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The FT-1000MP, MK V and Field: Filter Selection and Modification Guide

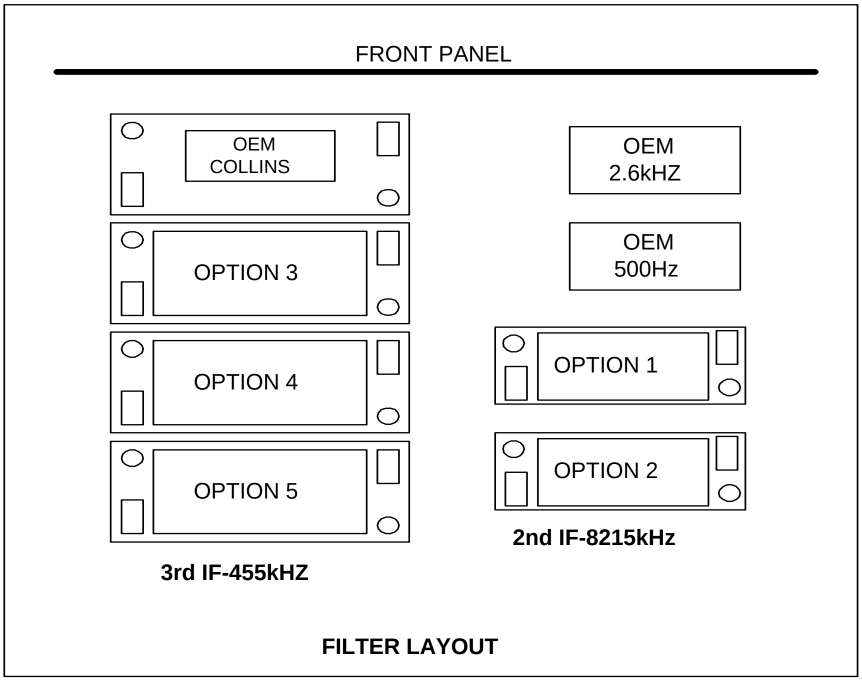
FT-1000MP Series Filter Selection

The FT-1000MP receiver is triple conversion, with IFs at 70.455 MHz, 8.215 MHz and 455 kHz. The first IF has a soldered-in 12 kHz monolithic 4 pole filter which is in line for all receiving modes.

When you purchase **any** version of the FT-1000MP, it comes with three filters installed and six additional option slots. The standard filters supplied are a pair of wide SSB for the second and third IFs, and a 500 Hz CW for the second IF. The OEM Collins filter is used for wide SSB and is mounted on a small PC board that is plugged in. In the MP this is a 2.55 kHz, 8 pole filter. In the Mark V versions, it is a 2.3 kHz, 10 pole filter.

The drawing below shows the various OEM filters, and empty option slots in the MP as delivered from the factory. Option 6 is a CW filter for the Sub-receiver.

With the radio turned upside-down and the bottom cover removed, the filter section of the IF board looks like the drawing below:



SSB Options

INRAD has two narrower filter types that may be used in the 2nd IF **Option 1** slot. The #709-B is a 2.1 kHz filter having a shape factor of 1.5 for a –60 dB bandwidth of 3.15 kHz. The second type is the #711-B with a 1.8 kHz bandwidth and a shape factor of 1.5 giving a –60 dB bandwidth of 2.7 kHz. The 2.1 kHz bandwidth is a time proven good compromise between readability in noise and QRM and speech fidelity. The 1.8 kHz bandwidth is useful for severe QRM conditions such as those found in a major contest.

A second filter installed in 3rd IF **Option 3** slot will improve the overall shape factor. It also will improve the operation of the IF Shift and Width controls. INRAD has a 2.1 kHz filter, #702-C, and a 1.8 kHz filter, #714-C, for **Option 3** slot. These filters also have a 1.5 shape factor.

INRAD has also made available a pair of wide SSB filters for higher quality voice reproduction. The #716 for the 2nd IF 8.215 MHz and #715-C for the 3rd IF455 kHz have 2.8 kHz minimum bandwidth. These filters can be used to replace the standard OEM filters in the 2.4 kHz slots. The #716 will solder in place of the OEM 2.6 kHz filter while the #715-C is a plug in replacement for the OEM 2.6/2.3 kHz filter. When used in this way, they will provide improved fidelity for both received *and* transmitted signals. The pair of filters may also be plugged into the **Option 1** (in this case, order #716-B) and **Option 3** (#715-C) slots if wider transmitted SSB is not desired, but a fuller sounding received signal is. In the Mark V, our customers report a substantial improvement in both transmitted and received audio when our #715-C is substituted for the OEM Collins.

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CW/PSK31/RTTY/
VHF Moon Bounce Options

The stock MP, Mark V and Field version all come with a 500 Hz CW filter in the 8.215 MHz IF. The following table shows the measured selectivity of the overall radio when this filter is used with a stock 455 kHz SSB filter and with several other choices. The second column shows the stock 8.215 MHz 500 cascaded with the Collins 500 (115C). Column three shows an Inrad #703-C 455 kHz filter with the stock 8.215 MHz filter. Column four shows an Inrad #701 400 Hz filter replacing the stock 8.215 MHz 500 Hz filter and cascaded with the #703-C 400 Hz 455 kHz filter. This combination provides the ultimate selectivity for the 500 Hz slot. The stock filter must be unsoldered from the IF board and the Inrad #701 is then dropped in and soldered.

	Standard	**Good**	**Better**	**Best!**
Filter Selection	Stock 500 + SSB	Stock 500 + 115C	Stock 500 + 703C	701B + 703C
-6 dB	610	490	410	400
-60 dB	1080	870	700	620

Some people find the 500 Hz bandwidth a bit too narrow for casual operating. When contesting, 500 Hz bandwidth can be restrictive while trying to move quickly across a band to find multipliers. On the higher bands where there is a lot of space, this is particularly true. INRAD offers 1000 Hz filters for these situations. In the standard MP, 1000 Hz filters can be put in the 8.215 MHz IF **Option 2** slot (#718-B) and/or the 455 kHz IF **Option 4** slot (#713-C). This leaves the **Option 5** slot open for a 500 Hz (#705-C) or 400 Hz (#703-C) filter. In the Mark V, a pair of 1 kHz filters can be installed in the 8.215 MHz IF (removing and replacing the standard OEM 500 Hz filter with the #718 filter) and the 455 kHz IF **Option 4** slot (#713-C)and selected as NARROW 1. Then, NARROW 2 can be used for a pair of 400 Hz (#701-B & #703C) or 250 Hz (#708-B & #704-C) filters in the **Option 2** and **Option 5** slots.

Another way to set it up for using the 1000 Hz filters is to put them in the NARROW 2 slots (**Option 2** 8.215 MHz and **Option 5** 455 kHz). A 400 (#703-C) can be then used in the **Option 4** 455 kHz slot along with the OEM 500 Hz 2nd IF filter and no soldering is required.

Other available CW filter options include 300 Hz (#712-C)and 500 Hz (#705-C) Collins mechanical CW filter for the 455 kHz IF as well as a 500 Hz crystal filter (#721-C) for the 455 kHz IF (steeper skirts compared to the mechanical filter).

For RTTY, the popular choices are a pair of 250 Hz filters (#708-B & #704-C) and/or the 400 Hz filters (#701-B & #703-C).

Finally, for the tightest possible bandwidth, INRAD also offers a 125 Hz filter (#719-C) for the 455 kHz IF. This filter is very useful for PSK-31, serious 80 and 160 meter DXers and VHF moon bounce enthusiasts.

AM OPTIONS

For improved AM selectivity, our #710-B can be used in the **Option 1** slot. This is the only slot which is functional in the AM mode. The #710-B is 6 kHz wide and has a shape factor of 1.5.

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Filtering Example

There are many filter options we provide for the 1000MP, Mark V and Field series of radios for those wanting to customize their radios for their own specific operating styles. Here is just one example, geared towards contesters and DXers, of filtering possibilities to take advantage of the filtering flexibility that the radio allows.

	8.215 MHz 2nd IF			**455 kHz 3rd IF**		
	OEM Slot	**Option 1 Slot**	**Option 2 Slot**	**Option 3 Slot**	**Option 4 Slot**	**Option 5 Slot**
Filter Selection	#701 400 Hz CW	#709-B 2100 Hz or #711-B 1800 Hz SSB-N	#708-B 250 Hz CW	#702-C 2100 Hz or #714-C 1800 Hz SSB-N	#703-C 400 Hz CW	#704-C 250 Hz or #719-C 125 Hz CW

Note: For the FT1000MP, Mark V and Field, menu options 5-0 through 5-8 need to be properly configured for desired selection of filter options installed. They are each set up somewhat differently, so read the manual for exact programming instructions.

Sub-Receiver Options

All versions of the MP come with a ceramic SSB filter having a bandwidth of about 2200Hz. The OEM ceramic has a poor shape factor and can be replaced with one of the better SSB filters. There is room near it to wire in a crystal filter with short pieces of RG-174. A good choice would be the 2.1 kHz filter (#702) with its steeper skirts.

There is an option slot for an additional 455 kHz filter, which can be used on CW only. The most common use for the sub-receiver is listening to a pile up to determine the calling frequency of stations after a DX station. In this instance, a CW filter that does not have steep skirts can be an advantage. It lets the operator hear calling stations which are slightly off frequency. The most popular filter for this type of operating is the 500 Hz Collins, #705-C. It is also useful for listening to pile ups that are calling during contest CQing. Another all around good choice is the #703-C 400 Hz filter for those desiring steeper skirts for the sub-receiver CW filter.

Any of the 455 kHz filters listed for the main receiver can also be used in the sub receiver option slot. That would include the 125 Hz (#719-C), 250 Hz (#704-C), 400 Hz (#703-C), 500 Hz (#705-C Collins mechanical or #721-C crystal) and 1000 Hz (#713-C) filters.

FT-1000MP/Mk V/Field 70 MHz IF Amplifier Mod

This mod applies to all versions of the FT-1000MP. Installation is slightly different for the Mark V and Field.

In the MP, Mark V and Field, the second mixer (at 70.455 MHz) has a higher than desired noise floor. The RF section of the radio has a very good noise floor, but it also has low gain. Because of this, the second mixer and following IF stages contribute substantially to the overall receiver noise floor. The ARRL tests (and INRAD's) have shown the noise floor in an unmodified radio (measured with the OEM 500 Hz filters) to be –128 dBm or so, depending on band and whether the *Tuned* or *Flat* mode is selected. (This is a noise figure of 19 dB, for those who prefer this type of measurement.) *Tuned* is the preferred mode for most kinds of operation. Also, it has been widely stated that the MP in its unmodified state does not hear as well as other radios. The worst band is 21 MHz (and below) as there is a separate preamp in line on 28 MHz which helps greatly.

Spurious free dynamic range (SFDR) is defined as the difference between the maximum allowable input signal and the system's minimum detectable signal. Note that it includes two factors. Minimum detectable signal is usually the noise floor, in dBm. Maximum allowable input signal is that level which produces IMD at the noise floor.

The MP, Mark V and Field have a 70.455 MHz crystal filter with a bandwidth of 12 kHz. The SFDR for signals outside this filter bandwidth is determined by the signal strength capabilities of the first mixer and RF stages. The INRAD mod is inserted after this filter and just prior to the second mixer. The mod gain is adjusted to 8 +/- 0.5 dB during final test. Thus, the maximum allowable signal within the 12 kHz bandwidth is reduced by 8 dB. However, the improvement in noise floor as measured in several MPs and Mark Vs has been 3 to 6 dB. The SFDR outside 12 kHz is not changed and inside 12 kHz it is reduced by 2 to 5 dB.

What does this all mean? There is a small degradation in strong signal handling within the 12 kHz filter. If this is a problem, use the IPO or the ATT to restore the strong signal handling and poor noise floor. The IF hiss will not return when this is done as the gain redistribution in the radio doesn't change. The actual result is that the improvement in noise floor is very noticeable whereas the small degradation in IMD dynamic range is not. Most of the time, the benefits of the mod will outweigh the small decrease in SFDR performance.

To prove out this modification in practice, the mod was installed in a radio which had an IN/OUT relay controllable from the front panel. For a year, the mod was switched in and out hundreds of times during regular operating and in the heat of contests. IMD was often heard, but there was never a time when switching the mod out made any noticeable difference. The position of the NB control has a great effect on IMD. If it's turned up even part way the IMD substantially increases. This can be easily noticed in a crowded band.

Most of the time, a noise floor of -128 dBm is adequate. However, if band conditions are quiet and you are running an antenna which has good directivity, you will miss weak signals. This was learned years ago when the first solid state radios came out and had high noise figures. The Collins S line with its 4 dB noise figure would hear signals that simply were not there in the TR-7 and other radios. The TR-7 had a noise floor 1 or 2 dB better than the MP.

This mod was developed because of the high level of IF hiss in the MP. The implementation also resulted in an improved noise floor, important for weak signal work. The combination of the INRAD mod and the K9AN capacitor mod has been installed in thousands of radios and is widely accepted as an improvement to the radio.

1. What can you expect from this mod?
The IF mod will reduce the internal noise in the receiver without changing the overall gain or S meter readings. The noise floor will be improved by a few dB and the receiver will sound more "lively".

2. Will this mod lower the dynamic range of my radio?
There will be very little change in dynamic range when this mod is installed. This has been proven by lab testing. The front end of the MP is gain starved and the few dB added gain from the IF mod has little effect on overall dynamic range.

3. Who can benefit from installing this mod?
Operators who need a bit more sensitivity in their radio. Operators who are annoyed by the internal noise or audio hiss.

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FT-1000MP/Mk V/Field Roofing Filter Mod

This mod applies to all versions of the FT-1000MP. Installation is slightly different for the Mark V and Field.

“Roofing filter” is the current buzzword in high-end radios. Just what does it mean? Basically, a roofing filter is simply the first IF filter in a radio. It is usually placed as close to the first mixer as possible in order to be effective. The term “roofing” stems from the fact that it protects the rest of the radio following it from out of passband signals.

The MP series radios do have a roofing filter as original equipment. It is a 4 pole monolithic device with a -6 dB bandwidth of 12 kHz. This filter is quite a bit wider than the information bandwidth we are trying to receive, so it allows multiple signals through in crowded band conditions. When several signals in the passband exceed S9 +25 or 30 dB, intermodulation is generated which makes copy difficult.

We have developed a better roofing filter and incorporated it into an easily installed mod. The mod contains a high dynamic range, feedback amplifier that compensates for the insertion loss of the added filter. Our filter has a nominal bandwidth of 4 to 5 kHz and has very steep skirts. For example: at -40 dB the OEM filter is over 45 kHz wide where our filter is less than 10 kHz wide.

The K9AN capacitor mod is also important to add with the roofing filter mod. It reduces the internal noise in the CW mode and is supplied along with instructions.

1. What can you expect from this mod?
Less IMD in crowded band conditions, particularly from stations at offset frequencies of 2 to 10 kHz either side of the operating frequency.

2. Will it defeat the noise blanker?
No, the roofing filter is in the circuit before the noise blanker sample is taken. The filter delay is added to both signal and noise. The key thumping from strong signals is greatly reduced with this mod installed.

3. Will this mod allow for wide band SSB?
No, the roofing filter will determine the overall widest bandwidth of the receiver, which is about 4 kHz wide. It will also limit the bandwidth of AM signals when both sidebands are being detected. The sub receiver is not altered and can still be used for the wider bandwidth modes.

4. If 6 poles work so well, why not 8 poles?
The most important part of the filter characteristic is from the pass-band on down to about –30 dB on either side of center. Eight poles would provide much better stop-band isolation, but this is not required in a roofing filter and would make no noticeable improvement in IMD performance.

5. Who can benefit from installing this mod?
Operators who experience lots of strong signals which are close together in frequency. This would include contesters with big antennas, people with really good antennas and a good location, and DXpeditioners who work large pileups. Casual operators would probably not notice any difference in receiver performance.

NOTE: It is NOT possible to install both the roofing and IF amplifier mods as they are designed to use the same mounting arrangement.

FT-1000MP Keying Improvement Mod

The keying mod will improve keying in all models of MP.

The MP keying rise time is 2.4 mS and fall time is 1.0 mS. The fall time is responsible for the somewhat wide signal which the MP generates on CW. There are two points in the radio which can be used to improve the keying by slowing the voltage change over from receive to transmit and back. One point is on the IF board and the other is on the RF board.

Results: Before and after measurements are listed below.

	OEM	Modified
Rise time	2.4 mS	4.0 mS
Fall time	1.0 mS	2.2 mS

The occupied bandwidth of the CW signal is reduced to 45% or less.

Note that as of about the middle of 2005 (we do not know any serial number details), Yaesu has been installing the key click mod, so it is not necessary for late model radios.

FT-1000MP AGC Improvement Mod

The AGC mod applies only to the original MP version.

While operating in contests at the 6Y and HC8 operations, several of the operators noted that picking out complete calls on CW in giant pileups was quite difficult and tiring with the FT-1000MP. N6TV noted that signals on the same frequency with levels differing by 10 dB sounded like one signal. Operators also reported that other radios, including the TS-930 and FT-990, did not seem to exhibit this problem.

Used in a typical domestic situation, there is no problem. The difficulty occurs when large pileups of S9+30 and +40 stations are calling.

Some experimenting was done by N6BV, AG9A and K2KW at one of the 6Y Team Vertical contest operations. They concluded that the problem was in the AGC timing. A 0.1 uF cap added to the fast time constant showed some improvement. Switching to slow improved the situation for picking out calls, but the decay time was much too slow.

After several fruitful discussions with W6NL about AGC circuits and measuring techniques, a test was set up using a signal generator with a steady tone that was switched between two levels 10 dB apart. Switching was done at a 32 wpm rate. While listening to the receiver output it was noted that distinct differences could be heard when the larger level was from S0 to about S6 or S7. If the level was increased to S9+ it sounded like one level with no switching. Switching to slow AGC or riding the RF gain control allowed hearing the two levels. Observing the AGC bus on a scope showed a fast ramping up of the AGC voltage when the tone level decreased 10 dB. This caused the two levels to merge into one at the receiver output.

Slowing the fast AGC decay time a bit was clearly the way to improve the situation. Various capacitor values were tried and the minimum that would reduce the ramping to the same rate as the slow AGC was selected. This value was a compromise that worked well for speeds in the 32 wpm range and is not very critical. Further testing revealed some overshoot in the acquisition timing due to some slowing from the added capacitance. A resistor was put in series with the capacitor and its value adjusted to eliminate the overshoot.

A modified radio was used by N6TV and K2KW in the IARU operating at 4M1X. N6TV reports "I had no trouble pulling callsigns out of the pileup, even when stations were right on top of one another."

This simple modification consists of a 0.47 uF capacitor in series with a 10K resistor with the combination placed across C2026 on the IF board. Very little difference will be noted under ordinary operating conditions.

Operating the FT-1000MP

What the Manual Doesn't Tell You

1. The Noise Blanker causes intermodulation.

The excellent IMD performance of this radio can be greatly deteriorated by the noise blanker. Sounds logical and you knew that, right? What you didn't know is that the setting of the NB front panel control is extremely important. The missing information is that the IMD is *also* deteriorated when the NB1 and NB2 switches are in the OFF position.

Some IMD measurements were made to verify this. With the NB1 and NB2 off and the NB control fully CCW (note that in the Mark V, the noise blanker settings are changed in the menu from A1 to A15 and B1 to B15, with A1 and B1 shutting off the noise blanker), the third order intercept (TOI) with tone spacing of 10 kHz is +14.5 dBm. This was measured in the CW mode on 7 MHz with the tuned front end selected. Filters were the 500 Hz Yaesu followed by the 400 Hz Inrad. The results were as follows:

NB Control	TOI
Fully CCW	+14.5 dBm
12 O'clock	+4.5 dBm
Fully CW	-7.0 dBm

The slope of the IMD characteristic is double the normal response, so for each 1 dB change in TOI, the IMD changes 2 dB. The difference in IMD for a given level of input signals spaced 10 kHz deteriorates by 2 x (14.5 - (-7)) = 43 dB!! Keep that NB control fully CCW when you are not using the noise blanker!

2. Using the RF Gain control under strong QRN conditions.

Most people set the RF Gain control at maximum and leave it there. Readability of weak signals in QRN can be greatly improved by setting the RF gain control back. When atmospheric noise is moving the S meter, readability will be improved if the RF gain is backed off to the point where it is no longer moving from the static crashes.

3. Using the RF Gain control to improve readability in pileups.

Normally the AGC will be in the FAST position for operation on CW and for contest type operating on SSB. When multiple signals are inside the passband of the receiver, the strongest one will control the AGC bus. In between the dots and dashes or speech peaks for SSB, the AGC voltage will decay quite rapidly down to the next strongest signal. When this occurs, the next strongest signal is amplified up to the same level as the strongest signal. It then is impossible to read either signal if they are essentially on the same frequency. This is due to the very fast decay time constant in the radio. Setting to the SLOW AGC position can improve matters, but the response time gets too long for contest style operating. The INRAD mod improves the situation somewhat by increasing the decay time constant in the FAST AGC position, but with or without this mod the situation may be improved by setting the RF gain control back.

Here is an example of the results gained with 2 tones spaced 10 kHz:

RFG setting	TOI	Noise Floor	Dynamic range
Full CW	+14.5	-130 dBm	96.3 dB
Set to S7	+17.5	-126 dBm	95.6 dB

There is a 4 dB reduction in sensitivity that is negligible under strong signal conditions and the TOI increases by 3 dB. The IMD level will be down by 6 dB.

This is good advice for any type of receiver, not just the 1000MP.

