

User Manual

Malahit Receiver

(Model: MALAHIT-DSP2)

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1 Product Profile

This document describes the Malahit-DSP2 wide-band radio receiver designed by Georgy Yatsuk (RX9CIM), Vladimir Gordienko (R6DAN), Vladimir Burlakov (R6DCY) and Igor Naumenko. The receiver is based on SDR architecture and most of the signal processing is done in software.

1.1 Product Function Introduction

Frequency Range: 10kHz-380MHz, 404MHz-2GHz

Panorama Width: 192kHz, 96kHz, 48kHz

Modulation Type: AM, SSB, DSB, CW, NFM, WFM

Sensitivity: 0.3uV up to 1GHz

Dynamic Bandwidth: 82dB

Antenna: 50 Ohm female female SMA connector

- High impedance mode

- Bias tee power

- Built-in pre-amplifier

Power: 5000mAh lithium-ion battery

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

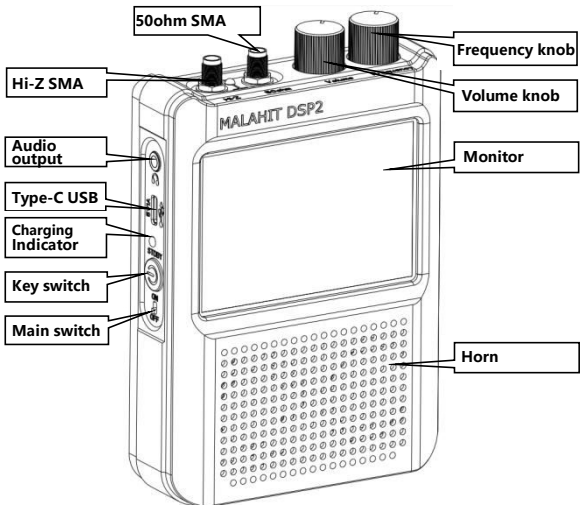
MSi001 multi-band, multi-mode tuner

3.5" 480x320 LCD high brightness capacitive touch screen

Front cavity dual-diaphragm speakers

IP6X Mechanical Encoders

Pure aluminum alloy shell design



1.2 Product Specifications

Product external size: 142mm*95mm*30mm

Product weight (single machine): 500g (aluminum alloy shell)

Packing list: Receiver×1, EVA package×1, Shelf×1, Type-C cable×1,

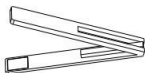
User manual× 1, SMA head trolley antenna×1, Portable rope×1



① Receiver×1



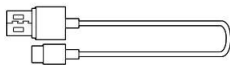
② EVA package×1



③ Bracket×1



④ user manual×1



⑤ Type-C cable×1



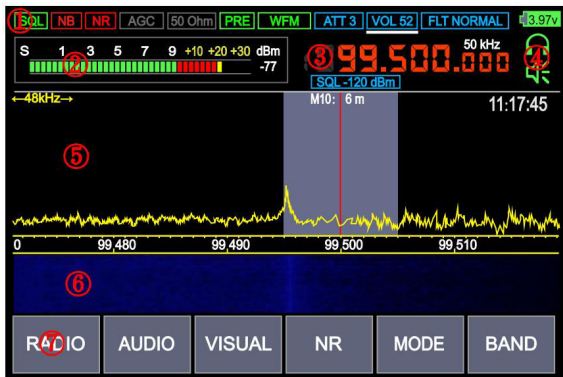
⑥ SMA head trolley antenna×1



⑦ Portable rope×1

2 Getting Started

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



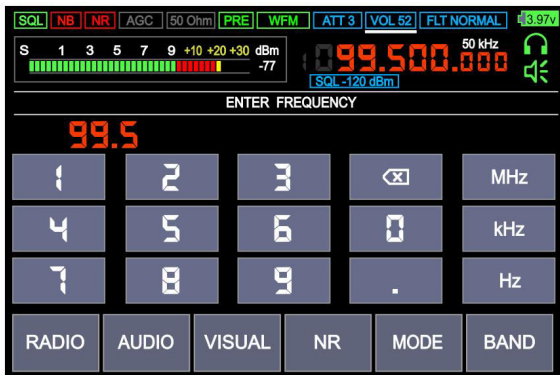
2.1 User Interface Overview

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

- ① Various indicators are discussed further in the following documentation.
- ② Signal strength meter (S-meter).
- ③ Current 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 the following documentation.

2.2 Common Operations Introduction

Entering the specified frequency: Touch the position of the frequency on the display and enter the specified frequency.



To fine-tune the frequency: rotate the receiver's Frequency knob.

To change the tuning step: short press the Frequency knob, rotate it to change the step value, then short press the knob again to exit the step value setting.

To change the volume: turn the Volume knob of the receiver.

To quickly set ATT, VOL, PLT parameters: You can press the Volume knob briefly to make the knob function to switch between VOL, PLT and ATT, rotate the Volume knob to call out the value you want.

To Change Panorama Width: Touch the waterfall display area to change the spectrum display bandwidth, the current spectrum display bandwidth is displayed in the upper left corner of the screen (48KHz,96KHz,192KHz).

To change the modulation type: touch the MODE button and touch the 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 emit a series of Morse code beeps and then the receiver will turn off.

Frequency knob, Volume knob other functions:

. To disable the touchscreen, press and hold the Volume knob for a few seconds until the receiver beeps; disabling the touchscreen reduces shortwave interference; at this point the receiver can still be adjusted with the knob; press and hold the Volume knob again for a few seconds to re-enable the touchscreen.

. To lock the currently adjusted frequency, press and hold the Frequency knob for a few seconds until the receiver beeps; press the Frequency knob again for a few seconds to unlock the frequency.

To set the displayed clock:

. Press and hold the RADIO button in the screen until the receiver beeps to display the time setting screen.

. Turn the Volume knob to change the value.

. Short press the Volume knob to advance to the next element.

. When date and time entry is complete, press and hold the Volume knob until it beeps to confirm the change.

3 Screen Indicators

3.1 Exploring the Indicators

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, and the red light indicates that squelch is enabled but not triggered.

NB Indicates that the noise canceler is enabled.

NR Indicates that noise reduction is on.

AGC-S Shows current automatic gain control status.

ANT The green light indicates that the Hi-Z antenna is enabled and the red light indicates that the antenna power supply ("bias tee") is enabled.

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.

VOL Shows current volume setting.

FLT NORMAL Shows the width of the audio filter applied to the decoded signal.

3.98 Shows current battery voltage and status.

4.Menu Settings

4.1 Menu Overview

The bottom of the home screen has 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 Saves and restores saved frequencies and other settings.

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

4.2 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 Frequency 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 accordingly.

Time correct

This item is used to correct the time.

Audio out

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

SW antenna

Typically the antenna input has an impedance of 50 ohms, which is compatible with most conventional shortwave antennas. This option will enable the High Impedance (Hi-Z) input mode for better shortwave reception when using a tie rod antenna or long wire. When this feature is on, the ANT indicator at the top of the screen will turn green. Hi-Z mode is automatically turned off at high frequencies, as it does not make sense to use it in this situation.

PREAMP

This item switches the built-in pre-amplifier for the input signal. Use the pre-amplifier to receive long-distance, weak signals, but note that it also amplifies noise. When this function is on, the PRE indicator at the top of the screen turns green.

ATT

High frequency Input Attenuator, the value is displayed in decibels. This is the same value displayed in the upper right corner of the screen. It can be adjusted with the Volume knob (described earlier) or with the Frequency knob after tapping the screen. Use the attenuation if you have a powerful radio overload receiver nearby.

PGA BST

If you are listening to a very strong signal that overloads the receiver, enable this feature.

RF GAIN

This is the signal gain at the broadband quadrature mixer of the MSI001 chip. Increasing this value amplifies the input signal. If you experience too much noise or signal distortion, decrease this value.

LNA/MIX UP GR

This is an internal MSI001 parameter that can be used to attenuate strong signals. Its behavior depends on the frequency to which it is adjusted: at frequencies above 30 MHz, the MSI001 chip uses an internal amplifier connected to a mixer, which reduces the amplifier gain. At lower frequencies, the MSI001 chip uses two mixers and this will reduce the gain of the first mixer input.

MIX GR

This is an internal MSI001 parameter that can be used to attenuate strong signals. Its behavior depends on the frequency to which it is adjusted: at frequencies above 30 MHz, the MSI001 chip uses a built-in amplifier connected to one mixer, which reduces the gain of the mixer input. At lower frequencies, the MSI001 chip uses two mixers and this will reduce the gain of the second mixer input.

EMI Reduction

Enabling this will reduce the display update frequency to minimize interference with the received signal. Enable this if you see a lot of pseudo-signal "spikes" in the panorama. When this is enabled, the touch screen will be less responsive. Instead of pressing too hard on the screen, just hold your finger in the same position for a while.

F correct

This value corrects the frequency displayed at the top of the screen if it differs from the actual frequency. Simply tune to a known frequency (the higher the better) and then adjust the value F correct until the displayed frequency becomes correct.

Sm correct

This value corrects the signal strength meter displayed at the top of the screen if it differs from the actual strength. Simply tune to a signal of known strength and adjust the value Sm correct until the displayed signal strength becomes correct.

BEEP LVL

This controls the system beep volume. This is the beeping sound you hear when the receiver is turned off. If these beeps are too loud for you, set them lower.

NCO

This enables the "numerically controlled oscillator" (NCO) mode, which allows any signal within the current panorama to be sampled. Normally, as you adjust the frequency with the Frequency knob, the entire panorama will move. In NCO mode, the tuned frequency within the panorama moves until you reach the edge of the panorama. By adjusting the panorama frequency to separate it from the signal, this mode is also useful for filtering out internal interference (EMI).

Ind type

This toggles between the signal strength meter displayed at the top of the screen and decibels (dBm).

Activity timer

If you do not touch the receiver for a set period of time (in minutes), it will turn off automatically.

PRE Gain

When pre-amplification is enabled, this value (in dB) is subtracted from the signal strength meter displayed at the top of the screen. This is to correct the S-meter reading of the pre-amplified signal.

4.3 The Audio Menu



The AUDIO menu allows you to configure various sound characteristics such as filtering, gain, noise reduction, noise cancellation, and squelch. Touch a menu item to select it. If an item has more than two different values, rotate the Frequency knob to toggle between these values. To exit the AUDIO menu, touch the button again.

The AUDIO menu contains the following sections:

Noise Blanking (NB)

The Noise Blanking feature is used to cancel incoming audio noise. This feature can be enabled or disabled by clicking the NB button. The Threshold value sets the trigger level and it is not recommended to set it below 3. The Config option toggles between several different noise cancellation configurations. Both parameters depend on the type of noise you are attempting to cancel and therefore need to be adjusted audibly.

Automatic Gain Control (AGC)

The Auto Gain Control feature is used to automatically adjust the audio amplification gain and can be selected among three different AGC modes via the

AGC MODE option. The AGC GAIN value controls the amount of amplification applied. The AGC LIM value sets the cutoff limit for the Auto Gain Control.

Filtering (FILTER)

The Filter option provides three different audio filter widths: normal, wide, and narrow. These are the same values displayed in the upper right corner of the screen. It can be adjusted with the Volume knob (described earlier) or with the Frequency knob after tapping the screen. Additionally the LOW freq and High freq values set hard thresholds for which sound frequencies can pass.

Squelch (SQL)

The squelch function, when enabled by the SQL button, will completely cut off the sound if the sound level falls below a threshold value specified by the SQL threshold value. The red SQL light at the top of the screen indicates that squelch is enabled but "off". Once the sound level exceeds the threshold, squelch is "on" and the SQL light turns green.

Noise Reduction (NR)

NR threshold specifies the threshold at which noise reduction is applied.

Automatic Notch Filter (ANF)

The automatic notch filter allows the carrier tone to be suppressed when using LSB or USB modulation. For other modulation types, this ANF is disabled. To toggle the filter, click the ANF button.

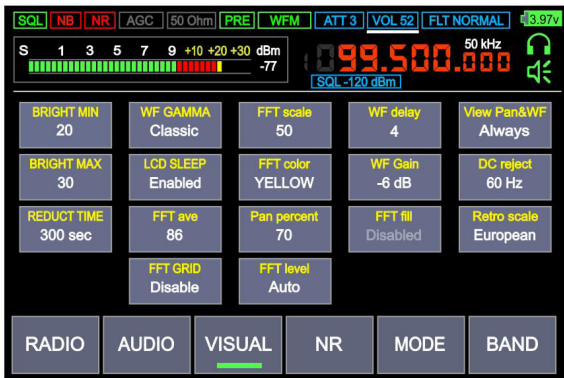
Broadcast FM Settings

The remaining two items relate to FM radio reception. the EQ TYPE option selects the type of equalizer to be applied to FM broadcasts. the WFM stereo option switches the FM stereo sound. Note that you need to enable FM stereo if you want to see text RDS messages transmitted by FM radio stations or automatically scan for stations in the FM band.

Stereo Effect Simulation

The PseudoStereo button enables stereo emulation from mono sound. For obvious reasons, it is only useful when listening to music through headphones. PseudoStereo mode is disabled when listening to radio stations using WFM modulation.

4.4 The Visual Menu



The VISUAL menu enables you to configure the panorama and waterfall displays, change 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 Frequency knob to change between those values. To exit the menu, touch the VISUAL button again.

The VISUAL menu contains the following items:

Screen Settings

- . The BRIGHT MAX value controls the regular screen brightness.
- . REDUCT TIME The screen is not operated for the set time (in seconds), it will reduce the brightness to the BRIGHT MIN value.
- . BRIGHT MIN The screen is not operated for the set time and the brightness is reduced to that brightness value.
- . LCD SLEEP If this option is enabled, the screen will turn off after the receiver has been placed for a selected number of seconds. However, the receiver will continue to operate and the screen will come on again whenever you touch the screen or any knob.

Waterfall Settings

- . The WF GAMMA option allows you to choose between several different color schemes for the waterfall diagram.
- . The WF Gain value makes the waterfall plot more sensitive to weaker signals, but at the cost of showing more noise.
- . The WF delay value controls the speed of the waterfall graph.

Panorama Settings

- . The FFT color option allows selection of the panorama color.
- . FFT ave adjusts the average number of samples of the panorama, the larger the value, the slower the panorama changes.
- . FFT scale determines the panorama amplitude range, the larger the value, the shorter the panorama display, the larger the signal amplitude can be displayed on the screen.
- . FFT fill panorama filling display switch.
- . FFT level adjusts the horizontal position of the panorama display.
- . The FFT GRID option turns on or off the panorama area grid-line display.
- . The Pan percent value controls how much of the panorama plot and waterfall plot are in the screen in relation to each other.

Disabling Waterfall and Panorama

To minimize screen distractions, you may wish to disable the waterfall graph and panorama displays by changing the ViewPan&WF options. When both the waterfall graph and panorama are disabled, the screen only updates when you change the frequency or other settings.

DC Rejection

For proper operation, the receiver suppresses the direct current (DC) signal component that occurs at the 0 Hz offset within the panorama. Although the DC component does not affect signal reception, it may appear as a spike in the center of the panorama. The DC reject value controls the strength of the rejection. Setting it too high may create a "gap" in the center of the panorama.

FM Scale Selection

The receiver includes a separate "retro scale" view of the FM radio band, similar to the front panel of older shortwave receivers. While the Retro Scale feature will be discussed later in this document, the FM band layout changes from one count to another. Retro scale allows selection between European and Japanese FM band layouts.

4.5 The Mode Menu



The MODE menu allows you to change the current modulation mode (shown at the top of the screen) and also enables the CW decoder function. Touch a menu item to select it. If an item has more than two different values, rotate the Frequency knob to change between these values. To exit the menu, touch the button again.

The MODE menu contains the following items:

Wide-Band Frequency Modulation (WFM)

Broadband frequency modulation used by commercial radio stations broadcasting in the FM band. When using WFM modulation, the WFM BW option selects between normal and narrow modulation widths. If you are experiencing interference from neighboring FM broadcasters, use narrow WFM modulation.

Narrow-Band Frequency Modulation (NFM)

Narrowband frequency modulation typically used by police and first responder radios. Amateur radio operators also use this mode when using the VHF and UHF bands.

Amplitude Modulation (AM)

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

- . Classical Amplitude Detector (MAG)
- . Synchronized 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 interfered with by a nearby signal.

Lower-Sideband Amplitude Modulation (LSB)

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

Upper-Sideband Amplitude Modulation (USB)

Upper sideband amplitude modulation commonly used by amateur radio operators operating in the 20M and higher bands.

Dual-Sideband Amplitude Modulation (DSB)

This option, when used in conjunction with LSB or USB, automatically selects sidebands with higher signal levels.

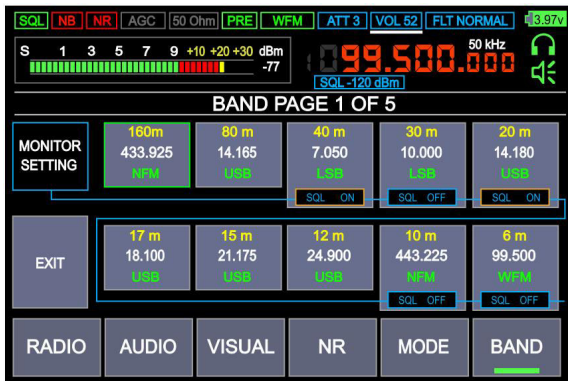
CW Mode (CW)

This option, when used in conjunction with LSB or USB, narrows the width of the audio filter to 1kHz, which is useful for monitoring and decoding Morse Code (CW) transmissions. The LSB/USB indicators at the top of the screen will change to CWL /CWU respectively. This option is not compatible with the Noise Reduction (NR) function!

CW Decoder (Decoder)

When CW Decoder is enabled, the CW Decoder function will attempt to decode Morse Code (CW) transmissions and display them below the spectrum display. Adjust the Min SNR value to approximately 29 for optimal decoding performance. To further improve CW decoding, you may need to enable the CW option and disable Noise Reduction (NR).

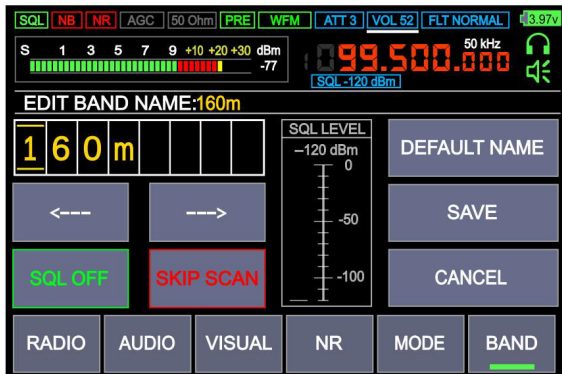
4.6 The Band Menu



The **BAND** menu is used to save and read radio settings. Click on the **BAND** icon to open the menu and click on the **BAND** icon again or click on the **EXIT** icon to exit the menu. The tabs are laid out on a page-by-page basis and are turned by turning the Frequency knob.

To save current settings to a memory slot

Press and hold the selected storage point for a few seconds until you hear a beep. Then go to the following screen.



- . Frequency knob to select the name letter, touch the left and right arrows to adjust or press the Frequency knob to toggle the next digit.
- . SQL OFF (green) squelch (SQL threshold) is off, and when SQL ON (red) the squelch threshold can be adjusted by the Frequency knob and displayed by the center ruler. Both of the above can be switched by touching the screen.
- . IN SCAN, SKIP SCAN set whether the storage point is listening or not, the former means listening, the latter means skipping.
- . DEFAULT NAME Click to restore the default name.
- . SAVE Click and save the settings.
- . CANCEL clicks to exit.

To restore settings from a memory slot

Tap the Store Point icon to access the stored channel settings and return to the receiver's main screen.

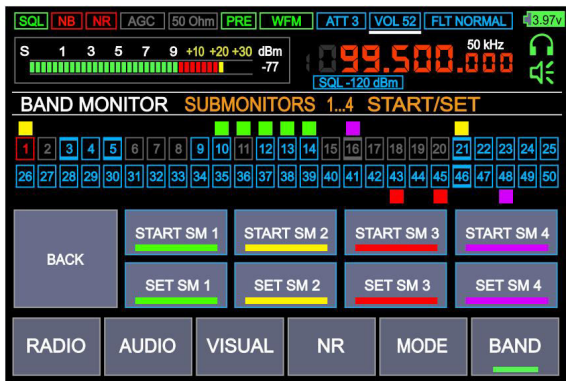
Band Monitoring



In the BAND screen, press MONITOR SETTING to enter the channel monitoring screen.

- . The Frequency knob switches the storage points for a total of 50 storage points.
- . BACK is used to return to the channel storage menu BAND.
- . SAVE & EXIT is used to store and return to the main user interface.
- . SKIP is used to set whether the storage point listens. Listening is shown in blue, skipping is shown in gray.
- . SQL Select a storage point and click the SQL icon to enable squelch. When enabled the storage point displays a thick box, otherwise a thin box. The squelch level can be set independently for each storage point. If the signal level falls below this squelch level, the listener will automatically jump to the next storage point.
- . With SQL LEVEL turned on for squelch, the threshold can be adjusted via the Frequency knob after clicking this icon.
- . START Clicking on this icon will start listening to the different storage points until the STOP icon is clicked to end.
- . TIMEOUT Click on this icon to set the amount of time the radio stays in listening to each storage point.

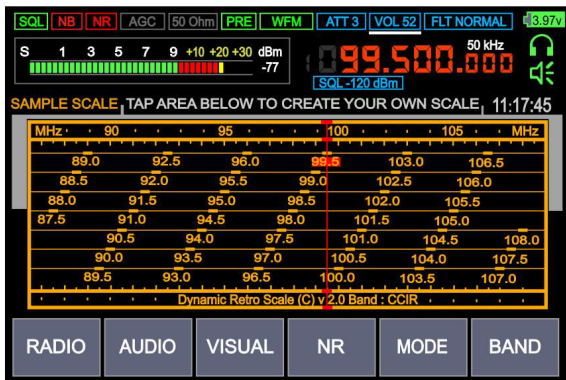
Band Grouping Monitoring



The receiver provides 4 sets of repositories that can listen to each other separately from the main listener, these repositories are called "sub-listeners". They can be accessed by clicking the SUBMON 1-4 icon on the main listener screen.

- . SET SM Click this item to mark a frequency point to this frequency point group, and a colored square will be displayed next to the frequency point, with different colors indicating different frequency point groups.
- . START SM Click this item to enter the sub-listening screen. you can listen between memory points that are marked with the same color.

5 The FM Retro Scale



5.1 Introduction to FM Retro Scale

When using WFM modulation, the receiver provides a "retro scale" view, similar to the front panel of older wave-testing receivers.

Steps to access the vintage scale view

- 1) Tune the radio to the FM broadcast band (75-109MHz). The specific FM broadcast band is determined by the region (Europe or Japan) set by the Retro scale option in the VISUAL menu.
- 2) Select the WFM modulation type in the MODE menu.
- 3) Click twice in the waterfall chart position to switch to the FM frequency scale table, the first click will enter the MPX interface, click again on the bottom half of the center screen.

Upon entering the retro scale view

- . Use the Frequency knob to switch between stations.
- . Click the lower half of the scale to return to the regular panorama view.
- . Click on the upper part of the scale to access the retro scale menu.

The Retro Scale menu provides options for adding, deleting, and editing stations. It contains the following buttons:

ADD/EDIT STATION

Use the Frequency knob to adjust to the desired frequency, click ADD/EDIT STATION on the screen to enter the setup interface, you can also enter the setup interface first and then call out the station you want to save, then press "ADD AND CONTINUE" to edit the next station, or "ADD AND EXIT" to return to the menu. The other two operations are "DELETE STATION" to completely delete the current station entry, and the "EXIT" button to discard the changes and return to the menu.

RENAME SCALE

Rename the current scale by rotating the Frequency knob to select a letter. Once you have selected a letter, press the Frequency knob to confirm and advance to the next letter. You can reset the name entry by clicking the "CLEAR NAME" button. When finished, press the SAVE AND EXIT button to confirm, or press the CANCEL AND EXIT button to discard the changes.

CLEAR SCALE

This option completely clears the current user-defined scale, deleting all stations and customized scale names (if any). Press the CLEAR button to confirm, or press the CANCEL button to cancel the operation.

SWITCH USER SCALE

The receiver provides two separately defined user scales. This option toggles between these two scales.

LOAD PRESET

The receiver has built-in preset scales for many cities. This option allows you to select the scale for your city using the Frequency knob. Note that your current scale will be replaced with the preset scale.

AUTO SEARCHING

This auto-search feature causes the receiver to scan the FM band for stations and automatically fills the current scale. See details below.

EXIT

Exit the menu to return to the Retro Scale view.

CHANGE COLOR

Select a vintage scale color by rotating the Frequency knob or clicking on the appropriate color example. When finished, press the SAVE COLOR & EXIT button to confirm your selection, or press the CANCEL AND EXIT button to discard the changes.

5.2 Automatic search

The Retro scale allows you to scan for radio waves and fill in the scale with found FM stations. The range of FM broadcasts searched depends on the region (Europe or Japan) set in the Retro scale option in the VISUAL menu. To use the automatic search function, follow the steps below:

- 1) Go to the RADIO menu and make sure the headphone output is enabled in the audio output options. If the headphone output is disabled, the auto search function will not be available.
- 2) Go to the AUDIO menu and make sure the WFM stereo option is enabled. If WFM stereo is disabled, the auto search function will not be available.
- 3) Click on the upper part of the scale to enter the vintage scale menu and click on the "AUTO SEARCHING" button.

The Auto Search screen displays a progress bar, the number of stations found, and a frequency guide indicator. Auto search can be canceled at any time by clicking the "CANCEL" button.

When the automatic search is complete, the screen displays the option to save the results to the current scale: the "SAVE SCALE & EXIT" button, or to discard the results the "CANCEL AND EXIT" button. "button to discard the results. Please note that if you choose to replace the current scale with an automatic search result, the previous scale content will be lost.

6 Connecting the Receiver to Computer

6.1 Connecting the receiver to computer

The following description assumes that you are connecting the receiver to a computer running Microsoft Windows 10 or a similar operating system. Windows 10 should have all of the drivers needed to interface with the receiver, so no third-party drivers are required.

You will need a micro USB cable (included with most cell phones) to connect the receiver to your computer. Make sure your micro USB cable supports data connections. After connecting the receiver to any available USB port on your computer and turning on the receiver, you can see the following three new USB devices in the Windows Device Manager panel:

. Malahit RX

This is an audio input device that feeds the sound from a malachite radio into your computer, and you can use it as you would a regular microphone device.

. Malahit IQ

This device is also used as a kind of 'audio input', but it inputs the entire 192kHz spectrum data. You can use this device with a variety of SDR software (such as HDSDR, SDR++, or SDR#) to receive and process the same spectral data as a Malachite radio.

. Malahit CAT

This is the USB serial port mode that allows you to change the frequency, modulation, volume and other parameters of the Malachite radio using your computer. The command set used by the Malachite radio is compatible with that of the Kenwood TS-480.

When you see "Malahit USB" in the Windows Device Manager panel, remember to go to the Windows Sound Control Panel and make sure the "Malahit RX" and "Malahit IQ" audio inputs are enabled.

Verifying Connection with HSDR

Verify the functionality of the radio with the HSDR application on a Windows system by following these steps:

1. Install and run the HSDR software.
2. Select "Options | Select input | Sound card" as the receiver acts as a sound card device.
3. Click on "Soundcard" and select "Malahit IQ" in the "RX Input (from Radio)" box. "RX Output (to Speaker)" can be selected as desired.
4. Click "OK" to confirm your selection.

After completing the above steps, the HSDR should display the same panorama and waterfall display as your radio. At this point you can use the radio's knobs to adjust the frequency.

6.2 Controlling the receiver from computer

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

1) Go to Windows Device Manager and locate the COM port device associated with the "Malahit CAT". This can be determined by disconnecting and reconnecting the Malahit receiver. One of the COM port entries located under the "Ports COM and LPT" branch should disappear and then reappear. That will be your COM port device. If you reconnect the receiver to a different USB slot, the port will change.

2) Install and run OmniRig. In the OmniRig window, set "RIG 1" according to the following configuration, and click "OK" to confirm the changes.

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

3) In HSDR, select "Options | CAT to Radio | Sync Rig1", and enable "Use v1", "Sync to Omni-Rig", "Sync from Omni-Rig", "Sync LO Frequency" and "Sync Modulation" in the same menu.

You should now be able to control the Malahit receiver through the frequency and other settings in the HSDR software.

7 Updating Firmware

7.1 Firmware update instructions

The Malahit development team regularly releases firmware updates by posting them on their website. On Windows, follow the steps below to refresh the receiver with the new firmware:

- 1) Install the STM32CubeProgrammer software, which we will use for refreshing.
- 2) Make sure your Malahit receiver is fully charged by turning the receiver off.
- 3) Press both knobs of the receiver at the same time. While holding them down, turn on the receiver with the power button. Release the knobs. The receiver's LED should begin flashing in red and green, indicating that the receiver is now in DFU mode and ready to receive new firmware.
- 4) Connect the receiver to the computer. At this point, you should see the "MALAHIT RECEIVER DFU" device in the Windows Device Manager.
- 5) Right click on the STM32CubeProgrammer desktop icon and select "Run as administrator" from the pop-up menu to run the program.
- 6) In the STM32CubeProgrammer window, locate the drop-down menu to the left of the green Connect button and select "USB" from that menu. Click on the icon to the right of the USB port name to refresh the USB configuration, and then click on the green Connect button. After a successful connection, the green button should change to a disconnect button.
- 7) Click on the "Hard Disk Download" icon on the left side of the STM32CubeProgrammer window. This will display the "Erasing & Programming" screen.
- 8) Click the "Browse" button and select the firmware file to be flashed. All valid firmware files will have a .BIN extension (e.g. "M2_FW2_10_F.bin").

9) Check the "Verify programming" and "Run after programming" checkboxes. Leave the other checkboxes unchecked.

10) Click the "Start Programming" button to refresh.

11) The bottom of the STM32CubeProgrammer window will show the progress of the refresh. When the refresh is complete, the program will display a success message.

12) When the refresh is complete, click the "Disconnect" button and the receiver will reboot and load the refreshed firmware.

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

8 Dealing with Internal Interference

8.1 Methods for reducing interference

A Malahit receiver is essentially a small computer containing several digital components such as a CPU, display and touch screen. Since all of these components operate using digital signals, they all generate their own electromagnetic noise that affects reception quality. In this section, we will describe common sources of interference within the receiver and how to deal with them.

Noise when touching the screen

Touchscreen noise occurs mainly in the shortwave band and manifests itself as a constant buzzing sound that gets louder when you touch the screen. The best way to solve this problem is to move the antenna away from the receiver by at least a few meters. If this is not possible (e.g. by using a tie rod antenna), you can temporarily disable the touch screen by pressing and holding the Volume knob for a few seconds. After disabling the touchscreen, you can still use the knob to adjust the receiver. Press and hold the Volume knob again to re-enable the touchscreen.

display noise

Display noise typically occurs in the VHF and adjacent frequency bands. It manifests itself in the form of visible "bumps" or "spikes" on the panoramic display, often blocking useful signals. The best way to solve this problem is to

move the antenna at least a few meters away from the receiver. If this is not possible, you can reduce the display noise by going to the RADIO menu and enabling the EMI Reduction option. This will slow down display updates and reduce interference, but will make the touchscreen more unresponsive. Finally, you can temporarily disable the display by clicking the Power button. After disabling the display, you can still use the knobs to adjust the receiver. Tap the Power button again to re-enable the display.

9 Choosing the Right Antenna

9.1 Antenna Introduction and Selection

Your antenna selection will always depend on the frequencies you wish to receive and the level of radio interference in your location. In this section we will cover some of the options available.

Telescopic Antennas

The receiver comes with a tie rod antenna that can be used on a variety of different frequencies, provided there are no strong sources of electromagnetic interference near you. Possible sources of interference include power supplies, cell phone chargers, LED lights, refrigerators, air conditioners, water pumps and other equipment.

In the Long Wave (LW), Medium Wave (MW) and Short Wave (SW) bands (<30MHz), the original tie rod antenna is not the best choice. However, it can still be used in these bands. To improve reception on these bands, go to the RADIO menu and enable the SW antenna option to enter high impedance (Hi-Z) antenna mode. The ANT indicator at the top of the screen will turn green when this feature is on. At higher frequencies, Hi-Z mode is automatically disabled as it does not produce any benefit. You can also enable the PREAMP option to increase signal amplification, but it will increase noise.

Other tie rod antennas can be used with receivers. They work in much the same way, with longer length antennas being more sensitive at lower frequencies. More expensive tie rod antennas are made of stronger materials and offer better tuning. Some popular choices are the Comet SMA-W100RX and the Diamond SRH789. Some antennas come with BNC connectors and require a BNC to SMA adapter to connect to the receiver. Whichever tie rod antenna you choose, keep in mind that a heavier antenna will put more stress on the SMA connector and may

eventually damage it.

Long Wire Antennas (LW, MW, SW)

The optimal length of a tie rod antenna should be close to 1/2 of the wavelength you wish to receive. e.g., if you plan to listen to the shortwave band on 25 meters, the optimal antenna length would be $25 / 2 \approx 12.5$ meters.

This makes it quite difficult to make a good shortwave tie rod antenna. However, you can still connect a very long wire to the antenna connector and project it outside or around the room as needed. Shortwave radio manufacturers offer some of these antennas, such as the Sangean ANT-60, Tecsun AN-05, or XHDATA AN-80, where the wire conveniently retracts into the reel. As with tie rod antennas, long wire antennas are susceptible to electromagnetic interference.

Rubber Whip Antennas (VHF, UHF)

At shorter wavelengths (above 80 MHz), short rubber whip antennas for walkie talkies, emergency communication radios and scanners can be used. These antennas are small, portable, and provide good reception in the FM, VHF, and UHF bands. Some examples include the Nagoya NA-701, Nagoya NA-771, Comet SMA-501, and Comet SMA-503. Note that these antennas are tuned specifically for the VHF and UHF bands and are not useful in the LW, MW, and SW bands.

Loop Antenna

As mentioned earlier, electromagnetic interference is usually a huge problem when listening to radio indoors or in urban environments. Magnetic loop antennas attempt to solve this interference by receiving the magnetic component of the signal instead of the noisier electrical component.

A typical loop antenna consists of one or more relatively small coils connected to a receiver by means of a small transformer ("balanced-unbalanced transformer" or "unbalanced-unbalanced transformer"). The total area of the coil determines the amount of magnetic flux it receives, so larger coils are more sensitive. The loop antenna is directional, and maximum gain is achieved when one side of the coil is pointing toward the source.

While loop antennas are more resistant to EMI, they are also less sensitive than conventional antennas. For this reason, most commercial loop antennas contain low-noise amplifiers that need to be powered. Some commercial loop antennas are YouLoop, MLA-30+, and GA-450.