Products: Audio Analyzer R&S UPL Signal Generator R&S SML

Measurements on RF radio tuners with Audio Analyzer R&S UPL and Signal Generator R&S SML with option -B5

Application Note 1GA43_0E

A great number of measurements have to be performed to determine the quality of FM tuners. This Application Note presents a program that permits these measurements to be carried out in line with DIN EN60315-4.

ROHDE&SCHWARZ

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Contents

1 Overview

A great number of measurements have to be performed to determine the audio quality of FM tuners. With the aid of the program described in this Application Note, these measurements can be performed in line with DIN EN60315-4.

2 Operating Principle

The Audio Analyzer R&S UPL generates all required test signals. The signals are applied to the stereo coder (option R&S SML-B5) in the signal generator and modulated onto the transmitter signal. The modulated signal is forwarded to the antenna input of the DUT. The demodulated audio signals at the DUT output are transferred to the audio analyzer for measurements.

When used together with the optional Universal Sequence Controller R&S UPL-B10, the Audio Analyzer R&S UPL automatically executes complete measurement sequences and controls the signal generator via the IEC/IEEE-bus or RS-232-C interface. Thus, even measurements versus the RF signal level, for instance, can be automatically performed .

3 Hardware and Software Requirements

Required Measuring Instruments and Accessories

An Audio Analyzer R&S UPL with option R&S UPL-B10 is required for generating and measuring audio signals. RF signals are generated by the Signal Generator R&S SML (alternatively R&S SMV) which must be equipped with the Stereo/RDS Coder Option R&S SML-B5.

An external keyboard and, if necessary, a printer are needed in addition.

The BASIC programs required for the automatic measurements are stored on a diskette available from your local Rohde & Schwarz representative or can be downloaded in the form of a file from the Rohde & Schwarz website, unpacked and then stored on a diskette. The R&S UPL should meet the following software requirements:

- UPL firmware version 3.01 or higher
- Universal Sequence Controller Option UPL-B10 installed
- R&S UPL configured with 64 Kbyte program memory and 32 Kbyte data memory (using configuration tool UPLSET setting 3)

4 Test Assembly

Required are the Audio Analyzer R&S UPL, Signal Generator R&S SML and probably an HP-deskjet-compatible printer for result documentation.

Link the audio analyzer and the signal generator via the IEC/IEEE bus. Routines are available for specific measurement modules, which control the signal generator via the RS-232-C interface. Measurements can thus be started in the R&S UPL by means of a macro via the IEC/IEEE bus, and necessary settings in the R&S SML can be made from the R&S UPL via the RS-232-C interface. Since control via IEC/IEEE-bus and RS-232-C interface can be used alternately in the R&S SML, the R&S SML and the R&S UPL can also be used for other tasks in the system after a measurement macro has been processed via the IEC/IEEE bus. For details refer to Appendix A.

The printer is connected to the Centronics interface of the R&S UPL.

Connect the RF output of the R&S SML to the unbalanced antenna input of the tuner. Since the R&S SML has an output impedance of 50 Ω, the generator has to be matched to the tuner. Usually, the coaxial 75 Ω antenna input is used. We recommend to use the Matching Pad R&S RAM which can be ordered under 358.5414.02.

If the receiver to be measured is only equipped with a balanced input, an adequate balun with an impedance of 240 Ω or 300 Ω must be connected in between. Since the measurements are referenced to the RF level at the antenna input of the tuner and not to the generator output level, the insertion loss of these matching elements must always be taken into account. The actual loss must be entered under SETUP and will then be considered by the program. For loss values, refer to the matching pad documentation or to the label on the pads.

Connect generator output 1 of the Audio Analyzer R&S UPL to the external modulation input (left) and generator output 2 to the modulation input (right) at the rear of Signal Generator R&S SML. Connect the tuner output for the left channel to analyzer input 1 and the right channel to input 2 of the R&S UPL.

Make sure that measurements are performed with adequate grounding, e.g. to eliminate hum pick-up. Since tuners are normally not grounded and their outputs are floating, the inputs of the R&S UPL should be grounded provided a ground connection is not established via the antenna connected to the R&S SML. A selection can be made under SETUP / R&S UPL Input Selection.

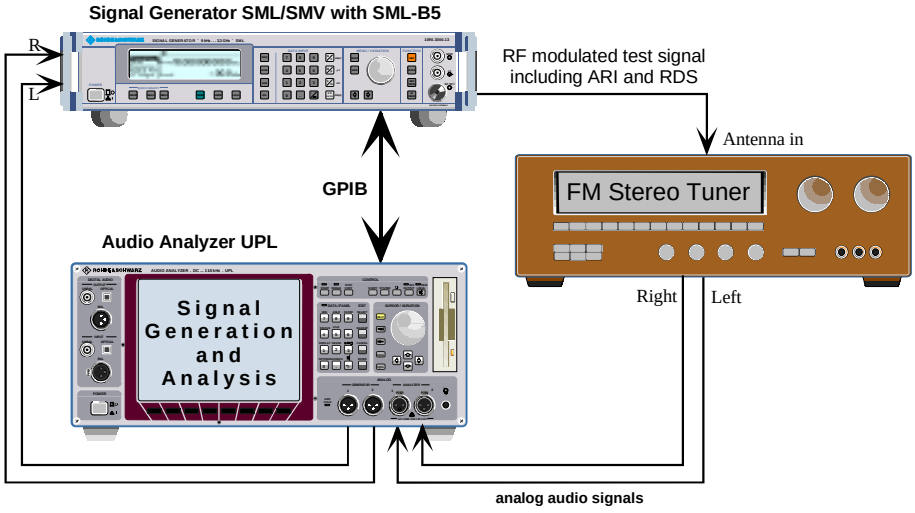


Fig. 1: Test assembly for tuner measurement

5 Installing the Software

The application software is installed with the aid of the INSTALL.BAT installation program which is also stored on the supplied floppy disk.

- Quit the R&S UPL software by pressing the SYSTEM key on the instrument or Ctrl F9 on the keyboard.
- Insert floppy disk.
- Select floppy disk drive (enter A:).
- Call the installation program (enter INSTALL).
- Return to UPL program (enter C:\UPL).

The INSTALL program creates the C:\TUNER directory in the R&S UPL (if it is not already available) and copies the BASIC programs and all setups required for the application into this directory.

Starting the Application Software

The application program is executed by way of the automatic sequence control of R&S UPL. After starting the UPL program, press the F3 key (on the external keyboard) to select automatic sequence control.

The logging function should be switched off; this is the case when "logging off" is displayed at the bottom right of the screen. With the logging function on, all commands entered in the manual mode would be appended to the program and so use up memory. The logging mode can be switched on and off with the F2 key of the external keyboard.

The application programs have to be called from path C:\TUNER where all program modules and setups are searched for. The path can be changed in the following ways:

- In the R&S UPL with the "Working Dir" command in the FILE panel
- By calling one of the setups required for tuner measurements
- In the R&S UPL-B10 with the BASIC command line UPD OUT "MMEM:CDIR '\TUNER' "
- Via the SHELL of the automatic sequence control by entering CD TUNER and then EXIT
- At DOS level by entering CD TUNER

The program floppy contains the BASIC program TUNER.BAS for automatic sequence control. The program is loaded and started by entering

- LOAD"TUNER"
- RUN

The respective softkeys displayed at the bottom of the screen in the automatic sequence control mode may be used instead.

- Upon delivery, the setups are configured so that measurement results are output to a "default" printer. This means that the printer settings used last by R&S UPL will be used again. The screen of the R&S UPL is set to colour display and an external monitor is driven (may be used).

IMPORTANT: Correct execution of the software cannot be guaranteed if changes are made in the setups.

Setup Conversion for Firmware Updates

For updating the UPL firmware, the setups may have to be converted. This is done automatically when the setup is loaded, but the conversion may delay the loading. To avoid this, the setups can be converted and stored before the application software is started. This can be done in two ways:

- At the DOS level by calling the conversion program DO_CONV \TUNER, which converts all setups in the TUNER directory
- In the R&S UPL by loading and storing each setup

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

6 Measurements to Standard

Standard Test Conditions

All measurements are to be performed under test conditions specified by the standard. In addition to correct supply voltage, specified ambient temperature, etc, this also means that any squelch that may be used has to be switched off in order not to impair the measurements.

The antenna signals used for the measurements must meet certain requirements (standard radio frequency input signal). To avoid description for each single measurement, all the conditions are listed and described below:

Standard Test Frequency

Frequency range in MHz	Standard frequency in MHz
65.8 to 73.0	69
76.0 to 90.0	83
87.5 to 104.0	94
87.5 to 108.0	98

The standard test frequency is a function of the frequency range of the receiver. The desired test frequency in the range from 65 MHz to 108 MHz can be entered under SETUP.

Standard Frequency Deviation

Operating mode/signal	RMSD ± 50 kHz	RMSD ± 75 kHz
Mono	± 50 kHz	± 75 kHz
Stereo	± 45 kHz	± 67.5 kHz
Pilot tone	± 4.5 kHz	± 6.75 kHz

The standard frequency deviation corresponds to the permissible rms deviation (RMSD) for mono and to 90% of RMSD for stereo. The maximum system deviation of ±50 kHz or ±75 kHz can be selected under SETUP. The permissible useful deviation (90% of RMSD) and the pilot tone deviation (9% of RMSD) are automatically calculated from this value.

Preemphasis

The fact that the amplitude of voice and music signals goes down when the frequency increases is normally utilized in sound broadcasting to reduce the noise. Preemphasis can be used in this case to increase the high signal frequencies during modulation in the transmitter. The inverse frequency response in the receiver again reduces these signal components so that a flat overall frequency response is obtained, but the reduction of the high frequencies in the receiver significantly reduces the noise. When measurements are performed, care must however be taken that the maximum deviation of the system is not exceeded even at high frequencies while preemphasis is on. Therefore, if measurements are performed at the modulation frequency with preemphasis on, the deviation should be

adjusted so that the maximum permissible deviation is only attained at a modulation frequency of 15 kHz.

The frequency response of preemphasis has the effect of a 1st order highpass filter with predefined time constant. A country-specific value of 50 µs or 75 µs is used. Measurements without preemphasis can also be performed.

Preemphasis with a time constant of 50 µs increases the signal by a factor of about 4.8 at 15 kHz relative to low frequencies. This yields the maximum deviation that can be adjusted for frequency response measurements (approx. 20% of the maximum deviation with 50 µs preemphasis and approx. 14% with 75 µs preemphasis). This influence must also be taken into account for measurements with the 1 kHz standard test frequency. In this case the setting is approx. 95% at 50 µs preemphasis and approx. 90% at 75 µs preemphasis.

A preemphasis of 0 µs (no preemphasis), 50 µs or 75 µs can be selected under SETUP.

Standard Modulation Frequency

The 1 kHz standard reference frequency should be used in this case.

Standard Input Level

The standard input level determines the antenna signal at the tuner input. It is specified with 70 dB(fW) which corresponds to 40 dB(pW). In practice, the antenna voltage is specified in most cases. A value of 70 dB(fW) corresponds to 866 µV at an input impedance of 75 Ω.
The antenna test voltage to be used can be entered under SETUP in the range 0.1 mV to 10 mV. This value is used for all measurements that are performed without regard to the RF signal level.

Filters

A bandpass filter is required for some measurements at the audio frequency outputs. The filter's passband range is 200 Hz to 15 kHz. To suppress residual pilot tones, the attenuation at 19 kHz must be higher than 50 dB. This filter can be directly selected in the R&S UPL under IEC TUNER. It either meets or exceeds the standard.

The A weighting filter to IEC 60651-1 is used for weighting noise signals.

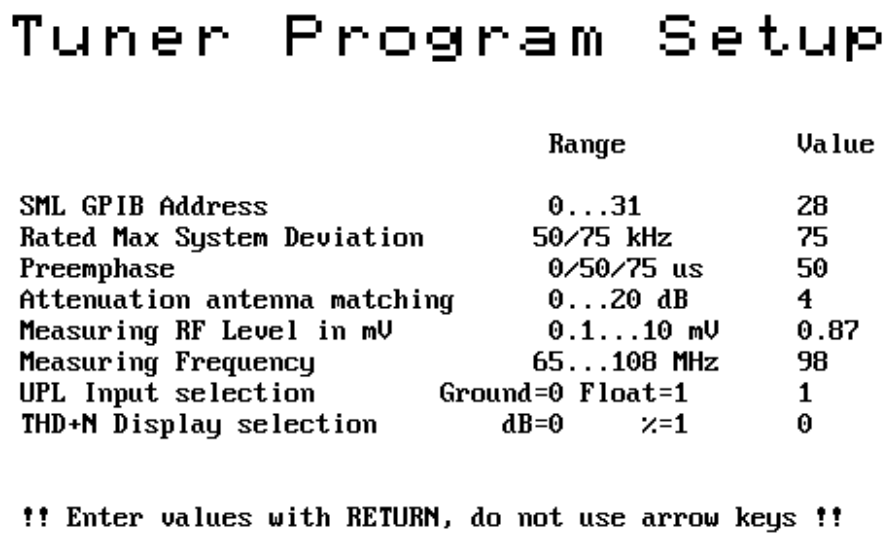
Configuration (SETUP menu)

F5	F6	F7	F8	F9	F10	F11	F12
END	FRQ_RESP	THDN_FRQ	THDN_DEV	CRSS_FRQ	CRSS_LEV	CRSS_DEV	→

Press key F12 to display the next level of the softkey labels.

F5	F6	F7	F8	F9	F10	F11	F12
←	S/N_LEV	IN/OUT	PIL_SUPP		ALL	RECALL	SETUP

Press the SETUP key to select the configuration menu. The following is displayed:



Enter the desired values and confirm with RETURN. After the last value has been entered, all values are stored in a file and automatically used each time the program is restarted.

Operation

F5	F6	F7	F8	F9	F10	F11	F12
END	FRQ_RESP	THDN_FRQ	THDN_DEV	CRSS_FRQ	CRSS_LEV	CRSS_DEV	→

Clicking the respective key starts the test routine. Since there are more selection items than softkeys, the next softkey levels are called with F12.

F5	F6	F7	F8	F9	F10	F11	F12
←	S/N_LEV	IN/OUT	PIL_SUPP		ALL	RECALL	SETUP

The next higher level can be selected with the F12 key as long as the → arrow is displayed below the key. With F5, the user can return to the next lower level as long as the ← arrow is displayed below the key. At the lowest level, END is displayed instead of the arrow. After pressing F5, the query "Do you really want to quit?" is displayed allowing the test program to be terminated.

A test routine is started by clicking the respective key, but the tuner to be measured has to be aligned to the test frequency before the routine is started. When the program is started, the R&S SML is automatically set to the desired test frequency and the desired antenna level.

After each measurement, the result is displayed and the softkeys are labelled as follows:

F5	F6	F7	F8	F9	F10	F11	F12
	CONT			EXP-FILE	TRC-FILE	PCX-FILE	PRINTER

A measured trace can now be stored in the form of an export file, trace file or PCX picture, or a hardcopy can be printed. The files are stored in the C:\TUNER\RESULTS directory. After storage, the respective key label is blanked to prevent the trace being stored twice.

Clicking the CONT key restores the selection menu for the various measurements.

When the EXP_FILE key is pressed, the displayed traces can be saved in a file in ASCII export format. This file has the name EXPxx.EXP, xx representing a consecutive number (of max. 5 digits). This allows direct import and processing of measurement results by means of other programs such as Excel.

When the TRC_FILE key is pressed, the displayed trace is saved in a file in ASCII format. This file has the name TRCxx.TRC, xx representing a consecutive number (of max. 5 digits). The TRC files can be reloaded in the R&S UPL and displayed.

The screen content can be copied into a PCX file with the aid of the PCX_FILE key. This file has the name PICxx.PCX, xx representing a consecutive number (of max. 5 digits). Thus the measurement results can also be used in word processing programs, for instance. The entire screen except for the softkey line is always copied.

Since both the EXP, TRC and PCX files are consecutively numbered, it is useful to copy the files of a measurement sequence, for instance, and to save them under a new name. The original files can then be deleted. Thus, results can be identified more easily and a mixup between them avoided.

To this end, a DOS shell can be called after termination of the test program (e.g. with key F5) by entering the command SHELL <RETURN>. The files can then be copied or renamed with the aid of DOS commands (standard procedure in the C:\TUNER\RESULTS directory). Entering EXIT <RETURN> restores BASIC without the program being cleared. The program can be immediately restarted with RUN.

The screen content can be output to a printer by pressing the PRINTER key. In this case the desired printer settings are not selected by the program. The printer remains set as selected last in the manual mode of the R&S UPL. The desired printer, scaling and format should therefore be manually set once in the OPTION panel of the R&S UPL prior to the measurement. It is recommended to select LOW or MEDIUM resolution and as far as possible integer scale factors for the printer output. If fractional scale factors (especially values <1) are used, the pixel values are interpolated and the print quality might be reduced.

When RECALL is selected, all saved data records are displayed. After a data record has been selected, the data is loaded and results are displayed in numeric form like after a measurement.

An automatic sequence of all measurement functions is started with ALL. All measured traces are temporarily stored and evaluated by the program, if required. After all measurements have been terminated, the results are displayed numerically and softkeys are labelled as shown below:

```
MEASUREMENT OF FM RADIO TUNER WITH AUDIO ANALYZER UPL


Measurement results:
  Audio level Left @ 1kHz @ 90%RMSD:          1.422V
  Audio level Right @ 1kHz @ 90%RMSD:         1.433V

  Maximum Signal/Noise ratio A wtd.:          75.9dB
  RF level for 50 dB S/N A wtd.:              59.9µV
  RF level for 40 dB S/N A wtd.:               3.3µV
  RF level for 30 dB S/N A wtd.:               2.6µV

  Sensitivity for Stereo switching:           23.6µV

  Pilot suppression:                          75.0dB
  Minimum pilot or spurious suppression:      64.6dB
```

F5	F6	F7	F8	F9	F10	F11	F12
BACK			VIEW		SAVE		REPORT

When the SAVE key is pressed, the user is first asked to enter additional information for the report, and then the results are stored after a file name has been entered (max. 8 characters). The following files are created in the C:\TUNER\RESULTS directory.

- Name.REP Report information
- Name.RES Numeric measurement results
- Name.FRQ PCX file of frequency response measurement
- Name.TNF PCX file for THD+N versus frequency measurement
- Name.TND PCX file for THD+N versus deviation measurement
- Name.CRF PCX file for crosstalk versus frequency measurement
- Name.CRL PCX file for crosstalk versus RF level measurement
- Name.CRD PCX file for crosstalk versus deviation measurement
- Name.SNL PCX file for S/N versus RF level measurement
- Name.IOL PCX file for IN/OUT versus level measurement
- Name.PIS PCX file for pilot tone suppression

The program temporarily selects the printer settings desired for report printing. It is assumed that the printer is deskjet-compatible. This printer type is emulated by laserjet and many other printers. After printout, the original settings are restored.

Using the VIEW key the grahpics can be reviewed in a sequence.

7 Measurement Functions

Audio Frequency Response

The audio frequency response of a UHF receiver is influenced by the quality of the IF section, detector, stereo coder and deemphasis circuit.

The measurement is performed under the conditions specified by the standard but without a bandpass filter.

The emphasis of 50 µs or 75 µs specified by the standard for VHF FM transmissions is simulated in the Signal Generator R&S SML. This means that low-frequency audio signals are modulated with a low deviation. The frequency deviation is then increased by emphasis to the maximum permissible deviation at the upper frequency limit.

This effect is compensated for by the deemphasis circuit in the tuner so that the frequency response of the audio signal becomes as linear as possible. Modern instruments have a deviation of max. 1 dB at the lower frequency limit and of max. 3 dB at the upper end of the transmission range (referenced to 1 kHz).

The level deviation between the two stereo channels is also a quality criterion because level differences shift the center for stereo sound impression.

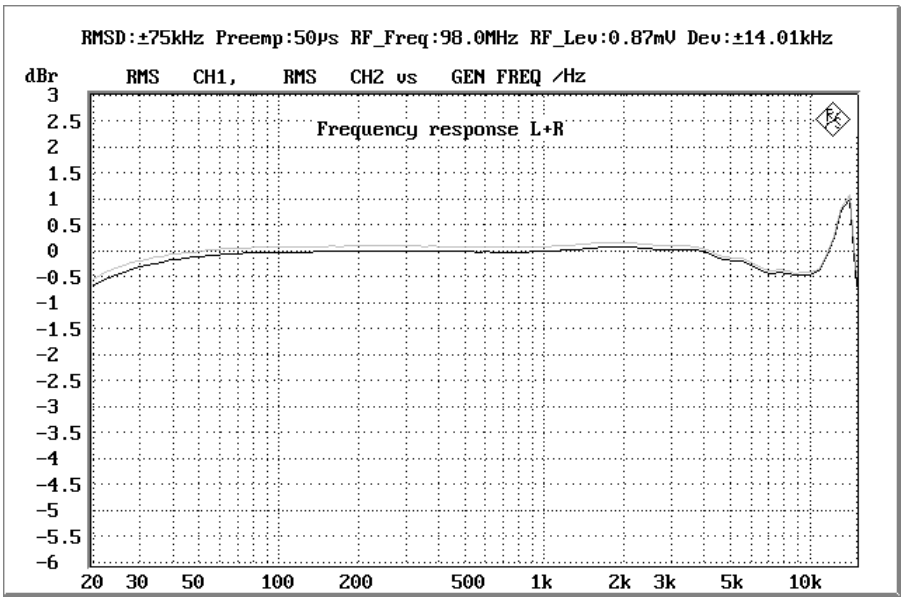


Fig. 1: Audio frequency response of a stereo receiver referenced to 1 kHz in the left channel

THD and Noise as a Function of Modulation Frequency

Distortions are caused by RF and IF sections and by the detector in the receiver but also by AF amplification circuits. IEC 60315 specifies also measurements that characterize the effects caused by the amplifier section. However, most of the distortions are normally produced by the tuner.

For THD measurements, the receiver is operated under standard conditions. The two stereo channels are modulated simultaneously; the modulation frequency is swept between 20 Hz and 5 kHz. THD and noise are measured with reference to the total output signal. The result - in % or dB - is graphically displayed versus the modulation frequency (THD+N measurement). The bandpass filter specified by the standard cannot be used here because frequencies below 200 Hz are also to be measured. In order not to corrupt measurement results by residual pilot tones, the measurement bandwidth is limited by a 15 kHz lowpass filter.

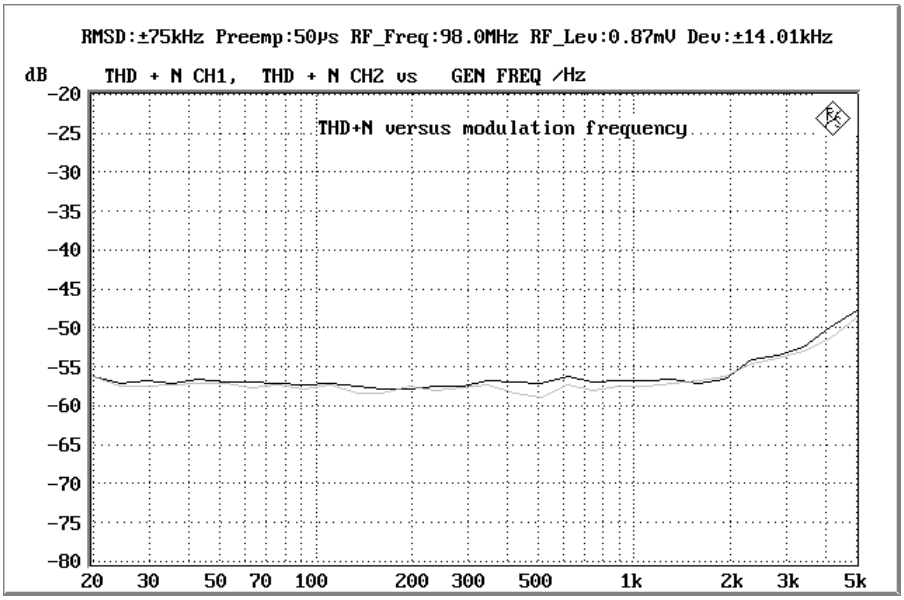


Fig. 2: THD+N measurement versus modulation frequency

THD and Noise as a Function of Modulation Deviation

In Fig. 2, THD was measured versus frequency at a deviation reduced by preemphasis. Particularly in the detector stage of the tuner, the THD may considerably vary depending on the actual frequency deviation. This effect can be determined by a THD measurement at 1 kHz versus the signal deviation.

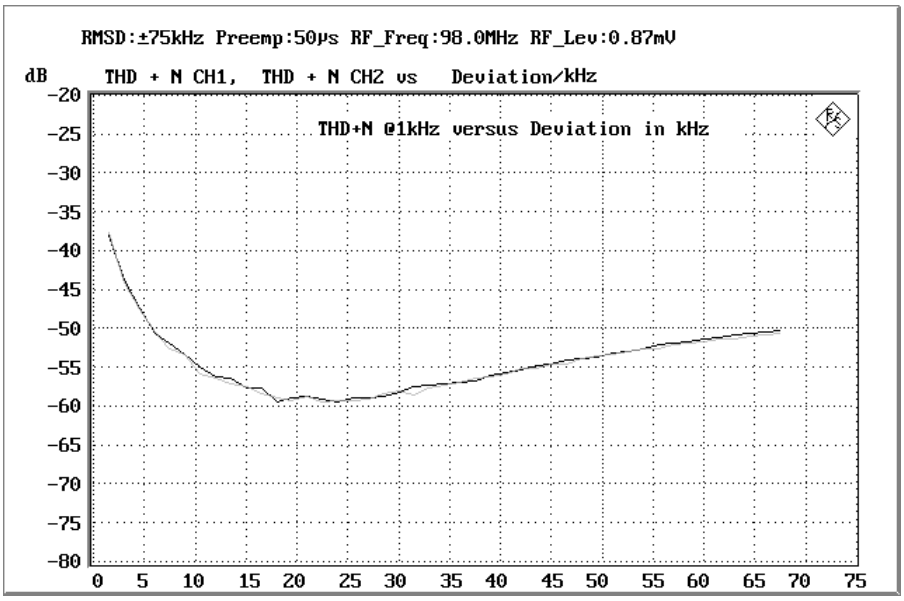


Fig. 3: THD+N measurement versus modulation deviation

When the deviation is small, the noise component dominates while the THD increases with increasing deviation. Fig. 3 shows the result of a high-class tuner where THD increases only slightly at larger deviations.

Crosstalk as a Function of Modulation Frequency

Crosstalk occurs when signal components of a channel are coupled into another audio channel. This reduces channel separation and thus impairs the stereo effect. Crosstalk attenuation is the level ratio of the wanted signal in a channel to the unwanted signal coupled into the other channel. It is specified as attenuation in dB. Crosstalk is measured in both directions.

The measurement is performed under the conditions specified by the standard. As with measurements of the audio frequency response, emphasis is switched on so that a smaller deviation is set at low frequencies. Only the left channel is modulated at first with a modulation frequency that is varied between 200 Hz and 15 kHz. The level is measured in both channels and the ratio is formed. To suppress the noise components, a selective measurement is carried out. The measurement is repeated in the modulated right channel. Results are graphically displayed as shown in Fig. 4.

Common crosstalk values at 1 kHz are within 30 to 40 dB.

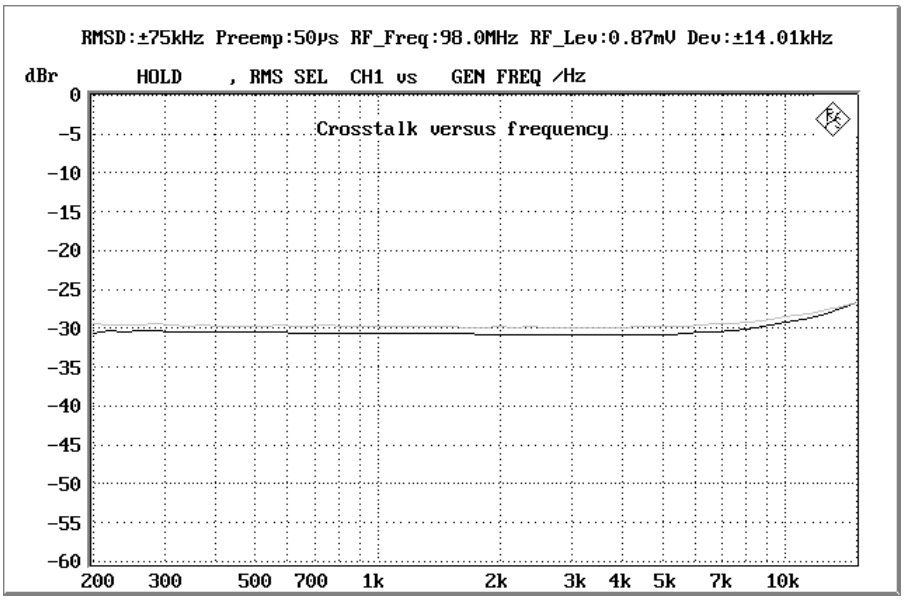


Fig. 4: Crosstalk attenuation as a function of modulation frequency

Crosstalk Attenuation as a Function of Modulation Deviation

The crosstalk attenuation may also be a function of modulation deviation. To investigate this effect, the crosstalk attenuation can be measured as a function of the deviation. The measurement is performed analogously to that versus the modulation frequency.

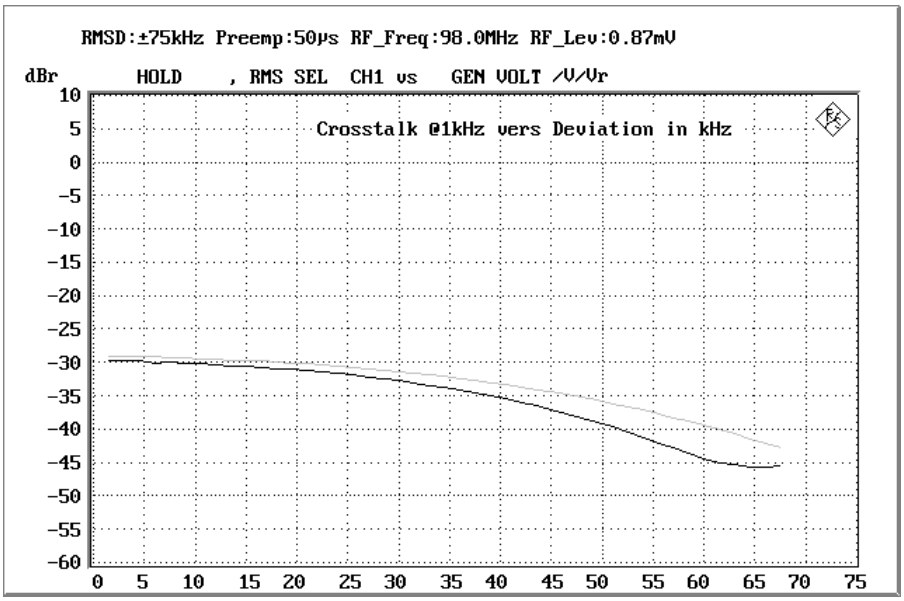


Fig. 5: Crosstalk attenuation as a function of modulation deviation

Crosstalk as a Function of RF Level / Stereo Switching Threshold

Another test is crosstalk measurement as a function of antenna input level. The receiver is operated under conditions specified by the standard but is set to maximum deviation. Starting at 100 nV, the input level is increased to 10 mV. Results are graphically displayed as is shown in Fig. 6.

This measurement shows the behaviour of the tuner when weak stereo signals are received. In the case of very weak antenna signals, reception is in the mono mode, i.e. the same signal is transmitted in both channels. In the diagram, this can be identified by the absence of crosstalk attenuation (0 dB). When the antenna voltage is increased, the stereo decoder starts operating at a certain level. This stereo threshold is clearly visible in Fig. 6 because of the sudden increase in crosstalk attenuation. The level of the stereo threshold is specified in the test report. For this purpose, a point is evaluated that has a crosstalk attenuation of 10 dB in both directions.

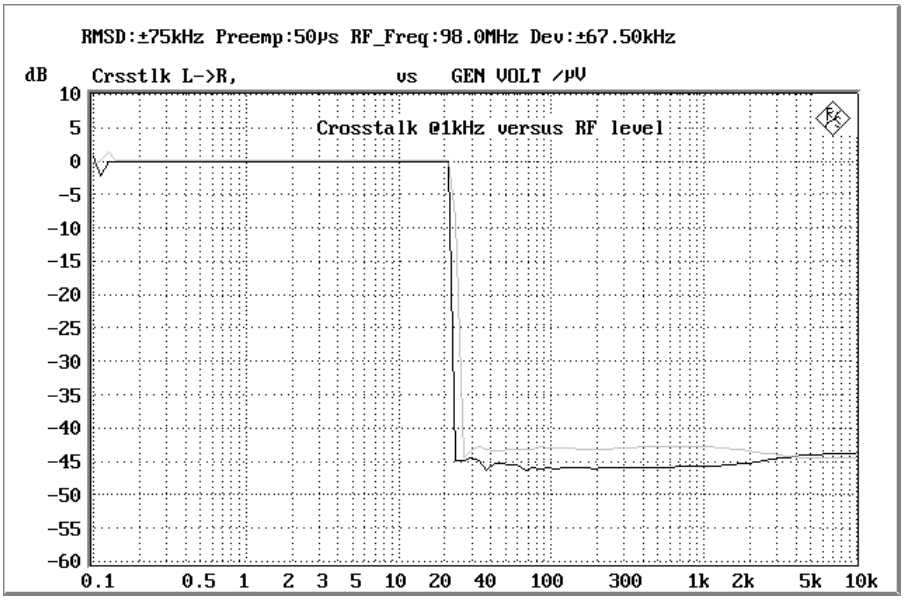


Fig. 6: Crosstalk attenuation as a function of the antenna level

Since the pilot-tone method is used, the noise increases when the stereo decoder is switched on. This is shown by the input signal / output signal characteristic in Fig. 8. The sudden noise increase is often disturbing particularly if this area is repeatedly traversed as the transmitter input signal varies. This is often the case in moving vehicles. For this reason smooth stereo switchover was developed where the crosstalk between the stereo channels is gradually increased with increasing antenna level. The use of such a circuit can be seen in the diagram where the crosstalk increases gradually above the stereo switching threshold.

Stereo operation is signalled on many FM broadcast receivers. However, the response threshold for this stereo indication need not be identical with the level at which the stereo coder starts to operate. Particularly when smooth stereo switchover is used, stereo reception is often signalled only when the received field strength is sufficiently high for adequate channel separation.

S/N Ratio as a Function of Input Level

The S/N ratio is the ratio of the audio frequency voltage of the signal to the noise voltage. According to IEC 60315-4, different weighting filters may be used with these measurements, but the test method with A-weighting in the HiFi sector has been adopted as standard and is the basis for the measurements described below.

The S/N ratio of receivers can be determined in different ways:

- When the sequential method is used and a modulated signal is received, the audio output voltage is measured, then modulation is switched off and the noise is measured. This corresponds to the in/out measurement shown in Fig. 9.
- When the simultaneous method is used and a modulated signal is received, the level of the 1 kHz audio signal is measured. The noise voltage is then determined with the aid of appropriate bandstop filters while a modulated RF signal is present. Since the noise output voltage of an FM receiver increases under certain circumstances when a modulated signal is present, this method more accurately represents the conditions encountered in practical applications.

In this application, the S/N ratio is measured with the simultaneous method. The rms value is measured with an A-weighting filter. This corresponds to the conditions used in the HiFi world.

The receiver is operated under the conditions specified by the standard and set to maximum deviation. The signal is stereo-modulated with a 1 kHz signal. The use of the bandpass filter reduces the measurement range to between 200 Hz and 15 kHz; effects of hum or insufficient pilot tone suppression are not taken into account. After the audio output voltage has been determined, the 1 kHz component is separated by a notch filter and the noise voltage is measured. In order not to influence the noise by the THD of the 1 kHz signal, a measurement is chosen in the Audio Amplifier R&S UPL, where any harmonics are also ignored. The S/N ratio is calculated from the signal voltage and the noise voltage and graphically displayed as a function of the RF input level (Fig. 7).

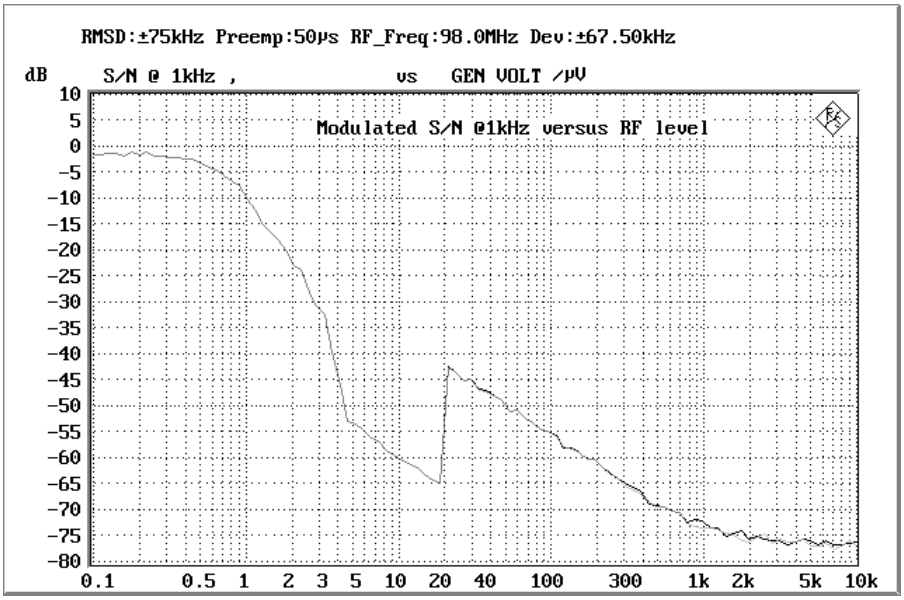


Fig. 7: S/N ratio as a function of the antenna voltage

Input Signal / Output Signal Characteristic

The in/out characteristic illustrates the relation between the antenna input voltage and the audio signal generated by the tuner. This is one of the most important measurements because the diagram provides a great deal of information particularly when the noise output voltage is considered in the measurement.

The receiver is operated under the conditions specified by the standard. For measuring the audio output voltage, the signal is modulated with maximum deviation; for the noise measurement with 0 deviation. The antenna level is logarithmically swept from 100 nV to 10 mV. The audio output signal is measured and graphically displayed with the maximum output voltage set to 0 dB. The level sweep is repeated and the noise output voltage is recorded. A diagram as shown in Fig. 8 is obtained.

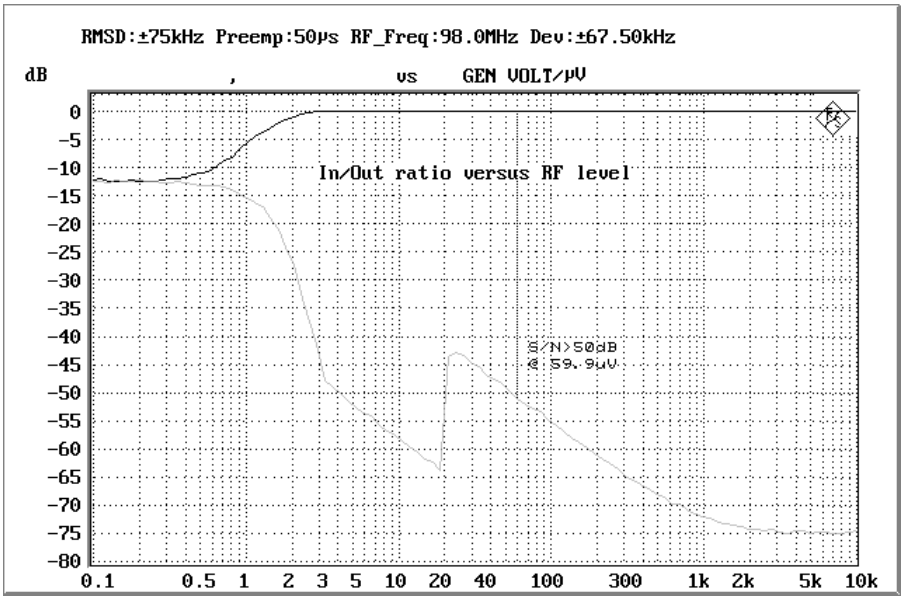


Fig. 8: Output / input signal characteristic of tuner with 50 dB S/N ratio

The following information can be obtained from the diagram:

- Characteristic of audio output signal

Only above a certain antenna input voltage will the tuner be able to detect an audio signal in the RF signal. This is at the point in the diagram where the signal characteristic and the noise characteristic separate. The associated level can be referred to as the absolute sensitivity of the tuner but plays only a minor role in amplifier characteristics.

The output signal characteristic always shows a steep rise when the antenna signal increases and then continues at a constant level. Depending on the receiver, this maximum level (which is also the reference level for the measurement) is attained with different RF levels.

- Noise signal

As the RF signal increases, the noise goes down until it attains its minimum. This minimum value is lower in the mono mode than in the stereo mode.

In the stereo mode, the level sweep of the input signal first shows the same characteristic as for a mono signal. When a certain signal level is attained, the stereo decoder starts operating (stereo threshold). This is first noticed by a clear increase of noise. As the input signal level rises, the noise is reduced again but normally does not attain the minimum value attained in mono reception.

- Max. S/N ratio

The maximum S/N ratio can be determined from the maximum audio output signal level and the minimum noise level. This value is also documented in the test report.

- Noise-limited sensitivity

The noise-limited sensitivity is the antenna level at which an audio signal with defined S/N ratio is obtained. The sensitivity value is at the same time a measure of the replay quality of the audio signal.

If HiFi stereo receivers are used, this value should be tested at an S/N ratio of 50 dB.

For instance, sensitivities of approximately 3 µV for mono reception and of 30 to 40 µV for stereo can be assumed for modern, high-quality tuners. The sensitivity for an S/N ratio of 40 dB and 30 dB is also determined. These values are often attained only below the stereo switchover threshold. They are documented in the report for information only.

Suppression of Pilot Tone and Subcarrier

A pilot tone is transmitted at 19 kHz to identify stereo broadcast transmissions. In order not to disturb instruments such as amplifiers and recorders connected to the tuner, the pilot tone and its subcarriers must be sufficiently suppressed in the tuner. This is done by circuits in the stereo coder or by means of filters at the tuner output.

Another quality criterion of a tuner is the suppression of pilot tone, auxiliary carrier or other interfering products. The audio frequency voltage normally measured at maximum deviation and at conditions specified by the standard is then used as a 0 dB reference in the display. Subsequently, the useful signal modulation is set to 0 and the remaining frequency components are displayed. The pilot signal suppression is measured and documented in the report. At the same time, the highest signal component is searched for and also documented in the report as interference suppression.

Fig. 9 shows the signal spectrum. The individual frequencies can be clearly identified.

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

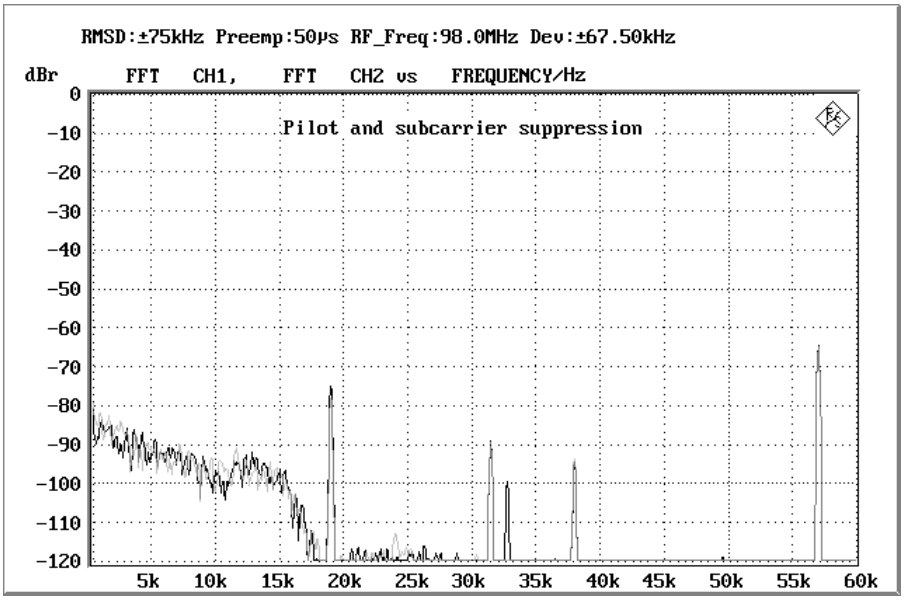


Fig. 9: Unmodulated output spectrum of a tuner with residual pilot tone, subcarrier and interfering components

8 Demo Programs for Production Tests

With the installation of the tuner program automatically the programs MULTFREQ.BAS and FASTDIST.BAS are generated. Those programs are intended as examples for fast frequency response and distortion measurements in production line use.

After loading and starting the program MULTFREQ it will be asked if the measurement should be done with approximately 20, 50 or 100 frequency points. Then after each hit of the SPACE key a measurement is done and displayed and the measured frequency response is PASS/FAIL checked versus the given frequency tolerance limits. The program can be stopped using the ESC key.

The program FASTDIST works in a similar way but after start it asks for the limit value of the measured distortion. The measurement is started with the SPACE key, the measured distortion value (THD+N) will be displayed and checked against the verdict value. The program can be stopped using the ESC key.

9 References

Methods of measurement on radio receivers for various classes of emission - Part 4: Receivers for frequency-modulated sound broadcasting emissions.
IEC 60315-4: 1997

10 Ordering Information

Audio Analyzer	**R&S UPL**	**1078.2008.06**
Universal Sequence Controller (option)	**R&S UPL-B10**	**1078.3904.02**
Signal Generator	**R&S SML01**	**1090.3000.11**
Signal Generator	**R&S SML02**	**1090.3000.12**
Signal Generator	**R&S SML03**	**1090.3000.13**
Signal Generator	**R&S SMV03**	**1147.7509.13**
Stereo/RDS Coder (option)	**R&S SML-B5**	**1147.8805.02**
Matching Pad 50/75 Ohm	**R&S RAM**	**0358.5414.02**

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