Measurements on Tuners using the Audio Analyzers UPL or UPD and Signal Generator SMT

Application Note 1GA24_1E

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Replaces 1GPAN24E

Subject to change

Products:

Audio Analyzer UPL

Audio Analyzer UPD

Signal Generator SMT

Contents:

1 Conclusion

To analyse the quality of tuners, lots of measurements have to be done. This application note presents a program, which combines these measurements to an automatically running sequence and gives a printout of the results. In addition, it explains the measurements and informs about the different standards.

2 Introduction

With the Audio Analyzers UPL and UPD we have measuring instruments which are able to carry out practically all necessary audio measurements. In addition to single measurements, whole test sequences can be performed automatically with the aid of the Universal Sequence Controller UPL-B10 respectively UPD-K1 available as an option. The option is used in the present Application Note. With the aid of this option also customized program functions not provided in the audio analyzer can be implemented. In the present example, the Signal Generator SMT is used for feeding the test signals to the antenna input to the tuner under test.

Operation of the universal sequence controller programs can be matched to the softkeys of the UPL/UPD display in appearance and functionality. This has been done for the described application.

The application uses a BASIC programs for automatic measurements on tuners. Results can be printed out or stored for further processing.

3 Preparation and Starting the Application Software

3.1 Required Instruments and Accessories

As regards the hardware, an Audio Analyzer UPL or UPD fitted with the optional IEC/IEEE-Bus Interface UPL/UPD-B4 will be sufficient to carry out the measurements. For generating the RF signals, Signal Generator SMT (alternatively SME) will be required and must contain option SM-B6 to enable stereo multiplex coding.
An external keyboard is also required.

The BASIC programs required for an automatic test run are stored on a floppy disk to be obtained from your local Rohde & Schwarz sales organization. UPL/UPD should meet the following software requirements:

- UPD firmware version 3.00 or higher,
- UPL firmware version 1.00 or higher,
- Universal Sequence Controller UPL-B10 / UPD-K1 built-in,
- UPL/UPD configured with 64-Kbyte program memory and 64-Kbyte data memory for universal sequence controller (select setting 5 using configuration tool UPLSET/UPDSET).

In Signal Generator SMT firmware version 1.63 or higher must be installed.

3.2 Software Installation

The application software is installed with the aid of installation program TUNINST.BAT which is on the floppy disk supplied:

- Quit the UPL/UPD software by pressing the SYSTEM key or Ctrl+F9 on the keyboard
- Insert floppy disk supplied
- Select disk drive (enter A:)
- Call up the installation program (enter TUNINST)
- Return to UPL/UPD program (enter C:\UPL respectively C:\UPD)

Program TUNINST generates the directory C:\TUNER in the UPL/UPD (if it does not yet exist) and copies the BASIC programs as well as the setups required for the application into this directory.

3.3 Starting the Application Software

The application program is run with the aid of the universal sequence controller. After the UPL/UPD program has been started, operation is switched to the universal sequence controller by means of key F3 (on the external keyboard).

Before switching over to the sequence controller make sure that the logging function is switched off. This is indicated by the message "logging off" displayed at the bottom righthand corner of the screen. With the logging function on, commands entered during manual operation would be appended to the program and take up additional memory capacity. The logging mode is switched off by pressing key F2 on the external keyboard.

Application programs are to be called up via path C:\TUNER as all program modules and setups are searched for in this path which may be changed either

- at the UPL/UPD level with the "Working Dir" command in the FILE panel,
- by calling up one of the setups required for measurements on tuners,
- at the universal sequence controller level by means of the BASIC command line
  UPD OUT"MMEM:CDIR\TUNER",
- via the SHELL of UPL-B10 / UPD-K1 by entering CD TUNER and pressing EXIT,

The program disk comprises the BASIC program TUNTEST.BAS for automatic test runs. It is loaded and started by entering:

- LOAD"TUNTEST"
- RUN

Loading and starting is also possible by means of the softkeys displayed at the bottom of the screen when universal sequence controller is called up.

3.4 Configuring the Application

The automatic test program controls the SMT under the IEC/IEEE-bus address 28 which is factory-set in the SMT.
If necessary, the IEC/IEEE-bus address has to be set to this value on the signal generator. To this end the menu structure UTILITIES/SYSTEM/GPIB/ADDRESS has to be called up and the numerical value entered.

Alternatively, the address in the automatic test program could be changed, which is however not recommended since this involves much more work. In this case the variable "SMT" would have to be changed in the BASIC program code to the new IEC/IEEE-bus address of the signal generator.

Measurements are carried out with a number of setups stored on the application floppy. All setups have the designation

TUN_XXXX.SAC

The code word under XXXX identifies the measurement function, eg "FREQ" stands for frequency response, "THDN" for THD+noise measurement, "SNR" for signal-to-noise ratio, etc. Only the "actual setups" are used. Contrary to the "complete setups" they comprise settings for analyzer ANLG 22kHz used in the application as well as settings made in the DISPLAY, FILE and OPTION panels. The advantage of actual setups is that they can be called up in a considerably shorter time than complete setups which hold all UPL/UPD settings.

Upon delivery the setups are configured for printout of measurement results on a "default" printer. This means, the settings of the printer which have been uses during the last operation of the UPL/UPD will be used again. The UPL/UPD screen is set to colour display and an external monitor is connected. These settings may, of course, be adapted to user requirements by modifying the settings in the OPTION panel.

Customers may wish to make other changes in the individual setups. In this case the respective setups are called up and after modification stored again under the same name. The following modifications can be made:

- Entry of a comment in the graphics display ("Comment" in the DISPLAY panel)
- Defining tolerance curves/values ("Limit Check" in the DISPLAY panel)
- Selection of settings to be displayed in the STATUS panel (marking)

IMPORTANT: If others than the above-mentioned settings are changed, a correct run of the software cannot be guaranteed.

3.5 Converting the Setups after Firmware Updates

Upon an update of the UPL/UPD firmware, setups may require to be converted. The conversion is carried out automatically every time the setups are loaded. However, this extends the loading procedure to an extent that execution of the measurement sequence is disturbed. For this reason the setups should be converted and stored before the application software is started. This can be done in two ways:

- At the DOS level by calling up the converter program
  DO_CONV \TUNER.
  In this case all setups in the TUNER directory are converted.

- At the UPL/UPD level by loading and re-storing every setup after conversion.

IMPORTANT: In setups with READ ONLY, the "r" attribute has to be cleared first (at the DOS level by means of command ATTRIB -r).

4 Operating Concept

After starting the program, the user is prompted to enter the information items to be printed on the test report. These include the type designation of the tuner to be tested and the name of the person carrying out the test. Date and time will be taken automatically from the audio analyzer system clock.
A list of possible measurements follows. A selection can be made whether an automatic test sequence or single measurements are to be made.
The CONFIG softkey (corresp. to F12) is displayed together with the list of possible measurements. When it is pressed, a menu is displayed where the units dB and % can be selected for the THD+N measurement. Moreover, the attenuation value of the antenna matching can be entered in this menu (see section 5.2 Test Setup).
After return to the main menu, the desired measurement can be selected.

At various stages of the program, sequence softkeys are displayed at the bottom of the screen. With the aid of these softkeys, which correspond to the function keys of the external keyboard, the measurement sequence can be changed.

The following functions are available:

GOTO UPD (=F5)	stops the ongoing program and switches to manual operation of the UPL/UPD, without terminating BASIC, eg for evaluating a graphics display by means of a cursor or for entering a comment.
STOP (=F7)	interrupts the ongoing measurement. It is followed by
CONT (=F7)	continue the measurement.
CONFIG (=F12)	branches to the above-mentioned configuration routine.
HARDCOPY (=F12)	outputs the screen content or measurement results to the interface selected in the OPTIONS panel (for printer, plotter or file).

5 Measurement Methods

5.1 Measurement Standards

Measurements are in line with the international standard IEC 315-4,1 issued in 1989: "Methods of measurement on radio receivers for various classes of emission; Part 4: Radio-frequency measurements on receivers for frequency-modulated sound broadcasting emissions" - and with the corresponding German standard DIN IEC 315-4 issued in July 1991: "Radiofrequenzmessungen an Empfängern für frequenzmodulierte Ton-Rundfunksendungen"
This standard describes a variety of measurement methods which can be used to determine the characteristics of mono or stereo VHF receivers. The broadcast receiver is being considered as a unit in whole, ie no measurements are carried out on individual modules. The measurement standard considers pure receivers (tuners) as well as of receivers with integrated AF amplifier (receivers) for which measurements are carried out at the loudspeaker outputs
In the standard it is expressly stated that it is neither necessary to perform all measurements nor that further measurements are excluded.
The IEC 315-4 standard is being revised at present. A few measurement methods will be modified, new measurements added. As far as already known, new measurements will be also be stated in this Application Note.

This Application Note covers the following measurements:

- Total harmonic distortion as a function of modulation frequency
- Audio frequency response
- Crosstalk as a function of modulation frequency
- Crosstalk as a function of RF level
- Stereo switchover level
- Signal-to-noise ratio as a function of input level
- Output/input signal characteristic
- Sensitivity (mono/stereo)
- Suppression of pilot and subcarrier

In this Application Note it is assumed that measurements are carried out on broadcast receivers without built-in AF amplifiers, ie on tuners. Therefore, all settings specified in the standards for the amplifier (volume, tone control, etc) need not be considered. The termination for the loudspeaker outputs is also not required since the control outputs are usually designed for high-impedance terminations and the Audio Analyzer can therefore be connected directly.

5.2 Test Setup

Audio Analyzer UPL or UPD, Signal Generator SMT and possibly a printer for printouts of results.

Audio Analyzer UPL/UPD and Signal Generator SMT must be connected via the IEC/IEEE bus.
The printer must be connected to the Centronics interface.

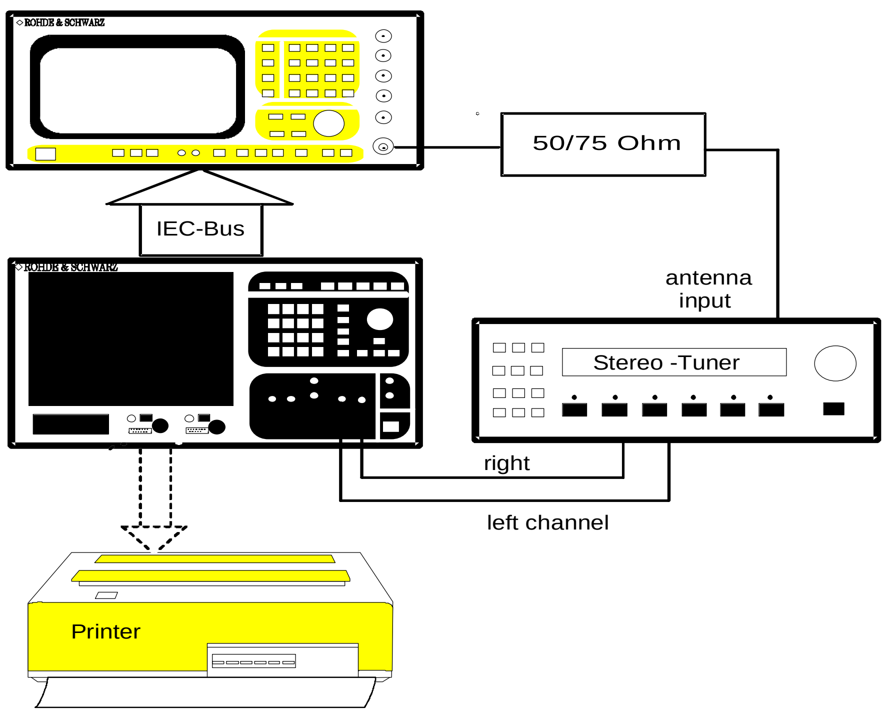

Fig. 1: Test setup for automatic tuner measurements

The RF output of the SMT has to be connected to the unbalanced antenna input of the tuner. Since the output of the SMT is 50 Ω, the generator must be matched to the tuner. Normally, the coaxial 75 Ω-antenna input is used so that we recommend the use of the Rohde & Schwarz Matching Pad of Type RAM, which can be ordered under Order No. 358.5414.02.
Should the tuner to be measured have a balanced input only, a suitable balun transformer with an impedance of 240 Ω or 300 Ω must be included. The insertion loss of the matching elements has to be considered in any case, since the measurements refer to the RF level at the antenna input of the tuner and not to the output level of the generator. By entering the attenuation value upon program start the insertion loss is appropriately considered. The attenuation values can be taken from the documentation of the matching pads or are directly labelled on the matching pads.

The tuner output for the left channel must be connected to test input 1 of the audio analyzer and for the right channel to input 2.
Proper grounding of the setup has to be ensured for all measurements, eg to avoid hum pickups. Since tuners normally have floating outputs, the inputs of the UPL/UPD are grounded by selecting "Common GROUND" and this setting has already been considered in the application setups.

6 Measurements

6.1 Standard Measurement Conditions

All measurements have to be performed in line with the standard measurement conditions. In addition to compliance with the prescribed supply voltage, ambient temperature, etc, this means also that any squelch has to be switched off for the measurements so that the results will not be falsified.
The antenna signals used for the measurements must satisfy certain conditions (standard radio-frequency input signal). These conditions are stated below so that they need not be repeated for every single measurement:

- Standard carrier frequency
  The standard carrier frequency depends on the frequency range for which the tuner is used. In our test setup a standard carrier frequency of 98 MHz is used as specified for the frequency range 87.5 to 108 MHz. For the frequency range 87.5 to 104 MHz it would have to be set to 94 MHz.

- Standard frequency deviation
  The standard frequency deviation is 30% of the permissible maximum deviation. For Germany, for example, where the permissible maximum deviation is ±75 kHz , the standard deviation is ±22.5 kHz.

- Standard modulation frequency
  The standard reference frequency of 1 kHz is to be used in this case.

- Standard input level
  The standard input level defines the antenna signal at the tuner input and is specified with 70 dB(fW) or 40 dB(pW).
  In practice the antenna voltage is stated which is 866 µV referred to an input impedance of 75 Ω.

- Filter
  For some measurements at the AF outputs the use of a bandpass filter is provided. The passband is specified in the standard with 200 Hz to 15 kHz. Below 200 Hz a filter slope of at least 18 dB per octave is required, for suppressing residual pilot tones the attenuation at 19 kHz must be greater than 50 dB and at higher frequencies greater than 30 dB. In the application, a 200-Hz highpass and a 15-kHz lowpass filter are used and the specifications of these UPL/UPD filters go far beyond the requirements of the standard.

In the following sections the individual measurements are described in the sequence in which they are carried out in the automatic test run.

6.2 Total Harmonic Distortion as a Function of Modulation Frequency

Distortions may be produced in the RF and IF circuits and detector stages of the receiver but also by the AF amplifying circuits. IEC 315 prescribes measurements for characterizing the effects caused by the amplifier section. However, thanks to improvements in amplifier technology, distortions caused by amplifiers have been pushed into the background. Today, the major part of the distortions is caused by the tuner section.

For measuring the total harmonic distortion (THD), the receiver is operated under the standard measurement conditions. As prescribed by the standard, the two stereo channels are modulated successively, the modulation frequency being swept from 40 Hz to 5 kHz. The harmonic distortion and the noise are measured with reference to the total output signal. The value is indicated in % or dB and graphically displayed (THD+N measurement) as a function of the modulation frequency. The bandpass filter prescribed in the standard specifications cannot be used in this case as also frequencies below 200 Hz have to be measured. However, to ensure that measurement results are not impaired by pilot-tone residuals, the measurement bandwidth is reduced by means of a 15-kHz bandpass filter.

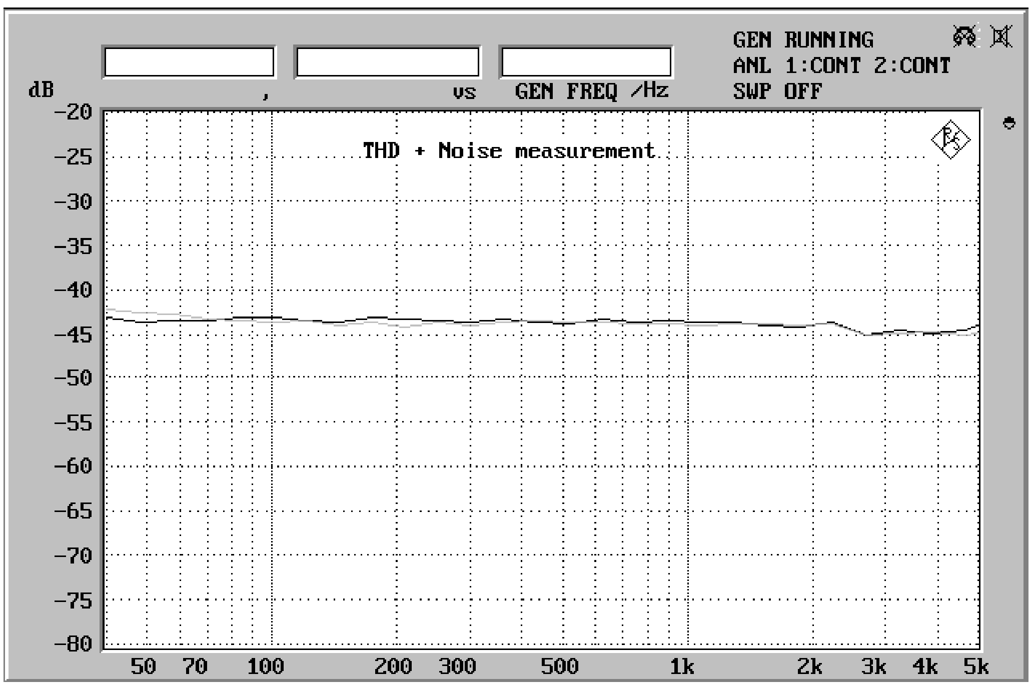

Fig. 2: THD+N measurement as a function of modulation frequency

Fig. 2 shows results obtained from a tuner in the medium-price range. The distortion is often specified exclusively to 1 kHz by the manufacturer. With top-quality receivers, values of down to 0.1 % or -60 dB can be expected.

For a more detailed analysis, the individual components of the distortion are measured. They allow conclusions to be drawn on possible sources, and in this case distortion and noise can be measured separately. Fig. 3 shows the spectrum analysis of a 1-kHz signal. The 2nd and 5th harmonic of the modulation frequency can be clearly distinguished.

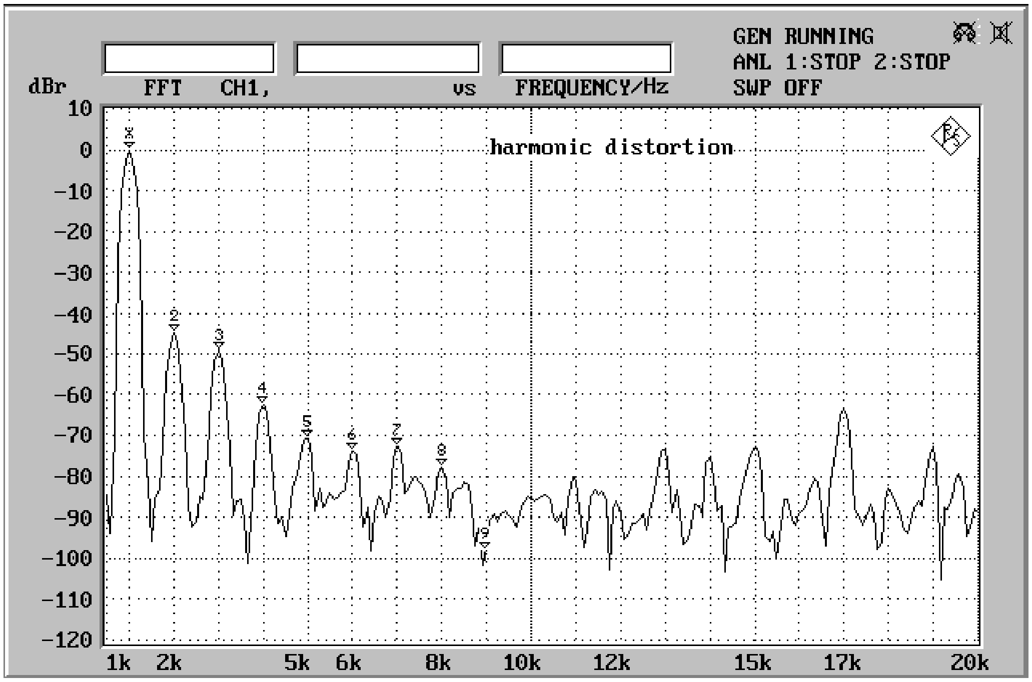

Fig. 3: Harmonic distortion of a 1-kHz signal

6.3 Audio Frequency Response

The audio frequency response of a VHF FM receiver depends on the quality of the IF section, detector, stereo decoder and deemphasis circuit.

Measurements are carried out in line with standard specifications but without the bandpass filter.

The two stereo channels are measured one after the other by increasing the modulation frequency in steps from 20 Hz to 16 kHz. Results are graphically displayed (Fig. 4). Since the transmission range for stereo broadcasting signals ranges up to 15 kHz, the drop at the upper frequency end is clearly visible in the diagram.

The emphasis of 50 µs prescribed by the standard for VHF FM transmissions is simulated by the Signal Generator SMT, ie low-frequency audio signals are modulated with a deviation of ±15 kHz. The deviation is then increased by emphasis to the ±22.5-kHz standard frequency deviation at the upper frequency limit.
This effect is compensated for by the deemphasis circuit in the tuner so that a linear frequency response of the audio signal is obtained. Modern instruments feature deviations of max. 1 dB at the lower frequency limit and max. 3 dB at the upper end of the transmission range (referred to 1 kHz).

Further results can be derived from the measurement of the audio frequency response:

- According to the latest recommendation for IEC 315, the frequency range is determined in which the level differs by not more than ±1.5 dB from that of the 1-kHz reference frequency. This range is specified as the true frequency response of the receiver. The range is marked in the diagram below, the numeric values are printed in the test report. The range in which both stereo channels are within the permissible level deviation is specified.

- The level difference between the two stereo channels is also a criterion for sound quality, as level differences shift the center of the sound spectrum. The draft standard suggests to use the maximum level difference in the frequency range from 250 Hz to 6.3 kHz for specifying the channel asymmetry (see Fig. 4).

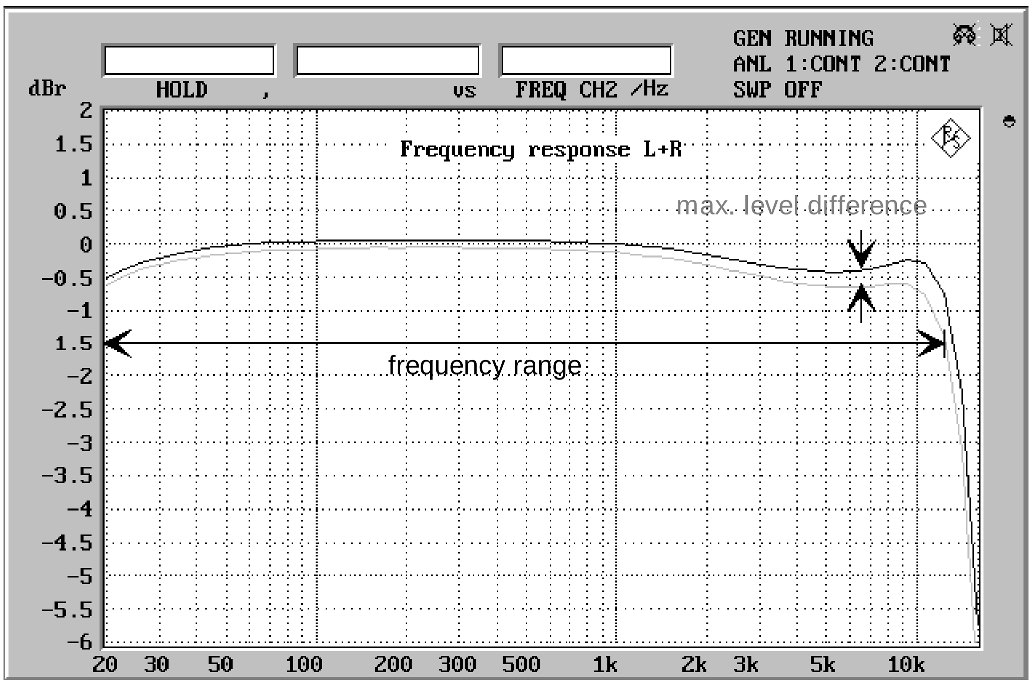

Fig. 4: Audio frequency response of a stereo receiver referred to the 1-kHz value of the right channel

6.4 Crosstalk as a Function of Modulation Frequency

Crosstalk is produced when signal components of a modulated channel are coupled into the other sound channel. It reduces channel separation and therefore the stereo effect. Crosstalk is the level ratio between the wanted signal in channel 1 and the unwanted signal in channel 2, which is coupled into channel 1. Crosstalk is measured in both directions and specified in dB.

For the measurement, the receiver should be set as specified by the standard. However, same as when measuring the audio frequency response, a 50-µs emphasis is used. At first the right channel is modulated, the modulation frequency being varied between 200 Hz and 15 kHz. The level is measured in both channels and the ratio obtained. Selective measurements are carried out to eliminate noise effects. The same measurement is carried out for the left channel. Results are graphically displayed (see Fig. 5).

In modern audio tuners, a crosstalk of 30 to 40 dB at about 1 kHz is a realistic value.

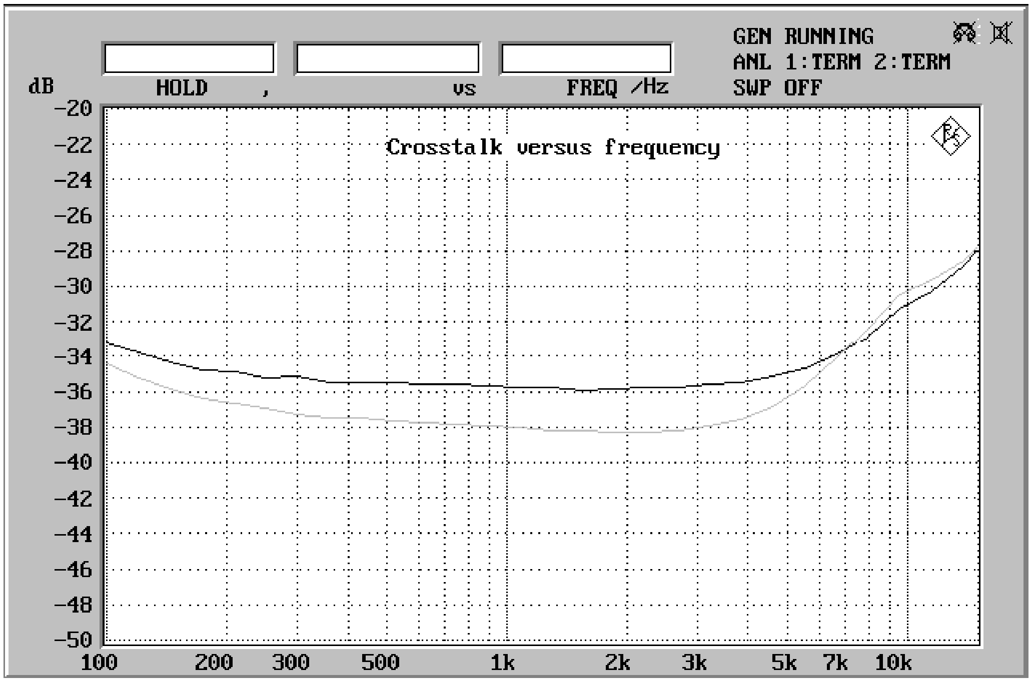

Fig. 5: Crosstalk attenuation as a function of modulation frequency

6.5 Crosstalk as a Function of RF Level/Threshold for Stereo Switchover

In another measurement the crosstalk is determined as a function of the antenna input level. The receiver is set according to the standard but with a deviation of ±67.5 kHz. The input level is increased from 100 nV to 10 mV. Results are displayed on the screen. An example is shown in Fig. 6.

The measurement shows the behaviour of the tuner when weak stereo signals are received. If signals from the antenna are extremely weak, only mono reception is possible, ie the same signal is transmitted in both channels. In the diagram this range can be identified by the absence of crosstalk (0 dB). If the antenna voltage is increased, the stereo coder starts operating at a certain level. This threshold can be seen in Fig. 6 from a sudden increase of the crosstalk. The level of the stereo threshold is specified in the test report.

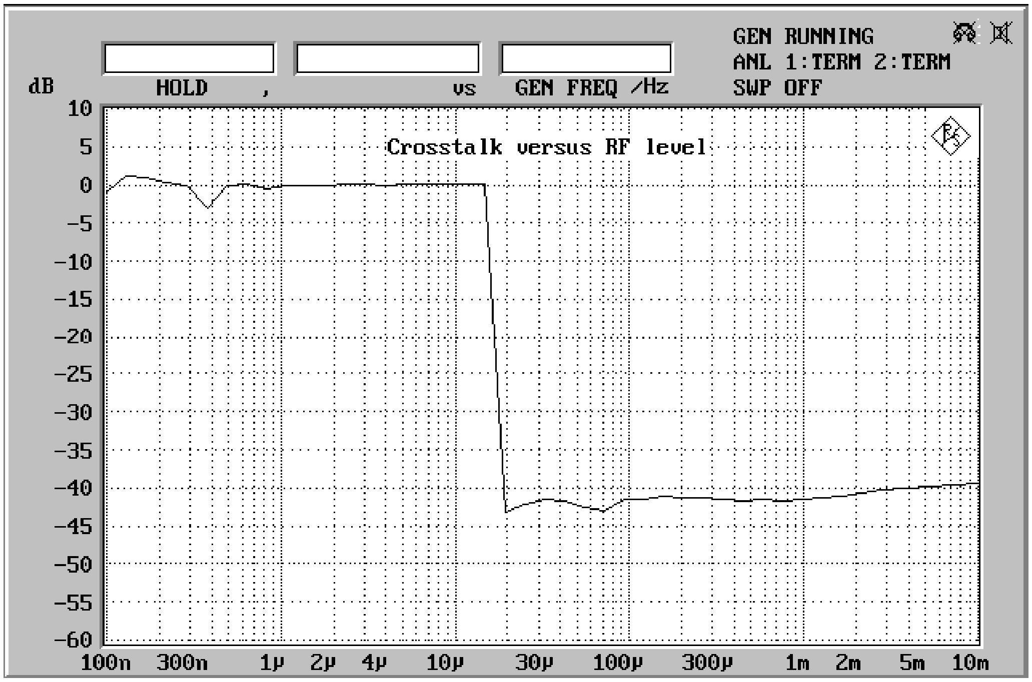

Fig. 6: Crosstalk attenuation as a function of RF level

However, because of the pilot tone procedure the noise increases when the stereo decoder is switched on, as can be seen from the output/input signal characteristic (Fig. 9) . The sudden increase of noise may be disturbing particularly in the case of strongly varying input signals from the transmitter, when the signal passes through this range repeatedly. This is often the case in moving vehicles. For this reason the variable stereo switchover was developed which causes an increase of crosstalk between stereo channels for low levels at the antenna. Since the noise in the two sound channels is of opposite phase, part of it is cancelled by the higher crosstalk. The circuit makes itself felt by the slow decrease of crosstalk after the stereo threshold as is shown in the diagram.

On many radio sets, stereo operation is indicated, for instance by means of an LED. The threshold for this stereo LED need, however, not be identical with the level at which the stereo coder begins to operate. Particularly in the case of variable stereo switchover it often happens that stereo reception is signalled only after the input field strength is high enough to cause the required channel separation.

6.6 Signal/Noise Ratio as a Function of Input Level

The S/N ratio is the ratio between the audio signal voltage and the noise voltage. Different methods may be used for measuring the S/N ratio, but at the consumer end rms voltage measurements with or without weighting filter are generally carried out. The current version of the IEC 315 standard also specifies a measurement to CCIR 468-2, but this method is only common in professional studios. The measurement with A-weighting employed in the hi-fi sector has now been considered in the latest draft of the standard and is the basis for the measurement described below.

Basically, the S/N ratio of receivers can be determined in different ways:

- In the case of the sequential method, the audio output voltage is measured with a modulated input signal present, then the modulation is switched off and the noise value is determined.

- With the simultaneous method, the level of the 1-kHz audio signal is measured with a modulated input signal present. The noise voltage is determined with the aid of bandstop filters with the RF signal still modulated. As in some case the modulated signal may increase the output noise of an FM receiver, this method meets much better the requirements of practical operation.

In this application, the simultaneous method is used and the S/N ratio is determined in an rms voltage measurement with A-weighting. This is in line with specifications of the latest draft standard and meets the requirements commonly encountered in hi-fi technology.
The receiver is operated under standard conditions with a deviation of ±67.5 kHz. The modulation is with a 1-kHz signal in stereo of opposite phase. The measurement range is limited to 200 Hz to 15 kHz by means of a bandpass filter, effects of hum or poor pilot-tone suppression not being taken into account. After determining the audio output voltage, the 1-kHz component is separated for the measurement by means of a notch filter. To avoid the noise value being influenced by the distortion of the 1-kHz signal, a measurement function is used in the Audio Analyzer UPL/UPD which does not consider any harmonics either. The S/N ratio is computed from the signal and the noise voltage and displayed in a diagram as a function of the RF input level (Fig. 7).
Since with this measurement the two stereo channels are modulated with opposite phase as specified by the standard, a signal component is present as soon as the stereo threshold is reached. During evaluation of the mono signal, the two stereo signals are cancelled because of the opposite phase and an S/N ratio of about 0 dB is displayed.

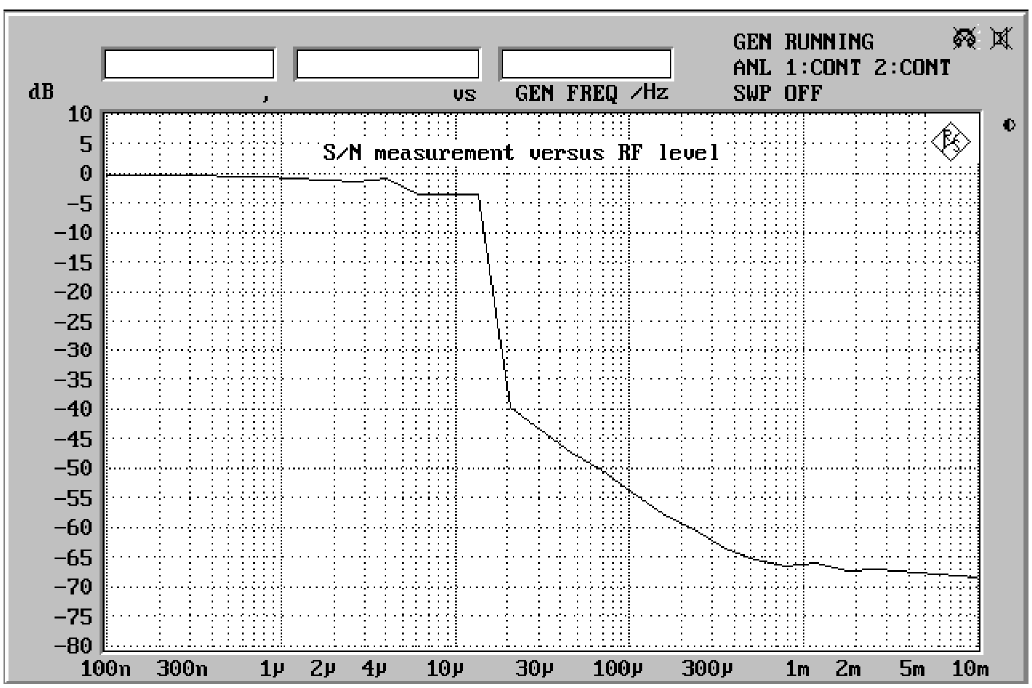

Fig. 7: S/N ratio as a function of modulation frequency

6.7 Output/Input Signal Characteristic

The output/input characteristic shows the relationship between the antenna input voltage and the audio signal generated by the tuner. This is one of the most important measurements since considerably more information can be obtained from the diagram particularly when the noise is also considered in the measurement.

The receiver is operated under standard measurement conditions but with a deviation of ±75 kHz for mono or ±67.5 kHz for stereo. The antenna level is swept logarithmically from 100 nV to 10 mV, the audio output signal measured and graphically displayed, with the maximum output voltage being set to 0 dB. The level sweep is repeated twice and the noise output voltage for mono and stereo is displayed. The curves shown in Fig. 8 are displayed.

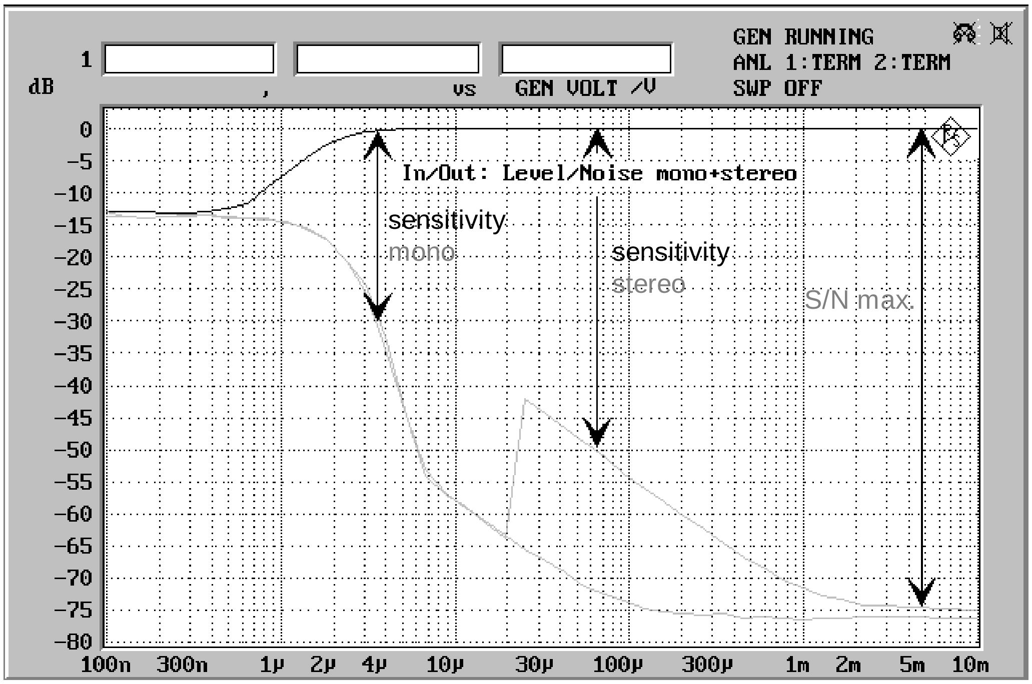

Fig. 8: Output/input signal characteristic of a tuner of the medium-price class

The following information can be obtained from the display:

6.7.1 Characteristic of Audio Output Signal

Only above a certain antenna input level is the tuner able to detect the audio signal in the RF signal. In the diagram, this is the point at which the signal curve and the noise curve separate. The respective level can be taken as the absolute sensitivity of the tuner, but this is of minor importance when receiver characteristics are to be determined.
Basically, the display shows a fast-rising curve with increasing antenna signal and than a constant signal level. Depending on the receiver, this maximum signal level (and at the same time the reference level for the measurement) is obtained with different RF input signals.

6.7.2 Noise Signal

As the RF signal level increases, the noise decreases until a minimum level is reached. As can be seen in Fig. 9 this minimum is lower with mono than with stereo reception.
A level sweep of the input signal during stereo operation yields the same characteristic as for mono. At a certain input level the pilot tone identifying stereo transmission switches on the stereo decoder (stereo threshold). The decoder starts operating which is first noticed by an increase of the noise. This effect has already been mentioned in section 5.4 (Crosstalk Attenuation). The noise decreases as the signal level increases however without reaching the minimum attained in mono reception.

6.7.3 Maximum Signal/Noise Ratio

The max. signal/noise ratio for mono and stereo is measured between the maximum audio signal level and the minimum noise level. These values are also printed in the test report. To note is the difference between this measurement and the measurement of the weighted S/N ratio described in section 5.6. In contrast to the later measurement no weighting filter is used for determining the output/input characteristic so that the results obtained are not directly comparable to those of section 5.6. In the case of the unweighted S/N measurement, the total noise spectrum is considered in the measurement while in weighted measurements, the amplitude is reduced by a filter at the lower and higher frequencies.

A max. (unweighted) S/N ratio of 75 bis 80 dB is obtained with high-quality tuners for stereo and up to 85 dB for mono reception.

6.7.4 Sensitivity Limited by Noise

The noise-limited sensitivity is the antenna level that yields an audio signal with a defined S/N ratio. This sensitivity is at the same time a measure for the fidelity of the audio signal.
The sensitivity for mono and stereo are different values: 30 dB for mono and 50 dB for stereo reception. The values are included in the test report and shown in the diagram in Fig. 9.

For modern, high-quality tuners a sensitivity of 1 µV for mono and 30 to 40 µV for stereo reception are typical values.

6.8 Suppression of Pilot and Subcarrier

For identifying stereo transmissions the so-called pilot tone is transmitted at 19 kHz together with the program signal. The pilot tone and its subcarrier have to be suppressed in the tuner in order not to disturb other devices, such as amplifiers or cassette recorders. This is done by means of a corresponding circuit in the stereo decoder or by filters at the tuner output.

The degree of suppression of the pilot tone, subcarrier and intermodulation products generated with audio signal is also a criterion for the quality of a tuner. For the measurement, the receiver should be operated under standard conditions with a deviation of ±67.5 kHz and the signal should be stereo-modulated with a 1-kHz signal of equal phase. The residual frequency components at 19 kHz (pilot tone), 38 kHz (subcarrier), and the intermodulation components at 37 kHz and 39 kHz (subcarrier ± modulation frequency) are measured. The squares of these components are added and referenced to the level at the modulation frequency. The suppression is indicated in dB.

In the present application also the spectrum of the signals is also displayed (Fig. 9). The individual frequency components can be clearly seen in the diagram.

High-grade tuners should suppress all frequency components above transmission range by at least 50 dB.

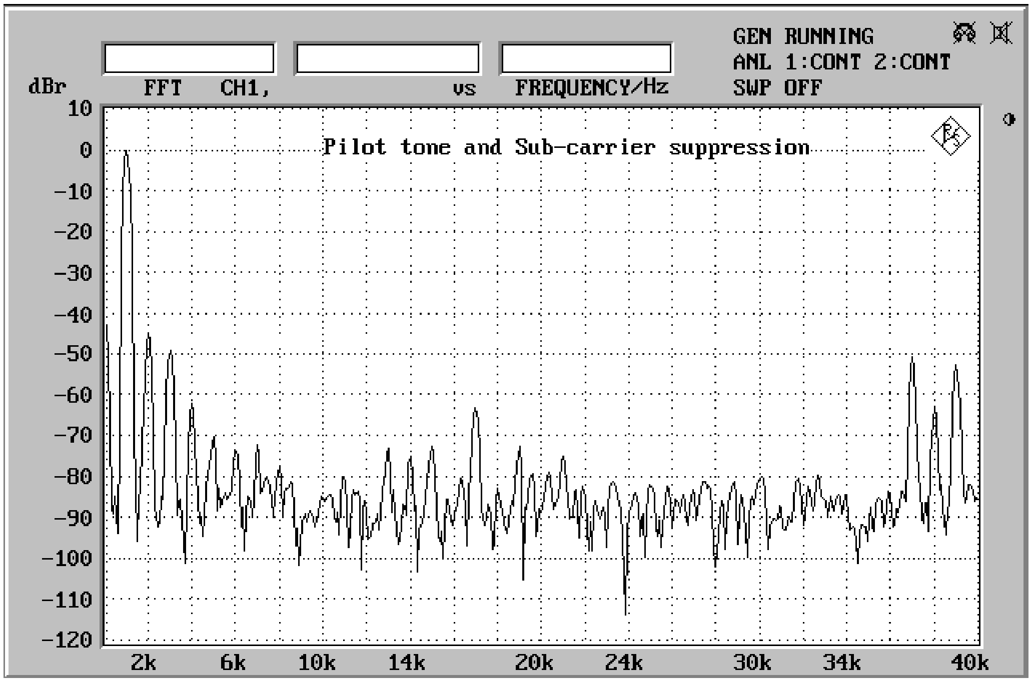

Fig. 9: Output spectrum of a tuner for 1-kHz modulation with pilot tone and subcarrier

7 Postprocessing of Measurements

Only single measurements can be manipulated. In this case the UPL/UPD has to be switched to manual operation, eg for modifying the graphics output.

7.1 Change of Task Universal Sequence Controller / Manual Operation

At the end of single-step measurements, the GOTO UPD (F5) is displayed for switchover to manual operation of the UPL/UPD without leaving the BASIC program. This may be used, for instance, for

- rescaling the graphics display
- shifting or switching the graphics cursor on or off
- adding a comment to the graphics display
- reconfiguring the printer interface
- printing out a display section with modified status panel
- displaying measured or out-of-limit values in tabular form

Pressing the F3 key of the external keyboard causes a return to the point in the application program where the BASIC program was quit.

7.2 Printout

When the test sequence is finished, a menu is displayed permitting the complete test report to be output to a printer or to be stored.

After a single-step measurement the HARDCOPY (F12) softkey is displayed printing out the graphics display.

Of course, the hardcopy function can also be triggered at the UPL/UPD level. In this case trace data and out-of-limit values can also be printed.

7.3 Restarting the Measurement

The application can be restarted any time by entering the BASIC command RUN.

7.4 Interrupting and Continuing a Measurement

The program can be interrupted with the STOP softkey (F5). The label of the softkey changes to CONT and the measurement can be continued by pressing the key again.

8 Terminating the Application

Pressing the ESC key on the external keyboard or the CANCEL key on the UPL/UPD causes a return to the previous menu level. Pressing one of these keys at the top level pressing this key terminates the program ie. by pressing the key several times the program can be terminated from any menu level.
To avoid the program being ended inadvertently, a confirmation query is displayed prior to the termination.

The software can be aborted any time by pressing CTRL + BREAK. After the entry of CONT the program is continued whereas RUN triggers a restart.

ROHDE & SCHWARZ

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