Malahit-DSP and Malahit-DSP2 Receivers

User Manual and FAQ

This document describes Malahit-DSP and Malahit-DSP2 wide-band radio receivers, designed by Georgy Yatsuk (RX9CIM), Vladimir Gordienko (R6DAN), Vladimir Burlakov (R6DCY), and Igor Naumenko. These receivers are developed, built, and sold from Yekaterinburg, Russia. Both receivers are based on the SDR architecture, where most of the signal processing is done in the software. They have the following features:

Frequency Range	10kHz-380MHz, 404MHz-2GHz (Malahit-DSP2) 10kHz-250MHz, 400MHz-2GHz (Malahit-DSP1)
Panorama Width	192kHz, 96kHz, 48kHz (Malahit-DSP2) 160kHz, 80kHz, 40kHz (Malahit-DSP1)
Modulation Types	AM, SSB, DSB, CW, NFM, WFM
Sensitivity	0.3uV up to 1GHz
Dynamic Bandwidth	82dB
Antenna	50Ohm female SMA connector High impedance mode (DSP2 or DSP1 with optional board) Bias tee power (DSP2 or DSP1 with optional board) Built-in pre-amplifier
Power	Single 18650 lithium-ion cell (two cells can be used in parallel) Consuming 300mA current when using headphones
Software Features	Adjustable filter width Adaptive noise reduction (NR) Threshold noise reduction Noise blanker (NB) Automatic gain control (AGC) Automatic notch filter (ANF) Stereo FM with RDS support Simulated stereo Equalizer

Hardware Features	STM32H743 ARM CPU at 480MHz MSi001 multi-band, multi-mode tuner 3.5” 480x320 LCD display Capacitive touch screen Two mechanical encoders

While the Malahit-DSP1 receiver is no longer being made, **you can order Malahit-DSP2 by emailing malahit_sdr@rambler.ru or from the online store:**

https://malahiteam.com/en/

Contents

Assembling the Receiver

If you have an assembled receiver, please, skip over this section and go to the next one. Otherwise, read on.

The receiver is shipped as a kit, without a battery. Hence, you will need to obtain a single, good, flat-top, unprotected 18650 lithium-ion cell prior to assembling the receiver. **Protected button-top cells will not fit into the receiver.** Manuel Maliszewski has published a review of available 18650 cells , where he suggests using Panasonic / Sanyo NCR18650B or NCR18650GA cells. 18650 cells can be purchased from this online store:

https://www.18650batterystore.com/

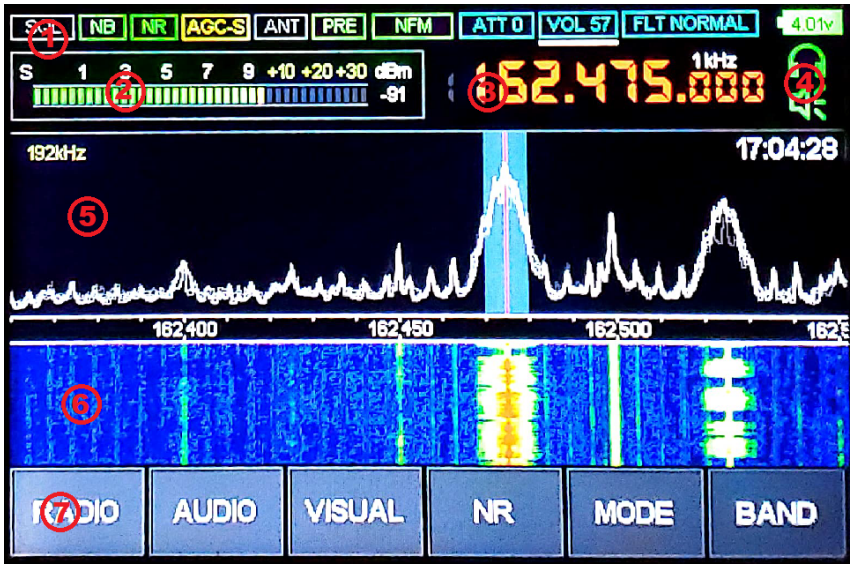
Once you obtain an 18650 cell, take a Phillips screwdriver and follow these instructions to assemble the receiver:

1. Insert the 18650 cell into its holder, found at the rear half of the receiver. Make sure it is installed in the correct polarity, with the positive end facing the red wire.

2. Check all wires for cracks, make sure they are firmly connected to the circuit board.
3. Put two halves of the receiver together, sliding them into the tracks. Make sure no wires are clamped or otherwise damaged in the process.
4. Holding receiver halves together, attach left and right covers, securing them with a screwdriver. Make sure that the LED, headphone connector, power button, and USB connector match holes found in the right-side cover.

Getting Started

Once you have your receiver assembled, attach and extend the included telescopic antenna, then click the power button found at the right side of its case. You should briefly see the title screen, followed by the main user interface screen:



From top to the bottom, this screen contains the following components:

1. Various indicators, discussed further in this document.
2. Signal strength meter (S-meter).
3. Currently tuned frequency and tuning step.
4. Headphone and speaker indicators.
5. Panorama display showing signal strength by frequency. The vertical line at the middle is your currently tuned frequency.
6. Waterfall display showing how signal changed over time.
7. Menu buttons, discussed further in this document.

The basic operation is very simple:

To change the frequency...
Touch the frequency display then use the touch screen to enter a new frequency.

To tune the frequency...
Rotate the larger knob found at the front of the receiver.

To change the tuning step...
Click on the larger knob, rotate it to change the step then click it again.

To change the volume...
Rotate the smaller knob found at the front of the receiver.

To change between volume, filter width, and attenuator...
Click the smaller knob, rotate it to select what you want to change, then click it again.

To change panorama width...
Touch the **lower half** of the panorama display. The current width is indicated at the top-left corner of the panorama.

To change modulation type...
Touch the **MODE** button, then use the touch screen to select a new modulation type, such as AM, WFM, NFM, LSB, or USB.

To quickly turn the screen off...
Click the power button. Clicking it again will turn the screen back on.

To turn the receiver off...
Press and hold the power button for a few seconds. The receiver will issue a series of Morse code beeps (guess what they mean) and then turn itself off.

Two more functions are toggled with the knobs found at the front of the receiver:

To disable touch screen...
Press and hold the smaller knob for a few seconds. Disabling touch screen will reduce the shortwave interference. You will still be able to tune the receiver by using knobs. Press the smaller knob again to reenable the touch screen.

To lock the currently tuned frequency...
Press and hold the larger knob for a few seconds. Press the larger knob again to unlock frequency tuning.

Finally, to set the clock shown at the top-right corner...

1. Hold the **RADIO** button until the receiver beeps, showing the time setup screen.
2. Rotate the smaller knob to change values.
3. Click the smaller knob to advance to the next element.
4. Once the date and time are entered, press and hold the smaller knob to confirm changes.

Exploring the Indicators and Menus

The top of the main screen contains a row of indicators, grayed if disabled, as follows:

SQL	The green light indicates that the squelch has been triggered. The red light

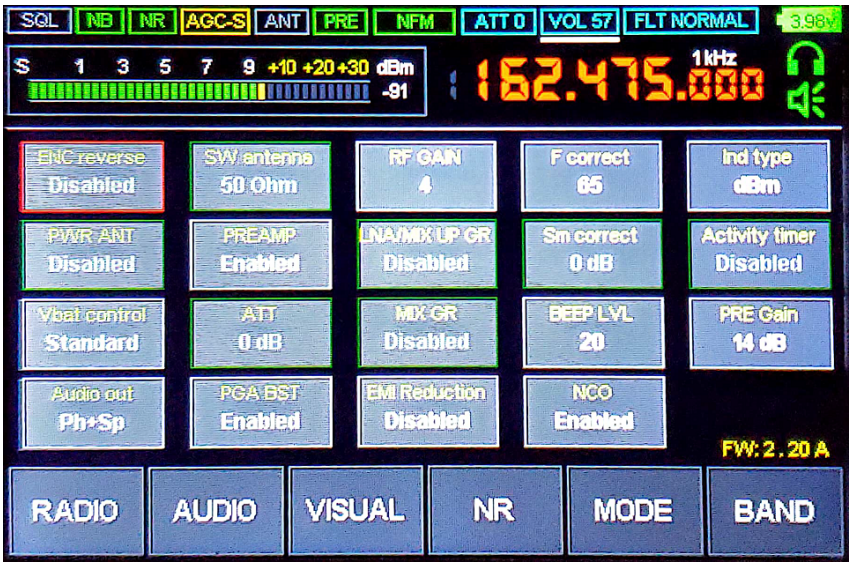
	indicates that the squelch is enabled, but not triggered.
NB	Indicates that the noise blanker is enabled.
NR	Indicates that the noise reduction is on.
AGC-S	Shows current automatic gain control status.
ANT	The green light indicates that the Hi-Z antenna is enabled. The red light indicates that the antenna power (*"bias tee"*) is enabled (DSP2 or DSP1 with optional board only).
PRE	Indicates that the pre-amplifier is on.
NFM	Shows current modulation type, such as AM, WFM, NFM, LSB, or USB.
ATT 0	Shows current attenuator setting, in decibels (DSP2 or DSP1 with optional board only).
VOL 57	Shows current volume setting.
FLT WIDE	Shows width of the audio filter applied to the decoded signal.
4.01v	Shows current battery voltage and status.

The bottom of the main screen contains a row of menu buttons, as follows:

RADIO	Configures the radio-frequency hardware and processing.
AUDIO	Configures the audio hardware and processing.
VISUAL	Configures the panorama and waterfall displays, as well as other visual features.
NR	Toggles the noise reduction feature on and off.
MODE	Switches between different modulation types.
BAND	Lets you save and restore saved frequencies and other settings.

In the following sections, we will go over each of the above menus in greater detail.

The Radio Menu



The **RADIO** menu lets you configure various hardware features, such as radio frequency gain, pre-amplifier, attenuator, and so on. Touch a menu item to select it. If an item has more than two different values, rotate the larger knob to change between these values. To exit the menu, touch the **RADIO** button again. This menu contains the following items.

ENC reverse — This item allows reversing the direction of one or both encoder knobs.

PWR ANT — The receiver has *"bias tee"* functionality for powering up external low-noise amplifiers (LNAs) and active antennas. When you enable this item, the battery voltage will be applied to the antenna connector. The **ANT** indicator at the top of the screen will go red while this feature is on. **Keep in mind that the voltage is going to be in the 3.3V to 4V range** and choose your LNA accoridngly.

Vbat control — This option does not currently work and will be removed in the future firmware versions. The receiver will always turn itself off once the battery voltage falls below the usable limit.
~~Normally, the receiver will turn itself off once the battery voltage falls below 3.3V. This item disables the safe voltage threshold and allows the receiver to operate until the battery is completely depleted.~~

Audio out — The audio output can be directed to the built-in speaker, the headphone jack, or both by using this item.

SW antenna — Normally, the antenna input has the impedance of 50Ohm, compatible with most regular, short antennas. This item will enable the high-impedance (Hi-Z) input mode for better shortwave reception when using telescopic antennas or a long wire. The **ANT** indicator at the top of the screen will go green while this feature is on. The Hi-Z mode gets automatically disabled at higher frequencies, where it makes no sense.

PREAMP — This item toggles the built-in input signal pre-amplifier. Use the pre-

amplifier to receive farther, weaker signals, but keep in mind that it will also amplify the noise. The **PRE** indicator at the top of the screen will go green while this feature is on.

ATT — High frequency input attenuator value in decibels. This is the same value as displayed at the top-right corner of the screen. It can also be changed with the smaller knob. Use attenuation if you are in the vicinity of very strong stations overloading the receiver.

PGA BST — Disable this function if you are listening to a very strong signal overloading the receiver.

RF GAIN — Signal gain at the wide-band quadrature mixer that is part of the MSI001 chip. Increase this value to amplify input signals. Decrease this value if you are experiencing too much noise or signal distortions.

LNA/MIX UP GR — This is an internal MSI001 parameter that can be used to attenuate strong signals. It behaves differently depending on the tuned frequency:

At 30MHz+ frequencies, where the MSI001 chip uses a built-in amplifier connected to a single mixer, this item will reduce the amplifier gain.

At lower frequencies, where the MSI001 chip uses two mixers, this item will reduce gain at the first mixer input.

MIX GR — This is an internal MSI001 parameter that can be used to attenuate strong signals. It behaves differently depending on the tuned frequency:

At 30MHz+ frequencies, where the MSI001 chip uses a built-in amplifier connected to a single mixer, this item will reduce gain at the mixer input.

At lower frequencies, where the MSI001 chip uses two mixers, this item will reduce gain at the second mixer input.

EMI Reduction — When enabled, this item will reduce the display updates frequency to reduce interference with the received signal. Enable it if you are seeing a lot of spurious "spikes" in the panorama.

Please note that the touch screen becomes less responsive when this item is enabled. Instead of pressing hard on the screen, simply hold your finger on the same spot for a little longer.

F correct — This value allows correcting the frequency display shown at the top of the screen, if it differs from the actual frequency. Simply tune to a known frequency (the higher the better), then adjust the **F correct** value until the displayed frequency becomes correct.

Sm correct This value allows correcting the signal strength meter shown at the top of the screen, if it differs from the actual strength. Simply tune to a signal with known strength, then adjust the **Sm correct** value until the displayed signal strength becomes correct.

BEEP LVL This item controls the system beep volume. That is the beep you hear when turning the receiver off, for example. Set it lower if those beeps are too loud for you.

NCO The *"numerically controlled oscillator"* (NCO) mode, enabled by this item, allows sampling any signal within current panorama. Normally, the entire panorama will move as you tune frequency with the larger knob. In the NCO mode, the tuned frequency within panorama will move until you reach an edge of the panorama. This mode is also useful for tuning out internal interference (EMI) by adjusting the panorama frequency separately from the signal.

Ind type This item toggles the signal strength meter, shown at the top of the screen, between S-levels and decibels (dBm).

Activity timer The receiver will turn itself off if you do not touch it for this preset amount of time in minutes.

PRE Gain With the pre-amplifier enabled, this value (in decibels) will be subtracted from the signal strength meter shown at the top of the screen. This is done to correct S-meter readings for the pre-amplified signal.

The Audio Menu

The **AUDIO** menu lets you configure various sound characteristics, such as filtering, gain, noise reduction, noise blanking, and squelch. Touch a menu item to select it. If an item has more than two different values, rotate the larger knob to change between these values. To exit the menu, touch the **AUDIO** button again. This menu contains the following sections.

Noise Blanking (NB)

The noise blanking feature is used for cancelling the incoming audio noise. You can enable or disable this feature by clicking the **NB** button. The **Threshold** value sets the triggering level. It is not recommended to set it below 3. The **Config** option switches between several different noise blanking configurations. Both parameters depend on the type of a noise you are trying to blank and thus need to be adjusted by ear.

Automatic Gain Control (AGC)

The automatic gain control feature is used for automatically adjusting audio amplification gain. You can choose between three different AGC modes with the **AGC MODE** option. The **AGC GAIN** value controls how much amplification is applied. The **AGC LIM** value sets cut-off limit for automatic gain control.

Filtering (FILTER)

The **Filter** option offers three different audio filter widths: normal, wide, and narrow. This is the same value as displayed at the top-right corner of the screen. It can also be changed with the smaller knob. The additional **Low freq** and **High freq** values set hard thresholds on what sound frequencies can pass through.

Squelch (SQL)

The squelch feature, when enabled with the **SQL** button, will completely cut off sound if its level is below a certain threshold, specified via the **SQL threshold** value. The red **SQL** light at the top of the screen indicates that the squelch is enabled, but "closed". Once the sound level exceeds the threshold, the squelch "opens" and the **SQL** light goes green.

Noise Reduction (NR)

The **NR threshold** value specifies the sound level at which the noise reduction is applied.

Automatic Notch Filter (ANF)

The automatic notch filter allows to suppress carrier tone when using LSB or USB modulation. This ANF is disabled for other modulation types. To toggle the filter, click the **ANF** button.

Broadcast FM Settings

Two of the remaining items have to do with the FM broadcast reception. The **EQ TYPE** option selects the equalizer type applied to the FM radio. The **WFM stereo** option toggles FM stereo sound. Please note that **you have to enable FM stereo if you would like to see textual RDS information transmitted by FM radio broadcasters or automatically scan FM band for stations.**

Stereo Effects Simulation

Finally, the **PseudoStereo** button enables stereo simulation from mono sound. For obvious reasons, it is only useful when listening via headphones. **The pseudo stereo mode is disabled when listening to FM broadcast stations** using WFM modulation.

The Visual Menu

The **VISUAL** menu lets you configure panorama and waterfall displays, changing their sensitivity, color scheme, and other settings. Touch a menu item to select it. If an item has more than two different values, rotate the larger knob to change between these values. To exit the menu, touch the **VISUAL** button again. This menu contains the following items.

Screen Settings

The regular screen brightness is controlled by the **BRIGHT MAX** value. If the screen is left alone for **REDUCT TIME** seconds, it will reduce brightness to the **BRIGHT MIN** value. If you enable the **LCD SLEEP** option, the screen will turn off after the receiver is left alone for selected number of seconds. The receiver will continue operating though, with the screen going back on once you touch it, or any of the knobs.

Waterfall Settings

The **WF GAMMA** option allows to choose between several different color schemes for the waterfall. The **WF Gain** value can make waterfall more sensitive to weaker signals, at the cost

of showing more noise. Finally, the **WF delay** value controls the waterfall speed.

Panorama Settings

The **FFT color** option allows to choose the panorama color. The **FFT scale** value determines panorama sensitivity. Finally, the **FFT fill** option toggles between plain and filled panorama styles.

The screen percentage taken by the panorama, relative to the waterfall, is controlled by the **Pan percent** value.

Disabling Waterfall and Panorama

To reduce interference from the screen, you may want to disable both waterfall and panorama displays by changing the **View Pan&WF** option. With both waterfall and panorama disabled, the screen will only update when you change the frequency or other settings. **This also applies to the S-meter.**

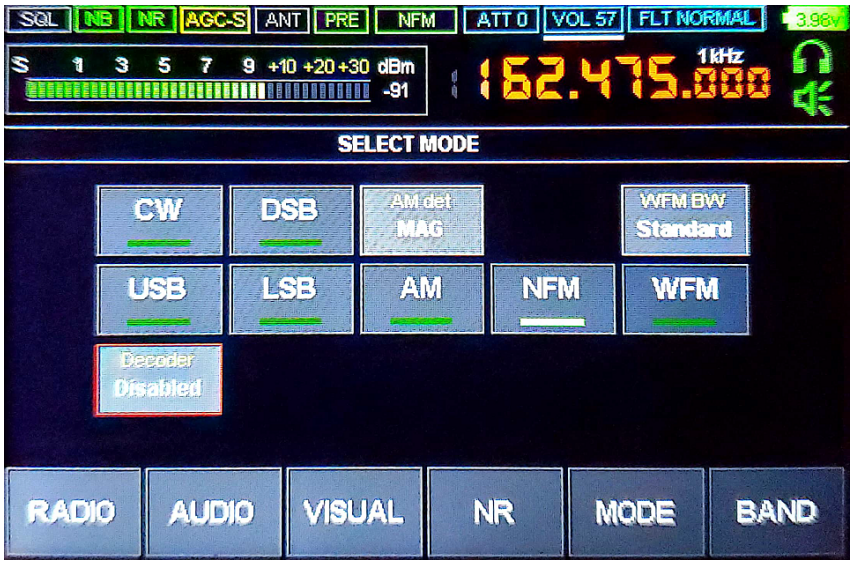
DC Rejection

For proper operation, the receiver supresses the direct current (DC) signal component that occurs at the 0Hz offset within panorama. While the DC component does not affect signal reception, it may show up as a spike at the dead center of the panorama. The **DC reject** value controls the supression strength. Setting it too high may create a "gap" at the panorama center though.

FM Scale Selection

The receiver includes a separate "retro scale" view of the FM broadcast band, similar to the old shortwave receiver front panels. While the retro scale feature will be discussed later in this document, the FM band layout changes from country to country. The **Retro scale** option allows to choose between European and Japanese FM band layouts.

The Mode Menu



The **MODE** menu lets you change current modulation mode (displayed at the top of the screen), as well as enable the CW decoder feature. Touch a menu item to select it. If an item has more than two different values, rotate the larger knob to change between these values. To exit the menu, touch the **MODE** button again. This menu contains the following items:

WFM **Wide-Band Frequency Modulation**

Wide-band frequency modulation used by commercial stations broadcasting in the FM band. When using WFM modulation, the **WFM BW** option selects between normal and narrow modulation widths. Use the narrow WFM modulation if you are experiencing interference from adjacent FM broadcasters.

NFM **Narrow-Band Frequency Modulation**

Narrow-band frequency modulation commonly used by police and first responder radios. Amateur radio operators also use this mode when working in VHF and UHF bands.

AM **Amplitude Modulation**

Amplitude modulation used by commercial stations broadcasting in LW, MW, and SW bands, as well as mariners, pilots, and air traffic control. When using AM modulation, the **AM det** option selects the AM demodulator type:

- Classic Amplitude Detector (MAG)
- Synchronous Amplitude Detector (SAM)
- Upper Sideband Synchronous Amplitude Detector (SAMU)
- Lower Sideband Synchronous Amplitude Detector (SAML)

While MAG is the safe default choice, you may want to change to a different demodulator if the AM signal is too weak or crowded by nearby signals.

LSB **Lower-Sideband Amplitude Modulation**

Lower-sideband amplitude modulation commonly used by amateur radio operators working in 160M, 80M, and 40M bands.

USB **Upper-Sideband Amplitude Modulation**

Upper-sideband amplitude modulation commonly used by amateur radio operators working in 20M and higher frequency bands.

DSB **Dual-Sideband Amplitude Modulation**

This option, when combined with **LSB** or **USB**, will automatically choose the sideband that has higher signal level.

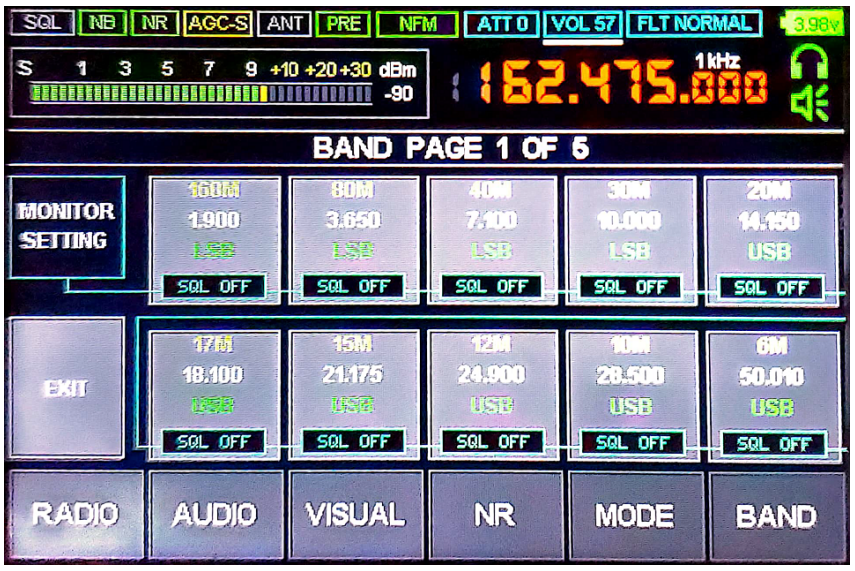
CW **CW Mode**

This option, when combined with **LSB** or **USB**, shrinks the audio filter to the 1kHz width, useful for listening and decoding Morse code (CW) transmissions. The **LSB** / **USB** indicator at the top of the screen will change to **CWL** / **CWU** respectively. **This option is not compatible with the noise reduction (NR) feature!**

Decoder **CW Decoder**

When enabled, the CW decoder feature will attempt to decode Morse code (CW) transmissions and show them below the panorama display. Adjust the **Min SNR** value to around 29 for the best decoding performance. To further improve CW decoding, you may want to enable the **CW** option and disable the noise reduction (**NR**).

The Band Menu



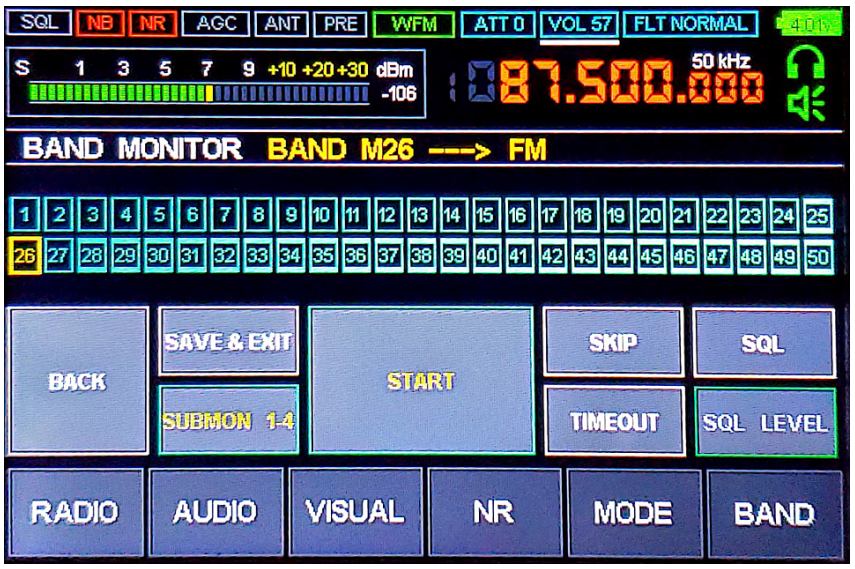
The **BAND** menu allows to save and restore current receiver settings to a collection of memory slots. These slots are organized into pages, flipped by rotating the larger knob.

To save current settings to a memory slot...

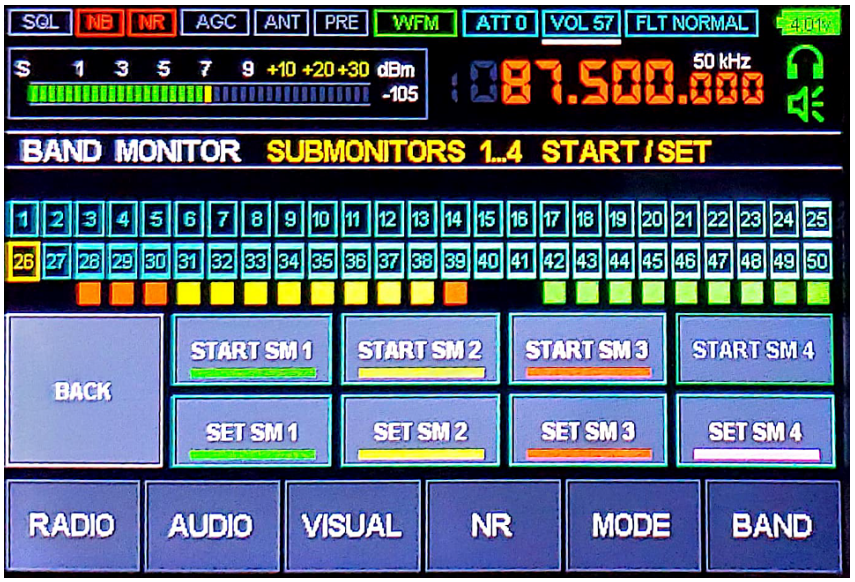
Press and hold chosen slot for a couple of seconds, until you hear a beep. You will then be offered opportunity to name saved slot.

To restore settings from a memory slot...
Briefly touch chosen slot.

Band Monitoring



TODO: This section will be expanded later.



TODO: This section will be expanded later.

The FM Retro Scale

When using WFM modulation, the receiver offers the "retro scale" view, similar to the front panels found in the old shortwave receivers.

To enter the retro scale view...

1. Tune receiver to the FM broadcast band (83-110MHz). The active FM bands depend on the country set with the **Retro scale** option in the **VISUAL** menu.
2. Select **WFM** modulation type in the **MODE** menu.

3. Click on the waterfall display twice, until the retro scale shows up.

Once in the retro scale view...

1. Use the larger knob to move between stations.
2. Click on the lower half of the scale to go back to the regular panorama view.
3. Click on the upper half of the scale to enter the retro scale menu.

The retro scale menu, invoked by clicking on the upper half of the scale, offers options to add, delete, and edit stations. It contains the following buttons:

SWITCH USER SCALE — The receiver offers **two separate user-defined scales**. This item lets you switch between these two scales.

CHANGE COLOR — Select retro scale color by rotating the larger knob or clicking on a corresponding color sample. Once done, press the **SAVE COLOR & EXIT** button to confirm your choice or **CANCEL** button to abandon changes.

LOAD PRESET — The receiver contains **pre-programmed scales for a multitude of cities**. This item lets you select the scale for a city where you live by using the larger knob. Keep in mind that **your current scale will be lost**, getting replaced by the pre-programmed scale.

RENAME SCALE — Rename your current scale, rotating the larger knob to select letters. Once you select the next letter, press the larger knob to confirm it and go to the next letter. You can restart the name entry by clicking the **CLEAR NAME** button. Once done, press **SAVE AND EXIT** button to confirm, or **CANCEL** button to abandon changes.

CLEAR SCALE — This item lets you completely clear the current user-defined scale, removing all stations and the custom scale name, if any. Press the **CLEAR** button to confirm, or **CANCEL** button to keep your current scale.

ADD/EDIT STATION — Before editing or adding a new station, tune to its frequency with the larger knob. Enter or change station name by using touch screen or rotating the larger knob to select letters. Once satisfied with your input, press **SAVE AND CONTINUE** to edit the next station, or **SAVE AND EXIT** to go back into the menu. Press **DELETE STATION** to completely remove the current station entry. Finally, press **CANCEL** to abandon changes.

AUTOSEARCHING — This auto-search feature makes the receiver scan FM band looking for stations and automatically populate the current scale with found

stations. It is described in the next section of this document.

CANCEL	Exit the menu back into the retro scale view.

The Auto Search

The retro scale lets you scan the airwaves and populate your scale with found FM stations. The searched FM bands depend on the country set with the **Retro scale** option in the **VISUAL** menu. In order to use the auto-search feature, follow these steps:

1. Go into the **RADIO** menu and make sure that the headphone output is enabled in the **Audio out** option. **The auto-search will not work with the headphone output disabled.**
2. Go into the **AUDIO** menu and make sure the **WFM stereo** option is enabled. **The auto-search will not work with the WFM stereo disabled.**
3. Go into the retro scale menu by clicking on the upper half of the scale and click the **AUTOSEARCHING** button.

The auto-search screen shows the progress bar, the number of found stations, and the pilot tone indicator. The auto-search can be cancelled at any moment by clicking the **CANCEL** button.

Once the auto-search completes, it presents the choice of saving the results to your current scale with the **SAVE SCALE & EXIT** button or abandoning them with the **CANCEL** button. Keep in mind that **the prior contents of the scale will be lost** if you choose to replace them with the auto-search results.

Connecting Receiver to a Computer

The following instructions assume that you are connecting the receiver to a **PC running *Microsoft Windows 10*** or similar operating system. *Windows 10* is supposed to have all the drivers needed to interface it with the Malahit receiver and thus **does not require any third party drivers**.

You will need a micro USB cable (shipped with most cell phones) to connect Malahit to a PC. **Make sure your micro USB cable supports data connections.** Once you connect the receiver to any available USB port on your PC and turn the receiver on, you should see the following three new USB devices in the *Windows Device Manager* panel:

- **Malahit RX**
  This is the audio input device that brings sound from the receiver into the computer. You can use it the same way you would use a regular microphone device.
- **Malahit IQ**
  This device is also treated as an "audio input" of sorts, but it carries the entire 192kHz of the panorama data. You can use this device with various SDR software packages (such as

HDSDR, *SDR++*, or *SDR#*) to receive and process the same panorama as received by the Malahit.

- **Malahit CAT**
  This is a USB-connected serial port used to tune Malahit's frequency, select modulation, volume, and other parameters. The command set used by the receiver is compatible with the *Kenwood TS-480* command set.

Once you have verified that the Malahit USB devices show up in the *Windows Device Manager* panel, go into the *Windows Sound Control* panel and **make sure both *"Malahit RX"* and *"Malahit IQ"* sound inputs are enabled**.

Verifying Connection with *HDSDR*

Now, let us verify the receiver functionality with the popular *HDSDR* application for *Windows*, by following these steps:

1. Install and run the *HDSDR* software.
2. Select *"Options | Select Input | Sound Card"*, since the receiver acts as a sound card device.
3. Click on *"Soundcard"* and select *"Malahit IQ"* in the *"RX input (from Radio)"* box.
4. Click *"Ok"* to confirm your choice.

At this point, the *HDSDR* should show the same panorama and waterfall displays as your receiver. Use the receiver controls to tune the frequency.

Controlling Receiver from a Computer

To tune the receiver frequency from a computer, you will need to interface the *OmniRig* software with the *"Malahit CAT"* USB device.

1. Go into *Windows Device Manager* and find what COM-port device your *"Malahit CAT"* is associated with. This can be done by disconnecting and reconnecting the Malahit receiver. One of the COM-port entries underneath the *"COM & LPT"* branch should disappear and then reappear. That will be your COM-port device. **It may change if you reconnect the receiver to a different USB socket.**
2. Install and run the *OmniRig*. In the *OmniRig* window, configure *"RIG 1"* as follows and confirm your changes by clicking *"Ok"*.

```
Rig Type  = TS-480
Port      = <your COM-port>
Baud Rate = 19200
Dara Bits = 8
Parity    = None
Stop Bits = 1
RTS       = High
DTR       = High
Poll      = 500
Timeout   = 4000
```

3. In the *HDSDR*, select *"Options | CAT to Radio | Sync RIG1"*, enable *"Use v1"*, *"Sync to Rig"*, *"Sync from Rig"*, *"Sync LO Frequency"*, and *"Sync Modulation"* in the same menu.

You should now be able to control Malahit receiver by changing frequency and other settings in the *HDSDR* software.

Updating Firmware

The Malahit development team releases firmware updates on the regular basis, publishing them at their web site. On *Windows*, follow these steps to flash your receiver with the new firmware:

1. Install *STM32CubeProgrammer* software, which we are going to use for flashing.
2. After making sure your Malahit receiver is fully charged, turn off your receiver.
3. **Press both receiver knobs. While holding them down, turn the receiver on with the power button.** Release the knobs. The receiver LED should start blinking red and green, indicating that the receiver is now in the **DFU mode** and ready to accept new firmware.
4. Connect receiver to the computer. At this point, you should see *"MALAHIT RECEIVER DFU"* device in the *Windows Device Manager*.
5. Click the right mouse button on the *STM32CubeProgrammer* desktop icon and select *"Run as administrator"* from the popup menu to run the program with administrative privileges.
6. In the *STM32CubeProgrammer* window, find the drop down menu to the left of the green Connect button and select *"USB"* from that menu.
7. Click on the 🔄 icon to the right of the USB port name to refresh USB configuration, then click on the green Connect button. Upon successful connection, the green button should turn into Disconnect .
8. Click on the "hard drive download" icon at the left edge of the *STM32CubeProgrammer* window. This should bring up the *"Erasing & Programming"* screen.
9. Click on the Browse button and select the firmware file you would like to flash. **All valid firmware files will have .BIN extension** (as in *"M2_FW2_10_F.bin"*).
10. **Check *"Verify programming"* and *"Run after programming"* checkboxes.** Leave the rest of checkboxes unchecked.
11. Click on the Start Programming button to proceed with the flash.
12. The *STM32CubeProgrammer* window will indicate the flash progress at its bottom. Once it is done flashing, the program will display the success message.
13. Once done flashing, click on the Disconnect button and the receiver should reboot into freshly flashed firmware.

If flashing fails, you can repeat the above process as many times as necessary. This will not damage your device.

Dealing with Internal Interference

The Malahit receiver is essentially a little computer containing multiple digital components, such as CPU, display, and the touch screen. Since all these components operate by using digital

signals, they all generate their own electromagnetic noise affecting reception. In this section, we will go over common interference sources inside the receiver and how to deal with them.

Touch Screen Noise

The touch screen noise mostly occurs in shortwave bands and manifests as a constant buzzing sound that becomes louder when you touch the screen. The best way to deal with it is by moving your antenna at least several meters away from the receiver. If this is not possible (when using a telescopic antenna for example), you can temporarily disable the touch screen by pressing and holding the smaller knob for a few seconds. You will still be able to tune the receiver by using knobs. Press and hold the smaller knob again to reenable the touch screen.

Display Noise

The display noise usually occurs in the VHF and adjacent bands. It manifests as prominent "bumps" or "spikes" on the panorama display, often obscuring useful signals. Once again, the best way to deal with it is by moving your antenna at least several meters away from the receiver. If this is not possible, reduce the display noise by going into the **RADIO** menu and enabling the **EMI Reduction** option. This will slow down display updates, reducing the interference, at the cost of making the touch screen more sluggish. Finally, you can temporarily disable the display by clicking the power button. You will still be able to tune the receiver by using knobs. Press the power button again to reenable the display.

Choosing the Right Antenna

Your antenna choice will always depend on the frequencies you would like to receive and the amount of radio interference at your location. In this section, we will go over some available options.

Telescopic Antennas

The **receiver comes with a short telescopic antenna** that can be used at a wide variety of different frequencies, as long as you do not have any strong electromagnetic interference sources nearby. Possible interference sources include power supplies, phone chargers, LED lights, refridgerators, air conditioners, water pumps, and other devices.

The stock telescopic antenna is not the best choice in the LW, MW, and SW bands (<30MHz), but can still be used there. To improve the reception in these bands, go to the **RADIO** menu and enable the **SW antenna** option to go into the high-impedance (Hi-Z) antenna mode. The **ANT** indicator at the top of the screen will go green while this feature is on. The Hi-Z mode is automatically disabled at higher frequencies, where it makes no difference. You may also want to enable the **PREAMP** option for additional signal amplification, at the cost of more noise.

Other telescopic antennas can also be used with the receiver. They all work approximately the same, with longer antennas being more sensitive at lower frequencies. More expensive telescopic antennas are made of sturdier materials and offer better articulation. Some popular choices are Comet SMA-W100RX and Diamond SRH789. Some antennas come with BNC connectors and will require a BNC-to-SMA adapter to attach to the receiver. Whatever telescopic antenna you choose, keep in mind that heavier antennas put more strain on the SMA connector and may eventually damage it.

Long Wire Antennas (LW, MW, SW)

The optimal length of a telescopic antenna should be close to 1/2 of the wavelength you expect to receive. For example, if you are planning to listen to the 25m shortwave band, the optimal antenna length will be

25 / 2 ~= 12.5 meters

which makes good shortwave telescopic antennas rather difficult to implement. It is still possible though to attach a really long wire to the antenna connector, throwing it outside or wrapping it around a room as necessary. Shortwave radio manufacturers offer such antennas as Sangean ANT-60, Tecsun AN-05, or XHDATA AN-80, where the wire conveniently retracts into a reel. Same as telescopic antennas, long wires are susceptible to the electromagnetic interference.

Rubber Whip Antennas (VHF, UHF)

At shorter wavelengths (80MHz+), it is possible to use short rubber whip antennas made for the use in walkie talkies, first responder radios, and scanners. These antennas are small, very portable, and offer decent reception in the FM, VHF, and UHF bands. Some examples are Nagoya NA-701, Nagoya NA-771, Comet SMA-501, and Comet SMA-503. It is necessary to say though that these antennas are specifically tuned for the VHF and UHF bands and thus become useless in the LW, MW, and SW bands.

Loop Antennas

As mentioned in the previous sections, the electromagnetic interference is often a huge problem when listening to the radio indoors or in urban environment. The magnetic loop antennas attempt to work around this interference by receiving the magnetic component of the signal rather than noisier electric component.

A typical loop antenna consists of one or more relatively small loops of wire connected to a receiver via a tiny transformer ("balun" or "unun"). The total surface of the wire loop determines how much magnetic flux it receives, making bigger loops more sensitive. **A loop antenna is directional, with the maximum gain achieved when a side of the loop is directed towards the signal source.**

While loop antennas are less susceptible to the eletromagnetic interference, they are also less sensitive than conventional antennas. Thus, **most commercial loop antennas include low-noise amplifiers, requiring a power source**. Some commercially available loop antennas are YouLoop, MLA-30+, and GA-450.

Accessories

Malahit receivers have been modified in different ways, to improve their characteristics or make them more comfortable to use. Additionally, there are people offering accessories made specifically for these receivers. In this section, we will go over some of these accessories.

Connecting BNC Antennas

Since the receiver comes with a female SMA connector, it requires an adapter for connecting BNC accessories. Using a heavy BNC adapter may damage the stock SMA connector. Fortunately, there are slim BNC adapters on Amazon, among other places.

Magnetic USB Cables

The micro USB socket inside the receiver is soldered directly to the circuit board and may eventually break off because of the repetitive stress. To avoid this problem, consider using a magnetic USB cable, available from many sources at Amazon and other ecommerce sites. These products consist of a tiny insert that plugs into the micro USB socket and a special cable safely attaching to that insert by magnetic force.

Better Encoder Knobs

Nikolay makes better encoder knobs, as shown below. At the time of writing this text, these knobs cost 14 euros when shipped from Russia to the EU, 17 euros when shipped to the US. You can contact Nikolay by emailing him in English or Russian. Similar, but less impressive knobs can be obtained from Amazon and other online shops.

Custom Stands

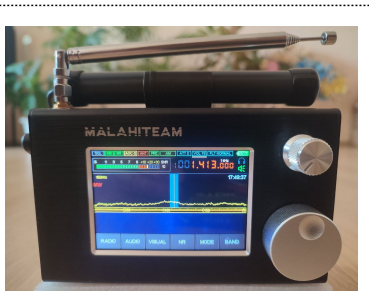
Serhii produces custom Malahit receiver stands made of stainless steel, as shown below. At the time of writing this text, these stands cost 40 euros when shipped from Ukraine to the EU, 44 euros when shipped to the US. You can contact Serhii by emailing him in English or Russian.

Bluetooth Transmitters

While the receiver does not have built-in Bluetooth interface for connecting wireless headphones, an external Bluetooth transmitter can be purchased on Amazon, among other places, and plugged into Malahit's audio output. For convenience, attach it to the back of the receiver with a piece of Velcro.

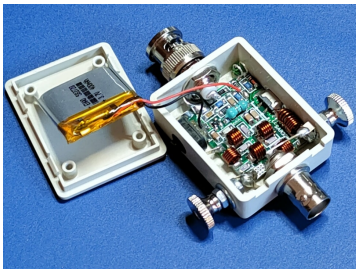
Ferrite Antennas

Vladislav makes active ferrite antennas for superior reception in LW, MW, and lower SW bands. The ferrite antenna works much better than the stock telescopic antenna at these bands, especially when used inside buildings and other noisy environments. The antenna attaches to the top of the receiver and plugs into the SMA socket. Malahit-DSP2 receivers will power the antenna using the bias tee. You can contact Vladislav by emailing him in English or Russian.



SV2CZF Antennas

Theo (SV2CZF) designs and builds a variety of small, highly effective antennas, including MWA30, TWA30P, and SAR32M. These antennas have proven to work very well with the Malahit receiver, as seen in the SAR32M review by Manuel Maliszewski. You can contact Theo by emailing him in English. Theo also has a Facebook group where he posts news about his products.



Modifications and Repairs

This section will cover Malahit receiver modifications and repairs.

Changing DIP Switches

Inside the receiver case, there is a block of DIP switches. These switches control experimental firmware features that have not yet made it into the on-screen user interface:

- **DIP2 -- Safe Power-On Sequence**
  With this switch enabled, the receiver will only turn on after you click the power button **three times**. This is done to prevent random power-ons when something accidentally touches the power button.
- **DIP3 -- Higher Display Frequency in WFM Mode**
  When this switch is on, and the receiver is in the WFM mode, it will run the display at higher frequency. Lower display frequency will be used when this switch is off.
- **Other Switches**
  Please, do not touch any other DIP switches, as this may interfere with the normal operation of the receiver.

Using Two 18650 Cells

To extend operating time, you can put two 18650 lithium cells into your receiver. Some receivers even come with a battery holder fitting two cells. If your receiver has a single battery holder, you will have to replace it with a dual type. Since the receiver expects single cell voltage, **your battery holder should connect cells in parallel**. **Do not connect cells in series**, since it will damage your receiver.

It has also been reported by multiple Malahit users that the cells may touch and short encoder pins inside the case. While this **does not** cause spontaneous combustion, the encoders may stop working as result. **Make sure your cells do not touch encoder pins** and bend pins away if it happens.

To avoid power drain and excessive heat...

1. Always **use the same exact cells**, same model, from the same manufacturer, preferably from the same batch.
2. Before placing cells into the receiver, make sure to **fully charge both cells**, with external charger if necessary.

Manuel Maliszewski provides more information on connecting and managing two 18650 cells in his blog. He is also suggesting the best 18650 cells to use.

Replacing SMA Connector

The SMA connector or the cable connecting it to the receiver board may break after a lot of use. If this happens, the replacement part is as follows:

150mm SMA-to-MCRF Cable	100mm SMA-to-MCRF Cable
MOLEX 0897629524	MOLEX 0897613412

Replacing Encoders

The mechanical encoders used in the receiver are known to wear our and break over time. If any of your encoders break, the replacement parts are as follows:

Frequency Encoder	Volume Encoder
BOURNS PEC11R-4020K-S024	BOURNS PEC11R-4220K-S024

The only difference between these two parts is that the volume encoder will click when rotated.

Useful Resources

This section contains links to documentation, software tools, and general reference databases.

Other Documentation

- **The Official MalahiTeam Site**
  Order Malahit receivers, download official firmware and documentation.
- **MalahiTeam YouTube Channel**
  Guides, tutorials, and new product announcements.
- **Manuel Maliszewski's Blog**
  Many modifications and accessory reviews.
- **David Zantow's (N9EWO) Blog**
  Tips, modifications, and suggestions. History of firmware changes and a deep dive into Malahit hardware.
- **Emil's Blog**
  Malahit hardware and firmware information and hacks.

- **Ash Nallawalla's Blog**
  Detailed guide to connecting Malahit to a PC.
- **Discussion Group at Groups.io**
  Community of Malahit users supporting each other.

General Software

- **OmniRig CAT Control**
  You will need this software in order to control Malahit from a *Windows* computer.
- **Virtual Audio Cable**
  This software creates a virtual "audio cable" for connecting SDR receiver apps to digital decoder apps on *Windows*.
- **HDSDR**
  SDR receiver for *Windows* that supports any SDR hardware implementing *ExtIO DLL* API. It also works with wideband audio sources, such as Malahit.
- **SDRSharp (aka SDR#)**
  SDR receiver from AirSpy. This application is written in C# and runs on *Windows*. It is made to support AirSpy's own SDR products, but will happily work with Malahit. When connecting Malahit to SDR#, make sure you identify it as a *"FUNcube Dongle Pro+"* device to access the whole 192kHz spectrum.
- **SDR++**
  Simple, open source, cross platform SDR receiver that runs on *Linux*, *Windows*, and *Android*.
- **CubicSDR**
  Open source SDR receiver that primarily runs on *MacOS*, but also supports *Linux* and *Windows*.

Digital Radio Software

- **MultiPSK Digital Modes Decoder**
  Universal decoder for many different digital communication types. The user interface is somewhat complex though.
- **FLdigi Digital Modes Decoder**
  Another digital communications decoder, with easier user interface.
- **WSJT-X FT8 Decoder**
  The FT8 digital mode decoder for simple long-range HAM communications.
- **GridTracker Interactive Map for WSJT-X**
  Run this software with *WSJT-X* to plot sources of received FT8 messages on a map.
- **MMSSTV Slow Scan TV Decoder**
  Decoder for the "slow scan TV" digital mode used by HAM operators to transfer images.
- **PDW POCSAG Decoder**
  Decoder for POCSAG and FLEX messaging protocols used by pagers, still popular in hospitals and for automated status reporting.

General Reference

- **QRZ HAM Callsign Database**
  Address book of HAM operators around the world, searchable by call sign.
- **QRZCQ HAM Callsign Database**
  Another address book of HAM operators, searchable by callsign.
- **Shortwave Radio Frequency Schedule**
  Index of shortwave broadcasters, with frequencies, times, and locations. Search by station name, frequency, band, or time.
- **Shortwave Schedule**
  Another searchable index of shortwave broadcasters. Search by station name, frequency, or see currently transmitting stations.
- **Radio Locator**
  Searchable index of AM and FM stations closest to your location. Only works for US locations though.
- **Signal Identification Guide**
  Visual guide to radio signals, for identifying modulation types and signal sources.
- **RadioReference**
  Forums, frequency database, trunked radio information, and FCC license data.