
Close
Analog inputs
Digital inputs
Digital outputs
Timed Outputs
Num. Name Location Addr View Units Scale Vw scale Al Level
000 Temperature int. an. 0 - 90° analog me... °C 0 <> 85 0 <> 85 y high
001 Oil pressure int. an. 1 - 90° analog me... bar 0 <> 100 0 <> 100 y high
002 Fuel level int. an. 2 - Round analog ... % 25 <> 100 25 <> 100 y very hi...
003 Battery voltage int. an. 3 - Text value % 8 <> 100 8 <> 100 y very hi...
Analog input parameters - tezera (user admin)
General parameters
Additional parameters
Prealarm
Alarm
History
Lower set point
15
Higher set point
95
Alarm level
high
Inform technician by
Sms
Email
Voice call
Time before sending
2
Send immediately


Rdf inputs and outputs - Kechema TV_FM station, address 1
New
Edit
Delete
View
Import device
Export device
System inputs
Export to Excel
Export csv
Close
Analog inputs
Digital inputs
Digital outputs
Timed Outputs
Num. Name Location Addr View Units Scale Vw scale Al Level Alarm set po... Sms
000 Temperature int. an. 0 - 90° analog me... °C 0 <> 85 0 <> 85 y high 20 <> 80 y
001 Oil pressure int. an. 1 - 90° analog me... bar 0 <> 100 0 <> 100 y high 20 <> 90 y
002 Fuel level int. an. 2 - Round analog ... % 25 <> 100 25 <> 100 y very hi... 25 <> 100 y
003 Battery voltage int. an. 3 - Text value % 8 <> 100 8 <> 100 y very hi... 8 <> 100 y
Edit analog input - tezera (user admin)
General parameters
Additional parameters
Prealarm
Alarm
History
Lower set point
25
Higher set point
80
Prealarm level
very high
Inform technician by
Sms
Email
Voice call
Time before sending
3
Send immediately
OK
Cancel


Rdf inputs and outputs - Kechema TV_FM station, address 1
New
Edit
Delete
View
Import device
Export device
System inputs
Export to Excel
Export csv
Close
Analog inputs
Digital inputs
Digital outputs
Timed Outputs
Num. Name Location Addr View Units Scale Vw scale Al Level Alarm set po... Sms
000 Temperature int. an. 0 - 90° analog me... °C 0 <> 85 0 <> 85 y high 20 <> 80 y
001 Oil pressure int. an. 1 - 90° analog me... bar 0 <> 100 0 <> 100 y high 20 <> 90 y
002 Fuel level int. an. 2 - Round analog ... % 25 <> 100 25 <> 100 y very hi... 25 <> 100 y
003 Battery voltage int. an. 3 - Text value % 8 <> 100 8 <> 100 y very hi... 8 <> 100 y
Edit analog input - tezera (user admin)
General parameters
Additional parameters
Prealarm
Alarm
History
Lower set point
20
Higher set point
90
Alarm level
high
Inform technician by
Sms
Email
Voice call
Time before sending
2
Send immediately
OK
Cancel


Input output status - Kechema TV_FM station (1) - tezera (user admin)
Read all
Date interval
Alarmed
Reading i/o
Rdf
Close
No readings available
Range: last 24 hours, max 3000 readings
Analog inputs
Digital inputs
Digital outputs
Radio levels
Power supply (255)
Power Supply ok
No historical data available
Battery voltage (256)
Battery voltage ok
No historical data available
Battery charger (257)
Battery is being charged
No historical data available
Aux fuse (258)
Aux fuse ok
No historical data available
Mains (260)
Mains power available
No historical data available

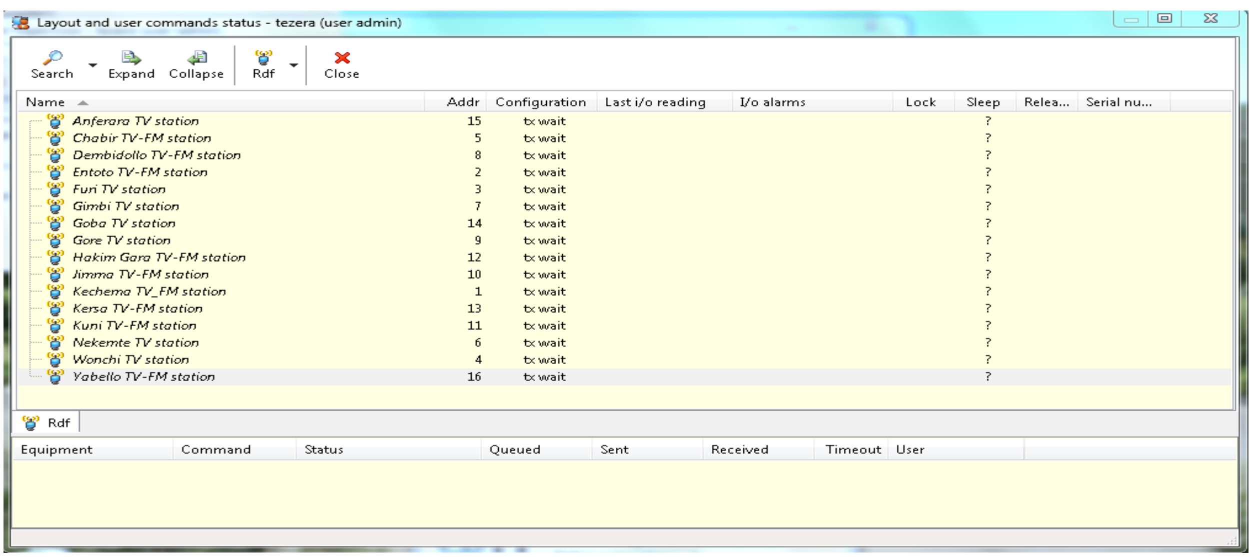

Rdf configuration - tezera (user admin)
New
Delete
Expand
Collapse
Parameters
Input/output
Search
Close
Rdf Address Connection Phone Time Matrix Ana in
Kechema TV_FM station 1 GSM modem 09109404... 120 Not linked 8 bit
Hakim Gara TV-FM station 12 GSM modem 09132688... 120 Not linked 8 bit
Kersa TV-FM station 13 GSM modem 09104012... 120 Not linked 8 bit
Yabello TV-FM station 16 GSM modem 09108744... 120 Not linked 8 bit
Dembidollo TV-FM station 8 GSM modem 09222497... 120 Not linked 8 bit
Chabir TV-FM station 5 GSM modem 09172843... 120 Not linked 8 bit
Gore TV station 9 GSM modem 09340262... 120 Not linked 8 bit
Goba TV station 14 GSM modem 09173702... 120 Not linked 8 bit
Anferara TV station 15 GSM modem 09168506... 120 Not linked 8 bit
Nekemte TV station 6 GSM modem 09178683... 120 Not linked 8 bit
Entoto TV-FM station 2 GSM modem 09274897... 120 Not linked 8 bit
Wonchi TV station 4 GSM modem 09107520... 120 Not linked 8 bit
Furi TV station 3 GSM modem 09389421... 120 Not linked 8 bit
Jimma TV-FM station 10 GSM modem 09122907... 120 Not linked 8 bit
Kuni TV-FM station 11 GSM modem 09220296... 120 Not linked 8 bit
Gimbi TV station 7 GSM modem 09103727... 120 Not linked 8 bit



Technicians archive - tezera (user admin)

New | Edit | Delete | Days | History | Test | Export to Excel | Export csv | Close

| Name | Sms al. | Sms pre. | Mail al. | Mail pre. | Msg al. | Msg pre. | Phone | Mobile | Email | Enabl... | Agen... |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Alemayehu Negese | schedules | schedules | - | - | - | - | | 0912234... | | Kech... | |
| Amanuel | schedules | schedules | - | - | - | - | | 0910372... | | Gim... | |
| Amanuel Amsalu | schedules | schedules | - | - | - | - | | 0927489... | | Ento... | |
| Ayana Imana | schedules | schedules | - | - | - | - | | 0917868... | | Neke... | |
| Behailu Gonfa | schedules | schedules | - | - | - | - | | 0916850... | | Anfe... | |
| Bikila | schedules | schedules | - | - | - | - | | 0938942... | | Furi ... | |
| Birhanu Teshome | schedules | schedules | - | - | - | - | | 0934026... | | Gore... | |
| Gelgelo Derara | schedules | schedules | - | - | - | - | | 0910874... | | Yabe... | |
| Habtamu Kasegn | schedules | schedules | - | - | - | - | | 0910236... | | Kech... | |
| Indalem Desalegn | schedules | schedules | - | - | - | - | | 0917370... | | Gob... | |
| Izkiyas Mezemir | schedules | schedules | - | - | - | - | | 0910940... | | Kech... | |
| Kasahun Tilahun | schedules | schedules | - | - | - | - | | 0913268... | | Haki... | |
| Kedir Ahmed | schedules | schedules | - | - | - | - | | 0910401... | | Kers... | |
| Masfin Mogas | schedules | schedules | - | - | - | - | | 0912290... | | Jim... | |
| Mengistu Negese | schedules | schedules | - | - | - | - | | 0910752... | | Won... | |
| Mitiku Miressa | schedules | schedules | - | - | - | - | | 0922249... | | Dem... | |
| Shimellis Lemma | schedules | schedules | - | - | - | - | | 0922029... | | Kuni ... | |
| Tariku | schedules | schedules | - | - | - | - | | 0917284... | | Cha... | |



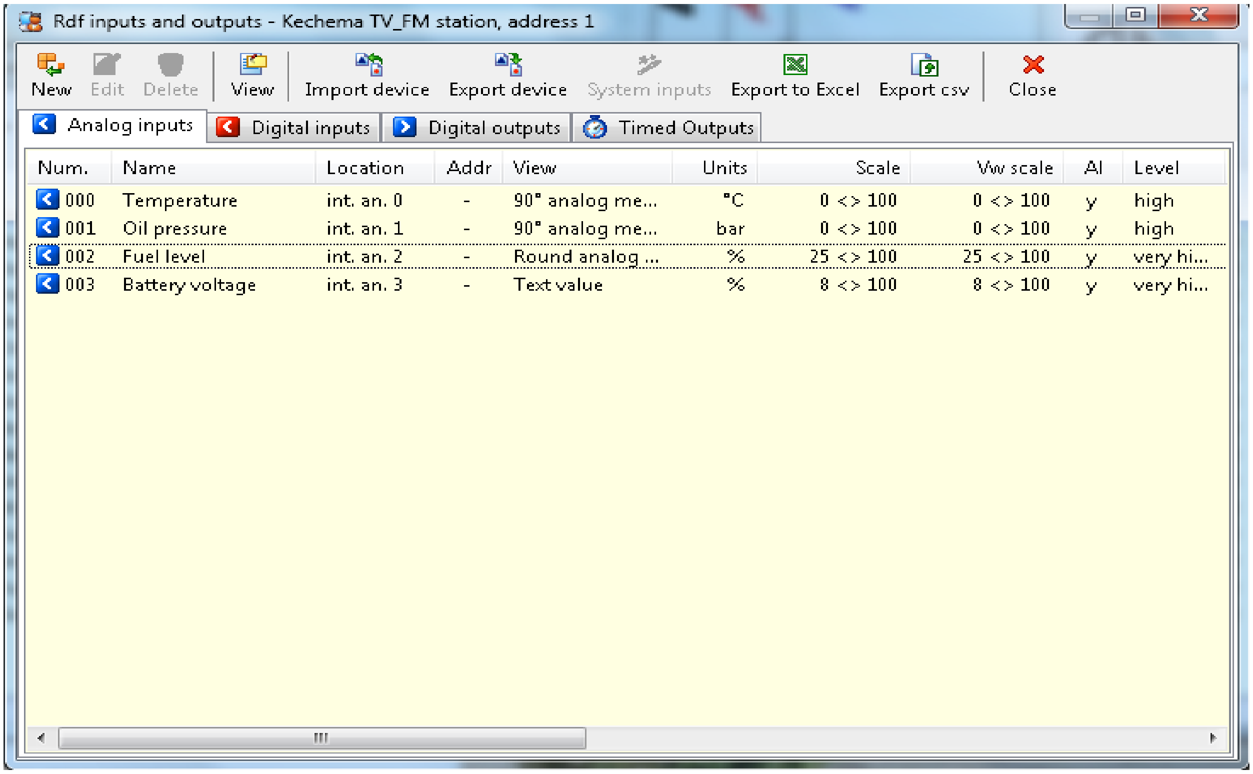
Layout and user commands status - tezera (user admin)

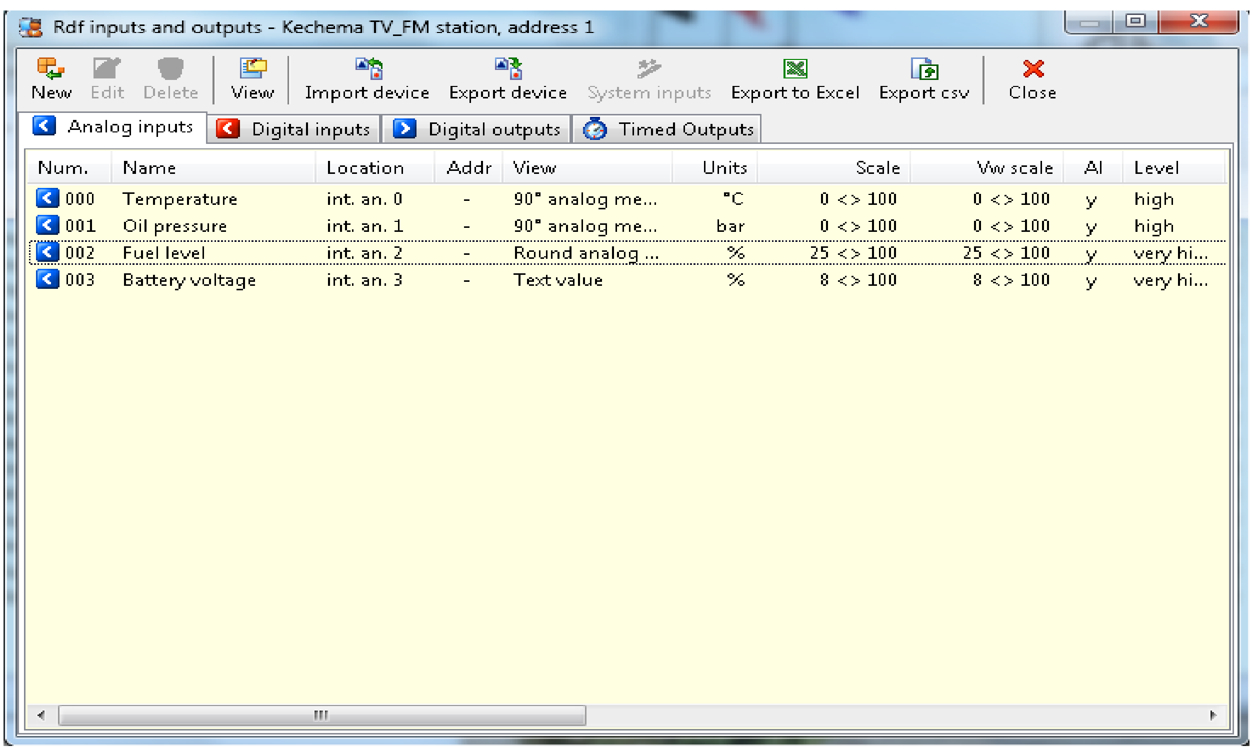
Search | Expand | Collapse | Rdf | Close

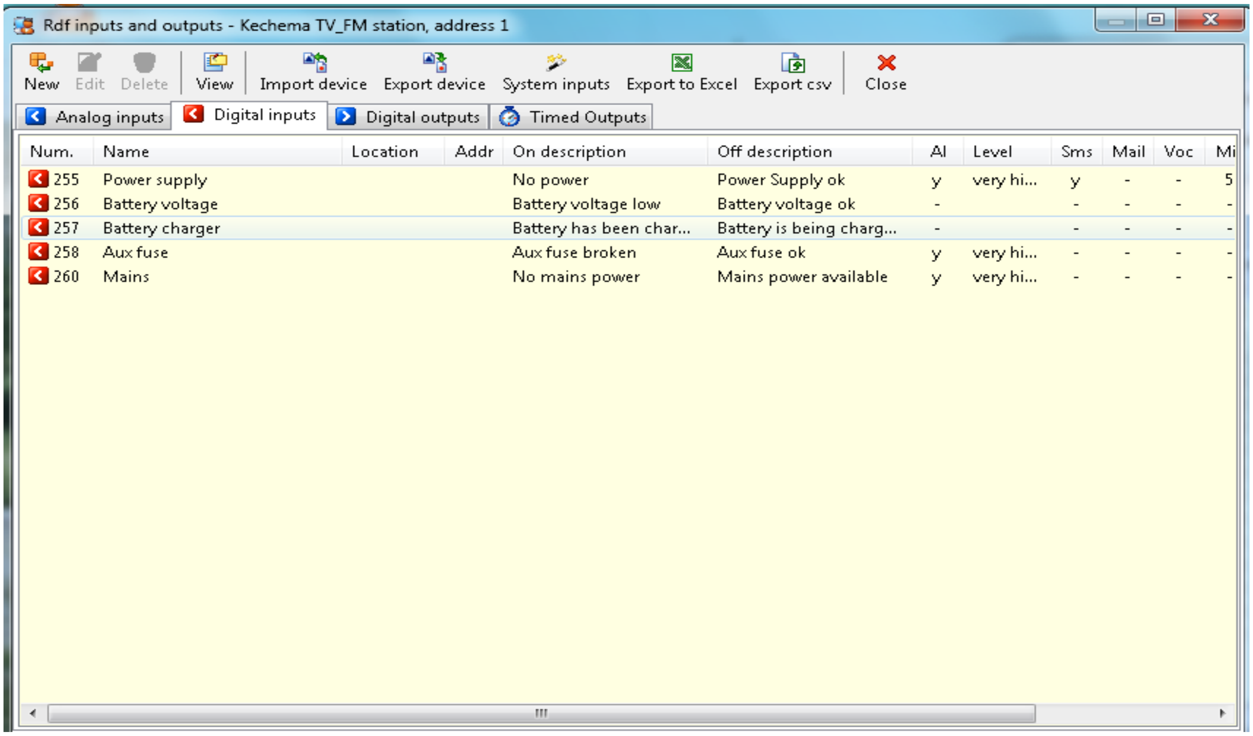
| Name | Addr | Configuration | Last i/o reading | I/o alarms | Lock | Sleep | Relea... | Serial nu... |
|---|---|---|---|---|---|---|---|---|
| Anferara TV station | 15 | tx wait | | | | ? | | |
| Chabir TV-FM station | 5 | tx wait | | | | ? | | |
| Dembidollo TV-FM station | 8 | tx wait | | | | ? | | |
| Entoto TV-FM station | 2 | tx wait | | | | ? | | |
| Furi TV station | 3 | tx wait | | | | ? | | |
| Gimbi TV station | 7 | tx wait | | | | ? | | |
| Goba TV station | 14 | tx wait | | | | ? | | |
| Gore TV station | 9 | tx wait | | | | ? | | |
| Hakim Gara TV-FM station | 12 | tx wait | | | | ? | | |
| Jimma TV-FM station | 10 | tx wait | | | | ? | | |
| Kechema TV_FM station | 1 | tx wait | | | | ? | | |
| Kersa TV-FM station | 13 | tx wait | | | | ? | | |
| Kuni TV-FM station | 11 | tx wait | | | | ? | | |
| Nekemte TV station | 6 | tx wait | | | | ? | | |
| Wonchi TV station | 4 | tx wait | | | | ? | | |
| Yabello TV-FM station | 16 | tx wait | | | | ? | | |

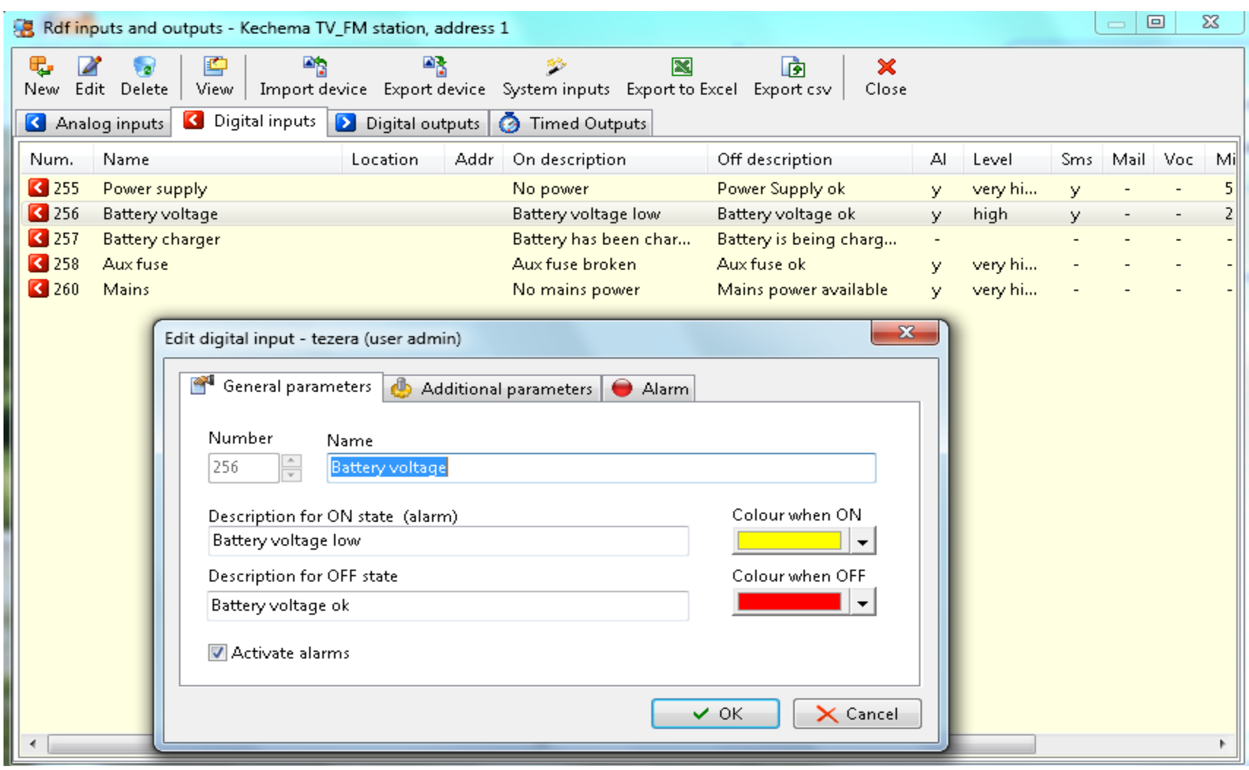
Rdf

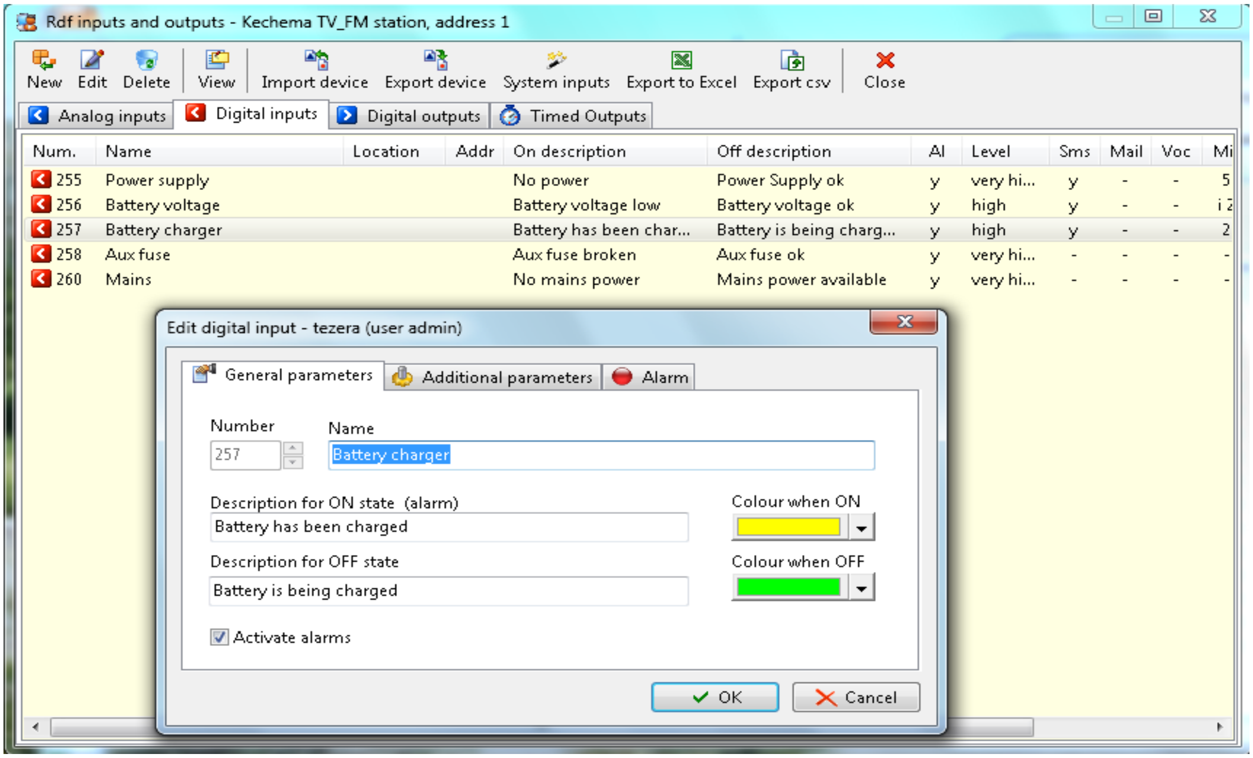
| Equipment | Command | Status | Queued | Sent | Received | Timeout | User |
|---|---|---|---|---|---|---|---|

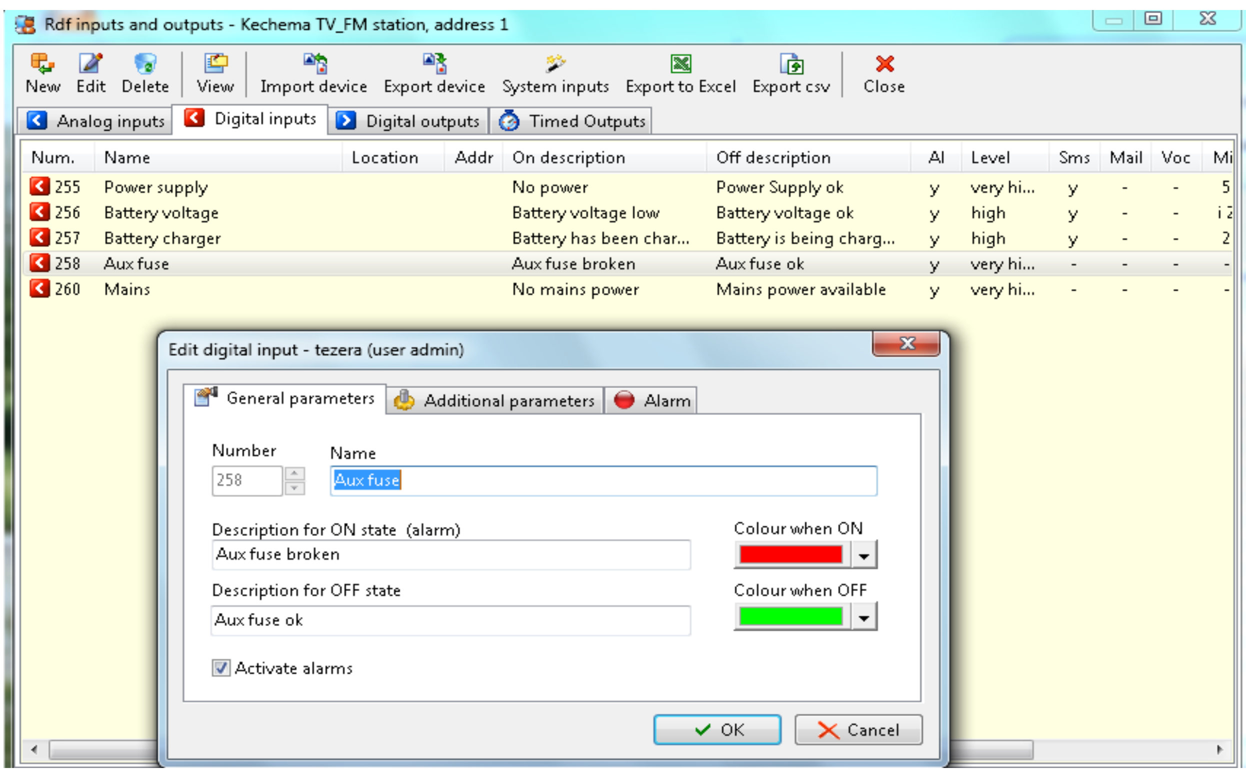

Rdf inputs and outputs - Kechema TV_FM station, address 1
New
Edit
Delete
View
Import device
Export device
System inputs
Export to Excel
Export csv
Close
Analog inputs
Digital inputs
Digital outputs
Timed Outputs
Num. Name Location Addr View Units Scale Vw scale Al Level
000 Temperature int. an. 0 - 90° analog me... °C 0 <> 100 0 <> 100 y high
001 Oil pressure int. an. 1 - 90° analog me... bar 0 <> 100 0 <> 100 y high
002 Fuel level int. an. 2 - Round analog ... % 25 <> 100 25 <> 100 y very hi...
003 Battery voltage int. an. 3 - Text value % 8 <> 100 8 <> 100 y very hi...

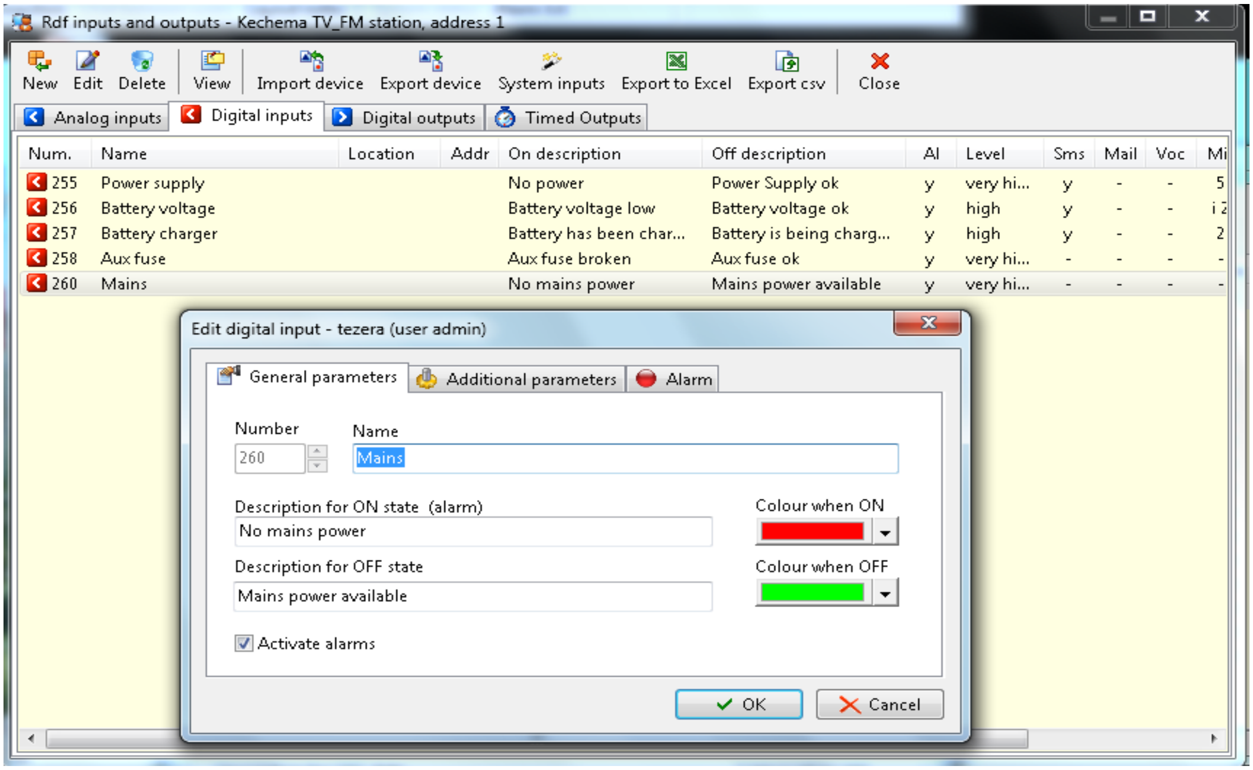

Rdf inputs and outputs - Kechema TV_FM station, address 1
New
Edit
Delete
View
Import device
Export device
System inputs
Export to Excel
Export csv
Close
Analog inputs
Digital inputs
Digital outputs
Timed Outputs
Num. Name Location Addr View Units Scale Vw scale Al Level
000 Temperature int. an. 0 - 90° analog me... °C 0 <> 100 0 <> 100 y high
001 Oil pressure int. an. 1 - 90° analog me... bar 0 <> 100 0 <> 100 y high
002 Fuel level int. an. 2 - Round analog ... % 25 <> 100 25 <> 100 y very hi...
003 Battery voltage int. an. 3 - Text value % 8 <> 100 8 <> 100 y very hi...

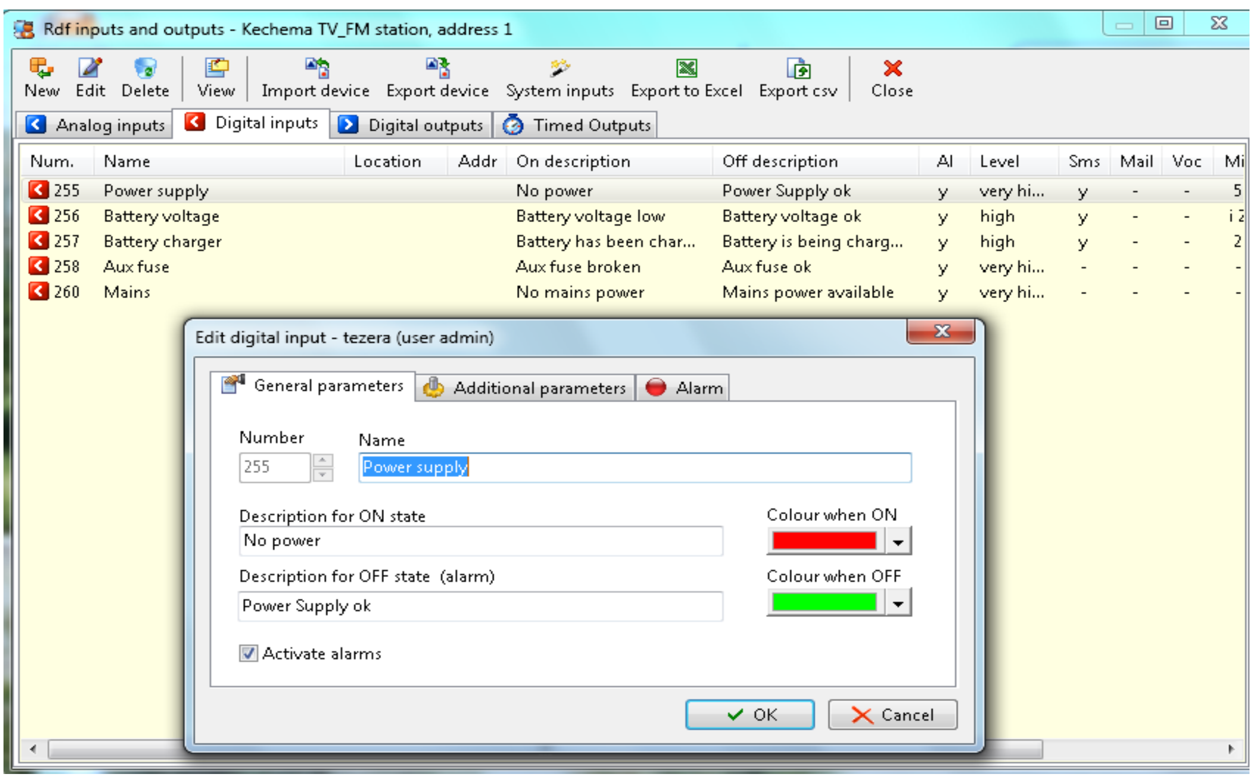

Rdf inputs and outputs - Kechema TV_FM station, address 1
New
Edit
Delete
View
Import device
Export device
System inputs
Export to Excel
Export csv
Close
Analog inputs
Digital inputs
Digital outputs
Timed Outputs
Num. Name Location Addr On description Off description Al Level Sms Mail Voc Mi
255 Power supply No power Power Supply ok y very hi... y - - 5
256 Battery voltage Battery voltage low Battery voltage ok - - - - -
257 Battery charger Battery has been char... Battery is being charg... - - - - -
258 Aux fuse Aux fuse broken Aux fuse ok y very hi... - - - -
260 Mains No mains power Mains power available y very hi... - - - -

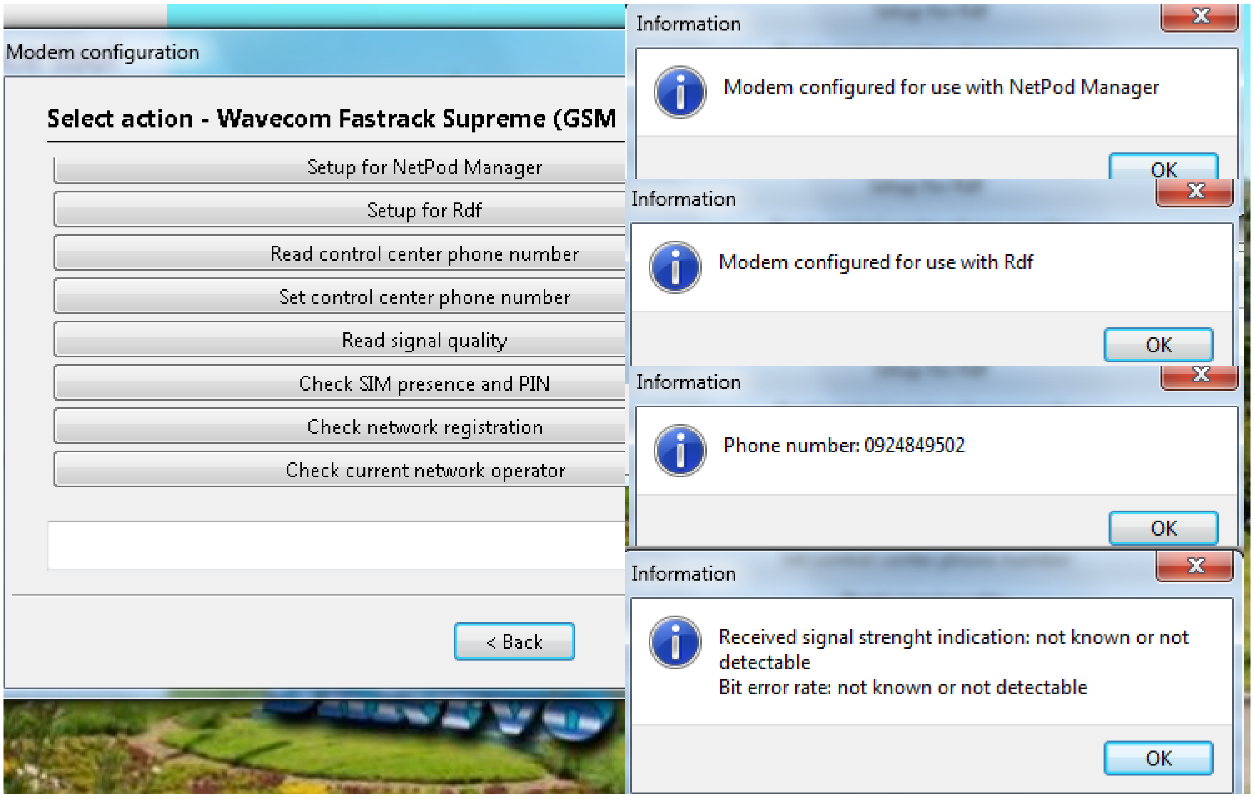

Rdf inputs and outputs - Kechema TV_FM station, address 1
New
Edit
Delete
View
Import device
Export device
System inputs
Export to Excel
Export csv
Close
Analog inputs
Digital inputs
Digital outputs
Timed Outputs
Num. Name Location Addr On description Off description Al Level Sms Mail Voc Mi
255 Power supply No power Power Supply ok y very hi... y - - 5
256 Battery voltage Battery voltage low Battery voltage ok y high y - - 2
257 Battery charger Battery has been char... Battery is being charg... - - - - -
258 Aux fuse Aux fuse broken Aux fuse ok y very hi... - - - -
260 Mains No mains power Mains power available y very hi... - - - -
Edit digital input - tezera (user admin)
General parameters
Additional parameters
Alarm
Number
256
Name
Battery voltage
Description for ON state (alarm)
Battery voltage low
Colour when ON
Description for OFF state
Battery voltage ok
Colour when OFF
Activate alarms
OK
Cancel

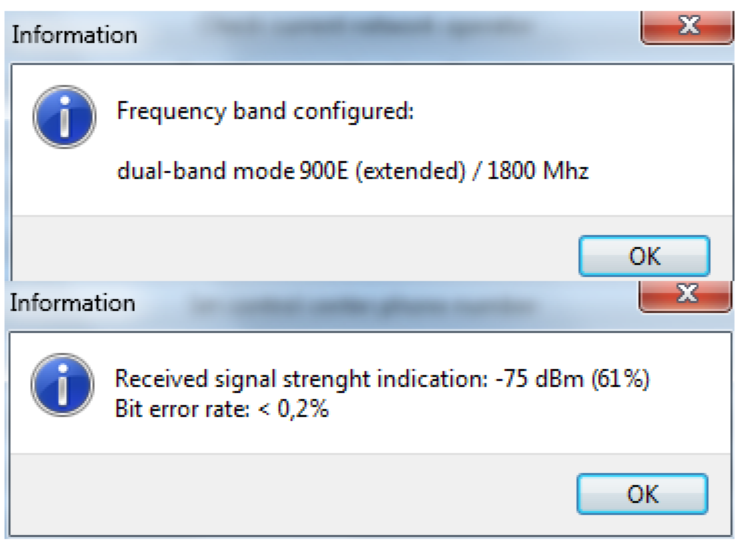

Rdf inputs and outputs - Kechema TV_FM station, address 1
New Edit Delete View Import device Export device System inputs Export to Excel Export csv Close
Analog inputs Digital inputs Digital outputs Timed Outputs
Num. Name Location Addr On description Off description Al Level Sms Mail Voc
255 Power supply No power Power Supply ok y very hi... y
256 Battery voltage Battery voltage low Battery voltage ok y high y
257 Battery charger Battery has been char... Battery is being charg... y high y
258 Aux fuse Aux fuse broken Aux fuse ok y very hi...
260 Mains No mains power Mains power available y very hi...
Edit digital input - tezera (user admin)
General parameters Additional parameters Alarm
Number 257
Name Battery charger
Description for ON state (alarm) Battery has been charged
Colour when ON
Description for OFF state Battery is being charged
Colour when OFF
Activate alarms
OK Cancel


Rdf inputs and outputs - Kechema TV_FM station, address 1
New Edit Delete View Import device Export device System inputs Export to Excel Export csv Close
Analog inputs Digital inputs Digital outputs Timed Outputs
Num. Name Location Addr On description Off description Al Level Sms Mail Voc
255 Power supply No power Power Supply ok y very hi... y
256 Battery voltage Battery voltage low Battery voltage ok y high y
257 Battery charger Battery has been char... Battery is being charg... y high y
258 Aux fuse Aux fuse broken Aux fuse ok y very hi...
260 Mains No mains power Mains power available y very hi...
Edit digital input - tezera (user admin)
General parameters Additional parameters Alarm
Number 258
Name Aux fuse
Description for ON state (alarm) Aux fuse broken
Colour when ON
Description for OFF state Aux fuse ok
Colour when OFF
Activate alarms
OK Cancel


Rdf inputs and outputs - Kechema TV_FM station, address 1
New
Edit
Delete
View
Import device
Export device
System inputs
Export to Excel
Export csv
Close
Analog inputs
Digital inputs
Digital outputs
Timed Outputs
Num. Name Location Addr On description Off description Al Level Sms Mail Voc Mi
255 Power supply No power Power Supply ok y very hi... y - - 5
256 Battery voltage Battery voltage low Battery voltage ok y high y - -
257 Battery charger Battery has been char... Battery is being charg... y high y - - 2
258 Aux fuse Aux fuse broken Aux fuse ok y very hi... - - - -
260 Mains No mains power Mains power available y very hi... - - - -
Edit digital input - tezera (user admin)
General parameters
Additional parameters
Alarm
Number
Name
260
Mains
Description for ON state (alarm)
Colour when ON
No mains power
Description for OFF state
Colour when OFF
Mains power available
Activate alarms
OK
Cancel


Rdf inputs and outputs - Kechema TV_FM station, address 1
New
Edit
Delete
View
Import device
Export device
System inputs
Export to Excel
Export csv
Close
Analog inputs
Digital inputs
Digital outputs
Timed Outputs
Num. Name Location Addr On description Off description Al Level Sms Mail Voc Mi
255 Power supply No power Power Supply ok y very hi... y - - 5
256 Battery voltage Battery voltage low Battery voltage ok y high y - -
257 Battery charger Battery has been char... Battery is being charg... y high y - - 2
258 Aux fuse Aux fuse broken Aux fuse ok y very hi... - - - -
260 Mains No mains power Mains power available y very hi... - - - -
Edit digital input - tezera (user admin)
General parameters
Additional parameters
Alarm
Number
Name
255
Power supply
Description for ON state
Colour when ON
No power
Description for OFF state (alarm)
Colour when OFF
Power Supply ok
Activate alarms
OK
Cancel


Modem configuration
Select action - Wavecom Fastrack Supreme (GSM
Setup for NetPod Manager
Setup for Rdf
Read control center phone number
Set control center phone number
Read signal quality
Check SIM presence and PIN
Check network registration
Check current network operator
< Back
Information
Modem configured for use with NetPod Manager
OK
Information
Modem configured for use with Rdf
OK
Information
Phone number: 0924849502
OK
Information
Received signal strenght indication: not known or not detectable
Bit error rate: not known or not detectable
OK


Information
Frequency band configured:
dual-band mode 900E (extended) / 1800 Mhz
OK
Information
Received signal strenght indication: -75 dBm (61%)
Bit error rate: < 0,2%
OK

## C. ORTVO transmitter stations location

| Name of site | Coordinate | | |
|---|---|---|---|
| | Latitude | Longitude | Altitude |
| (kechema station) | $8^0$ 33′ 3.61″N | $39^0$ 13′58.11 ″ E | 1953.8m |
| Finfine (Entoto Site) | $9^0$ 06′10.88″ N | $38^0$ 45′57.42 ″ E | 3057m |
| Finfine(Furi Site) | $8^0$ 52′ 56.88″ N | $38^0$ 41′12.68 ″ E | 2927m |
| Ambo & Waliso (Wonchi Site*)* | $8^0$ 48′ 37.33″ N | $37^0$52′25.65 ″ E | 3422.6m |
| HoroGuduru Wellega (Chabir Site) | $9^0$ 35′ 19.56″ N | $37^0$ 04′14.24 ″ E | 2945m |
| East Wollega (Nekemte Site) | $9^0$ 04′ 35.81″ N | $36^0$ 35′27.16 ″ E | 2292m |
| West wollega, Gimbi (Bedesa meko Site) | $9^0$ 09′ 48.51″ N | $35^0$ 50′25.61 ″ E | 2175m |
| Kelem Wollega (Dimbi Dolo Site) | $08^0$ 32′ 32.4″ N | $34^0$ 48′36.2 ″ E | 1866.9m |
| Ilubabor (Gore site) | $8^0$ 09′ 05.49″ N | $35^0$ 32′46.74 ″ E | 2014m |
| Jima (Kujo Muja Site) | $7^0$ 43′ 10.07″ N | $36^0$ 52′01.35 ″ E | 2281.8m |
| West Arsi, (Karsa Site) | $7^0$ 07′ 51.78″N | $38^0$ 47′38.42 ″ E | 2738 |
| Borana(Yabelo) Site | $4^0$ 52′ 55.87″ N | $38^0$ 05′51.01 ″ E | 1960m |
| Guji (Anferara Site) | $5^0$ 58′ 41.31″ N | $38^0$ 53′47.68 ″ E | 2221m |
| Bale (Goba Site) | $7^0$ 00′ 15.73″ N | $39^0$ 58′01.95″ E | 2753.9m |
| West Hararge,(Kuni Site) | $9^0$ 00′ 11.12″ N | $40^0$ 52′58.58 ″ E | 2536.8m |
| East Hararge (Hakim gara site) | $9^0$ 17′ 21.19″ N | $42^0$ 07′32.62 ″ E | 2153m |

### D. Research questions and hypotheses

This thesis will find out solutions to the below listed questions and hypotheses in general and to any related questions and hypotheses in specific.

- Are all the station machines (generator, TV and FM transmitters) be monitored remotely from central station in integrated way?
- Which status of the generator interrupts the program? Is this status critical to damage the generator itself?
- Do the zonal transmitters (TV and/or FM) have remote/local features of operation?
- Where does a technician report for any technical support?

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