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ELBER

MICROWAVE RADIO LINKS

Your Broadcasting partner

Millecanali

ENGLISH

High Capacity
Signal Transport

The highly reconfigurable digital modem, DDM310, offers the best of what is available on the market regarding flexibility and performance. The DDM310, equipped with various input/output data interfaces (DVB-ASI, STM-1, G.703,..), can tolerate heavy selective fading distortions.

Modulation schemes available are QPSK, 16/32/64/128/256 QAM; important to underline that the modulator and the demodulator sections can be configured with different modulations schemes hence data rate can be different between forward and return path.

These features make the DDM310 ideal for the transport of signals both in broadcast and telecom applications. Thanks to the high bit-rate (up to 310Mbit/s), the DDM310 is ideal for the transport of High Definition signals.

Similarly powerful is the digital system RK210, which Elber has developed in order to offer a flexible solution for the transport of different data streams over the same microwave link.

The RK210 is geared with different plug-in boards:
transparent multiplexing/de multiplexing of DVB-ASI signals; network adaptors from SDH/PDH G.703 to an ASI signal and vice versa; and for redundancy microwave radio links, the HS210 plug-in board makes the RK210 a high performance system.

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Here is the story of a company that always has used the most advanced technology and an excellent technical support as basic elements of its own philosophy.

ELBER
MICROWAVE RADIO LINKS

the client first

by **Antonio Franco**

The market of the Italian companies manufacturing transmitting devices has always been very crowded, especially when compared to other scenarios, not only at a European level but also worldwide.

This particular "phenomenon" has certainly been facilitated by a lack legislation, that, together with the entrepreneurship and the typical Italian fantasy, has led to a proliferation of television and radio broadcasters, with an unimaginable density, unique in the world.

This situation has allowed many to gain experience, to experiment and to build companies that otherwise would have been difficult to realize, especially considering the high level in terms of technological development. It is not a coincidence that today the Italian companies are world leaders in this sector and that, during the past years, they have also targeted the high level market, which in some way had already been achieved by Itelco.

Between the numerous companies that developed a proper activity in this particular and propitious climate, Elber has certainly distinguished itself not only in commercial terms, but also for the high technological level of its production, offering an incomparable client support.

And – if a personal recollection is consented – I can testify all this directly, not only as a journalist but also as a personal client of Elber, referring to the dawning of the private broadcasters in Italy.

CONTENT

The "personality" Mario Bernardi

But let's start from the beginning.

In the mid 70s, with the increase of activities that characterized the radio and television sector, Mario Bernardi was one of the first to setup small transmitting sites on Liguria's heights, close to the French border, to re-transmit foreign channels. Gaining a remarkable experience in the reception and transmission of RF signals, in 1978, Mario Bernardi together with Engineer Vittorio Lagomarsino started to develop and produce microwave radio links to facilitate the task of the television broadcasters that needed to transfer the signal to various repeater stations.

There was a lot of confusion in these times, where often signals received in band IV and V were repeated on out of range frequencies (maximum between 1,8 and 2,5 GHz). To avoid such problems, Mario Bernardi has thought to use the 10 and 14 GHz frequency range. Not only; he also understood that the lack of knowledge regarding the prob-

▶ *A historical company that continuously grows.* **A photo of some years ago of Mario Bernardi, founder of Elber, today led by his son Edoardo and daughter Donatella.**

lems of radio and television networks was also linked to the correct design of such networks and to the installation of the equipment. He concluded then that the quality of technical support is fundamental to obtain the client satisfaction, more than for the achievement of success on the Elber product's market. For this reason, almost all links sold during the first years were installed directly by Mario Bernardi himself. This is a proof ot the above mentioned technical support. Mario Bernardi not only installed and tested the correct functioning of the equipment but he "transmitted" his know-how to the technicians of the broadcaster. And what about his unimaginable solutions: right after a rare failure, maybe due to a swing in the supply voltage or due to lightning, was communicated to Elber; only few minutes were required for immediate intervention to solve the problem, in case no immediate solution was found, a replacement equipment was instantly sent to the client to limit the down time to a minimum.

All this completely for free, as Mario said "Elber links have a life long guarantee". Afterwards the equipment was repaired, but in the meantime the broadcasters (in those times many small companies did not have any back-up equipment) could continue broadcasting for their proper viewers.

This has been a precise choice, putting the client's real needs first defining the company's philosophy. It has also been a totally new way of working, that at a distance of few years has brought Elber to acquire a remarkable share of the Italian and worldwide market. Amongst the Italian clients Tele-Montecarlo (now La7), MTV, Rete A, Elefante TV, Odeon TV, ReteMia, Tvr Voxson, Canale Italia, La 8, La 9, Club Dab Italia, RTL 102.5 and many regional and local broadcasters.

In 1996 , contemporarily with Lagomarsino's decision to leave the company's board and to dedicate himself exclusively to the Research and Development Department, his shares where transferred tp Sitel. The following year, Carmelo Mallia, (one of the owners of Sitel) decided to leave Sitel and the shares in Elber where transferred to him directly.

An engagement that continues

Today Elber is led by Edoardo and Donatella Bernardi who run the activity with the philosophy developed by their father and to get bigger on the international market.

The commercialization can rely on representatives and clients in the five continents, with prestigious orders in USA, Australia and many European countries, Middle East, Africa , Asia etc.

We could also confirm ,without fear of disprove, that Elber's links are the Italian links most sold in the world. Often the Italian company is in direct competition with the main and giants brands in the world of broadcast, obtaining in many cases gratifying results.

Up to date the links sold all over the world are coming close to the ten thousand units.

The product range of Elber include portable links, wireless camera systems, microwave radio links for radio broadcasters and for television broadcasters. The traditional analogue link is today integrated with digital technology, using multi-carrier transmission, COFDM, and single carrier transmission, QPSK, 16QAM, 32QAM, 64QAM, 128QAM and 256QAM. Numerous accessories are available: Hitless switches, ASI switches, RF switches, DVB-ASI/G703 interfaces…. For detailed information about these products, refer to the following pages.

Over 20 years of experience and the care for details, together with the research for innovation are the characteristics that distinguish Elber. The company offers a wide range of products in continuous evolution: fixed and mobile radio links, DENG systems and FM links.

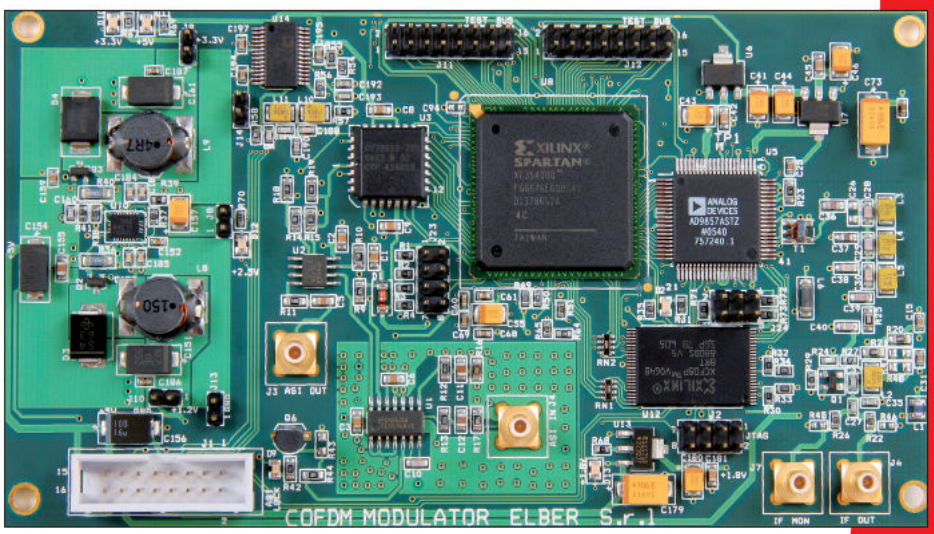
quality and reliability

1. RESEARCH & DEVELOPMENT

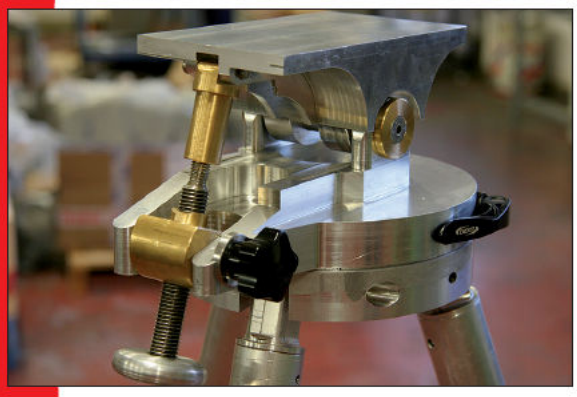
Over 20 years of experience, the care for details and the research for innovation are the keys for high quality and reliable products, characteristics that distinguish Elber on the worldwide market. The founding craft tradition in the production is maintained linked to the actual production philosophy of manufacturing all products completely within the company's premises.

This is possible thanks to the highly specialized Research and Development department (**fig. 1**), equipped with the latest simulation, testing and synthesis *software*; used in the product development's phases: from the design of PCB, RF circuits and mechanical parts, the firmware development for the *signal processing* on the most recent microcontrollers, DSP or FPGA, to the one for the equipment management.

The used components are chosen accordingly to the quality and the reliability of the manufacturer. An organized and well-supplied store allows a fast procurement of every type of device, from the basic discrete ones to the most complex IC's,



▼ ***Fig. 1*** - **Research & Development**



▲ *Fig. 2* - **Mechanical machine shop**

from PCB to mechanical modules. Most part of these modules are prepared by the mechanical workshop, allowing to have in short times all necessary pieces for the prototypes and all accessories for the fixed or mobile microwave radio links and for the *wireless camera*. Two CNC machines also manufacture filters, cavities, *diplexer*, circulators...

Equipped with an etching machine, all circuitry on PCBs both on FR4 and Teflon materials are produced in-house. Afterwards the components are then soldered by the assembly department's personnel, and subsequently passed back to the engineering department for testing and design check.

Elber pays a lot of attention to the laboratory because the calibration and the reliability of the products are very important. Specialized technicians work with the latest instruments: spectrum analyzers, oscilloscopes, vector network analyzers, video signal analysers, RF signal generators... The reliability of the instrumentation is guaranteed by the ISO 9001:2000 Certification and by a continuous equipment renewal.

▶ *Fig. 3* - **Middle East: King of Jordan's Palace**

Furthermore, the reliability of Elber's products in critical weather conditions. Temperature and humidity level, is assured by testing them in a climatic chamber. This allows Elber to sell its systems in all parts of the world: from the humid and rainy forests in central America to the deserts in the Middle East, from the cold Alps to the hot Maltese summers.

2. PRODUCT LINE

To satisfy the needs of the always growing number of clients and to be competitive in different applications, Elber has a wide range of products in continuous evolution. The products can be distinguished according to their application: fixed radio links, mobile radio links , DENG systems and FM links for radio broadcasters.

The **fixed microwave radio links** product line, also known as STL and TSL systems, have always been Elber's selling force. Superior performance, proven reliability and the simplicity of installation are the main characteristics of these products that bring Elber to the world leadership in this market segment

However, to respond to the constant evolutions of the market, it is necessary to develop equipment that require fast installation, have small dimensions and are highly reliable. Such characteristics are met by the **mobile radio links**, a sector where Elber has made many investments in the past years.

The latest challenge for Elber is the **DENG** market. Aware of the ever increasing need of portable and fast setup systems, Elber presents

a new highly technological range of products, maintaining the Company's idea of offering high performance equipment at competitive prices.

The R&D department offers an innovative and highly performing solution for **Radio Broadcasters**: apart from the renowned NBFM-01 microwave link, using an innovative digital signal processing of the modulated FM signal, Elber has developed new and alternative solutions for audio transport on digital networks. A new product line, called SRS, has been developed based on the Radio Software technology, obtaining excellent results and flexibility unique on the world market.

Fig. 4 gives a general view of the products offered by Elber for the transport of audio and video signals on large scale.

The scheme visualizes the 4 main categories, with particular attention to the key products of the Company.

For a television broadcaster it is extremely important to have equipment which is quick and easy to install, suited for mobile applications. This is the typical configuration for live transmissions for both news, and entertainment programs, where the use of a *wireless camera system* (WLCT-02) is ideal to guarantee portability and mobility. The video signal of the *wireless camera* is transmitted to the mobile site (OB-VAN) where a digital COFDM receiver and decoder (WLR-03) are installed. The DVB-ASI output signal from the receiver is subsequently transferred to the studio through a portable microwave radio link (CPM).

At the studios of the radio or television broadcasters, it is important to have a highly performing and reliable fixed microwave radio link, able to transport audio and video signals. Same characteristics are required for the receiving sites; that can receive and demodulate audio and video signals.

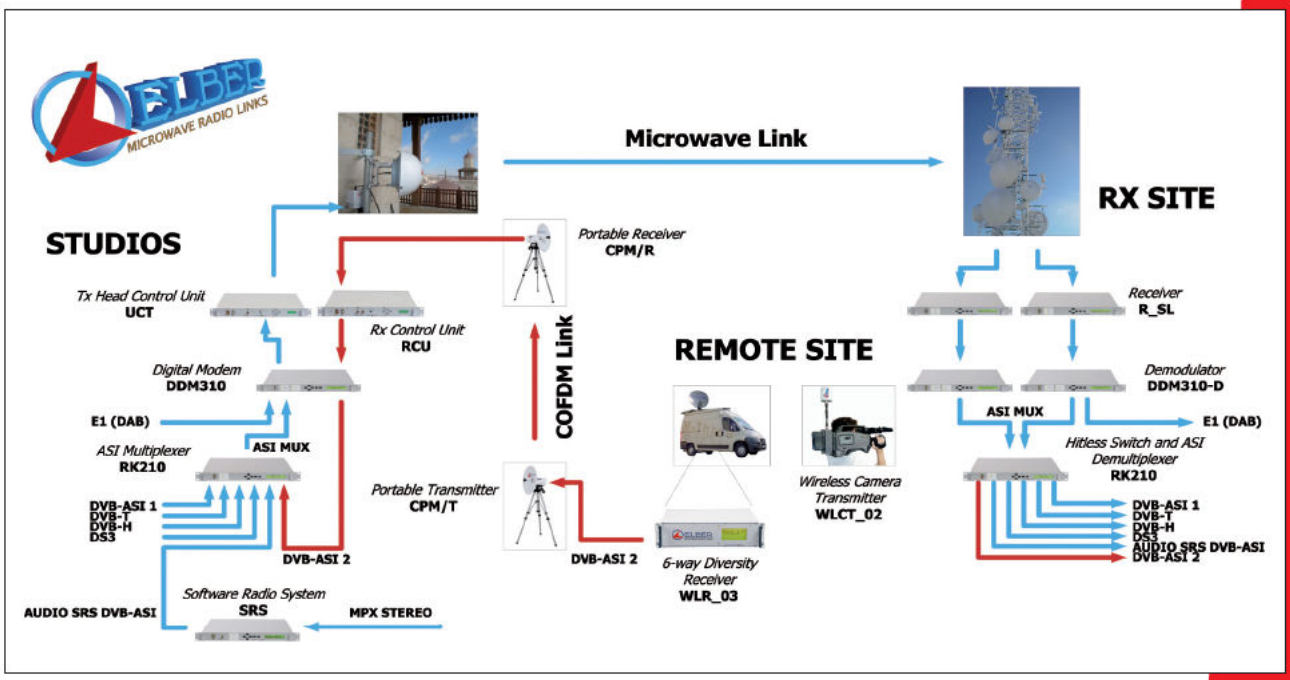
The studio applications vary from the transport of the DVB-ASI signal coming from a remote site, to the transport of a DVB-ASI signal generated by the *Software Radio System* (SRS)- able to process digitally and transport audio signals (MUX STEREO) on DVB-ASI streams. The multiplexed composite signal ASI-MUX is digitally modulated by the DDM310.

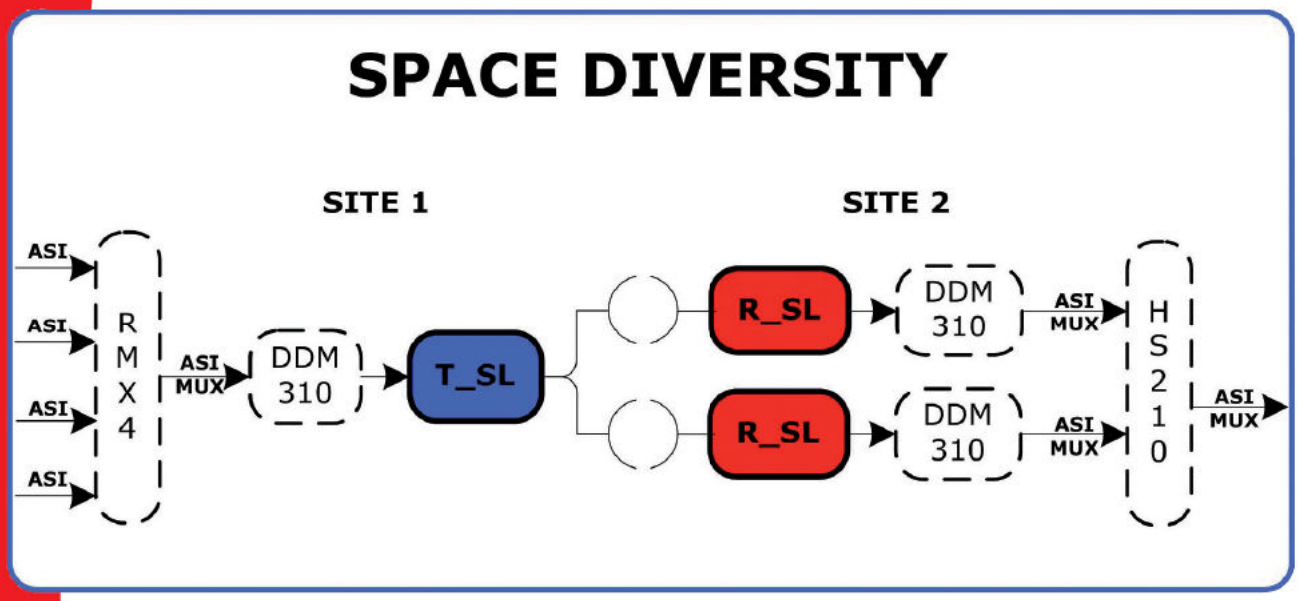
This highly reconfigurable modem contains adaptable modulation schemes based on the required *data rate* and on the level of robustness and protection, allowing an efficient band use.

The modulated signal is then transmitted (T_SL) on the desired frequency band. The output signal of the transmitter can be divided and sent to two separate antennas placed at different heights, to protect the system from *multipath fading* (*space diversity*, **fig. 5**).

The reception of both signals is independent but with the use of a *Hitless Switch*, the two composite

▼ *Fig. 4* - Elber's Products





▲ *Fig. 5* - **Space Diversity technique**

ASI-MUX streams are aligned and packet by packet, the error-free stream is sent to the output. The ASI demultiplexer separates and gives back the original signals.

2.1 STL Systems

This sector has always been the *core-business* of the Company. The RF transmitters and receivers are available in a modular version (TMC-R, **fig.6**), *indoor* and *outdoor*, and in a *Slim Line* version. Both can transport analogue and digital modulated signals.

The TMC transmitter is designed to convert the IF signal at 70 MHz to a microwave frequency in the RF range from 2 GHz to 15 GHz and amplify it to various power levels.

Conversely, the receiver, model R, converts the RF signal (from 2 GHz to 15 GHz) back to the IF 70 MHz frequency and amplifies it to the nominal output power.

Both models are 4U standard 19" racks and the modular boards increase the versatility and facilitates the maintenance and control.

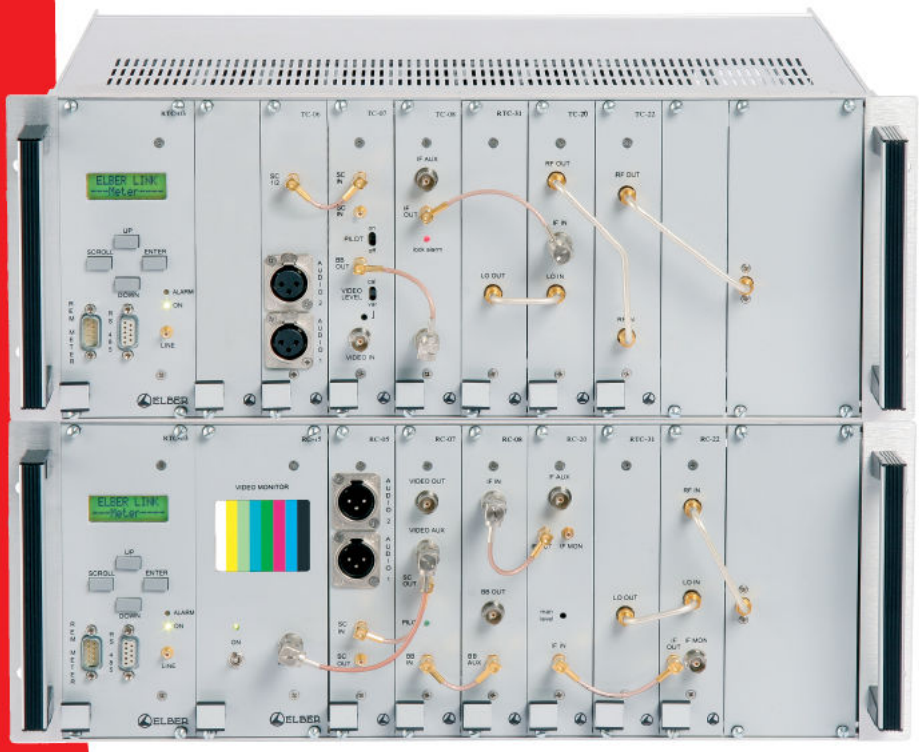
It is possible, for example, to insert an analogue modulator in the transmitter and/or an analogue demodulator in the receiver.

Thanks to the modularity of the system it is also possible to digitalize the configuration.

Inserting the corresponding modulator and demodulator modules in the transmitter and the receiver, this link can be configured to work either using QPSK or 16/32/64/128/256QAM digital modulation schemes.

The transmitter and receiver are also available in a *split* version (TMC/P e R/P), with external transmitting and receiving aerial heads. The modular control unit (AL/P - in 4U rack; AL/

▼ *Fig. 6* - **TMC-R**



▲ *Fig. 7* - T_SL

P-SL – in 1U rack), sends, through the connecting 75Ohm coaxial cable, the power supply for the aerial head, the IF signal at 70 MHz and all control and monitoring signals. The aerial heads are assembled in *waterproof* boxes, allowing the installation close to the antennas. The outdoor configuration reduces to a minimum the loss created by the waveguide and offers practical advantages in transmitting sites that often are variable (mobile links). This solution allows to extend the operational frequency range to 19 GHz.

The SL microwave link series consists of two indoor units, the transmitter (T_SL, **fig. 7**) and the receiver (R_SL), housed in a 19" 1U rack standard, whose compactness doesn't compromise product performance. The operational frequency band is 2-15 GHz. The double frequency conversions configuration (1st IF 70MHz; 2nd IF 1100MHz) makes the equipment frequency agile; with covered band of up to 500MHz. Other salient characteristics of the product are the low group delay (less than 10 ns), low Noise Figure (less than 5 dB).

These characteristics make this the ideal product for the transport of both analogue and digital (with modulation schemes up to 256QAM) modulated signals.

Moreover, Elber offers *boosters*, available in the 2-15 GHz range, compatible with all transmitters to amplify the RF signal to higher power levels.

In addition to the microwave transmitters and receivers, Elber also offers a wide range of innovative accessories suitable for the installation of complex transport networks.

All these equipments use the DVB-ASI interface (in digital mode), also used for the DVB-T and DVB-H transmission, making it possible to efficiently use the available bandwidth.

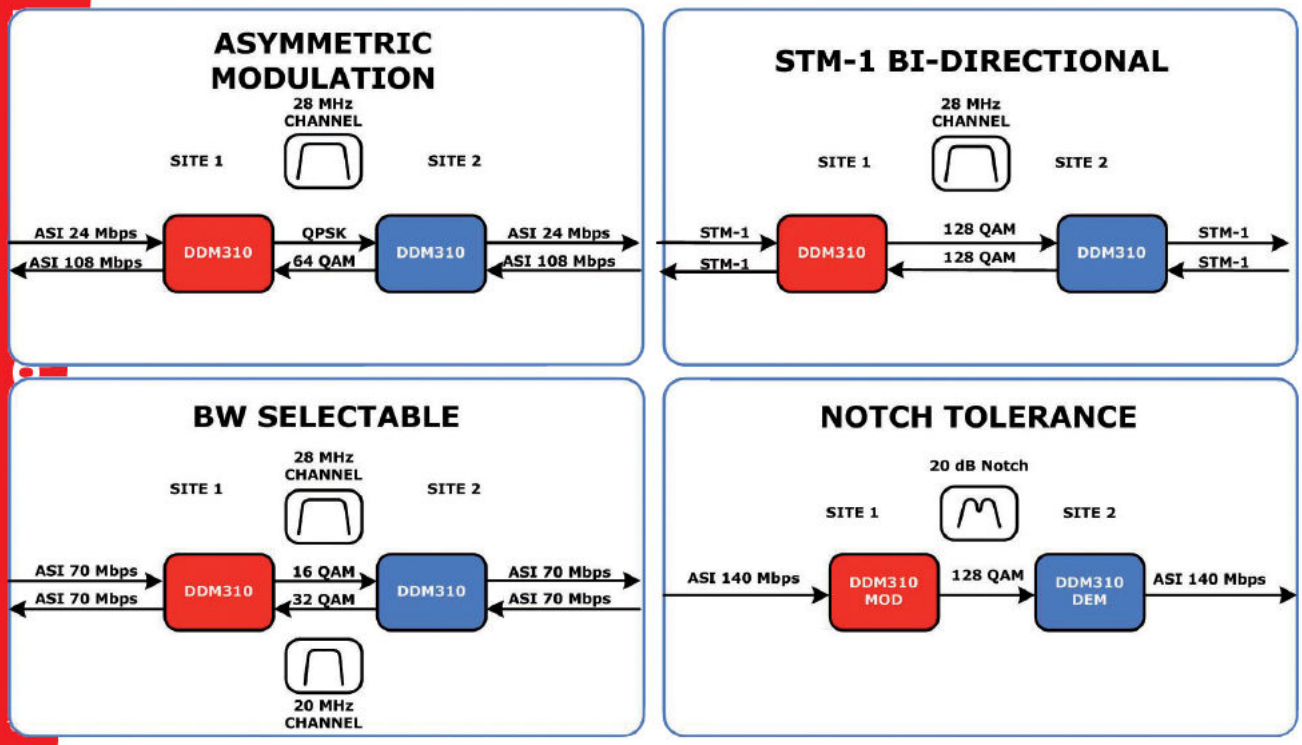
Knowing the potentiality of such products in the broadcast market, Elber focuses its forces on such products. The digital modem DDM310 and the digital RK210 system (multiplexer, demultiplexer, hitless switch, etc…) are the two most important products of this section.

The DDM310 (**Fig. 8**) encloses in a 1-unit rack the best of what can be offered with regards to flexibility and performance on the world market, with various data input interfaces (DVB-ASI, G.703, STM-1..) tolerating heavy distortions due to the selective fading, and is ideal for the transport of signals in broadcast and telecom applications.

The DDM310 is a high speed, highly reconfigurable modem and can be configured according to the functionality: modulator only, demodulator only or modem with a variable data rate up to 310 Mbit/s. There are different modulation schemes (QPSK, 16 QAM, 32 QAM, 64 QAM, 128 QAM e 256 QAM), for each modulation scheme it's possible to set the Baud rate, the Reed Solomon coding, the PTCM/convolutional coding, the roll-off factor of the shaping filters and other main parameters.

An advanced 24 taps adaptive equal-

▼ *Fig. 8* - DDM310 Digital Modem



▲ *Figura 9* - Applications

izer is responsible for the DDM310 robustness to dispersive multipath fading; notch of up to 50dB can be tolerated in QPSK mode.

The DDM310 is the ideal equipment to be coupled with digital radio links for communications in difficult situations.

The configurations installed in the modems will be tailor made. This ensures the best performance, efficient use of bandwidth, nevertheless these configurations can be modified at a later stage. It's important to underline that the modulator and the demodulator sections can be set with different configurations to implement bidirectional link with different data rate between forward and return path.

The high bit-rate that the DDM310 can transport makes it suitable for the transport of HD signals, the technology of the future for broadcast transmissions. This is not a trivial remark as only few companies in the world can achieve such performance. In fact, Elber's DDM310 modem is already used by clients transporting HD signals.

Figure 9 shows four frequently applications where the DDM310 is deployed.

The *asymmetric modulation* is a typical situation of a bidirectional link with different data rates in the two directions, this is necessary for example if one wants to transport a DVB-T (DVB-ASI 24 Mbit/s) *bouquet* in the forward path and in the return path four DVB-T (ASI 108 Mbps) *bouquets*, appropriately multiplexed by the RK210. To satisfy this demand, the two modems can be configured to support two modulations, for example QPSK on the forward link and 64 QAM on the return link.

In an STM-1 interface duplex configuration both modulation schemes will be the same (128 QAM).

On the contrary, if two different channel bandwidth are required for the forward and return link, the DDM310 is the ideal equipment because band occupation is configurable (*Bw selectable*).

Transmitting two multiplexed HD streams (ASI 140 Mbps) with a 128QAM modulation, Elber's DDM310 modem can tolerate notches of up to 20 dB (*Notch tolerance*). This guarantees an extreme robustness of the transmitted signal.

The RK210 (**Fig. 10**) is a digital modular equipment that, according to the modules that are inserted, can have various functions: from the multiplexing of DVB-ASI signals, to the conversion of IF signals, SDH interfaces or data to ASI streams to facilitate the transport over Elber links.

The RK210 is a multi-purpose digital system which Elber has developed in order to offer different and flexible solutions for the transport of streams over microwave radio links.

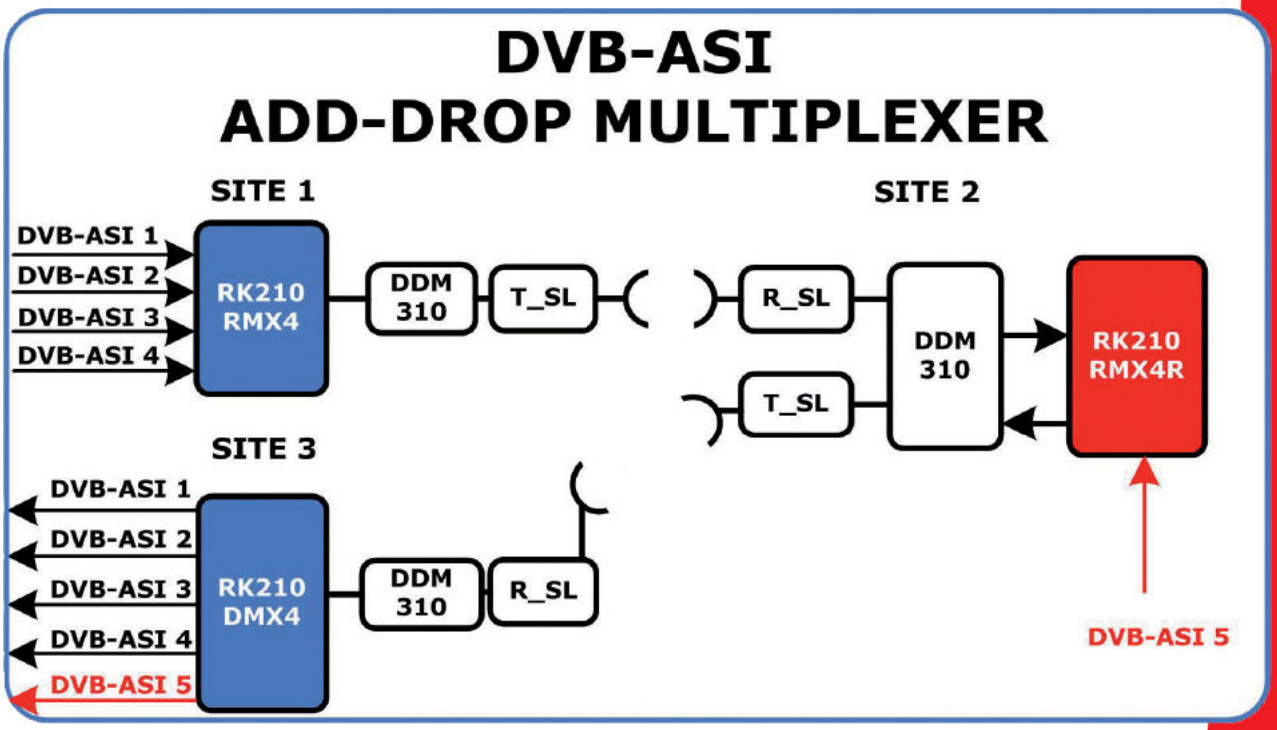
▲ *Fig. 10* - **RK210**

It is composed of a standard chassis which can house up to four plug-in boards.

The RMX4 plug-in board is an ASI multiplexer, which accepts up to 4 DVB-ASI Transport Streams input signals, assigns each input to a transport channel and generates a proprietary composite DVB-ASI signal at the output. The maximum number of channels is 8 or 15, function of the system configuration, and the maximum output bitrate is 210 Mbit/s.

Very different is the remultiplexer RMX4. Whereas the RMX4 can accepts only 4 inputs, the RMX4R plug-in board is used to multiplex a greater number of streams; it is a DVB-ASI remultiplexer which accepts one proprietary composite DVB-ASI signal and three DVB-ASI Transport Stream signals. Each channel of the composite stream can be re-mapped together with the local inputs in a new composite DVB-ASI stream. To retrieve the original signals, a DMX4 plug-in board is used: it is a DVB-ASI demultiplexer, which accepts a proprietary composite DVB-ASI signal as input and returns the DVB-ASI Transport Stream original signal.

Substantially, the RK210 as a multiplexer can be used in two configurations: hierarchically or add-drop. In the former the RMX4 boards are installed in cascading; where the output of the first RMX board is fed as an input to one of the channels of the second RMX4 board. To extract a stream, at the receiving side, from one specific hierarchy through a DMX4 demultiplexer, it is necessary to extract all streams belonging to



▼ *Fig. 11* - **Add-Drop Multiplexer**

the same hierarchy and to the previous ones.

In the add-drop configuration (**Fig. 11**) a RMX4R board is used, which free of any hierarchical bond, allows to extract any original stream directly. The HS210 plug-in board, used in redundancy configuration (space/frequency diversity) is a hitless switch module which accepts and aligns two composite DVB-ASI signals generated by the same RMX4 or RMX4R. Then, packet by packet, chooses and sends at the output the error-free signal.

The ASID4 is a DVB-ASI distributor, which accepts a DVB-ASI signal as input and, after the equalisation of cable distortion and clock regeneration, distributes on the four outputs the input signal.

The DS3_F and DS3_T module are network adapters between DS3/E3 signals and DVB-ASI signals.

The flexible structure of the RK210 system led Elber, on customers' request, realize other boards converting any kind of signal into a composite DVB-ASI stream and transport it over its microwave link. Programming and monitoring of the main parameters, could be done through the local interface (keypad and display interface on the front panel), and remotely (RS232/RS485 interface or Ethernet).

Available are also dividers, switches and distributors for the realization of complete networks and redundant architectures.

2.2 Mobile systems

Besides the fixed microwave radio links, Elber also dedicates a particular attention to the sector of the **mobile radio links**, more and more widespread by television broadcasters. In the past years the company has developed new techniques offering high performance in the forefront products. One of the examples is the new portable microwave radio link, CPM (**Fig. 12**): practical, portable, analogue (FM) or digital (COFDM), the ideal solution for quick and reliable connections. The **digital technology COFDM**, together with the extreme low phase noise of the **RF oscillators**, guarantee stable connections also in difficult weather or environmental conditions.

The working frequency can be any 500 MHz band between 6 GHz and 15 GHz and the output power, depending on the frequency band, can be 1 W or 2 W.

The transmission section includes a SD MPEG-2 4:2:0/4:2:2 encoder with a low delay mode (less than 100 ms) and a COFDM modulator, particularly suited for digital transmissions on channels with frequency selectivity, where the signal, during the transit from transmitter to receiver, can undergo reflections from obstacles. At the receiving side, apart from the main signal, arrive replicas of the transmitted signal, attenuated, out of phase and delayed in different ways depending on the path. The multicarrier COFDM technique allows to distribute the information through many subcarriers., each one modulated QPSK or 16/64-QAM, equally frequency spaced inside the channel's band channel. In this way a practically flat channel is obtained on each subcarrier with high spectral efficiency values.

The biggest advantage of this transmission mode is that the replicas received with a delay less than than a chosen guard interval do not generate any intersymbolic interference (ISI).

The COFDM technique is particularly suited for mobile applications with a medium capacity bit-rate (30 ÷ 35 Mbps).

These features makes the CPM the ideal equipment for fast and reliable mobile links, even in harsh weather conditions.

The CPM can transport analogue FM modulated signals. The analogue modulator and demodulator sec-

▶ *Fig. 12 -* **CPM portable microwave radio link**

tion are implemented using the most recent radio software techniques on FPGA. This contributes to the system's extreme flexibility and versatility.

Different input types are available: Audio/Video in base band (analogue/digital), SDI, DVB-ASI (digital) or IF at 70 MHz for repeater use.

Depending on the different applications, two control units have been developed: one for OB-VAN applications in 1Urack, and one in an external version, weatherproof and of same identical dimensions as the RF aerial heads, to guarantee maximal portability.

The external equipment consists of a tripod complete with panoramic head, a support base, orthomode transducer, antenna with feeder and one or two RF aerial heads. The control units can be placed close to the tripod connected by an RG216 cable

To satisfy the need of different application contexts, it is now possible to place two aerial heads on the same support base. The CPM *simplex* configuration has one aerial head, transmitting or receiving, according to its function. Redundant networks are obtained combining two transmitting or two receiving heads on the same support base (*Double Simplex* configuration).

Quick and easy to install bidirectional links are composed by a transmitting and a receiving head on the same support base (*Duplex* configuration).

If higher data-rates need to be transported, the generated IF signal from the DDM310 can be fed directly to the IF input of the control unit. As previously described, the DDM310 can transport data-rates up to 155Mbit/s in a 28MHz channel.

This characteristic is even more important for the SPM system (**Fig. 13**): originally developed as a duplex semi-fixed link, able to transport two HD signals of 70 Mbit/s (coupled by a DDM310 modem and a RK210Multiplexer and Demultiplexer). The very strong and stable structure and heavy duty tripod are the key differences when compared to the CPM.

The transmitting and receiving heads are the same that are used for split type systems, based on a double frequency conversion. This allows, as for the CPM, to select the operation frequency in a 300-500 MHz band (depending on the central frequency of the link).

The perfect equalization of the hardware filters, the extreme low phase noise of the RF oscillators and the efficiency of the final amplifiers make it possible to use very complex modulation schemes such as the 128 QAM. In this way the mobile link can transport from a signal of low bit-rate such as a live event to the multiplexed signals in a single STM-1 bidirectional bundle.

The system can be equipped with one or two aerial heads, coupled through an orthomode on a circular waveguide, entirely designed by the Company.

For applications where frequency agility is not required a monochannel version is available.

Elber offers a complete range of accessories for its own mobile and portable links: antennas, carrying cases, cable drums and on demand other devices.

2.3 DENG

The abbreviation DENG stands for Digital Electronic News Gathering and indicates all those portable digital systems used for television journalism and live coverage. These modern

◀ *Fig. 13* - SPM mobile microwave radio link

communication means have remarkably changed television broadcasting. Such systems are widely used in news coverages around the world.

The DENG devices represent a real launching pad to an emerging broadcast market with enormous potential.

The digital wireless cameras of Elber offer a complete high level solution for mobile applications. Available in SD and HD version, compact, performing and directly dockable on every type of professional video camera. This equipment uses the latest coding technology and the over 25 years of experience in design and realization of microwave devices.

From the WLCT-01 SD for News applications - MPEG2 4:2:0 coding, analogue video and audio inputs, to the WLCT-02 SD for Studio applications - MPEG2 4:2:2/4:2:0 coding, analogue and digital audio and video inputs and ultra low end-to-end latency, to the WLCT-03 HDV and WLCT-04 HD high-definition versions.

The system is centred on the high performance and extremely versatile WLCT-01SD and WLCT-02 SD *Wireless Camera Transmitters*.

The integrated MPEG-2 4:2:0 digital encoder, the COFDM transmission system and the accurate design of the RF part make the WLCT-01SD (**Fig. 14**) the ideal equipment for news applications, where the low power consumption, the robustness to multipath fading and the quickness of installation are the most important features.

Many optional accessories are available for this model: an integrated 1W power amplifier or an active antenna providing a 600 mW EIRP can be used to increase the maximum distance covered between camera operator and the receiver; the GV-01 and GV-02 Gold-Mount adaptors permit the WLCT-01SD to be installed on every camera and used with any battery; the carrying case offers a useful protection for the transmitter and its accessories (cables, antennas, control panel..).

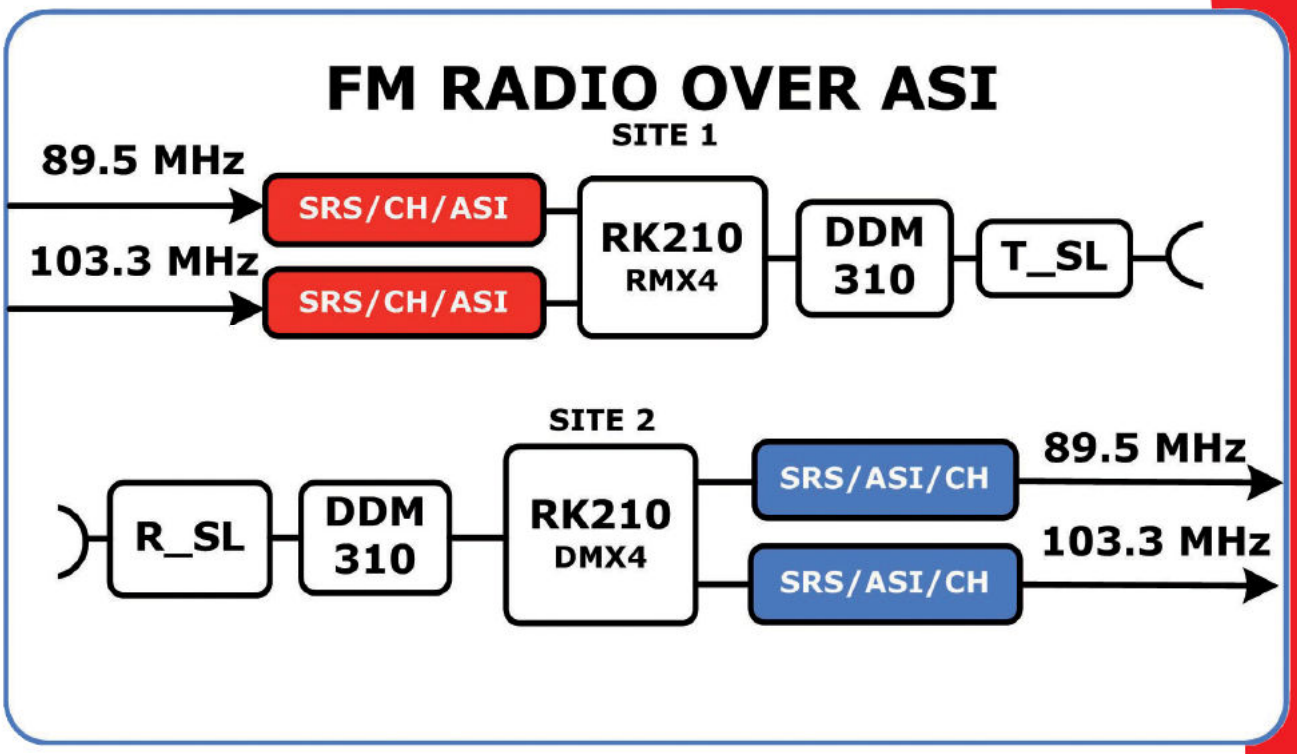
Quite different are the performances of the WLCT-02 SD. The integrated MPEG-2 4:2:2/4:2:0 digital encoder, able to accept digital SDI video as well as analogue (Component or Composite), and up to four mono audio channels or SDI embedded, provides a high quality digital video and audio signal that can be utilized with others coming from wired cameras; thanks to the ultra low delay (< 64 ms) between encoding and decoding, in fact, WLCT-02SD is the ideal equipment for both studio and news applications. The integrated modulator is designed according to the most recent COFDM multicarrier technology.

Many optional accessories are available for this model: from an active antenna providing a 600 mW EIRP to the GV-01 and GV-02 Gold-Mount adaptors and the carrying case.

At the receiving side internal receivers have been developed, with up to 6-way frequency diversity and a MPEG-2 with both analogue and digital audio and video output.

According to the application (the principal parameters are the decoding type and the latency) it is possible to associate the most suitable receiver. The WLR-01 is a low-cost model, with a minimal latency of 700 ms and MPEG2 4:2:0 decoding. More performing are the WLR-02 with 2-way diversity and the WLR-03 with 6-way diversity, allowing a low latency (<64 ms) and MPEG2 4:2:0/4:2:2 decoding.

▼ ***Fig. 14*** - **WLCT-01 SD Camera Back Transmitter**



▲ *Fig. 15* - Audio SRS Systems

Elber offers also antennas, control systems for the telecamera, carrying cases, cables, connectors and other accessories: the wide range of products, the availability and the professionalism characterize the Elber service at the client's disposal to compose the most suitable system according to its proper needs.

2.4 FM audio Solutions

From 1935, the year of Armstrong's invention of the FM frequency modulation, passing through World War II characterized by an important growth of the FM transmission in many sectors (public, private, military, government, police and transport) arriving today where FM radio systems have undergone a fast development and a consequent consolidation of the technology.

The present scenario is moving towards digital technologies, evolving towards very important changes in the radio transport market too.

Elber adapts its products to this new situation, hence remaining at the forefront with technology. In this way, besides the consolidated narrow band systems (NBFM-01), the Company offers also innovative solutions for the audio transport. A new product line, named SRS, is the latest launched by Elber for the radio market. Characterized by Software Radio Technology, these new devices aim to process and transport audio signals with digital techniques, allowing high performances and absolute flexibility.

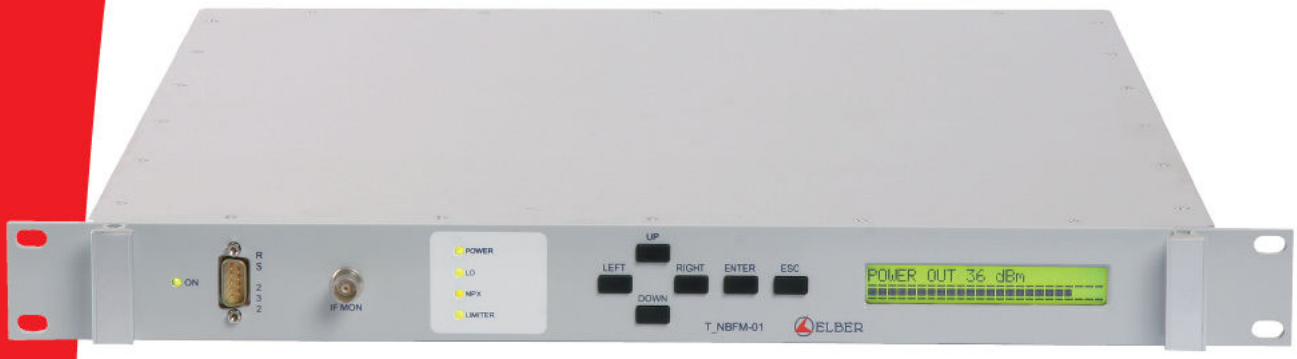
The audio input signal, provided as multiplex stereo, as base band, as channel 87.5-108 MHz or as IF (10.7/21.4 MHz), is digitalized and coded in a DVB-ASI stream to be transported on a digital television radio link, bundled in for example with DVB-T *bouquets*: this allows to maintain at destination the same audio quality as at the input and also the possibility to share the costs of the link with a television broadcaster.

Thanks to the digital processing, performed both with latest DSP and FPGA, SRS equipment get optimum signal to noise ratio and a very low cross-talk distortion.

Alternatively, the digital conversion of the input audio can be used in repeaters.

Without using the DVB-ASI coding, according to the client's needs, various output interfaces are available: multiplex stereo, base band, channel 87.5-108 MHz and IF (10.7/21.4 MHz). On demand alternative and personalized solutions can be developed. The quality and competitiveness distinguishes Elber from other brands.

Fig. 15 represents one of the possible applications of the system. Two audio input signals, provided as FM channels at 89.5 MHz and at 103.3 MHz are processed, digitalized



▲ *Fig. 16* - **Transmitter T_NBFM-01**

and encoded in two different DVB-ASI streams. The two streams are then multiplexed using the Elber's RK210-RMX4, and then transported through a digital television radio link to the receiving site, where they are reconverted back to the original format.

In any case, the importance, the reliability and the compactness guaranteed by the traditional FM narrowband links cannot be omitted. Different models are available such as the T_NBFM-01 (**fig.16**) transmitter and R_NBFM-01 (**fig.17**) receiver that are able to transport on a long distance an MPX FM stereo signal or an audio mono channel maintaining a very high quality.

The excellent performance of these devices, operating in the 2 GHz frequency band with 200kHz channels are due to the use of *fast signal processing techniques* (on DSP), applied to the IF signals (79 MHz).

The most recent technologies regarding the design of low phase noise oscillators and the front-end reception with a wide dynamic range allow the FM link to obtain extraordinary results in terms of stereo separation (more than 65 dB), S/N in base band (more than 60 dB) and IF ripple (less than 0.05 dB).

In Elber's software based R_NBFM receiver, the IF signal from the first (and only) analogue down conversion is immediately digitalised; all subsequent signal processing like filtering and frequency discrimination processes occur in digital domain.

The IF digital filter present in Elber's equipment guarantees without any adjustment:

- Extremely flat frequency response (ripple < 0,01dB in a bandwidth of ±100 kHz)
- Selectivity (rejection > 100dB @ ±200kHz from central frequency)
- Ideal linear phase (and hence guaranteed stereo separation without necessary phase equalisation.)
- Software re-programming.
- Necessary stability with respect to time and temperature variation.
- Equal performances guaranteed for every receiver.

To obtain good selectivity with standard analogue receivers, normally two or three frequency conversions are needed. The increasing number of conversions normally leads to a degradation in the dynamic range and to the risk of increasing the possibility of introducing spurious signals.

Conversely, in a traditional analogue IF filter the disadvantages are:

- The frequency response depends on the accuracy of the multiple calibration components and will however still be worse than that of a digital filter (0,1 dB in the best possible scenario)
- The equipment calibration will change through equipment ageing and environmental conditions (temperature, humidity).
- The values of the adjacent frequencies and filter response are difficult to obtain to a level easily obtained with a digital filter.
- The frequency response of the analogue filters (group delay) is not optimised and an accurate equalisation is necessary. Even in this case, the final result will be inferior compared to the characteristics of the digital filters. The performance is however a function of the compensation accuracy which in general is critical and suffers to a higher extent of the same frequency stability problems.

It follows that there is no guarantee that the filter's response with time can't suffer and performance degradation.

The digital solution adopted by Elber for the T_NBFM transmitter is based on the numeric processing of the Multiplex signal after the conversion from analogue to digital.

This process is carried out in sequence by two devices, a DSP and a Digital Up Converter to obtain the signal synthesis. This systems has numerous advantages such as:

▲ *Fig. 17* - Receiver R_NBFM-01

- The frequency response can be extended up to DC.
- The filter rejecting the out band noise present on the multiplex signal is extremely accurate and precise (±0.01dB up to 80kHz, stop-band > 45dB at 110kHz) and with a group delay virtually zero.
- The limiter (with limit at ±80kHz) has ideal performances: no distorsion introduced up to the limit of operation.
- The modulation sensibility is absolutely constant with variable transmitting frequency and is capable of being controlled through software, with the use of the keypad on the front panel of the equipment.

These performances are combined with a reduction of unnecessary cumbersome components, both in the transmitter and the receiver which leads to a production of a 1U rack mountable unit and a decrease of the manufacturing and production costs especially in the testing and calibration part; this is reduced to a functional verification process (excluding the RF section).
Important also to underline the simplified management of all the functions and the monitoring of the functional parameters through the front panel user interface (6 keys keypad and LCD) and remotely via RS232 and RS485.

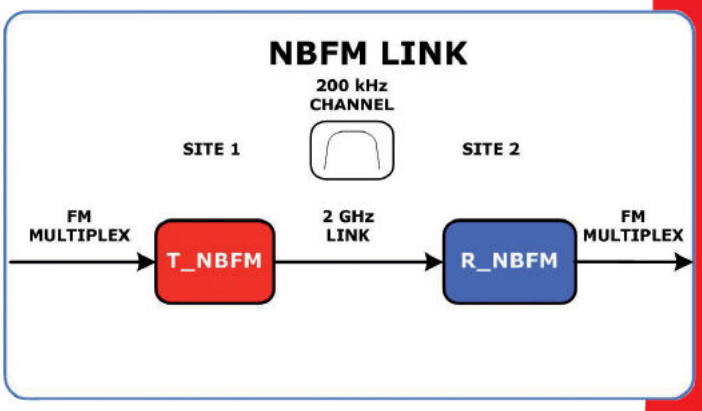
Very different is the typical traditional approach of a narrowband FM radio link, where direct modulation of a local oscillator is normally used. The frequency of such an oscillator is maintained stable to the transmitting frequency using slow PLL. Some of the limitations in such a solution are:

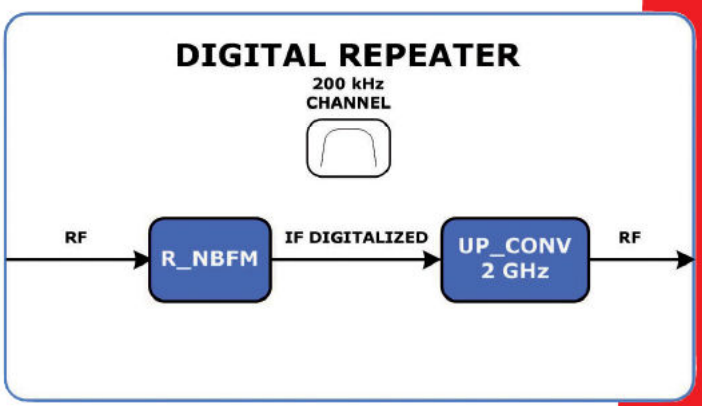
- The difficulty of extending the frequency response for lower frequencies of the modulated signal;
- Equalisation necessity and the complexity of the required filter in order to attenuate components out of the multiplexed signal band;
- The distortion effect introduced by a possible analogue deviation's limiter;
- Possible modulation sensitivity variation with the operative frequency.

The block diagram of **Fig. 18** shows two different ways of using the NBFM system. The top scheme visualizes a 2 GHz link, with 200 kHz channel, suitable for the transport of an FM multiplex signal between two sites.

The bottom scheme shows a site where a digital repeater with a traditional loop between receiver and transmitter for the retransmission of the FM multiplex signal is replaced by un up-conversion of the digitalized IF output signal of the receiver. This solutions eliminates the loss that would have been introduced by the extra conversions, from the digital IF signal to multiplex stereo and back.

▼ *Fig. 18* - Elber NFBM Link





A "FUNCTIONAL" ORGANIZATION CHART

The organization chart of Elber looks for harmonization and maximum flexibility with the highest possible production capacities with a maximum consideration for the research and development department and for the laboratory where the products are tested and calibrated.
These orientations determined the choice of an organization structure based on the production needs and sources out only those parts that do not have direct influence on the quality and reliability of the products.
At the same time, Elber's structure allows a greater control over all the activities and a quicker decisional process.
This consents also a more direct contact with all clients, especially on the Italian territory.
Let's enter in the details of the structure.
The managing director is Donatella Bernardi, who is in charge of the administration and , in part of the logistics.
Edoardo Bernardi follows the coordination of the production, the client support and the sales in Italy.
The international sales department is managed by Antoine Busuttil , and last but not least, the Research and Development department, in hands of Vittorio Lagomarsino, in charge of all activities related to the integration of new components, the development of new projects and the innovative structuring of the production phases, testing and calibration.
It needs to be underlined that Elber counts more or less 25 employees, out of which five engineers dedicated to the research and development. By end of the year, Elber will be moving to its new premises of around 2000 square meters situated at a short distance from the actual factory.
The new location will help to improve both management and productive activities. In the end the summary of the organizational structure and the services of Elber:

- ***Managing Director:***
  Donatella Bernardi – d.bernardi@elber.it
- ***General Director and Sales (Italy):***
  Edoardo Bernardi – e.bernardi@elber.it
- ***Director R&D:***
  Vittorio Lagomarsino – technical@elber.it
- ***Director International Sales:***
  Antoine Busuttil – a.busuttil@elber.it
- ***General information:***
  info@elber.it
- ***Information regarding the Privacy:***
  privacy@elber.it
- ***Commercial Department:***
  sales@elber.it
- ***Client assistance:***
  support@elber.it
- ***Department Research & Development:***
  technical@elber.it

An enviable and close team. **A group picture of the Elber team during one of the past NAB editions. Edoardo (in fifth position from left) and Donatella (in sixth position from left) together with, amongst others, (in second position from left) Carmelo Mallia. The first from left is Nabil Abi Habib, responsible for the Technical Office of Elber in the Middle East.**

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