Monitoring device (MD) for FM signal quality monitoring
Radio Monitoring (RMS) for FM signal quality monitoring

Specially issued for FEM Nigeria

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SW version: 1.06
HW version 2.1

Signal measurement:

- FM RSSI
- FM SNR
- FM multipath
- FM carrier
- GSM RSSI
- L, R, L+R, L-R audio level

Analyses:

- remote MONO
- remote noise
- audio mute
- modulation depth
- local MONO time
- remote MONO time

Advanced:

- Stereo DTMF decoding
- Audio recording
- GSM direct audio monitoring

Annotation:

1. HW description
2. Wirring diagram
3. Specifications
4. Top zone display descriptions
5. Bottom zone display description
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9. BBserver connection and data structure

QUICKSTART

There are no settings needed to be configured. All settings for FEM Nigeria are pre-configured. So only plug-in to USB port using any MICRO USB plug(s) should be enough to work normally if power consideration are passed [3]. Also attaching FM and GSM antenna is necessary to get propper signal and inserting SIM card with GPRS data tarif needed.

Working conditions:

To search best working position, there are four LED's from which two LED's left bottom of MD used to determine overall FM and GSM signal quality. So even non-experienced usem can determine best antenna positioning either for FM and GSM.

Power supply state (must be always green) -->

DTMF/BT power state (green if enable) ----->

FM receiver signal quality indicator ---------->

GSM module signal quality indicator --------->

Signal quality indicator:

Determine and displays signal quality according to more variables and conditions. To get 100% usefull conditions, indicator must be Yelow/Green. If RED, low quality of signal is presented on antennas and services must not be working succesfully.

Setting-up propper conditions:

- Simply move FM or GSM antenna (according to propper signal indicator) to diferrent position.
- Ensure antenna is properly installed on flat metallic plate of size > 20x20cm
- Use higher gain antenna or more quality antennas

If not succesfull with the signal, BB nstalling is not recommended or special working conditions and accesories must be considerred.

1. HW descriptions

Monitoring device (MD) has following interfaces:

- USB micro plug for digital audio recorder
- USB micro plug for serial monitoring console
- STEREO audio jack 3,5mm for audio Line-out
- SMA plug for FM receiving antenna
- SMA plug for GSM antenna
- SIM card slot
- programming plug
- menu navigating button
- reset button
- Bluetooth (BT) device select button
- OLED 128x32 display
- 8x LED indicators

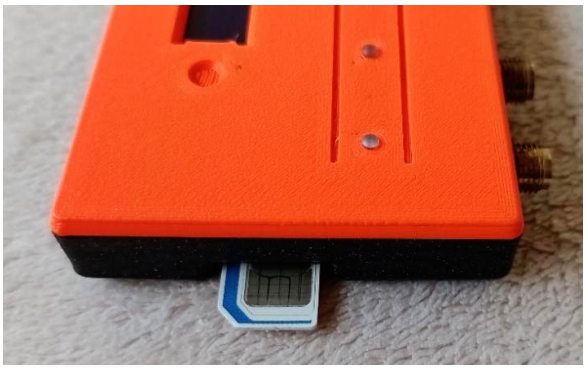

Illustration 1: SIM card slot

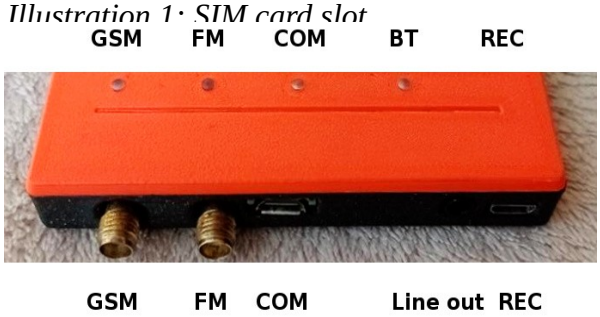

Illustration 2: Plugs and top LED's

Top indicators (from left):

- BT pairing
- serial communication
- FM MONO/STEREO status
- GSM status

Left indicators (from top):

- 5V supply voltage
- DTMF/BT on/off
- FM signal status
- GSM signal status

Illustration 3: MD overview

Buttons (from left):

- BT pairing
- RESet button
- OLED menu NAVigation

Illustration 4: Buttons

2. Wirring diagram

MD is designed to operate form USB 5V/500mA source through any or both of the USB micro. Using both plugs in paralel is recommended to get lowest wires resistance. MD is tolerant up to 6VDC, voltage bellow 4,7VDC or voltage supplies with low current source ability can cause GSM module restarting/not operating.

Audio output jack can feedany of Line-in inputs with input resistance >1kOhm, 10kOhm optimally.

Usage of any FM receiving 50Ohm antenna supported, also active antennas (with preamplifier) can be used.

Any standard type of 800/1600MHz GSM antennas can be used. Using of small non-wired antenna is not recomended if GSM signal is weak beacause of low gain and also, high radiation power can cause MD to get stucked and MD need to be restart manually in such cases (this must be considered according to local conditions). Usage of 6-12dBGSM antennas with pigtail is recommended to get best GSM signal. Note, that most of the cables have significant attenuation each metter of the cable, so no longer that 2 metters of the cable and not lower gain that 6dB of gain for antenas is recommended.

Illustration 5: Small antenna

Use SIM card in size of 12mm - “Micro SIM” only.

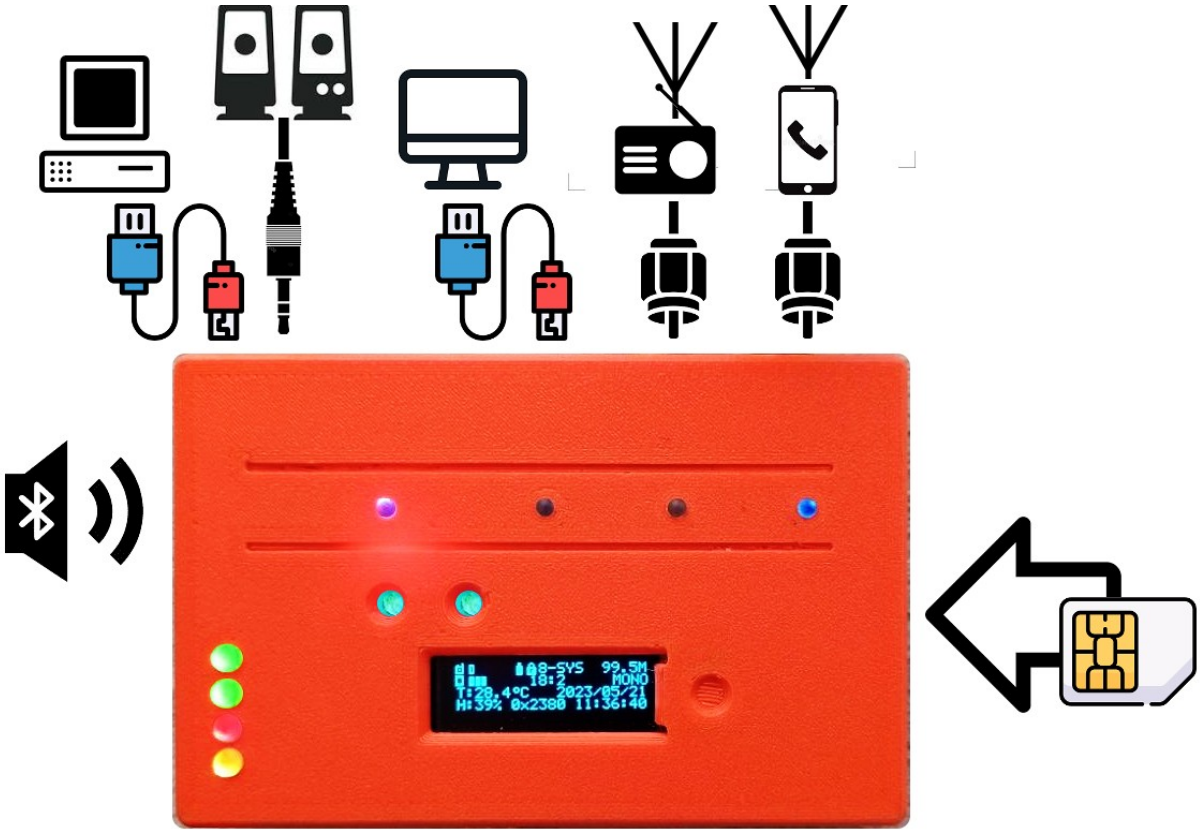

Illustration 6: Connection scheme

3. Specifications

- Recommended supply voltage: 5,1VDC; designed to operate from USB powerbank 5.000mAh-10.000mAh
- Absolute maximum supply voltage range: 4,7-6,4VDC
- Supply current: 30<40mA (no DTMF, no digital audio recorder, no BT)
- Supply current: <50mA (DTMF on, BT not connected)
- Supply current: <60mA (DTMF on, BT connected)
- Supply current <100mA if DTMF, BT and audio REC active
- Supply current >200mA if GSM/GPRS operate
- FM band: 87,5-108MHz
- GSM band 800/1600; GPRS data connection
- Communication protocol: UDP
- Serial settings: 9600/8N1
- Line out: 1Vpp max, 10kOhm
- programming slot: 6pin AVRdude/ATMEGA328

Monitoring device works as pre-configured device which cannot be set-up locally. Implemented display shows main informations and some configuration settings, but only a few of them can be set directly. To set-up device fully, you must use SMS commands in a form described in [5]. All settings are valid as they received and confirmation status is reported back to the telephone number from which was command sent. Those settings are valid until device is rebooted. After reboot, values stored in internal flash memory are loaded back to MD and all unsaved changes are forgotten. To save changes, special command to save current values must be applied. Previous settings are lost and replaced by current ones.

Oled display has two zones, top and bottom. Top zone are two lines displaying the same content in all user menus. Bottom zone has four lines and content is changing by browsing the menus.

Menu navigating button have two diferrent length of press. Short press for menu navigating when screen is locked and value changing/activating when screen is unlocked. Long press lock/unlock the screen.

4. Top zone display description

Top zone of display area displays the same values through all menu structure. It consists of two lines divided into three areas: left, middle, right. Left area contains signal info, middle area system information and right belongs to FM receiver.

Supply voltage state Lock Menu FM Rx frequency
| System load MONO/STEREO indicator

FM RSSI/SNR --->
GSM RSSI ------->

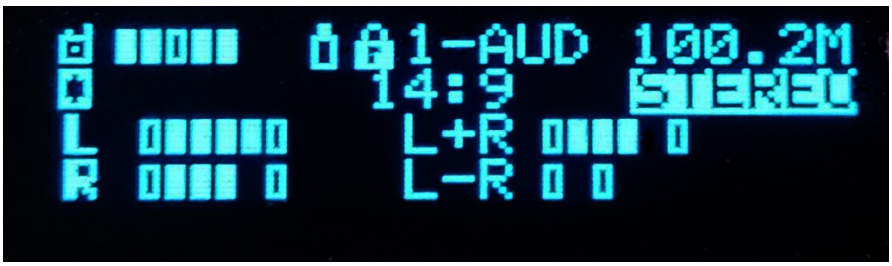

Illustration 7: Top zone display description

5. Bottom zone display description

Menu 1 – Audio levels (default menu)

Audo levels are represented by bars. Filled bars represents current value, empty bars represents zero and maximum values. All audio levels are maximum values of audio channels averaged through 100ms. Added channel L+R is a source of MONO signal, subtracted channel L-R is source of phase shifted channel used for DTMF STEREO decoding and as a source for remote MONO analyse.

Left channel -->
Right channel ->

<--- L+R channel
<--- L-R channel

Button activity: NONE

Menu 2 – Averaged values for analytic purposes

Those signals are long time averages of maximum values to remove noise influence to the signal. DS equals to maximum dynamic span counted from L+R signal and used to analyse dynamic envelope for noise detection. MS is maximum value for observing period. Averaging time can be optionally set by SMS command. Observing period is the same as reporting period and can be also changed by SMS command. A, B, A_B and A-B values repesents L and R averaged levels for averaging time and they used to analyse modulation level and STEREO disballance

Button activity: NONE

Menu 3 – A/D converter

Those values represent instant values of A/D converters. 1=Left channel; 2=Right channel; 3=L+R; 4=L-R; 5=supply voltage; 6=number of low_voltage events since last power-on or reset

Button activity: RESET to factory settings

Menu 4 – FM receiver

This menu displays basic FM receiver settings.

Button activity: Restart FM module

Menu 5 – DTMF decoder

DTMF min are minimum charracters in reception to activate trigger. Max is maximum value of DTMF charracters to activate trigger. Rx code displays received code. There are no any blacklists or preset codes, so any received code within charracter ranges activate trigger if DTMF decoder is ON. Maximum time for charracters bunch is preset to 4s.

Button activity: Toggle ON/OFF DTMF/BT modules

Menu 6 – GSM settings

Rt is time in seconds for periodic frame 0x80 trasmission. Wd is GSM watchdog, represented in seconds x10. Scrolling walues on a bottom line shows all settings needed for data connection: Right mottom value shows current PIN to use remote SMS commands. If value blinks, there were changes via SMS applied and not saved.

APN – internet provider APN name
USR – username (if applied)
PAS – password (if applied)
SIP – BBserver IP address
CON – connection protocol and port

Button activity: if unlocked, bottom line displays GSM communication log. Pressing button when ulocked toggle GSM module ON/OFF. *Note:* it take up to 30s to shutdown/enable GSM module.Also, enabling and disabling module is NOT saved, its just for debugging and GSM reset purposes.

Menu 7 – Audio multiplexer

Displays, enable and changes audio routing in MD. There are two main audio routes. One to GSM module for MD audio monitoring and secod for DTMF decoder. DTMF decoder can be feed by L+R or L-R signal, GSM can be switched between DTMF route and audio L/R route.

DTMF – source for DTMF decoder
GSM – select source for audio input
State – DTMF decoder status
Audio – source for GSM mux

Button activity: toggle all multiplexer settings (8 states)

Menu 8 – System menu

Displays general information such as system temperature, humidity, date/time and MD_ID

Button activity: if MD_ID blinks, it means some settings are not saved, then pressing button current values are saved to FLASH when unlocked

Menu 9 – Counters

Display main internal and statistic counters state.

LM – local MONO time [s]; increments when no STEREO carrier detected. Resets every Tx period
RM – remote MONO time [s]; increments when remote MONO signal over STEREO carrier detected
RQ – remote QUIET detected, increments when quiet over MO/ST carrier detected
RN – remote noise detected; increments when dznamic treshold reached (testing version)
AVG – averaging counter state

Menu 0 – Screensaver

Screensaver is activated avery screensaver delay when no button pressed. Cannot be disabled because of power saving procedure. Delaz can be set through SMS command.

6. Remote GSM configurations

MD can be configured and also monitored by remote SMS commands. If these commands are succesfully decoded by MD, it replies by time of local time reception and command number.. All settings made by remote SMS config are immediatellz activatted. Changes to be stored, must be saved using local ol remote save command unless they are lost when reboot.

Delivering SMS can take a while, especially when GSM signal is low. Also, some commands can be missed if MD is bussy at the time of reception. In case that you don't receive SMS confirmation within adequate time, try resend command.

Note: every command is stored into a GSM module. While new command is resend after there is no confirmation received and previous command still waiting to be executed,, the first waiting command will be executed as soon as any new command(s) are received and all other commands received and pending are ignored and erased.

7. Remote GSM commands table

	CMD	NO	PAR (default)	Note
System commands				
	SC	00	---	unsupported adr
Set APN	SC	01	55:"nternet"	AT_APN[24]
Set auth. Name	SC	02	"55:"	AT_NAME[18] – minimum 1. charracter, otherwise credentials off
Set auth. Passwd	SC	03	"55:"	AT_PASS[18]
Set protocol	SC	04	"55:UDP"	AT_protocol[4] – UDP/TCP
Set IP address	SC	05	"55:195.140.252.32"	AT_ip[16] BBserver IP
Set port	SC	06	"55:4321"	AT_port[6] BBserver port
Send AT command	SC	07	'55:"at+cpms?"	---
Shutdown/ena GSM	SC	08	"55:a"	a=0 shdn; a=1 on
GSM watchdog	SC	09	"55:aa"	nn*10[s]
Set report period [min]	SC	10	"10"	report every 10min
Set RF AGC	SC	11	"0"	RF AGC value 0=auto
Set Rx volume	SC	12	"55:aa"	Aa = Vol = 63; DEC value 0..63
Ena/Disa DTMF	SC	13	"55:a"	a=0 shdn; a=1 on
Set new MD_id	SC	14	"55:aa"	aa=MBid_L HEX value
Unlock code	SC	15	"55"	PIN value to unlock settings, "a" must be:< 0..9 or a..z or A..Z>
				Note: writting the same value saves all to EEPROM
User commands				
Screensaver	UC	16	"120"	seconds
Set DTMF source	UC	17	"1"	0=A+B; 1=A-B
Set GSM source	UC	18	"0"	0=DTMF; 1=LR
Set LR source	UC	19	"60"	0=L 1=R
Goto menu	UC	20	"8"	
Remote MONO treshold	UC	21	"1"	Remote MONO bellow A-B if not QUIET
Remote QUIET treshold	UC	22	"1"	Remote MONO bellow A+B
Remote NOISE treshold	UC	23	"90"	Remote noise if bellow max_avg_span
	Example:		55:"internet"2380SC01#	change API to internet
	<unlock code = 55>		55:"60"2380SC12#	set FM Rx audio volume to 60
			55:"55"2380SC15#	save values to FLASH
			55:"78"2380SC15#	change unlock code from 55 to 78

8. SW upgrade

See specisl document "Software ugrade" for details

9. BBserver connection and data structure

Monitoring device produces two type of data frames for BB server. Frame type 0x80 which is proprietary for monitoring device and frame 0x01 which is standard trigger frame. Frame 0x80 is activated and sent every cycle defined in MD by command 10 - "sent report period". Frame 0x01 is activated and sent only when DTMF decoder decodes a code at minimum length of "n" charracters. There is no other restriction for triggering, no blacklist, no pre-selected codes table. Triggering can be disa bled by SMS or manually from MD.

For detailed description of Bbserver connection an data representation see appendix: "Monitoring Device and BBserver communication"