DMR Repeater

Version 1v4

Radio Activity S.r.l.

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DMR SYSTEM GENERAL CHARACTERISTICS

ETSI standard and previous systems compatibility

DMR standard (ETSI TS 102 361 technical specification) is an open standard, defined in ETSI world by a working group made of main PMR equipment producers of the world. DMR standard building followed guide lines of PMR market requirements for digital flexible systems, able to give added value to the present analogical systems, but at the same time to guarantee a gradual migration between the two technologies, making investments and specific operative existing requirements safe.

To this aim Radio Activity DMR repeaters are designed with the double standard technology, they are able to work both in analogical and digital way, then supporting both classic PMR terminals and the new DMR ones, with every operating characteristic of each technology ("multi-protocol"):

- voice communications with FM analogical modulation and selective calling based on traditional protocols;
- Voice communications and data transmission with 4FSK digital modulation, according to the DMR standard, with 9600 bps gross total speed.

Furthermore the selection of required working mode is fully automatic, this meaning that the repeater is able to autonomously detect if the incoming communication is analogical or digital and can consequently configure itself to work as a PMR or DMR respectively.

Two TDMA timeslots per 12,5 kHz wide channel

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.

Greater efficiency of spectrum employment

By implementing two "virtual radio channels" on the same physical radio channel (a couple of frequency), DMR systems increase the efficiency of radio-electrical spectrum employment and they reduce the need for radio frequencies supporting the same traffic amount.

Greater efficiency of battery

Due to the TDMA management of DMR protocol, terminals transceivers consume less power, because their transmission is active for the 50% of time compared to conventional terminals. This happens because the terminal only transmits during one of the two protocol timeslots, while the other timeslot is available for another radio communication or for control signalling transit.

Increased data transmission capacity

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.

Greater audio quality of communications

Digital modulation employment allows to get a greater audio quality of digital radio communications in comparison with analogical ones, thanks to the implementation of digital techniques of information coding and error correction. While the audio quality guaranteed by analogical modulation is directly proportional to the received field strength (that is, the weaker the received signal, the poorer the communication audio quality), digital technology allows to obtain the same high audio quality practically all over the coverage area.

Lower costs for licenses and equipments.

Digital radio systems based on TDMA (Time-Division Multiple-Access) technology, realize two virtual channels inside the same physical licensed 12.5 KHz wide channel. This means to double traffic capacity, at constant license price, because the physical channel are virtually doubled.

Clearer voice communication over a wider coverage.

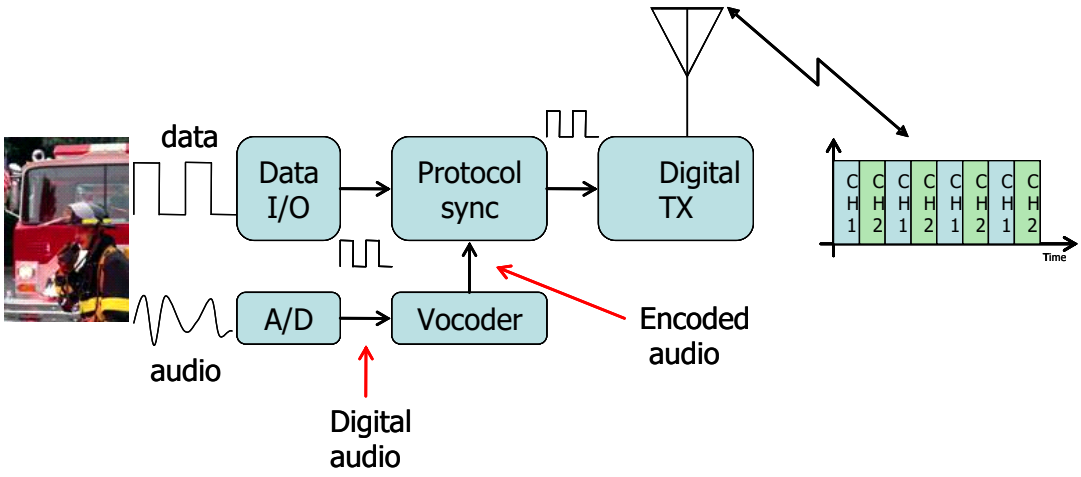
When signal intensity decreases because of the distance, digital technique of error correction is able to transfer voice and data information without errors or any loss over bigger areas. To increase disturbances immunity and to maximize the coverage area, it is needed however to minimize the “fading” effect due to signal multiple paths, which in digital communication systems is the main cause for rapid degradation of reception quality with decreasing the intensity of received field. To overcome this problem, the space diversity reception technology can be used: the integration of a double coherent receiver, connected to two different antennas immunizes from fading effect because it is statistically not probable to have two contemporary nulls of field on two different antennas, as a consequence of multiple signal paths.

Noise suppression.

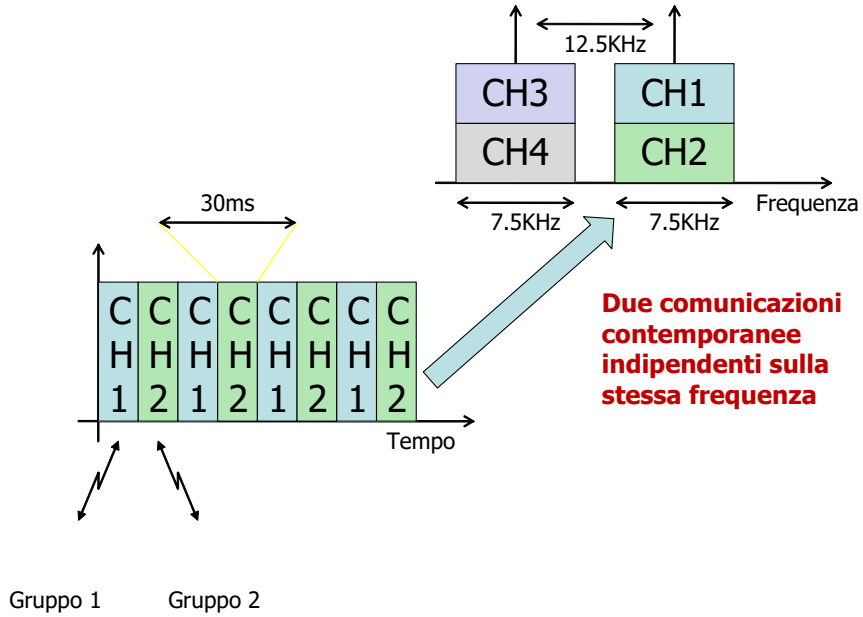
While signal intensity decreases, analogical signals suffer from distortions producing similar to discharges noise. In contrast, digital receivers simply reject everything can be seen as error and this allows a better listening by users

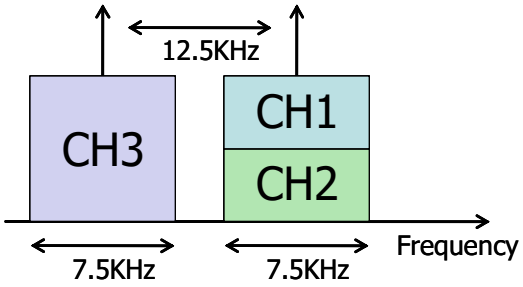
BASIC CONCEPTS ON DMR STRUCTURE

DMR standard performs the transportation of both data and voice. Audio signal is converted into digital format, compressed, "packed" into digital transportation channel, differently "marked" than the data digital signal.

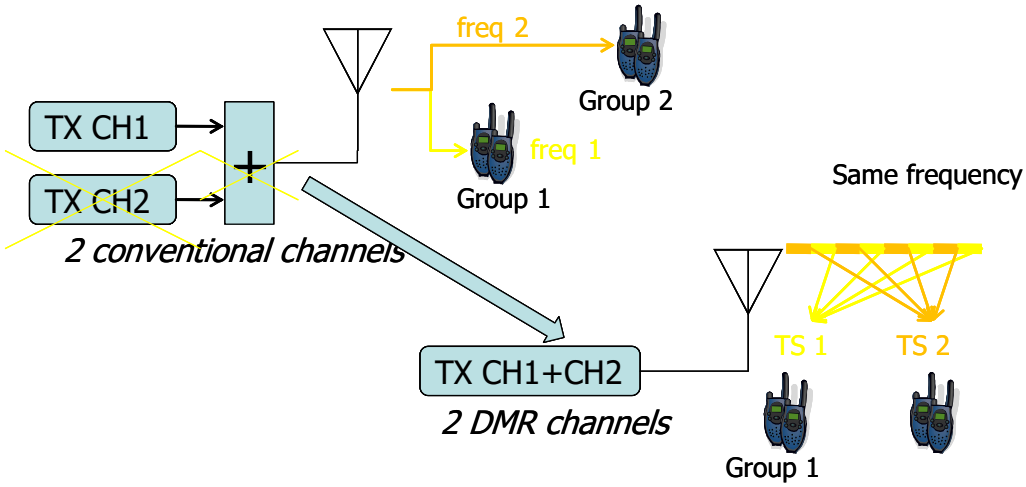


Audio/data channels are managed with two TDMA (Time Division Multiple Access) timeslots sharing the same radio 12.5 KHz wide channel. The two audio/data channel are perfectly separated and independent each from the other, as if they worked in a conventional mode on different frequency (carriers). The transmitter becomes active only during timeslots belonging to their working channel.

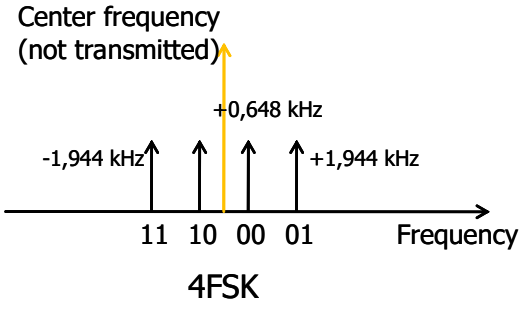




DMR system can live together with conventional analogical systems on adjacent channels without any performance degradation for both ones. DMR system has a spectral efficiency of 1CH/6.25KHz, the same as TETRA and double in comparison with conventional systems. Only one radio head (only one transmitter) gives 2 CH without the need of RF coupling systems, with the effect of lower costs and consumptions and greater available power. Furthermore, DMR system allows the direct communications between terminals. In this case only one channel per 12.KHz will be available because the synchronization is missing, made by repeater/network.



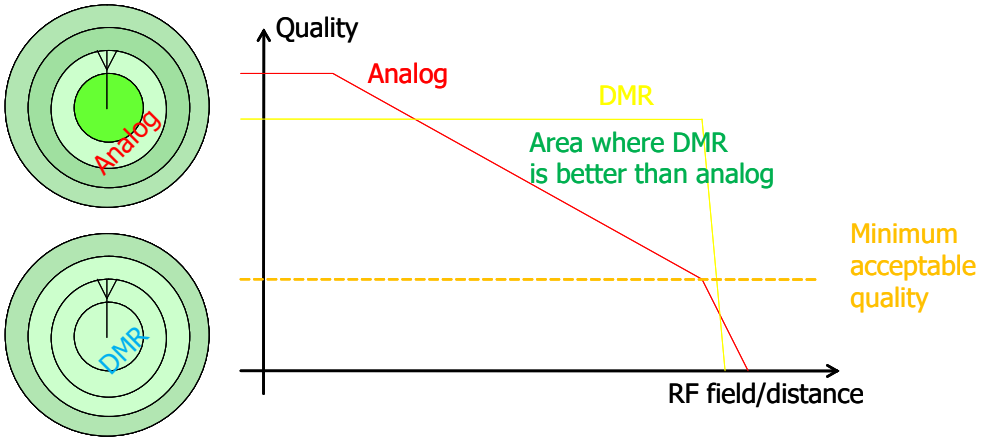
The implemented modulation is 4FSK type (Four-level Shift Keying), optimal for use with PMR communications. Information bits are transmitted by couples, each couple is assigned to a frequency shift



The modulation is constant envelope frequency type, I contrast with TETRA. This imply great advantages in terms of energy consumption: transmitters are very similar to their classic analogical version, expensive linearization is not required, they can work in saturation mode (C class or superior) with energy saving and consumption compatible with solar panels systems. The modulator must have a flat frequency response between 0 and 5 KHz.

Transmitted RF power level by a DMR systems is the same as the one of a traditional analogical system (constant envelop).

The sensitivity of a DMR receiver is about the same as the one of a traditional analogical system, but the audio quality remain constant up to the sensitivity limit and the coverage is slightly bigger than 12.5 KHz analogical systems.



DMR terminals can work in “open channel” mode like traditional systems for emergencies, but individual calls and group calls are available: obviously selective callings are addressed in a digital format between DMR equipments. Network access of DMR terminals is regulated by a “colour code” which replaces sub-tone sub-audio tone.

RADIO ACTIVITY DMR REPEATER AND EXPANDIBILITY 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 iso-frequency multi-site system, with different type of links, operating with different transportation system topology, like microwave, UHF, fiber optics, generic TCP/IP connections.

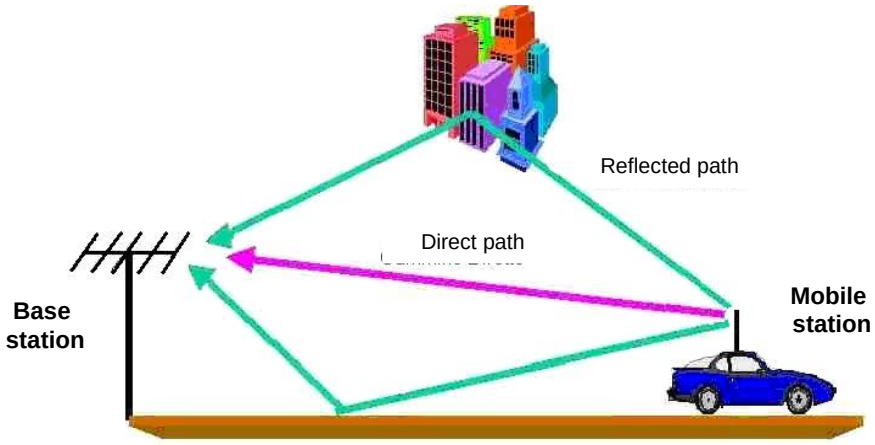
Privileged communication interface is ethernet standard type, maximally compatible with more diffused technology. This interface supports not only voice and data digital traffic, but also remote control management, which for Radio Activity equipment is very powerful: it is possible to have a complete 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.

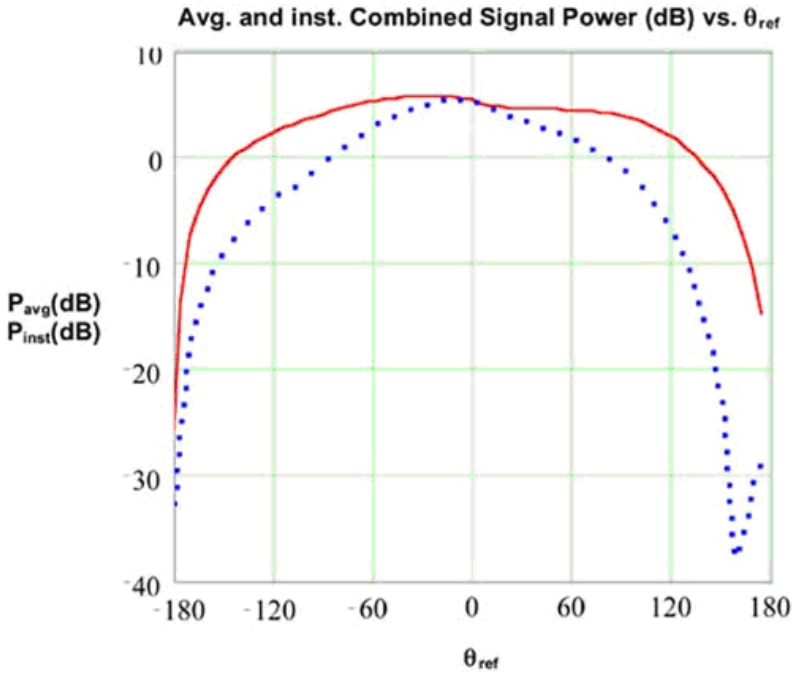
Fully modular structure allows to best configure the radio equipment, by adding and/or changing the required HW and SW functional blocks, to work as simple repeater, multi-frequency multi-site repeater, iso-frequency multi-site repeater.

Diversity space reception

One of the biggest problems that could arise when receiving digital signals is caused by “multipath fading”: in complex environments between transmitting and receiving antenna of a communication equipment more paths can established for the signal, one direct and one or more reflected, each of them with a different amplitude and delay, that generally are time varying, especially with mobile systems.



Coming from different paths signals sum together with different phases and amplitudes, not predictable in a deterministic way. If reflected paths has a delay equal to half a wavelength (180° signal phase difference) the sum of direct and reflected signals will be affected by disruptive interference and received signal can suffer from a very strong attenuation. Also a carrier cancellation can happen. Following figure shows average and instantaneous power, as measured at receiver input, under multipath fading effect. The result, even if dealing with a particular realization, however shows a generally valid concept.



This phenomenon acquires increasing importance with decreasing of the received field that is while approaching the edge of radio coverage. Although this is also for analogical communications, the phenomenon is much more significant with digital communications: in the first case in fact nulls of fields worsen the signal quality, but the content often remains intelligible; in the second case instead a BER increasing can cause the total loss of information.

The solution for this problem is fairly simple, effective and very diffused in digital communication world (GSM, GPRS, TETRA, WiMAX, …), especially for microwave. It is sufficient to realize a space diversity receiving system, with 2 coherent independent receivers, connected to two different antennas. The probability to have contemporary fading effects on both the antennas is very low if the antennas are far enough one from the other (typically al least 2 wavelength) to let the signals be considered not correlated. By summing in phase received fields on the two antennas it is possible in case of fading over an antenna to have a good signal over the other one and to obtain a continuous and stable data flux at demodulation output.

Qualifying aspects of DMR system

In synthesis DMR digital simulcast system has the following feature:

- *Doubling of communications on the same radio channel:* maintaining the same ministerial concession for the use of the 12.5 KHz wide radio channel, DMR technology allows to double voice/data traffic. Twice the service with the same cost.
- *Total reuse of existing infrastructure:* the transition from analogical to digital DMR technology does not require any search for new and additional broadcasting sites to preserve the existing service coverage areas. Radio-electrical efficiency of the two technologies is substantially equivalent; it is indeed possible to improve communications at the field boundaries by equipping the stations with additional receivers to perform diversity reception. Furthermore, to not need new sites means that it is possible to reuse existing power supply systems, the same antennas and the same filters systems as the ones used for analogical stations.
- *Multi-protocol*: the network is automatically and real time able to discriminate, manage and process both analogical and digital signals on the same radio-mobile channel. Multi-protocol functionality allows to manage an equipments fleet made of both analogical and digital DMR transceiver and to support advanced services for data transmission, like GPS localization, AVL applications, SMS and files exchange, …
- *Flexible voice/data management in digital mode*: radio resource is optimized because it is shared by voice services and data services; digital voice communications can be performed without any interruption of GPS positioning updating service and with the ability of alarms signalling transit (thanks to the presence of two timeslots)
- *Audio band optimization*: the full audio bandwidth is available to carry information about the signal to be broadcast on territory
- *Data transmission reliability*: the reliability is guaranteed by strength of transmission protocol which provides a set of algorithms and techniques for the maximum guarantee of error free data delivery
- *Upgradability:* thanks to advanced and quality modular technology, future introductions of technological innovations will make initial investments safe and will optimize maintenance operations which can be best programmable.

- *Insensitivity to components aging*: given that DMR base stations are fully digital, every parameters of both transmission and reception are analytically and automatically obtained during self-calibration process of the equipment. This imply a lower maintenance cost because modules do not require regular manual tuning.
- *Fleet dynamic management*: users can be singularly or by groups addressed
- *Automatic hand-over*: mobile units can move inside the operative area preserving communication continuity during the transition between coverage areas of two different repeaters stations and keeping the same radio channel; the call is immediately and contextually delivered to targets, although covered by different repeaters.
- *"Direct mode" functionality*: for short distance calls, or outside network coverage, terminal equipments (portable and/or vehicular) can communicate with each other on a dedicated channel.
- *Configuration flexibility, expandability and extension*: complex network configurations can be realized which can fit the orography of the territory through installation of further base stations working on the same radio channel. Furthermore other broadcasting channels can be added to improve the radio traffic management.

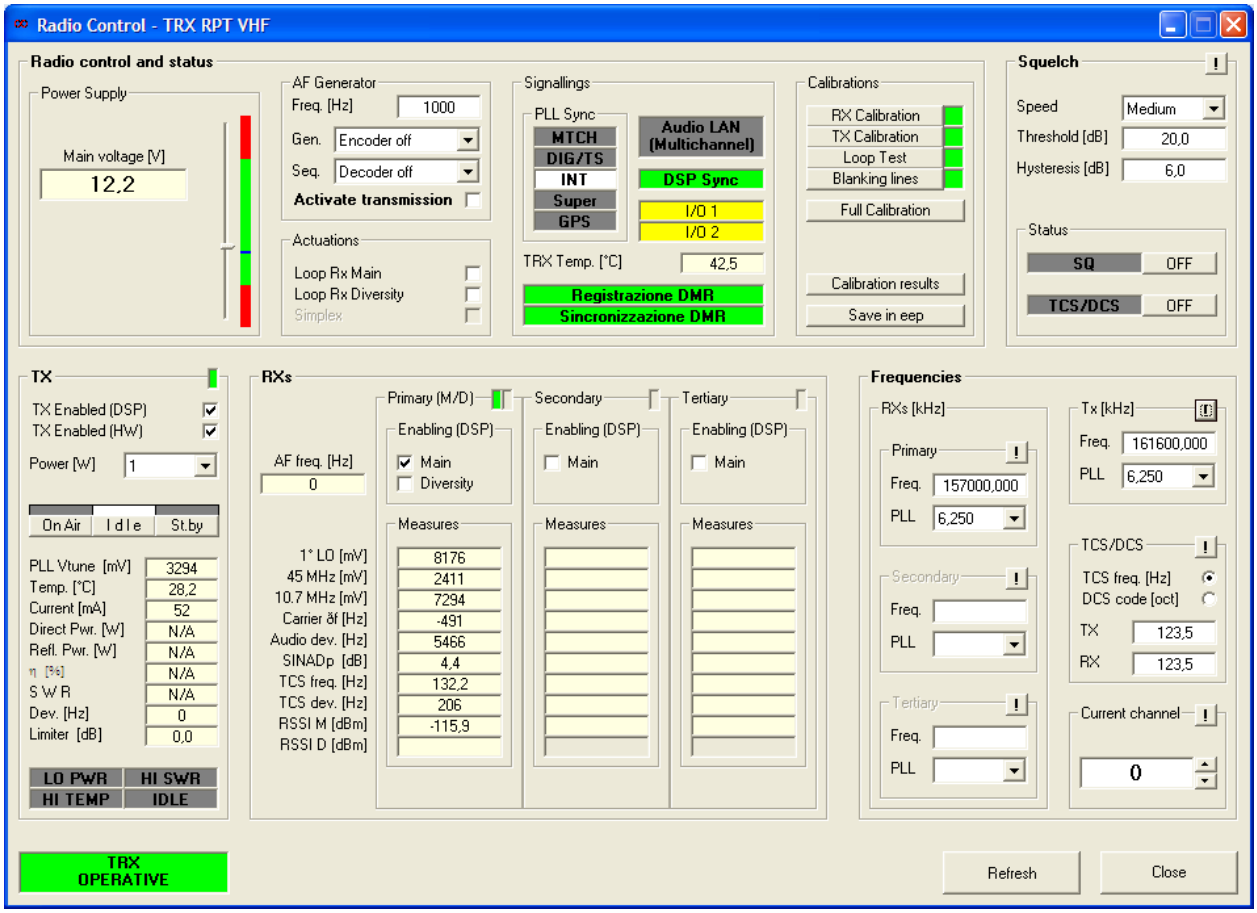
DMR radio base station transceivers must comply with ETSI EN300-086 & EN300-113 regulations and with the one about Electromagnetic Compatibility and Safety, and they must have the following characteristics:

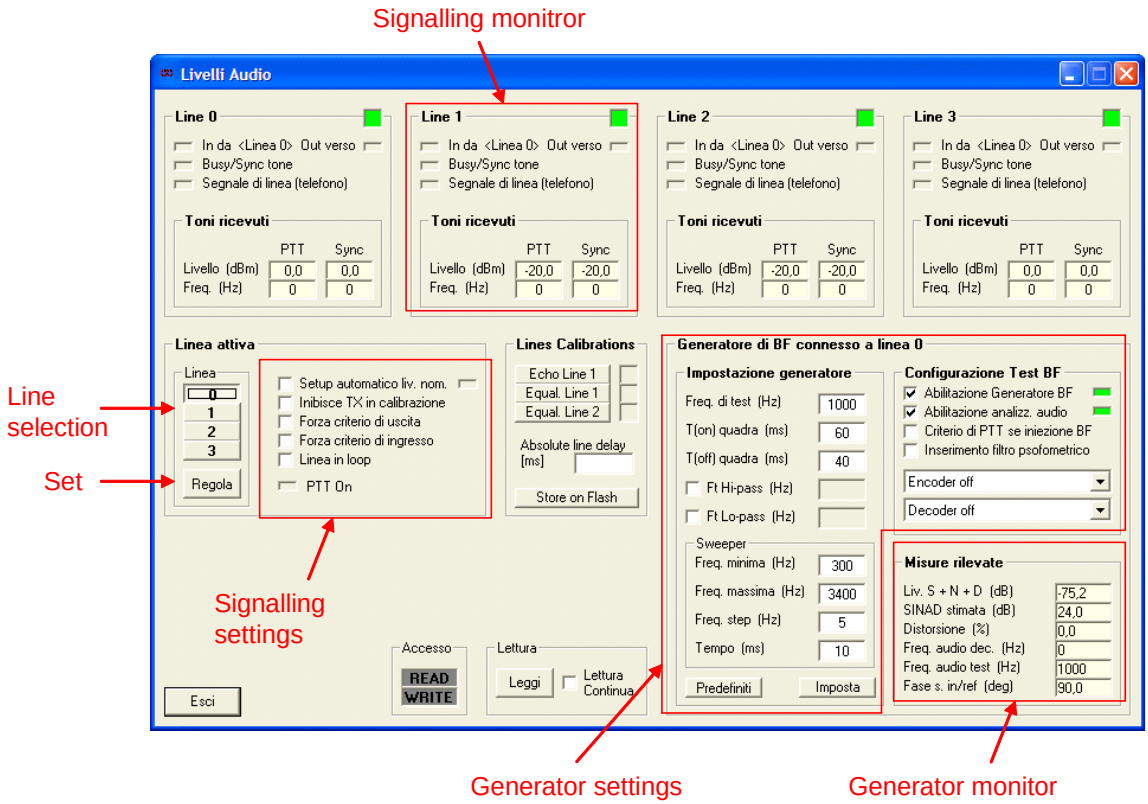
- *synchronization*: all Radio Base Stations can be fully synchronized by the same network reference
- *continuous voting*: best network signal to be broadcast is performed real time
- *Self-adaptive digital equalization*: in case of analogical mode, the system can automatically and without any operator implements necessary procedures and techniques, performed by DSP, to equalize the links interconnecting repeaters stations, regardless of the used link type. Adaptive self-equalization can automatically and real time practically correct any changes in transmission characteristics of carrier in use. In case of digital mode, the system can generate coherent and temporally aligned modulation signals
- *reconfiguration in case of failure*: in case of failure or interruption of connection between radio stations, the station can automatically switch into simple repeater to support local traffic

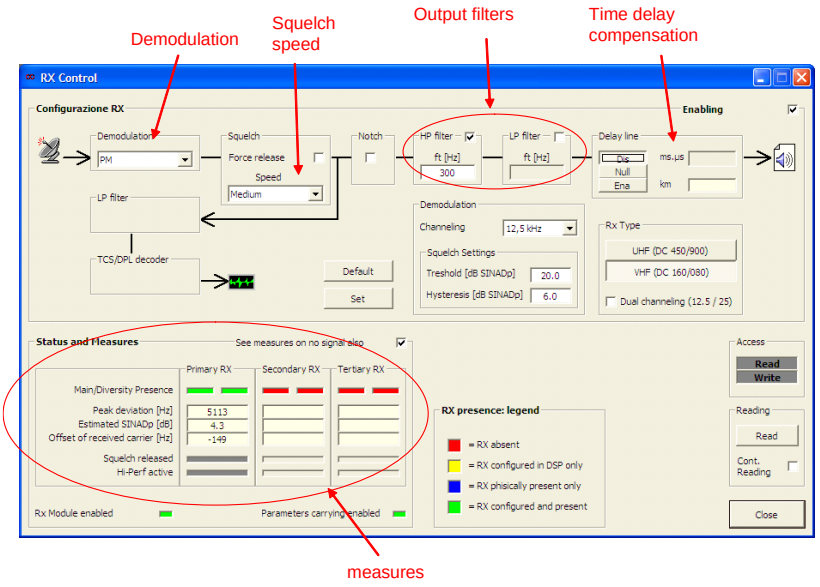
PARAMETERS CONFIGURATION AND REMOTE CONTROL

Working parameter of the station are completely programmable through a SW package and a PC connection. The visible (and programmable) parameters set is very wide and extends from radio channel setting to tuning voltage measure of each local oscillator.

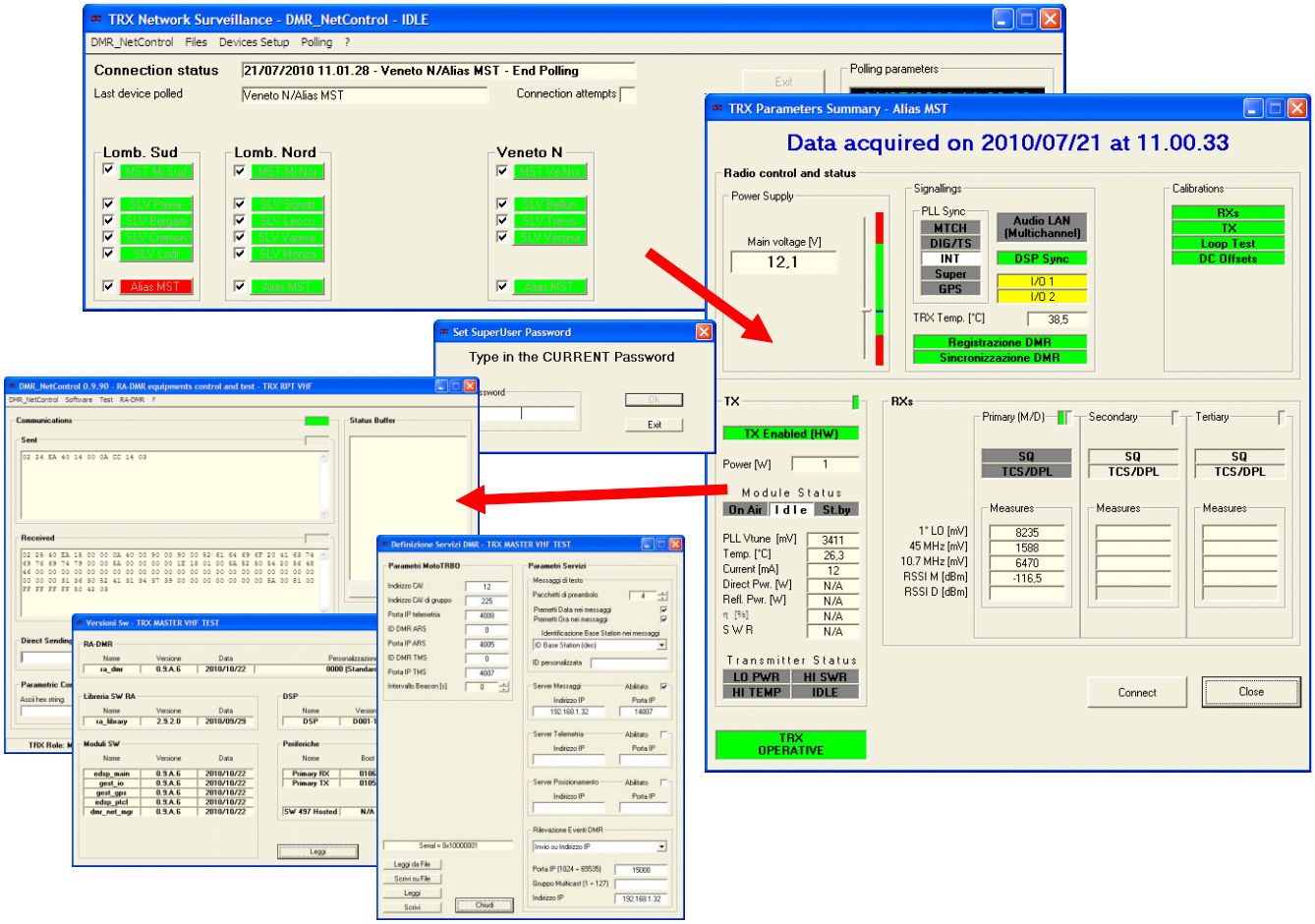
Here following some exampling mask are shown.


Radio Control - TRX RPT VHF
Radio control and status
Power Supply
Main voltage [V]
12,2
AF Generator
Freq. [Hz]
1000
Gen.
Encoder off
Seq.
Decoder off
Activate transmission
Actuations
Loop Rx Main
Loop Rx Diversity
Simplex
Signallings
PLL Sync
MTCH
DIG/TS
INT
Super
GPS
Audio LAN (Multichannel)
DSP Sync
I/O 1
I/O 2
TRX Temp. [°C]
42,5
Registrazione DMR
Sincronizzazione DMR
Calibrations
RX Calibration
TX Calibration
Loop Test
Blanking lines
Full Calibration
Calibration results
Save in eep
Squelch
Speed
Medium
Threshold [dB]
20,0
Hysteresis [dB]
6,0
Status
SQ
OFF
TCS/DCS
OFF
TX
TX Enabled (DSP)
TX Enabled (HW)
Power [W]
1
On Air
Idle
St.by
PLL Vtune [mV]
3294
Temp. [°C]
28,2
Current [mA]
52
Direct Pwr. [W]
N/A
Refl. Pwr. [W]
N/A
η [%]
N/A
S W R
N/A
Dev. [Hz]
0
Limiter [dB]
0,0
LO PWR
HI SWR
HI TEMP
IDLE
RXs
AF freq. [Hz]
0
Primary (M/D)
Secondary
Tertiary
Enabling (DSP)
Main
Diversity
Measures
1° LO [mV]
45 MHz [mV]
10.7 MHz [mV]
Carrier δf [Hz]
Audio dev. [Hz]
SINADp [dB]
TCS freq. [Hz]
TCS dev. [Hz]
RSSI M [dBm]
RSSI D [dBm]
8176
2411
7294
-491
5466
4,4
132,2
206
-115,9
Frequencies
RXs [kHz]
Primary
Freq.
157000,000
PLL
6,250
Secondary
Tertiary
Tx [kHz]
Freq.
161600,000
PLL
6,250
TCS/DCS
TCS freq. [Hz]
DCS code [oct]
TX
123,5
RX
123,5
Current channel
0
TRX OPERATIVE
Refresh
Close

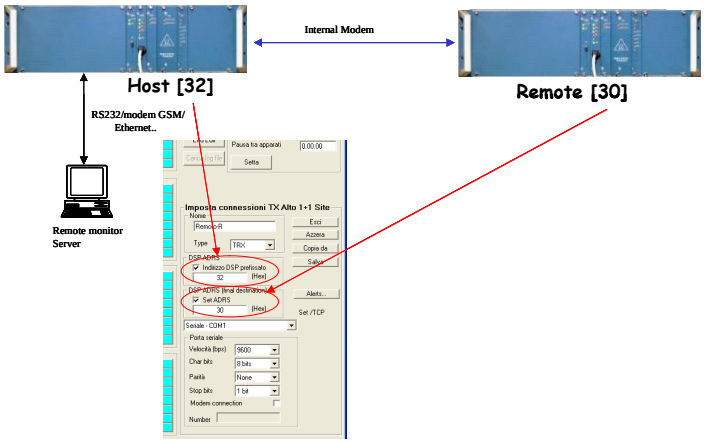

Signalling monitror
Livelli Audio
Line 0
Line 1
Line 2
Line 3
In da <Linea 0> Out verso
Busy/Sync tone
Segnale di linea (telefono)
Toni ricevuti
PTT
Sync
Livello (dBm)
Freq. (Hz)
Linea attiva
Linea
0
1
2
3
Regola
Setup automatico liv. nom.
Inibisce TX in calibrazione
Forza criterio di uscita
Forza criterio di ingresso
Linea in loop
PTT On
Lines Calibrations
Echo Line 1
Equal. Line 1
Equal. Line 2
Absolute line delay [ms]
Store on Flash
Generatore di BF connesso a linea 0
Impostazione generatore
Freq. di test (Hz)
1000
T(on) quadra (ms)
60
T(off) quadra (ms)
40
Ft Hi-pass (Hz)
Ft Lo-pass (Hz)
Sweeper
Freq. minima (Hz)
300
Freq. massima (Hz)
3400
Freq. step (Hz)
5
Tempo (ms)
10
Predefiniti
Imposta
Configurazione Test BF
Abilitazione Generatore BF
Abilitazione analizz. audio
Criterio di PTT se iniezione BF
Inserimento filtro psofometrico
Encoder off
Decoder off
Misure rilevate
Liv. S + N + D (dB)
-75,2
SINAD stimata (dB)
24,0
Distorsione [%]
0,0
Freq. audio dec. (Hz)
0
Freq. audio test (Hz)
1000
Fase s. in/ref (deg)
90,0
Accesso
READ
WRITE
Lettura
Leggi
Lettura Continua
Esci
Line selection
Set
Signalling settings
Generator settings
Generator monitor



Remote diagnostic from PC towards radio stations can be performed through station Ethernet line remote. This interface is absolutely standard and much diffused, so relatively simple to be remoted. Radio Activity stations can be equipped with an embedded GSM modem which will provide remote access to the station, provided service coverage. From remote each operation can be performed, exactly the same as in local connection, including FW down-loading, configuration Down-loading and up-loading, station check, parameters changing.



Remote equipment can be monitored by PC via radio channel also, by enabling the internal embedded modem, realized in DSP technology, provided the targeted equipment is reachable through radio link from a similar equipment, which is in turn connected through Ethernet to the PC. The connection between PC and remote equipment can be implemented according to the following scheme:

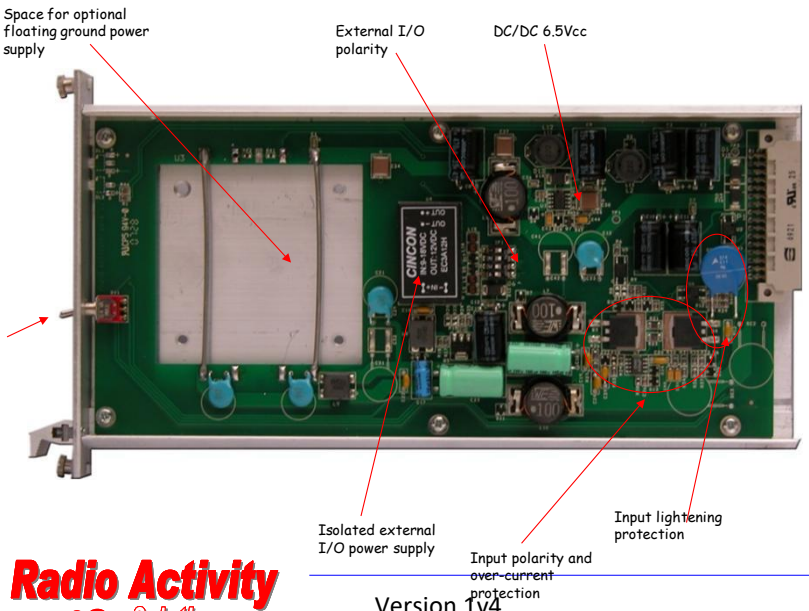


Communication and supervision unit spontaneously transmits a diagnostic message if “self-alarming” defined events happen.

If required by Control Centre, working parameters of RBS are sent to Supervisor Server for events collection and analysis.

STATION MAKEUP

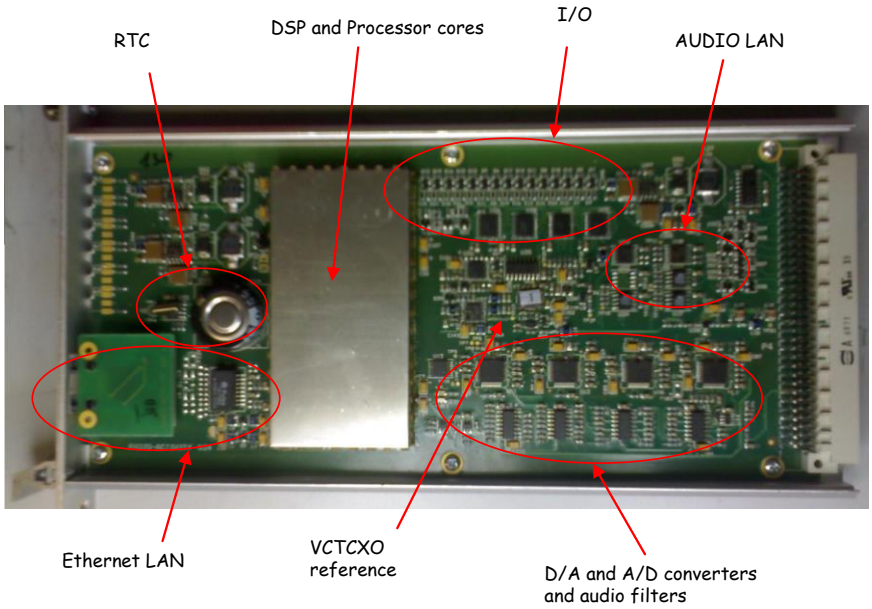
PSU: POWER SUPPLY UNIT MODULE



Equipment is power supplied by nominal 13,8Vdc from battery with negative shorted to ground and with a maximum current absorption of 5 A. In case of other power supply sources, other PSU models are available, DC/DC (nominal 12-24-48V, isolated) or AC/DC (nominal 220V) with battery charger.

D.S.P.

The core of system “physical layer” is this unit which via software performs every function of signal processing into radio station. What other equipments implement by adding boards (like synchronizers, phase and amplitude equalizers, signal decoders, modem, etc.), here are implemented by routines which can be freely matched, down-loaded and with superior performance.



This board can process up to 8 analogical duplex signals ensuring 70 dB of SNR; it can manage 16 logical signals which can be configured both as input and output.

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 fiber optic 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:

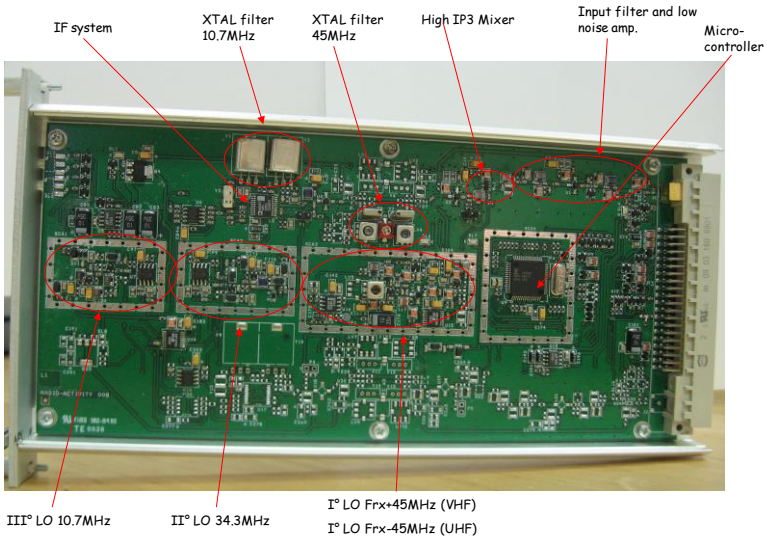
- Frequency self-tuning device
- Deviation self-calibration device
- Analogical and digital demodulation
- RF circuits testing
- Phase modulator calibration
- RF output power control
- Low frequency lines management
- DMR protocols management
- Digital signals processing
- Management, conditioning and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

RECEIVER

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 a triple conversion heterodyne structure, with 45 MHz and 10.7 MHz intermediate frequencies and 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 (with double funnel option) for special applications.

Vectorial receiver gives to the DSP input the electromagnetic field vector, as received from antennas, without performing any demodulation. By this way the DSP can sum with the appropriate phases the received signals to obtain a "soft diversity" reception. This corresponds to an electronic antennas alignment in order to receive the maximum available information along the incoming signal direction.



A further input (TX Test input), common for both receivers (main and diversity) is available, for the receiver self-test and for modulator calibration. Through a DSP command, the receiver can switch its input onto test signal generated inside transmission synthesizer module. That signal, amplitude calibrated by Factory, is modulated at receiving frequency and received by DSP. A fundamental test loop is close by this way.

The switching between normal and test input is implemented through PIN diodes.

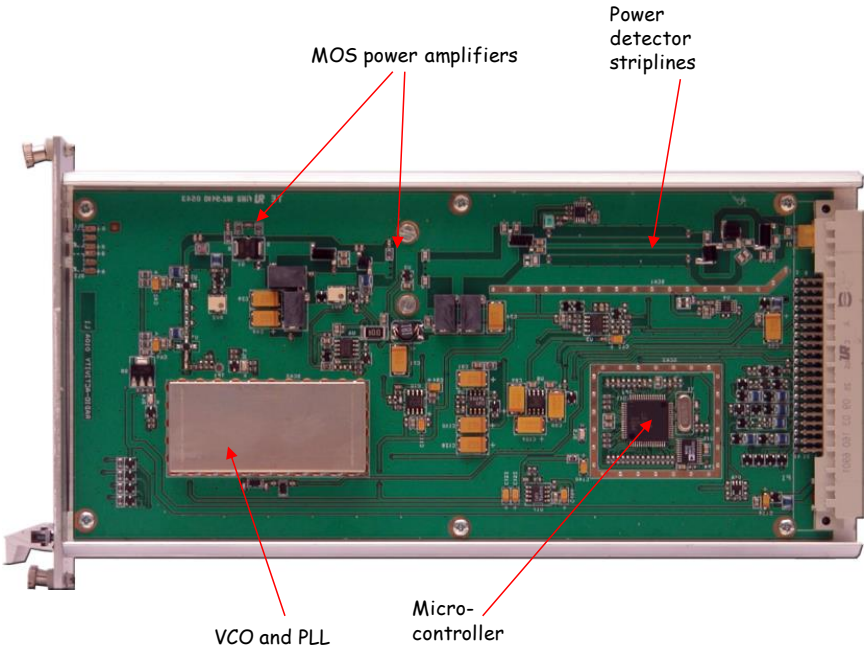
Receiver modules is managed by a microcontroller unit whose program is hosted inside internal e2prom flash memory to lower parasitic emissions. This FW can be loaded through serial connection. The microcontroller, in addition to managing internal function of the unit, transfers measured parameters to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

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

Modular unit is housed in a shielded, 4TE high box for 220mm Eurocards. On the frontal panel 2 LEDs are placed for monitoring internal PLLs lock status.

TRANSMITTER

Transmitter module is realized with surface mounting components (SMD) and it is housed in a shielded, 8TE box for 220mm Eurocards, with a 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 vectorial, 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 gates voltages of MOSFET amplifier 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 an eventual efficiency degradation.

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

I/O AND SERVICES MODULE

I/O and Services module is a unit integrating different interfaces and functions that for some applications can be optional but for others become essential. For this reason the module can be differently equipped with its different logical blocks, according to the particular application. The embedded block are the following:

- *Telephone line interface*: 2/4W+E&M line interface to remote analogical audio and perform automatic routing through telephonic line
- *Opto-isolated I/O*: 2 input + 2 output contacts programmable (both N.O. or N.C.) for remote monitoring local sensors and remote controlling local actuators
- *Opto-isolated alarms*: two alarms output (1 warning + 1 fatal)
- *Analogical input*: 2 not isolated inputs, 1 for voltage sensing (0..20V referred to ground) + 1 for current sensing (4…20mA). These input can be connected the first in parallel and the latter in series with the analogous ones of other similar equipments
- *GSM/GPRS modem*: embedded communication module for remote control if the site is covered by GSM or GPRS service. It requires only an external passive antenna
- *GPS receiver*: embedded receiver for GPS service, with high precision Pulse Per Second (PPS) output function in order to synchronize the station. Only an external active antenna is required
- *RS232 converter*: 115.2Kbit/s serial interface for remote control

I/O and services module is equipped with 8 LEDs on the frontal panel to monitor the status of opto-isolated I/O, the status of GPRS modem and the presence of PPS.

Modular unit is housed in a shielded, 4TE high box for 220mm Eurocards.

TECHNICAL DATA

REGULATIONS COMPLIANCE

Equipments are compliant with existing regulations, in particular:

1. ***EN 300 086-2***: Technical characteristics and test conditions for radio equipment for analogue speech.
2. ***EN 300 113-2***: Technical characteristics and test conditions for non-speech radio equipment for the transmission of data.
3. ***ETSI TS 102361***: Electromagnetic compatibility and Radio spectrum Matters (ERM); Digital Mobile Radio (DMR) Systems.

The equipment is able to manage OSI stack layers 1 – 2 – 3 of DMR protocol, making active interaction possible with mobile terminals.

GENERAL CHARACTERISTICS

Channel spacing	12.5 KHz (25KHz optional for special purpose)
Maximum channels number	200
Operating mode	Multi-protocol, analogue and digital
Operating mode selection	Totally automatic
Frequency stability	+/- 0.5 ppm
I/O	4 opto-isolated OUT (2 alarms + 2 generic) 4 IN (2 digital opto-isolated + 2 analogical referred to ground)
Voice/data digital interface	LAN 10/100 copper or fiber optic
Analogical audio interface	2/4W + E/M (BCA-C/U optional)
Base Bandwidth	Audio 300-3400 Hz ±1dB Modulation 0-5 KHz
Calibration and tests	Automatic at start-up and/or by remote control
Remote control	Via ethernet / serial RS232 / GPRS

ENVIRONMENTAL CONDITIONS

Operating temperature	-25 / +55° C
Stocking temperature	-40 / +70° C

POWER SUPPLY

Power supply of equipment is nominal 13.8Vdc with negative connected to ground, with maximum current consumption of 5A. If required, different power supply units are available, DC/DC (nominal 12-24-48V, isolated) or AC/DC (nominal 220V) with battery charger.

The station will automatically disconnect from battery if the input voltage decreases under the minimum threshold (10.8V) to avoid permanent damage. Protection against overvoltage (16V) and short circuits are implemented also.

Nominal voltage	13,8 Vcc (neg. to ground)	24Vcc (float)	48Vcc (float)
Minimum voltage	11 V	19 V	38 V
Maximum voltage	15,5 V	29 V	58 V
Maximum admitted ripple	30 mVpp	30 mVpp	30 mVpp
Over-voltage protection	30 V	30 V	60 V
Low battery voltage power off	10,8 V	19 V	38 V
Protection against polarity reversal	-48 V		
Protection against short circuits	Electronic protection with automatic restoration and bipolar input fuse		
Power supply in TX	<75 W @25W RF		
Power supply in Rx	<8 W		
Power supply in standby	<50 mW		

MECHANICAL DIMENSIONS

Rack dimensions	128 x 426 x 280 mm
Rack dimensions (telephone unit)	19” x 84 TE x 280 mm
Single transceiver	½ Rack 19”
Weight including duplexer	6Kg

TRANSMITTER CHARACTERISTICS

Power supply voltage	+6.5V and +13V DC
Power supply in TX	4,5 A @25W
Power supply in stand-by	80 mA @6.5V / 15mA @13V
Power supply in power-down	< 10 mA
Operating class	C
RF power regulation steps	1/5/10/15/20/25 W @50 Ohm
Frequency stability	+/- 0.5ppm
Thermal protection threshold	85°C +/- 5°C with progressive power reduction and automatic restoration
Modulation	FM, PM, GFSK, 4FSK
Modulation bandwidth	0..5000 Hz (audio 300 .. 3400 Hz)
Available bands	145-174 MHz 407-470 MHz (according to the RSS 119/SRSP-501, only 406.1-430 and 450-470Mhz are available)
Synthesis step	2.5;5;6,25 KHz
Duty cycle	Up to 100%
ROS protection	10’ min. with open or shorted load
Adjacent channel power	-77 dBc @25KHz -70 dBc @12.5KHz
Intermodulation	-70 dBc (with external circulator)
Parasitic emissions	<-36 dBm
FM distortion	< 1.5 %
SNR	53 dBp @25KHz 47 dBp @12.5KHz

RECEIVER CHARACTERISTICS

Following characteristics refer to a single receiver of the RX module.

Power supply voltage	+6.5 e +13,8V DC
Power supply	150 mA (ogni RX)
Power supply in Power-down	< 10 mA
Reception mode	Vectorial I and Q
Receiver type	heterodyne with 3 conversions
Configuration	Single or double coherent (space diversity reception)
Input impedance	50 Ohm
Maximum available sensitivity (analogical)	-113 dBm @20 dBp SINAD -120 dBm @12 dBp SINAD (with voice search option)
Maximum available sensitivity (digital)	5% BER: 0.3uV
Maximum input level (operating)	0 dBm
Maximum input level (without permanent damage)	+20 dBm
Frequency stability	+/- 0.5ppm
Modulation bandwidth	DC..5000 Hz (audio 300..3400 Hz +/- 1 dB)
Demodulation mode	FM, PM, GMSK,4FSK, AM, USB, LSB
Synthesis step	2.5;5;6,25 KHz
Co-channel rejection	8 dB @25 KHz 12 dB @12.5KHz
Adjacent channel selectivity	73 dB @25 KHz 62 dB @12.5 KHz
Parasitic response	80 dB
Intermodulation	75 dB
Third order input intercept point IP3in	+15 dBm
Squelch level (analogical)	20 dBp SINAD (programmable)
Parasitic emissions	-70 dBm
PM distortion	<3 %
SSB distortion	<3 %
SNR	53 dBp @25 KHz 47 dBp @12.5 KHz