AR-IQ-III

Receiver control, I/Q recording & playback

for AR2300/AR5001D/AR6000 receivers

Operating manual

AOR Ltd.

Authority On Radio Communications

Table of contents:

1. Introduction and software description

Thank you for purchasing the AR2300/AR5001D/AR6000 receiver with the optional **IQ5001 I/Q** board and **AR-IQ-III software.**

To obtain the best possible results from your receiver, we strongly recommend that you read this manual and familiarize yourself with the receiver. Every effort has been made to make this manual correct and up to date. Due to continuous developments of the receivers and this software, we acknowledge that there might be some changes, errors or omissions.

The AR-IQ-III software allows direct control of the receiver through a graphical interface. The I/Q digital output of the IQ5001 board represents the actual signal used after digital processing in the receiver. The digital I/Q output interface streams I/Q data to the PC through USB2.0 isochronous mode, at 72Mbit/sec with a sampling rate of 1.125Msample/sec. All commands are sent to the receiver through the receiver's remote control USB port.

Compared to a regular AF, which only allows recording one frequency at a time, I/Q allows you to store and playback a full 0.9MHz bandwidth with no loss of quality!

This 0.9MHz bandwidth can be anywhere within the receiving range of the receiver.

Off-line, you can listen and decode within the recorded 0.9MHz range, tuning any frequency as you would in real time. You can even loop a particular time frame to listen repeatedly to a signal received in difficult conditions, or search for and analyze hard to catch signals bursts.

It is also possible to move the I/Q data to another PC and to listen/decode it off line, provided the USB license dongle is inserted into that PC.

Please note that there is no inter-compatibility of wav files recorded with AR-IQ I, AR-IQ II and AR-IQ III, as they all use different headers.

2. PC requirements

Suggested PC system:

Supported OS: Win 7/8.1/10

Intel I7 CPU

16 GHz RAM

HDMI resolution monitor

Large size HDD for record/playback operations

Three available USB 2.0 ports are required (one for the I/Q stream, one for receiver control, one for the license dongle)

If you notice "audio stuttering" due to insufficient PC resources, it is possible to adjust the software's "Buffer Reads/Interval" to match your PC's specifications, as described in chapter 9 "ADVANCED PARAMETERS".

3. Connecting the receiver to the PC

Connect the two supplied USB cables as pictured here. One cable is for the I/Q data output and the other for receiver control.

- Make sure to connect the I/Q stream USB cable to a direct USB socket connection on your PC. Avoid using a USB hub.
- Some type of USB 3 ports can be incompatible due to the particular chipset they use. If that occurs, use a USB 2.0 port instead.

（AR2300 rear panel）
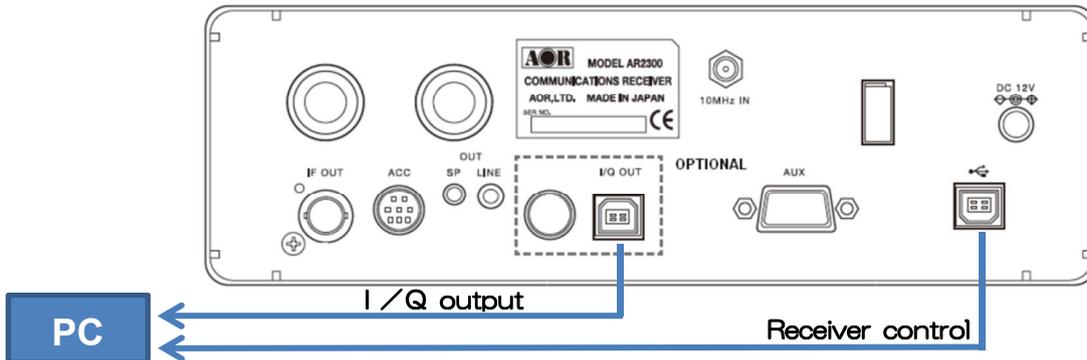
（AR5001D/AR6000 rear panel）
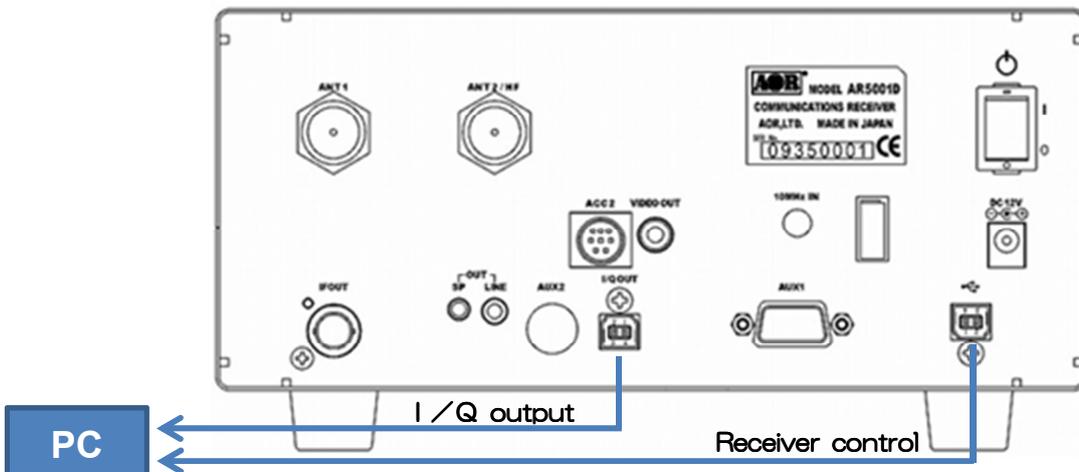
4. Installing the drivers

There are 2 drivers to install: One for the I/Q output and one for the receiver control.

(All following instructions and screenshots are based on the Windows 10 operating system)
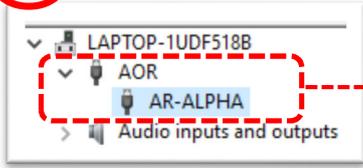
- Switch the receiver ON.

Depending on your Windows version and whether or not you have already installed the drivers on your PC before, it is possible that Windows automatically installs the drivers for you.

- To check the driver status, open WINDOWS DEVICE MANAGER (press simultaneously the Windows key and the X key, then select "Device Manager")
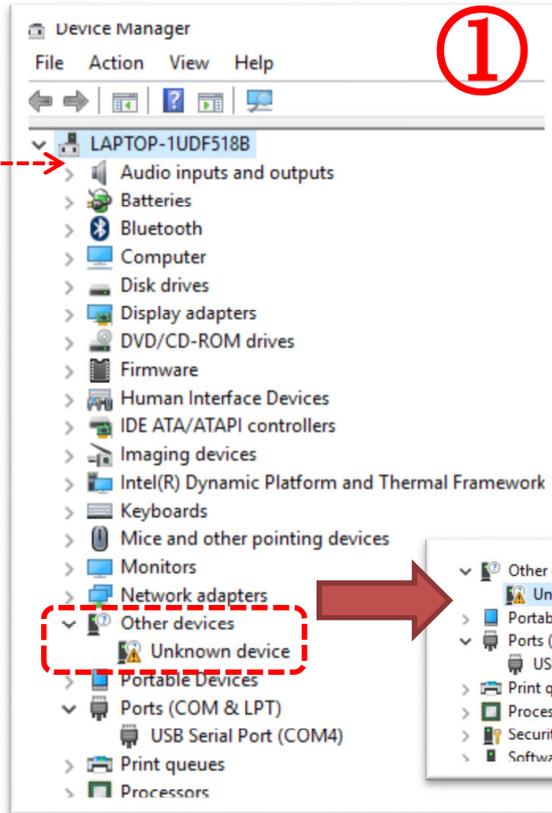
4-1 I/Q OUTPUT DRIVER INSTALL PROCEDURE:

⑦

⑦ This is how the I/Q driver will appear in device manager, once the driver is installed.

⑥ Update Drivers - AR-ALPHA
Windows has successfully updated your drivers
Windows has finished installing the drivers for this device:
AR-ALPHA

① Device Manager

File Action View Help

LAPTOP-1UDF518B
- Audio inputs and outputs
- Batteries
- Bluetooth
- Computer
- Disk drives
- Display adapters
- DVD/CD-ROM drives
- Firmware
- Human Interface Devices
- IDE ATA/ATAPI controllers
- Imaging devices
- Intel(R) Dynamic Platform and Thermal Framework
- Keyboards
- Mice and other pointing devices
- Monitors
- Network adapters
- Other devices
  - Unknown device
- Portable Devices
- Ports (COM & LPT)
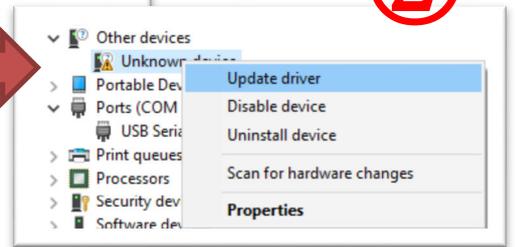 - USB Serial Port (COM4)
- Print queues
- Processors
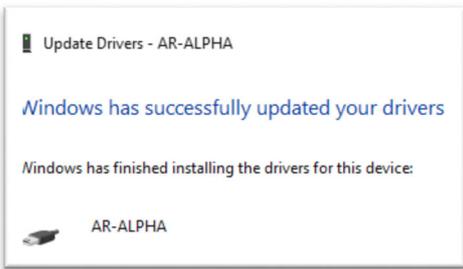
The I/Q connection will first be detected as an "unknown device".

Right-click it and select "update driver"

② Other devices
  - Unknown device
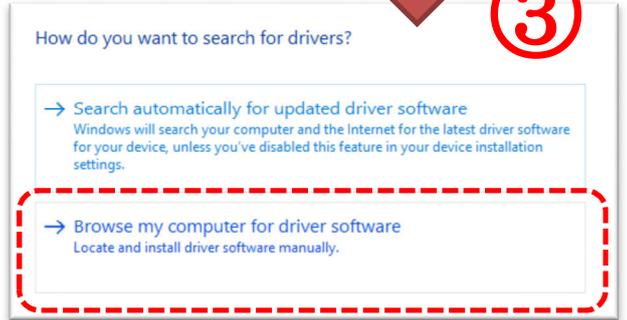 - Portable Dev...
  - Ports (COM...
    - USB Seria...
  - Print queues
  - Processors
  - Security dev...
  - Software de...

  Update driver
  Disable device
  Uninstall device
  Scan for hardware changes
  Properties

③ How do you want to search for drivers?

→ Search automatically for updated driver software
Windows will search your computer and the Internet for the latest driver software for your device, unless you've disabled this feature in your device installation settings.

→ Browse my computer for driver software
Locate and install driver software manually.

⑤ Update Drivers - Unknown Device
Browse for drivers on your computer
Search for drivers in this location:
E:\   [Browse...]
☑ Include subfolders

→ Let me pick from a list of available drivers on my computer
This list will show available drivers compatible with the device, and all drivers in the same category as the device.

[Next] [Cancel]

"Next" will load and install the driver.

④ Update Drivers - Unknown Device
Browse for drivers on your computer
Search for drivers in this location:
[   ] [Browse...]
☑ Include subfolders

→ Let me pick from a list of available drivers on my computer
This list will show available drivers compatible with the device, and all drivers in the same category as the device.

[Next] [Cancel]

Browse For Folder
Select the folder that contains drivers for your hardware.
- DVD RW Drive (E:) AOR
  - AR-ALPHA
  - ARD9800, ARD9900
  - ARIQ2
  - ARL2300
  - SR2200
Folder: DVD RW Drive (E:) AOR
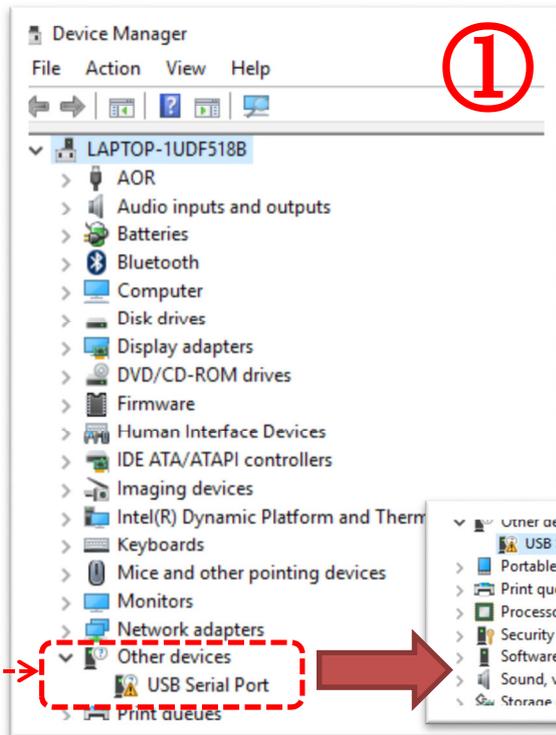[OK] [Cancel]

Insert the supplied driver CD into your computer and select the corresponding drive.

3

4-2 RECEIVER CONTROL DRIVER INSTALL PROCEDURE:

Only necessary if for some reason the USB SERIAL PORT driver has not been automatically installed by Windows or your PC is not connected to Internet and you need to manually install the driver from the supplied CD.

The connection has been flagged with a yellow exclamation mark under "Other devices"

This is how the USB SERIAL PORT driver will appear in device manager, once the driver is installed. The COM number (4 in this example) is automatically assigned by Windows

Right-click it and select "update driver"
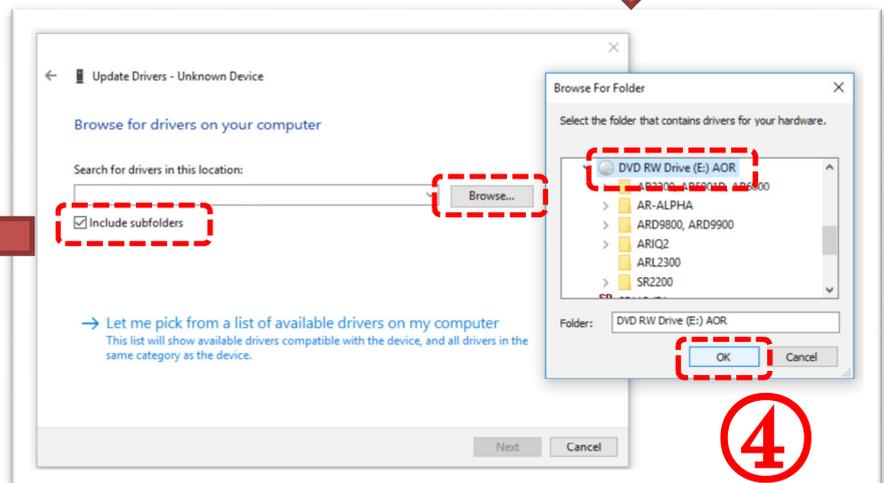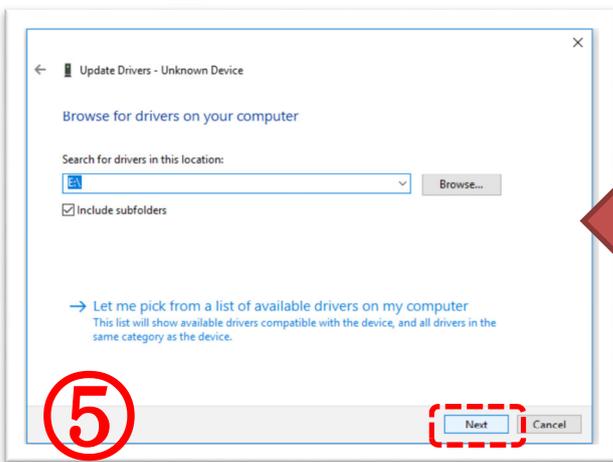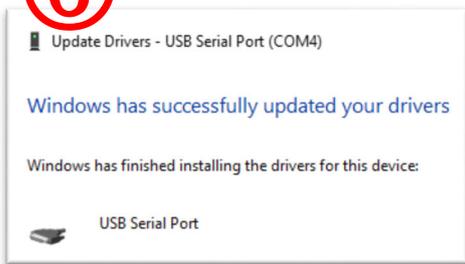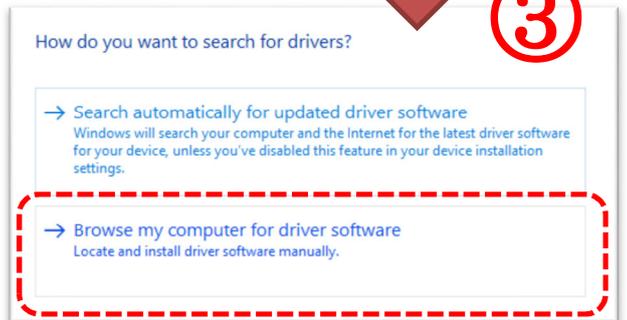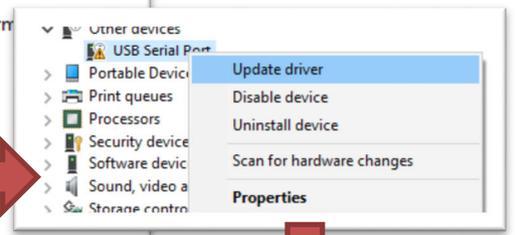
"Next" will load and install the driver.

Insert the supplied driver CD into your computer and select the corresponding drive.
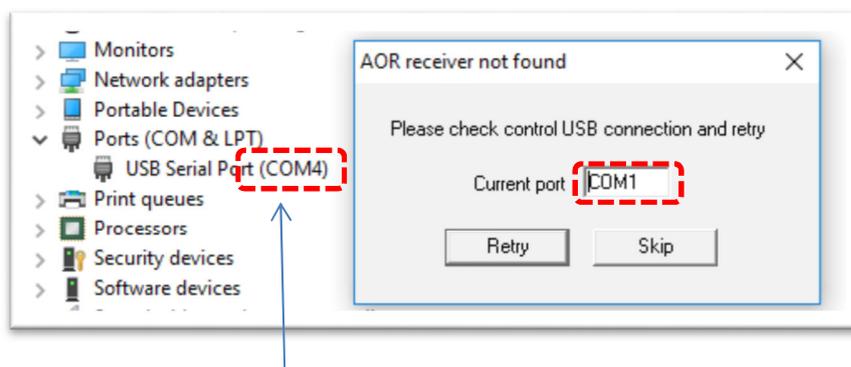
5. License dongle

① Insert the supplied USB dongle in an available USB port of your PC. Windows will automatically install a driver, recognize it as a common USB flash drive and assign a drive letter such as "D:", "E:" etc.…

WARNING: Our USB dongles are guaranteed without virus infection, nevertheless some virus detection software may incorrectly detect some of its files as a virus (or Trojan). This is called a false-positive alarm and does not mean that files are indeed infected. Whenever your virus detection software informs you about a possible threat, it usually gives you a choice of options about what to do next. Be sure to flag those files as SAFE files, otherwise the dongle's files might be rendered unusable or even deleted by the virus detection software, and the AR-IQ III software will not run.

It is your responsibility to make sure that your virus detection software does not accidentally render the USB license dongle and I/Q software unusable. The license information data inside the USB dongle is unique and cannot be copied or backed-up. If you damage the USB license dongle, a new one needs to be purchased.

② Inside the USB dongle, locate the software's executable "ariq3.exe" and double click it to start the software. The software runs directly from the USB dongle.

③ When you start the software for the first time, Windows will ask you to which COM PORT the receiver is connected. Providing the correct number is entered, it will be saved in the registry, therefore you should not need to enter it again. Nevertheless, after connecting the receiver to a different USB port on your PC, the COM port number will change. If the com port number you entered is incorrect, the following error message will appear:


The COM PORT number is the one Windows automatically assigned in DEVICE MANAGER.

Note: ● The license information data inside the USB dongle is unique and cannot be backed-up, copied or moved. If you lose or damage the USB dongle, a new USB dongle needs to be purchased.

● Do not record I/Q data to this dongle and do not use the dongle to store any data.

● Formatting the USB dongle, overwriting or deleting its content will destroy the licensing system, and another USB dongle would have to be purchased.

6. AR-IQ III software operation

AR-IQ III interface:
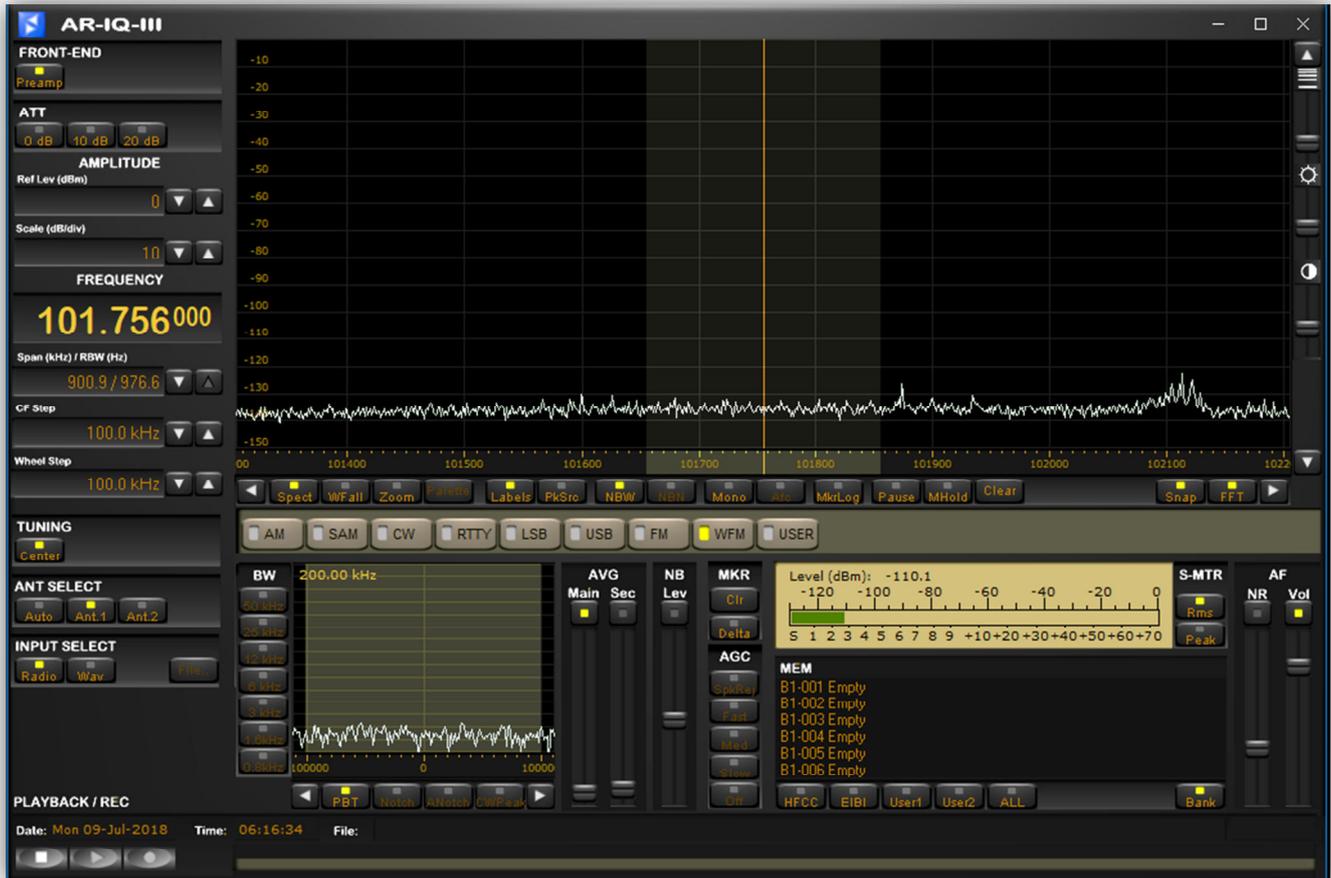
6-1 Frequency tuning

6-1-1 Frequency tuning with mouse wheel

Tuning with mouse wheel while hovering on the digits of the frequency indicator panel. The digit of the currently tuned frequency will be shifted upwards or downwards depending on wheel rotation direction.

Example: Let's say you are tuned to 101.756 MHz and you hover the mouse over the third digit "1". Then by scrolling up or down you will change the tuned frequency of 1 MHz for each scroll increment.

If you wish to tune by increments of 100 kHz, hover the mouse over the digit "7". Then by scrolling up or down you will change the tuned frequency of 100 kHz for each scroll increment.

To tune by increments of 10 kHz, hover the mouse over the digit "5". Then by scrolling up or down you will change the tuned frequency of 10 kHz for each scroll increment.

6-1-2 Frequency tuning by ten-key input

- Double click on the marked frequency indicator panel to display the ten-key window. This allows direct frequency input.
- Enter the desired frequency by clicking on the digits of the ten-key, including the [.] if necessary.
- Select [kHz] or [MHz]. The receiver will then be tuned to this frequency.
- Click on "Close" when that panel is not needed anymore.

.
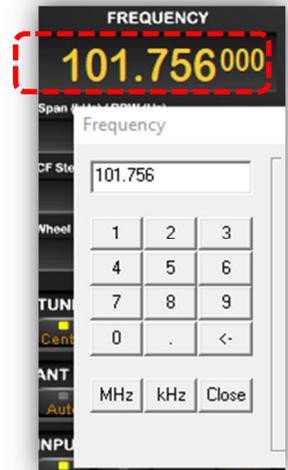
6-1-3 Frequency tuning by CF step

Clicking on the buttons with the white triangle, on either side of the main spectrum control bar does increment or decrement the frequency by the step size set in the CF STEP indicator panel.

(Main spectrum control bar)

(Span, CF Step, Wheel Step indicator panel)

6-1-4 Frequency tuning with the frequency bar

A) Drag the frequency bar left or right while pressing the left mouse button.

B) Hover with the mouse over the frequency bar and scroll the mouse wheel up or down, at increments as set in the WHEEL STEP indicator panel.

6-1-5 Frequency tuning with the secondary spectrum window

Allows to fine-tune the filter passband in 3 modes: PBT, NOTCH and AMREJ.

a) PBT mode (Passband tuning)

Centers the carrier frequency you have double clicked on the secondary spectrum.

Press the left mouse button while dragging left or right does retune the center frequency.

Adjust the filter bandwidth with the mouse scroll. (30 Hz to 225 kHz, IF mode and BW dependent.)

Drag either filter edge. Hover with the mouse over the filter edge until a horizontal double arrow appears, then drag the filter edge while left-clicking.

Clicking on the white arrows does increase/decrease the frequency by the value set in WHEEL STEP.

Shift the entire filter by dragging it left or right, while pressing the right mouse button. This is an actual software emulation, therefore the received frequency and the frequency on the frequency panel do not change. Convenient for co-channel interference removal.
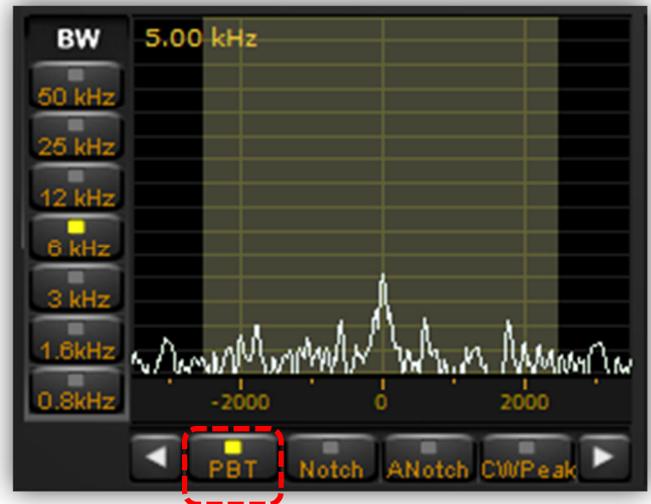
b) Notch mode (not active in WFM mode)

The notch function is effective for cycle noise on the receive signal.

To activate it, double click the offending signal on the spectrum.

Attenuation is tunable using the mouse wheel.

Filter signal can be dragged with the left mouse button.

The notch function is also accessible in the PBT mode, by pressing the CTRL key.

Deactivate the notch by right clicking on it.

The vertical yellow bar does mark the place where the notch has been applied. The frequency is displayed at the top of the bar (5.00 kHz in this example)
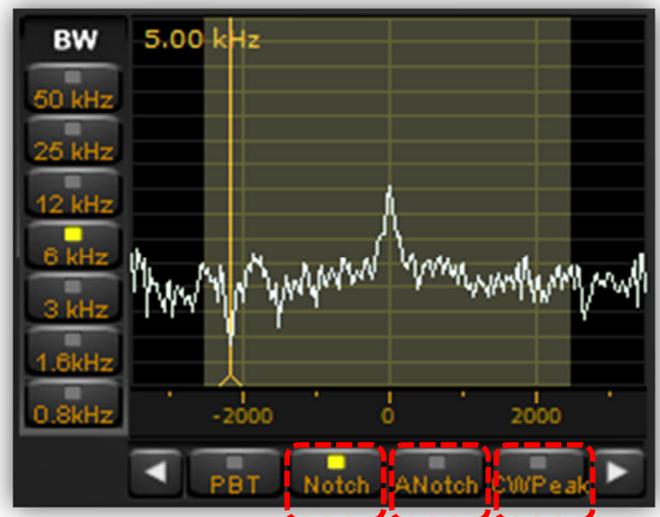
c) ANotch (auto-notch) mode (not active in WFM mode)

Automatically detects cycle noise and applies a notch on it. The slider with "Slow" to "Fast" markings determines the speed at which the notch is applied.

d) CWPeak filter

This is an adaptive filter for CW signals. It only works if there is a carrier. The slider with "Slow" to "Fast" markings determines the speed at which the filter adaptation takes place.
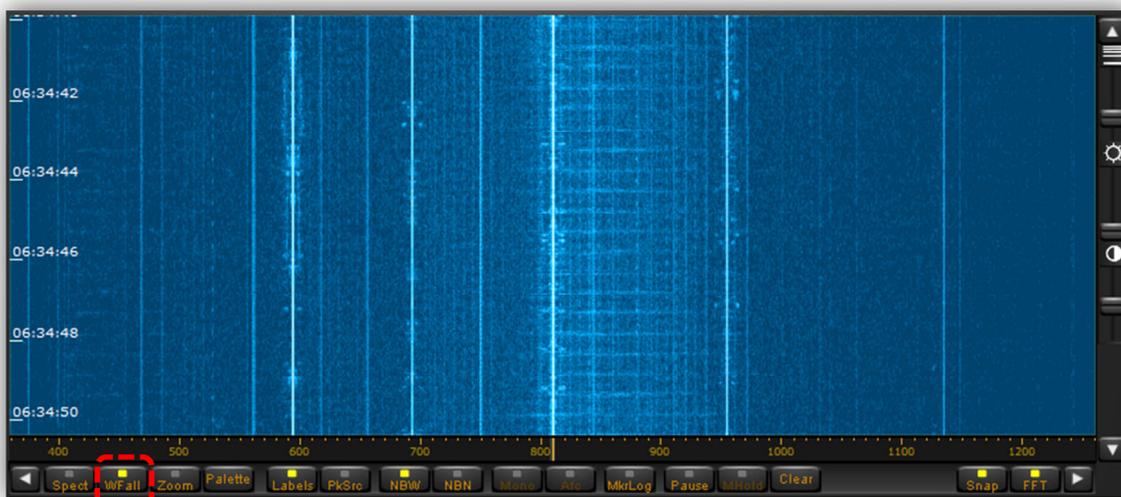
6-2 The main spectrum / waterfall window

Displays the spectrum with a bandwidth of up to 900 kHz. (+/- 450 kHz around the center frequency).

You can chose between spectrum view and waterfall view.
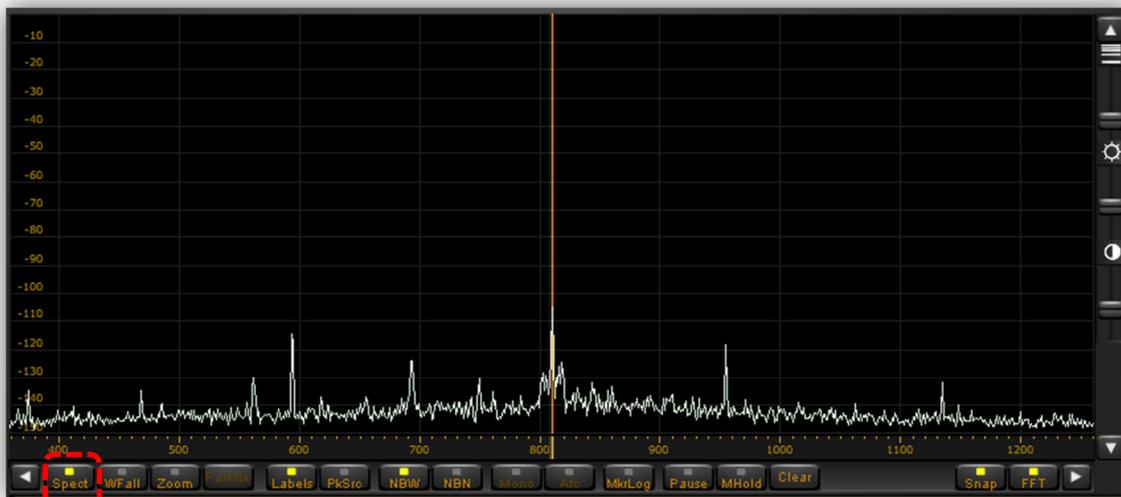
(Main spectrum view)

(Waterfall view)

6-2-1 Wheel step

This is the value by which the spectrum will be shifted by scrolling the mouse wheel, when the mouse is hovered anywhere over the spectrum or waterfall.

Possible steps are:

500kHz, 100, 50, 25, 12.5, 10, 9, 5, 1kHz, 100, 10Hz, 1Hz.

6-2-2 Frequency tuning by double click on spectrum

It is possible to "visually" decide to which frequency you would like to tune the receiver by double-clicking directly on the spectrum or waterfall. The minimum resolution is 1 kHz.

6-2-3 Frequency tuning by mouse drag on spectrum

Note: CENTER button in TUNING panel must be unchecked.
A faster way to quickly change frequencies "visually" on the spectrum is to hover your mouse inside the grayed out range of the IF filter until the mouse pointer changes to a horizontal double arrow, then drag the mouse either left or right on to the spectrum while pressing the left mouse button.
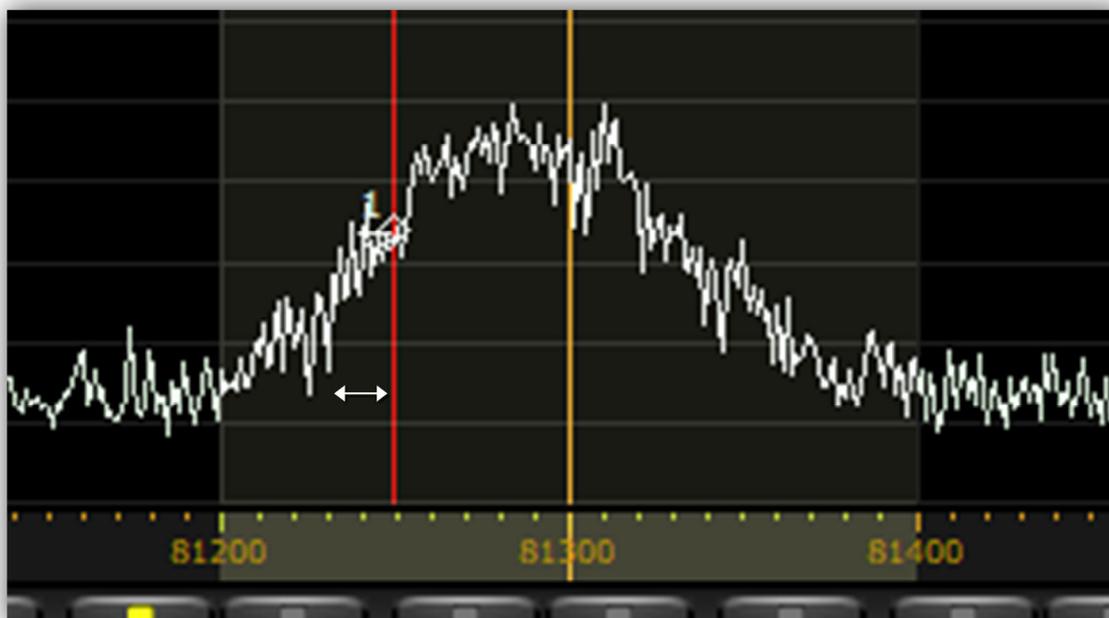
(Tuning by mouse drag)

6-2-4 Frequency tuning with "center" button ON

With this setting, the yellow tuning dial line will always represent the center of the frequency scale. Double clicking somewhere on the spectrum will shift the whole spectrum to the double-clicked frequency being the new center of the frequency scale. Doing so while in waterfall mode, will be the easiest way to understand the procedure.
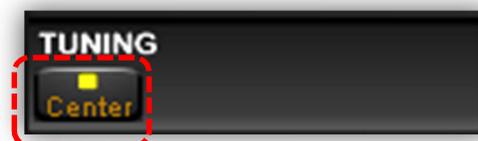
6-2-5 Frequency tuning with "center" button OFF

With this setting, the spectrum remains fixed, whereas the yellow tuning dial will jump to whatever frequency you double clicked on the spectrum. This mode is convenient if you want to search through frequencies between a fixed start and end frequency. Also, in the waterfall mode (see image below), you can keep track of active frequencies (vertical lines) no matter what frequency you are actually listening to.
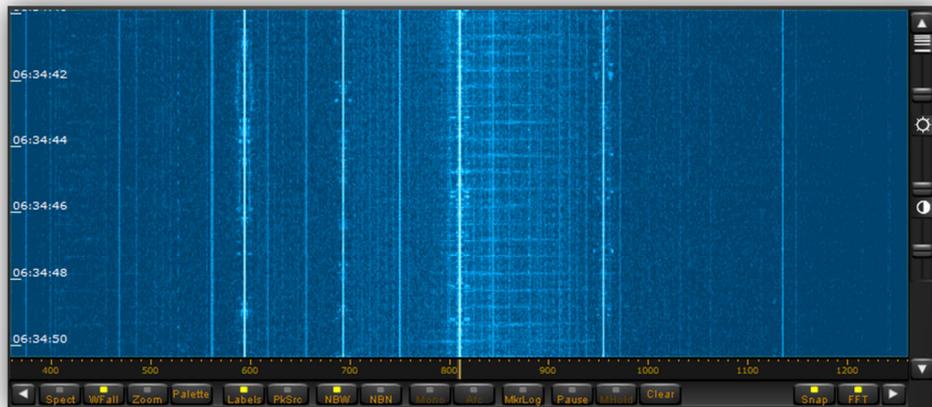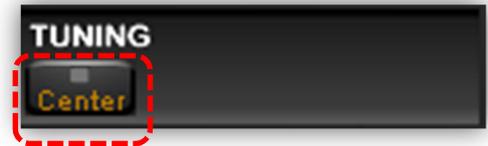
6-2-6 Span

The span is the width of the main spectrum window. You can chose between 900.9kHz, 450.4kHz, 225.2kHz, 112.6kHz, 56.3kHz, 28.2kHz, 14.1kHz, 7.0kHz, 3.5kHz.
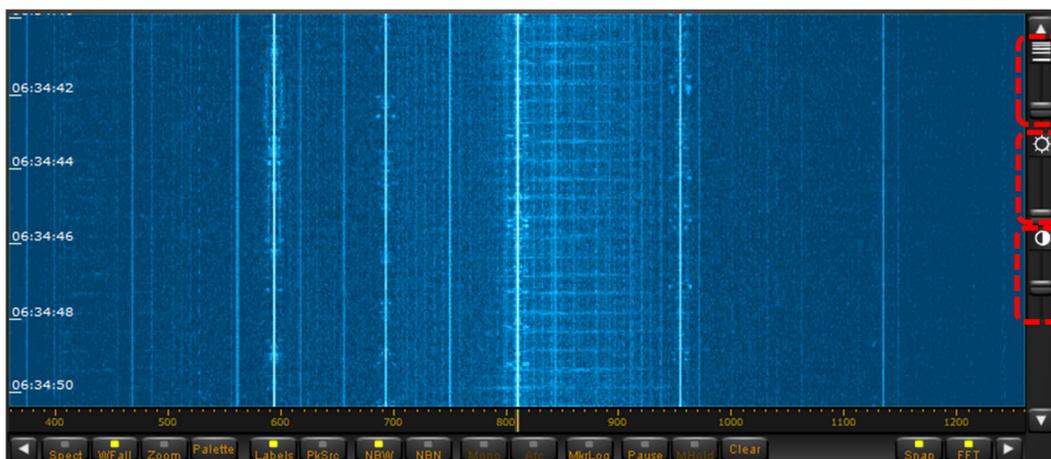
Used in both live reception and playback.

Please note that in order to provide the best possible spectrum accuracy, as per the rule 1FFT bin = 1 pixel, and to avoid resampling the spectral data, the full bandwidth of 900kHz can only be displayed when the program window is shrinked to its minimum width.
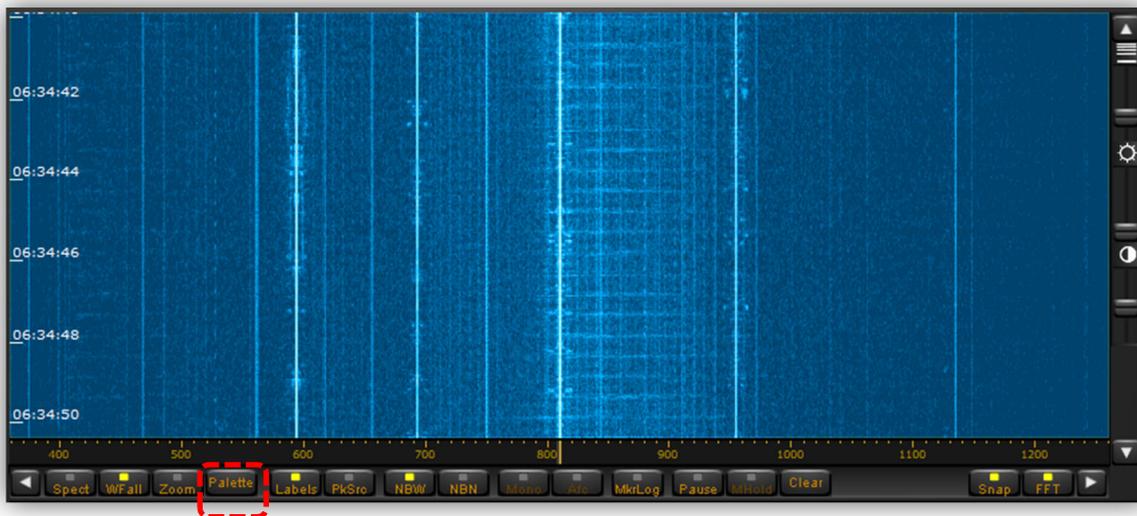
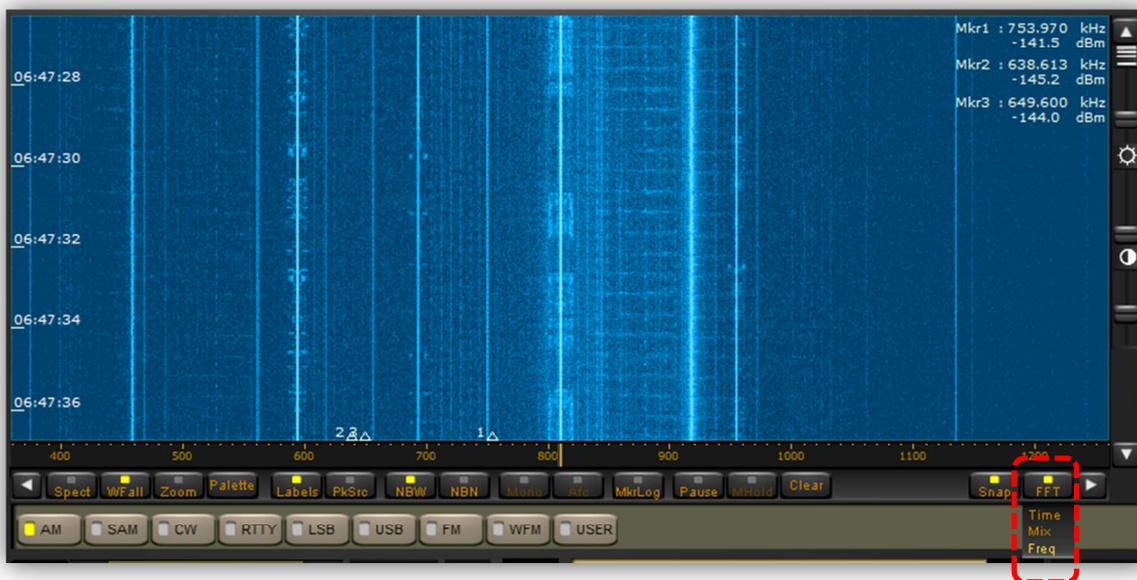## 6-2-7 Waterfall control

a) Speed, brightness, contrast

The 3 sliders on the far right side of the spectrum window allow adjusting of the waterfall's speed, brightness and contrast for optimal viewing.

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b) Color palette

Here you can decide which colors are displayed depending on the signal strength. Not active for regular spectrum view.

c) FFT resolution

The FFT sharpness (spectral resolution) can be improved at the expense of refresh rate. This function is particularly useful when analyzing strong carrier signals and carrier feed-through on adjacent bins has to be reduced at minimum.

Freq: offers the best performance at the expense of a slight degradation of the signal amplitude accuracy and refresh rate.

Time: Selects the FFT algorithm of previous software versions (FFT with Hann window)

Mix: Selects a polyphase FFT analysis with increasing window length (Polyphase FFT with quasi-flat-top amplitude response)

6-3 Marker

A right mouse click feature is available within the spectrum / waterfall panel. Right click on up to eight frequencies, and a small arrow appears. In waterfall mode, the arrow is situated where the signal waveform would be on the spectrum

view. On the spectrum view, the arrows are located where the mouse was right clicked. The screenshot below shows the numbered arrows, relating to Mkr1-Mkr8 in small text on the top right. The frequency and signal intensity in dBm is also given.
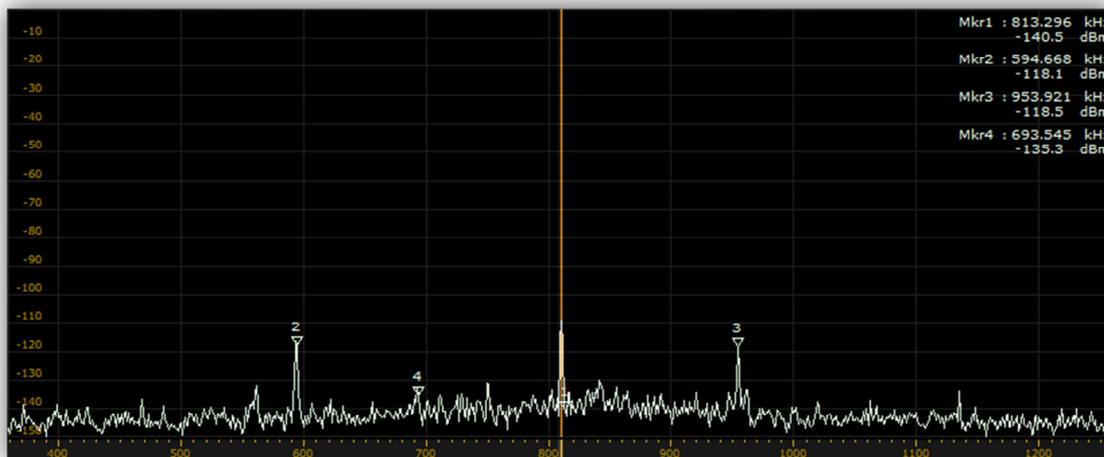
(Spectrum view with MARKER function enabled)

【Clr】button: Clears the marker arrows from the spectrum / waterfall display.

【Delta】button: This button changes the values from the markers 2 to 8 to delta values (different from MRK 1)

【Labels】button: Activates a vertical scale at the left side of the spectrum window. When the scale is activated, the value of the frequency and of the amplitude of the signal at the frequency pointed by the mouse (indicated by the reference red line) will be shown.

【PeakSrc】button: When activated, the frequency and the amplitude of the signal peak nearest to the reference line will be shown.

6-4 Spectrum average (AVG)

AVG Main: Stabilizes the spectrum waveform in the main spectrum / waterfall display. Will also stabilize the waterfall mode. The main spectrum average function and its slider control are active only when the enable button above the slider is enabled.

AVG Sec: Stabilizes the spectrum waveform in the secondary "bandwidth" display/panel. The secondary spectrum average function and its slider control are active only when the enable button above the slider is enabled.

7. I/Q recording & playback

AR-IQ III allows to record 900kHz of the RF spectrum directly to the PC's hard drive, and to play back the file at a convenient time, while having all features such as bandwidth, mode, passband tuning, etc.…available as in a live reception situation.

The software will automatically divide the recording into "wav" files of approx. 2GB, which corresponds to approx. 4 minutes of recording. Although a recording is divided into multiple files, the playback will be without any interruptions.

Every 4 minutes, a new .wav file will be created of which the 3 last digits will be automatically incremented.

For example:

XXX_000.wav

XXX is the file name you chose

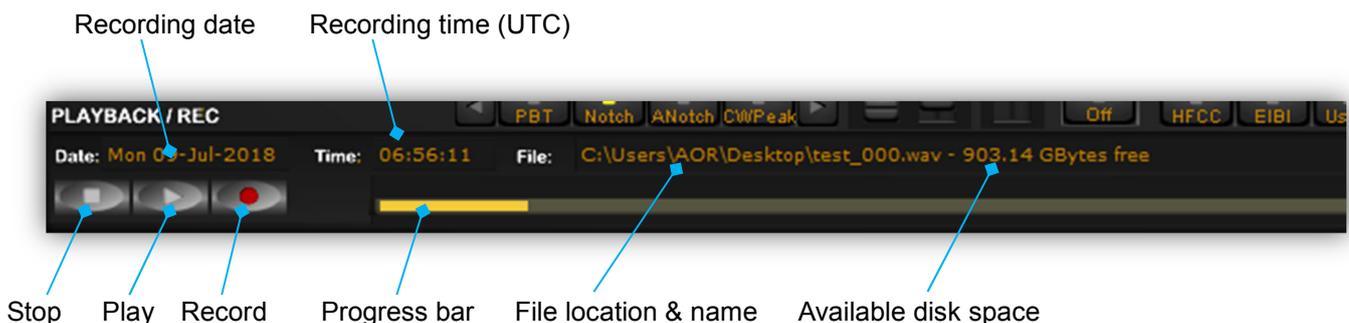After 4 minutes, the next file will be:

XXX_001.wav

And then every 4 minutes:

XXXXXX_002.wav

XXXXXX_003.wav   etc.…

- <u>The resulting .wav file can only be played back with the AR-IQ III software! It will not work in other media player software.</u>

Controls:

The recording date is based on your PC's system date, however the recording time is UTC.

7-1 Recording

To record, first select the center frequency of your choice.

Click on the record button at the bottom left of the window.

A new window pops up asking for a user defined file name and folder location to store the file. For ease of use it is advised to create a file name which includes the date, such as 180622 for June 22, 2018. The software will amend this file name with _000 to become 180622_000.

Note: During recording and playback, the frequency range (start and end frequency) cannot be changed.

7-2 Playback

To play back a file which has been recorded at an earlier time, click on the "Wav" button, within the "INPUT SELECT" panel.

The receiver stops receiving live signals and the "Wav" and "File" buttons are now activated. Click "File" and browse on the PC to the location of the pre-recorded file(s).

If your previous recording has created numerous automatically named files, the software will playback the

whole series of files if required. This playback should be continuous and flawless, even during track / file change.

During playback, the software will display date and time in the same format as during recording.

Note: Playback of a .wav file will also work if the receiver is not connected to the PC.

- Playback will only work properly if the data is read off an internal HDD, or SSD. It is unlikely to function well off a USB key, USB hard-drive, DVD disk, or any networked storage device.

7-3 Fast forward & rewind

Left click anywhere on the progress bar to advance to a chosen point of the recording.
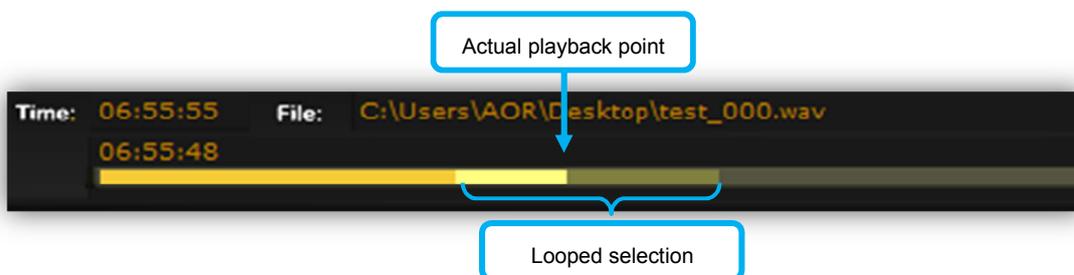
To loop the playback over a smaller selection, simply left click and hold at the desired spot on the progress bar. Drag the mouse pointer along to the right to create a new line, which will be a much paler shade of yellow. Release the mouse button to start playback immediately from the new desired spot. This should be flawless and instant. The player will repeat the new selected section only, over and over, until manually stopped. This may be useful if the user wishes

to repeat a possible station ID over and over again.

A left click on the line cancels the new selection, and continues playback normally.

Troubleshooting: If the user fails to create a new line, but only "clicks" to attempt to advance playback by a few minutes, the software may seem to "stick". The player is probably only playing back a very small selected area over and over again, hence the impression of "stuttering and jamming".

8. Other controls

8-1 Antenna input

Allows manual or automatic antenna selection.

- Note regarding HF reception:

When receiving frequencies below 25MHz through the AR-IQ3 software, the HF antenna should be physically connected to the antenna socket #1, even though it's usually #2 when the receiver is used "stand-alone". This is due to the fact that the receiver's internal antenna wiring is different when used "stand-alone" vs controlled by software.

8-2 Pre-amp

Switches the receiver's front-end pre-amplification on. When in the ON position, the attenuator level is set to 0dB.
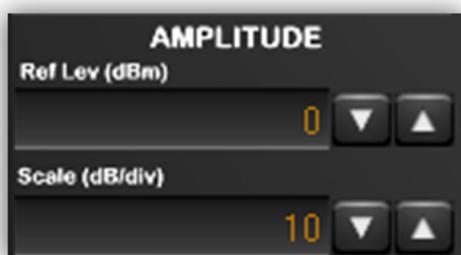
8-3 Attenuator

Like on a conventional receiver, the attenuator reduces signal input. This may be useful if a user has problems with strong local signals appearing on frequencies other than their own.

Possible selections:【0dB】【10dB】【20dB】

Whichever selected, the "Pre-amp" is switched off.

8-4 Amplitude (reference level & scale)

Both "Ref Level" and "Scale" alter the height and position of the spectrum waveform displayed when the spectrum mode on the main panel is selected, as well as the spectrum waveform in the secondary "bandwidth" window.

8-5 Demodulation modes

The following modes can be used:

AM, SAM (SYNC AM), CW, RTTY, LSB, USB, FM, WFM, USER

8-6 Volume & mute

Volume control is on the bottom right of the software, though many users prefer to use the volume on their external amplifiers. The button above the volume slider enables the audio output and mutes it when disabled.

8-7 Noise reduction

The NR control reduces background noise and is activated by the button above its slider control. The NR slider controls the amount of noise reduction. The noise reduction can be activated in all modes except with the USER demodulator.

8-8 Noise blanker (NB)

The NB control reduces impulsive noise and is activated by the button above its slider control. The NB slider sets the threshold of the noise blanker. Care should be exercised when strong signals are present in the band where the receiver is tuned. A too low NB threshold (NB slider at or near its maximum position) may affect the quality of the tuned signal and introduce intermodulation distortions.

Two noise blankers can be selected with the two buttons "NBW" (Wide) and "NBN" (Narrow).
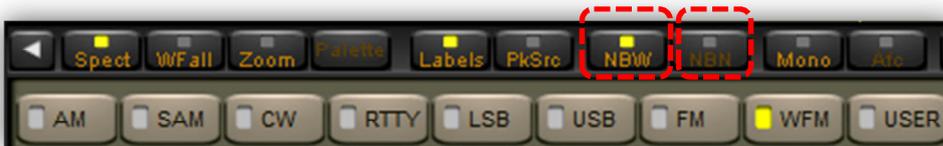
The Narrow NB, operates on the bandwidth selected with the BW buttons (50 kHz, 25 kHz, 12 kHz, etc.).

The Wide NB is more effective when there are no strong signals in the bandwidth the DDC is tuned to.

The Narrow NB is more effective in all other cases.
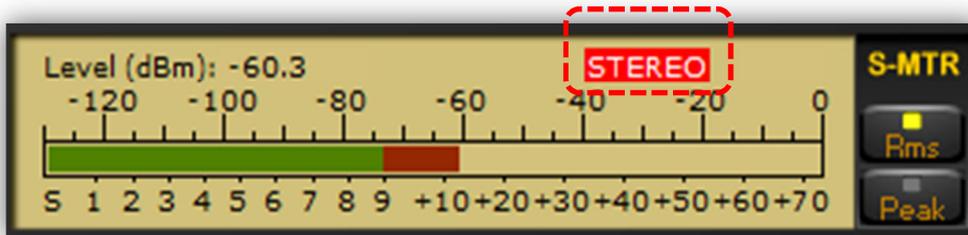
8-9 S-meter

The signal strength meter (S-meter) is marked in both S points and dBm (S9=-73 dBm input). The S-meter response is very linear thorough all its scale and accurate to within less than 1 dB across the range.

LOCK indication: When operating in Sync AM mode (SAM), a small "LOCK" display appears at the top right of the meter, when the demodulator locks on to the AM carrier.
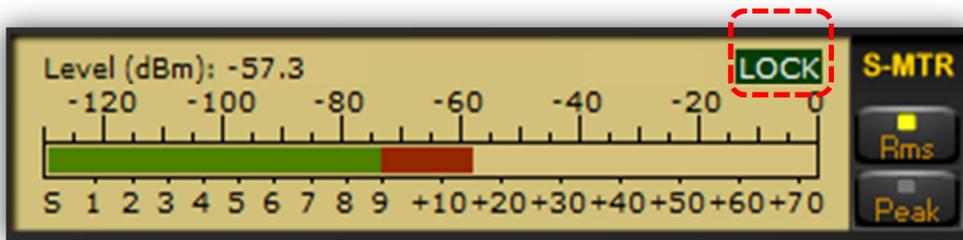
STEREO indication:

Whenever a stereo signal is decoded in WFM mode, a small "STEREO" display appears at the top right of the S-meter.

You can also force MONO reception by clicking the "Mono" button as follows:

The S-meter can be operated in RMS mode (input signal RMS power displayed) or in Peak mode (input signal peak power displayed) clicking the "RMS" or "Peak" at the right side of the S-meter.
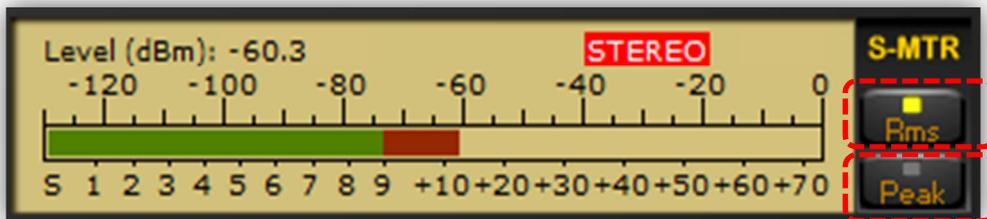
8-10 Squelch & auto-mute

Squelch and Auto-Mute threshold levels can be controlled clicking the desired value in the S-Meter bar with the left button of the mouse.

The Auto-Mute function works in the opposite way of the squelch block. It mutes the audio when the RF input level is GREATER than the desired threshold.

The squelch level is set clicking the S-Meter bar in the S1-S9 zone. A triangle with a left oriented vertical side in the S-Meter bar indicates the selected squelch threshold.

The Auto-Mute level is set clicking the S-Meter bar in the S9 - S9+70 zone. A triangle with a right oriented vertical side

in the S-Meter bar indicates the selected Auto-Mute threshold.

To disable the squelch and/or the Auto-Mute functions, right click the appropriate S-Meter zone.

The hysteresis of the squelch and Auto-Mute functions is approximately 6 dB.

The selected thresholds are peak values.

Squelch   Auto-mute
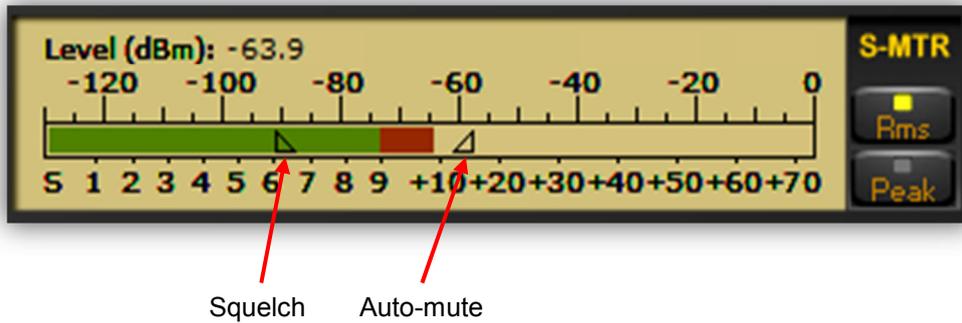
8-11 AGC (automatic gain control)

The Automatic Gain Control keeps the audio output at a constant output level, disregarding the input signal power. Three time decay constants can be selected with the buttons "Fast", "Med", and "Low" in the AGC control bar.

The AGC can be excluded with the "Off" button. In this case the audio output level is controlled by the VOLUME slider. When the AGC is off, large input signals can cause the saturation of the audio output.

8-12 AGC spike rejection

The Spike Rejection function emulates the behavior of the AGC of old analog receivers with a relatively long attach time constant. When this function is selected the AGC circuit is much less sensitive to impulse noise which can completely close the receiver gain and affect negatively the receiver performance.

NOTE: The Spike Rejection function introduces a small amount of (soft) audio distortion which is tolerable in SSB/CW communications and should not be activated for digital modes which may be far more sensitive than human hear to nonlinear distortions. Use this function only when required.

9. Advanced parameters & reset

Advanced settings are only for advanced users. Do only change its values if you really know what you are doing!

To access:

- Click on the blue icon
- Click on the "Software Settings" tab.
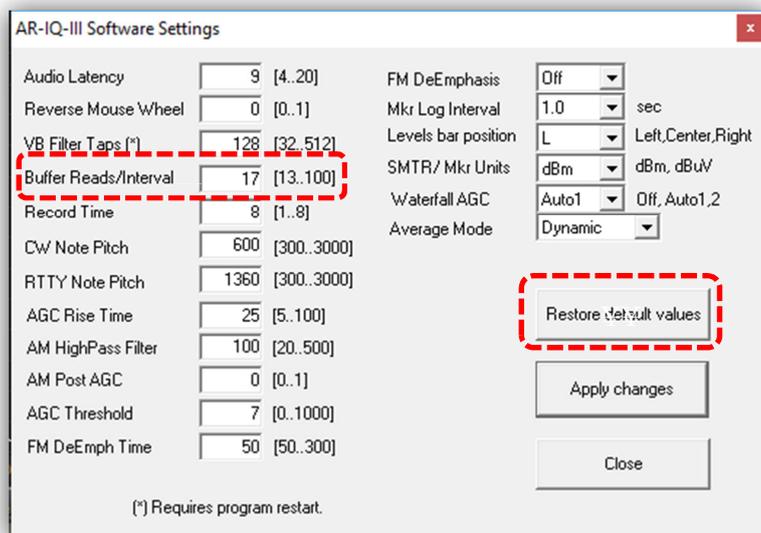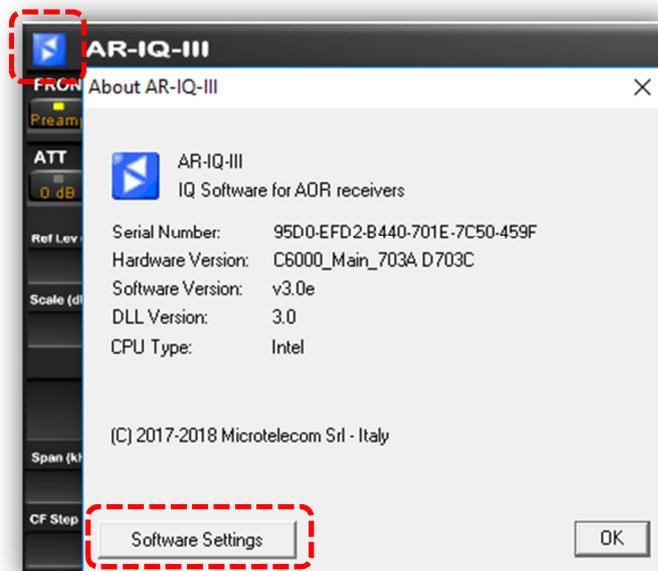
RESET:

To restore default values, click this button followed by the "apply changes" button.

Troubleshooting "audio stuttering":

If you notice "audio stuttering" due to insufficient PC resources, it is possible to adjust the software's **"Buffer Reads/Interval"** to match your PC's specifications.

This parameter controls the amount of data that the software reads from its data queue in a given time interval. If you increase it you will allow the software to read more data from the queue and this will prevent that the queue overflows causing audio stuttering.

Possible values are from 13 to 100. Default is 17. The higher the value, the less CPU power is needed, however it also degrades the vide refresh rate. If audio stuttering is noticed, try to increment this value by 1 and press "Apply changes" and continue to increment until audio is normal.