

Table of Contents

Filter Specifications 1
 Notch Filters:..... 2
 Random Noise Reduction Filter:..... 2
 Signal Processor: 2
 General Features: 2
 Rear Panel: 2
 Introduction to DSP 3
 Connections..... 4
 Input Connections 4
 Output Connections 5
 Connecting to Receive Audio 6
 Power 6
 Headphones Out 6
 Speaker Out 6
 Filtered Audio Out 6
 Input Level Adjust 7
 Receive Audio In..... 7
 To Radio and To TNC..... 7
 Front Panel 8
 AGC On-Off..... 8
 Program..... 8
 Custom Tunable/Pre-Set Filters 8
 Filters..... 9
 Tunable Filters 9
 Notch ON - OFF 9
 Notch AUTO - MANUAL..... 9
 Noise Reduction 10
 Noise Reduction On - Off 10
 Volume 10
 Power On - Off..... 10
 FILTER IN - FILTER OUT 11
 Filter Description..... 12
 LR/HR [1] 12
 LR/HR [1] (Bandstop) 12
 BP [2] 13
 2BP [3] 14
 CW [4] 14
 SSB [5]..... 15
 RTTY [6] 16
 HF PACKET [7] 16
 AMTOR [8] 16
 PACTOR [9]..... 16
 SSTV/ FAX/ WeFAX [10]..... 17
 NOTCH 17

DSP Operation..... 18
 Initial Operation 18
 CW Operation..... 19
 SSB Operation 20
Custom Filters 21
 Programming a Custom Filter 22
Jumper Settings..... 24
 CW Sidetone Filter Settings 24
 DATA Default 24
In Case of Difficulty 26
Technical Assistance 26

MFJ-784 *tunable* DSP Filter

The **Filter Specifications** chart lists the parameters for the ten filters available on the MFJ-784. Definitions for the abbreviations used on the chart are listed below:

LR: Low Reject Cutoff Frequency fc: Center Frequency
 HR: High Reject Cutoff Frequency BW: Bandwidth
 f1: Center or Notch Frequency #1 FIR: Finite Impulse Response
 f2: Center or Notch Frequency #2 IIR: Infinite Impulse Response

Filter Specifications

Tunable Filter	Left Control	Right Control	Attenuation	Type
LRHR ¹	LR: 200-2200 Hz	HR:1400-3400 Hz	60 dB @ 74 Hz outside passband	FIR linear phase
BP	fc: 300-3400 Hz	BW: 30-2100 Hz	50 dB @ 60 Hz outside passband	FIR linear phase
2BP ²	f1: 300-3400 Hz	f2: 300-3400 Hz	50 dB @ 60 Hz outside passband	FIR linear phase
CW ³	fc: 300-1000 Hz	BW: 30-700 Hz	50 dB @ 60 Hz outside passband	FIR linear phase
SSB ⁴	fc: 600-1700 Hz	BW:1000-2500 Hz	60 dB @ 74 Hz outside passband	FIR linear phase
Manual Notch	f1: 150-3400 Hz	f2: 150-3400 Hz	40 dB @ 95 Hz outside passband	IIR

All FIR filters have a 24 mS delay time and have the highest cutoff frequency limited to 3900 Hz.

Notes

- 1 The **LR HR** filter becomes a band-stop filter when **LR** is adjusted higher than **HR**.
- 2 The **2BP** filter uses the bandwidth setting last used in **BP** filter but allows independent variation of the two center frequencies.
- 3 The **CW** filter has an optional jumper-programmable sidetone filter, see page 22
- 4 The **SSB** filter has its lowest cutoff frequency limited to 175 Hz.

Pre-Set Filter	Mark-Space Freq.	Bandwidth	Attenuation	Type
RTTY	Jumper Programmable	250 Hz	50 dB @ 60 Hz outside passband	FIR linear phase
HF PACKET	Jumper Programmable	540 Hz	50 dB @ 60 Hz outside passband	FIR linear phase
AMTOR	Jumper Programmable	340 Hz	50 dB @ 60 Hz outside passband	FIR linear phase
PACTOR	Jumper Programmable	440 Hz	50 dB @ 60 Hz outside passband	FIR linear phase
SSTV/FAX/WeFAX	Dual filter with passbands fixed @ 1050-1350 Hz and 1450-2350 Hz	300 and 900 Hz	44 dB @ 60 Hz outside passband	FIR linear phase

- * All pre-set filters have a 24 mS delay time.
- * The data filters allow 170 or 200 Hz shift mark-space frequency; see page 24.

Interference Filter	Frequency Range	Attenuation	Type	Delay
Multiple Automatic Notch	Entire freq. range of the received audio	Up to 50 dB, varies with stability of the heterodyne	Adaptive	8 mS max.
Random Noise Reduction	Entire freq. range of selected bandpass filter	Up to 20 dB, varies with the characteristics of the noise	Adaptive & adjustable	8 mS max.

Notch Filters:

Multiple automatic notch attenuates up to 4 tones.
 Manual notch attenuates 2 separate tones with the front panel knobs.
 Automatic Notch is disabled in the following modes:
 CW, RTTY, HF PACKET, AMTOR, PACTOR, SSTV/ FAX/ WeFAX

Random Noise Reduction Filter:

Adaptive and manually adjustable algorithms provide up to 20 dB noise reduction.

Signal Processor:

Signal Processor: Analog Devices ADSP-2105
 Clock: 12 MHz
 Data Width: 16 bits

General Features:

Direct audio bypass when power switch is in "off" position.
 Audio output power is 1.2 w into 6 ohms (MFJ power supply).
 Audio frequency response is 250 to 3500 Hz (-3 dB).
 Maximum audio input at full sensitivity is 3 volts P-P nominal (190 mW 6 ohms).
 Input circuit loading is 10 K ohms nominal.

Rear Panel:

Power: 10-16 Vdc @ .35 amp peak (low "Z " audio load)
Headphones Out: 1/4" stereo (or mono) phone jack
Speaker Out: 3.5 mm mono phone jack
Receive Audio In: RCA phono jack
Input Level Adjust: screwdriver adjustable potentiometer
Filtered Audio Out: RCA phono jack (~1.5 V P-P @ 600 ohms)
To Radio: 5 pin DIN female (filtered audio out, PTT sense, receive audio in).
To TNC: 5-pin DIN female (filtered audio out, PTT sense, receive audio in).

Introduction to DSP

The MFJ-784 *tunable* DSP Filter™ uses state-of-the-art Digital Signal Processing (DSP) technology. Digital Signal Processing greatly improves signal clarity by reducing or eliminating noise (QRN) and interference (QRM). DSP technology has existed for many years but has always been very complicated and expensive. Recent advances in integrated circuits have greatly increased the processing power and reduced the size of DSP units. These same advances also lowered the cost of DSP filtering, making DSP technology affordable for the average amateur or short wave listener.

Almost any microprocessor can perform DSP, but only very fast or special-function processors perform DSP in *real time*. Therefore the heart of any DSP system is the digital signal processor. A digital signal processor is similar to the CPU in a conventional home computer, but its commands are tailored to the type of instructions used in signal processing. The use of special DSP commands allows a DSP filter function to be completed in very few clock cycles (usually one); where a typical home computer CPU would require a long set of instructions and therefore many clock cycles to perform the same function. Analog Device's ADSP-2105 16-bit processor is used in the MFJ-784.

The MFJ-784 DSP Filter converts the analog input signals from your receiver to digital information. This conversion is achieved through the sampling of the signal many thousands of times per second with an A-to-D converter. The result is a string of digital "numbers" that represent the amplitude and frequency of the analog input signal. The ADSP-2105 chip then processes the resulting digital information with different digital filter algorithms depending on which one the user selects with the front panel controls. The end result is a digitized signal with undesired signal components either reduced or removed. The processed digital signal information is converted back to an audio signal by a digital-to-analog converter and sent to the audio outputs and speaker.

Connections

The illustration below shows the DSP's rear panel connectors.

Power: The power connector connects the MFJ-784 to a 12 - 16 Vdc, 350 mA (or larger) power supply.

Headphones Out: This jack connects the MFJ-784 to your station headphones or speaker. Inserting a plug in this jack disables the SPEAKER OUT jack.

Speaker Out: This jack connects the MFJ-784 to your station speaker. A connection made to the HEADPHONES OUT jack disables this jack.

Filtered Audio Out: This jack connects the MFJ-784 to the external audio input jack of a radio or other accessory. This jack has a fixed level output independent from the DSP's volume control.

Input Level Adjust: This adjustment varies the sensitivity of all audio inputs.

Receive Audio In: This jack connects the MFJ-784 to the audio output of the radio.

To Radio: This jack supplies connections to the filtered audio output and the receive audio inputs. In addition, a connection is available for a PTT sense line to automatically bypass the filter during transmit.

To TNC: This jack supplies connections to the filtered audio output and the receive audio inputs. In addition, a connection is available for a PTT sense line to automatically bypass the filter during transmit.

Input Connections

In most cases, the MFJ-784 will be installed between the speaker or headphone audio output of the receiver and your headphones or speaker. This diagram shows the typical connections used to attach a radio to the MFJ-784. Only one of the method of connection may be used.

Output Connections

Connecting to Receive Audio

The MFJ-784 **Receive Audio In** jack connects directly to your receiver's headphones or speaker jack. A minimum of 2 volts P-P (peak-to-peak) is required for full audio output when the **Input Level Adjust** is set for maximum sensitivity.

Audio input peaks that exceed 4 volts P-P will cause distortion, especially with the AGC or noise-reduction enabled. This distortion may occur while the audio output control of the receiver is at a normal gain setting. This distortion may be minimized or eliminated by adjusting the **Input Level Adjust**. See the CW and SSB operation sections starting on page 19 to adjust the input level or receiver volume.

Power

The **Power** connector is located on the left rear panel of the MFJ-784. This connector accepts the dc input that powers the MFJ-784. The **Power** connector of the MFJ-784 accepts a 2.1 mm coaxial plug with a positive polarity center conductor. An optional dc supply, the MFJ-1315, is available from MFJ.

The MFJ-784 requires a filtered voltage of 12 to 16 Vdc with a negative ground (or ground independent) power source. The maximum current demand changes with the volume level and the impedance of the load. The maximum current demand will be less than 350 mA at maximum volume but will always be more than 175 mA. If supply voltage drops below 11 volts the MFJ-784 will enter a power down reset mode and go "dead".

WARNING: Application of reverse polarity or voltages greater than 18 volts may permanently damage the MFJ-784.

Headphones Out

The **Headphones Out** jack can be used to connect the MFJ-784 audio output to headphones or a speaker. This jack accepts a standard male 1/4 inch stereo or mono headphone plug. The tip supplies the monaural audio and the ring supplies the ground. This allows the use of either stereo or monaural headphones, or a speaker. The **Speaker Out** is disabled when a plug is inserted in the **Headphones Out** jack.

Speaker Out

The **Speaker Out** jack accepts a 3.5 mm phone plug. This jack provides the same audio output as the **Headphones Out** jack. The "hot" audio signal appears on the tip. This jack will function with either mono or stereo plugs, but only the tip will supply audio. This jack is automatically disabled whenever a plug is inserted into the **Headphones Out** jack.

Filtered Audio Out

The **Filtered Audio Out** connector is a standard RCA phono jack. A quality shielded cable should be used for connections to the **Filtered Audio Out** jack. This jack provides approximately 1.5 volts P-P into 600 ohm (or higher) impedance loads. The output voltage of this jack is not affected by DSP volume control knob adjustment. The voltage level at the **Filtered Audio Out** jack is dependent on the receiver's audio output level when the DSP's **AGC** is turned "off" or if the DSP is bypassed. When the **AGC** is operating the voltage will remain nearly constant at 1.5 volts P-P.

Input Level Adjust

The **Input Level Adjust** controls the sensitivity of the MFJ-784 receive audio and the audio input pins (pin 4) of the DIN connectors. Proper adjustment is achieved if the receiver volume control can be set at the normal setting without overdriving the DSP (with the **AGC** and/or the noise reduction operating). The DSP's volume should barely change as the **AGC** is turned "on" or "off". The chart below describes symptoms that will appear if the input level is adjusted to an incorrect level. See the CW and SSB operation sections starting on page 19 to adjust the input level or receiver volume.

Symptom	Line Level Adjustment
turn AGC "off", volume decreases slightly	No Adjustment
turn AGC "off", volume decreases significantly	Increase
turn AGC "on", volume increases significantly	Increase
audio distortion	Decrease
cracking or popping on signal peaks	Decrease

Receive Audio In

The **Receive Audio In** connector is a standard RCA phono jack. A shielded cable should be used to connect the **Receive Audio In** connector to the station receiver. This jack should be driven with a minimum of 2 volts P-P, and no more than 3.5 volts P-P unless the setting of the **Input Level Adjust** is reduced (counterclockwise adjustment from rear view). This jack has an impedance of approximately 10,000 ohms, and is normally connected to the receiver's speaker or headphones output.

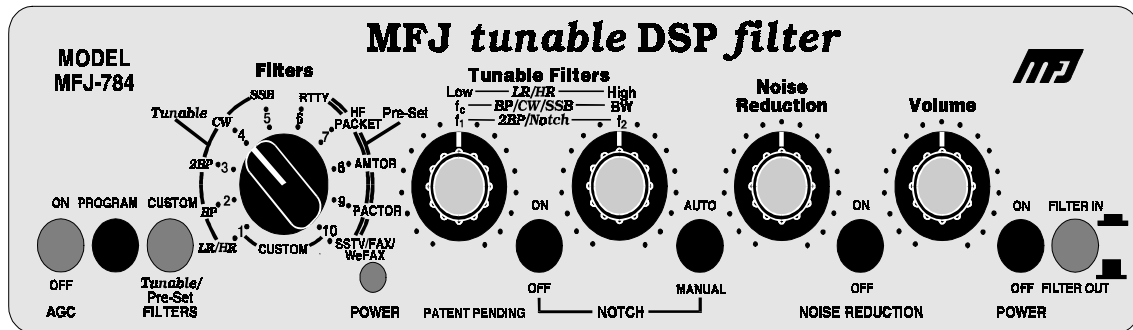
To Radio and To TNC

The **To Radio** and **To TNC** ports are standard ports used by MFJ products. These ports allow the DSP unit to be connected to MFJ or other brands of TNC without disturbing the speaker or headphone connections. These ports can be connected to virtually any radio with one of the pre-assembled MFJ-50xx series cables (available from MFJ). Each cable in this series is wired for a specific brand of radio.

The **To Radio** and **To TNC** ports also provide connections to the PTT line input. All signal processing functions are bypassed when this line is pulled low. Pulling the PTT line low allows the transceiver's sidetone and audio monitoring functions to appear at the DSP output without modification. The PTT line has a blocking diode to prevent other equipment connected to the PTT line (such as a linear amplifier) from damaging the DSP. Refer to the CW section starting on page 14 for a description of PTT configuration.

WARNING: Never connect the PTT line to negative voltages or to positive voltage sources that exceed 35 volts. If a linear amplifier is connected to the PTT line, a blocking diode (1N4001 or equivalent) should be connected from the linear amplifier's control (relay) jack to the PTT line. This diode prevents the amplifier from loading the DSP's PTT line when the amplifier is turned "off". The anode of the diode should be connected to the amplifier and the cathode (banded end) to the PTT line.

Front Panel



Eight push buttons, 5 knobs and one LED are present on the front panel of the MFJ-784 DSP unit. The following section will help you become familiar with the various functions of these items. These controls are explained as they appear from left to right on the panel.

AGC On-Off

This push-button switch controls the automatic gain control (**AGC**). The **AGC** will maintain the same DSP audio output level if the input signal level changes less than 18 dB (0.5 to 3.9 volts P-P).

*Note: If the audio-input level from the receiver is too high the audio will distort on voice peaks. This is especially true when the **AGC** is being used. If you turn the **AGC** "off" and the DSP volume drops greatly the input level is too low. Page 19 describes input level adjustment.*

Program

This non-latching push-button is used in conjunction with the **Custom Tunable / Pre-set FILTERS** button. Pushing this momentary contact switch saves the last filter setting used into the current **Filters** switch position (1-10).

Refer to page 22 for a thorough description of filter programming.

Custom Tunable/Pre-Set Filters

This push-button switch selects either the 5 tunable filters (LR-HR, BP, 2BP, CW, and SSB) or the 5 preset filters (RTTY, HF PACKET, AMTOR, PACTOR, SSTV/ FAX/ WeFAX) in the "out" position, or up to 10 custom user-programmed filters (1-10) in the "in" position.

Filters

This rotary switch selects any one of the 5 tunable filters (LR-HR, BP, 2BP, CW, and SSB) or 5 preset filters (RTTY, HF PACKET, AMTOR, PACTOR, SSTV/ FAX/ WeFAX) with the **Custom Tunable/Pre-Set FILTERS** switch in the "out" position, or one of the 10 available user-programmed (custom) filters (1-10) with the **Custom Tunable/Pre-Set FILTERS** switch in the "locked" position. See the *Filter Description* section on page 13 for detailed information..

Tunable Filters

The **Tunable Filters** controls adjust the center frequency and the bandwidth of the various filters. The following chart lists the adjustment made by each control in the different filter modes.

Mode	Left Control	Right Control
LR/HR	lowest freq. limit	highest freq. limit
BP	center freq.	bandwidth *
2BP *	center freq. 1	center freq. 2
CW	center freq.	bandwidth
SSB	center freq.	bandwidth
NOTCH (manual only)	notch freq. 1	notch freq. 2

* 2BP Bandwidth is set with the BP bandwidth control

*Note: The **manual notch** function uses the same controls (knobs) as the filters. Therefore any time the manual notch is being used, the adjustable filters cannot be changed.*

Notch ON - OFF

This locking push-button switch enables (in) or disables (out) the notch function. Up to four frequencies may be notched in the **AUTO** mode. Two frequencies can be manually notched in the **MANUAL** mode. The attenuation of the notch filter can be as great as 50 dB in the automatic mode, and 40 dB in the manual notch mode. The automatic notch filter is disabled in the following **Filters** switch positions: CW, RTTY, HF PACKET, AMTOR, PACTOR, and SSTV/FAX/WeFAX.

*Note: If the DSP fails to process properly with the **Notch "on"** the input level may be adjusted incorrectly. See page 19 to adjust the input level.*

Notch AUTO - MANUAL

The AUTO - MANUAL locking push-button switch selects either the two manual notch adjustments (out position) or the automatic notch filters (in and locked position). The **Tunable Filters** controls are used to adjust the notch frequencies when the AUTO - MANUAL switch is in the MANUAL position. The **Tunable Filters** knobs will vary each notch frequency from 150 to 3400 Hz. The manual notch bandwidth is 275 Hz at -3 dB, and 85 Hz at -40 dB. Since the manual notch uses the **Tunable Filters** controls to adjust the notch frequency, the filter selected by the **Filters** switch must be properly adjusted before engaging the manual notch. The MFJ-784 will "remember" the **Tunable Filters** setting at the moment the manual notch is engaged, and the **Tunable Filters** controls will adjust the manual notch frequencies.

Note: The DSP chip remembers the filter knob settings from the moment the notch is activated until the notch is turned off and the knobs are moved. The instant any filter knob is moved, the filter will jump to new position of all the knobs. .

In the AUTO (in) position, a multiple automatic notch searches for heterodynes or steady tones and nulls them. The automatic notch will not function in any of the following **Filters** switch positions: CW, RTTY, HF PACKET, AMTOR, PACTOR, and SSTV/FAX/WeFAX.

NOTE: *The automatic notch will not recognize interference that varies rapidly in frequency or amplitude. This is because the filter must ignore rapid amplitude and frequency changes to avoid nulling or distorting voices. If the automatic notch distorts voice use the manual notch filter. The manual notch causes less distortion of voice modes.*

Noise Reduction

This knob varies the noise reduction level. Maximum noise reduction is available in the full clockwise position, where random noise can be attenuated up to 20 dB (depending on the characteristic of the noise). This algorithm uses both adaptive and adjustable LMS (Least Mean Square) algorithms.

Some echo or hollowness will be present due to phase delay and the algorithm's effect on voices. This is a normal unavoidable characteristic of this function. The effects are less noticeable as the reduction level is decreased.

Noise Reduction On - Off

This push-button switch turns the noise reduction ON (in) or OFF (out). The noise reduction functions in all filter modes.

Note: If the audio input level from the receiver is too high the audio will distort on audio peaks. This is especially true when the noise reduction is being used. If the DSP fails to process properly with noise reduction the input level may be too low. See page 19 to adjust the input level.

Volume

The Volume knob controls the gain of the internal audio amplifier, and adjusts the audio output available at the Headphones Out and the Speaker Out jacks. The Volume knob does not adjust the audio output level at the **Filtered Audio Out, To Radio, and To TNC** ports.

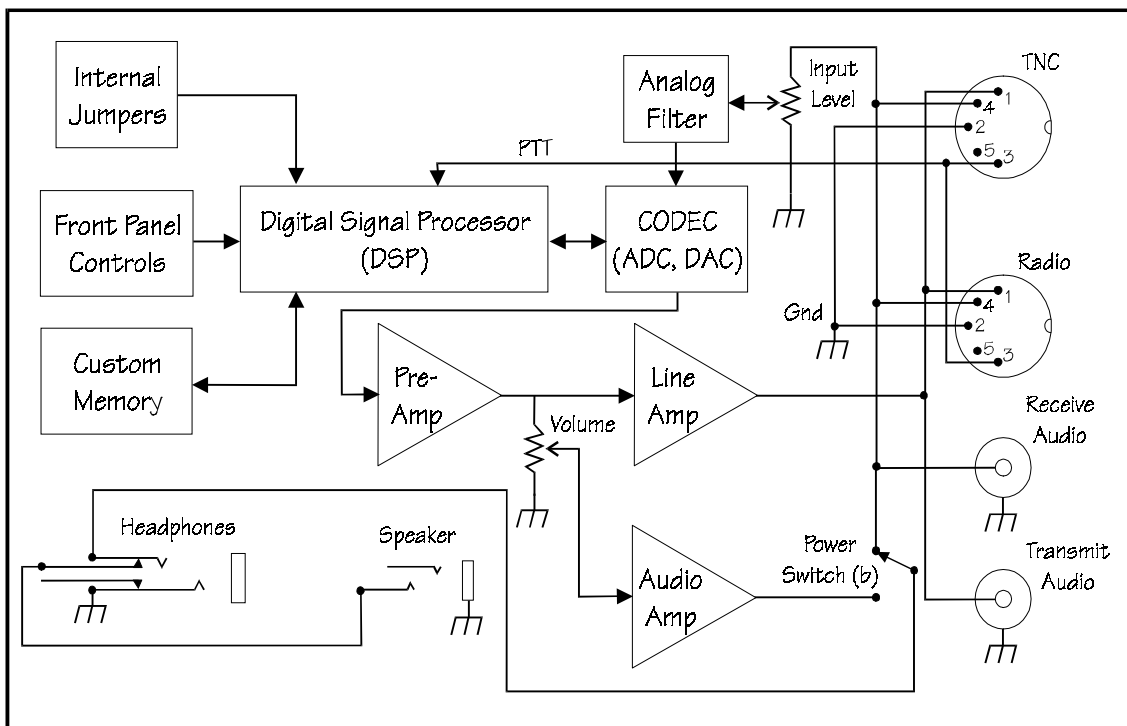
Power On - Off

This push-button switch controls the main dc power to the internal DSP electronics. When the **Power** switch is in the "off" position, the **To Radio** port, the **To TNC** port and the **Receive Audio In** connectors are connected directly to the **Headphones Out** and **Speaker Out** jacks. Also, the audio output lines at the **Filtered Audio Out** jack and the **To Radio** and **To TNC** ports are "dead."

FILTER IN - FILTER OUT

This push-button switch either processes the audio (**Filter In**) or routes the audio through the DSP electronics without any digital signal processing (**Filter Out**). Non-processed audio is available at all audio outputs when this switch is in the "out" position. Also the audio output voltage will no longer be a constant 1.5 V P-P because the internal digital **AGC** is not operating.

DSP Block Diagram



Filter Description

The following section describes in detail the filters available in the various **Filters** switch positions. All graphs of the following filters show a line at the noise floor of -55 dB. The response for these digital filters is typically much deeper than -55 dB but circuit noise will generally mask any response below that point.

LR/HR [1]

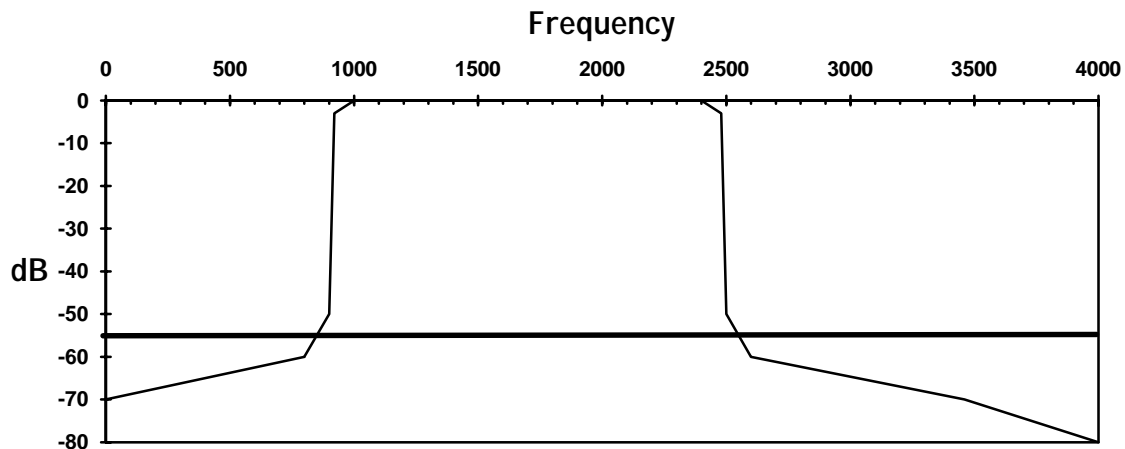
Use: Custom Voice, FSK, Wide CW Filter.

Passes medium to wide frequency width.

This position selects an adjustable low reject/high reject filter. The low reject filter (left knob) removes all signals below a user-selected frequency. The low reject filter cutoff frequency can be varied between 200 Hz and 2200 Hz with the left-hand **Tunable Filters** knob. The high reject filter (right knob) removes all signals above the selected frequency. The high reject limit is adjustable between 1400 and 3400 Hz with the right hand **Tunable Filters** knob.

For example: If the low reject filter is adjusted to 900 Hz, and the high reject filter is adjusted to 2500 Hz, all frequencies below 900 Hz and above 2500 Hz will be rejected. In this case, the DSP filter will only pass frequencies from 900 Hz to 2500 Hz.

Typical Low Reject/High Reject Filter Response



LR/HR [1] (Bandstop)

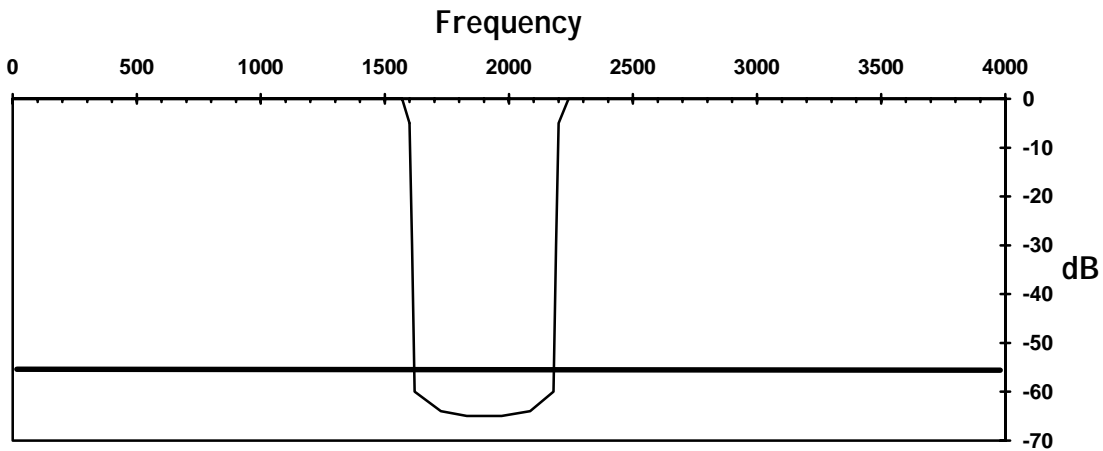
Use: Rejecting broad or variable frequency signals between 1400-2200 Hz in all modes. Removes medium to wide frequency width.

When the low reject **Tunable Filters** knob is adjusted to a frequency higher than the high reject **Tunable Filters** knob, the filter removes all frequencies between the two filter settings, and passes all frequencies outside the settings of the two filters. This special filter is called a *band-stop* filter. A bandstop filter makes a "hole" in the middle of the frequency range, and passes everything on either side of the "hole."

For example: If the low reject filter is adjusted to 2200 Hz and the high reject filter is adjusted to 1600 Hz, all frequencies between 1600 Hz and 2200 Hz will be removed. This creates a hole with a 600 Hz bandwidth.

See below for a graph of a band-stop filter.

Typical Bandstop Filter Response



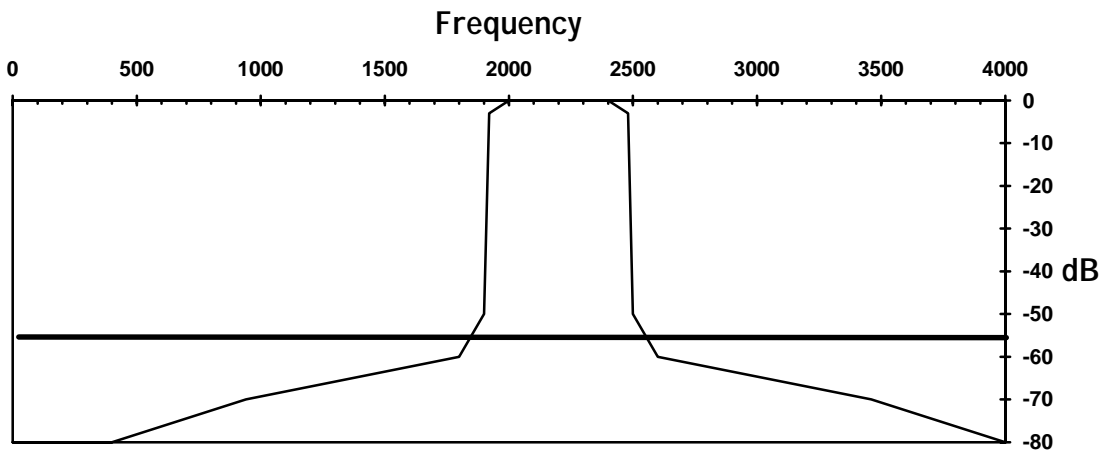
BP [2]

Use: Custom Voice, FSK, Custom CW Filter.

Passes narrow to wide frequency width.

This filter is an adjustable bandpass filter. The bandwidth is controlled by the right **Tunable Filters** knob. This adjustment is similar to the selectivity control on a receiver. It can be adjusted from 30 to 2100 Hz. The left **Tunable Filters** knob varies the center frequency between 300 and 3400 Hz. This adjustment is very much like the pass band tuning or IF shift control on high quality receivers.

Typical Bandpass Filter Response



2BP [3]

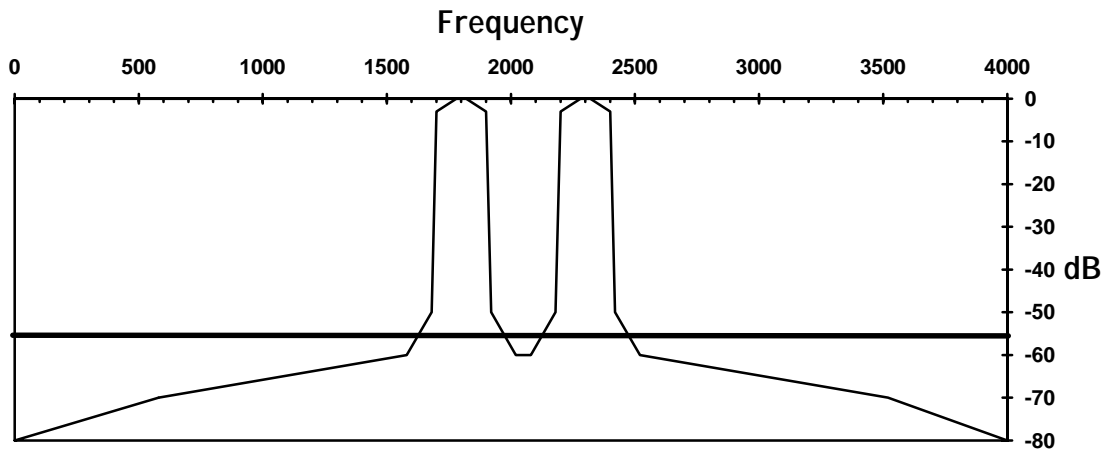
Use: Custom Voice, FSK, Dual Pitch CW Filter.

Passes 2 separate narrow to wide frequency width.

This position allows the use of two frequency-independent variable bandpass filters in parallel. The left and right **Tunable Filters** knobs control the individual center frequencies of the filters.

Each filter has the same bandwidth. The **2BP** position uses the bandwidth setting from the **BP** filter. The bandwidth can be adjusted by switching to the **BP** position and adjusting the right-hand **Tunable Filters** Knob (see the **BP** section).

Typical Dual Bandpass Filter Response



*Example: The **Filters** knob may be placed in the **BP** position and the right **Tunable Filters** knob adjusted to 200 Hz of bandwidth. When the **2BP** filter will now have two filters available, with the left **Tunable Filters** knob controlling the center frequency of a 200 Hz filter and the right **Tunable Filters** knob controlling the center frequency of a second 200 Hz filter.*

CW [4]

Use: CW Filter, Narrow FSK.

Passes "razor sharp" to medium frequency width.

*Note: The automatic notch function is disabled when the filter is in the **CW** mode.*

The **CW** position of the **Filters** switch provides an adjustable bandpass filter that can be varied over the normal frequency range preferred by most CW enthusiasts. The center frequency (or pitch) is controlled by the left **Tunable Filters** knob, and has a frequency range of 300 to 1000 Hz. This **Filters** knob functions similarly to the pass band tuning or the IF shift control of a receiver.

The right **Tunable Filters** knob adjusts the filter bandwidth from 30 to 700 Hz. This knob acts exactly like the selectivity control on a receiver. Note that as the bandwidth of this filter approaches the on-off rate of the dot and dashes, some ringing may appear. This is an inherent characteristic of any filter when the bandwidth approaches the on-off rate. When this filter is operated using a very narrow bandwidth, some ringing or softening is inevitable. To minimize ringing use the maximum bandwidth possible.

The operator may prefer to listen to a tone that is different than the sidetone of the transmitter. In this situation, the filter may not pass the sidetone and the operator may not be able to monitor his sending. There are two methods of correcting this problem.

The first (preferred) method for passing sidetone is to ground the PTT line (pin 3 on either rear panel DIN connector) during transmission. This procedure will bypass the DSP and pass any sidetone frequency. Refer to the **To Radio** and **To TNC** section on page 7 for PTT hardware requirements.

The second (less preferred) method for passing sidetone involves activating and setting a special internal CW sidetone filter. The CW sidetone filter is a totally separate, jumper programmed, constant frequency filter. This option makes the DSP function with two separate parallel filters. One filter is the standard adjustable CW filter and the other is the fixed frequency (sidetone) filter. This method has the advantage of not requiring a PTT connection, but the disadvantage of allowing unwanted signals to feed through if they happen to be within 30 Hz of the sidetone frequency. To enable the CW sidetone filter, internal jumpers must be set to the sidetone frequency of your radio. Refer to page 24 for a description of jumper settings. The center frequency of the sidetone filter ranges from 300 to 1000 Hz in 50 Hz increments. The bandwidth of the sidetone filter is fixed at 50 Hz.

SSB [5]

Use: All Voice modes, FSK, CW Filter.

Passes medium to wide frequency width.

The SSB filter is a bandpass filter with an adjustable center frequency range of 600 Hz to 1700 Hz. The right tunable filters knob adjusts the bandwidth from 1000 Hz to 2500 Hz. The actual filter response is limited internally to a minimum of 175 Hz.

While some voice transmissions may be understandable with only 1000 Hz of bandwidth if the center frequency is properly adjusted, the majority of stations will be copied best with the controls nearly centered. The optimum center frequency and bandwidth setting will be determined by the transmitting operator's voice, the transmitter's response, the receiver's response, any noise or QRM, and/or the receiving operator's hearing.

The operator may prefer to monitor himself in the transmit mode. The PTT line available at the TNC and Radio connectors (pin 3), can be grounded by the transmitter's external control line to cause the DSP to bypass all filters when

transmitting. This will prevent the DSP from delaying or distorting the monitored audio.

RTTY [6]

Use: RTTY, FSK.

Passes high frequency tones with narrow frequency width.

The RTTY filter center frequency can be adjusted by moving internal jumpers. These jumper settings are detailed on page 24. The RTTY filter has a bandwidth of 250 Hz. This bandwidth offers excellent performance with standard 170 Hz shift, 45 baud RTTY signals. Under special conditions the operator may wish to use one of the adjustable bandpass filters.

HF PACKET [7]

Use: Packet, Wide RTTY, FSK.

Passes high frequency tones with medium frequency width.

The HF PACKET filter center frequency can be adjusted by moving internal jumpers. The jumper settings are detailed on page 24. This filter has a bandwidth of 540 Hz, and is the optimum filter for a 200 Hz shift, 300 baud signal. Under special conditions the operator may wish to use one of the adjustable bandpass filters.

AMTOR [8]

Use: AMTOR, Narrow PACTOR, Wide RTTY, FSK..

Passes high frequency tones with narrow frequency width.

The AMTOR filter center frequency can be adjusted by moving internal jumpers. The jumper settings are detailed on page 24. This filter has a bandwidth of 340 Hz. This is the optimum filter for 200 Hz shift, 100 baud data. Under special conditions the operator may wish to use one of the adjustable bandpass filters.

PACTOR [9]

Use: PACTOR, Narrow Packet, Wide RTTY.

Passes high frequency tones with medium frequency width.

The PACTOR filter center frequency can be adjusted by moving internal jumpers. The jumper settings are detailed on page 24. This filter has a bandwidth of 440 Hz. This is the optimum filter for 200 Hz shift, 200 baud data. Under special conditions the operator may wish to use one of the adjustable bandpass filters.

SSTV/ FAX/ WeFAX [10]

Use: Slow Scan, Facimile.

Passes 2 seperate frequency ranges, one narrow and one wide frequency width.

This filter is a dual bandpass filter that allows two separate frequency groups to pass through the filter. The first filter is pre-set to pass frequencies between 1050 and 1350 Hz. The second filter passes 1450 to 2350 Hz.

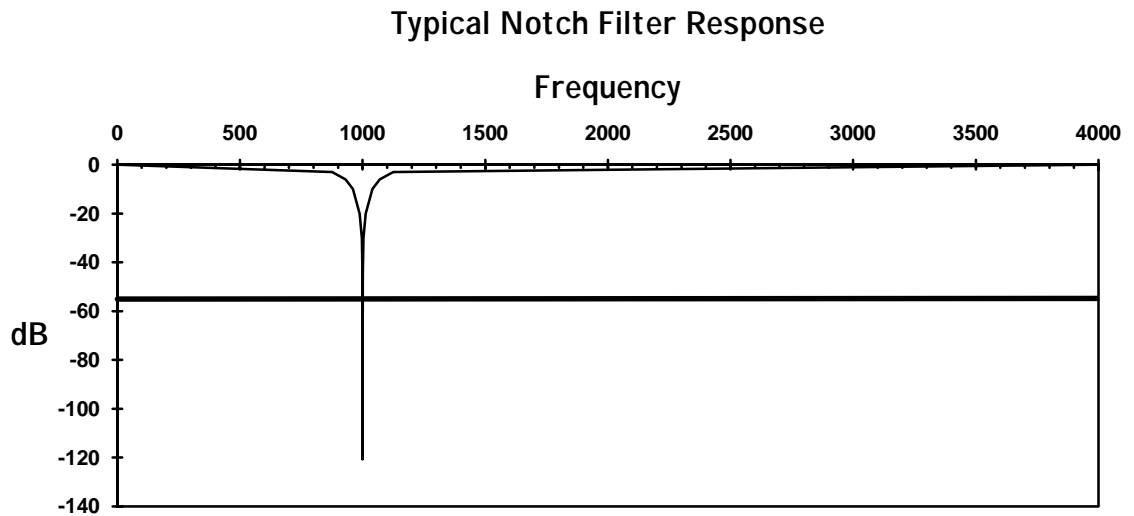
NOTCH

Use: Removes unwanted tones or heterodyne

Removes 2 to 4 very narrow frequency ranges, passes all others.

Two frequencies can be notched in the **MANUAL** mode or four can be notched in the automatic mode. The attenuation of the notch filter can be as great as 50 dB in the automatic mode, and 40 dB in the manual notch mode. The automatic notch filter is disabled in the following **Filters** switch positions: CW, RTTY, HF PACKET, AMTOR, PACTOR, and SSTV/FAX/WeFAX.

The following graph shows the digital response of the manual notch filter.



DSP Operation

Initial Operation

Connect the MFJ-784 as outlined earlier in the section Installations on page 4. Set the controls as follows to prepare the unit for operation.

AGC:	OFF (out)
PROGRAM:	N/A
FILTERS:	Tunable / Pre-Set (out)
Filters:	CW
Tunable Filters:	both knobs in center of range
NOTCH:	ON/OFF switch to off (out)
NOTCH:	AUTO/MANUAL to auto (in)
Noise Reduction:	minimum (full counter clockwise)
NOISE REDUCTION:	on/off switch to off (out)
Volume:	minimum (full counter clockwise)
Power:	OFF (out)
Filter In -Bypass:	out (bypass)

Warning: Damage or improper operation may occur if the polarity, current or voltage of the supply is incorrect. See the power supply section on page 6. Never assume your power supply is correct without checking.

The external power supply should be connected and on. The headphones or speaker should be connected to the output jack. Be aware that whenever a plug is inserted in the headphone jack, the speaker jack will be disconnected.

The MFJ-784 should be "powered up" by depressing the **POWER OFF/ON** button. During this initial operational phase, the front panel LED will glow *red*. The red glow indicates the normal filter modes are selected. The front panel LED will glow *green* if the custom filters are selected. Press and release the **Filters** button if the front panel LED is green.

This DSP unit provides the unique ability to customize filters for many different applications. For example, while most other filters only provide one pass frequency on CW, this filter is continuously adjustable from 300 to 1000 Hz tones. Instead of limiting the bandwidth to two or three pre-determined settings, the MFJ-784 allows the user to adjust the bandwidth continuously between 30 and 700 Hz.

CW Operation

This operational example demonstrates how the CW filter operates and helps adjust the audio from the station's receiver to the proper drive level for the DSP.

A CW station should be tuned in with comfortable levels of pitch and volume. Next, engage the **FILTER IN - FILTER OUT** push button, and adjust the **Volume** control of the DSP to a comfortable setting. Make sure the **Tunable Filters** controls are at midrange.

NOTE: Always use the DSP's volume control to adjust the volume when the DSP is "on" unless told otherwise.

- 1.) Adjust the center frequency (left Tunable Filters knob) to peak the CW signal.
- 2.) Engage the AGC by pressing and locking the **AGC** button. Adjust the DSP's volume control to a comfortable level. Adjust the *receiver's* volume control until the DSP's audio output is slightly weaker when the **AGC** is disengaged (out).

*Note: If the audio input level from the receiver is too high, the audio may distort on peaks. This is especially true when the **AGC** and **Noise Reduction** are being used.*

- 3.) With AGC "on", switch the DSP's **FILTER IN - FILTER OUT** button ON(in) and OFF(out) to confirm that the signal is slightly louder with the DSP engaged. The signal should have slightly less volume with the DSP bypassed.
- 4.) If the *receiver's* volume control is now set abnormally low, advance it to a more normal setting. Adjust the rear panel **Input Level Adjust** with a small flat-bladed screwdriver until turning the **AGC** off only slightly reduces (and ON slightly increases) the DSP's audio output. This adjustment can be confirmed by repeatedly engaging and disengaging the DSP (with the DSP's AGC on). The audio level should barely decrease with the filter bypassed.
- 5.) Adjust the bandwidth (right Tunable Filters knob) to the desired bandwidth or selectivity. Note that the desired signal will become clearer (less noise and QRM) as the selectivity is increased. The frequency control may have to be readjusted at high selectivity if it wasn't centered in step 1.
- 6.) Place the DSP filter in the **FILTER OUT** position, and adjust the receiver until a frequency is found that has several CW signals audible at the same time. When the DSP filter is placed back in line (**FILTER IN**), the **Tunable Filters** knobs can be adjusted to select one signal at a time. Careful adjustments to the DSP filter's center frequency (with moderate or high selectivity), may allow the user to find perfectly readable signals that are undetectable without the filter.
- 7.) Experiment with the **NOISE REDUCTION** and the **Tunable Filters** controls in the CW mode to become familiar with the function and effects of these controls.

Note: You may have to set a filter or ground PTT to monitor yourself. See page 15.

SSB Operation

The example in this section demonstrates the basic SSB filter functions, and allows for further confirmation of the station receiver audio level adjustments. Place the **DSP Filters** switch in the SSB mode and turn the **AGC** and **NOISE REDUCTION** off. Place the **FILTER IN - FILTER OUT** switch in the BYPASS position (out).

Tune in a SSB station with normal pitch and volume. Press and lock the **Filter In - Filter Out** button. Adjust the Volume control of the DSP to a comfortable volume setting.

NOTE: Always use the DSP's volume control to adjust the volume when the DSP is "on" unless specifically told otherwise.

- 1.) Adjust the center frequency (left **Tunable Filters** knob) and the bandwidth (right **Tunable Filters** knob) to peak the SSB signal for maximum intelligibility.
- 2.) Engage the **AGC** by pressing and locking the **AGC** button. Adjust the DSP's volume control to a comfortable level. Adjust the *receiver's* volume control until the DSP's audio output is only slightly weaker when the **AGC** is disengaged.
- 3.) Turn the DSP's **FILTER IN - FILTER OUT** button ON (in) and OFF (out) to confirm that the signal is just slightly louder with the DSP engaged than it is with the DSP bypassed.
- 4.) If the *receiver's* volume control is set abnormally low, advance it to a normal setting. Adjust the rear panel **Input Level Adjust** with a small flat-bladed screwdriver until turning the **AGC** off barely reduces the DSP's audio output. This adjustment can be confirmed by disengaging the DSP (with the DSP's AGC on). The audio level should barely decrease with the filter bypassed.

*NOTE: Some compromise may be required if the receiver does not maintain the same audio level on different modes. Set the **Audio Level Adjust** on the DSP for the most common mode, and use the receiver's volume knob to properly adjust the level when switching modes.*

- 5.) You will find that the desired signal becomes clearer (less noise and QRM) as the selectivity is increased and the center frequency is readjusted.
- 6.) Place the DSP filter in the BYPASS mode. Adjust the receiver until you find a frequency that has CW or other any other tone audible with a SSB signal.
- 7.) Place the filter back in line with the **FILTER IN - FILTER OUT** push button. Press and lock the **NOTCH ON** and the **NOTCH AUTO** buttons. The interference should disappear or be greatly reduced.

NOTE: The automatic notch will not recognize signals that vary rapidly in frequency or amplitude, because the filter must ignore rapid amplitude and frequency changes to avoid nulling or distorting voices. If the automatic notch distorts voice use the manual notch filter. The manual notch causes less distortion of voice modes.

- 8.) Experiment with different filter adjustments and functions under various conditions to become familiar with the various controls.

*Note: If the audio input level from the receiver is too high the audio may distort on voice peaks. This is especially true when the **AGC** and **Noise Reduction** are being used. If the audio input level is too low, the automatic notch and the noise reduction may not function properly.*

Note: You have to ground PTT to monitor yourself. See page 15.

Custom Filters

The MFJ-784 can store up to 10 custom filters in non-volatile memory. The custom filters store all front panel settings from the "**Filters**" selection knob on the left, to the "**Noise Reduction**" push-button on the right plus internal jumper settings.

The filters stored in memory can not be adjusted. Only the **AGC On - Off**, **Power On - Off**, **Volume**, and **Filter In - Filter Out** functions are adjustable when in the **Custom** mode.

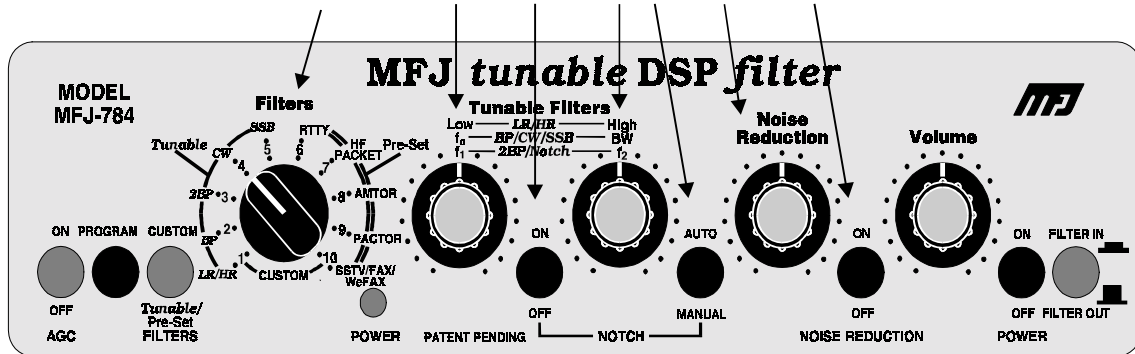
Each position of the **Filters** switch can select a custom filter for a total of 10 filters. These filters are selected with the "**Custom Tunable/Pre-set Filters**" push-button. To program a filter follow the procedure below. It is not necessary to "erase" an old custom filter. Old filters are erased when a new filter is programmed over them.

The jumper settings for the data modes and internal CW sidetone filter are also stored in the programmable filters. If you have several different mark-space frequencies that you will be using, you only have to take the cover off once to set all of the filters. Set the jumpers to a mark-space frequency and program a filter. Program the next programmable filter with another mark-space frequency, etc.

Programming a Custom Filter

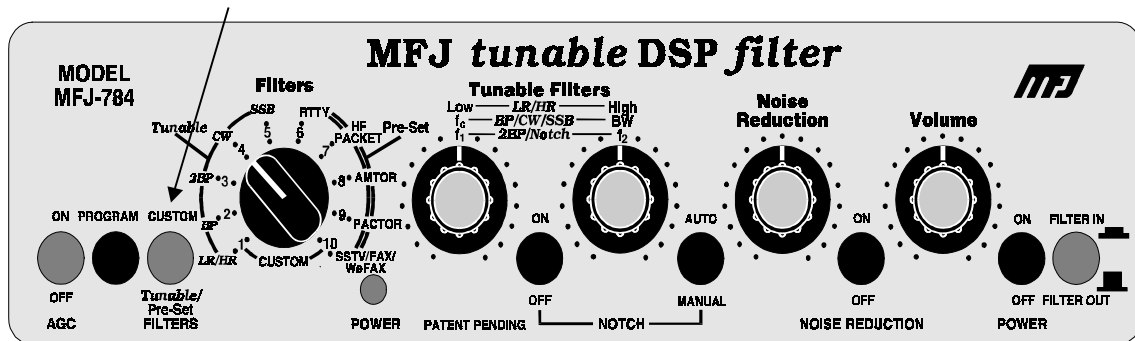
A custom filter is stored with the following steps:

- 1.) Select the filter mode and the control settings that you want to store.



LED is Red

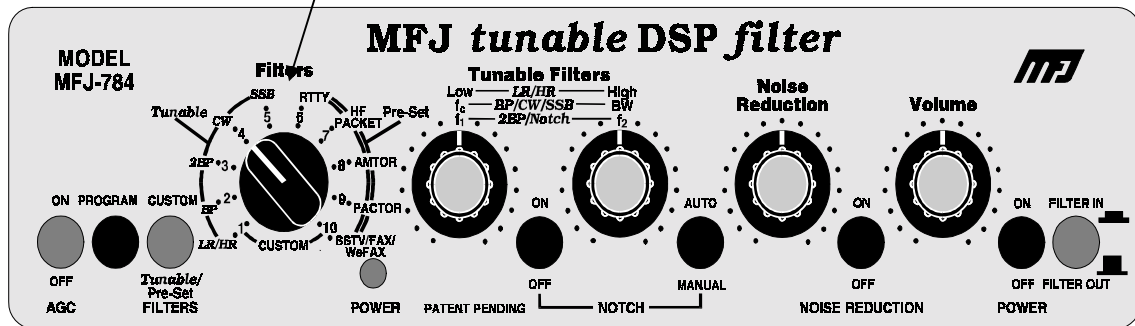
- 2.) Enter the "custom" mode by pressing and locking the CUSTOM Tunable/Pre-Set FILTERS button in the CUSTOM position. The power indicator should now turn green, indicating custom mode, and your new filter will be stored in temporary memory until it is programmed into a nonvolatile filter setting (1-10).



LED is Green

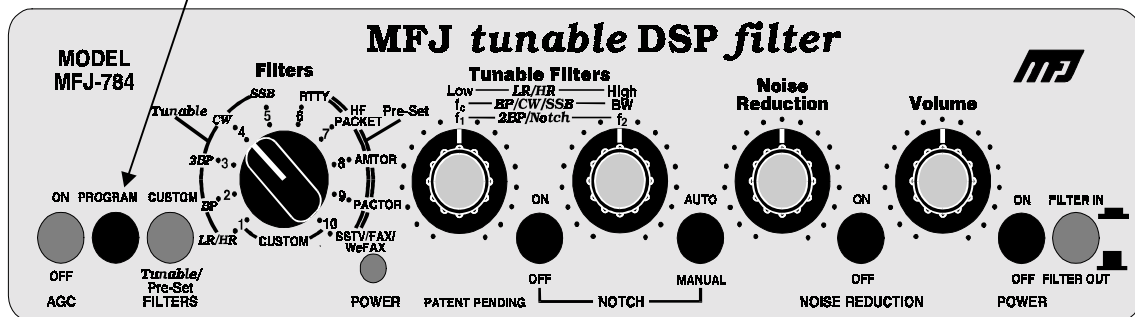
NOTE: When you enter the "Custom" mode, the active filter will be set to the old custom filter until you program the new filter (at step 4). From step 2-4 your filter may not appear to work because the filter position (1-10) is still set to the old custom filter.

- 3.) Turn the **Filters** knob to the position where the new settings are to be stored.



LED is Green

- 4.) Press and hold the **PROGRAM** momentary push button. The power indicator will light *red* and the DSP will beep within one second. Release the **PROGRAM** button. This **Filters** position [1-10] will now operate with these settings whenever the **CUSTOM** mode is selected.



LED is Red while Program button is held.

Jumper Settings

The MFJ-784 has provided the user with the ability to enable and set the CW sidetone filter frequency, jumpers 1 through 4, and to change the data mode mark-space frequencies (RTTY, HF Packet, AMTOR, and PACTOR), jumpers 5 through 7, by removing the cover and moving a group of plug in jumpers. Jumper eight is not used. The jumpers are located on the circuit board next to U15. A diagram of the jumper area is shown below.

More information on jumpers settings may be found on the *JUMPER SETTINGS CHARTS* on the next page.

CW Sidetone Filter Settings

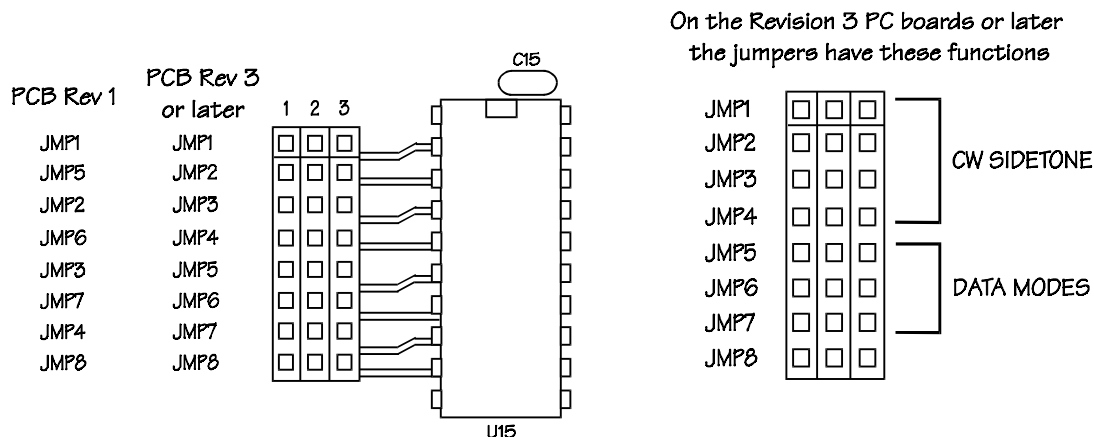
The CW sidetone filter is a jumper programmable internal constant frequency filter. It is used to pass sidetone through the DSP unit in the CW mode. Any signal within 30 Hz of the sidetone frequency will also pass through the filter.

This is not the preferred method to pass sidetone, see page 15 for the preferred method.

The DSP unit is shipped with the CW sidetone filter set to "off". To enable the CW sidetone filter internal jumpers must be set to the sidetone frequency of your radio. The center frequency of the sidetone filter ranges from 300 to 1000 Hz in 50 Hz increments. The bandwidth of the sidetone filter is fixed at 50 Hz. See the chart on the next page to set the sidetone filter.

DATA Default

The data modes are set to a default mark-space frequency of 2125-2295 and 2110-2310 Hz, with shift of 170 or 200 Hz. See the chart on the next page to set the mark-space frequency and shift to different settings.



NOTE: The chart to the left shows the position of the jumper settings area on the circuit board. The JUMPER SETTINGS CHARTS contain more detailed information on the jumper settings and how each affects the unit's operation.

In Case of Difficulty

If you experience low volume, hum only when the DSP volume control is high, or distortion:

Double check the wiring used to connect the DSP to the receiver's speaker and headphones jacks. The wiring can be tested by turning the DSP "off". When the DSP power switch is in the "off" position, the audio input jack is connected directly to the DSP's speaker and headphones jacks. If the DSP is properly connected and the wiring is good, the volume level and audio quality should be exactly the same as when the speaker or headphones is plugged directly into the receiver's speaker or headphones jacks.

If the DSP fails to process properly when using the Automatic Notch or Noise Reduction, or if the DSP audio is distorted intermittently:

The receiver's volume or the DSP's input level control may need to be adjusted. The DSP's volume should barely change as the AGC is turned "on" or "off". If you turn on the DSP's AGC and the volume increases significantly, the audio input level needs to be increased. If the signal cracks or pops on peaks, the audio input level may be too high. See page 19

If you hear hum at high or low volume:

The power supply you are using may not be filtered properly.

If the DSP won't start or shuts off intermittently:

The power supply may not be within the required 12-16 volt range. If the power supply drops below 12 volts from poor regulation or a bad connection, the DSP may go into a power down reset and go "dead". The power LED may flash erratically.

Technical Assistance

If you have any problem with this unit first check the appropriate section of this manual. If the manual does not reference your problem or your problem is not solved by reading the manual you may call MFJ toll-free at 1-800-647-TECH (8324). Outside of the continental U.S.A. call 601-323-5869. You will be best served if you have your unit, manual and all information on your station handy so you can answer any questions the technicians may ask.

You can also send questions by mail to MFJ Enterprises, INC., PO. Box 494, Mississippi State, MS 39762; by FAX to 601-323-6551 or on Compuserve at 76206.1763@Compuserve.com. Send a complete description of your problem, an explanation of exactly how you are using your unit and a complete description of your station.

FULL 12 MONTH WARRANTY

MFJ Enterprises, Inc. warrants to the original owner of this product, if manufactured by MFJ Enterprises, Inc. and purchased from an authorized dealer or directly from MFJ Enterprises, Inc. to be free from defects in material and workmanship for a period of 12 months from date of purchase provided the following terms of this warranty are satisfied.

1. The purchaser must retain the dated proof-of-purchase (bill of sale, canceled check, credit card or money order receipt, etc.) describing the product to establish the validity of the warranty claim and submit the original of machine reproduction or such proof of purchase to MFJ Enterprises, Inc. at the time of warranty service. MFJ Enterprises, Inc. shall have the discretion to deny warranty without dated proof-of-purchase. Any evidence of alteration, erasure, of forgery shall be cause to void any and all warranty terms immediately.
2. MFJ Enterprises, Inc. agrees to repair or replace at MFJ's option without charge to the original owner any defective product under warrantee provided the product is returned postage prepaid to MFJ Enterprises, Inc. with a personal check, cashiers check, or money order for **\$7.00** covering postage and handling.
3. MFJ Enterprises, Inc. will supply replacement parts free of charge for any MFJ product under warranty upon request. A dated proof of purchase and a **\$5.00** personal check, cashiers check, or money order must be provided to cover postage and handling.
4. This warranty is **NOT** void for owners who attempt to repair defective units. Technical consultation is available by calling (601) 323-5869.
5. This warranty does not apply to kits sold by or manufactured by MFJ Enterprises, Inc.
6. Wired and tested PC board products are covered by this warranty provided **only the wired and tested PC board product is returned**. Wired and tested PC boards installed in the owner's cabinet or connected to switches, jacks, or cables, etc. sent to MFJ Enterprises, Inc. will be returned at the owner's expense unrepaired.
7. Under no circumstances is MFJ Enterprises, Inc. liable for consequential damages to person or property by the use of any MFJ products.
8. **Out-of-Warranty Service:** MFJ Enterprises, Inc. will repair any out-of-warranty product provided the unit is shipped prepaid. All repaired units will be shipped COD to the owner. Repair charges will be added to the COD fee unless other arrangements are made.
9. This warranty is given in lieu of any other warranty expressed or implied.
10. MFJ Enterprises, Inc. reserves the right to make changes or improvements in design or manufacture without incurring any obligation to install such changes upon any of the products previously manufactured.
11. All MFJ products to be serviced in-warranty or out-of-warranty should be addressed to **MFJ Enterprises, Inc., 300 Industrial Park Road, Starkville, Mississippi 39759, USA** and must be accompanied by a letter describing the problem in detail along with a copy of your dated proof-of-purchase.
12. This warranty gives you specific rights, and you may also have other rights which vary from state to state.