

Filter settings for multiple receiver slices using ANAN-100 or ANAN-100D

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Power SDR mRX is able to display two receivers on different bands, cuSDR can display up to seven receiver slices and can also display a full HF spectrum using the 'wideband' function. Other software may also be able to support multiple slices. But the operation is somewhat confusing, for example if you have RX1 on the 20m band and you open another receiver on 15m, the second receiver may not display any signals. Open a third receiver on 10m and it is deaf as well. When you click on RX3 it bursts into life, but signals on the 20m receiver disappear!

The reason that this occurs is the automatic switching of the front end high pass and low pass filters inside the ANAN radio. The low pass filters are used on transmit to limit harmonics and they are used on receive to provide additional protection from aliased signals from the VHF spectrum above the wanted band. The high pass filters protect the dynamic range of the receiver by cutting out signals below the wanted band, particularly AM broadcast signals.

In most situations the receiver will work perfectly well on receive without either the high pass or the low pass filters. There is also a 55MHz low pass filter on the input port(s) of the Hermes / Angelia board, which is for protection from aliased signals from the VHF spectrum from 61.44 MHz up to the 700MHz cut off of the ADC.

If you want to display the entire spectrum or operate receiver slices on several bands, you have to bypass some or all of the filters.

- You cannot bypass the 55MHz low pass filter on the Hermes / Angelia board. So if you want to deliberately receive VHF signals above 61.44MHz you would need to physically remove it or bridge it out.

The ANAN-100D:

The 100D has two ADCs and is capable of diversity reception. The RX2 port antenna port is always connected to the second ADC and the signal is not routed through any of the high pass or low pass filters apart from the fixed 55MHz LPF on the Angelia board.

If you open a second receiver slice in PowerSDR mRX or cuSDR it defaults to the second ADC and you will **only** see signals from the antenna connected to the RX2 port. If you don't have an antenna connected to RX2 it will not see anything. Receiver slices 1 and 3 to 7 default to the 1st ADC and you will see signals from the 'main' antenna.

As far as I know it is not possible to use the 2nd ADC with any antenna port other than RX2. If you want to use the 2nd ADC with a single antenna, you need to add an external splitter using the 'Bypass', EXT1 and RX2 connectors.

ANAN-100 and ANAN-100D BNC connectors

1. ANT1, ANT2 and ANT3 go through both LPF and HPF
2. EXT1, EXT2 and XVTR go through the HPF but not the LPF
3. BYPASS is an output for the connection of an external splitter, amplifier or filter
4. RX2 never uses the LPF or HPF only the anti-alias 55MHz LPF on the Angelia board
5. RX2 is always connected to ADC2 on an ANAN-100D and comes up as RX2 in Power SDR mRX or cuSDR
6. RX2 is not connected to anything on an ANAN-100

PowerSDR mRX

High pass filter (HPF) section:

- You can bypass the high pass filters by pressing the 'Alex' switch or by setting 'manual' on the ANT/Filters setup tab. Check the 'ByPass/55MHz LPF' check box.
- If ALEX is highlighted (automatic selected) the high pass filters will be selected according to the frequency table on the setup tab.
- The high pass filters are not ham band specific they are designed to work when the receiver is used as a general coverage receiver as well.
- In automatic mode, the high pass filters are selected according to the frequency that the RX1 receiver is tuned to. This affects what you can see on the RX2 spectrum display. If RX1 is on a lower band than RX2 the HPF will pass signals for both receivers, but if RX1 is on a higher band than RX2 you may need to press the Alex switch to bypass the HPF, (see the table for band selection).
- If RX2 is enabled, pushing the Alex button will cause a bypass even if the bypass check boxes are not checked.

RX1	Filter name	RX2
160m	1.5 MHz HPF	Set Alex to auto
80m	1.5 MHz HPF	Set Alex to auto
60m	1.5 MHz HPF	Set Alex to auto
40m	6.5 MHz HPF	Set Alex to manual for RX2 on 160m, 80m, 60m
30m	9.5 MHz HPF	Set Alex to manual for RX2 on 160m, 80m, 60m, 40m
20m	13 MHz HPF	Set Alex to manual for RX2 on 160m, 80m, 60m, 40m, 30m
17m	13 MHz HPF	Set Alex to manual for RX2 on 160m, 80m, 60m, 40m, 30m
15m	20 MHz HPF	Set Alex to manual for RX2 on 160m, 80m, 60m, 40m, 30m, 20m
12m	20 MHz HPF	Set Alex to manual for RX2 on 160m, 80m, 60m, 40m, 30m, 20m
10m	20 MHz HPF	Set Alex to manual for RX2 on 160m, 80m, 60m, 40m, 30m, 20m
6m	50 - 61.66 MHz BPF	Set Alex to manual for RX2 on 160m, 80m, 60m, 40m, 30m, 20m, 17m, 15m, 12m, 10m
RX2	Filter name	RX1
6m	50 - 61.66 MHz BPF	Set Alex to manual for RX1 on 160m, 80m, 60m, 40m, 30m, 20m, 17m, 15m, 12m, 10m

PowerSDR mRX selects the HPF according to the table on the ANT/Filters setup tab. Note that this does not change the filters themselves; it only changes the frequency that PowerSDR switches between filters. The default is for a HPF to always be selected, but you can make the radio switch to bypass outside the ham bands by adjusting the numbers in the table.

Power SDR mRX	
Filter name	HPF Default settings
1.5 MHz	1.8 MHz – 6.499999 MHz
6.5 MHz	6.5 MHz – 9.499999 MHz
9.5 MHz	9.5 MHz – 12.999999 MHz
13 MHz	13 MHz – 19.999999 MHz
20 MHz	20 MHz – 49.999999 MHz
6m BPF/LNA	50 MHz – 61.440000 MHz

For example if you set the 13 MHz filter to be active between 13.000 MHz and 13.999999 MHz the receiver will drop to bypass when you tune between 14 MHz and 20 MHz.

- Selecting the bypass check box beside any of the HPF filters causes the receiver to switch to bypass, provided;
 - a) the receiver is tuned to a frequency within that filter range and
 - b) the Alex switch is set to manual and
 - c) the 'ByPass/55MHz LPF' check box is not selected.
- Selecting the bypass check box beside the 'ByPass/55MHz LPF' causes a switch to bypass whenever the Alex switch is set to manual.
- In an ANAN-100 the antenna that RX1 is using is used for RX2 as well. You cannot have RX2 on a different antenna to RX1, (in an ANAN-100D RX2 is always on the RX2 antenna port).
- In the current release of PowerSDR mRX, the 'radio buttons' indicating the filter selection on the ANT/Filters setup tab **do not** indicate the current status of the filter selection.

Low pass filter (LPF) section:

The LPF is selected according to the frequency that the radio is set to transmit on. In Power SDR it seems to be switched to 6m, or to the highest band, during receive operation, at least when two receivers are active. I am not sure about this as PowerSDR does not show which LPF is selected when you change bands on either receiver. In any case the LPF does not seem to affect received signals on either receiver.

- The low pass filters are not included if you use the EXT1, EXT2 or on the ANAN-100D RX2 antenna ports.
- The low pass filters are included if you use the ANT1, ANT2 or ANT3 antenna ports.
- It is not possible to bypass the LPF with switching, but using the 6m LPF has the same effect. There is no user control of the LPF filter selection, but you can change the frequencies that cause PowerSDR to switch between filters.
- I have not tested this, but I expect that (similar to the HPF) if you change the default settings, the LPF will revert to the 6m position outside of the nominated frequencies. For example if you set the 30/20m filter to operate between 8.000 MHz to 13.999 MHz the LPF will drop to 6m LPF when you tune between 14 MHz and 16.5 MHz. This is what happens when using cuSDR.

Power SDR mRX	
Filter name	LPF Default settings
160m	0 MHz – 2.5 MHz
80m	2.500001 – 5 MHz
60/40m	5.000001 – 8 MHz
30/20m	8.000001 – 16.5 MHz
17/15m	16.500001 – 27.8 MHz
12/10m	27.800001 – 35.6 MHz
6m / Bypass	35.600001 – 61.44 MHz

cuSDR

cuSDR operates differently to PowerSDR mRX. I think that this mostly because the default settings for the HPF and LPF are not contiguous in cuSDR, they are aligned to the ham bands, not to general coverage. In the current release the filter switching is quite confusing and there is no manual.

cuSDR can display up to seven receivers at the same time, which can make the filter operation even more of a challenge. In the default (automatic) situation the second and subsequent receivers are likely to display no signals until you click on the spectrum display which shifts the focus and rearranges the filter switches to that receiver. This is a bit counter-intuitive since you would expect that every time you open another receiver that it would be working.

- If you have an ANAN-100D then the RX2 receiver slice will always show the signal from the 2nd ADC which is connected to the RX2 antenna port. If you want another receiver on the main antenna simply open a 3rd receiver slice and then close the RX2 slice.
- Unlike PowerSDR mRX, if you click on a receiver slice, the filters will change to the settings for that slice. For example if RX1 is on 20m and RX2 is on 10m, clicking on RX1 will cause signals on the 20m band to display, but the signals on RX2 will disappear. Clicking on RX2 will cause the signals on the 20m band to disappear and the 10m signals on RX2 will appear.

It is not very useful to have seven receiver slices unless they can all display signals at the same time. To do that you need to bypass the filters.

One very neat features of cuSDR is that you can see the effect of the selected filters and your antenna system on the wideband display.

As the filters are changed you can see the spectrum respond. Of course if the antenna is a mono-bander most of the energy will (hopefully) be in the band that the antenna is on.

Alex Auto / Alex Man filter settings:

1. If the **Alex Auto** button (with a blue border) is showing on the main cuSDR display, the radio is set for automatic filter selection. This does not seem to be connected with the frequencies in the tables on the HPSDR Filter setup tab.
 - Note that the filter selection on the setup tab will not indicate the true state of the filters in this mode.
 - ANAN-100 - Until you click on the slice to shift the focus, RX2 and any subsequent receiver slices will not display any signals unless they are on the same band as RX1 (or the active selected slice).
 - ANAN-100D - Until you click on the slice to shift the focus, RX3 and any subsequent receiver slices will not display any signals unless they are on the same band as RX1 (or the active selected slice). But RX2 will work because it is connected to the 2nd ADC on the RX2 antenna with none of the software selectable LPF or HPF.
2. The Auto / manual button on the HPSDR filter setup tab seems a bit random. Sometimes it toggles the main screen Alex Auto button and at other times it seems to have no effect. (*Someone might like to help out with an explanation here*). In any case it seems to be unimportant.

3. If the [Alex Man](#) button (with no blue border) is showing on the main cuSDR display, the radio is still set for automatic filter selection. But now the manual selections and the frequencies set in the HPF and LPF tables are active. Also as you change bands (for example by clicking on the wideband display), the setup page shows the current filter selection.
 - You can force the HPF to bypass by setting the bypass button to on (blue).
 - You can temporarily remove an HPF band from the table by setting an individual band bypass button to on (blue).
 - If you don't have any bypass buttons selected the radio will;
 - i. Operate in **automatic mode** based on the frequencies in the HPF and LPF tables.
 - ii. If the radio slice is tuned to a frequency outside of any of the HPF filters the HPF will switch to bypass.
 - iii. If the radio slice is tuned to a frequency outside of any of the LPF filters the LPF will switch to the 6m position (effectively the same as a bypass).
 - iv. It is possible for HPF to be bypassed but not LPF and vice versa

HPF	1.5 MHz HPF	Bypass	6.5 MHz	Bypass	9.5 MHz HPF	Bypass	13 MHz HPF	Bypass	20 MHz HPF	Bypass	50-61.44 MHz BPF											
	-1.5	-1.8	-2.0	-3.5	-4.0	-5.33	-5.5	-7.0	-7.3	-10.0	-10.1	-10.15	-14.0	-14.35	-18.068	-18.168	-21.0	-21.45	-24.89	-29.7	-50.0	-54.0
LPF	Bypass	160m LPF	Bypass	80m LPF	Bypass	60/40m LPF	Bypass 6m LPF	30/20m LPF	Bypass	17/15m LPF	Bypass	12/10m	Bypass 6m LPF	6m LPF								

What this means is that even when switched to 'Alex Man' the radio will probably not display signals on all receiver slices and the wideband display will be filtered, not fully wideband.

The slice you have as the active receiver, which is the one that you are listening to since cuSDR can only demodulate signals from one of the displayed slices at a time, is the slice that sets the filter selection.

If you click on another slice, to move the frequency or change mode etc., the filters will change to the settings for that frequency. Depending on the frequency that the active slice is tuned to, the HPF and/or the LPF may be active or bypassed.

Making cuSDR receive signals on all slices

1. The BEST way to make all receiver slices work is to select [Alex Man](#) on the main cuSDR display **and** turn on the [Bypass](#) button (blue) on the HPSDR filter setup tab
2. An alternate is to select [Alex Man](#) on the main cuSDR display and set the active (RX1) slice to a frequency where both the LPF and the HPF will automatically select the bypass positions, i.e. between 29.7MHz and 50MHz. The only disadvantage with this method is that if you make another slice active by clicking on its spectrum display, the filters will switch and you will probably lose visibility of the signals on all of the other receiver slices.
3. These settings will show on the HPSDR filter setup tab and will affect the wideband spectrum display.

Default HPF and LPF settings - Alex Man setting only

cuSDR		
Filter name	Band	HPF Default settings
1.5 MHz HPF	160m, 80m, 60m	1.500 MHz to 5.500 MHz
6.5 MHz HPF	40m	7.000 MHz to 7.300 MHz
9.5 MHz HPF	30m	10.000 MHz to 10.150 MHz
13 MHz HPF	20m, 17m	14.000 MHz to 18.168 MHz
20 MHz HPF	15m, 12m, 10m	21.000 MHz to 29.700 MHz
50 - 61.66 MHz BPF	6m	50.000 MHz to 54.000 MHz

Note that unlike PowerSDR mRX the default filter settings have gaps where the radio will default to bypass.

cuSDR	
Filter name	LPF Default settings
160m	1.800 MHz to 2.000 MHz
80m	3.500 MHz to 4.000 MHz
60/40m	5.330 MHz to 7.300 MHz
30/20m	10.100 MHz to 14.35 MHz
17/15m	18.068 MHz to 21.450 MHz
12/10m	24.890 MHz to 29.700 MHz
6m	50.000 MHz to 54.000 MHz

The PA and Filter board:

The normal receive path is via one of the three main antenna connectors. There are also two antenna ports for receive antennas, a transverter port, and a Bypass output port designed so that you can insert an external filter which could be useful in a contest station or a pre-amplifier. The normal signal path is into the low pass filter section which is used on both transmit and receive. There is a choice of seven software selectable low pass filters for the ham bands. The low pass filter section is not in circuit if the EXT1, EXT2, or RX2 antenna inputs are used.

On receive; the output of the low pass filters is routed via the TR switch to the high pass filter section which contains five software selectable high pass filters which can be bypassed. The five high pass filters are not ham band specific, they break the spectrum into zones so that the receiver retains general coverage receive capability. The sixth filter selection is a band pass filter for the 6m band and includes a low noise amplifier. The board includes a software selectable 10 / 20 / 30dB attenuator before the high pass filters.

It is very important that the filters and associated switching at the input of an SDR receiver are well designed as it is essential that they do not introduce any sources of intermodulation products.

Why do we need all these filters?

There seems to be a lot of filters in the receive path and there is also a 55MHz low pass filter at the input of the Hermes / Angelia board. Why does the radio need all of these filters? There are two answers, one is much more important than the other. The first and less important reason is that the dynamic range of the ADC is affected by the total power of all the signals presented to it. This includes signals within the Nyquist bandwidth such as AM broadcast stations and signals within multiples of the Nyquist bandwidth, up to 700 MHz in the case of the LTC2208 ADC in an ANAN receiver. These signals could include high power stations in the FM broadcast band and TV transmitters. Receiving a lot of strong signals reduces the dynamic range and the displayed noise floor rises.

The low pass filters block 'out of band' signals to prevent break through from FM and VHF TV stations.

The high pass filters block unwanted signals below your wanted range such as AM broadcast stations, ensuring that there is minimal reduction of the dynamic range and signal to noise ratio. A medium level of signals within the Nyquist bandwidth, between 0 and 61.44 MHz, will not affect the noise floor much and will act to reduce the effects of intermodulation distortion, so the 'in band' unwanted signals must be reduced, but they do not have to be entirely eliminated.

The ability to sample frequencies above the Nyquist bandwidth is known as aliasing and is used in commercial SDR receivers for receiving signals above the sample rate. The ADC used in the ANAN radio can sample frequencies as high as 700MHz. In our ham transceiver, we don't want interfering signals from above the Nyquist bandwidth because once they are sampled they can't be removed. The 55MHz low pass filters ensure that any aliased signals are attenuated by at least 100dB and end up below the noise floor. Phil Harman said that he can't see any FM broadcast signals on his Mercury receiver even without the Alex filters, so I believe that this issue has been fully resolved. The FM band extends from about 88 MHz to 108 MHz, which would appear as signals between 26.56 and 46.56 MHz in the receiver. At my QTH I cannot see any sign of the local FM stations even when the filters are set to bypass.

The front end filters mess up your ability to take advantage of the capability to display multiple receiver slices on different bands and the wide 0-66 MHz spectrum display, you have to bypass them if you want to view slices on multiple bands. In most cases unless you live in Europe where there are often very close FM and TV stations, bypassing the filters will have no effect on the receiver performance. At my QTH on the 20m band, I see no increase in the noise floor and no unwanted new signals at all when the filters are switched to bypass mode. It is difficult to persuade PowerSDR to bypass the low pass filters because they are automatically selected for the transmit frequency in use. You can adjust the frequencies at which it changes filters, so that it switches to bypass when the radio is tuned to a frequency outside the ham bands, but the default is for a low pass filter to always be in circuit. If you want full unfiltered receive capability it is probably easier to use the EXT1 or EXT2 antenna connectors. With cuSDR the LPF engages for each ham band and automatically drops to bypass when the radio is tuned to a frequency outside of a ham band.