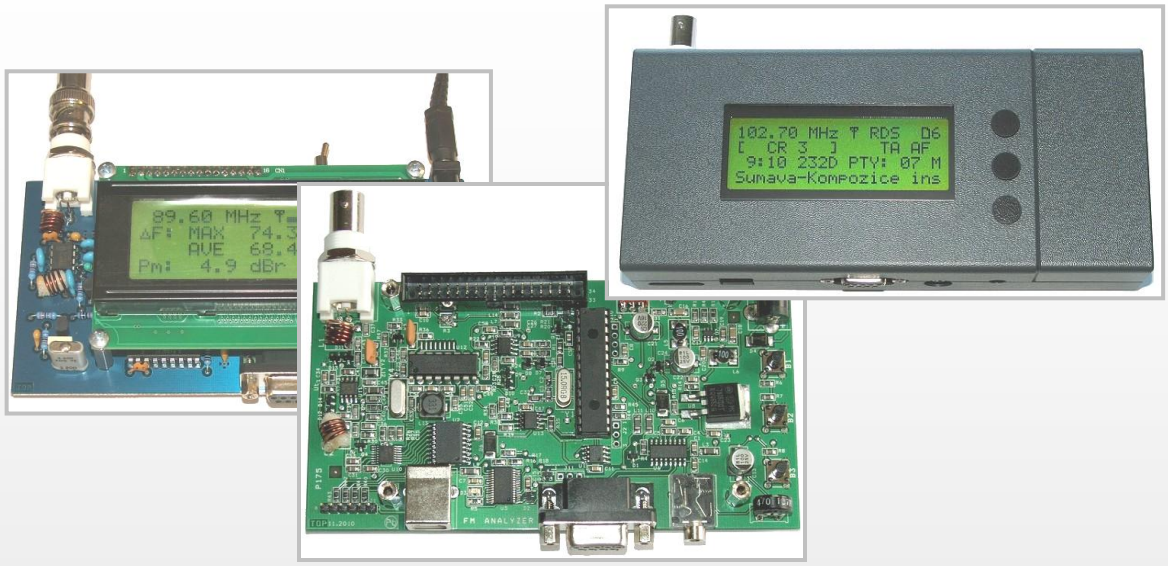


PIRA75 / P175
FM Broadcast Analyzer

User Manual

Firmware version 1.5 rev. 2

Web: http://www.pira.cz E-mail: mail@pira.cz

Table of Contents

Related Documents

Visit the Website for the latest documentation version and the following additional documentation:

- FM Scope - User Guide (http://pira.cz/fm_broadcast_analyzer/fmscope.pdf)
- RDS Spy - RDS Decoder for Windows (http://rdsspy.com/download/mainapp/rdsspy.pdf)

Introduction

The P75 and P175 FM Broadcast Analyzer is a stand-alone low-cost solution for FM broadcast analysis. It provides complete FM modulation and basic AF spectrum measurements in FM radio band through the antenna input.
Built-in LCD display and control interface allows to measure and collect data in terrain without need of any PC computer. Serial interface and the control software provide a possibility of remote control, data viewing and automated data logging.
This kind of analyzer is essential equipment for all FM radio stations to ensure compliance with basic technical broadcast standards and to accomplish the highest audio quality possible.

Main highlights

- Stand-alone design, completely DSP based from IF to outputs
- Compliant with CEPT/ERC REC 54-01 E and ITU-R SM.1268
- Dual-conversion receiver
- Built-in LCD display and RS-232 interface
- Built-in USB interface (P175)
- Firmware updates are free
- Easy to use

Measurements, indications and outputs

- Overall frequency deviation incl. histogram
- Modulation power (MPX power)
- Baseband spectrum, RF carrier spectrum
- Pilot deviation
- RDS deviation
- Pilot-to-RDS phase difference
- FM carrier frequency offset
- Reception quality and signal strength
- Stereo balance meter
- Headphones audio output
- Alarm logic or general purpose outputs (P175)
- RDS/RBDS decoder

Please read this entire manual and familiarize yourself with the controls before attempting to use this equipment.

The equipment has been thoroughly tested and found to be in proper operating condition when shipped. The manufacturer is not liable for any damages, including but not limited to, lost profits, lost savings, or other incidental or consequential damages arising out of the use of this product.

It is our intention to provide you with the best documentation possible to ensure successful use of the product. If you wish to provide your comments on organization, clarity, subject matter and ways in which our documentation can better serve you, please mail us your comments.
Information in this document is subject to change without notice.

Revision: 2016-10-05

Technical Specifications

Parameter	Condition	Value
General		
Supply voltage (P75)	external	8 – 16 V DC
	battery	4.8 – 5.8 V DC (4x AA NiMH)
Supply current (P75)	LCD off	170 mA
	LCD on	240 mA
Supply voltage (P175)	external	8 – 12 V DC
	battery	2.3 – 4.5 V DC (2x or 3x AA NiMH)
	USB	5.0 V
Supply current (P175)	LCD off	140 mA
	LCD on	210 mA
	battery	up to 500 mA
External power supply connector		DC 2.1 mm
Board dimensions (P75)		139 x 72 mm
Board dimensions (P175)		133 x 70 mm
CPU		120 MHz RISC DSP
Data connector (P75)		RS-232 (DCE, 9 pins), bidirectional
Data connector (P175)		RS-232 (DCE, 9 pins), bidirectional, USB (FTDI based, virtual serial port)
Communication speed		19200 bps
Communication mode		1 stop bit, 8 data bits, no parity, (no flow control)
RX buffer length		40 bytes
Intermediate frequency (IF)	1st IF	10.675 MHz
	2nd IF	0.325 MHz ± 0.005 MHz
IF bandwidth		280 kHz
Antenna Input		
Antenna connector		BNC, 50 Ohms
Frequency range		87.5 – 108.0 MHz
Tuning step		selectable 50 kHz or 100 kHz
Input sensitivity	S/N 26 dB	4 µV
	basic measurements	30 µV
	full measurements	70 µV
Maximum input level		0.5 V (5 mW)
Intermodulation immunity		basic (single input LC circuit with coil tap)

Never connect RF power output from the transmitter directly to the device's antenna input!

Measurements		
Frequency deviation range	min.	0 – 121 kHz
Frequency deviation error	1 kHz sine	< ± 1.5 kHz
	typical content	< ± 2 kHz
Modulation power range	min.	-12 – 14 dBr
Modulation power error	-6 – 6 dBr	± 0.2 dBr
Pilot deviation error	6.8 kHz	± 0.2 kHz
RDS deviation range		1.0 – 17.9 kHz, note 5
RDS deviation error	full signal	± 5% ± 0.5 kHz
Pilot-to-RDS phase difference error		± 4 deg.
Baseband frequency response flatness	10 Hz – 60 kHz	± 0.3 dB
Stereo balance error		± 0.5 dB
Signal level error (P175)	35 – 86 dBµV	non-linearity ± 3 dBµV, offset ± 2 dBµV
	0 – 35 dBµV	not specified
Alarm Outputs (P175)		
Maximum current from pin 1		100 mA
Maximum current from/to pin 2, 3, 4, 5		15 mA (internally limited by 390R serial resistor)
Headphones Audio Output		
Audio channels		1 (switchable R+L, L, R, R-L)
Output impedance	typ.	100 Ohms
Output level	no load	adjustable 0 – 2.5 V p-p @ 75 kHz
Signal to noise ratio	75 kHz, volume 0 dB	55 dB
Stereo decoder separation	1 kHz	>23 dB
Distortion	1 kHz	2 %
Internal RDS/RBDS Decoder		
RDS groups detected		All RDS groups 0A-15A, 0B-15B
RDS services supported		PS, PI, PTY, PTYN, TP, TA, M/S, DI, AF, EON, ECC, LIC, PIN, RT, CT, AID, RT+
RDS groups decoded		0A, 0B, 1A, 2A, 2B, 3A, 4A, 10A, 14A
RDS deviation (ΔF_{rds}) required	min.	1.0 kHz
Antenna input sensitivity (average BER = 5 % or less, single station, no interference)	ΔF_{rds}=2.0 kHz	30 µV
	ΔF_{rds}=3.4 kHz	18 µV
	ΔF_{rds}=6.8 kHz	9 µV

Never exceed specified voltage value at the battery power supply connector! It may cause permanent damage to the device! Disconnect or remove accumulators from the unit when it is not in use!

Don’t open the plastic cover (boxed versions)! No user adjustable parts inside! Risk of damage!
Take care to avoid strong mechanical pressure on the power switch during transport!
Never use the equipment if there's any visible damage on its electrical parts! In that case disconnect all cables, remove accumulators and contact the vendor or manufacturer.

Notes (Technical specifications):

1. p-p = peak-to-peak value; BER = Block Error Rate
2. Due to inherent reception the unit may have reduced sensitivity at 90.0 MHz.
3. Very strong el. field intensity (above 130 dBµV/m) may cause additional measuring error or may disallow the measurement.
4. Shadowed fields are device specific.
5. If pilot and RDS are not synchronized, the range reduces to 1.7 – 17.9 kHz. Spurious RDS detection may occur on stations without RDS if the station's signal is noisy or specific static sine tones are transmitted. If ARI system is used simultaneously with RDS on the same transmitter, the RDS deviation value should not be taken into consideration. Instead of this the Windows application and MPX spectrum graph gives an image about signal level of each component.

Power supply (P75)

External power supply connector

The FM analyzer can be supplied from any power supply, which delivers a voltage between 8 and 16 V DC and continuous current of 300 mA to 1 A. The FM analyzer has polarity protection and own voltage stabilizer. The central conductor of the power supply connector is positive (+).

Battery power supply connector

Use this connector for supplying the FM analyzer from 4x 1.2V NiMH accumulator or stabilized +5V power supply. This connector is polarity protected.
If both power supply connectors are being used to power the FM analyzer, the external connector has higher priority.
The unit does not charge the battery.

Power supply (P175)

External power supply connector

The FM analyzer can be supplied from external power supply (typically DC wall adapter), which delivers a voltage between 8 and 12 V DC and continuous current of 300 to 500 mA. The FM analyzer has polarity protection and own voltage stabilizer. The central conductor of the power supply connector is positive (+).

Battery power supply connector

Use this connector for supplying the FM analyzer from 2x or 3x 1.2V NiMH accumulator.
Due to safety reasons, the unit does not charge the battery.

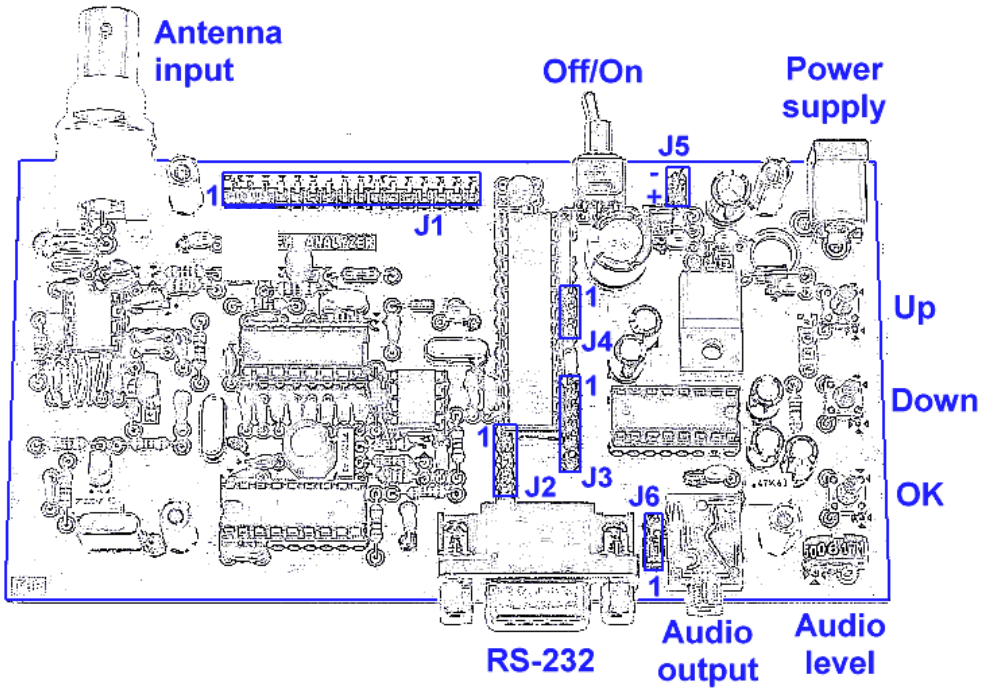
USB connector

Use this connector for supplying the FM analyzer from PC computer or stabilized +5V power supply.
This connector is **not** polarity protected. Connecting an active USB cable the unit is always turned on, i.e. the power off/on switch has no effect if the unit is powered from USB.

Never exceed specified voltage value at this connector! It may cause permanent damage to the device!

The USB port must be rated to full **500 mA** current! When supplying the unit from USB bus, it is a better choice to connect the unit to the USB interface on the main board. Supplies for pocket USB hubs and for some USB interfaces of lap-top and desk top computers are not sufficient and an **external power supply** is necessary!

Mainboard composition (P75)



J1 – LCD display connector (HD44780 standard)

J2 – Expansion IIC bus
1: +5 V
2: SDA
3: SCL
4: Ground

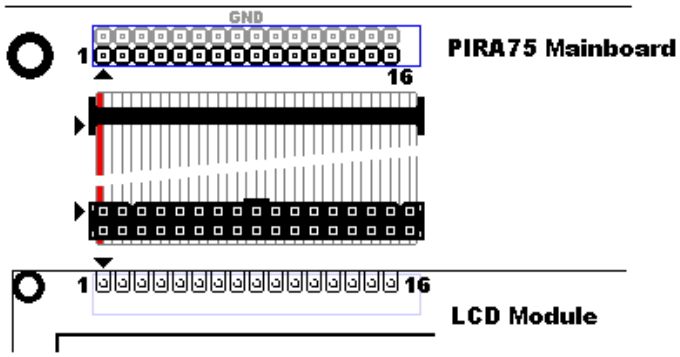
J3 – Reserved for user applications
1: Ground
2: DIP5 output (for remote switching)
3: Reserved
4: Ground
5: +5 V

J4 – Reserved
1: MPX/audio PWM output (no LPF)
2: Receive Data (RxD), TTL
3: Transmit Data (TxD), TTL

J5 – Battery power supply connector

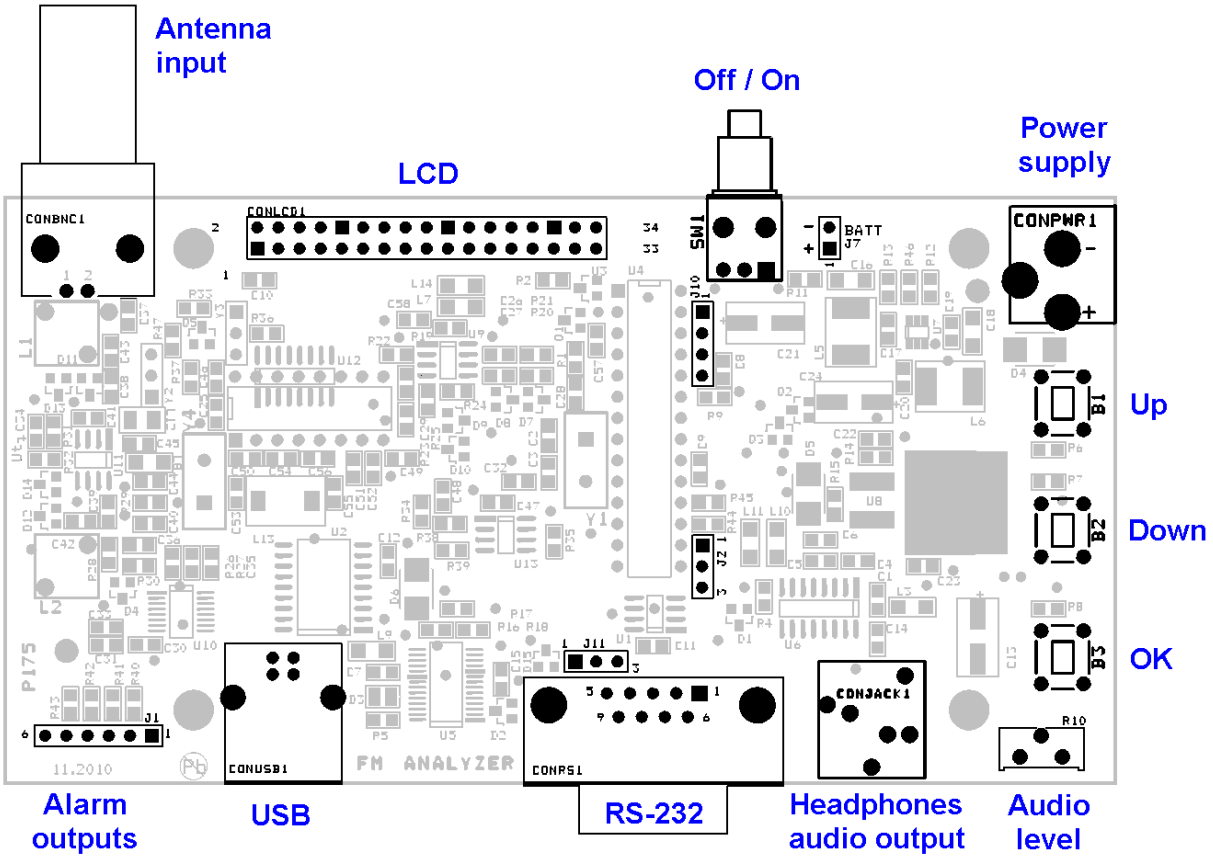
J6 – Audio connector mono/stereo switch
1-2: mono jack
2-3: stereo jack (headphones)
Note: the audio output is still one channel.

LCD module connection (if flat cable is used)



Make sure the LCD module is connected right before connecting power supply!
Incorrect connection will cause permanent damage to the LCD module.

Mainboard composition (P175)



J1 – Alarm outputs / General purpose outputs *
1: +5 V output for powering external device (max. 100 mA)
2: Alarm 1 (Signal lost)
3: Alarm 2 (Silence)
4: Alarm 3 (Overmodulation)
5: Alarm 4 (Pilot or RDS level error)
6: Ground

J2 – Reserved for special applications
1: DIP5 output (for remote switching)
2: Reserved
3: Ground

J7 – Battery power supply connector

J10 – External buttons (pull-up resistors on board)
1: Ground
2: Up
3: Down
4: OK

J11 – Serial RS-232 port (TTL levels)
1: Receive Data (RxD)
2: Transmit Data (TxD)
3: Ground

** Notes:*
The Alarm outputs can be used as independent general purpose logical outputs. See the section "List of commands and configuration registers" for more details.
Maximum current from/to pins 2-5 is limited by internal 390R serial resistors.

Note: The device provides three serial communication ports (USB, RS-232 and J11). These ports are internally linked together so the user may select any of these ports that best fits the communication requirements. When requesting data via any port, all ports will send the reply. The user must ensure that different ports will not receive requests at the same time.

Note for boxed version: There are no user-adjustable elements inside! Don't remove the front panel!

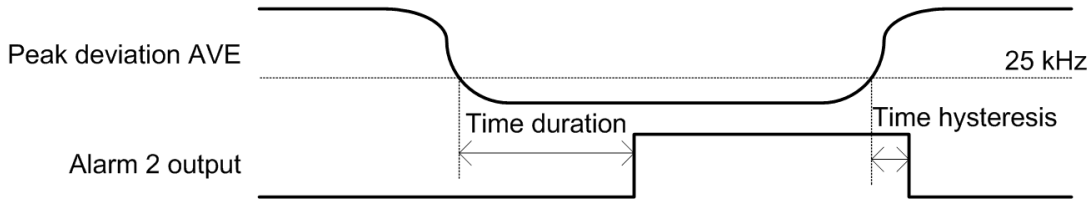
Alarm outputs (P175)

The device provides four independent logic outputs that are set by specific alarm conditions. These outputs can be used for direct LED driving, switching to backup transmission equipment, signalizing via GSM gateway etc.

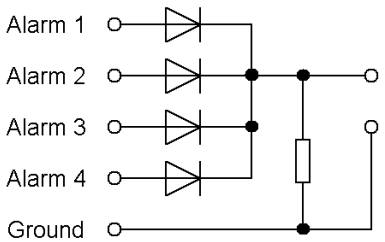
The alarm outputs are active high. If the alarm condition is no longer actual, appropriate output is driven low when the time hysteresis elapses. Almost all parameters are user configurable. With factory default values the alarm behavior is as showed in this table:

Alarm output	Condition	Interpretation
Alarm 1: Signal lost	Signal quality < 4 (time duration 30 seconds)	FM transmitter failure or signal for the P175 device is too weak for permanent monitoring.
Alarm 2: Silence	ΔF AVE < 25 kHz (time duration 1 minute)	There's no audio or the audio level is too low. Broadcast automation system has crashed or studio's mixing console has been set improperly or connection between studio and transmitter has been lost.
Alarm 3: Overmodulation	ΔF MAX Hold > 88 kHz and [Histogram Max At > 78 kHz or ΔF AVE > 78 kHz] (time duration 1 minute)	Transmitter problem or sound processing problem or unauthorized manipulation with the broadcast equipment or signal too bad (alarm 1 interpretation may apply).
Alarm 4: Pilot or RDS level error	ΔF Pilot < 5.8 kHz or ΔF Pilot > 7.7 kHz or ΔF RDS > 8.5 kHz (time duration 1 minute)	Stereo encoder fault or transmitter problem or unauthorized manipulation with the broadcast equipment.

The device must operate in Measuring mode otherwise alarms are deactivated and the outputs are driven low. The user must ensure that the device will receive the station's signal in appropriate quality. To resume the monitoring on desired frequency automatically after eventual power drop out, save the settings using menu item 4. To configure the alarms see the section 'USB and COM Port Communication'.



Alarm response example.



Application example – Logical sum (OR function) of alarm outputs.

Operating Instructions

Power-up

For external power supply, make sure the unit is switched off. Connect the power supply and then switch the unit on. The device requires no heating time. After a few seconds the unit is ready for operate. The antenna, audio and data cables can be connected regardless of the operating state.

Control buttons

Button	Meaning
	Go to next page or menu item, tune up.
	Go to previous page or menu item, tune down.
	OK, enter the menu, confirm or change the option.

Operating modes

Measuring ON		
Measuring OFF	RDS decoder mode	
	Stereo decoder mode	*L*
		R
		L-R
		L+R

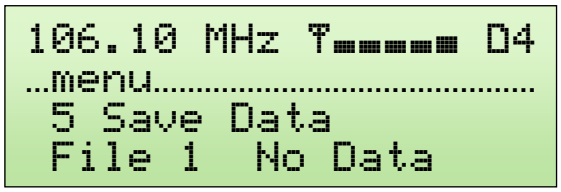
The mode selected is indicated at the first line of the LCD. When switching between the modes, the values measured will remain. The stereo decoder modes affect the audio signal in headphones output. This output is one-channel.

Menu

To enter the menu, press the OK button. Some items are showed depending upon context (page or operating mode).

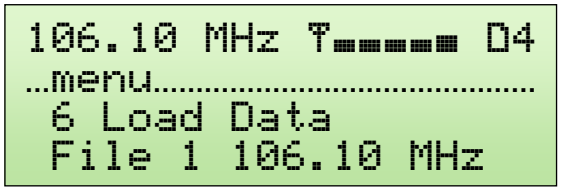
Menu item	Meaning
1 – Tune	Tune to a desired frequency in FM band (manual tuning)
2 – Scan	Tune using a scan mode (automatic tuning, stops on each station).
3 – Histogram Data 3 – Set as Normal 3 – More RDS Data	Show frequency deviation histogram values. Consider the 2nd IF as a normal (see Carrier frequency offset) Show more Radio Data System information.
4 – Save Settings	Save settings (incl. actual frequency tuned)
5 – Save Data	Save measured data and RDS data into EEPROM.
6 – Load Data	Load measured data and RDS data from EEPROM.
7 – Clear Data	Clear all measured values in operational memory.
8 – Volume	Adjust audio volume in steps.
9 – Sending Pm 9 – Mode	Enable/Disable sending of modulation power values via serial port if measuring is enabled. Set the operating mode if measuring is OFF: RDS, Stereo L, R, L-R, L+R.
10 – Measuring	Enable/Disable the measuring.
11 – Return	Return from the menu.

Save Data



The FM analyzer can store data from up to 4 (P75) or 30 (P175) measurements into internal EEPROM memory. This memory does not lose the data after power-off.
Select the Save data menu item and choose unused file position (or rewrite any actual position).
In addition actual frequency and these RDS information are saved: PS, PI, PTY, TP, TA, M/S, RT (P175), EON, AF, DI, group statistics.
The Save Data feature also supplies a preset memory function for tuning frequencies.

Load Data

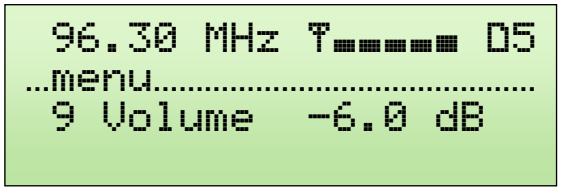


Select the Load data menu item and choose the file required. The data are identified by the frequency.

To use the file as a frequency preset:
- Make sure the device operates in Measuring or RDS mode
- Load the file

To use the file for the purpose of reading all stored data:
- Make sure the device is set to Stereo decoding mode
- Load the file
- You may browse the data, send them via serial port or continue in measurement by enabling the Measuring option in menu.

Headphones output volume



The menu item 9 allows adjusting of audio volume in steps. Fine adjust or max. level adjust is made using the on-board control.

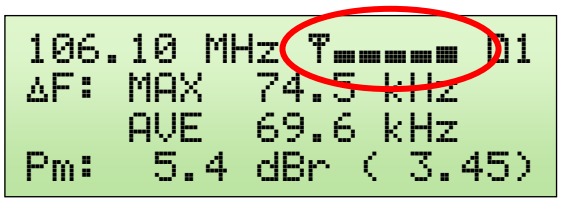
Note: The headphones output is not suitable for rebroadcast or streaming purposes.

Low battery indication

When the accumulator voltage drops below 4.7 V (P75) or 2.3 V (P175) or when the external power supply voltage drops below 6.9 V, the “BATT” indicator is showed. The device will not stop the operation by force; it allows the user to continue in their work. It’s on the user’s responsibility to finish the measurement and switch the unit off as soon as possible. Disregard for the low battery indicator may result in data loss and accumulator damage!

Measurements

Signal quality



The signal quality indication does not reflect the signal strength directly. It's a result of the following input parameters and influences:

- Noise level (measured in baseband above 100 kHz)
- Multipath propagation
- Intermodulation
- Amplitude ripple (AM modulation)
- 2nd IF frequency (frequency offset) – "in-channel" check

The essential condition for the measurement is enough signal level on the antenna input and sufficient frequency spacing between the stations. Not all signals that you can listen can be also measured. The following scale illustrates it and it's valid generally:

Signal level	1 µV	10 µV	100 µV	1000 µV
Reception on typical receiver	Mono only	Poor quality stereo	High quality stereo	
Measurement ability	Not possible	Basic	Full	

The basic measurement includes modulation power, pilot level and RDS decoding. The full measurement includes overall frequency deviation and RDS level. In noisy environment or in a location with many strong stations the minimum signal level may increase.

It's possible to say that optimal signal strength range and reception conditions for full measurement coincide with the requirements placed on high quality stereo reception. This rule determines the demands closely.

Signal reception quality table:

Signal	**Meaning**
T	No signal.
T▂	Weak signal detected.
T▂▂	Signal still unusable for measurement.
T▂▂▂	Poor signal. Basic measurement is possible with reduced accuracy for RDS level. Full measurement is not possible.
T▂▂▂▂	Good signal. Full measurement is possible with partially reduced accuracy.
T▂▂▂▂▂	Excellent signal.

Note: For proper measurement of modulation characteristics, internal bandwidth for RF signal is fixed at 280 kHz. In locations where stations are present in 200 kHz or even 100 kHz spacing, the device may indicate insufficient signal quality unless signal of the adjacent stations is rejected enough by positioning of the receiving antenna.

Following tables illustrate approximate max. measuring distance as a result of transmitter's ERP power and measuring conditions:

Estate housing, telescopic antenna:

ERP	Max. distance
1 W	300 m
10 W	800 m
100 W	3 km
1 kW	8 km
10 kW	20 km
100 kW	40 km

Open space, hill, Yagi antenna:

ERP	Max. distance
1 W	800 m
10 W	3 km
100 W	7 km
1 kW	20 km
10 kW	50 km
100 kW	100 km

Baseband noise spectrum from the area around 100 kHz is mirrored to audio spectrum in the audio output. This results in audible noise expansion and helps to find the best antenna position if the input signal is weak.

Selecting an antenna

There is no generally valid choice for the antenna. The requirements for the antenna differ with local conditions and kind of use. The essential condition for the measurement is enough signal level of the desired station on the antenna input. Not all signals that you can listen on any radio receiver can be also measured. It's possible to say that optimal signal strength range for full measurement coincides with the range which is required for high quality stereo reception. From this observation it's clear that simple telescopic or whip antennas are not enough for some applications. On the other hand special calibrated antennas for EMI and RF field applications have no reason for FM modulation measurements.
In the transmitter's near field (up to 1 km distance from the transmitter) any piece of wire connected to the antenna input should be always sufficient. When measuring other than only local stations or where number of stations reaches a couple of tens, a single dipole or 3-element Yagi antenna will give considerably better results than simple telescopic or whip antenna. In many cases this kind of antenna must allow positioning in horizontal plane in order to boost signal of stations of interest and reduce signal of all other stations.
Always make sure there is no pulse interference source near the antenna. These sources especially include computers, cars, electric motors, PWM regulators, high voltage lines etc. Assure stable antenna position during the measurement. Especially the frequency deviation should not be measured in motion like in ridden car.

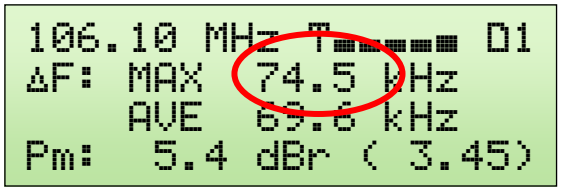
Hint: Keep on mind that with fixed omni-directional antenna, the number of stations with excellent reception (full measurement ability) usually does not exceed 15, regardless of how many strong stations are on air overall in the location. This is caused due to multipath propagation of many station signals, as well as by the receiver's limited selectivity (restricted by requirement of proper FM deviation measurement) and intermodulation predisposition of the receiver's simple front-end. If the station of interest is 30 dB or more below the strongest stations, finding the best antenna position may be necessary to reduce this ratio and to ensure full measurement ability.

Measurement using the transmitter's test RF output

Many FM broadcast transmitters are equipped with a test RF output. This output is primarily not intended for modulation characteristics measurement using an analyzer based on a receiver as the P75/P175 device is. In most cases it can be used for this purpose but this usually does not bring any advantage. Special care is required before connecting the analyzer to this output. Make sure the output signal power does not exceed 5 mW (7 dBm). In some cases the test RF output gives 30 dBm (1 W) or more. This signal must be attenuated to less than 5 mW before connecting to the analyzer!
Sometimes it is better not to use the test output and get the signal "from air". The modulation characteristics are not affected in near field. Another recommended way is to connect only the transmitter's and analyzer's ground (shielding).
On the transmitter sites where many transmitters are operating the user may be forced to find one of the methods mentioned that gives full quality result. It's due to intermodulations caused by many strong signals and their harmonics that are present in this environment.

Overall frequency deviation (peak frequency deviation)

Frequency deviation (ΔF) is used in FM radio to describe the maximum (peak) instantaneous difference between an FM modulated carrier frequency, and the nominal carrier frequency.

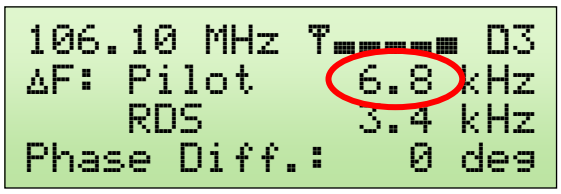


The overall peak frequency deviation shall not exceed **75 kHz**.

The peak hold values of the deviation are taken during a measuring time of 50 ms, 20 times per one second. From this array of values the MAX, AVE and MIN values are calculated and showed. These values represent signal characteristics in last second. The measurement is fully **continuous** over the signal, without any gaps. Moreover, MIN Hold and MAX Hold functions are provided. The MAX Hold value represents the maximum deviation found in last 10 seconds. Since it may be affected by pulse interference, interpret it very carefully. **Remember that any "Hold" or "MAX" function based on a single number cannot fully and adequately describe the FM modulation characteristics as a histogram function can (described thereinafter).**

Pilot deviation

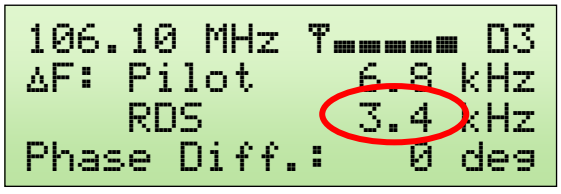
In FM stereo broadcasting, a pilot tone of 19 kHz indicates that there is stereophonic information. The receiver doubles the frequency of the pilot tone and uses it as a phase reference to demodulate the stereo information. The (L+R) main channel signal is transmitted as baseband audio in the range of 30 Hz to 15 kHz. The (L-R) subchannel signal is modulated onto a 38 kHz subcarrier occupying the baseband range of 23 to 53 kHz.



The deviation range of the FM carrier caused by pilot tone is from **6.0 kHz** to **7.5 kHz**. The recommended value is **6.8 kHz**.

RDS deviation

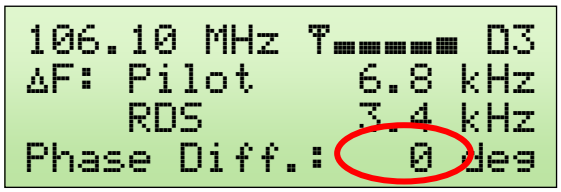
Radio Data System (RDS), is a standard from the European Broadcasting Union for sending small amounts of digital information using conventional FM radio broadcasts. Radio Broadcast Data System (RBDS) is the official name used for the U.S. version of RDS. The two standards are nearly identical, with only slight differences. Both use a 57 kHz subcarrier to carry data.



The deviation range of the FM carrier caused by RDS/RBDS is from **1.0 kHz** to **7.5 kHz**. The most used value is around **3.0 kHz**. This value should be considered as a minimum if dynamic PS or TMC service is being broadcasted.

Pilot-to-RDS phase difference

The 57 kHz for RDS subcarrier was chosen for being the third harmonic of the pilot tone for FM stereo, so it would not cause interference or intermodulation with it. The amount by which RDS subcarrier and third harmonic of pilot tone are out of step with each other can be expressed in degrees from 0° to 360°. Since the RDS signal is based on its carrier phase alternating, the full angle reduces to straight angle and we can equate 90 degrees = -90 degrees.



During stereo broadcasts the RDS subcarrier will be locked either in phase (**0 degrees**) or in quadrature (**90 or -90 degrees**) to the third harmonic of the pilot-tone. The tolerance on this phase angle is **±10 degrees**.

A value out of the specification is however not to be considered as a critical failure, i.e. there's no need to solve that situation promptly.

If no value is given, the RDS and pilot are not in stable phase relation. In that case check if pilot or MPX signal is connected to the RDS encoder input and external synchronization is enabled. Follow the instructions supplied with your transmission equipment.

Set the phase difference when the transmission equipment works under common conditions and after enough time of warm-up. The phase difference depends a little on the transmission equipment temperature and other physical quantities.

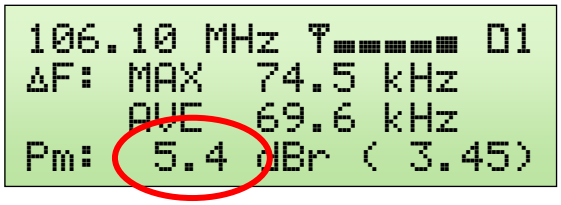
Modulation power (MPX power, P_m)

The modulation power is a relative power of the MPX signal averaged over 60 seconds according to the formula:

modulation power = $10 \log \{(2/60\ s) \int(\Delta f(t)/19\ kHz)^2\ dt\}$ [dBr]

0 dBr corresponds to an average power of a signal equivalent to the power of a sinusoidal tone which causes a peak deviation of 19 kHz.

Intensive audio dynamics compression as well as increasing overall peak deviation causes the modulation power to rise.



The modulation power limit, if defined in your country, is usually **0 dBr** or **+3 dBr**. Please refer to your local communications authority for more information.

Since the modulation power is averaged over last 60 seconds, first value can appear after one minute from power-up or tuning to a new frequency. However the analyzer reduces this time using estimation method during first minute so it shows an estimated value of the modulation power almost immediately, saving considerably the operator's time but still keeping compliance with standards. This is indicated by the 'Pm:' symbol blinking. Relevancy and accuracy of the modulation power value increases with each second. After the first minute elapses, the value is accurate from this moment and the 'Pm:' symbol stops blinking.

The measurement should represent typical modulation of the programme material of the broadcasting station. The observation time should be at least 15 minutes or in some cases one hour may be required to be sure to measure representative programme material.

The value in (...) is a linear representation of the modulation power, 0 dBr = 1.00.

Frequency deviation histogram

To provide more information the deviation is better represented by histogram rather than only displaying the highest value in over a certain period of time. In this device the histogram of frequency deviation is processed as follows:

a) Obtain **N peak hold values (samples)** of the deviation, each taken during a measuring time of **50 ms**. The measuring time has influence on the distribution plot and hence must be standardised in order to ensure repeatability. The 50 ms ensures that the peak values of the deviation are captured even at modulating frequencies as low as 20 Hz.

b) Discard the samples that have been taken in presence of noise or interference.

c) Divide the range of frequency deviation of interest (0 – 120 kHz) into 1 kHz resolution to give relevant number of bins.

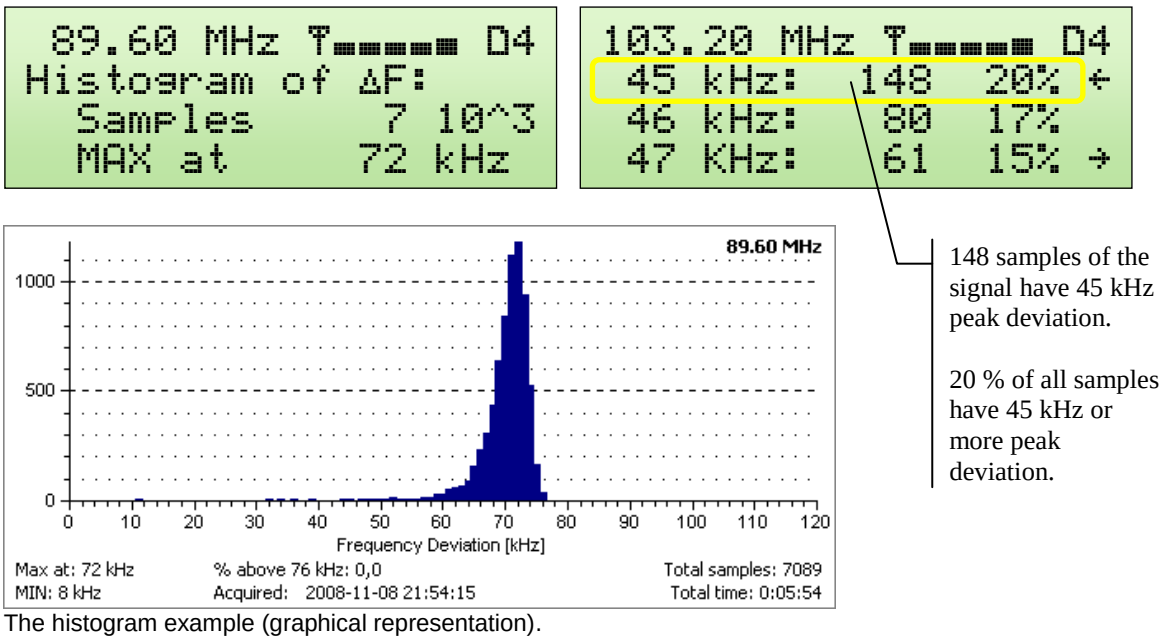
d) For each bin, count the number of samples which have a value within the bin. The result is a distribution plot of the deviation – frequency deviation histogram (see the figure below).

e) Add counts in each bin from left to right and normalise by N. The result is a plot of the accumulated distribution which starts with a probability of 100 % from the lowest deviation and will finish with a probability of 0 % at the highest deviation.

The measurement should represent typical modulation of the programme material of the broadcasting station. The observation time should be at least 15 minutes or in some cases one hour may be required to be sure to measure representative programme material.

Note: Samples associated with the deviation of 121 kHz represent all values above 120 kHz.

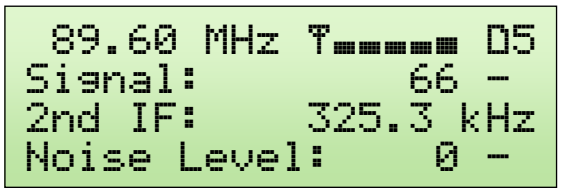
Note: Samples are added to the histogram only when the signal quality ensures that the values measured have a sense. This extends the histogram readability in the cases the reception quality is not good enough.



The histogram example (graphical representation).

Service details (P75)

Several service values are provided on the page 5:



The Signal value has two main reasons:

- In production / service process: To adjust antenna input circuitry and trace the signal path.
- During measurements: To find the best antenna position (strongest signal) resulting in the best suppression of pulse interference (as recommended for peak deviation measurements).

The Signal value becomes zero when the input level drops below 100 µV, while the maximum Signal value is reached when input level is about 2 mV.

Use of the 2nd IF parameter is described on following page.

The Noise Level is an output of the internal digital demodulation process telling how much energy is above 100 kHz in the demodulated signal. It's used as a main indicator of the signal quality.

The user should awake to the fact that the Signal and Noise Level values are dimensionless variables. Comparing these values makes no sense. They do not evaluate the original signal but the reception quality in the actual place and using actual antenna and equipment.

Service details (P175)

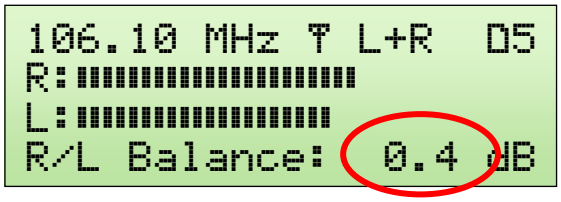
The same information applies as above except for following:

- The Signal represents real signal level on the device input in dBµV unit. Values 0 to 35 dBµV are estimated from the noise level, thus accuracy is not defined in this range.
- There's an additional peak amplitude modulation indicator. The AM on the received signal may occur for various reasons, including but not limited to transmitter failure, broadcast antenna coupler, motion, interference, multipath propagation and other characteristics of the environment. In general the AM modulation of the signal is undesirable. Thus whenever possible the user should choose such antenna placement and direction that maintains a low or zero AM level. AM below 15 % has usually no effect on the measurement.

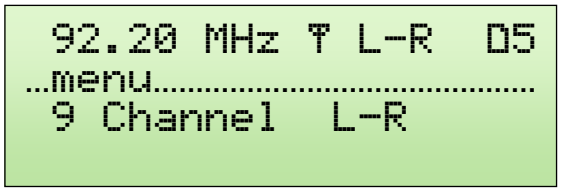
Simple stereo balance meter

To activate the stereo decoder, disable Measuring first. Set the Mode to any of the four Stereo options.

The simple stereo balance meter helps to maintain the same peak signal level in both right and left audio channels if stereo encoder is present in the transmission chain. The best value is around 0 dB (1:1). No special audio signal is required to be broadcasted but it’s preferable to use a sample with no stereo information.



The menu item 9 determines which audio channel will be present on the audio output. You may choose from L+R, L, R and L-R. The L-R channel can help to find the best channel balance as well. If monaural audio sample is being broadcasted, the best balance corresponds with no audio in the L-R channel.



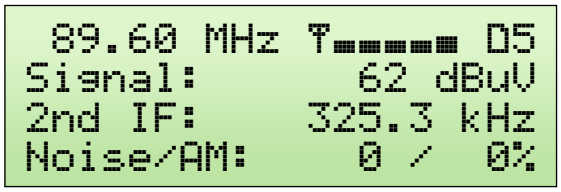
In common operation, the L-R channel may be affected by distortion produced by audio processing. There is also strong “karaoke” effect present.

Carrier frequency offset

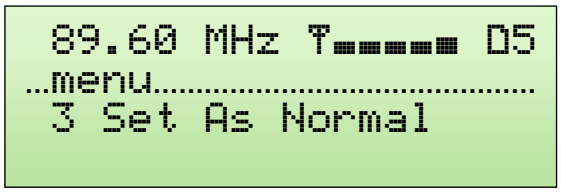
The unit can provide a relative carrier frequency offset from the nominal frequency. Although there is no calibrated frequency normal included for this purpose, it can be simply found in the band. If any station can be considered as a frequency etalon, the unit can be used to adjust right carrier frequency on the transmitter with 0.1 kHz precision.

To determine the carrier frequency offset

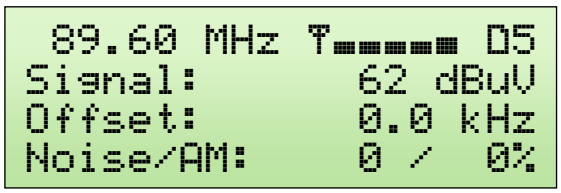
Under normal conditions the page 5 shows second IF frequency:



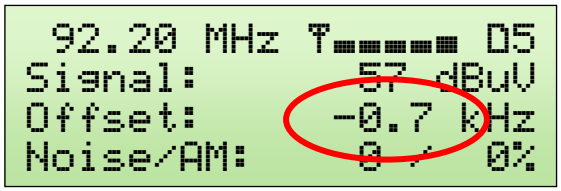
Now select menu item 3:



The Offset value appears which is 0.0 on the station selected as Normal:



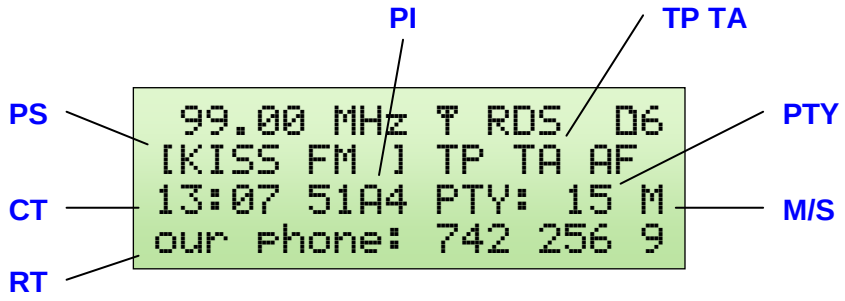
Now tune to any other station:



Still not sure how to read the result of this example? If real frequency of the station at 89.6 MHz is exact, real frequency of the station at 92.2 MHz has -0.7 kHz offset so its exact value is 91.1993 MHz

Radio Data System decoding

To activate the RDS decoder, disable Measuring first. Set the Mode to RDS. Page 6 shows the basic RDS information:



If RT+ service is being broadcast, the RT line contains [ ] symbols indicating begin and end of each RT+ tag in the text. More information is provided on RDS sub-page 15.

When the RDS decoder is active, page 5 shows block error rate (ber) and indicates RDS groups that are being received. This gives quick survey of the RDS services present in the RDS stream. The group numbers are in hexadecimal representation:

```
 99.00 MHz T RDS  D5
RDS Groups:  ber  0%
a 012.......A...E.
b ................
```

Detailed RDS information is accessible from page 5 or 6 under the menu item 3 (More RDS Data). Total 48 sub-pages are provided. Last 32 sub-pages are reserved for group content viewer.

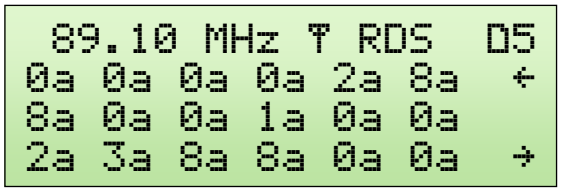
```
 99.00 MHz T RDS  D6
PTY: 15  (EU/US)   ←
Other M /Classicl
PTYN: TRANCE       →
```

```
 99.00 MHz T RDS  D6
AF:    87.6  98.4  ←
103.2 104.5
                   →
```

```
 99.00 MHz T RDS  D6
Group Statistics:  ←
 0a: 57.0% b:  0.0%
 1a:  4.5% b:  0.0%→
```

Group order viewer

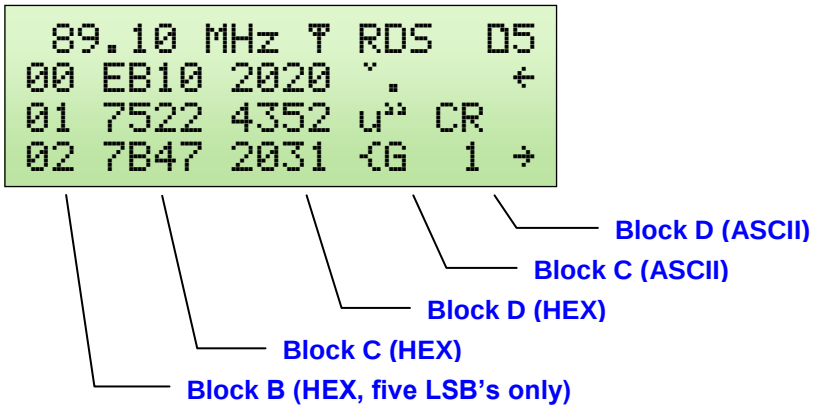
When you access the Group order sub-page, internal group order buffer starts filling. The group order buffer capacity is 18 groups. The group order is showed after about 2 seconds and locked for viewing.



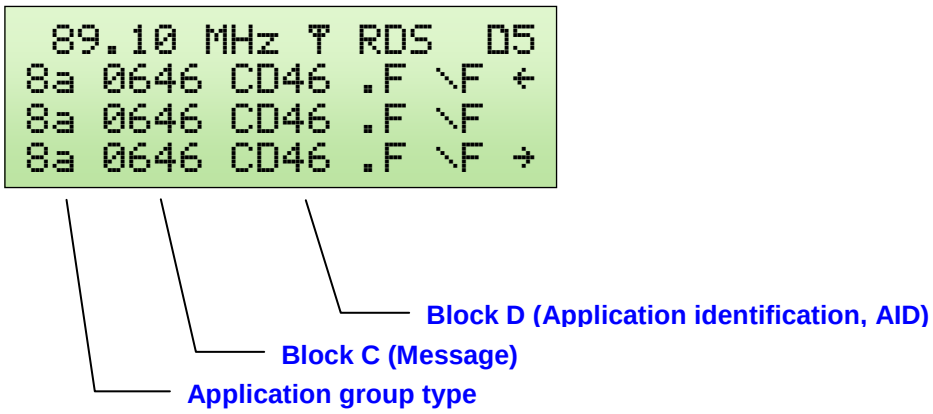
Read the group order line per line from left to right. To view actual group order again, go to previous or next sub-page and then back.

Group content viewer

When you access any Group content sub-page, the group content is showed on each error-less reception of the group type desired. After reception of 3 groups the process is locked for viewing. To view actual group content of the desired group type again, go to previous or next sub-page and then back. The content does not stay in memory, a new content is received instead.



Special case is group type **3a** (ODA AID) where application group type is directly showed:



More RDS Data summary

Sub-page	Service / Function
1	Detailed PTY, PTYN
2	EON (PI of other networks), ECC, LIC
3	RT type (A/B), actual RT
4	DI
5-7	AF list
8-13	Group statistics
14	CT, PIN
15	Static PS, actual RT+ markers (running, toggle, type1, start1, length1, type2, start2, length2)
16	Group order
17	Group content 0a
18	Group content 0b
...	...
23	Group content 3a (ODA AID)
...	...
48	Group content 15b

List of RDS services

RDS Service	Decoded by the device	RDS Groups
PI (Program Identification)	yes	All
PTY (Program Type)	yes	All
TP (Traffic Program)	yes	All
TA (Traffic Announcement)	yes	0a, 0b, 15b
M/S (Music/Speech)	yes	0a, 0b, 15b
DI (Decoder Identification)	yes	0a, 0b, 15b
PS (Program Service)	yes	0a, 0b
AF (Alternative Frequencies)	yes	0a
ECC (Extended Country Code)	yes	1a
PIN (Program Item Number)	yes	1a
LIC (Language Identification Code)	yes	1a
RT (Radiotext)	yes	2a, 2b
CT (Clock-Time and date)	yes	4a
PTYN (Program Type Name)	yes	10a
EON (Enhanced Other Networks)	yes (PI)	14a, 14b
AID (Application Identification)	yes	3a
RT+ (Radiotext Plus)	yes	3a, 2a, 2b (note 1)
TDC (Transparent Data Channels)		5a, 5b
IH (In-house Applications)		6a, 6b
RP (Radio Paging)		7a, 13a
TMC (Traffic Message Channel)		3a, 8a (note 2)
EWS (Emergency Warning Systems)		9a

Notes:
1) Does not include the group with tags that is defined in AID group 3a.
2) This is the most frequent group type used for TMC. An indication in the AID group 3a is decisive.

List of ODA applications

AID	Application name
125F	I-FM-RDS for Fixed and Mobile devices
1C68	ITIS In-vehicle database
4BD7	RT Plus
5757	Personal weather station
6552	Enhanced RadioText / eRT
7373	Enhanced early warning system
C350	NRSC Song title and artist
C3B0	iTunes tagging
C3C3	Traffic Plus
C4D4	eEAS
C737	Utility Message Channel
CD46	TMC
E123	APS Gateway
E1C1	Action code
E411	Beacon downlink

Notes:
This is not a complete ODA registration list reference.
Some applications are special purpose only or are used very rarely and may require special receiver.

The most frequent RDS setting errors

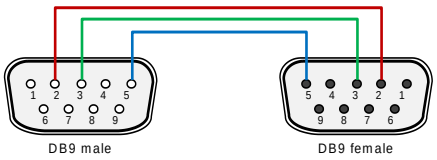
Error	Implication	Solution
First PI digit is 0 (zero).	RDS is not working on some receivers.	First PI digit can't be 0. It should be set in accordance with the country where the station is located.
Two different stations have the same last two PI digits, for example 5AFF and 51FF.	Car radios switch between different stations oneself.	Stations that carry different program entire day must be unambiguously identified by the last two PI digits.
AF list contains more frequencies but second PI digit is 0, for example 603B.	Many receivers ignore the AF list and listener must tune manually to the strongest frequency.	The second PI digit can't be 0 if the station has more transmitters listed in AF.
The station uses only one transmitter but second PI digit is not 0, for example FFFF.	Car radios search for another frequency using PI seek, this takes up to one minute, of course without any result.	The second PI digit must be 0 if the station has only one transmitter (local station).

USB and COM Port Communication

Connecting the FM analyzer to a PC

For configuration and control requirements a PC is connected to the FM analyzer via standard RS-232 interface provided by D-SUB9 female connector (DCE) on the FM analyzer side. On the PC side locate an unused COM port. If the free port exists in a form of 25-pin connector, use a standard D-SUB9 (male) to D-SUB25 (female) adapter. It's preferable to use standard modem serial cable with one male and one female connector. Any USB to RS-232 adapter can be also used.
The P175 version allows direct USB connection. Using appropriate drivers the device will appear as a new COM port in the system so the method of software access is the same for both the RS-232 or USB connections.

FM analyzer	PC
2 (TxD)	2 (RxD)
3 (RxD)	3 (TxD)
5 (GND)	5 (GND)



Configure the communication parameters as follows:

Transmission speed	19200 bps
Data bits	8
Parity	None
Stop bits	1
Flow control	None
Parity checking	*No*
Carrier detection	*No*

List of commands and configuration registers

Note 1: There is no need to validate the commands by any additional character or key, such as <Enter>.
Note 2: Some commands have their equivalent in the FM analyzer's menu.

Command	Meaning
`*+`	Tune up (one step).
`*-`	Tune down (one step).
`*P`	Switch on the modulation power sending.
`*p`	Switch off the modulation power sending.
`*M`	Switch on the MAX value sending.
`*m`	Switch off the MAX value sending.
`*R`	Switch on RDS groups content sending
`*r`	Switch off RDS groups content sending
`*F`	Tune to a frequency entered in kHz. Example (tune to 96.2 MHz): 096200*F
`*S`	Save settings to EEPROM, incl. DIP switches and alarm registers
`*E`	Set the unit to measuring mode
`*D`	Set the unit to RDS decoding mode
`*B`	Set the unit to stereo decoding mode
`*L`	Load station data saved in EEPROM memory. Example (load file 3): 03*L
`*C`	Clear data.

RESET*X	Hardware reset.
DIPx:y*X	Set DIP switch. Example (set tuning step to 100 kHz): DIP2:1*X
ARx:yy*X	Set alarm register. Example (set silence detector threshold to 25 kHz): ARA:25*X
*1 to *6	Switch the LCD view to page 1 to 6.
*0	Activate the LCD backlight.

Commands returning value

Command	Meaning
?B	Return all basic data.
?F	Return actual receiver frequency.
?R	Return the RDS deviation value.
?L	Return the pilot deviation value.
?P	Return actual modulation power value.
?M	Return actual frequency deviation MAX value.
?A	Return actual frequency deviation AVE value.
?N	Return actual frequency deviation MIN value.
?O	Return actual frequency deviation MIN Hold value.
?Q	Return the signal quality (0-5).
?D	Return RDS data.
?T	Return RDS group statistics.
?E	Return the pilot-to-RDS phase difference.
?G	Return the signal information (strength, IF, noise).
?H	Return the frequency deviation histogram data.
?I	Return the 2nd IF.
?C	Return the channel balance (Hz*100/Hz*100, stereo mode only).
?X	Return actual frequency deviation MAX Hold value.
?S	Return actual FFT data.
?U	Return signal level (P175 only)
?V	Return firmware version. No response: version 1.3a or older 1: version 1.3b, 2: version 1.3c, 3: version 1.4, 4: version 1.5
?a	Return address content in ASCII format. Syntax: (address),(length)?a Example (return actual radiotext): 19C,040?a
?h	Return address content in HEX format. Syntax: (address),(length)?h Example (return actual PI): 032,002?h

Note:
See Annexes for commented memory map.

DIP switches

	Meaning	0	1		Meaning	0	1
DIP0	LCD backlight	Auto	Manual	**DIP1**	Manual LCD backlight	Off	On
DIP2	Tuning step	50 kHz	100 kHz	**DIP3**	Scan sensitivity	Low	High
DIP4	Optional LED bargraph hardware installed	**No**	Yes	**DIP5**	J3 pin 2 state (P75) J2 pin 1 state (P175)	0	1
DIP6	Noise cancellation between stations	Off	On				

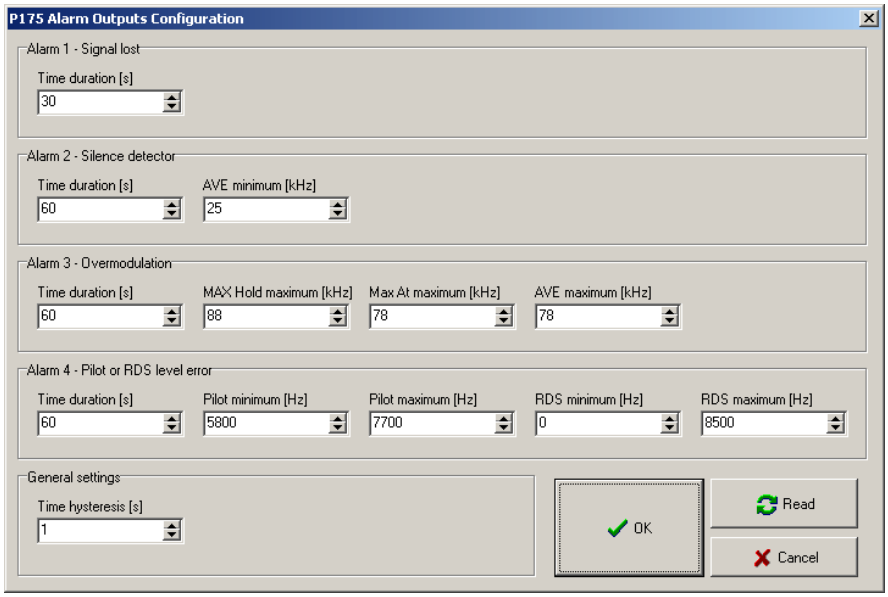
Note:
By default, all DIP switches are set to 0 except for DIP2.

Alarm registers (P175)

Register	Meaning	Default value	Unit
A	Silence detector ΔF AVE minimum	25	kHz
B	Overmodulation ΔF MAX Hold maximum	88	kHz
C	Overmodulation Histogram MAX At maximum	78	kHz
D	Overmodulation ΔF AVE maximum	78	kHz
E	Pilot minimum	58	kHz/10
F	Pilot maximum	77	kHz/10
G	RDS minimum	00	kHz/10
H	RDS maximum	85	kHz/10
I	Signal lost time duration	03	s*10
J	Silence time duration	06	s*10
K	Overmodulation time duration	06	s*10
L	Pilot or RDS error time duration	06	s*10
M	Alarm time hysteresis (common to all alarms)	01	s
N	(Reserved – currently it may be used to store any value)	00	-

Notes (Alarm registers):

1. The alarm registers value range is 00 to 99 (DEC).
2. The built-in alarm feature works independently from any alarms realized in the Windows control software.
3. Due to characteristics of common radio signals it is not recommended to set very short time duration and very long time hysteresis.
4. For user-interactive setting of the alarm feature use the Windows FM Scope application.
   Select Options – Alarm Outputs in the main menu:



To store the settings to a non-volatile EEPROM memory, use the button in tool bar.

Using the Alarm output pins as general purpose outputs (P175)

Storing a special value to the time duration alarm registers (I to L) the alarm output is overridden by user defined state. This special value can be either GD for logical low (0) or GH for logical high (1).

This feature can be used for switching of external circuits using up to four independent logical outputs. General purpose outputs can be controlled regardless of the operating mode.

J1 – Alarm output pin number	Command required	
	to force low (0)	to force high (1)
2	ARI:GD*X	ARI:GH*X
3	ARJ:GD*X	ARJ:GH*X
4	ARK:GD*X	ARK:GH*X
5	ARL:GD*X	ARL:GH*X

Notes:

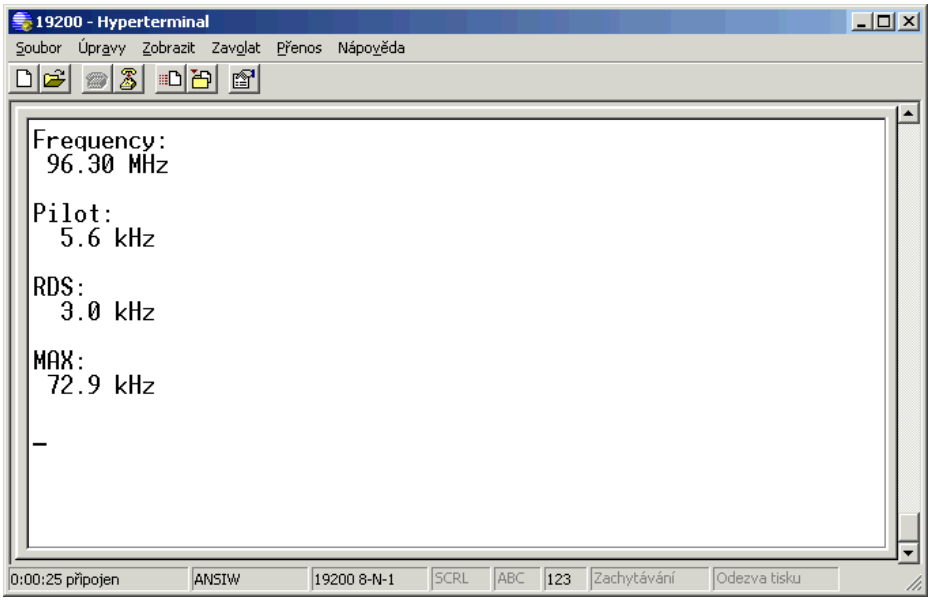
1. Pin 1 is located on the right.
2. It may take up to one second before the pin state is updated.
3. To control the pin state from the FM Scope script, use the command send, for example: send(ARI:GD*X)
4. To reactivate all alarms, place valid numerical values (00-99) into the time duration registers. Optionally store the setting to EEPROM and restart the unit.

Data format

The format of all data returned by the device is defined as follows:

key+":"+Chr(13)+Chr(10)+Chr(13)+Chr(10)
(if return value is empty)

key+":"+Chr(13)+Chr(10)+**value**+Chr(13)+Chr(10)+Chr(13)+Chr(10)
(otherwise)



Example of the outputs when using Windows HyperTerminal. Local echo is off.

List of keys

Key	Invoked by	Key	Invoked by
Frequency	?F	Pilot	?L
G	*R	RDS	?R
PS	?D	RDS Group Statistics	?T
PI	?D	MAX	?M or *M
RT	?D	AVE	?A
LTO	?D	MIN	?N
CT	?D	IF	?I
PTY	?D	ASCII	xxx,xxx?a
MS	?D	HEX	xxx,xxx?h
TP	?D	FV	?V
TA	?D	Signal Quality	?Q
AF	?D	Fast Signal Info	?G
DI	?D	Modulation Power	?P
EON	?D	Pm	*P
ECC	?D	RDS Phase Difference	?E
LIC	?D	Histogram Data	?H
PTYN	?D	FFT Data	?S
PIN	?D	MAX Hold	?X
R/L	?C	Level	?U

Service Part

Firmware update

The FM analyzer has a firmware update capability. This allows easily implementing of new features. When a new firmware version is released, a special simple Windows application provides the firmware update. The firmware updates are provided at no additional costs.

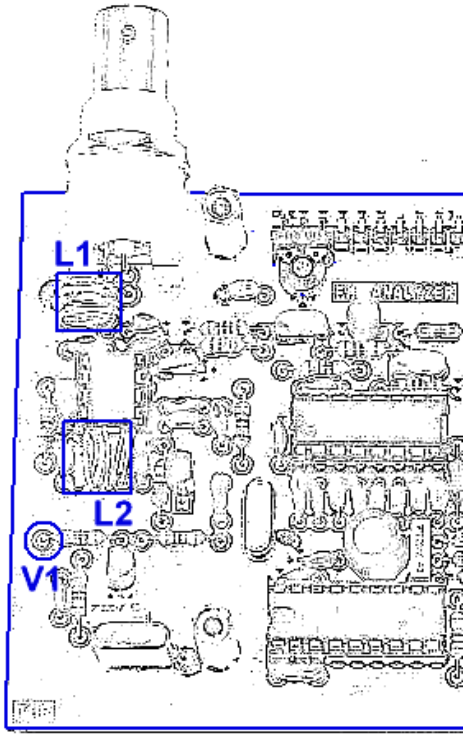
1. Connect the FM analyzer to any local COM port or USB port (P175).
2. Run the update utility, select the COM port and click Start! button.
3. Turn on the FM analyzer if not done yet.
4. The upgrade process is fully automated and takes about 1 minute.

Please refer to the web site for more information.

Don't forget to download also actual control software and manual with the new firmware! Keep all parts the same version!

Superheterodyne receiver ganging

This operation should make a qualified person only!
Under normal conditions there is no need to proceed this operation!
The device comes optimally adjusted from factory!
User should not touch the coils!



L1 – Antenna coil
L2 – Oscillator coil

V1 / Ut – Tuning voltage

1. Tune the unit to 108.0 MHz.
2. Adjust the tuning voltage to 4.0 V by oscillator coil. The tuning voltage tolerance at 108.0 MHz is ±0.1 V.
3. With the antenna connected tune any station in range 89.0-92.0 MHz and adjust antenna coil to the best (strongest) signal.

Annexes

Memory map

Address	Length	Content	Unit
01A	002	Actual receiver frequency raised by 1065	kHz*10
020	002	DIP switches (bit 0 = DIP0)	-
024	002	Pilot deviation	Hz*10
026	002	RDS deviation	Hz*10
028	002	Pilot to RDS phase difference	deg.
02A	002	ΔF MAX	Hz*10
02C	002	ΔF AVE	Hz*10
02E	002	Modulation power (linear)	1/100
030	002	ΔF MIN Hold	Hz*10
032	002	RDS PI	-
034	008	RDS static PS	-
03C	001	RDS PTY	-
03E	002	RDS status bits, bit 10: CT indicator, bit 9: RT indicator, bit 8: RT Type (A/B), bit 7: AF indicator, bit 6: TP, bit 5: TA, bit 4: MS, bits 3 to 0: DI.	-
040	020	RDS group counters (0a, 0b, 1a, 1b, ... 15b)	-
060	01A	RDS AF list	channel No.
07A	008	RDS EON PI (up to 4)	-
082	001	Signal quality	-
088	002	ΔF MAX Hold	Hz*10
08E	001	Amplitude modulation (0xFF = not available)	%
144	002	ΔF in last 50 ms time period (0xFFFF = not available due to noise)	Hz*10
146	002	Noise level averaged over 1 sec.	-
19C	040	RDS RT	-
1DC	008	RDS PTYN	-
1E4	001	RDS CT Hour	-
1E6	001	RDS CT Minute	-
1EA	003	RDS MJD	-
1EE	001	RDS RT+ group type	-
1EF	001	RDS RT+ status	-
1F0	001	RDS RT+ item 1 type	-
1F1	001	RDS RT+ item 1 start	-
1F2	001	RDS RT+ item 1 length	-
1F3	001	RDS RT+ item 2 type	-
1F4	001	RDS RT+ item 2 start	-
1F5	001	RDS RT+ item 2 length	-
1F8	001	RDS PIN day	-
1F9	001	RDS PIN hour	-
1FA	001	RDS PIN minute	-
1FB	001	RDS LIC	-
1FC	001	RDS ECC	-
1FD	001	RDS CT local time offset	half of hour

48C	002	Instant Modulation power (linear)	1/1755
4CE	001	Alarm - Silence detector ΔF AVE minimum	kHz
4CF	001	Alarm - Overmodulation ΔF MAX Hold maximum	kHz
4D0	001	Alarm - Overmodulation Histogram MAX At maximum	kHz
4D1	001	Alarm - Overmodulation ΔF AVE maximum	kHz
4D2	001	Alarm - Pilot minimum	kHz/10
4D3	001	Alarm - Pilot maximum	kHz/10
4D4	001	Alarm - RDS minimum	kHz/10
4D5	001	Alarm - RDS maximum	kHz/10
4D6	001	Alarm - Signal lost time duration	s*10
4D7	001	Alarm - Silence time duration	s*10
4D8	001	Alarm - Overmodulation time duration	s*10
4D9	001	Alarm - Pilot or RDS error time duration	s*10
4DA	001	Alarm - Alarm time hysteresis	s
572	0F4	ΔF Histogram	-

Important notes:
Lower byte is carried first (higher byte is placed at Address+1 for 2-bytes variables).
The Address and Length values are in HEX format.