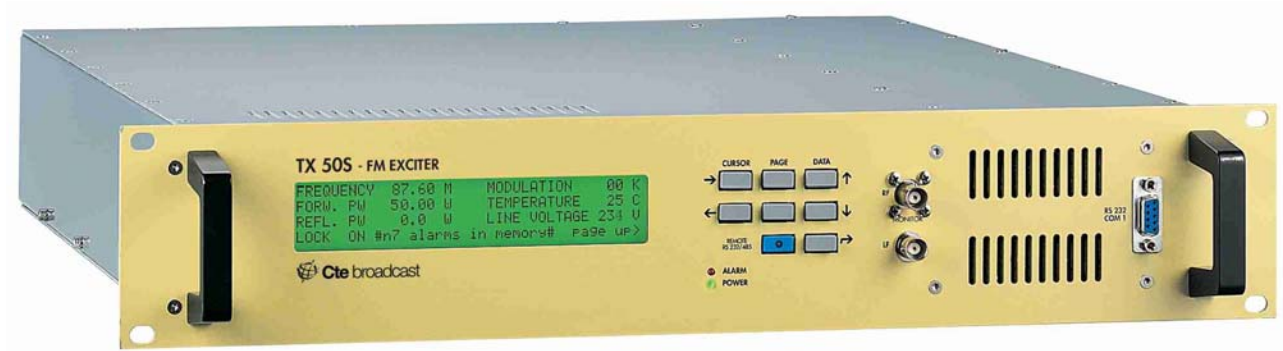




Cte broadcast



TX100 S 100 W FM TRANSMITTER

Model	Option		
	stereo	remote controll	AGC
TX 100S	NO	NO	NO
TX 100S/B	NO	NO	YES
TX 100S/C	NO	YES	NO
TX 100S/CB	No	YES	YES
TX 100S/S	YES	NO	NO
TX 100S/SB	YES	NO	YES
TX 100S/SC	YES	YES	NO
TX 100S/SBC	YES	YES	YES

SERVICE AND OPERATION MANUAL

TX 100 S is the generic name used in this handbook for identify all the variant of the TX 100 S

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**OWNERS MANUAL
MAINTENANCE MANUAL
TX100S FM TRANSMITTER**

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SAFETY INSTRUCTIONS

1.1 Introduction

CTE has always managed to improve the safety standard of its transmitting and receiving equipment. All produced systems are tested in compliance with international EN60950 and EN60215 rules.

Obviously this is not sufficient to avoid any accident during the installation and the use of our equipment in compliance with EN60215 rule, the radio transmitters and the auxiliary equipment must be used by qualified technical staff only and CTE declines any responsibility for damages caused by an improper use or improper setting up performed by inexperienced staff, not qualified or operating with instruments or tools not in compliance with safety set of rules.

WARNING

CURRENT AND VOLTAGE WORKING IN THIS EQUIPMENT ARE DANGEROUS. THE STAFF MUST ALWAYS OBSERVE THE SAFETY RULES, INSTRUCTIONS AND NORMS CONTAINED HEREIN.

WARNING

THE INSTRUCTIONS CONTAINED IN THIS MANUAL MUST BE READ BEFORE SWITCHING ON OR SETTING THE TRANSMITTER

WARNING

ANY TRANSMITTER SERVICING, REPAIRING OR CHECKING OPERATION REQUIRING THE OPENING OF THE TOP OR BOTTOM COVER, MUST BE PERFORMED AFTER THE MAINS SUPPLY DISCONNECTION WITHOUT REMOVING THE EARTH CONNECTION WHICH THE EFFICIENCY MUST BE VERIFIED: THE CABLE MUST BE IN GOOD CONDITIONS AND WELL CONNECTED.

WARNING

STAFF OPERATING UPON THE TRANSMITTER SYSTEM MUST NOT BE TIRED: AFTER HEAVY WORKS OR CARRYING HEAVY MACHINES BY HAND, IT IS NECESSARY TO RESPECT A PERIOD OF REST BEFORE WORKING WITH SYSTEMS WHICH COULD HAVE DANGEROUS ELECTRIC VOLTAGE IF THEY ARE NOT DISCONNECTED.

WARNING

SEVERAL SYMBOLS, INSIDE THE TYPICAL TRIANGLE SHOWING DANGER, HAVE BEEN PRINTED ON SEVERAL TRANSMITTER PARTS. ATTENTION SHOULD BE PAID, BECAUSE THERE COULD BE THE DANGER DUE TO HOT SURFACES, ELECTRIC VOLTAGE HIGHER THAN 50VOLT OR OTHER SPECIFIED DANGERS.

Certain devices (for example the RF final circuits mosfets) contain Beryllium Oxide BeO; these components must not be broken, crashed or heated. This oxide passes through the common systems of filtering, including the respiratory apparatus. The prolonged inhalation at high degrees causes poisoning with respiratory apparatus paralysis, till death.

WARNING

ALL THE MODULES CONTAINING BeO ARE MARKED WITH THE TRIANGULAR WARNING SYMBOL INDICATING THE NOTICE:

***WARNING !* TOXIC HAZARD
THESE DEVICES CONTAIN BERYLLIUM OXIDE
OBSERVE SAFETY INSTRUCTIONS !**

The staff in charge, besides being technically qualified, must have a practice of the first aid in case of emergency or accident (reanimation, heart massage, mouth to mouth respiration, etc.). Before going on with the operations to be performed, it is necessary to know the position of the general electric switch and the one of the extinguishers, which are to be used very quickly if necessary.

TX100S FM BROADCASTING TRANSMITTER

ELECTRICAL SPECIFICATION

2.1 FREQUENCY - POWER

Frequency range -----	87.6 to 107.9MHz
Frequency setting -----	in 100KHz steps (model TX100S-S have 10 KHz steps)
Internal setting mode -----	by keys
External setting mode-----	by remote control (RS232-RS485)
Frequency stability-----	±1000Hz/year
Frequency generation-----	PLL synthesizer
Modulation type-----	direct VCO frequency modulation
Nominal frequency deviation-----	±75KHz
Deviation linearity in all frequency range-----	±0.2dB
Peak detector error-----	<0.1dB
RF output power -----	0 to 100W
Power resolution setting-----	0.1W
Power control limit setting -----	1 to 100W
Power control stability-----	< 0.1dB
Reverse output power control limit -----	1 to 9.9W
Reverse output power steps control-----	0.1W
Harmonics emission -----	<-70dBc
Spurious emission-----	<-95dBc
Carrier reduction power (carrier enable off) -----	>60dBc

2.2 MODULATION CAPABILITY

MONO (left and right)-----	30Hz to 15KHz
STEREO (by internal stereo generator)-----	30Hz to 53KHz
SCA (two channels) -----	30Hz to 100KHz
COMPOSITE -----	MONO or STEREO + SCA

2.3 CHARACTERISTICS IN MONO

Signal input -----	Left + Right
Input impedance-----	600Ω (balanced) or 10kΩ
Unbalance rejection-----	>40dB
Input level-----	-6 to +12dBm
Pre-emphasis -----	75 or 50μs
Audio frequency response (30Hz to 15KHz) -----	<0.15dB
Audio frequency response (19KHz to 100KHz)-----	<-40dB
Modulation distortion-----	<0.03%

2.4 CHARACTERISTICS IN STEREO

Signal inputs-----	Left or Right
Input impedance-----	600Ω (balanced) or 10kΩ
Unbalance rejection-----	>40dB
Input level-----	-6 to +12dBm
Pre-emphasis-----	75 or 50μs
Audio frequency response (30Hz to 15KHz)-----	<0.15dB
Audio frequency response (19KHz to 100KHz)-----	<40dB
cross-talk between left and right channel-----	>50dB
Distortion at frequency deviation of 75KHz-----	<0.03%
Distortion at frequency deviation of 100KHz-----	<0.03%
Signal to noise referred at deviation of 75KHz-----	>80dB
Suppression of 38KHz-----	>80dB
Spurious suppression outside band-----	.in according to ETS 300-384
Pilot reference for RDS encoder (19 KHz out)-----	1Vpp

2.5 SCA CHARACTERISTICS

Input (SCA1, SCA2)-----	BNC unbalanced
Input impedance-----	10KΩ
Frequency response (50KHz to 100KHz)-----	<0.1dB
Distortion-----	<0.1%
Modulation capability-----	0 to 10%

2.6 READOUT ON LCD DISPLAY (40x4 character)

Forward power resolution-----	0.1W
Reverse power resolution-----	0.1W
Modulation resolution-----	1KHz
Line voltage resolution-----	1V
Power amplifier voltage resolution-----	1V
Power amplifier current resolution-----	0.1A
Heatsink temperature resolution-----	1°C

2.7 REMOTE CONTROL

COM1 (front panel)-----	RS232
COM2 (rear panel)-----	RS232
COM3 (rear panel)-----	RS485
Personal computer software-----	National Instruments LAB-VIEW ®
Transmission protocol-----	AES-EBU SP 490

2.8 POWER SUPPLY AND TEMPERATURE RANGE

Operating voltage	-----	115 or 230V _{AC} ±10 %
Line power	-----	<150VA
Nominal temperature range	-----	-5° to 45°C
Operating temperature range	-----	-10° to 50°C
Storage temperature range	-----	-40° to 50°C

2.9 MECHANICAL SPECIFICATION

19" rackmount	-----	485x88x500mm
Weight	-----	12Kg

2.10 OPTIONS

Option A	-----	Stereo generator
Option B	-----	Automatic Audio Level Control
Option C	-----	Remote Control
TX100S-S	-----	10 Khz frequency steps

2.11 STANDARDS COMPLYS

Electrical characteristics	-----	ETS 300-384
EMC characteristics	-----	ETS 300-447
Safety characteristics	-----	EN-60950-EN-60215

GENERAL DESCRIPTION

3.1 Main features

TX100S is a FM band broadcasting transmitter with modern conceiving and technology, which by a simple design produces an output radio signal with high characteristics of quality, reliability and security.

The simple manufacturing obtained with a hi integration of functions, has allowed to create a machine with few controls and connections. Most printed circuits are multilayer with a surface mounting technology component assembling. The eventual repairing can be done by simply changing the fault involved board, without searching the defective component.

One of the most important characteristics is done by the high quality of the frequency modulation and the high signal-to-noise ratio; moreover, the modulation is typically constant within 0.1dB throughout the whole FM band (88–108MHz). A proper peak detector allows to perform both traditional modulation measurements (usual bar-graph with peak), and modulation and power modulation ones with long observation periods (even with many hours or days) according to the latest international regulations, which properly cared to fix a limit scientifically measurable to the peak and modulation power (CEPT 54-01).

An particular audio circuit can control the input audio level with a ± 6 dB dynamics referred to the nominal value: this can be extremely useful when the audio signal level is not fixed or when this one can be subject to fluctuations (usually very slow) due to thermal drifts and systems maintenance, possible damages along radio link paths etc. A proper board can be inserted to obtain this function and a proper microprocessor follows constantly the modulation value correcting through proper algorithms, implemented in its memory, the value of the modulator gain, keeping this way the modulation very close to the maximum allowed value. The corrections take place at very long periods of time; the board does not perform the audio compressing-limiting functions, but just compensates possible drifts occurring on the systems carrying the audio channel before entering in the FM transmitter. No measurable phase or amplitude distortion is introduced in the modulation when the automatic gain control circuit is enabled. In addition an alarm which switches the power off in case of modulation absence can be inserted since the unmodulated carrier transmission is forbidden in many countries, with no chance to identify the radio.

The transmitter can be set like a modern signals generator so the output power is completely managed by a device which guarantees that the values of forward power, reflected power, maximum output power versus the temperature and loading conditions, are always the ones set or the ones allowed by maximum limits. A directional wide band coupler with remarkable directivity and large on board memory allows to obtain a power accuracy worthy of a good measurement instrument.

All parameters (frequency, levels, mono/stereo, pre-emphasis, power) can be set by the keyboard and stored in EPROM in order to be kept even without electric supply. A great number of events can be stored: each alarm is distinguished by a starting and an ending alarm date. The

controlled parameters are: modulation absence, heatsink temperature, mains supply voltage, RF power final stage voltage and current, main oscillator fault.

Besides the keyboard, the transmitter can be remotely controlled in different ways. A personal computer can be connected as monitor to the DB9 socket placed on the front panel and by a special program, to be load easily on the PC, all the transmitter parameters can be set and seen. Furthermore it's possible to perform all the modulation analysis provided by the CEPT 54-01 regulations and create the related graphics which can be stored as a file in the PC.

A second RS232 port placed in the transmitter rear part can be connected to the power amplifier connected in series to the exciter, thus allowing the power data display on the same PC connected to the front RS232.

A third RS485 port placed in the rear part can be connected to a MODEM which is connected to the phone line thus assuring the transmitter telecontrol, remotely or from the studio.

The same RS485 port can be used for the connection N+1 of more transmitters (max 32). In this case a transmitter acts as a "joker", so it replaces the faulty equipment, automatically adapting to all its parameters. Each transmitter is also provided with an output port (IN/OUT) suitable to drive the antenna cable multiplexer and the one for the input audio signals switching.

3.2 Available options

- a) STEREO ENCODER : additional board allowing the internal encoding of the stereophonic signal
- b) AGC : additional board allowing a frequency modulation control
- c1) REMOTE CONTROL : software for the PC connection
- c2) N+1 system : software to obtain N+1 system

Model TX100S-S have 10 Khz frequency steps

3.3 Block diagram

The transmitter can be modulated by five different audio signal.

The first two ones are made by monophonic left and right channels, which can be balanced or unbalanced. The input dynamic goes from -6 to +12dBm with an input impedance which can be high or low. On these channels either the European or American pre-emphasis value can be inserted. A low pass filter on each of the two inputs assures a good attenuation of audio frequencies higher than 15KHz which could interfere, in case of stereophonic transmission, with higher band and with la subcarrier of the Multiplex signal; the out-of-band attenuation of the filter is not excessive in order not to increase then phase distortion (group delay) of the in band audio signal: 60-70dB of attenuation, even with 0.1dB of amplitude linearity up to 15KHz, unavoidably creates a distortion on the analogue signal that an experienced ear can perceive. Right or left signals can be combined to generate monophonic transmission (should you only have one of the two signals, it

will be necessary to externally put in parallel the two inputs); in case of stereophonic transmission, the two channels are fed inside the stereo code board.

The mono signal or the stereo one, thus obtained, is combined with the other three possible input audio signals: an external Multiplex signal and two SCA signals, one of which can be the RDS one, which can be synchronized with a 19KHz one connected on the IN/OUT rear connector.

The composite signal can enter the AGC board, which has the task to check the its amplitude and consequently to keep the modulation at the correct value, or it can follow its path and enter into the frequency modulator after having passed through a limiter circuit (CLIPPER). This circuit must become active just in cases of faults of previous circuits or in case of mistake in the setting of the low frequency input nominal levels; this is to avoid to interfere with the adjacent channels. For not activating this “fuse”, which produces remarkable distortions on the modulation, it is necessary to take all proper cautions, that is the use of external compressor-limiters or by inserting the internal AGC circuit which protects a lot against damages and drifts.

The oscillator, directly modulated by the composite signal, covers the whole FM band and it's synthesized in steps of 10KHz . The reference frequency is obtained by a 10MHz crystal kept at constant temperature of 55°C, whilst the output frequency is set by the main microcontroller. The oscillator phase noise is very good and it is in compliance with ETSI 300-384 regulations (<-145dBc for a shifting of 1MHz from the carrier). The modulation linearity is typically contained within 0.1dB without complicated corrections.

The RF final power circuit is wide band and it provides 100W RF output controlled with high accuracy; directional coupler has a directivity higher than 25dB on the whole band and an error which is lower than 0.2dB, it is also compensated in temperature and totally shielded.

The power supply is of a switching type and it gives the four essential voltages, all obtained with this technique. A small voltage measurement transformer allows to check the effective value of mains supply voltage with accuracy and to interrupt the output power in case this value exits from the normal operating window of the transmitter (10% respect the nominal value of 115V_{AC} or of 230V_{AC}). The mechanical position of the power supply and the final circuits of RF power allow to obtain a vent flu just for cooling of the involved circuits, obtaining this way a really remarkable efficiency of that function. In normal running conditions, when the transmitter is working in a full power at environmental temperature, the radiator temperature is lower than 40°C, whereas the other circuits temperature does not exceed 30°C. No components are involved with the air flow, so it isn't requested a filter on the aspiration fan, which replacing is rather simple. The power supply is completely shielded both for internal circuits and for its unavoidable emissions toward the outside.

Data displaying and setting is obtained by a board which is placed directly on the front panel containing a microprocessor, memory, keyboard, LCD display. The displaying area is wide so allowing to display and set needed data in a very easy way, thus making the transmitter-user technician interaction extremely user friendly.

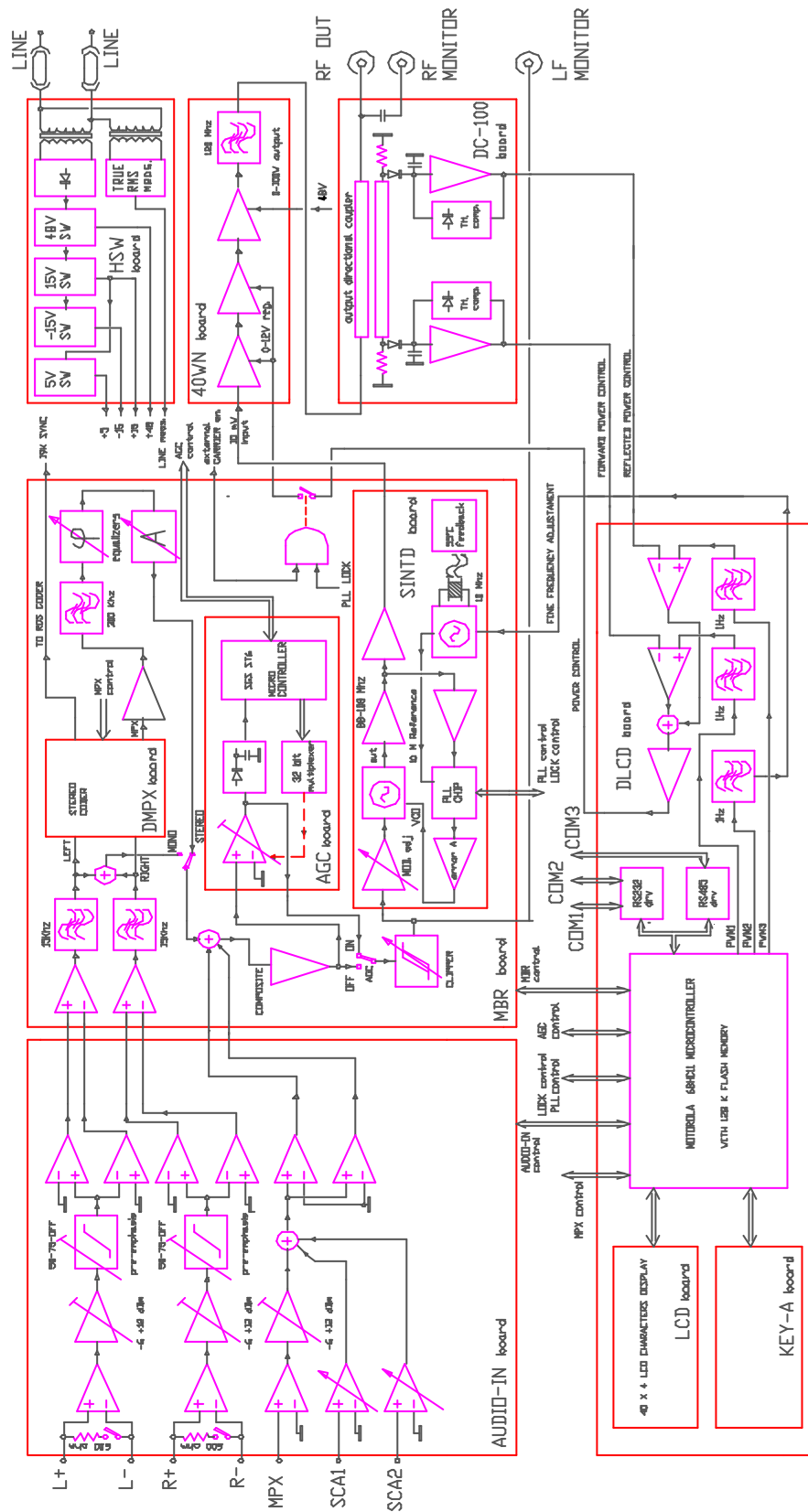
It's possible to protect the transmitter input and output parameter settings with a password, while all measurements can be done by whoever without interfering on its operation.

Two communication RS232 ports and a RS485 port can make possible the communication between the transmitter and a PC, with the power amplifier and the driver exciter, or with a modem connected with the telephone line.



Maintenance or repairing of damages do not require the soldering use for the replacement of the parts to be changed; only six flat cables link all different boards.

TX100S BLOCK DIAGRAM



INSTALLATION

4.1 Unpacking and inspection

Immediately, after the transmitter has been delivered, please carefully check the package to verify possible damages caused by shipment. Should be found some damages, please immediately contact the CTE dealer.

It is recommended to keep the original package for a future shipment due to, for instance, repairing or setting. A return with a package which is different from the original one will make the warranty rights lost.

4.2 Installation

The transmitter TX100S is composed of a 19 inches width rack which takes 2 units in height in a vertical rack mount.

It is recommended to use 4 fixing plastic washers in order to avoid damages to the front panel varnishing. We remind to carefully connect the earth both to the transmitter and to the rack mount-never disconnect it without having switched the supply voltage off by the mains switch.

Design has considered the new rules concerning the electromagnetic compatibility so there aren't problems to locate systems CE marked nearby.

4.3 Power supply

AC power supply at 50/60Hz can be at 115V_{AC} or 230V_{AC}.

The switching on control is placed for security reasons on the rear panel with the protection fuse, which must have the value 3.15A for the higher voltage and 6.30A for the lower one and it must be a delayed type. To change the value of the mains supply voltage, the small PCB placed inside the mains supply socket must be switched, taking care to place it in the position allowing to read of the needed voltage.

BEFORE SWITCHING THE TRANSMITTER ON, MAKE SURE
THAT THE POWER SUPPLY IS CORRECT AND CONNECT
THE RIGHT LOAD OR ANTENNA!

4.4 Ground loops

Sometimes connecting various ground sockets having different potentials may produce some unwanted loops, which may create hum in the modulation: in this case it is essential to firstly identify the origin of these currents, which normally spring from the antenna ground, mains supply ground or from the input low frequency signals ground.

If the inconvenience can not be removed, the balanced input of the two channels LEFT and RIGHT can be used, thus obtaining common mode noise rejection of 40dB approximately.

All the inputs and outputs are protected by diodes against the electrostatic discharges and they are provided with filters against the RF noise.

4.5 Transmitter power up

After making sure about the proper earth socket connection, correct power supply and connection of the load on the antenna output, the equipment can be switched on.

If there is the first switching on, problems of wrong setting can't occur since the transmitter contains some standard values and **the output power will be set to 0.5W**, in order to avoid any problem of interference or driving for possible following amplifiers. The set values will be displayed and changed according to your need before the RF power is emitted from the transmitter. The equipment is provided with a memory which holds all settings even when the electric supply is off, however it is recommended to set the power at 0.5 W when uninstalling the transmitter itself to avoid any problem in case of a new setting up.

REMEMBER THE PASSWORD !

To enter the setting menu, knowing the password is mandatory. It's a four digits number written on the transmitter delivery document. Should it be forgotten, it will be possible to perform the set up by setting the Z2 jumper placed on the board DLCD (vertical board placed behind the rear panel) on the soldering side; the jumper is easy to identify through the close capture: PASSWORD ON/OFF.

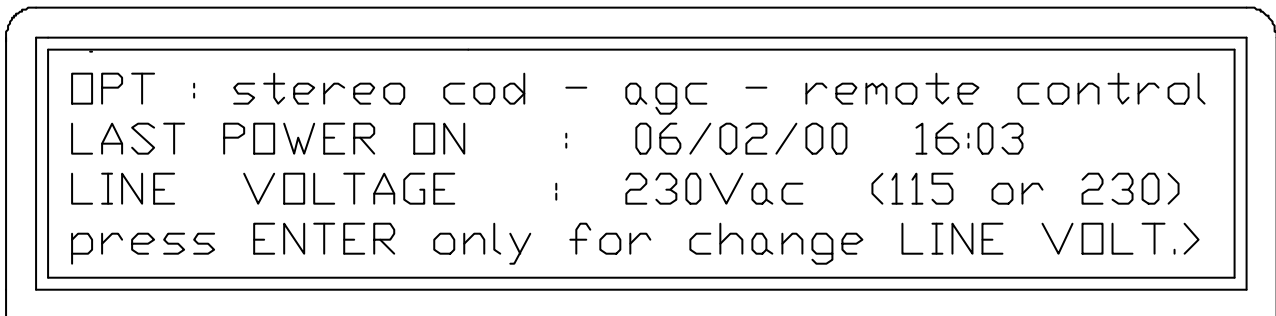
In this case, this operation must be performed with the equipment switched off and it requires also the opening of the top cover which, at ended operation, must be closed again with all its screws; it is essential to use a proper cross point screwdriver.

4.6 Transmitter settings

4.6.1 At the switching on, the display will glow giving for few seconds the following screen shot



4.6.2 Afterwards another page will appear for few seconds allowing to change the mains supply voltage value; the value setting operation to 115 or 230V_{AC} by switching the network socket, and eventually changing the fuse value, allows the transmitter to operate correctly, but it doesn't allow the microprocessor controlling the equipment to know the mains supply voltage value. For this reason, if the value appearing on the said screen shot doesn't match with the one set on the rear voltage changer, it will be necessary to type ENTER to update to the changing; if the set value unmatched with the one read on the mains supply switch, the transmitter will turn to MAINS SUPPLY VOLTAGE ALARM, for example reading a 220V_{AC} voltage when it is set for a 115V_{AC} value: in this case the alarm is obviously given since the read voltage exceeds 15% of the nominal value (220V is almost the double of 115V).



If the line voltage appearing on the display matches with the one reading on the mains supply switch, it isn't necessary to type anything. On the opposite ENTER is required.

On the screenshot the options contained in the transmitter and the hour of the last switching on will also appear and it will correspond to the current hour and date. If one finds out a discrepancy between the hour given and the current one, it will be necessary to correct the error in the clock setting.

If this screenshot is accessed from another menu, the indication LAST POWER ON will show the last switching on date and it will be able to give the operator some indications about accidental switching off.

4.6.3 If all the indications are right, after a while the first page will be shown; which with the second one will contain all the most important measurements of the transmitter:

```

FREQUENCY 101.30 M    MODULATION      75 K
FORW. PW   45.60 W    TEMPERATURE    29 C
REFL. PW   3.2 W     LINE VOLTAGE   226 V
LOCK ON #n5 alarms in memory# page up>
  
```

The display is explanatory enough

FREQUENCY	is the output frequency set in MHz
FORW. PW	is the forward output RF power
REFL. PW	is the input reflected power on the RF connector
LOCK ON	shows that main oscillator is locked the programmed frequency
MODULATION	shows the modulation value of the COMPOSITE signal
TEMPERATURE	shows the radiator temperature value of the RF power final mosfet
LINE VOLTAGE	shows the mains supply voltage

Moreover, in the lower part of the display, at the middle there is the indication of the number of alarms eventually set in the memory which have taken place after the last clearing of the memory. These ones will be displayed automatically by a continuous enter of **PAGE UP**.

If one enters **PAGE DOWN** in this screen shot, the previous one returns and it will be possible to see once again the date of the last switching on or to change the mains supply voltage value.

If an alarm is on, always in the same position of the display, the intermitting message **ALARM** will be pointed out.

4.6.4 By entering **PAGE UP**, it's possible to see the second screen shot of the most important measures:

```

AUDIO LEVEL 6 dBm    PA VOLTAGE 48.0 V
PREEMPH. 75 us OFF  PA CURRENT 1.6 A
AUDIO STEREO MAX PW SET. 49.0 W
CARRIER EN. ON RFL PW SET. 6.1 W
  
```

AUDIO LEVEL	is the nominal audio signal set on the setting window placed on the rear panel: if this value doesn't match to the needed one, it's possible to choose 0 , 4.1 , 6dBm or, by placing the jumper on var , it's possible to choose a value between -6 and +12dBm.
PREEMPH. 75	is the chosen pre emphasis value, always on the rear window, also the value 50µs can be selected; the inclusion or the disabling may be performed by the keyboard in a following screen shot.
AUDIO	shows whether the transmitter is set to mono or stereo .
CARRIER EN	shows if the output power is enabled either by a keyboard command or by an external command through the IN/OUT rear connector.

PA VOLTAGE is the supply voltage of the RF power final mosfet.
 PA CURRENT is the voltage drained by the mosfet final power.
 MAX PW SET is the maximum power value which can be programmed by the keyboard in the screen shot Forward PW adj (1-50W) to avoid accidental over drivings of the following amplifiers.
 RFL PW SET is the maximum allowed output reflected power. Should this limit be reached, the direct power will be reduced to keep constant the limit value of the reflected power

4.6.5 By entering again PAGE UP, eventual alarms present in the memory will be displayed:

```

pA----- alarm number 1 ----- TOT7
ALARM FOR MODULATION ABSENCE (T>2min)
05/27/00 09 :46
mm/dd/yy hh :mm press page up>
  
```

They are stored in a chronological order ordered by number, type and date.

Besides the real alarm, also the complementary event is stored (return to normality), in order to know the alarm period time:

```

pA----- alarm number 1 ----- TOT7
MODULATION RETURNED TO NORMAL VALUE
05/27/00 09 :58
mm/dd/yy hh :mm press page up>
  
```

By entering PAGE UP, the next alarm is displayed, or, if in the last screen shot of main measures there was not any alarm, it will be displayed the screen shot for the PASSWORD request to access the measures. If inside the transmitter the Z2 jumper placed on the DLCD board (in the rear of the front display panel board) is placed to OFF, this request is skipped, so it's possible to directly set the transmitter.

4.6.6 The screen shot for the password request is the following:

```
p2-----  
enter your password for TX setting  
PASSWORD : 0000  
-----
```

To go on, it is essential entering the four numbers which can be known by reading the transmitter delivery document. If the password is unknown or it is too difficult to open the top cover by unscrewing the 20 locking screws, it is just possible to surf among the previous screen shots which give all the information about the transmitter.

4.6.7 By entering the right combination and then ENTER, the first setting of the transmitter is accessed:

```
p4- max output forward power setting -  
OLD POWER : 40 Watt  
NEW POWER : 50 Watt  
press data and enter only for new power
```

In this screen shot i the maximum value of the direct power setting can be changed by the keyboard with the limit of 50W, this to avoid to drive an eventual following amplifier, which could bear an input maximum power of few Watts, with an excessive power and harmful consequences; therefore in this screen shot output power can't be adjusted, but a remedy is taken to solve a quite common error in the output power adjustment of the exciter-amplifier systems.

The change and entry of new data may be performed by pressing the horizontal and vertical cursors and the ENTER button.

4.6.8 Entering instead PAGE UP, the following screen shot is accessed:

```
p5- max output reflected power setting -  
OLD POWER : 3.5 Watt  
NEW POWER : 2.4 Watt  
press data and enter only for new power
```

In this screen shot, like in the previous one, it's possible to set the higher limit of the allowed maximum reflected power. If the set limit tends to be exceeded, for a bad antenna operation or a bad load connected to the RF connector, the direct power is reduced proportionally so that this limit won't be exceeded, thus protecting the RF power final mosfet. Usually the reflected power limit is set to a value equal to 10% of the set direct power. Therefore, if the output power is adjusted at 90W, the reflected one can be 9W.

The higher limit of this parameter is 9.9W and the resolution is 0.1W.

4.6.9 By entering PAGE UP, the following screen shot is accessed:

```
p6----- forward power adjustment -----  
FORW PW meas: 10.2 W   REF PW meas.: 0.1W  
NEW F.PW adj: 10.2 W   CARRIER EN:    
press data and enter only for new power
```

In this screen shot the output power can be set by means of NEW F. PW adj.. The resolution is 0.1W and the new direct power data are entered by the horizontal and vertical cursors and ENTER. After the new power has been set, it will be possible to read the power measurement really present on the antenna connector (forward and reflected), which may be slightly different from the set one due to the control circuit error or it may be very different in case of standing waves on the output circuit which forces the power control circuits to reduce the power in order not to exceed the reflected power limits.

By means of the horizontal cursor, the power enable can be set, this software command doesn't operate if the transmitter is externally disabled through a CARRIER EN control placed on the rear IN / OUT connector.

Each output power variation command is softly performed with the achievement of the final value in 3 seconds approximately.

4.6.10 By entering PAGE UP the following screen shot is accessed :

```
p7----- output frequency setting -----  
LD FREQUENCY  101.300 MHZ --- lock   
NEW FREQUENCY  103.400 MHZ  
press data and enter only for new value
```

In this screen shot the output frequency can be set by the usual cursors with a resolution of 10KHz. On the display the current frequency and the new value appear.

After the ENTER key has been pressed for the new value, the output power is disabled for a few seconds, allowing the oscillator to exactly reach the new value.

4.6.11 By entering PAGE UP, the following screen shot is accessed:

```

p8--output fine frequency adjustment -
OLD VALUE : 100           NEW VALUE : 102
      number must be >0 and <255
press data and enter only for new value
  
```

All the rules concerning the radio transmitters in FM band include some limits of accuracy and stability of the output frequency. These limits usually depend on parameters of internal crystal reference, which are at the same time connected firstly to the temperature and ageing of the crystal itself. For this reason the crystal is heated at a constant temperature of 55°C, which guarantees a considerable thermal stability, however a frequency correction due to ageing is easily implemented just manually.

The present screen shot allows a very fine adjustment of the frequency value assigned to the radio station without the need to open the transmitter. By entering a correction factor between 0 and 255, the transmitter frequency can be corrected with a 20Hz step only; this operation can be performed during the normal periodical check of the transmitter or, as it is shown below, through a remote telecontrol.

By entering the new correction value, it's possible to reach a 2KHz offset in comparison to the central value.

4.6.12 PAGE UP for a new screen shot :

```

p9----- audio signal setting -----
PREEMPHASIS 75 us : OFF mono/st : STEREO
press cursor and enter only for change
  
```

In this case it's possible to insert the pre-emphasis or to set the transmitter from mono to stereo and vice versa.

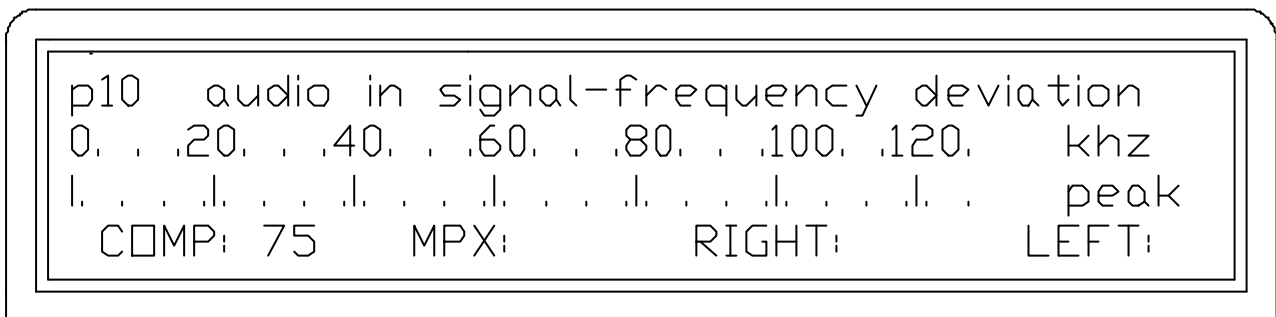
The pre-emphasis value (50 or 75µs) is switched by a jumper placed on the rear window of the rack. The pre-emphasis operates on the LEFT and RIGHT channels only.

By choosing the STEREO option, the LEFT and RIGHT channels are encoded with the stereo subcarrier addition, from which it's possible to get a synchronism in the IN/OUT rear connector (1Vpp sine wave).

On the opposite, if an external stereophonic source is already available, the LEFT and RIGHT inputs must be kept free by using the MPX input (rear BNC); in this case **the transmitter must be set to MONO even if the transmission is STEREOPHONIC.**

When the transmission is monophonic, if one enters by the two LEFT and RIGHT channels, the transmitter is modulated at the nominal value; if only one channel is available, this one must enter at the same time both in the LEFT and RIGHT channel inputs, so **they must be put in parallel otherwise the deviation would be half of the nominal one.**

4.6.13 By entering PAGE UP the following screen shot appears :



Here it's possible to see the frequency deviation value and the input signal values.

When the composite signal is chosen (addition of all the modulating signals), the numerical and visual indication appearing is the frequency modulation expressed in KHz while on the LEFT, RIGHT MPX signals, the level is measured and displayed as value 100 when it matches the nominal value.

The indication states the peak and the chosen measurement will be flashing displayed on the LCD.

By modulating the transmitter through the nominal level input signals and with fixed tone (i.e.. 400Hz), the deviation must not exceed 75KHz (COMP) and the input signal level must not exceed 100%. But if a music signal is available at the input, indication can also exceed this value and the exact rules for this check will be seen in the screen shot 11.

Besides, if the automatic audio gain control is off, the 75KHz deviation value is equivalent to 100% of the input signal values. On the opposite, if the AGC is on 75KHz deviation can be obtained by an input signal which is variable, as level, from half to the double of the nominal value.

4.6.14 By entering PAGE UP the following screen shot will appear:

```
p11-----Automatic Audio Gain Control -----
Range: +/- 6dB referred to nominal value
GAIN CONTROL: N Mod.absence ALARM: N
  press data and enter only for change>
```

In this screen shot it's possible to enter, if installed, the option of the modulation level automatic control due to the audio signals: when the AGC is on, the maximum modulation value is checked at 75KHz varying the audio amplifiers gain; the dynamic is $\pm 6\text{dB}$ and this is useful when the input signal level is not sure.

For a wider explanation about the AGC operating see paragraph **4.4**.

There is also a control on the modulation presence, since everywhere it isn't allowed to transmit by unmodulated carrier; after two minutes of modulation absence an alarm can be given and the power can be disabled. When the modulation returns to the normal value, the alarm stops and the usual operation is restored; in case of stereophonic transmission, the threshold for the modulation absence is 10KHz, because of the subcarrier value.

4.6.15 By entering PAGE UP the following screen shot appear :

```
p12      Measuring maximum FM deviation
of transmitter emission in according to
REC-CEPT/ERC 54-01E (1998) - [ ANNEX 2 ]
page up to skip>      enter to continue>
```

```
p13----- CEPT/ERC 54-01 -----
      modulation analysis over 60 sec
VERMODUL. PEAK FACTOR K press page up>
POWER MODULATION      press enter>
```

```
p14-----CEPT/ERC 54-01 -----  
0. .20. .40. .60. .80. .100. .120. khz  
over modulation factor K (must be <0.2)  
press ENTER to measurement start
```

```
p14-----CEPT/ERC 54-01 -----  
0. .20. .40. .60. .80. .100. .120. khz  
WAIT 60 sec FOR MEASUREMENT RESULT  
K= ?
```

```
p14-----CEPT/ERC 54-01 -----  
0. .20. .40. .60. .80. .100. .120. khz  
K= 2.7  
page up/down to exit or continue
```

```
p14-----CEPT/ERC 54-01 -----  
0. .20. .40. .60. .80. .100. .120. khz  
modulation power PM (must be <0)  
press ENTER to measurement start
```

```

p14-----CEPT/ERC 54-01 -----
0. .20. .40. .60. .80. .100. .120.   khz
  WAIT 60 sec FOR MEASUREMENT RESULT
PM = ?
  
```

```

p14-----CEPT/ERC 54-01 -----
0. .20. .40. .60. .80. .100. .120.   khz
          PM = -1,6 dB
  page up/down to exit or continue
  
```

The previous eight screen shots, if selected, allow to perform the measurement of the modulation analysis according to the CEPT 54-01 rule. For an exhaustive explanation of this new measurement method see chapter 7.

Briefly, it can be said that a music signal can exceed the limit threshold of 75kHz, provided that this exceeding is contained in a certain percentage. The rules concerning this topic are contained in the above mentioned regulation and in the IEC-244. Thus it's possible to quantify the excess of over modulation peak and it's possible to show, as in the appendix, that the numerical factor K fixing this limit can not be greater than 0.2. Modulation power on the opposite can not be higher than the one relating to a sine signal deviating 19KHz (reference =0dB)

The observation period, for the measurement and the calculation of these factors, is 1 minute, after that the result will be displayed.

For the calculation of the K over modulation peak factor, 1200 samplings are performed during a 60 sec measurement, and the value factor is obviously 0 if no peaks exceed 75KHz. The value 0.2 is acceptable as a higher over modulation limit; the value 0.5 shows that the modulation must be reduced of 1dB at least, values higher than K indicates strong over modulations.

For the modulation power, over 10 millions of samplings are performed during the minute of examination and power integral defined in the measurement segment is calculated; the result is compared to the one equivalent to a sine signal which deviates 19KHz; the result of the comparison is expressed in dB and it must not be higher than 0, in order to make the measurement complying with the rule. This limit is debatable and, as it has been described in chapter 7, normally in on-field measurements the values of 2,3dB are found which, after all, we estimate don't cause over modulations.

Since the peak modulation values are random (they depend, besides on the set levels, on the type of musical pieces as well), K or PM values can remarkably vary during the day relating to the type of

the transmitted program; it's useful to do many measurements at different times by trying to measure dance-music rather than spoken. By using the Personal-Computer interfaced with COM1

placed on the front panel it's possible to perform this measurement with many hours of observation periods as it will further be seen.

4.6.16 By entering PAGE UP the following screen shot is accessed:

```
p16----- clock setting -----  
OLD ---- date 06/03/00      time 08:41:34  
NEW ---- date 06/03/00      time 00:00  
      press data and enter for change>
```

Here the transmitter internal clock which is used for the memorisation of all the events can be set. At the top the current date appears, the new date at the bottom; in left to right order **month, day, year, hours, minutes, seconds** appear.

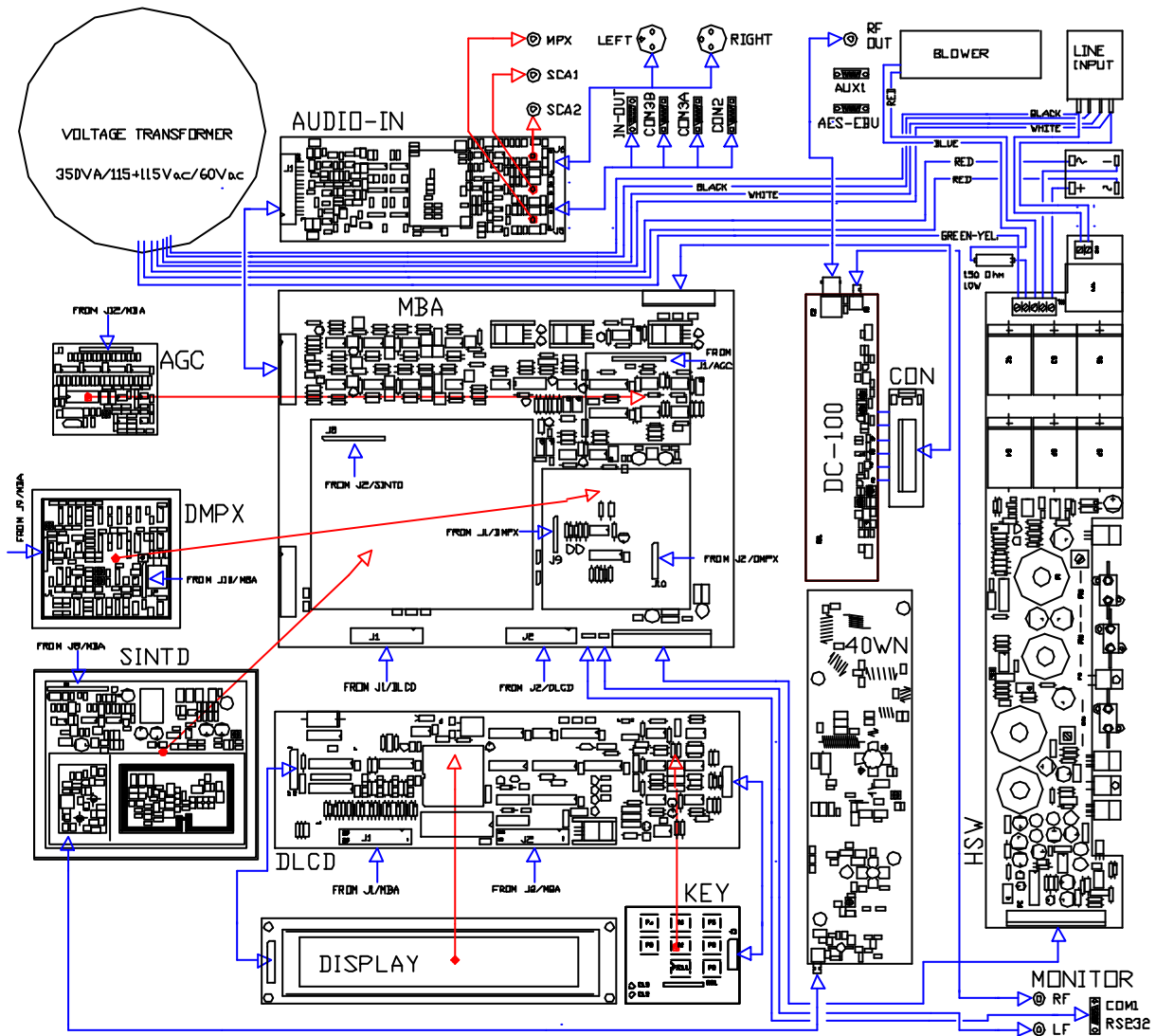
4.6.17.1 By entering PAGE UP the next page is accessed:

```
pCA----- alarms erase -----  
IF YOU WANT ERASE ALARMS  
press ENTER three times      >>>  
      page up to exit >
```

By pressing three times the ENTER button, all the alarms in the memory are erased.

By entering PAGE UP, the start position is restored.

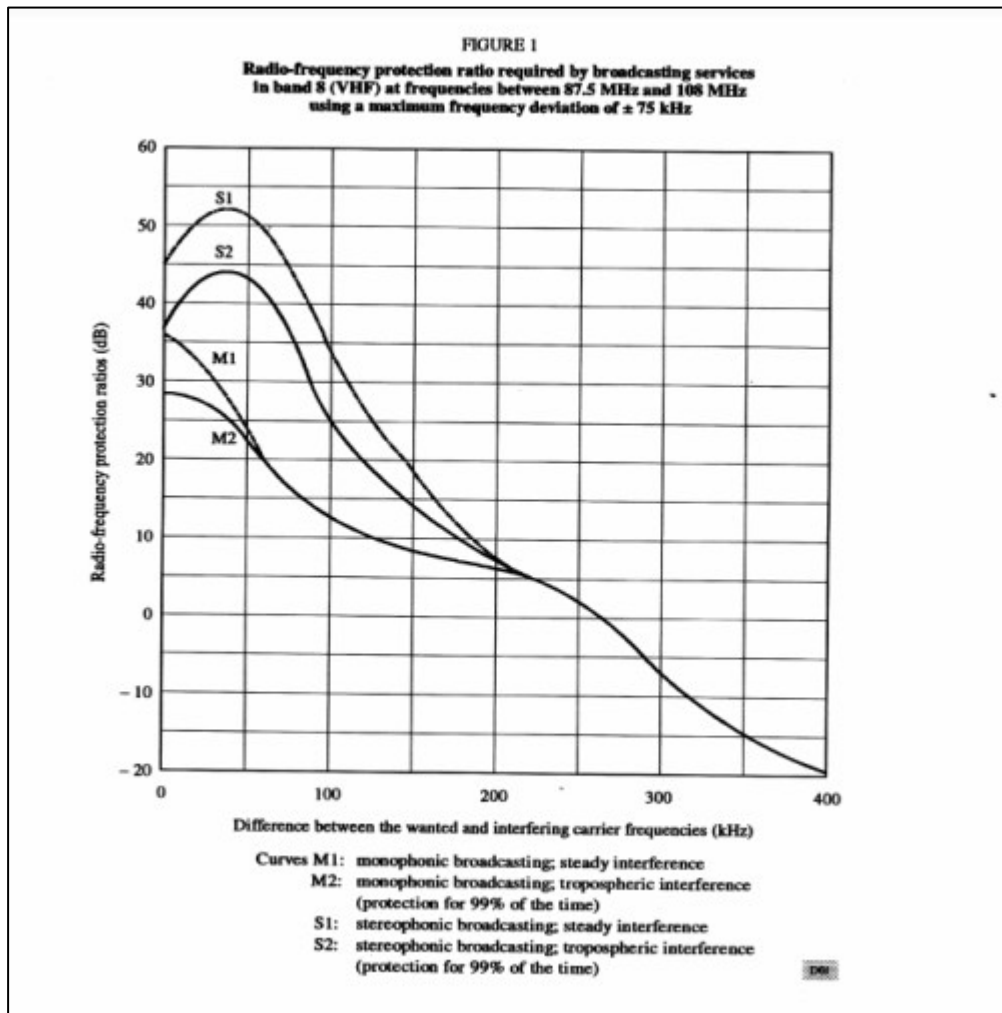
CONNECTION DIAGRAM



MODULATION MEASUREMENT

5.1 General information

The broadcast reception at frequency modulation is often made difficult because of the networks exceeding crowding; the interferences due to the adjacent channels makes the listening unpleasant. This inconvenient may be caused by an ignoring of the protection rules mentioned in the REC. ITU-R BS.412-7 of which the remarkable graphs reported below:



The graph shows that if the interfering network is at 300KHz far from the program we are listening, it must have a level higher than the maximum of 7dB, if it's at 200KHz the field intensity level at the point of listening, will be 6dB lower in monophonic or 7dB in stereophonic.

These values, expressed in dB as protection ratio, assume that the interfering network is broadcasting with the maximum allowed spectrum width and this reaches the maximum at the

correspondence of peaks and the maximum modulation power. In a laboratory it's possible to simulate the worst example of modulation by modulating the transmitter, instead of dance-music,

with coloured noise as mentioned in the CCIR 559 rule (annex B). The process is described in the IEC 244-13 standard and consists of modulating the transmitter with noise as above, with a deviation equal to 32KHz. This work condition corresponds to the maximum allowed band occupation and to a radio broadcast spreading dance-music which modulates ± 75 KHz.

At these conditions (modulated transmitter with coloured noise in accordance to CCIR-559) there is the chance to have a reference of a radiophonic transmitter at frequency modulation which occupies the maximum allowed spectrum and on which it's possible to perform all the modulation measurements repeatedly, having some parameters as results which can be applied and compared on the field to modulation measurements of a network which is broadcasting a normal music program.

The music signal can not be surely measured by a normal detector with effective or peak value, differently from a fix tone signal. The measurement must be done, being not sinusoidal or other periodical form, detecting the power of the signal self (function proportional to its instantaneous value square) or the peak with very long observation periods.

5.2 Modulation peak analysis measurement

The CEPT 54-01 rule shows, in its paragraph 4.2, how the peak measurement must be performed on the modulation of a frequency modulation transmitter.

The maximum deviation peak must be found in a 50msec window, to be sure of catching also modulating frequencies till 20Hz. At each minute 1200 representative peak modulation samples are available.

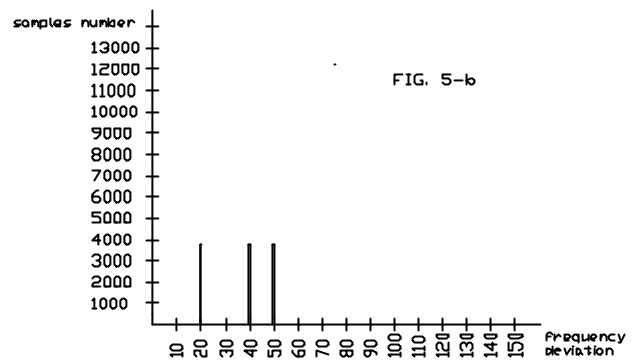
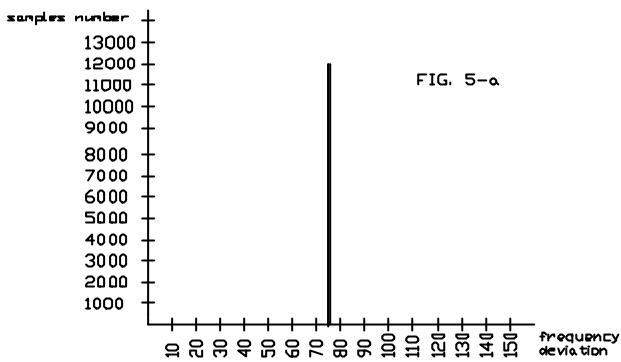
These values, obtained with even many minutes long observation periods, will be placed into a graph in the following manner:

on the abscissas, the frequency deviation will be placed with a deep scale of 150KHz

on the ordinates the number of samples of the corresponding deviation value will be placed

It may be by extreme examples it's possible to explain the concept better. Suppose to modulate the transmitter with a fix tone having a deviation of ± 75 KHz and to perform the peak measurement in object for a period of 10 minutes. Thus 12000 samples all with the value 75 will be obtained: the graph will be of a single vertical line 12000 high and placed on the abscissa 75 (fig. 5.a).

On the opposite if we modulate the transmitter for 3 minutes with ± 20 KHz deviation, then for further 3 minutes with ± 40 KHz and at last for further 3 minutes with ± 50 KHz and the observation period fixed at 9 minutes we will obtain 10800 samples 3600 of which will have abscissa 30, other 3600 samples abscissa 40 and the last ones abscissa 50 (fig. 5.b).



Now, instead of these simple examples, take our transmitter modulated with the sample noise previously mentioned, and we detect in accordance with the CEPT 54-01 the modulation peak samples in a 30 minutes observation period, so obtaining the graph. **5.c-a** whereas, if we increase the modulation, always with the same input signal, of 1dB, we'll obtain the graph **5.d-a** with a 30 minutes observation period:

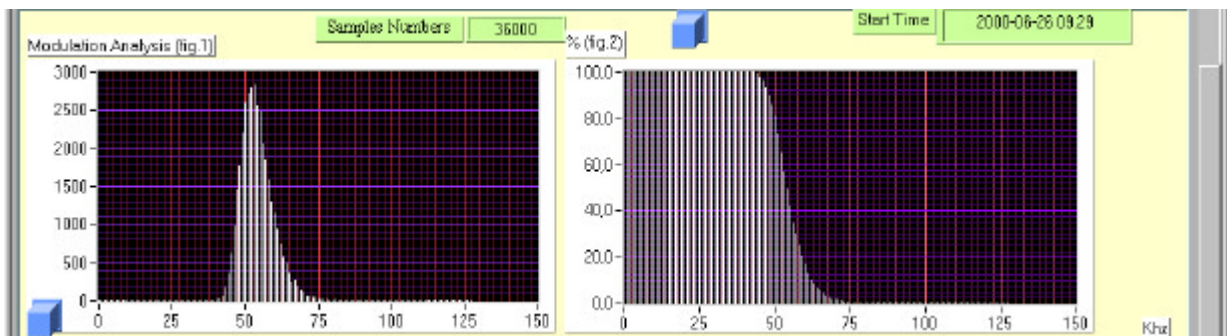


fig. 5.c-a

fig. 5.c-b

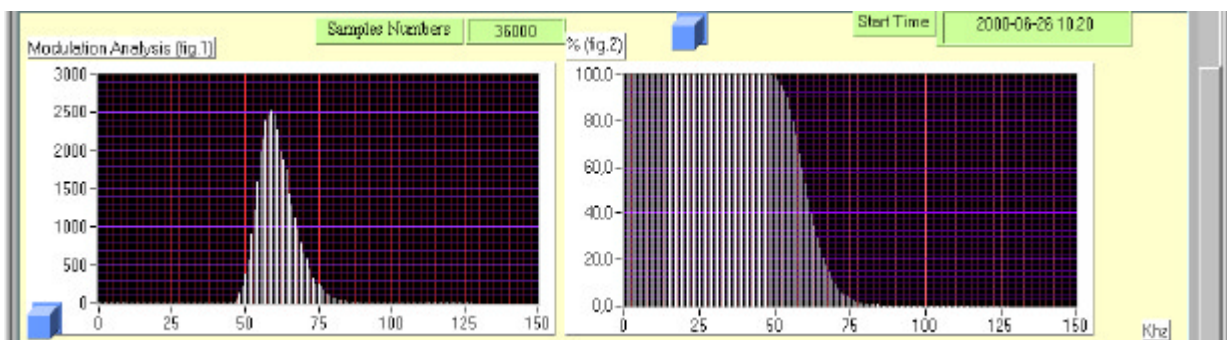


fig. 5.d-a

fig. 5.d-b

On the first graph it can be observed that during the 30 minutes about 2600 peak samples have been measured which have deviated the carrier of $\pm 54\text{KHz}$, $1500 \pm 60\text{KHz}$, $10 \pm 75\text{KHz}$, while about ten samples resulted higher than $\pm 75\text{KHz}$. What has been measured is a signal which respects all the spectrum occupation and over modulation rules; it can be soon noticed that this signal has been

higher with its modulation peaks than the threshold of 75KHz for about 0.2% of the samples so it's wrong to sustain that this value is never exceeded at all. Relying for the modulation adjustment on

the bar-graph of which almost all the transmitters are equipped, one risks to have to under modulate if the trimmer is set to remain within 75KHz.

In the figures 5.c-b and 5.d-b, as suggested by CEPT 54-01, the "Accumulated distribution plot of deviation" have been reported on the graph, relating to the graphs of the left figures -a and -b ; in this case all the samples from left to right have been added and the samples total value has been normalized.

In other words, starting from left fig. 5.d-a (0KHz) and going towards right (150KHz) it's noticed that all the samples are towards right (100 %) till about 35KHz, to 50KHz over than the 80% of samples is on the right, at 70kHhz just the 5% of samples is on the right, as it has been evidenced on the graphs -b ordinates.

The CEPT 54-01 rule and the equivalent REC. ITU-R SM.1268 and REC. ITU-R BS.412-7, at this point stop and they do not give exact and rigorous information about the interpretation of the graphs mentioned above.

On the opposite by connecting the different rules it's possible to analyse the graphs of fig. 5.c-a and 5.c-b to draw some statistic parameters which, deriving from a reference system, can, as said previously, be applied to a typical music broadcast.

So some quantities will be defined peculiar to the two graphs which will define just one over modulation factor, whose value will be used as limit parameter.

Definitions:

- M : average of all the measured samples as peak maximum every 50msec
- OM : average of the samples which have exceeded the 75KHz threshold only
- OM% : samples percentage which has exceeded 75KHz as to the total
- K : over modulation factor, defined as follows:

$$K = (OM - 75) * OM\% / 100$$

The formula can be explained easily and intuitively, since the over modulation factor is directly proportional to the peak number percentage detected over 75KHz (OM%), while the ones lower than this threshold must not give any contribution to K, and it's also directly proportional to the peaks KHz value which have exceed 75KHz (OM-75).

If no maximum peaks measured through the 50msec samples has exceeded 75KHz, we are in a favourable condition, OM = 0 and OM% = 0 and so K = 0

If all the peaks exceed 75KHz and their average is 78 then $K = (78 - 75) * 100 / 100 = 3$

Now getting the example again of the transmitter modulated with coloured noise as to the CCIR-559 and IEC-244 rules previously seen, which has originated the graphs of fig. 5c-a , 5c-b, 5d-a and 5d-b and we apply the above mentioned parameters and calculate them each minute. Thus it will be

obtained other graphs which can be added to the two previous couples, so originating a screen shot full of all the parameters relating to the peak modulation measurement:

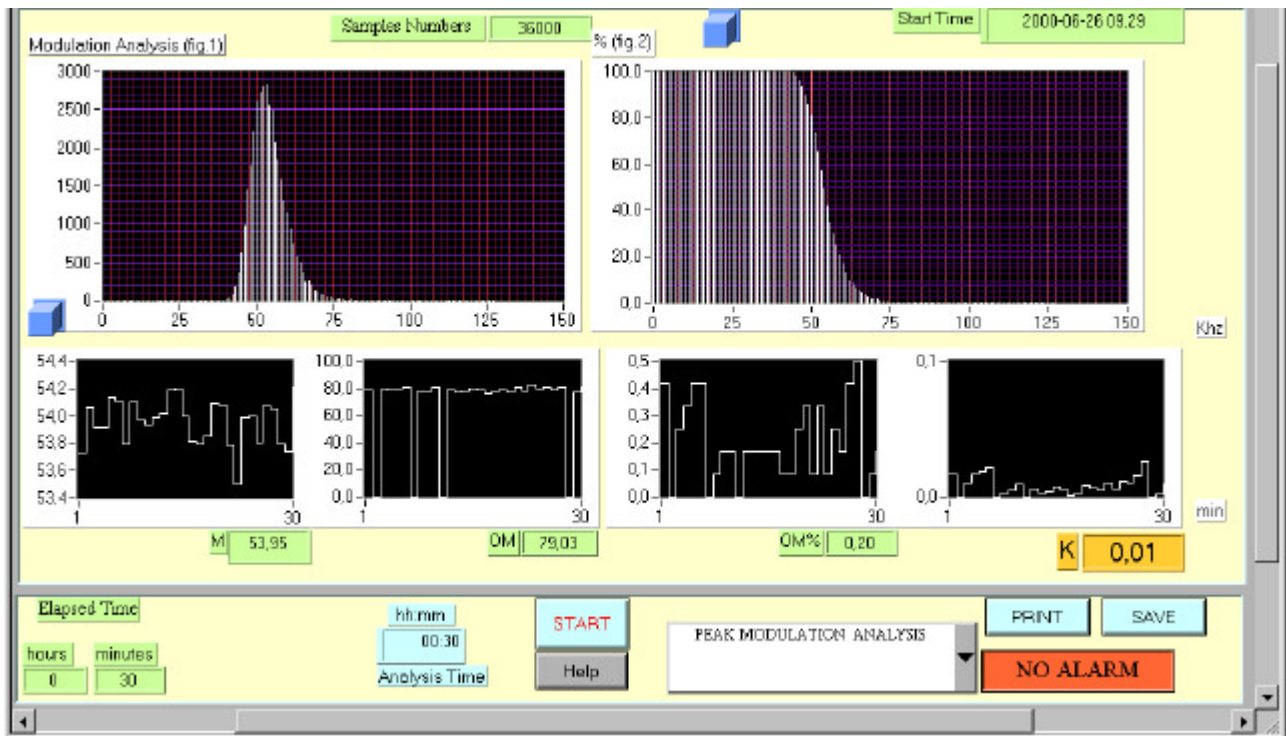


fig. 5.e

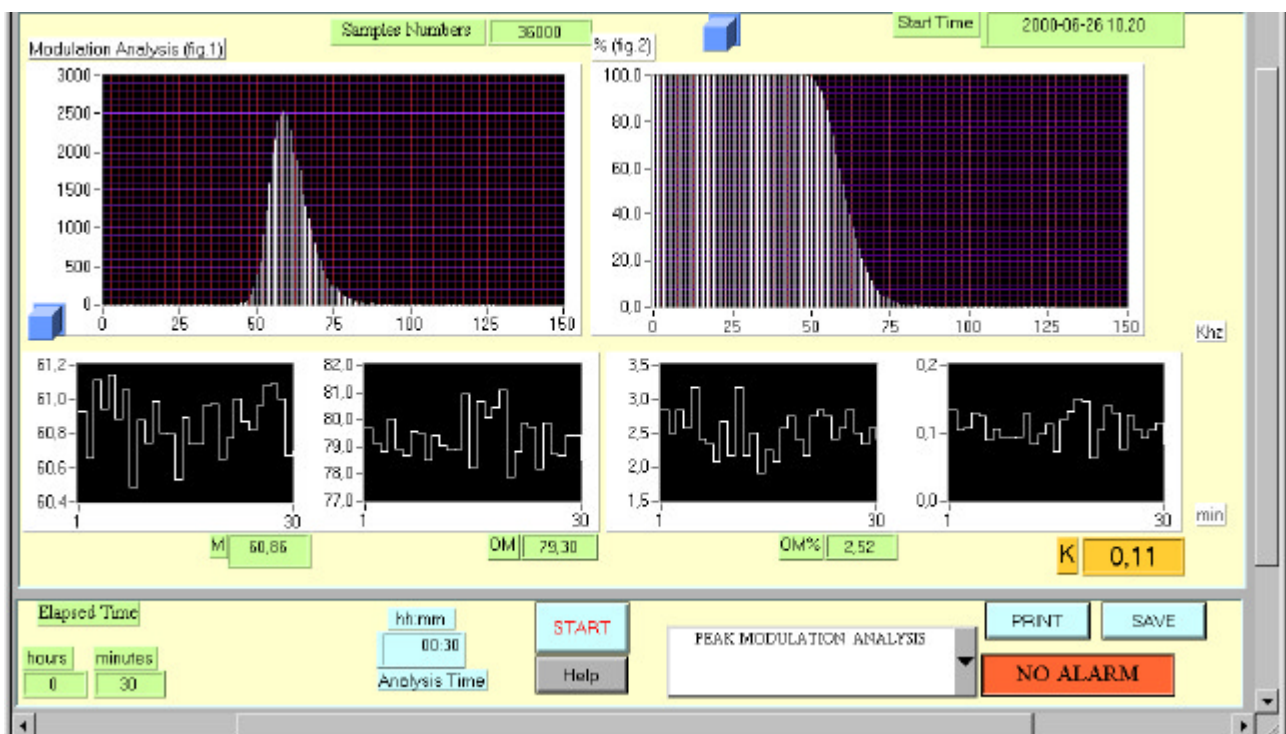


fig. 5.f

Examine the graphs of. 5.e, which could correspond to the modulation peak analysis of a regular transmitter which doesn't over modulate: in these each minute M, OM, OM% values have been calculated and consequently the K factor. It can be noticed that K value constantly keeps each minute below the **value 0.01**.

So assume this value as limit for the over modulation factor.

Increasing the modulation of 1dB the graphs in fig. 5.f are given, corresponding to a transmitter which deviates little more than $\pm 8\text{KHz}$; in this case K value is 0.11. Thus it can be noticed that for small modulation values higher than $\pm 75\text{KHz}$, K increases considerably.

The rules rightly have tried to fix some limits for the instruments accuracy which need to perform this kind of measurements, but the system weakness is surely constituted by the receiver, with all its problems concerning the answer to quick transitory and also the peaks, which is almost ever distorted by the medium and low frequency filters group delaying with over elongations or miscompensated attenuation.

So it would be ideal to draw the modulating signal, which is usually available on all the transmitters, performing all the measurements on it, after having made sure of the exact relation between the audio level and the frequency deviation. In the XPT-50 this is automatic and we think if a modulation peak analysis measurement made far from the transmitter, has produced doubtful and questionable results, it must be repeated by the instrument inside the transmitter like in the XPT-50.

The measurement must be started for a whole day observation period so to pick up the programs having most over modulation problems and consequently to act on the dynamic limiter-compressor every study must have. With this measurement method help it's possible to set best the limiter-compressor no longer by ear but by real data and no more subjective elements.

5.3 Modulation power measurement

Another important parameter determining the interference intensity on the adjacent channel is the modulation power value. The term is not of common use and the idea that the modulation power can influence the interferences is not easy to understand.

Reading the CEPT 54-01 rule it's noticed that the transmitter modulation power in object must not exceed the samples reference signal one, represented by a sinusoidal signal which deviates 19KHz of peak. **The 19KHz value has no relation with the stereophonic subcarrier value but it's the frequency deviation which the sample signal creates on the transmitter.** On the tuned receiver this signal will be carried to the loudspeaker with a certain voltage directly proportional to the deviation value; then there will be a certain electric power on the loudspeaker equal to the effectual voltage square about divided into the loudspeaker impedance; it, at less of the diffuser efficiency, coincides

to the acoustic power. So it's possible to believe the modulation power as the equivalent of the acoustic power spread by the loudspeaker, and perceived by our ears.

Thus as for the electric power, the equivalent mathematical rules are valid for the modulation power also. In the first case the value depends on the voltage square, in the second one on the deviation square.

In the case of a sinusoidal quantity, which may be voltage or deviation, the power is calculated for a time equal or multiple the semi period of the wave form, while in the case of a music signal the calculation is to be made by the integral which defines the power. Besides the modulation power value in absolute form would be of a difficult understanding, for this reason any sinusoidal signal is taken as reference whose power, for long observation periods, doesn't depend on the sinusoid frequency but only on its peak value square.

So the rule provides to measure the modulation power, which is as previously seen equal to modulating signal electric power, for one minute time period and to compare it to a sinusoidal modulating signal one which deviates $\pm 19\text{KHz}$. The result, expressed in dB, must be lower or equal to zero to comply the rule.

The modulation power integral calculation is made inside the transmitter by integrating, between 0 and 1 minute, the modulating signal square. The integration is made in a discreet manner by calculating the function area in the integration time; the signal sampling is made at a double speed respecting its bandwidth, so microprocessor is practically locked for a minute to follow instant by instant MPX signal value. After this period it performs the set values square, add them up, which is equal to the integral, then it calculates the logarithm respecting the reference sinusoidal value. The value is displayed in a numerical form or on a graph (on the PC) which has in the abscissas the time (discreet with 1min steps) and in the ordinates the value in dB of the music signal power and the reference sinusoidal one ratio.

Even in this case it's possible to refer to a modulating signal made of the usual coloured noise in accordance to CCIR-559 particularly Rec.ITU-R BS.412-7 mentions at pag.5-note 4:

The power of a sinusoidal tone causing a peak deviation of 19KHz is equal to the coloured noise modulation signal according to Recommendation ITU-R BS.641 , i.e. a coloured noise signal causing a quasi-peak deviation of 32KHz

So, for the modulation power measurement instrument alignment, it's possible to refer either to a 500Hz sinusoidal signal (the frequency is not important) which makes the carrier to deviate of 19KHz or to the coloured noise which deviates 32KHz. Both signals give the listening the same sensation of " volume intensity ", told in non technical words and not considering physiological effects of the ear sensibility at the different frequencies.

5.4 Considerations on the real measurements performed

Performing modulation measurements with the methods described so far on broadcast networks which have been modulating for years without over modulation problems, one realizes how the

limits imposed by the rules mentioned so far are particularly restrictive and maybe not in compliance with current reality.

There are some contradictions and gaps the rules self sometimes point out. We report two examples which give the idea of the real difficulty about the strict application of them:

REC. 641 , Rep.1064

5. FREQUENCY DEVIATION OF THE SIGNAL GEN.

*.The unwanted transmitter L is then modulated with a 500Hz sinusoidal one obtained from audio generator A. Attenuator B is then adjusted to obtain a deviation of 32 KHz. The audio frequency level as the input of the unwanted transmitter **before the pre-emphasis** is now measured by means of the noise voltmeter U. The noise-weighting network is switched off. Next, a noise signal C+D replaces the sinusoidal tone, and attenuator E is adjusted to obtain the same peak-reading as before at the noise voltmeter. The quasi-peak deviation is thus equal to 32 KHz. **Since the pre-emphasis has not been included in the level measurement, the actual peak deviation is higher** .The described adjustment corresponds to the present-day broadcasting practice.*

Note. – A normal sound-broadcasting programme without compression is simulated by modulating the unwanted transmitter with the standardized coloured noise signal using a frequency deviation of 32 KHz. Therefore, the results obtained with this method and this deviation are only valid for sound broadcasting programmes without compression.

The not considering the pre-emphasis leads to a difference of 1dB about, whereas the audio compressors installed now in every broadcast networks increase the modulation power of 2dB further on.

If a stereophonic signal is being examined the Rec.ITU-R BS.412-7 is very clear and it makes no distinction between the modulation power within monophonic and stereophonic signal:

Rec. ITU-R BS.412-7

2.3 *The radio-frequency protection ratios assume that the maximum peak deviation of 75 KHz is not exceeded. Moreover, it is assumed that the power of the complete multiplex signal including pilot-tone and additional signals , integrated over any interval of 60 s is not higher than the power of a MPX signal containing a single sinusoidal tone which causes a peak dev. of 19 KHz (see Note 4)*

.....
Note 4 – The power of a sinusoidal tone causing a peak dev. of 19 KHz is equal to the power of the coloured noise modulation signal according to ITU-R BS.641 i.e. a coloured noise signal causing a quasi-peak deviation of 32 KHz .

Whereas the IEC 244-13 makes a difference between monophonic signal (reference of 32KHz) and stereophonic one (40KHz):

9.4 For monophonic operation

*Check that the pre and de-emphasis filters are in circuit
Adjust output of the LF generator at <1KHz to a level which
corresponds to a frequency dev. 7.4 dB below maximum rated
deviation (32 KHz for 75 KHz dev.)*

*Measure the peak value by means of the noise meter at the out
of the demodulator (without weighting network).
Switch the LF generator out of circuit and the noise generator
in circuit and adjust the output of the noise generator , so that
the noise meter gives the same reading. The peak-dev. is now
correct.*

.....
.....

For stereophonic operation

*Check that the appropriate pre and de-emphasis are in circuit
Adjust the output of the LF generator at <1KHz to a level
corresponding to a frequency deviation of 40 KHz including
pilot tone.*

*Measure the peak value in channel B after the demodulator
and stereo encoder by means of the noise meter (without the
weighting network).*

*For the remaining procedure , see the method used for
monophonic operation*

In case of stereophonic broadcast in accordance to the IEC 244-13 rule the reference power is moved highwards of 1.9 dB in relation to the corresponding REC. ITU-R BS.412-7.