FSM2017

Field Strength Meter

ABSTRACT

The ultimate radio coverage measurement and recording device

FDPB

User Manual. Revision 1.31

Field Strength Meter Revision 2017

User Manual

Revision 1.10, 1396-05-06

Introduction

FSM2017 is a completely redesign firmware for FSM2017. It is compatible to FSM2016, the previous hardware design (with slight hardware modifications). The graphic enhanced and enriched with more features. More configuration options are now available for user to customize the measurements and features. A lot more data can be measured with advanced pages.

Firmware Specifications

- AM/FM band selection
- Three method of frequency selection
- Real-time measurement of channel parameters (SNR, RSSI, Modulation and a lot more)
- Volume and mute control independent of recording level
- GPS reception for providing location, speed and global time
- Showing GPS satellite status and location
- Recording of voice and data for selected channel
- Multiple station view and recording
- SD Card storage media
- USB support for record transfer
- On-device file management
- Manual and automatic screen lock and screen saver
- Showing Battery status
- Internal and external antenna selection
- Visual alarm for various device status
- Band scan graph
- Favorite station list
- Headphone output

GUI Description

Home Screen

The home screen of the system can be seen in the below picture.

Four main group of objects are available in the home screen.

- Tuning objects
- Measurement objects
- Status objects
- Control objects

Tuning objects

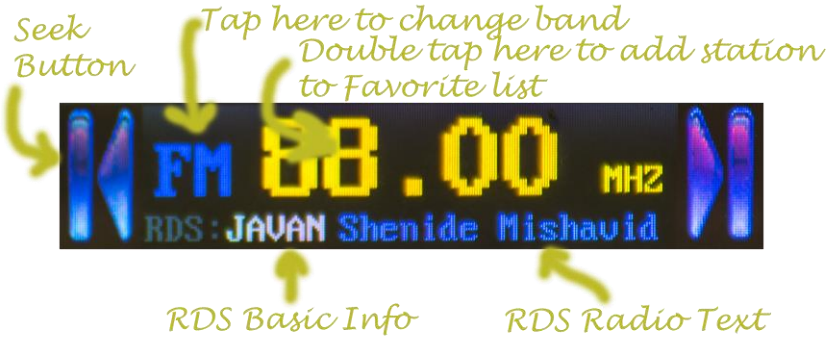
A cutout of these objects can be seen in the following picture.

These objects are

- Station Tuning
- RDS Line
- Frequency Strip Line
- Seek Mode button
- Favorite List

Station Tuning

This object shows the selected band and frequency. The band can be changed by taping on AM or FM word. The band will change and the last selected frequency on the new band will be tuned. Double tapping the frequency will add the band/frequency to the favorite list. If RDS is available at the time of double tap, it will be added to favorite station too.



RDS Line

If the selected frequency in FM band contains RDS information and the signal is strong enough, received RDS information will be displayed on this line (above picture). The RDS information contains two part. The Basic Info which is displayed as fixed text with white color and Radio Text which is displayed as scrolling text in blue color. The second part is switched with Program ID and Block Error every 5 seconds after finishing the scrolling.

Frequency Strip Line

This line shows the full band frequency range and a needle on the tuned frequency. The frequency can be changed by dragging figure over the band.

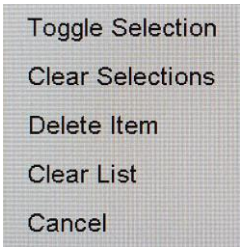
Seek Mode Button

This button changes the function of the seek buttons. In normal mode, clicking seek left or right buttons, will seek for next station to left or right. When seek mode button clocked once, the seek buttons change to forward and backward and every time they clocked, they will change tuning frequency by one.

Automatic Frequency Seek	
Manual Frequency Change	

Favorite List

This list holds a list of stations. The stations added by user in runtime and loaded from a text file on startup. The favorite list can be externally edited by user on SD Card (see appendix).



Favorite list Popup menu

To add a station to favorite list, double tap on the frequency on tuning station object. To remove stations from the list long hold the station. After 2 seconds a pop menu appears that contains, Toggle Selection, Clear Selection, Delete Item, Clear List and Cancel.

- Toggle Selection will change the selection status of the item.
- Clear Selection will remove all items selection.
- Delete Item will remove the item from the favorite list.
- Clear list will remove all items from the favorite list.
- Cancel will hide the popup menu.

Station selection must be on one band only. User cannot select two station on different bands.

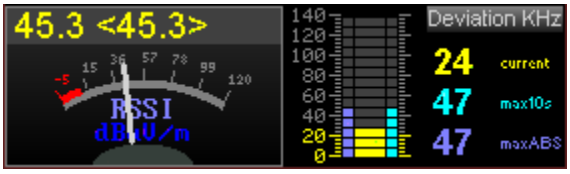
Measurement Objects (Basic View)

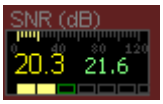
These objects are

- SNR gauge
- RSSI gauge
- Modulation bar

RSSI Gauge, Modulation/Deviation meter and SNR bar

This gauges show the real-time value of RSSI, SNR and deviation or modulation of the current tuned station. The gauges contain a peak holder as a thin gray line that holds the maximum seen value in the selected station. The caption bar shows the current and maximum values in numbers. The RSSI gauge shown the threshold levels as a red a section. If the values go below this threshold the color of the caption will change to red.





The RSSI gauge unit is dBuV/m by default. If the uV/m is selected as RSSI unit, the value of caption will change to uV/m but the gauge range will still be in dBuV/m.

The SNR gauge shows the current and peak value in dB unit.

This control shows the deviation in KHZ for FM band and modulation percent in AM band. It has two peak holders the first one shows the peak for last 10 seconds and the second one is the maximum seen since the station is selected.n

Status Objects

These objects are

- Date and Time
- Recording Status
- SD Card Insertion Status
- SD Card Used Space
- GPS Status
- Antenna Selection
- Battery Status

Date and Time

This field is provided by internal RTC circuitry and it will synchronize with GPS every time GPS clock is available. It represents the local time of Tehran (+3.5) and daylight saving is considered. There is no interface to set the clock manually.

Recording Status

The Recording Status shows the recoding time if a recording is in progress and show Idle if no recording is in progress. Its icon will blink during recording. If the circle blinks in red, it shows voice recording is in progress. For data recording it blinks to green.

SD Card Insertion Status

This field show if SD Card inserted or not. If SD Card is detected, the size of the card will be shown. The size of inserted card is also shown beside the icon.

SD Card Used Space

The used space of SD card will be shown as percentage.

GPS Status

This field show the GPS connection status. It three or more sat can be synched, the icon will change and the number of synchronized sat will be shown.

 Searching for Satellites	 GPS is synchronized

Antenna Selection

This field shows the selected antenna for the selected band. AM antenna can be set as internal or external in the system settings. FM always uses external antenna.

 Internal Antenna	 External Antenna

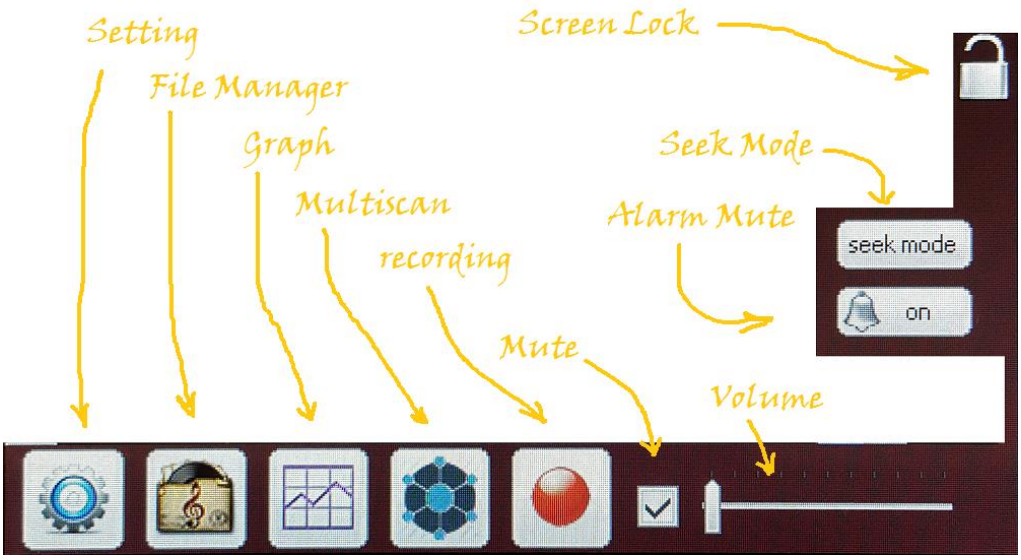
Battery Status

This field shows the battery charge left in percent. The icon will be updated with the percent in 6 steps. During charging the percentage cannot be shown. It shows the characters ‘chr’. A full charge of battery can be found when the charger led turns to green (the device must be off).

Control Objects

These objects are

- Alarm button
- Volume and mute
- Screen lock
- Setting button
- Keypad
- Folder button
- Record and Stop buttons



Alarm Mute

This button mute all the buzzer beeps regardless of the alarm settings.

ON Audio Alarms are Enabled	OFF Audio Alarms are Disabled

Volume and mute

The function is quite clear. It only controls the speaker volume. The recording volume will be always at maximum.

Screen Lock

This slider will disable all the controls over the screen. Pulling down the lock icon will activate the clock while pulling up disable the function. If screen lock time out is defined, it will be activated automatically after defined timeout if user did not touch the screen during the timeout period.

Seek Mode

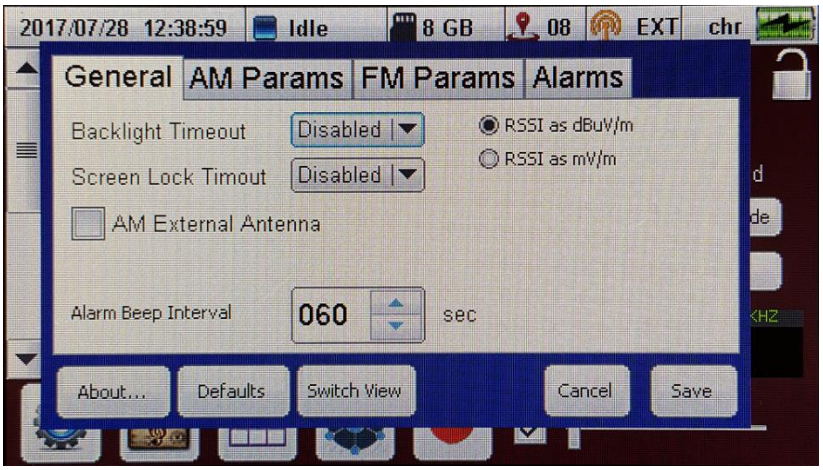
The button changes the way user can change tuned frequency. It switches between seek and inc/dec.

Setting

This control will lead to the following configuration window.

The window is in four tabs.

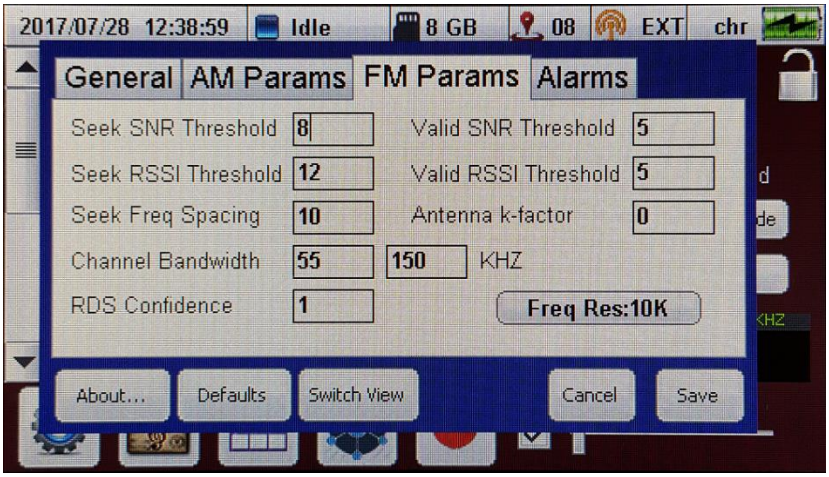
General Tab



User can configure Backlight and screen lock timeouts in 5 steps (disable, 1, 2, 5, 10 minutes). Use of external antenna for AM band also can be configured. RSSI unit (the value representation) can be changed as dBuV/m or uV/m.

Interval between alarms beeps can be configures

AM and FM Parameters



These two tabs are similar except in one parameter for FM.

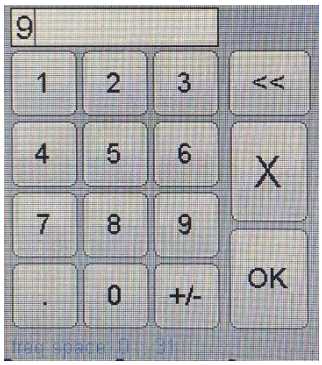
The seek SNR and RSSI thresholds and space frequency are used for seek operation. Valid SNR and RSSI are used for alarms and they are shown on home screen gauges.

The RDS confidence determines the required receiver confidence level for each RDS block prior to demodulation. Higher confidence results in more block errors.

Channel bandwidth is the tuner output filter bandwidths.

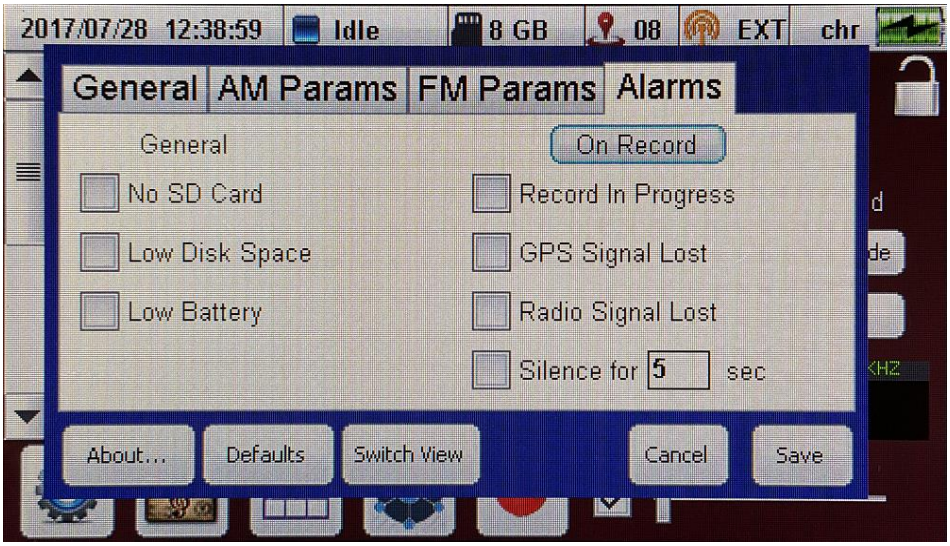
The ‘Freq Resolution’ button can change the FM frequency view format and manual seek resolution.

Antenna k-factor is a parameter for adjusting antenna reception differences. The value in dB will be added to the RSSI value.



For changing the parameter values, the user must touch the edit field. A keypad will be appearing which can edit the values. It shows the name of the parameter and the range that can be entered. The out of range values will not be accepted.

Alarm Tab



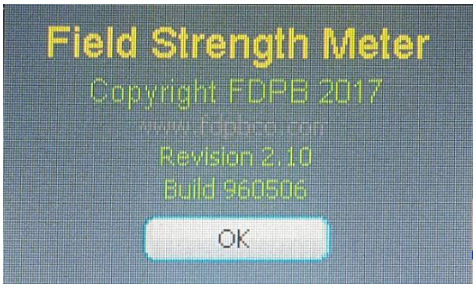
This tab let the user to select alarms that result to audio beeps.

The right column alarms can be active only in recording mode or always. It depends on the status of the top right button. The button can be ‘Always’ or ‘On Record’ by taping on it.

Default button will reset all the parameters to its default.

The result configuration will be saved on a text file on SD Card on the CONFIG folder. It can be edited by user, but the format must not be modified. Editing configuration file may result to undetermined exceptions on the device.

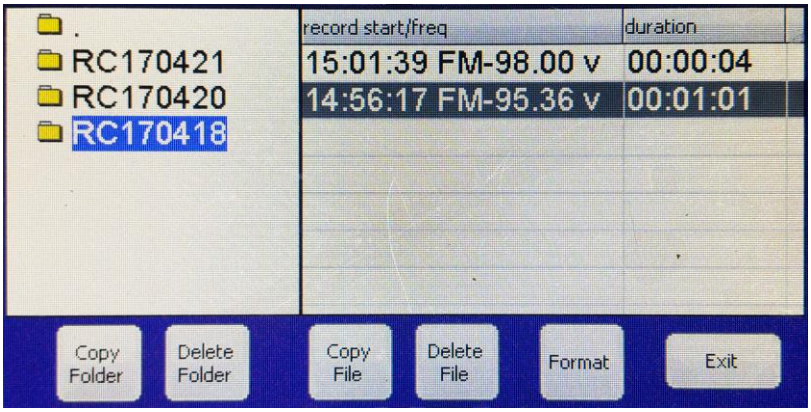
About button will show information about the firmware revision.



The revision will show compatibility changes and build number will show the release date which mostly include features and bug fixes.

Folder Button

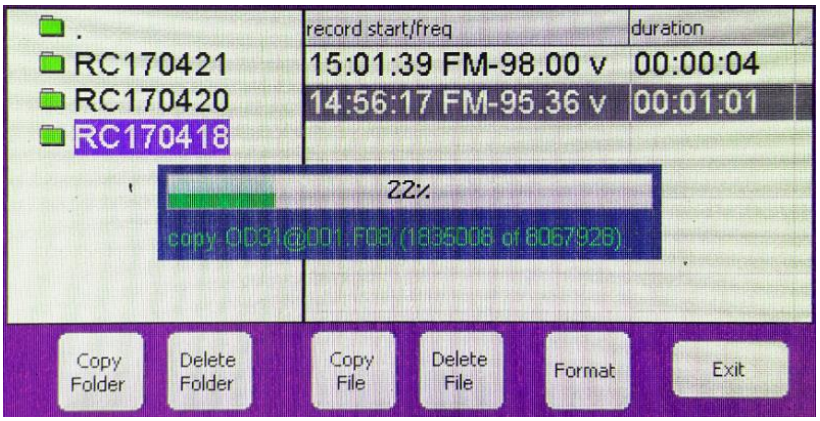
This button will lead to the following window. The file system is FAT32 and the recordings are divided to 5 minutes of recording. So if anything happens during recording (like battery loss) the maximum of 5 minutes of recording will be lost.



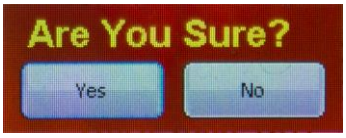
The windows show the folder list on the left and the folder content in right. For the record folders (started with RC) the content is a processed list of records. The file names are only a representation of what is really created in that folder.

The selected record can be deleted using Delete File button. The selected folder can be deleted using Delete Folder button.

When a USB flash storage is attached, the Copy buttons will be enabled after the media is detected. A single file or a full folder can be copied to the USB flash using Copy File or Copy Folder buttons. The copy process can be seen as a progress bar on the screen.



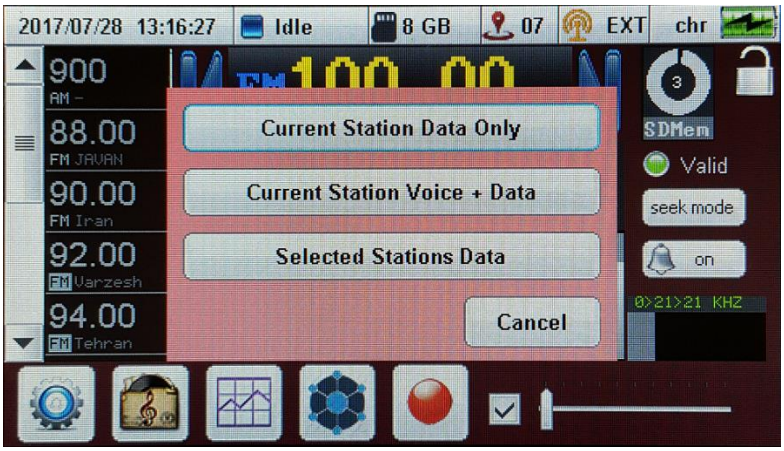
The SD Card can be formatted using Format button. Confirmation will have requested before formatting begins. Formatting SD Card will erase the system configuration and favorite list. So everything will reset to default. For a clean startup it is better to turn off and on the device right after finishing the format operation. User can copy the configuration and favorite files to PC before format and copy them back to SD after format.



Each recording folder represents one day of recording. The folder name contains the date. Each folder can hold up to 100 recording.

Record Button

The record button will start record operation by asking user the record mode through another dialog.



The record mode dialog contains three mode of recording.

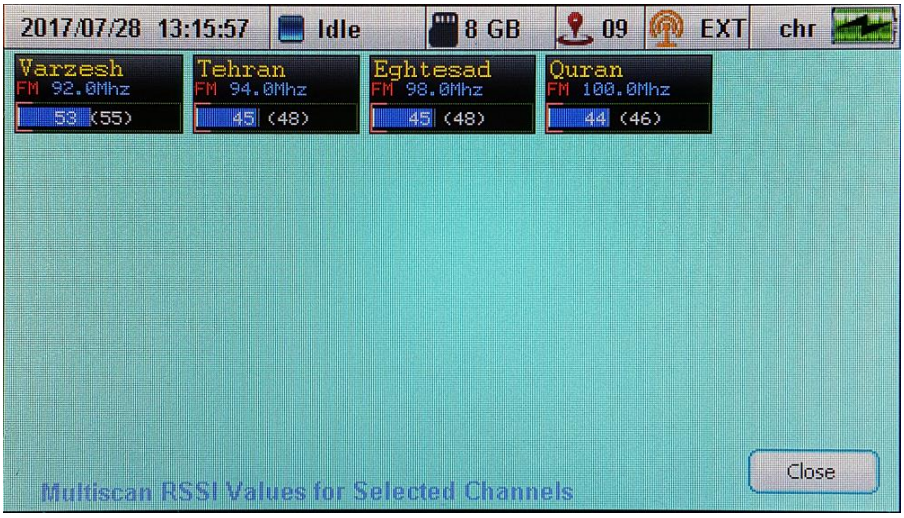
- Data Only. Which start recording of current tuned station. The recording contains only GPS and RSSI, SNR, Modulation information.
- Voice + Data. This mode contains the data and voice samples. The voice will be recorded as 2channel, 16bit, 32ksample/s.

- Selected Stations Data. This mode record RSSI and SNR of all selected stations from favorite list. The view of multi-scan will be shown on the screen.

After starting one the above modes, the start button changes to stop and recording status in the header will show the recording time.

Multi-scan Button

If any selected stations is available in the favorite list, multi-scan view will be shown.



This view shows RSSI value for selected stations. The speed of scan is 10 station per seconds. The voice will be disconnected on this screen. The items contain station name, frequency, current RSSI and maximum of RSSI. On recording, the close button will be shown as stop.

Graph Button

This is a pro version feature. Graph view is a band scan of the RSSI over a range of frequencies.

The dialog gets a center frequency and a frequency span and a step frequency for scanning. The default center frequency is the one tuned before calling this screen. The dialog tries to set a maximum span with

lowest step as default setting. If user change the span, the step will set to a minimum that can fit the span on the screen. Then user can change the step. When user change the step the width of graph will change to fit the points according as one pixel for one sample.

By starting the graph, the frequency and RSSI of the current sample will be shown on the left of the screen as graph is plotted. After finishing the plot, user can activate a cursor by touching the graph or using move left/right buttons on the right of the screen. The green cursor always shows the center frequency location on the graph.

Advanced View

By using the Setting/Toggle View button, the basic view will change to advanced view as following figure

If this view some other parameters are measures and shown as follow

The Valid LED will be on if selected frequency RSSI and SNR meets the setting parameters.

Common Parameters on Advanced View

- RSSI, SNR. These two gauges show the current RSSI and SNR value and their maximum. The unit of RSSI will change according to setting. The gauge levels are always based on dB.
- GPS coordinates and speed. There values are highlighted when the GPS is connected.
- Offset. The offset frequency that tuner is currently tuned on from the user selected frequency.
- LASSI. Low Side Adjacent Channel Strength Indication (Signal + Noise power relative to carrier)
- HASSI. High Side Adjacent Channel Strength Indication (Signal + Noise power relative to carrier)

FM Advanced View Parameters

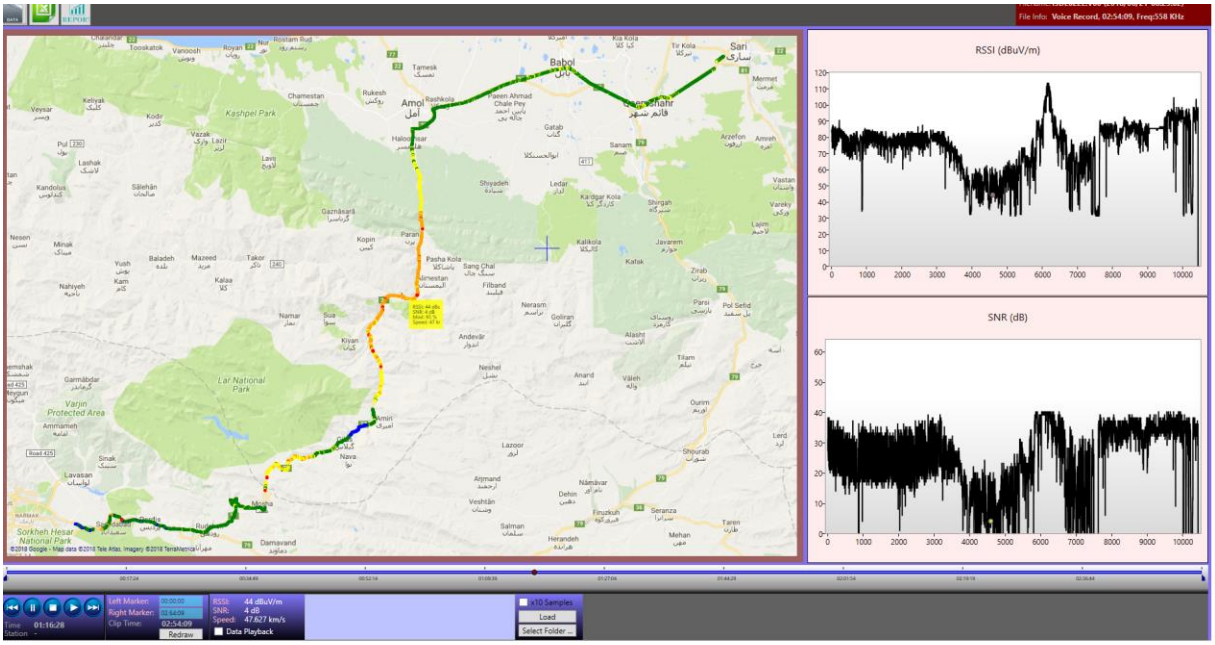
- ASSI. Adjacent channel (200kHz) deviation
- ASSI Deviation. Deviation of strong desired signals.
- USN. Ultrasonic Noise Indication in –dBFS (down from full scale)
- Pilot Deviation.
- RDS Deviation.
- Multipath. Multipath Indicator.

AM Advanced View Parameters

- AntCap. Antenna Capacitor. Antenna tuning capacitor value.

System Software

The PC Software for browsing the recorded data is named FSM Browser. It can show geographical recording path on google map and playback the recorded station voice.



FSM Browser capabilities

- Loading and browsing three type of FSM records (Data, Voice, Multi-scan)
- Shows geographical path on google map
- Shows SNR and RSSI on separate line graphs
- Play, pause, stop, seek left and right, clip, media controls
- Exporting recorded voice as standard wave file
- Export data as excel file
- Clip the records for exporting
- Show live measured values on map during playback
- Data playback (with x10 speed)
- Caching maps for offline usage

Operations

Transferring records from FSM device to PC. The record on FSM device are saved on SD card. For small records (a few minutes) records can be transferred to USB flash using FSM file manager menu, then the record folder must be copied somewhere on PC for browsing by software. The date information is saved in record folder so during transferring data to PC, it must be noted to copy the folder too. To transfer big records it is better to remove SD card from device and connect it to PC using a card reader.

Loading Data. The top left button will open a file browser for selecting record data. The file list contains only the record starter file. The rest of files (5 minute partitions) will be loaded automatically. Right after loading data, the map and graphs updated with loaded data and map will show the starting location.

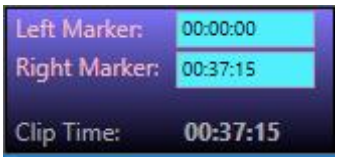
Map Zoom. By using mouse wheel over the map, the map can be zoom in and out in 16 levels.

Map Pan. By holding mouse right click on the map and moving around, the map can be panned.

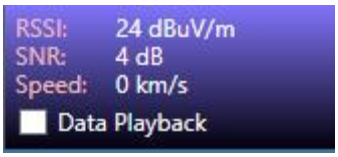
Clip and slider. By dragging the clip handles along the slider, clip bounds can be changed. The exports and seek operations will be limited to these bounds.
The slider thumb also can be dragged along the slider to change the playback current position.

Playback panel. Left bottom panel contains the media controls. Left and right seek will move the media position to left and right bounds of clip. Current position of media playback and the name of the station can be seen on this panel.

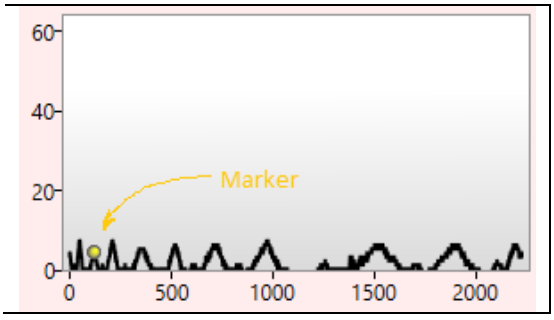
Clip panel. This panel used for entering the precise values for clip bound. It also shows the bounds and total clip time.



Real time panel. This panel contains the current position data. The current position can be seen on slider, map marker and a yellow marker on graphs.



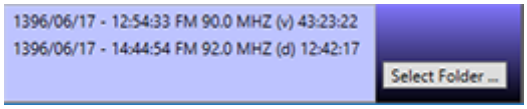
Graph. The graphs shows the value of measured RSSI or SNR during the record. A marker shows the current playback position. The vertical axis is dB for SNR and dBuV/m for RSSI.



File Information. After loading a record file, file information will be shown on top right panel. It contains starter filename, date and time of record start, type of record, duration and station frequency.

On Map Information. A small balloon window on the map will show the location data. During playback this balloon will move along the path and update its data according to the record.

File Description. At the bottom of window there is a descriptive record list of a selected folder. The folder can be changed to anywhere. The list will shows the folder record contents.



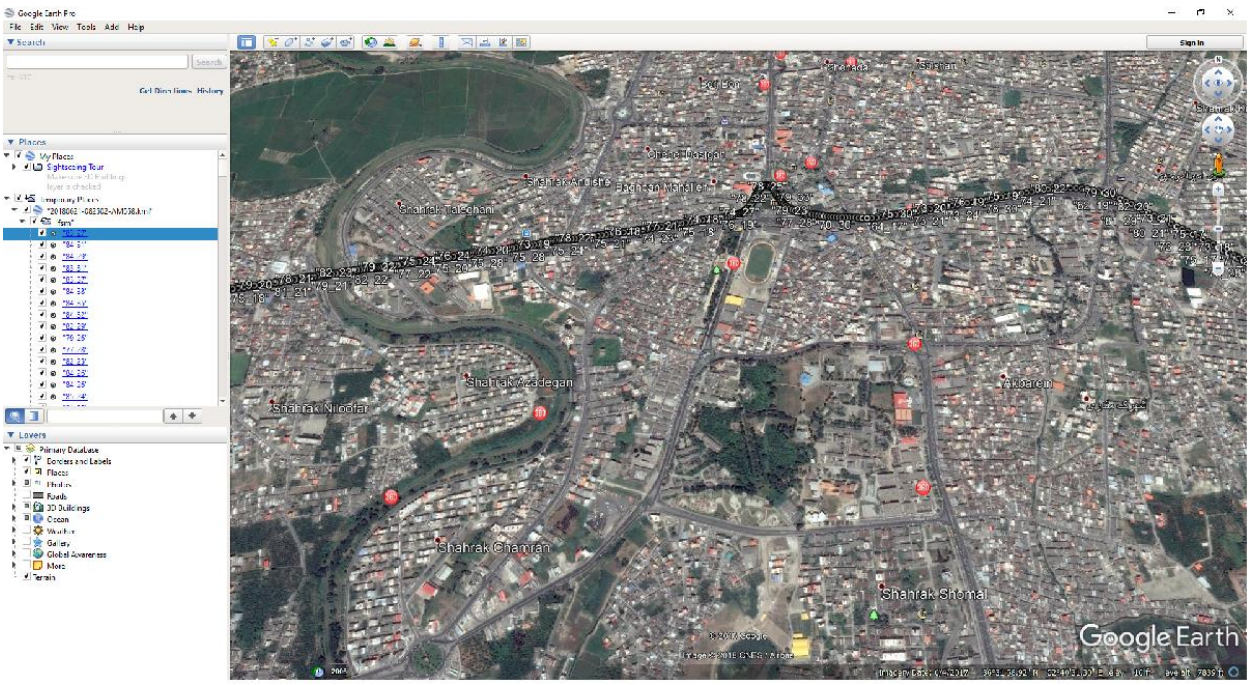
Export Button. This button will export record data into excel file. Excel data can be used for google earth import or graphing the result …

Hardware and Software Requirement

- PC System with Window 7 or higher.
- Intel Core with 2GHZ or higher clock.
- 1 Giga Bytes of HDD for installation and a few more for data records.

An hour of voice recording will generate a 450 Mega Bytes of wave file. Loading and extracting big files will need more processing power. To get better performance on loading records, use small record times. Practically FSM can record data up to the used SD Card size and there is no other limitation.

Google Earth file. Exporting data will generate three files. One excel file which contain all selected values, One wave file which contains the recorded voice (if the record contains voice) and one kml file which can be opened using google earth.



Fast Sampling 10X. In recent firmware (revision 2.30 and above) fast sampling is enabled which help to view data with 10x more detail. For viewing 10x data after checking the 10x button, map must be redrawn.

Colored RSSI levels. The color of RSSI points on the map is shown by the following rule:

RSSI 0..41 = RED

RSSI 42..59 = ORANGE

RSSI 60..75 = YELLOW

RSSI 76..95 = GREEN

RSSI 96.. = BLUE

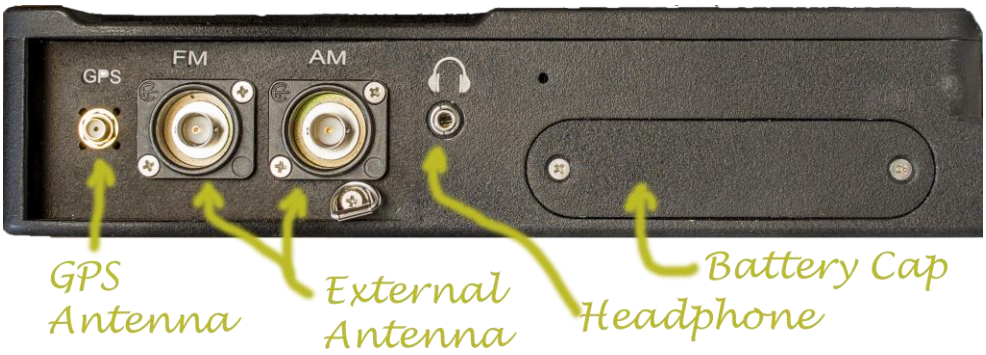
Ports and Connections

The connections are as follow

- External Power/Charger
- Power Switch
- External Antenna Connector for FM
- External Antenna Connector for AM
- GPS Antenna Connector
- Battery Cap
- Headphone Connector
- SD Card Slot

Top Side

Right Side



Left Side

Connector Types and specifications

- Headphone: 3mm socket
- SD Card: Micro SD up to 32 GBytes
- AM/FM Antenna: BNC
- GPS Antenna: SMA
- Charger: 5mm Jack

Appendix (SD Configuration Files)

The favorite station names is provided from RDS data. So the AM stations do not have a name in favorite list. The list of favorite stations can be edited manually to add more stations or assigning arbitrary names to the stations. The file name on SD is FAVO.TXT and here is a sample.

```
Tehran, 35.6944, 51.4215
AM,QURAN,900,0
FM,JAVAN,88000,0
FM,Iran,90000,0
FM,Varzesh,92000,1
FM,Tehran,94000,1
FM,Maaref,96000,0
FM,Eghtesad,98000,1
FM,Quran,100000,1
FM,Payam,104000,0
```

The format must not change. User can add or delete station lines. Station line format is

BAND,NAME,FREQUENCY,SELECTION

Appendix (Configuration File)

The configuration file contains all the parameters used by system. It contains two type of parameters. Static parameters are the one set by user and dynamic parameter are saved by firmware for example to preserve the last working status. Some data like battery calibration data and tuner calibration data are also accessible from this file. These data are not meant to be changed by user. It is a plain text file.

Here is a sample configuration file

```
FSM Config Version 1.00
!!! Please do not change the order of lines !!!
profile number = 0
favorite number = 0
use am external antenna (0/1) = 0
audio volume (0..63) = 0
audio mute (0/1) = 1
alarm mute (0/1) = 0
seek or tune mode (seek:1/tune:0) = 1
rssi unit (dBuV/m:0/mV/m:1) = 1
radio band (AM:0/FM:1) = 1
AM current radio frequency (KHZ) = 1418
FM current radio frequency (KHZ) = 90000
backlight timeout (seconds)= 0
screen lock timeout (seconds)= 0
alarm beep period (seconds)= 60
FM seek snr threshold (-127..127) = 8
FM seek rssi threshold (-127..127) = 12
FM seek frequency space = 10
FM valid snr threshold (-127..127) = 5
FM valid rssi threshold (-127..127) = 5
FM antenna kfactor (-127..127) = 0
FM channel bandwidth minimum (1..150) KHZ = 55
```

FM channel bandwidth maximum (1..150) KHZ = 150

FM RDS confidence (0..15) = 4369

FM resolution (10/100) = 10

AM seek snr threshold (-127..127) = 5

AM seek rssi threshold (-127..127) = 10

AM seek frequency space = 9

AM valid snr threshold (-127..127) = 5

AM valid rssi threshold (-127..127) = 5

AM antenna kfactor (-127..127) = 0

AM channel bandwidth minimum (1..150) KHZ = 20

AM channel bandwidth maximum (1..150) KHZ = 35

no SDCard alarm enable (0/1) = 0

low disk alarm enable (0/1) = 0

low battery alarm enable (0/1) = 0

always on alarm flag (0/1) = 0

record in progress alarm enable (0/1) = 0

GPS signal lost alarm enable (0/1) = 0

radio signal lost alarm enable (0/1) = 0

silence detected alarm enable (0/1) = 0

silence detection timeout (1..127) = 5

am calibration 0 (-64 ..64) = 38

am calibration 1 (-64 ..64) = 59

am calibration 2 (-64 ..64) = 61

am calibration 3 (-64 ..64) = 61

fm calibration 0 (-64 ..64) = 0

fm calibration 1 (-64 ..64) = 0

fm calibration 2 (-64 ..64) = 0

fm calibration 3 (-64 ..64) = 0

battery discharge at %0 (0..4095) = 2230

battery discharge at %18 (0..4095) = 2650

battery discharge at %97 (0..4095) = 3100

battery discharge at %100 (0..4095) = 3100

battery charge at %0 (0..4095) = 2700

battery charge at %15 (0..4095) = 2730

battery charge at %90 (0..4095) = 2790

battery charge at %100 (0..4095) = 3000