DMR_Manager Operating Manual

Version 1v2

Index

1   INTRODUCTION

This document illustrates the applications and how to use the Radio Activity DMR base stations management software.

Radio Activity DMR base stations can support a lot of applications and the management software is designed with forms for reading the parameters that can change depending on the particular application.

For that reason the forms shown in this document may be different from the ones in use or they could not appear in your application if the specific functionality is not enabled.

Some forms may be incomplete because it is a work in progress, please notify us errors or inconsistencies.

2   CONCEPTS OVERVIEW

The Radio Activity DMR Base Station can include several TRX (master and slaves), where TRX refers to a transmitter, one or many receivers, DSP, IO board and a power supply.

Radio Activity DMR Base Stations allow many different applications: they can work like a single repeater or in a radio network made of different repeaters linked together in different way such as Ethernet link, RF link.

2.1   TRX ARCHITECTURE

The core of "physical layer" of the system is a unit which via software performs every function of signal processing into radio station.

So, it is not necessary to add boards (like synchronizers, phase and amplitude equalizers, signal decoders, modem, etc.) because the functions can be implemented by routines which can be freely matched, down-loaded and with superior performance.

Communication and control functions of module are entrusted to a microprocessor which manages communications with external world and with other equipment modules. The microprocessor is based on LINUX operative system; it can manage a LAN ethernet 10/100 interface both for copper line and for optical fiber links, it is equipped with 4 serial ports to manage radio modules, GPS, auxiliary devices, external hosts; it is equipped with a Real Time Clock with tampon battery; it controls an embedded PLL to synchronize the entire station upon an internal (VCTCXO 0.5 ppm) or external temporal reference. DSP module is equipped with a synchronous serial port according RS485 standard levels, which can be programmed up to 16Mbit/s and can be used to interconnect together more transceiver or additional equipments.

Main performed functions are the following:
∞ Frequency self-tuning device
∞ Deviation self-calibration device
∞ Analogical and digital demodulation
∞ RF circuits testing
∞ Phase modulator calibration
∞ RF output power control
∞ Low frequency lines management
∞ DMR protocols management
∞ Digital signals processing
∞ Management, conditioning and routing of traffic and remote control signals from and towards external world

Receiver can be supplied as single or double for space diversity reception. Main and diversity channels are completely independent and coherent (sharing the same local oscillators) and they are designed according to an heterodyne structure, with vectorial conversion to base-band.

Channel standard bandwidth is 12.5 KHz, but the receiver is prepared to accept also a settable channel bandwidth of 25 KHz, 20 KHz, 10 KHz (with double funnel option) for special applications.

Receiver module is managed by a microcontroller unit whose program is hosted inside internal e2prom flash memory to lower parasitic emissions. This FW can be loaded through serial connection. The microcontroller, in addition to managing internal function of the unit, transfers measured parameters to the control unit through 115.2 Kb/s serial line.

The board is realized with surface mounting components (SMD) to maximally reduce dimensions.

On the frontal panel 2 LEDs are placed for monitoring internal PLLs lock status.

Transmitter module is realized with surface mounting components (SMD) and it is housed in a shielded, 8TE box for 220mm Eurocards, with an heatsink mounted on side, with a thermal resistance of about 1.2°K/W. The unit can be extracted from the front side of the rack. On the frontal panel two LEDs are placed to monitor the transmitter status.

Base-band functions, equalizing, limiting, low-pass filtering end eventual emphasis functions are performed by the DSP unit, which provides also for nominal and maximum deviation calibration by looping modulator with receiver.

Modulator is digital vector, then the synthesized signal by local oscillator implements the frequency shifting of the signal which has been directly modulated in base-band by DSP unit and transferred to transmitter through its I and Q components.

The amplifier is realized by three cascaded stages and RF output power regulation (between 1 and 25W) is implemented by controlling the stages. Power amplifier works in C class and ensures a very high efficiency, lowering the needed power from supply system and lowering the thermal dissipation inside the cabinet. Direct and reflected output power are measured by a directional coupler. Power control circuit acts in a closed loop and keeps constant the total power at MOSFET drain. Inside the module a thermal sensor is hosted and it is directly connected to the internal microcontroller which enables the command for air forced cooling fan of the cabinet if the temperature rises over 85°C. Anyway, if reflected power or mosfet temperature exceeds protection threshold, regulation circuit will lower output power up to safe levels for transmitter.

The current flowing into final amplifier transistor is continuously monitored by microcontroller to verify the correct functioning and to reveal any efficiency degradation.

The module is equipped with an harmonic filter to lower spurious emissions under required levels by existing regulations.

2.2   RADIO ACTIVITY DMR REPEATER AND UPGRADEABILITY TO SIMULCAST NETWORK

Radio Activity DMR repeater is designed to be modular from both HW and SW point of view, to maximize its flexibility and minimize costs, physical dimensions, consumptions.

Basic model already has all the characteristics to work as a double standard repeater with all the features of analogical and digital service. It can be equipped with double receiver to counteract fading effects through diversity space reception. It is set to host communication and synchronization embedded devices to make the network expandable to a multi-frequency or single-frequency multi-site system, with different types of links, operating with different transportation system topology, like microwave, UHF, optical fibers, IP connections.

Privileged communication interface is Ethernet standard type, compatible with more diffused technology. This interface supports not only voice and data digital traffic, but also remote control management, which for Radio Activity equipment is very powerful: it is possible to have a complete monitor system of equipment status, it is possible to modify each parameter, to down-load each SW and configuration, launch self-test and calibration functions, to perform specific tests through internal embedded function generators and software analyzers of the station. For analogical voice traffic instead, a 2/4 wire and criteria line interface is available.

Remote control service can be performed through an Ethernet connection pre-existing in the site, or through GPRS modem which can be integrated into the station, or through the radio channel and another Radio Activity station.

Fully modular structure allows to best configure the radio equipment, by adding and/or changing the required HW and SW functional blocks, to work as simple repeater, multi-frequency multi-site repeater, single-frequency multi-site repeater.

2.3 NETWORK

It is possible to configure the network in many different ways, with different kinds of links (Ethernet, RF, Optical fibers)

2.3.1 MASTER BASE STATION IN "RF LINKED" NETWORKS

The master base station is equipped with a "voting system", which select the "best" signal among all the signals received by the Satellites and the local receiver(s).

Besides this the master sends the digital synchronization towards the satellites and, in the case of Base Stations "RF linked" equalizes the absolute and group delay due to the RF channel.

2.3.2 SATELLITE BASE STATION IN "RF LINKED" NETWORKS

The duty of the Satellite is:
- ∞ receiving the signals from the terminals and sending them to the Master through the RF link,
- ∞ transmitting to the terminals the signals received by the Master (voted) through the RF link.
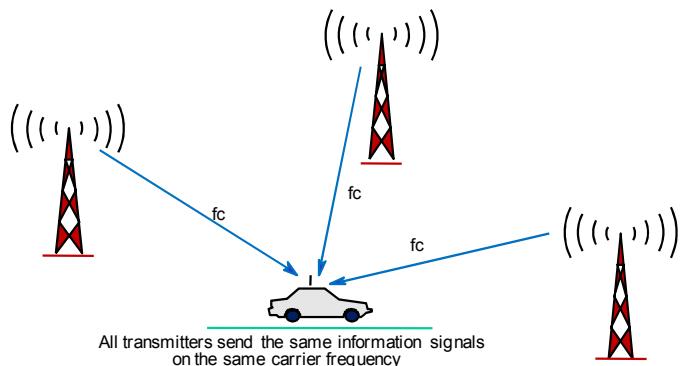
The satellite performs also the group delay and absolute delay equalization on broadcasting transceivers both down link and up link.

2.4 SIMULCAST NETWORKS

Simulcast type networks operate on the same radio channel on the whole coverage area.

Communications can be both open and selective channel, semiduplex mode between mobile terminals or duplex mode between Central and terminals. The network will make the automatic selection of accessing terminals and will broadcast the signal on the same frequency throughout the coverage area. The terminals are served regardless of their position as if they were covered by a single repeater.

All transmitters send the same information signals
on the same carrier frequency

2.4.1 SYNCHRONIZATION, VOTING AND EQUALIZATION

Simulcast radio network are able to realize the maximum radio coverage of the territory with minimum use of radio frequency.

In a simulcast network, unlike a cellular system in which each cell is characterized by a particular frequency, all the terminals operate at the same frequency, like a big cell.

Therefore it is necessary that the carriers of all transmitters are frequency locked and phase coherent with the master one.

Frequency synchronism of the **Radio Activity** station can be extracted from multiple sources, depending on network needs and the references availability, and transmitted to all the base stations from the master one.

This signal is received from all the satellites that reset their clock on it.

In this way all satellites are zeroed in frequency compared to master and then zeroed between them.
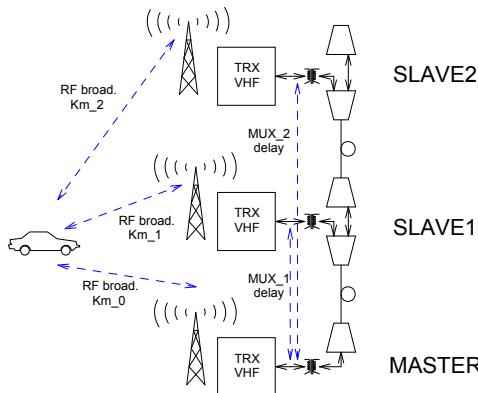
If there is not a good frequency synchronization the quality of communication considerably decreases in the equal fields strenght areas.

Another essential function of **Radio Activity** simulcast networks is the voting, which is the method by which the best signal received from the network is continuously selected. The signal voted is sent to the satellite and then diffused in the whole coverage area.
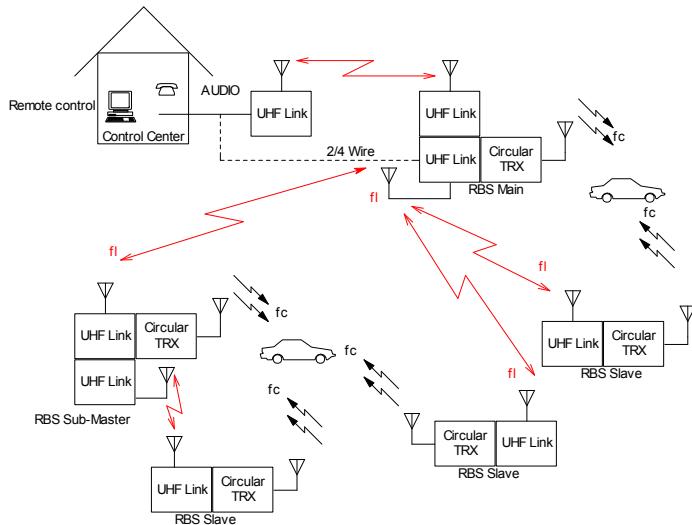
Simulcast networks require also particular attention in the choice of media linking the various stations. The characteristics of these media must be such as to make as much as possible identical signs of low frequency (audio) that each station must retransmit.

For that reason simulcast networks made by **Radio Activity** employ equalization devices based on Digital Signal Processing, which are able to automatically minimize the differences between the media paths

This feature allows to use a large family of communication media, including time-varying lines as pupinized copper, presenting considerable variations in temperature, or as non-dedicated telephone lines and therefore subjected to variations of delay and BF response.
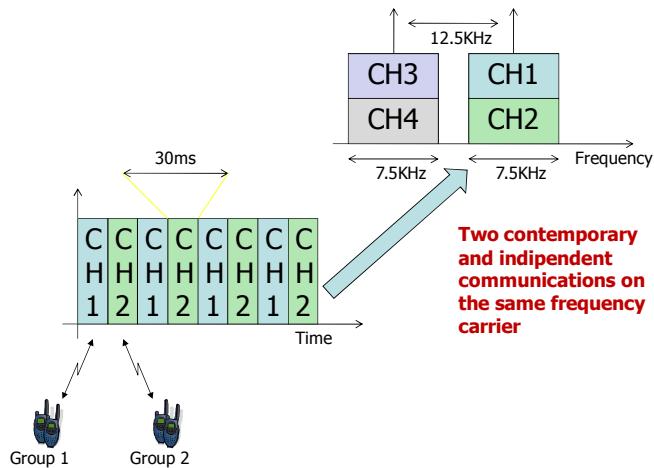

Linear simulcast network configuration

Star simulcast network configuration

2.5   DMR (DIGITAL MOBILE RADIO)

DMR digital protocol is based upon two TDMA (Time Division Multiple Access) managed timeslots on the same 12.5 KHz wide radio channel. This means that through the same radio channel broadcast by radio network, two digital communications can be established, and the radio channel capacity is doubled. The use of two timeslots allows also to exchange control signalling while radio communication is in progress, in order to manage, for example, the communication priority or to remote control the terminals functionality .

A physical radio channel is identified by a couple of frequencies (Duplex and Semiduplex).

Digital modulation requested by DMR standard (4FSK) allows an increased data transmission capacity compared with analogical traditional systems. In fact the system supports data transmission speed up to 9.6 Kb/s over the 12.5 KHz wide radio channel. It is possible then to implement data services with added value between terminals and the operative central, like for example radio traffic management and messages, localization through GPS (Global Positioning System) management, telemetry, with performances greatly better then what analogical systems can offer

2.5.1   ALARM MESSAGES

This feature of Radio Activity DMR Base Stations allows the user to bind some events with the sending of short text messages: when a certain event occurs, the user will receive the text message on the designed mobile terminal and a warning message when the problem is resolved (see Alarm Events Setup).

3   INSTALLATION

To use the DMR-Manager properly and to the correct management of the Radio Activity DMR Base Stations it is necessary to have a PC and a LAN connection.

3.1   SYSTEM REQUIREMENTS

The following operating systems are supported:

- ∞   Windows XP®
- ∞   Windows Vista™ 32 bit
- ∞   Windows 7

Not supported:

- ∞   Windows NT®
- ∞   Windows 9x
- ∞   Windows ME
- ∞   Windows 2000®
- ∞   64 bit Windows Vista™ versions

The processor must fit the following requirements:

Operating system: .... Microsoft Windows XP® SP2 or Windows Vista™ 32 bit or Windows 7.

Processor: .... Intel Pentium® or compatible.

Speed .... 700 MHz (Minimum).

Memory: .... 64 MB (Minimum).

Disk space: .... ~30 MB.

I/O: .... LAN and/or serial port.

3.2   INSTALLATION ON THE PC

DMR_Manager is normally distributed on a CD ROM. To install the program insert the CD ROM in the CD reader and then run the installation script, depending on the particular operating system in use.

3.2.1   INSTALLATION ON WINDOWS XP® OPERATING SYSTEMS

To install DMR_Manager double click the file:

- ∞   `Setup2000.bat` for Windows 2000 operating systems;
- ∞   `SetupXP.bat` for Windows XP operating systems.

The program creates the folder `Radio_Activity` in the program folder (normally `C:\Program Files`)

3.2.2   INSTALLATION ON WINDOWS VISTA™ OR WINDOWS 7 OPERATING SYSTEM

Run `SetupVista.bat` as Administrator (click with the right button on `SetupVista.bat`, then click on `Run as Administrator`)

The folder `Radio_Activity` will be created on `C:\`.

3.3   CREATING LINK TO DESKTOP

It is possible to create a link on the desktop of the file **DMR_Manager.exe**, from **Radio_Activity** folder: click with the right button on **DMR_Manager.exe**, then click on **Send to**, click on **Desktop.**

3.4   UNINSTALLATION FROM WINDOWS 2000 OR WINDOWS XP

Double click on **Unistall.bat**

3.5   UNINSTALLATION ON WINDOWS VISTA OPERATING SYSTEM

Run **Unistall.bat** as Administrator (click with the right button on **Unistall.bat**, then click on **Run as Administrator**).
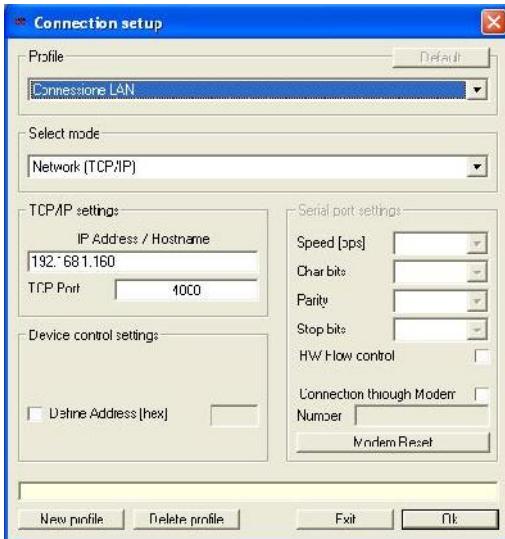
4   PROGRAM STARTUP

To start the program:

- ∞   double click on **DMR_Manager.exe** in the **Radio_Activity** folder;
- ∞   double click on the link created on the desktop.

4.1   CONNECTION SETUP
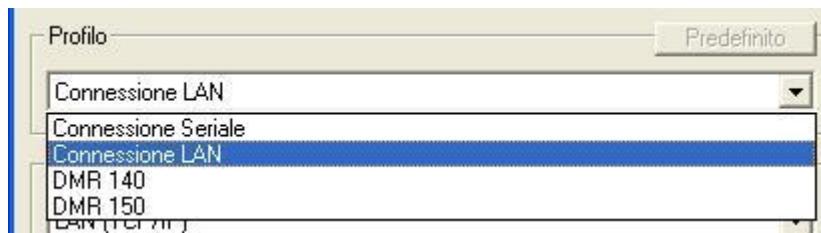
After the welcome screen, the connection setup mask will appear:

The equipment can be accessed through LAN or through Asynchronous Serial Port: you can choose by this form the connection mode and specify the proper parameters.

The connection mode and the connection parameters are normally stored on the PC under the item
Profile , which you can modify according to your needs.

Selecting the item **Default** it is possible to set the profile that will be used when the program start up (if
the loaded profile already is the defined profile, the **Default** button will not be active).
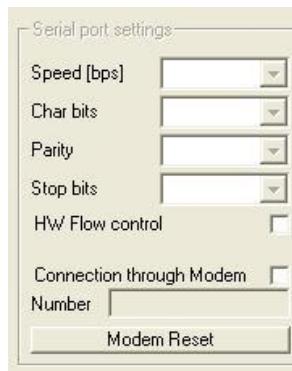

You can now modify an existent profile, or create a new one clicking on **New profile** .

In both cases you must choose the connection mode (IP LAN or COM1-COM9 serial connection)

A serial connection requires the setting of the following parameters:

- ∞   port speed (600 bps – 115,2 Kbps);
- ∞   bit per character (7 – 8);
- ∞   parity (nothing, even, odd);
- ∞   stop bit (1 – 2)
- ∞   possibility of activating the HW control flow (RTS/CTS)
- ∞   possibility of activating a connection through a modem rather than a direct connection (if this is the case you must specify the phone number and the ⌐Modem Reset⌐ button will be activated).

The requested parameters for a LAN connection are only the IP address and the TCP port (normally port 4000) necessary for the remote control:

You can also specify the remote control address of the device (if you do not select the item ⌐Define Address (hex)⌐ the broadcast address will be used)

Note:	Normally you need not to specify the remote control address. You must specify it if you want to connect to the remote device through the RF channel of the local one (future feature), or if you have a Base Station configured as 1+1 and you want to connect to a TRX even if it isn't the active one.

If you have made a simple change of the parameters of an existing profile, the program automatically require saving the modified parameters:
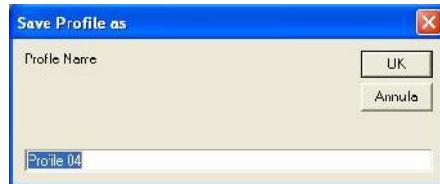

You can save the parameters in the case of permanent change, but it is also possible to continue with the modified parameters not saved: in this case a subsequent restart of the program will present the original parameters on the profile you worked with.

When you create a new profile, before going on,you have to save it clicking [New profile] :

The program will require a name to store the new profile:

Clicking [Ok] the remote control system will be activated.

Note: *Clicking* [Exit] *will cause the termination of the program; if you saved a changed profile, or it has been created a new one, these changes will be maintained.*

4.2 REMOTE CONTROL CONNECTION LOST
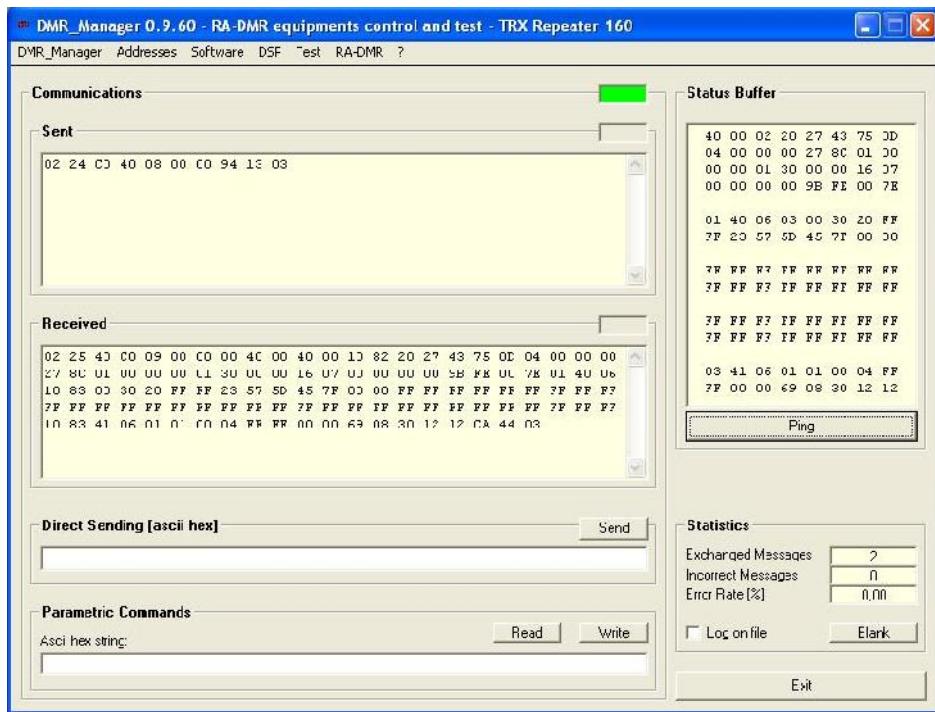
If the DMR_Manager close the logical connection, two cases are possible:
- ∞ If there is a serial bus connection, the device just do not react to the solicitations;
- ∞ If there is a LAN connection, the lost of the connection will be reported by a specific form:

5   MAIN MENU WINDOW

Once the logical connection is established, the main menu window will appear:

Many of the functions that can be activated here are dedicated to control activities /factory diagnostics that the user is not normally required to do (unless this is required by technical staff).

> *Note: Many of the functions activable here can seriously compromise the entire system: it is recommended to not "try" anything and be very cautious when you perform some actions on the request of technical staff.*

The elements of this window useful for the user are:

∞ The green/red light on the top right of the communications section;

∞ Menu bar items

∞ The boxes **Direct Sending** and **Parametric Commands**

In these last two boxes you can have a direct visual feedback on the exchange of information between the PC and the device connected. During the normal activities of monitoring/diagnostics the PC interrogates the device and the device responds to it. The absence of data in one of the two boxes indicates a problem on the physical link or on the connection parameters set.

The green/red light on the top right displays the result of the "interrogations" made by the PC:

Action	Light colour
Interrogation sent by the PC, waiting for an equipment reply	Yellow
The equipment has sent the reply into a predefined timeout	Green
No reply from the equipment into a predefined timeout	Red
The PC sent an interrogation which do not require any reply from the equipment (special cases)	Blue

All the items in the Menu bar are illustrated in the following paragraphs.

5.1 DMR MANAGER
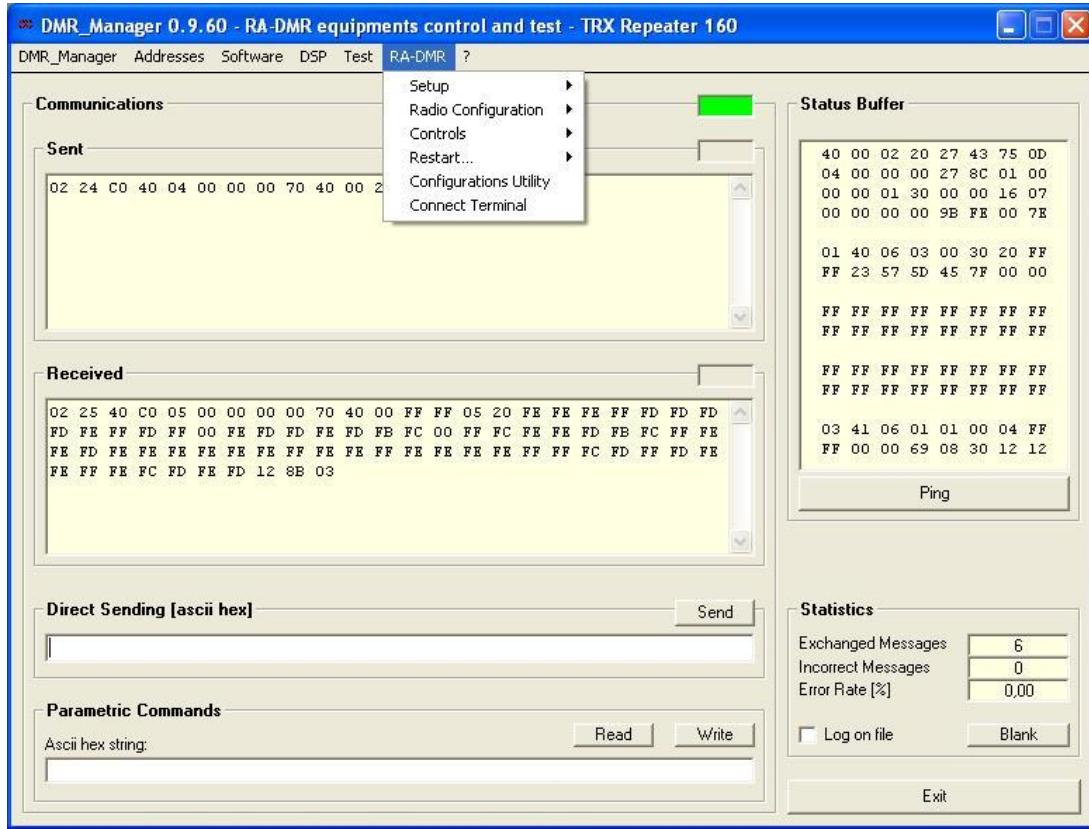
Menu item	Description
Select language	Allows the user to choose the DMR_Manager language (English, Italian, French)
Exit	Terminates the current session of DMR_Manager

5.2 SOFTWARE

Menu item	Description
Software	This menu item is about the software on the Base Station
Versions	Shows the current version and the emission date of all the software modules in the Base Station
Download	Allows the user to update the software on the Base Station

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5.3   RA-DMR

Menu item	Description
RA-DMR	*Settings and configurations of the Base Station*
Setup	Allows the user to display and modify the general settings
Radio Configuration	Allows the user to display and modify the TRX configurations
Controls	Allows the user to real time monitor the radio and to modify some settings
Restart	Allows the user to restart the system or the TRX or the DSP
Configurations utility	Allows saving on the PC and loading the whole TRX and/or the DSP configurations from the PC

6   MENU DETAILS

A detailed description of all the menu items follows.

6.1   SOFTWARE MENU

6.1.1   VERSIONS

Clicking **Software** → **Versions** the following form will appear:
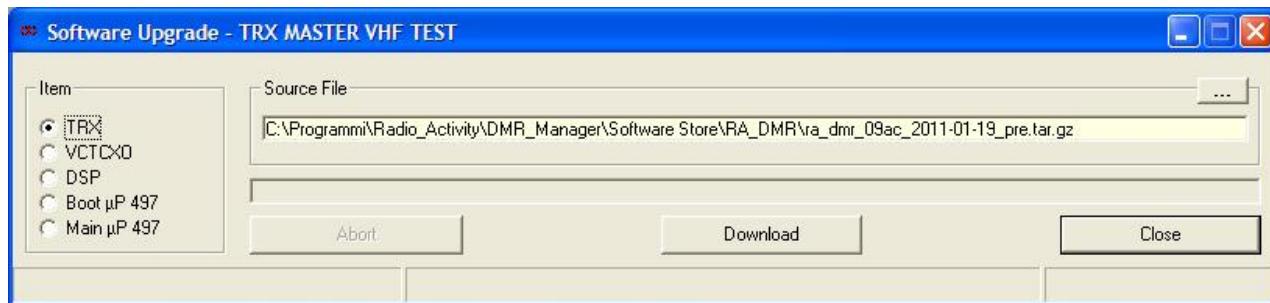
This form shows the current version and the emission date of all the software modules in the Base Station

Click **Read** to refresh the data in the window; click **Close** to close the window.

6.1.2   DOWNLOAD
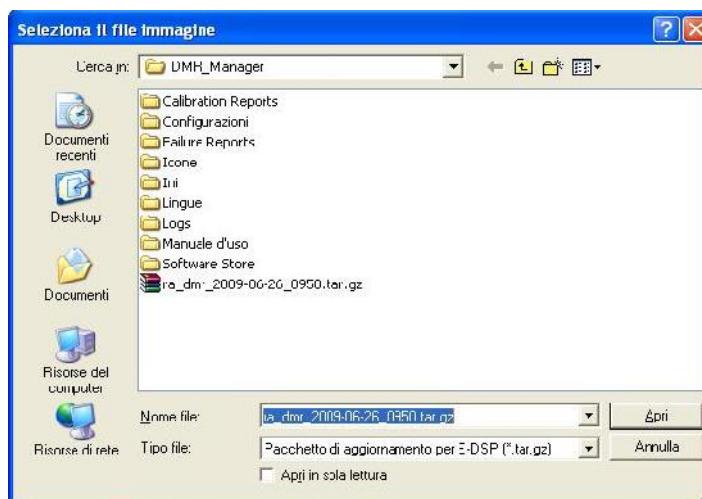
Clicking **Software** → **Download** the following form will appear:
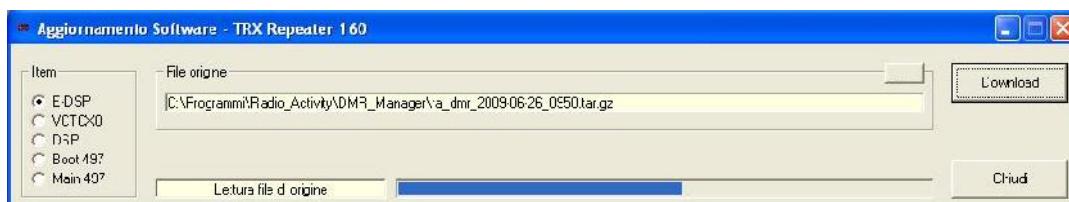
This form allows the user to update the whole or a part of the software of the Base Station.

In the section **Source File** of the form the name of the file to download will appear with its complete path.
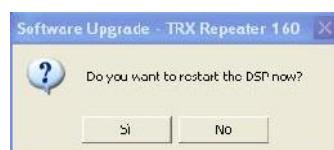
If this field is empty or the name/path is not correct click **...** to choose the right file to download.

Once you have chosen the file clicking **Open** , to download the file click on **Download** .
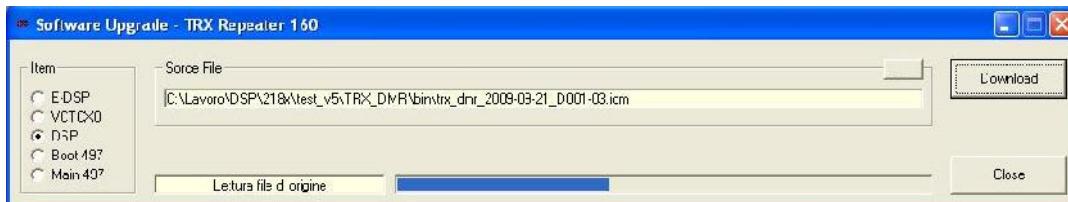

The new software will be effective after a restart, therefore, once the download is completed, you are prompted to restart the TRX immediately:

The user can choose to restart the system immediately or to postpone the restart.

Note: The cold restart will close the logical connection.

To download the DSP software you have to select the right **.idm** file.
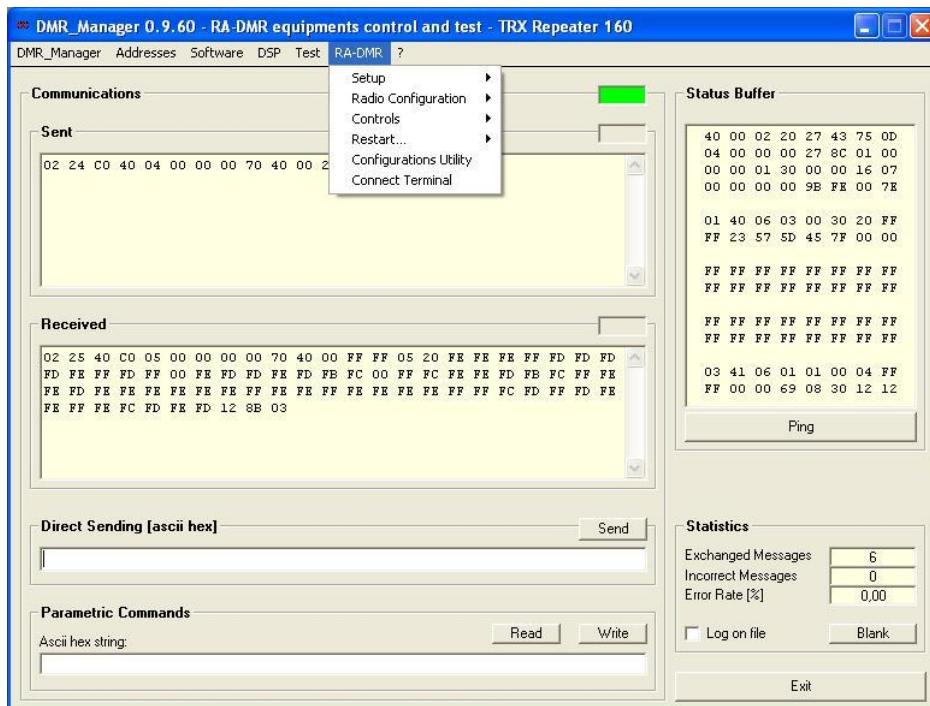
The new software will be effective after a restart, therefore, once the download is completed, you are prompted to restart the DSP immediately, clicking **Sì** :
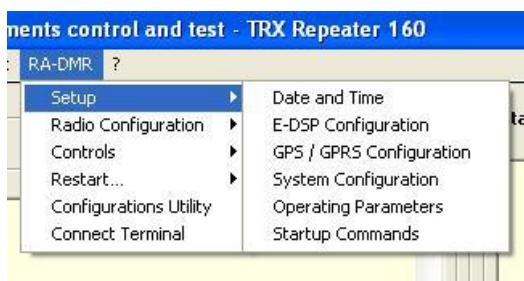

The user can choose to restart the system immediately or to postpone the restart.

The **VCTCXO** , **Boot 497** and **Main 497** options are used to upgrade the software of the peripheral modules (TX and RX). They may be used only on request of the technical staff.

6.2 RA-DMR MENU

6.2.1 SETUP

Menu item	Description
Setup	System's general settings
Date and Time	Allows the user to update the date and the time clock of the device basing on the time of the PC. To perform this operation you must switch the device in Off-Line mode (see start-up commands)
E-DSP configuration	Configures the E-DSP board
GPS/GPRS configuration	Configures the GPS/GPRS module
Operating parameters	Configures the TRX working parameters
Startup status	Configures the startup mode of the equipment
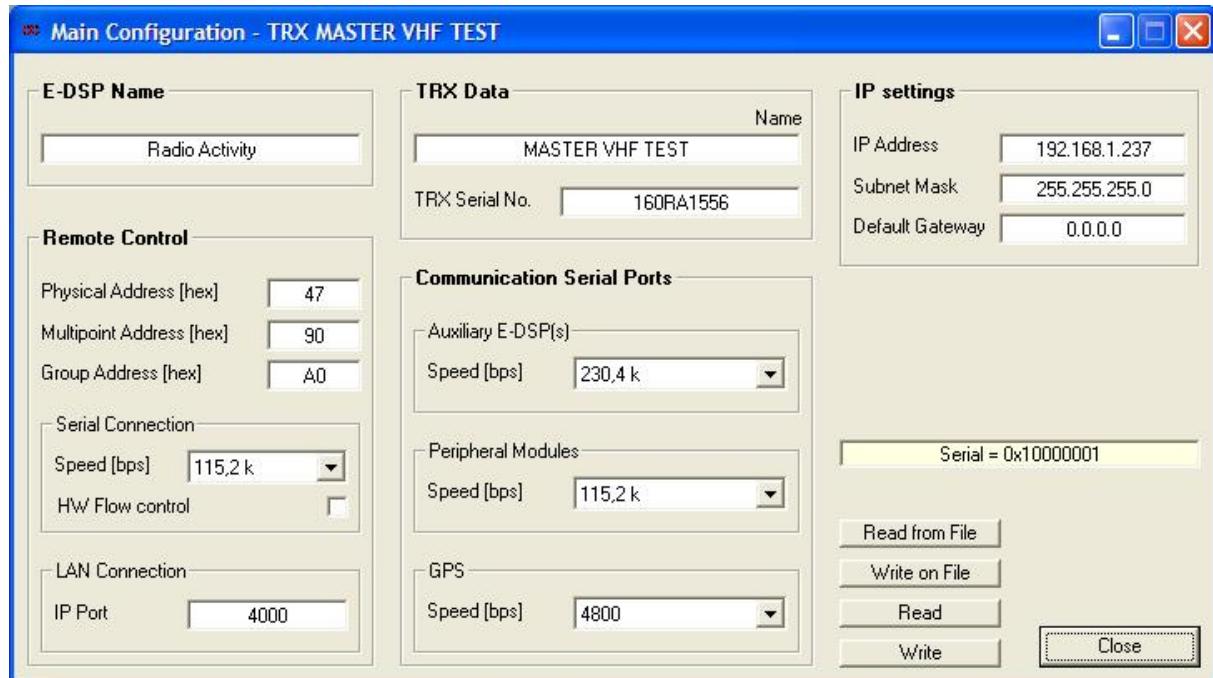
6.2.1.1 DATE AND TIME

Allows the user to update the real time clock of the Base Station basing on the time of the PC. To perform this operation you must switch the device in Off-Line mode (see

STARTUP) and click   **Align**
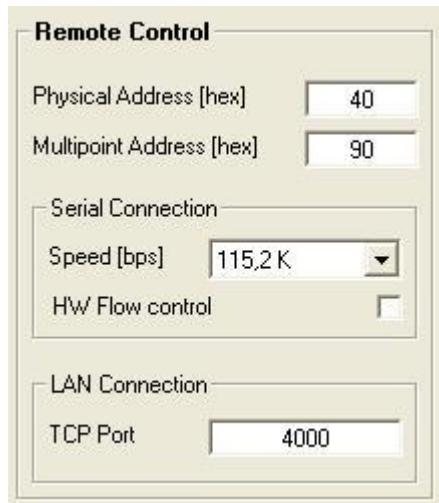
6.2.1.2 E-DSP CONFIGURATION
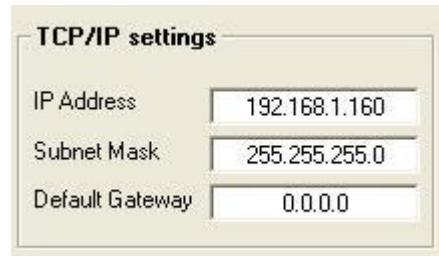
This form allows to set some fundamental parameters of the Base Station.   **Name**   allows the user to specify a name to facilitate the identification of the Base Station: this name will appear in the title bar of all the windows related to this equipment. The   **Remote Control**   section allows to specify the remote control parameters of the device.

Click   **Read**   or   **Write**   to read/save the current settings.

Click **Write on file** **Read from file** to save or read a configuration on/from a file on the PC.

The form **TCP/IP settings**

allows to set the data network basic parameters of the Base Station.

6.2.1.3 GPS/GPRS CONFIGURATION
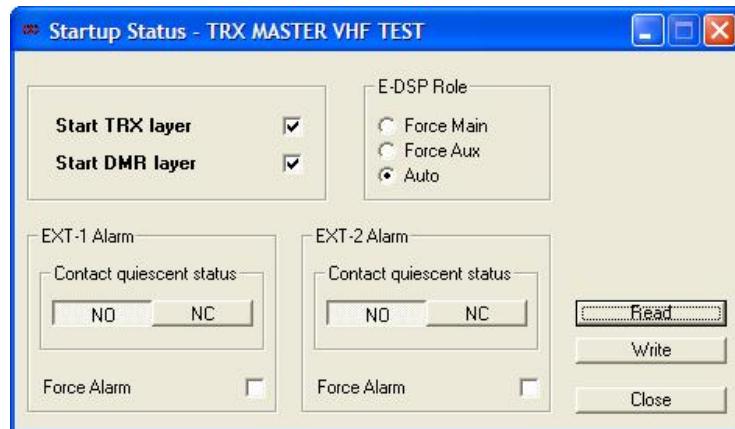
This form allows to set the GPS/GPRS module functionalities.

Click **Read** or **Write** to read/save the current settings.

Click **Write on file** or **Read from file** to save or read a configuration to/from a file on the PC.

6.2.1.4 STARTUP STATUS
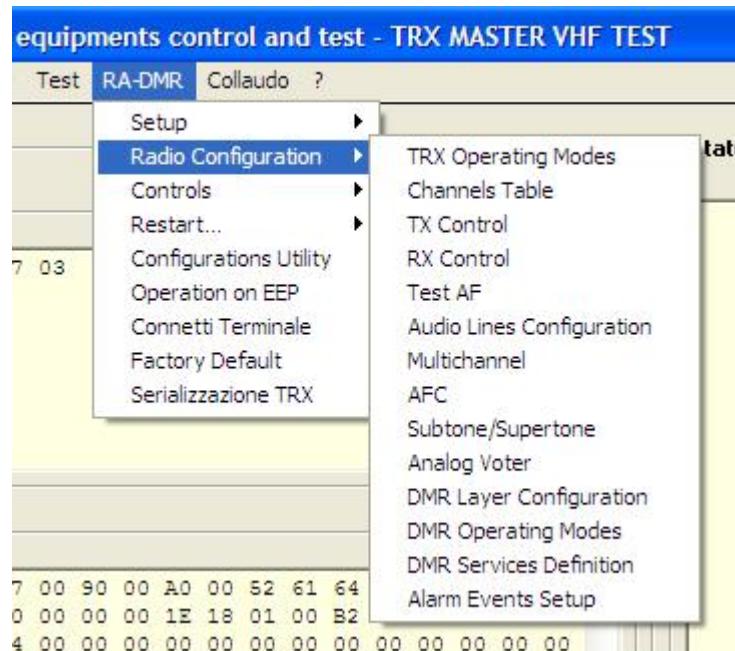
This form contains the start commands of the Base Station.

If the **… ON-LINE** button is not checked, the TRX is not active but can react to Remote Control commands: therefore it is possible to update software, configurations and settings. If this button is checked, the TRX is online and fully working.
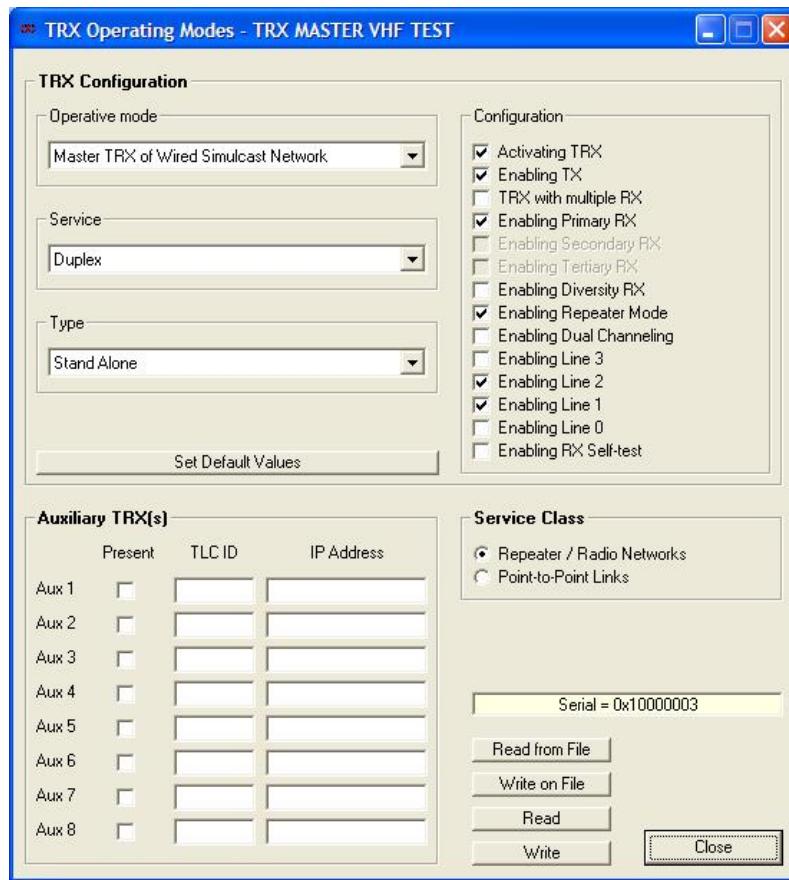
Click **Read** or **Write** to read/save the current settings.

6.2.2 RADIO CONFIGURATION

| Menu item	Description
Radio Configuration	*TRX configurations*
TRX Operating modes	Sets TRX operating mode
Channels table	Displays/setting channel parameters
TX control	Displays/setting TX parameters
RX control	Displays/setting RX parameters
Test AF	Allows to test the internal audio chain
Audio Lines configuration	Displays/setting Audio lines
Multichannel	Displays/setting Multichannel parameters
AFC	Displays/setting synchronism status
Subtone/Supertone	Displays/setting Subaudio/Superaudio parameters
Analog Voter	Displays the Analog voter
DMR Layer configuration	Displays/setting DMR parameters
DMR Operatin modes	Displays/setting TRX parameters in case of radio network
DMR Services definition	Allows to set parameters if using Motorola DMR terminals
Alarm event setup	Allows the user to bind some events with the sending of short text messages.

6.2.2.1 TRX OPERATING MODES

Menu item	Description
Configuration	TRX configuration
Activating TRX	The TX is active
Enabling TX	The TX is available
TRX with multiple RX	Tx with multiple receiver
Enabling primary RX	Primary receiver active
Enabling secondary	Secondary receiver active
Enabling tertiary RX	Tertiary receiver active
Enabling diversity RX	Primary receiver with diversity option
Enabling repeater mode	Switches from fixed station to repeater station
Enabling dual channeling	Enables dual 12,5 and 25KHz channeling filters on the RX module
Enabling Line 3	Unused
Enabling Line 2	Enables PCM audio compression over Ethernet
Enabling Line 1	Enables audio frequency line interface
Enabling Line 0	Unused
Enabling RX Self-test	Enable automatic RX test function at fixe time intervals

| Menu item	Description
Operating modes	*Radio operating mode*
No configured Radio	No options selected
Subscriber point-point	Telephone point to point radio link, subscriber side
User point to point	Telephone point to point radio link, user side
2/4 wires point to point	Point to point radio link, 2/4 wires
Duplex repeater	Repeater
Satellite link side	RF link in a satellite, iso-frequency network
Satellite local transmitter side	Local transmitter in a satellite, iso-frequency network
Master	Master in iso-frequency networks
Master II	Sub master in iso-frequency network
ISO satellite 2/4 wires intermediate	Intermediate satellite in wire linked linear iso-frequency network
ISO terminal satellite 2/4 wires	Terminal satellite in wire linked linear iso-frequency network
Master ISO 2/4 wires	Master in wire linked linear iso-frequency network
Multiple RX master	Multiple receiver RF linked master
Line 0	Auxiliary line interface
Line 1	Auxiliary line interface
Line 2	Auxiliary line interface
Line 3	Auxiliary line interface
Special applications	Customized applications
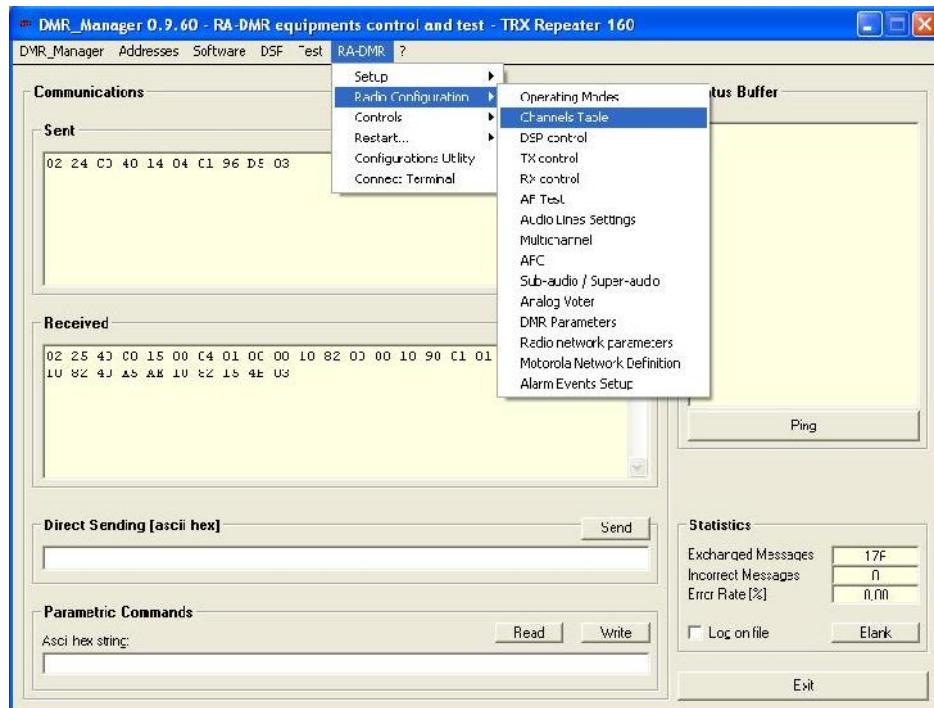
Menu item	Description
Service	*Communication service type*
Simplex	Refers to a communication that occurs in one direction only.
Semiduplex	Refers to a communication that occurs in both directions, only one direction at time.
Duplex	Refers to a communication that occurs in both directions at the same time.

Menu item	Description
Type	*Radio configuration*
Available	Available to define
Normal	TRX of a Base Station configured as 1+1 (active)
Backup	TRX of a Base Station configured as 1+1 (hot spare)
Stand alone	Base Station configured as 1+0

6.2.2.2 CHANNELS TABLE

The channels table displays all the parameters associated with all channels set in the Base Station.

To open the channel table click on, **Radio configuration** → **Channels table**, as shown in the figure.

DMR_Manager 0.9.60 - RA-DMR equipments control and test - TRX Repeater 160

DMR_Manager Addresses Software DSP Test RA-DMR ?

Setup ▶
Radio Configuration ▶   Operating Modes
Controls ▶   Channels Table
Restart... ▶   DSP control
Configurations Utility   TX control
Connect Terminal   RX control
                             AF Test
                             Audio Lines Settings
                             Multichannel
                             AFC
                             Sub-audio / Super-audio
                             Analog Voter
                             DMR Parameters
                             Radio network parameters
                             Motorola Network Definition
                             Alarm Events Setup

Communications

Sent

02 24 C0 40 14 04 C1 96 D5 03

Received

02 25 40 C0 15 00 C4 01 0C 00 10 82 00 00 10 90 C1 01
10 82 40 15 4B 10 82 15 4E 03

Status Buffer

Ping

Direct Sending [ascii hex]   Send

Parametric Commands   Read   Write
Ascii hex string:

Statistics
Exchanged Messages   17F
Incorrect Messages   0
Error Rate [%]   0,00

☐ Log on file   Blank

Exit

Channels Table - TRX Repeater 160

	Channel 0	Channel 1	Channel 2	Channel 3	Channel 4	Channel 5	
Channel Name	Channel 0	Channel 1	Channel 2	Channel 3	Channel 4	Channel 5	
Channel present	Yes	Yes	Yes	Yes	Yes	Yes	
Channel enabled	Yes	Yes	Yes	Yes	Yes	Yes	
TRX mode	ANA+ETSI+MOTO	ANA+ETSI+MOTO	ANA+ETSI+MOTO	ANA+ETSI+MOTO	ANA+ETSI+MOTO	ANA+ETSI+MOTO	ANA+
Channels spacing [KHz]	12,5	12,5	12,5	12,5	12,5	12,5	
TX Frequency [KHz]	448500,000	443512,500	448525,000	448537,500	448550,000	448562,500	4
Primary RX Frequency [KHz]	438500,000	433512,500	438525,000	438537,500	438550,000	438562,500	4
Secondary RX Frequency [KHz]	0,000	0,000	0,000	0,000	0,000	0,000	
Tertiary RX Frequency [KHz]	0,000	0,000	0,000	0,000	0,000	0,000	
Simplex Frequency Shift	No	No	No	No	No	No	
TX Power [W]	1	1	1	1	1	1	
Maximum continuis transm. time [s]	0	0	0	0	0	0	
Transm. closure delay [ms]	500	500	500	500	500	500	
TX DCS Code [oct]	--	--	--	--	--	--	
RX DCS Code [oct]	--	--	--	--	--	--	
TX TCS Frequency [Hz]	123,5	123,5	123,5	123,5	123,5	123,5	
RX TCS Frequency [Hz]	123,5	123,5	123,5	123,5	123,5	123,5	
RX Emergency TCS Frequency [Hz]	0,0	0,0	0,0	0,0	0,0	0,0	
RX TCS hold time [ms]	500	500	500	500	500	500	
Sub-audio tone deviation [Hz]	250	250	250	250	250	250	
Super-audio Frequency [Hz]	0	0	0	0	0	0	
RX Squelch level [dB]	20,0	20,0	20,0	20,0	20,0	20,0	
RX Squelch Hysteresis [dB]	6,0	6,0	6,0	6,0	6,0	6,0	
RX DMR Colour Code (main)	1	1	1	1	1	1	
TX DMR Colour Code (main)	1	1	1	1	1	1	
RX DMR Colour Code (aux)	1	1	1	1	1	1	
TX DMR Colour Code (aux)	1	1	1	1	1	1	

Write on File   Read from File   Edit data   Write on TRX   Read from TRX   Close

The parameters of the channels table are reported in the following table.

Channel name	
Channel present	Presence of the channel
Channel enabled	Enabling of the channel
TRX Mode	Indicates all of the possible transmission mode allowed: Analog, compatible with ETSI standard, compatible with Motorola terminals
Channel spacing [KHz]	Allows to choose the channel spacing: 25KHz, 20KHz, 12.5KHz, 10KHz
TX Frequency [KHz]	Transmission frequency
Primary RX frequency [KHz]	Receiving frequency of the primary receiver
Secondary RX frequency [KHz]	Receiving frequency of the secondary receiver
Tertiary RX frequency [KHz]	Receiving frequency of the tertiary receiver
Simplex frequency shift	If set, when the TX is active, the RX frequency is shifted to avoid interferences. This is meaningful only for simplex operating mode.
TX power [W]	Transmission power
Maximum continuous transmission [s]	Maximum time allowed for continuous transmission (if 0, this option is not active)
Transmission closure delay [ms]	Time before carrier off after the end of the communication
TX DCS code [oct]	Allows to choose a DCS code to transmit (Octal notation)
RX DCS code [oct]	Allows to choose a DCS code to receive (Octal notation)
TX TCS frequency [Hz]	Allows to set a subaudio tone to transmit
RX TCS frequency [Hz]	Allows to set a subaudio tone to receive
RX emergency TCS frequency [Hz]	Allows to set an emergency subaudio tone to receive
RX TCS hold time [ms]	Time before TCS off after the end of the communication
Subaudio tone deviation	Subaudio deviation
Superaudio frequency [Hz]	Superaudio frequency
RX squelch level [dB]	Allows to set a squelch opening level
RX squelch Hysteresis [db]	Difference between squelch opening and closure levels
DMR colour code RX Main	RX colour code
DMR colour code TX Main	TX colour code
DMR colour code RX aux	RX emergency colour code
DMR colour code TX aux	TX emergency colour code

To modify the channel parameters click on the column of the channel to modify…

…and then click on **Edit data** :the following form will appear:

It is also possible double click on the column of the channel to modify.

To add a new channel you must select an empty channel in the channels table and modify it as described above.

The maximum number of channels is 200.

6.2.2.3 TX CONTROL.

Clicking on **RA-DMR** → **Radio configuration** → **TX control** you can adjust the settings of the transmitter: You can set some filters (low pass, high pass and notch), set a delay, choose to equalize the signal to transmit (choosing the number of equalizer filter taps) and choose the modulation type (PM or FM).

| HP filter	It is a programmable high pass filter that can be inserted at the transmitter. It is used to eliminate the received sub-audio.
LP filter	It is a programmable low pass filter that can be inserted at the transmitter. It is rarely used to limit the bandwidth of the receiver output.
Notch	The notch filter, if enabled, is automatically set on the frequency of sub-audio tone transmission. It may be useful for reducing the phase distortion in simulcast networks with a sub-master (it is factory set for a given application).
Equalization	Allows to insert a filter that equalizes the phase and amplitude response of the transmitter in the whole bandwidth (except for the sub-audio tone frequency). It is used in simulcast networks and it is set in the factory if necessary.

Delay	allows to set a delay on the transmitted signal up to 127 ms
	This functionality is organized as follow:
	      Off: the filter is not active.
	      On: the filter is active, with minimum delay 1.938ms.
	Set: the delay is selectable in the range 0 to 127ms (minimum+1.938ms), step 4 μs.
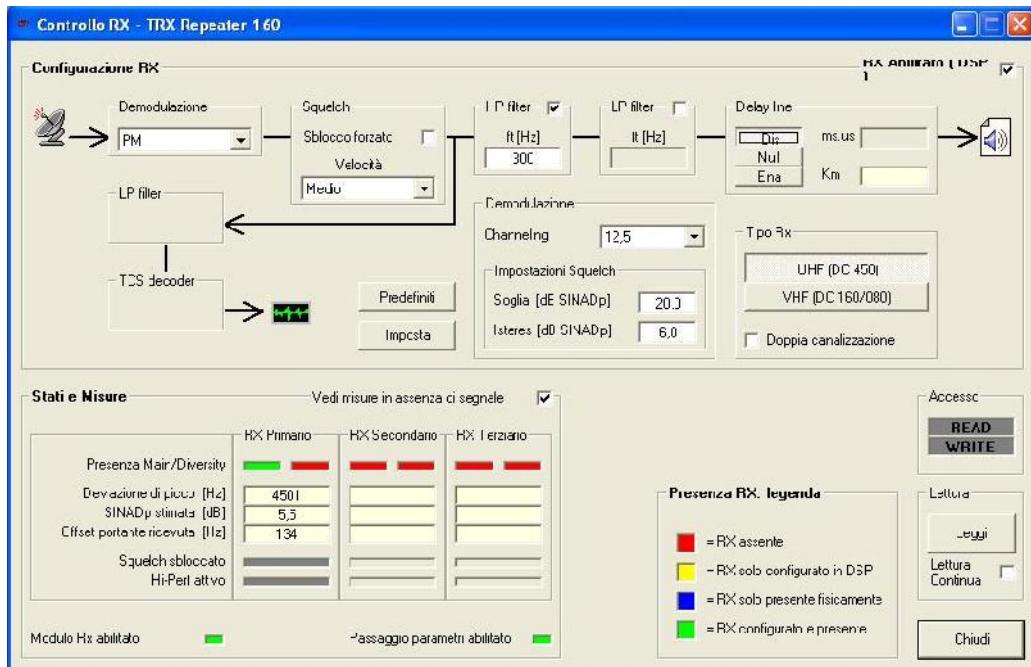
The settings specified in **Parameters of transmission** will not be effective (they come from the settings in the channels table).

To enable these functions click on **Set** ; All the parameters will assume their original values if you restart the device, unless you perform a **Save in eep** operation (see the DMR LAYER CONFIGURATION paragraph).

6.2.2.4 RX CONTROL
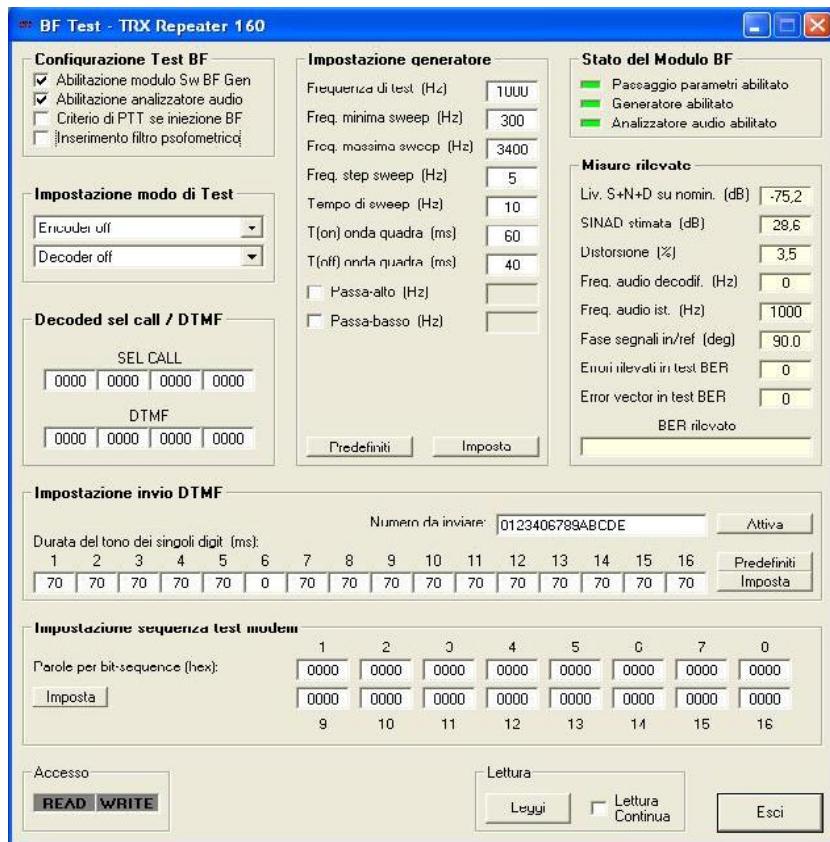
Clicking on **RA-DMR** → **Radio configuration** → **RX control** you can adjust the setting of the receiver: it is possible to choose how to demodulate the received signal, set the squelch opening, enable some filters (low pass and high pass) and set a time delay.

To enable these functions click on **Set** ; All the parameters will assume their original values if you restart the device, unless you perform a **Save in eep** operation (see the DMR LAYER CONFIGURATION paragraph).

HP filter	It is a programmable high pass filter that can be inserted at the output of the receiver. It is used to eliminate the received subaudio.
LP filter	It is a programmable low pass filter that can be inserted at the output of the receiver. It is rarely used to narrow the bandwidth of the receiver.

Delay	Allows you to set a delay on the received signal.
	Its function is organized as follow:
	        Off: the filter is not active.
	        On: the filter is active, with minimum delay 1.938ms.
	Set: the delay is selectable in the range 0 a 127ms (+1.938ms minimum delay), step 4 μs.

6.2.2.5 **AF TEST**

This form allows to personalize the internal audio generator and can be used to test mobile terminals.
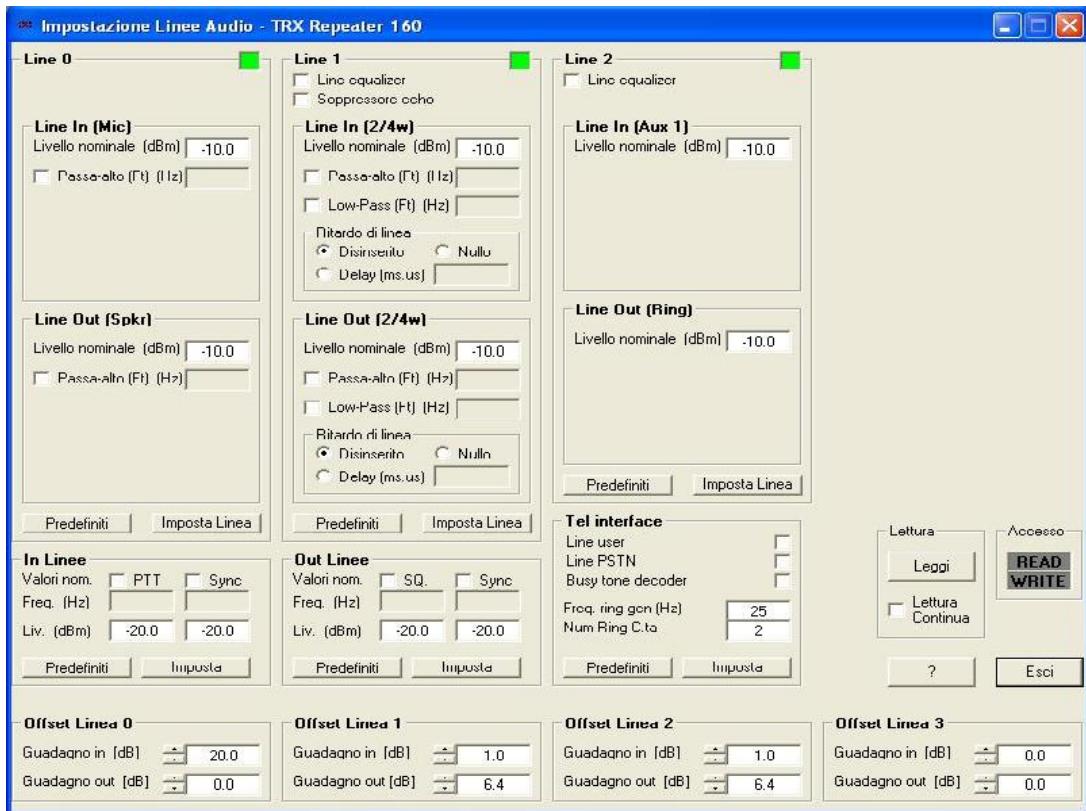
A monitor of the received selective call is available setting the desired standard in the section Decoded sel call/DTMF

The generator features and analyzer measures are referred to the selected test input, usually TX and RX; if the lines test form is active, signalling is sent to the selected line.

To enable these functions click on Set ; All the parameters will assume their original values if you restart the device, unless you perform a Save in eep operation (see the DMR LAYER CONFIGURATION paragraph).

6.2.2.6 AUDIO LINES CONFIGURATION (FOR ANALOG USE OR FOR SYNCHRONIZATION AIM ONLY)

Clicking on RA-DMR → Radio configuration → Audio lines setting you can set the input and output audio lines levels.

DMR users are interested only in using the section **Line 1** .

It is possible to set nominal levels for input and output lines, high and low pass filters and delays. The input signal in fact, after the analog to digital conversion, is regulated in amplitude according to the user's settings.

The echo canceller is a filter that sums the output signal, after an appropriate phase correction, with the input signal, in order to minimize signal reflection effects.

This function is selectable by checking **Echo canceller**

There are also band pass and notch filters to remove PTT and sync tones. The filters are automatically inserted if you select a tone in the setup line section. You can define the level and the frequency of the used tones and the filters are automatically aligned with the desired frequency. The extracted signals are sent to the decoding tones block.

The **Line delay** block allows to delay the input signal up to 127 ms using a 2 us step. The processing chain towards the balanced output is the reversal of the processing chain for an input signal.

The **In Line** and **Out Line** sections allow to specify the PTT, squelch, synchronism criterions setting the level and the frequency of the signal.

To activate these functions click on **Imposta Linea** .

TELEPHONE INTERFACE SETTINGS (FOR ANALOG USE ONLY)

The telephone interface settings are usually set by the technical staff for the specific application. The section to set these features is the following.

You must check **Line user** if there is a user side telephone interface, or **Line PSTN** if there is a subscriber side telephone interface (BCA-C).

The **Busy Tone Decoder** function activates the engaged line recognition algorithm (used in the automatic radio-telephone interface).
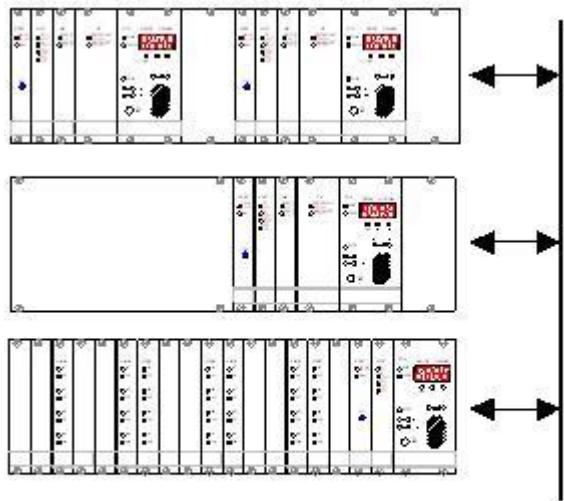
The **Freq Ring Gen** box allows to set the frequency of the telephone call signal (usually 25Hz), which is active only in user side interfaces (bca-u).

The box **Num Ring C.ta** allows to set the number of rings after that the telephone interface automatically engages the line. It is active only for subscriber side telephone interfaces (bca-c).

6.2.2.7 MULTICHANNEL

All DSP modules have a connection bus "MTCH" that allows different radio systems to synchronously exchange data in particular network configuration. This feature allows to realize many different solutions.

The MTCH bus can hold both anlog audio signals in 16 bit digital format and synchronism/signalling/control parameters.
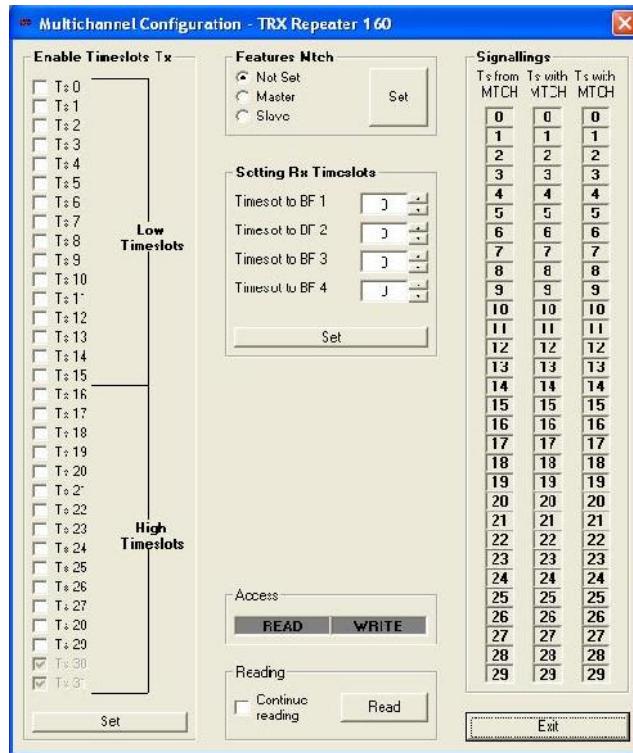
It is possible to connect up to 12 transceivers directly ,to perform a digital audio matrix in case of complex base station solutions.

The MTCH protocol is configured on 28 timeslots, selectable to transmit or receive. All the timeslots are accessible to all the DSP connected to the same bus.

To set the MTCH parameters click on RA-DMR → Radio configuration → Multichannel .

The following form will appear:

The section Enable timeslot tx allows the user to select the timeslot to transmit, and the section

Setting RX Timeslot allows to select the timeslot to read from the LAN.

The button Master in the section Features MTCH must be selected in the master radio, so a radio works as a master and the other radios of the system as slaves.

It is also possible to get the synchronism for the base station by "Multichannel" (see AFC - AUTOMATIC FREQUENCY CONTROL), as shown in the figure below:

The **Signallings** section of the multichannel configuration form, displays the timeslot in use (first column) and related signalling (usually PTT).

To enable these functions click on **Set** ; All the parameters will assume their original values if you restart the device, unless you perform a **Save in eep** operation (see the DMR LAYER CONFIGURATION paragraph).

Note: The configuration of MTCH is set by the factory for the intended use. The use of this form is restricted to skilled users and only to test the presence of the timeslots in the section **Signallings** .

6.2.2.8 AFC - AUTOMATIC FREQUENCY CONTROL

Clicking on **RA-DMR** → **RadioConfiguration** → **AFC** it is possible to continuously monitor the synchronization of the equipment and change some related parameters.

The timing of the Base Station can be extracted from different sources:
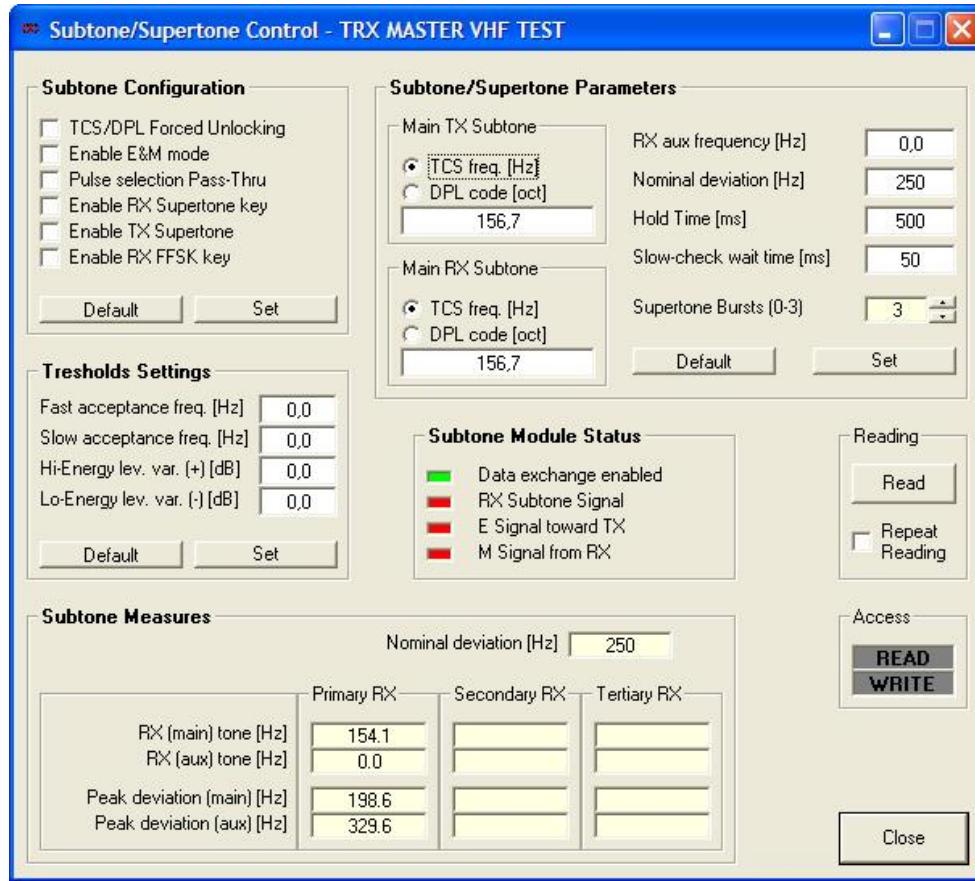
Menu item	Description
Synchronism source	*Allows to choose the synchronism source*
No sync	No Synchronism source selected
Digital	Synchronism based on a proprietary pattern sent at the beginning of the transmission and then on superaudio tones.
Internal	The synchronism source is a crystal oscillator placed inside the DSP module, which has a stability better than 0.5 ppm in the thermal range of functioning. On demand, higher stability oscillators can be used. The frequency tuning is digitally controlled and the setting can be stored. An internal self calibration function allows to correct the natural aging of the oscillator, by simply connecting the receiver to a calibrated external source.
From multichannel	The synchronism is obtained from Audio LAN connection clock (patch cord on the rear of the rack). This synchronism can be required for systems with more digitally linked together radio stations. Equipment synchronization time <2 s Long period relative stability 0 ppm Short period relative stability <0,001 ppm
From PPS GPS	The GPS receiver (inside the station) provides a pulse every second, which is used by the DSP to clear its frequency and time reference. The time reference allows automatic equalization of absolute delays of the links (useful in networks with IP links or MUX SDH links with automatic reconfiguration of routes in case of backbone failure). In the case of GPS failure the synchronism is automatically switched to super-audio tone received from the master station (see following method). Equipment synchronization time <120 s Long period relative stability 0 ppm Short period relative stability <0,01 ppm
From superaudio	A super-audio tone, superimposed to the analog signal, is the reference for the DSP to lock its internal clock. That tone, whose frequency can be freely set between 3100 and 3400 Hz (typ = 3400Hz), is sent 10dB lower than the nominal audio level. Equipment synchronization time <60 ms Long period relative stability 0 ppm Short period relative stability <0,01 ppm
From 4 FSK timeslot	Synchronism based on the 4FSK timeslot

To enable these functions click on **Set** ; All the parameters will assume their original values if you restart the device, unless you perform a **Save in eep** operation (see the DMR LAYER CONFIGURATION paragraph).

6.2.2.9 SUBTONE / SUPERTONE

Clicking on **RA-DMR** → **RadioConfiguration** → **Subaudio/superaudio** the subaudio/superaudio form will appear:
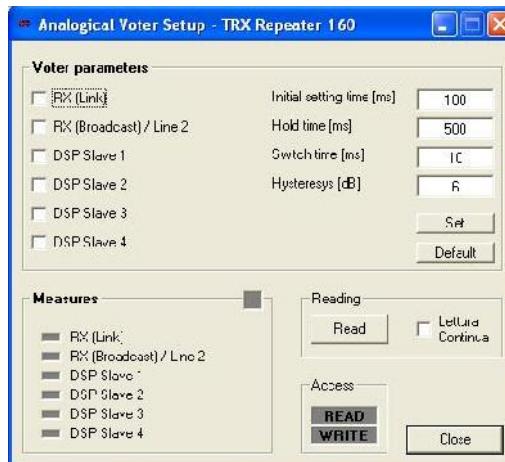
This form allows the user to control and modify the subaudio and superaudio parameters.

You can set the frequency of the TCS tone (both TX and RX) or choose a DPL code (in the octal range 001-777), which is expressed in octal notation.

To enable these functions click on Set ; All the parameters will assume their original values if you restart the device, unless you perform a Save in eep operation (see the DMR LAYER CONFIGURATION paragraph).

6.2.2.10 ANALOG VOTER

Clicking on RA-DMR → RadioConfiguration → Analogical voter the following form will appear:

This form allows the user to set the analogical voter inputs (in the section ▐ Voter parameters ▌),

In the ▐ Voter parameters ▌ section you can:
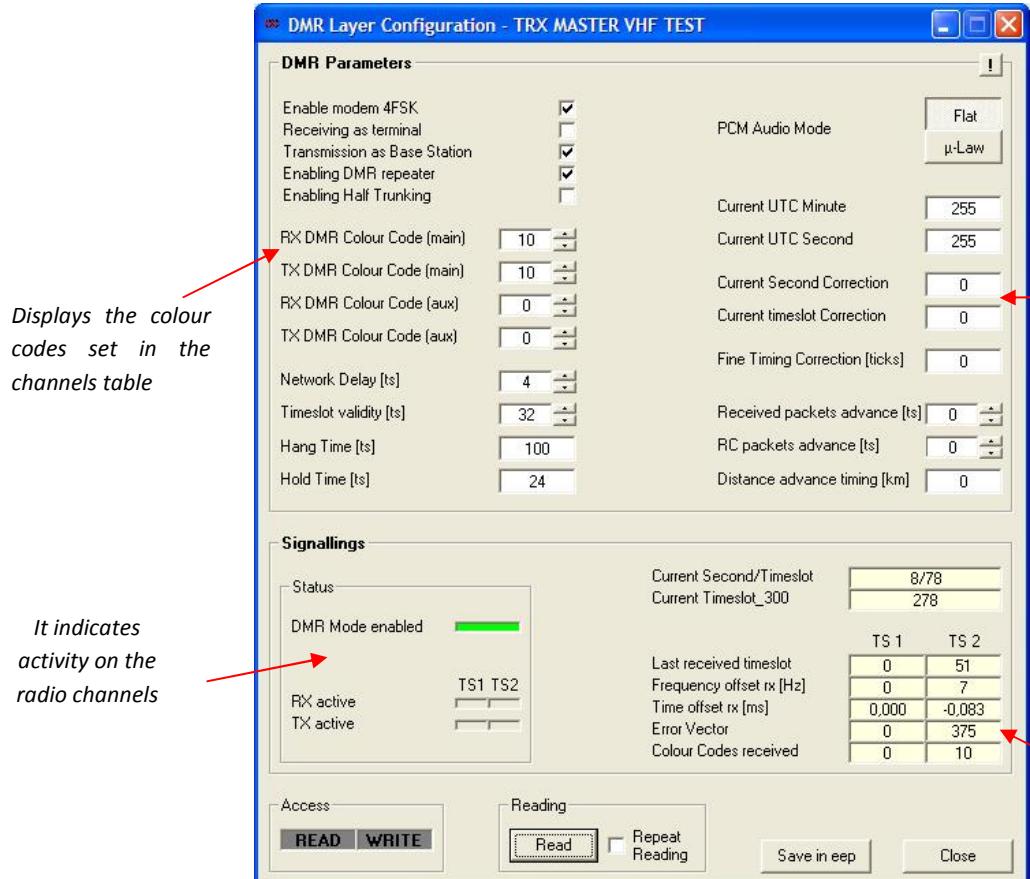
- ∞ choose the signal sources for the analogical voting and the related setting time,

- ∞ set the hold time for the voted source (that is the minimum time before source changing),

- ∞ set the switch time (that is the minimum time between source changing after hold time expiration),

- ∞ set the signal hysteresis (that is the signal threshold for a valid candidate source).

You can set these parameters specifying the numbers in the section on the right: ▐ Initial setting time [ms] ▌ is the searching time for the best signal initially, ▐ Hold time [ms] ▌ is the time the voted source is maintained. ▐ Switch time [ms] ▌ is the time step after which a different input can be voted as the "best", ▐ Hysteresys [dB] ▌ is a threshold: if another signal is ▐ Hysteresys [dB] ▌ better than the currently voted one, that signal become the new voted one.

To enable these functions click on ▐ Set ▌; All the parameters will assume their original values if you restart the device, unless you perform a ▐ Save in eep ▌ operation (see the DMR LAYER CONFIGURATION paragraph).

6.2.2.11 DMR LAYER CONFIGURATION

Displays the colour codes set in the channels table

These parameters are set by the technical staff according to the network configuration

It indicates activity on the radio channels

Displays the quality of the signal received on the timeslots

The 　**Parameters**　 section allows to enable different features:
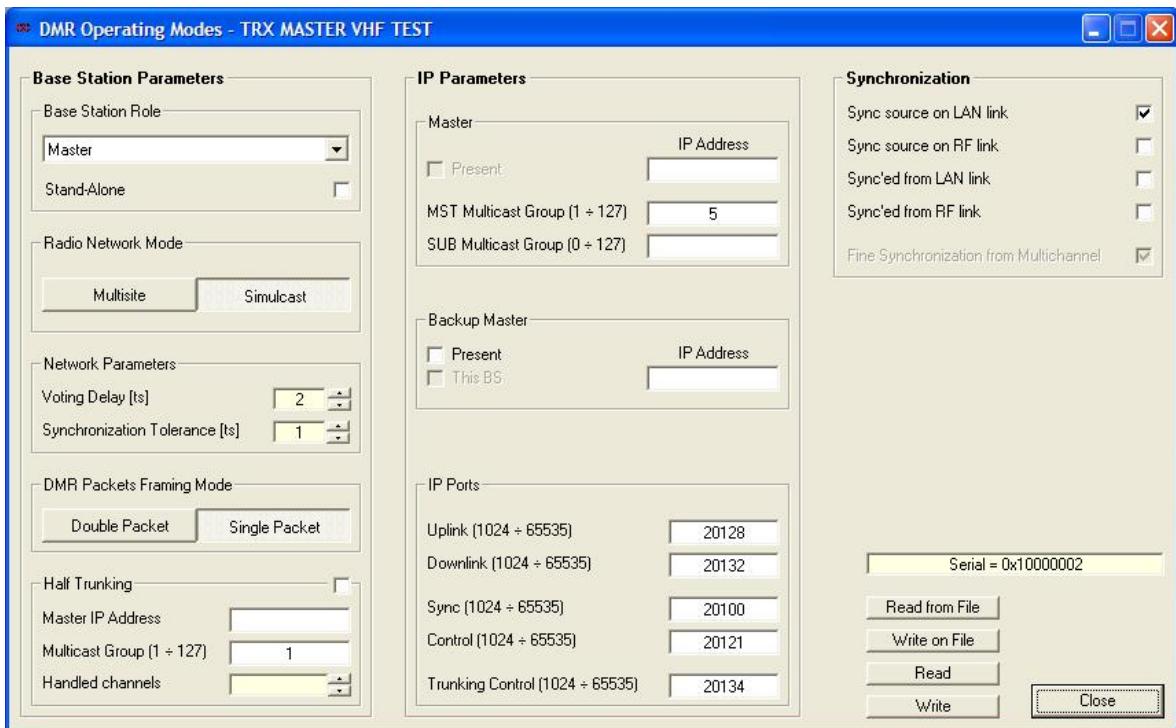
- ∞ 4FSK modem: enables the 4FSK modem performed by the DSP,

- ∞ Receiving as terminal: if checked, the Base Station receives as it were a terminal, without the repeater features,

- ∞ Transmission as Base Station: if not checked, the Base Station transmits as it were a terminal, without the repeater features,

- ∞ Enabling DMR repeater: enables the repeater features.

　Hang time　 is the time that elapses after the killing of communication to the state of hibernation of the base station. During this time if the terminal accesses the network it does not need to perform the de-hibernation procedure and acquisition of synchronization, but can simply access the network. After this time a terminal, to access the network, must "wake up" the base station by the hibernation state and acquire the synchronization.

　Hold time　 is the time the TX remains on air after the PTT release.

The 　**Signalling**　 section displays radio activities on the two timeslots and also some measures about the quality of the radio channel.

6.2.2.12 DMR OPERATING MODES

This form allows the user to enable the radio network in simulcast or multisite mode.

In the section 　**Base Station parameters**　 you must specify the role of the Base Station (Master or Satellite), the voting delay (it is the time that elapses from the current timeslot to the time of arrival of the
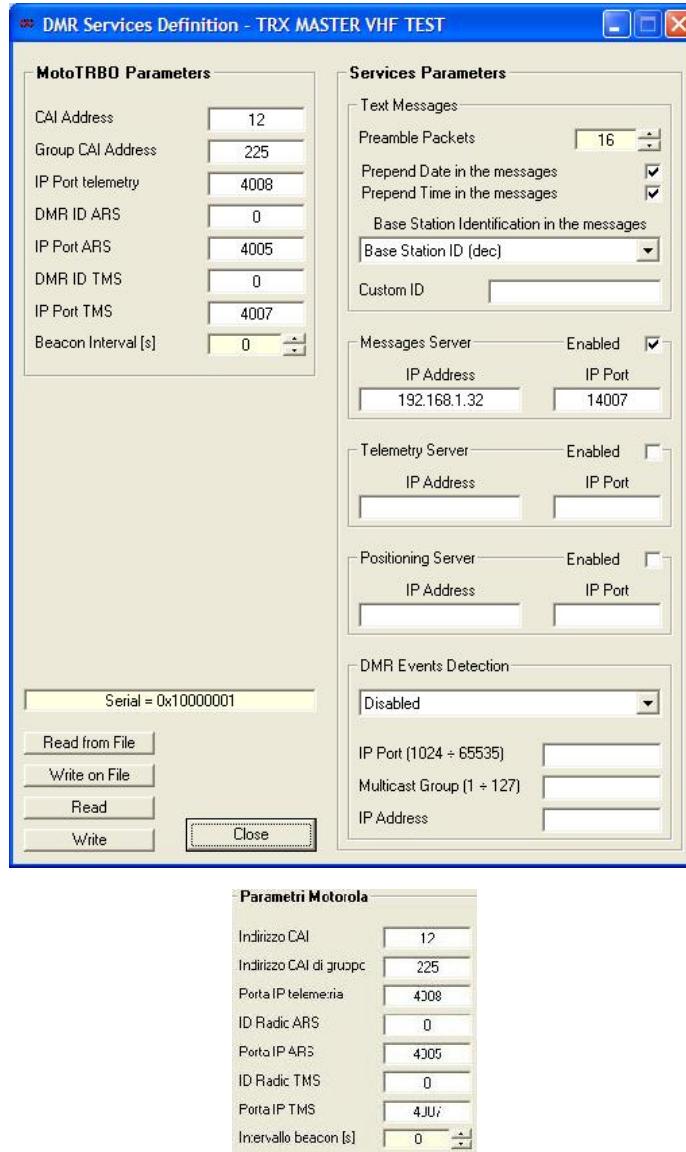
packets to be voted). All the other features in this form are set by the technical staff according to the particular network configuration.

In the section ❘ **Master** ❘, you must insert the IP address of the Master Base Station.

Click ❘ **Read** ❘ or ❘ **Write** ❘ to read/save the current settings.

Click ❘ **Write on file** ❘ ❘ **Read from file** ❘ to save or read a configuration on/from a file on the PC.

6.2.2.13 DMR SERVICES DEFINITION
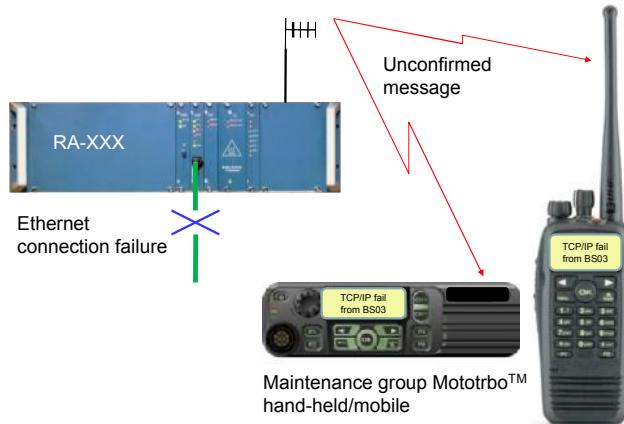
You can set this parameters as to be congruent with the DMR Motorola MotoTRBO™ terminals network settings.

Click ❘ **Read** ❘ or ❘ **Write** ❘ to read/save the current settings.

Click ❘ **Write on file** ❘ ❘ **Read from file** ❘ to save or read a configuration on/from a file on the PC.
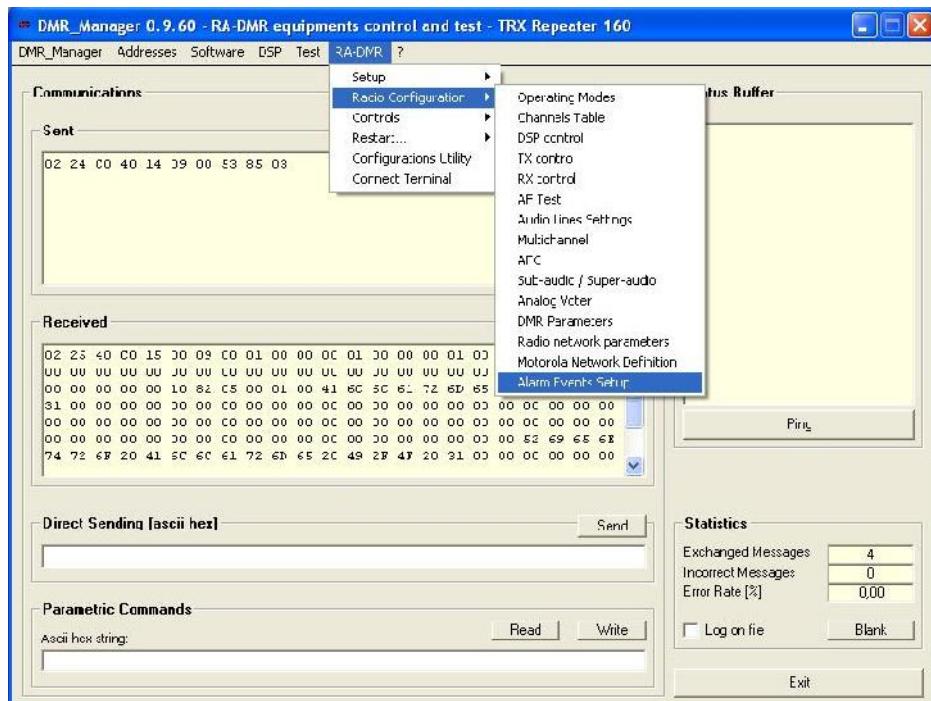
6.2.2.14   ALARM EVENTS SETUP

This new feature is particularly useful because allows the user to receive on his mobile terminal (or on a group of user terminals) short text messages at the occurrence of certain events.

Thanks to a new and easy to use DMR_Manager form the user can activate this service with the features that best suit his needs.

You must click on **RA-DMR** → **Radio configuration** → **Alarm events setup** .
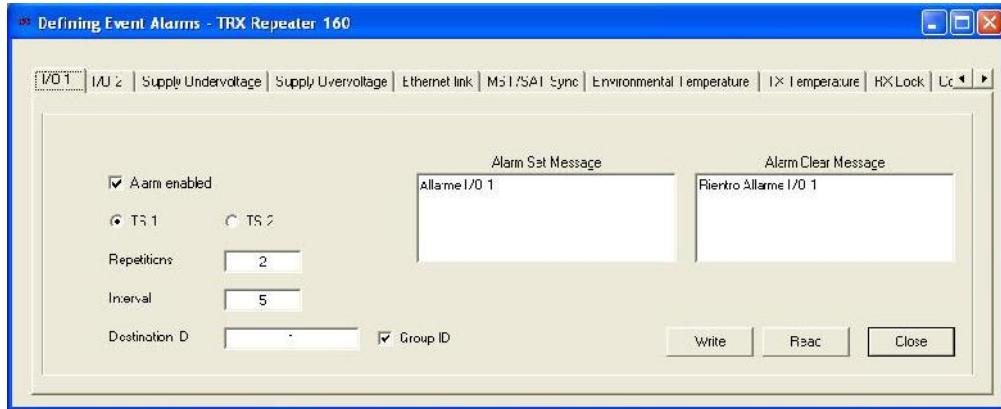
This form allows the user to bind each of the events reported in the table below with a short text message: when the event occurs the user will receive the text message on the designed mobile terminal and a warning message when the problem is resolved.

To enable the sending of a warning message, select **Alarm enabled**

It is necessary to insert the ID (or the group ID) of the terminals designed to receive the warning messages.

If the message has to be sent to a group of terminals, select Group ID
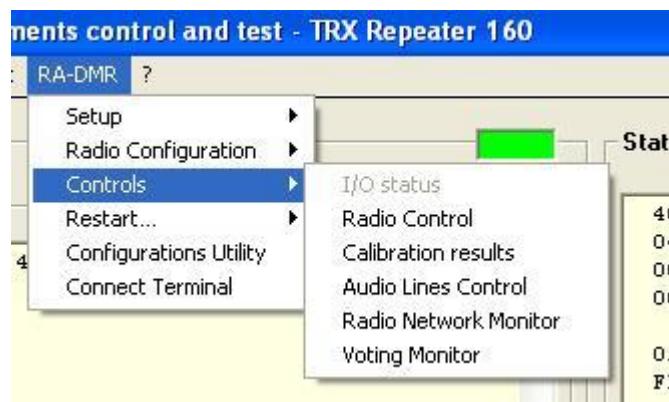
It is possible to set how many times sending the alarm message consecutively by selecting Repetitions ,
and how frequently (seconds) by selecting Interval

It is possible to set the timeslot the warning messages will be sent by selecting TS 1 or TS 2 .

Select Write to activate the current settings.
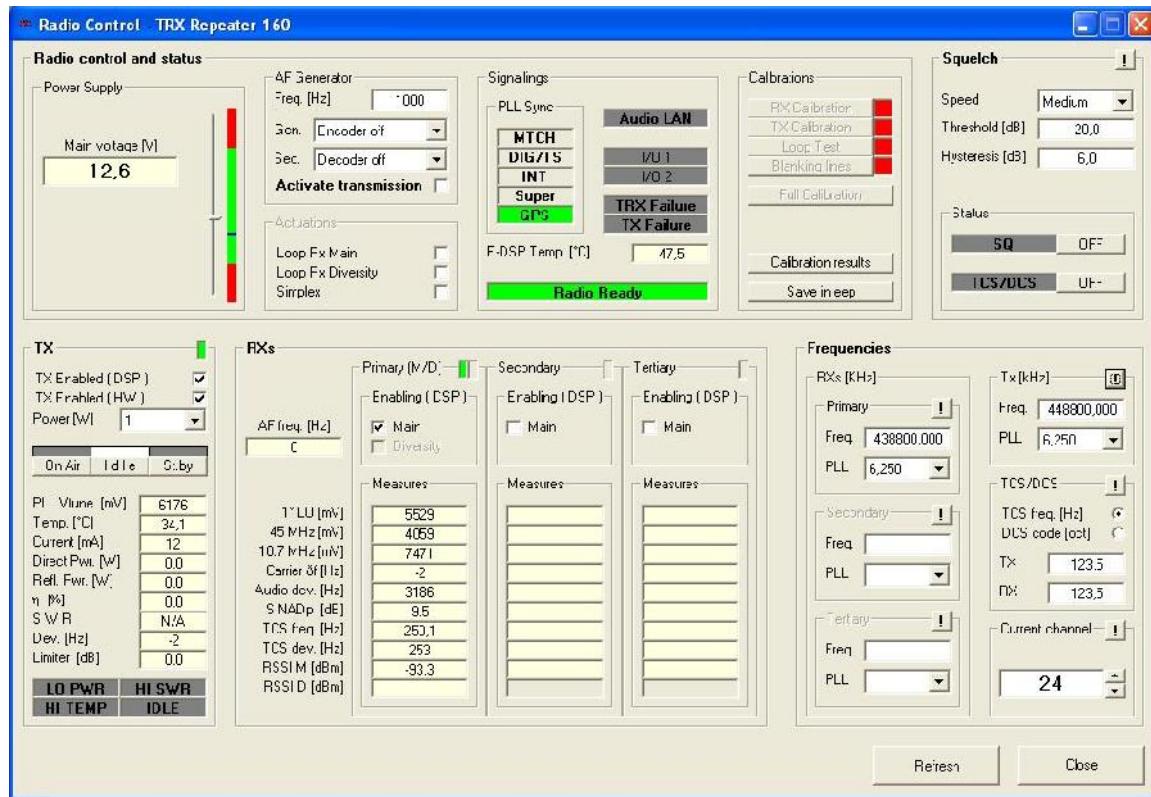
| Alarm	Event
I/O 1	Active I/O 1 contact
I/O 2	Active I/O 2 contact
Supply undervoltage	Voltage supply under the minimum value
Supply overvoltage	Voltage supply over the maximum value
Ethernet link	Link Ethernet disrupted
MST/SAT sync	Loss of synchronism between Master and Satellite
Environmental temperature	Environmental temperature out of range
TX Temperature	TX temperature out of range
RX lock	RX unlocked
Connection to master	Connection with working Master (Satellite only)
Satellite registration	Registration of new Satellite (Master only)
Satellite deregistration	Deregistration of new Satellite(Master only)
Satellite lost	Unreachable satellite(Master only)
GSM/GPRS not working	GSM/GPRS connection not working (only for Base Stations equipped with I/O board and GSM/GPRS module)
Noise on the RF channel	Not yet active
Emergency call on TS1	An emergency call is ongoing on TS1
Emergency call on TS2	An emergency call is ongoing on TS2
DSP generic failure	Internal alarm on DSP module
TX generic failure	Internal alarm on TX module
RX generic failure	Internal alarm on RX module
TRX alarm	TRX alarm 1 (strong alarm) is enabled

6.2.3 CONTROLS.
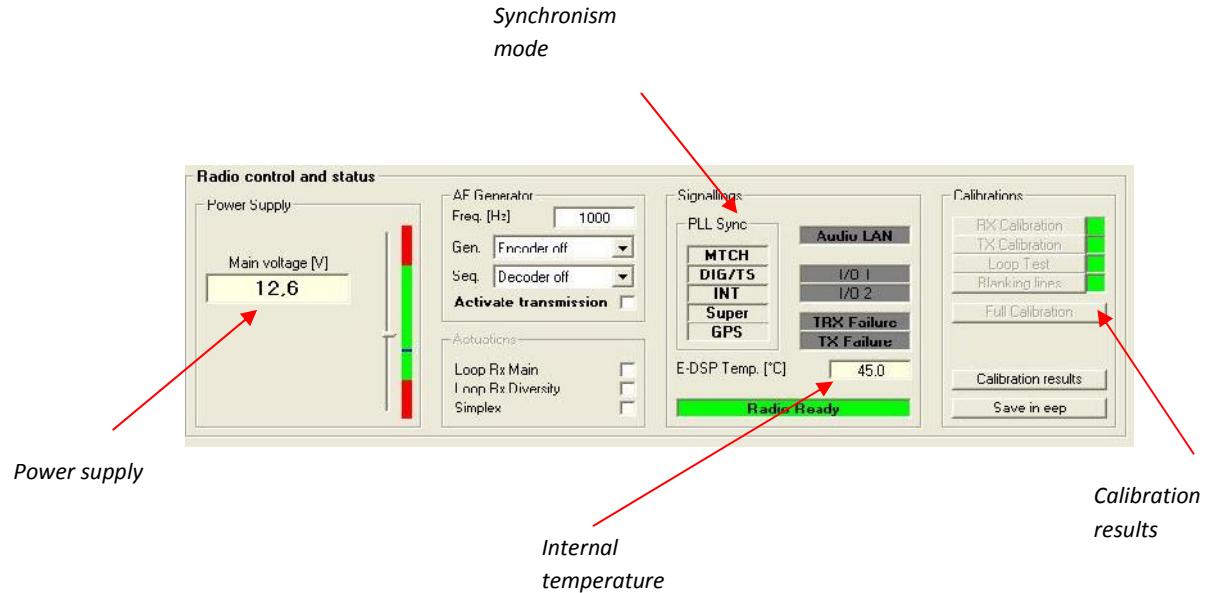
Menu item	Description
Controls	*Displays the current state of the Base Station*
I/O status	Displays the state of I/O
Radio control	Displays and sets the radio operating parameters
Calibration results	Displays calibration results (TX,RX and loop)
Audio lines control	Displays and sets audio lines parameters
Radio network monitor	Displays the activity of the radio network (form under development). The data displayed are meaningful only for connection to a master TRX.
Voting monitor	Displays the digital voting (only if the Base Station is configured as master).
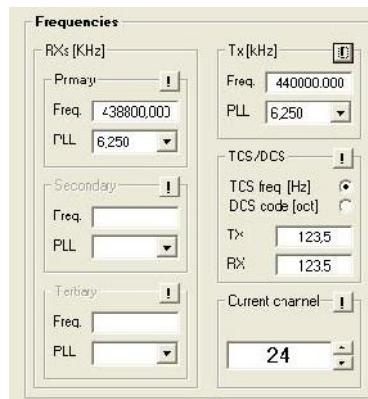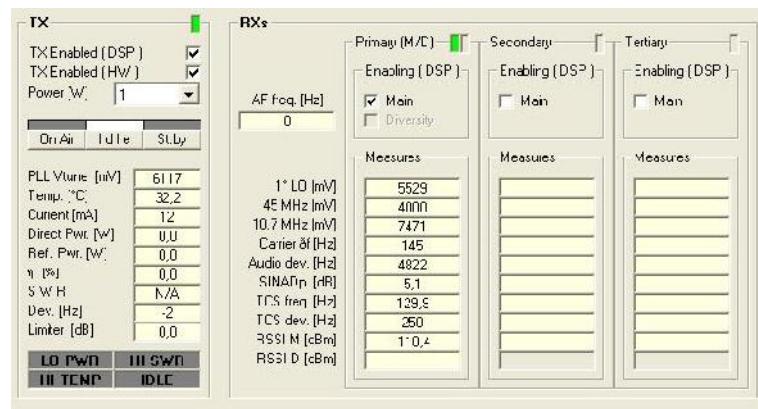
6.2.3.1 RADIO CONTROL

This form allows to constantly monitor the state of the radio. It is possible to monitor the power supply, the synchronism, the internal temperature, the calibration results and many other working parameters.

Synchronism mode

Power supply

Internal temperature

Calibration results

This section displays the TX current settings and all the RX measures.

The   **Frequencies**   section displays the current operating channel, the transmitting and receiving frequencies and the subaudio settings (TCS,DPL,TCS frequency, DPL code).

6.2.3.2 CALIBRATIONS RESULTS
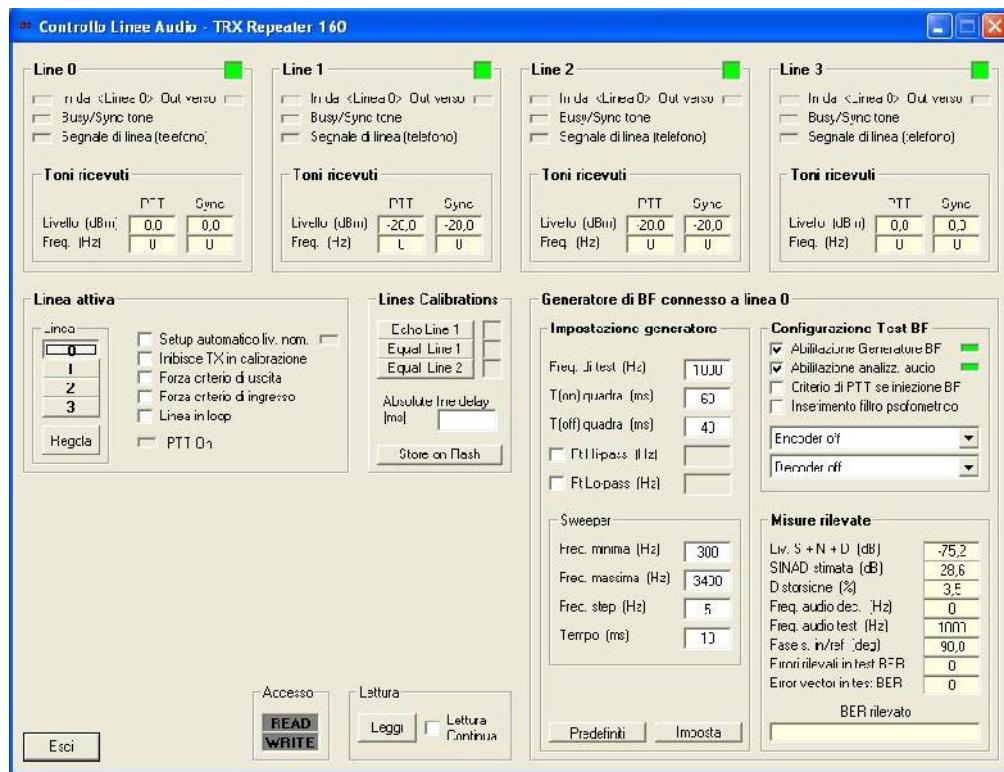
This form displays the calibration results (TX,RX and loop test).

Clicking **Save in eep** calibration levels will be saved on eeprom and used in case of unsuccessful result of a further calibration process.

The **Refresh** button update the calibration results: it is useful when calibrating, to real time monitor the calibrations results.
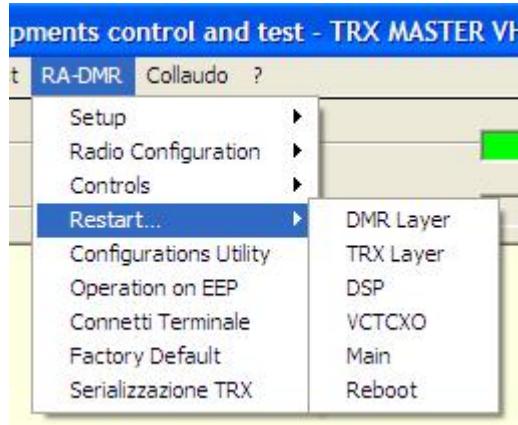
User are strongly advised not to use **Write**

6.2.3.3 <u>AUDIO LINES CONTROL</u>

This form allows the user to perform some tests on the line interfaces. In the section $\boxed{\textbf{Linea attiva}}$ you can select the line to be tested (clicking on $\boxed{\textbf{Regola}}$), in the section $\boxed{\textbf{Line n}}$ you can monitor the lines criteria. You can also set a audio signal generator connected to the output line and analyze the audio signal coming from the input line.

6.2.4   RESTART

Menu item	Description
Restart	
DMR Layer	Restart the DMR application, which is based on radio layer
TRX Layer	Restart the radio Layer which manages the RF section
DSP	Restart the DSP
VCTCXO	Restart the internal clock
Main	Restart the whole software
Reboot	Restart the equipment (it is the same of switch off and switch on the radio)

6.2.5 CONFIGURATIONS UTILITY

This form allows to save to the PC and load from PC the TRX and/or DSP parameters.