Contents

Before Reading This Manual

The first chapter is an introduction to DSP and the MFJ-781. The second chapter tells about the back panel and how to install the unit between a radio and a multi-mode data controller. It also describes the various front panel controls. Chapter 3 is a description of the digital filters used in this unit. The last chapter is an explanation of the function of the jumpers.

The appendix has two important sections, troubleshooting and technical assistance. There is also a self-test for the unit's digital circuitry and controls. Refer to these sections if you should have any problem with your MFJ-781.

Important: ***Please read this section to become familiar with the terms and mechanics used in this manual.***

Whenever the manual text discusses a control, jack, or level adjustment, the name will appear in **Bold**; the filter mode name will be CAPITALIZED.

Example: Turn the **Filter Select** switch to CW 2 position for ...

The RTTY, AMTOR, PACTOR, and HF PACKET filters will be collectively referred to simply as the DATA filter.

Explanation of graphical symbol:

WARNING: The exclamation point within an equilateral triangle is intended to alert you of conditions that may be damaging to the product or resulting in a risk of electric shock to persons.

Introduction

Contents of This Chapter

Introduction to DSP

The MFJ-781 DSP Multimode Data 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.

The heart of any DSP system is the digital signal processor. Almost any microprocessor can perform DSP, such as the one in a personal computer, but only very fast or special-function processors perform DSP in *real time*. A digital signal processor's 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). The CPU in a typical personal computer would require a long set of instructions and therefore many clock cycles to perform the same function. Analog Device's 16-bit 12 MHz processor, the ADSP-2105, is used in the MFJ-781.

The MFJ-781 DSP Multimode Data Filter converts the analog audio signals from your receiver to digital information. This conversion is achieved by sampling the audio signal many thousands of times per second with an analog-to-digital 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 digital information with different digital filter algorithms depending on the settings of the front panel controls. The end result is a digitized signal with undesired signal components either reduced or removed and desired components enhanced. The processed digital signal information is converted back to an audio signal by a digital-to-analog converter and sent to the amplifier and line level outputs.

Product Overview

The MFJ-781 DSP Multimode Data Filter is a highly selective audio filter suitable for most amateur multi-mode applications. The MFJ-781 consists of an automatic gain control and 100 linear phase FIR (finite impulse response) bandpass filters: 32 CW filters, 64 DATA filters, and 4 fixed filters for VHF Packet, Clover, SSTV, and WeFAX.

In CW mode, there is a choice of two tone (pitch) frequencies selected with a front panel button; these frequencies are set with jumpers from among 8 different choices each. In addition, there are four bandwidths selected with the front panel switch.

In DATA mode, there is a choice of two mark-space frequency pairs selected with a front panel button; these frequency pairs are set with jumpers from among 16 different choices each (170, 200, 425 and 850 Hz shifts). In addition, there are four baud rates selected with the front panel switch, which affect the filter's bandwidth for optimal uses.

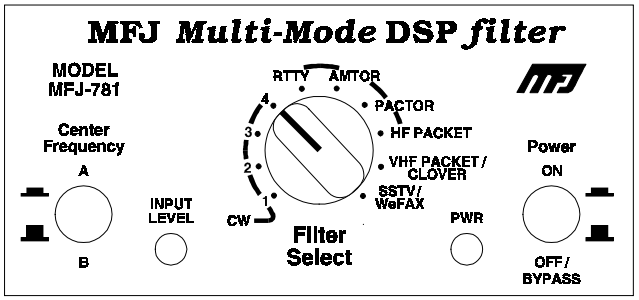
The four fixed filters are optimized filters for the corresponding data modes.

Filter Specifications

Filter[1]	Frequency	Attenuation[4]	Delay
CW[2]	Jumper-Set Center Frequency Switch-Selected Bandwidth	50 dB @ 50 Hz	29 mS
DATA[3]	Jumper-Set Mark-Space Frequency Switch-Selected Baud Rate	40 dB @ 60 Hz	19 mS
VHF PACKET	Fixed @ 500-2900 Hz	45 dB @ 75 Hz	16 mS
CLOVER	Fixed @ 1950-2550 Hz	45 dB @ 75 Hz	16 mS
SSTV	Fixed @ 1050-1325 Hz and 1475-2350 Hz	45 dB @ 75 Hz	16 mS
WeFAX	Fixed @ 1450-2350 Hz	45 dB @ 75 Hz	16 mS

Note 1: All bandpass filters are linear phase FIR (finite impulse response) filters that minimize ringing.
Note 2: The CW filter has center frequencies of 300-1000 Hz in 100 Hz increment and bandwidths of 50, 100, 200, and 500 Hz.
Note 3: The DATA filter has 16 different mark-space frequencies (170, 200, 425, and 850 Hz shifts) and baud rates of 45, 100, 200, and 300.
Note 4: All filter attenuation is indicated in dB @ a distance in Hz outside the passband.

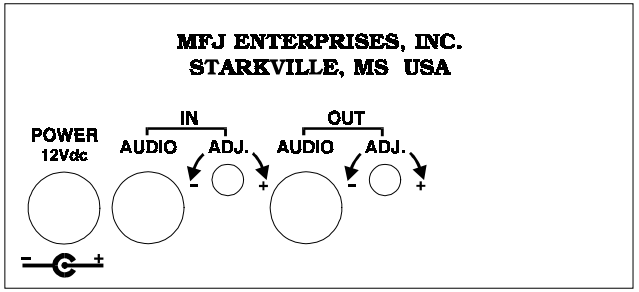
Front Panel Layout



Center Frequency button:	Selects between two center frequencies.
Input Level LED:	Indicates input signal level (red too high, off too low, green is OK).
Filter Select switch:	Selects one of ten filter modes.
PWR LED:	Indicates the power is on.
Power button:	Press to turn the power on or off.

For an in-depth description of the front panel controls, refer to chapter 2, Installation & Operation.

Back Panel Layout



Power:	10-16 Vdc @ .5 amp peak (low "Z " audio load)
Audio In:	RCA phono jack
Audio In Adjust:	screwdriver adjustable potentiometer
Audio Out:	RCA phono jack (~1.5 V P-P @ 600 ohms)
Audio Out Adjust:	screwdriver adjustable potentiometer

For an in-depth description of the back panel connections, refer to chapter 2, Installation & Operation.

Unit Specifications

General Specifications

Processor: Analog Devices ADSP-2105. Data width - 16 bits. Clock speed - 12 MHz.

Bypass: The MFJ-781 DSP filter has a direct audio bypass when power switch is in "OFF" position.

Input / Output Specifications

Audio In: This jack should be driven in a range of 1 to 2.8 volts P-P when **Audio In Adjust** is set to maximum sensitivity. When **Audio In Adjust** is set to minimum sensitivity, the DSP requires a very high input voltage. Input circuit loading is 10 K ohms nominal.

Audio Out: This jack provides approximately 1.5 volts P-P into 600 ohm (or higher) impedance loads (160 mW @ 6 ohms). The output voltage of this jack is dependent on **Audio Out Adjust**.

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Installation & Operation

Contents of This Chapter

Back Panel Connection

Power: This connector supplies power to the unit. It connects to a 2.1 mm coaxial plug with the center conductor positive and the shield ground. An optional dc supply, the MFJ-1315, is available from MFJ. The voltage should be 10-16 Vdc. **If the power supply voltage drops below 10 volts the MFJ-781 will perform erratically.**

WARNING: *Voltages greater than 18 volts or reverse polarity may permanently damage the MFJ-781.*

Audio In: This jack is normally connected to the receiver's speaker or headphones output. It is a standard RCA phono jack. A shielded cable should be used to connect this connector to the station receiver.

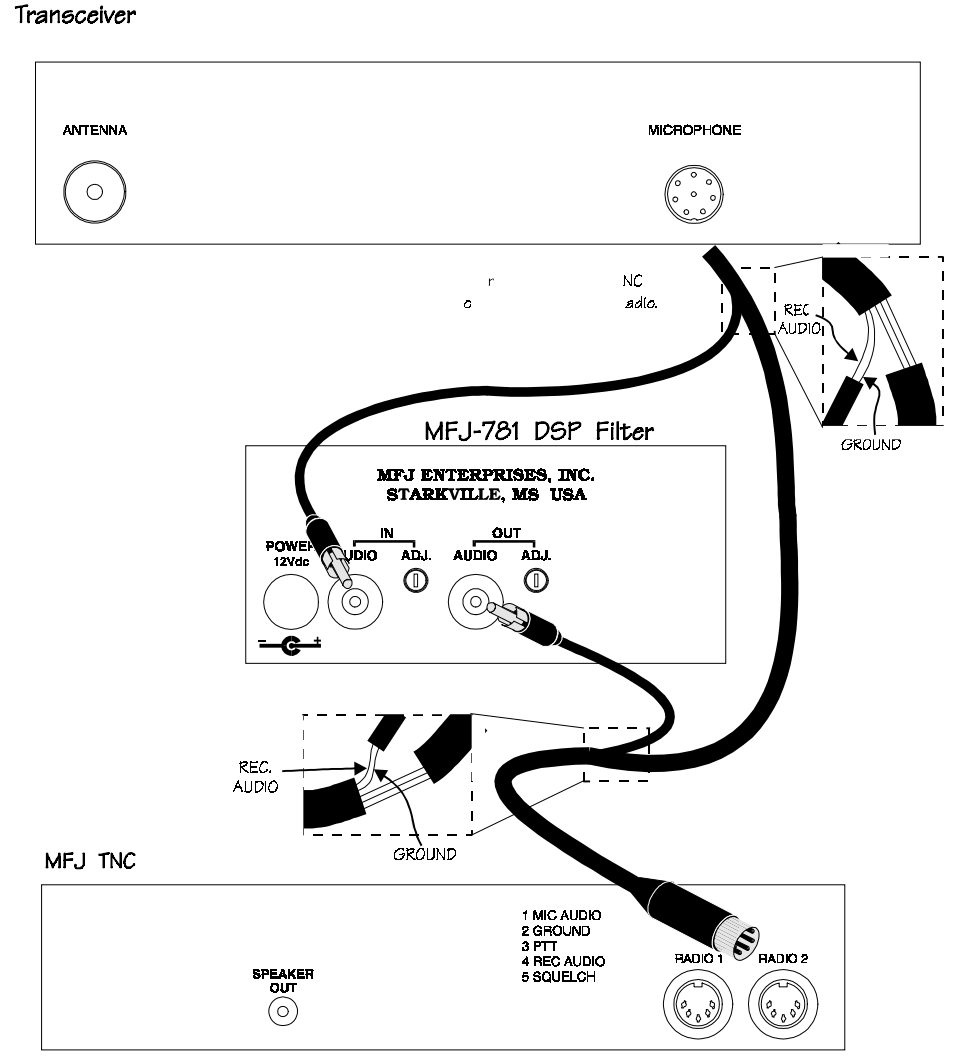
Audio In Adjust: This adjustment varies the level of the audio input to **Audio In** jack. Proper adjustment is achieved if the **Input Level** indicator flashes mostly green and never red when the receiver's volume is at normal levels. Refer to page 2-4.

Audio Out: This jack supplies line level audio for tape recorders, audio amps or multi-mode TNCs. It is a standard RCA phono jack. A quality shielded cable should be used for connection to this jack. The output level is dependent on the **Audio Out Adjust** control.

Audio Out Adjust: This adjustment varies the level of the audio output to **Audio Out** jack.

Basic Connection

The MFJ-781 is installed in the audio path between the receiver and the multi-mode controller.



Setting Audio In Level (Input Level)

When first connecting the DSP filter and whenever the receiver audio level changes, you should check the **Input Level** indicator. This LED indicates the input signal level. As a signal is received, the **Input Level** LED will flash from "off" to either green or red.

If the indicator flashes:

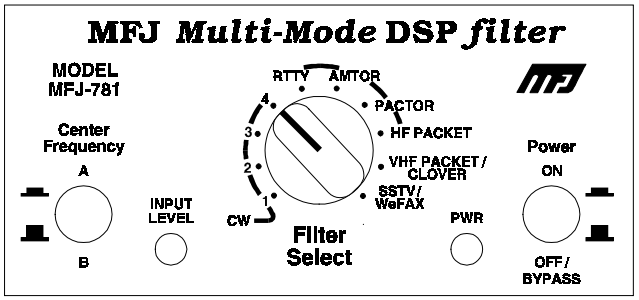
Mostly Green (never red)	the input level is adjusted correctly.
Any Red	the input level is too high.
Stays Off (or barely green)	the input level is too low.

To set **Audio In Adjust**:

1. Tune your radio to the type of signal you will be operating most.
2. Set your ***radio's*** volume control to a normal level.
3. Use a screwdriver to adjust the **Audio In Adjust** (on the back panel of the DSP) until the **Input Level** LED (on the front panel) flashes mostly green and never red.

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

Front Panel Description



The following section will help you become familiar with the operation of the DSP. The controls are explained from left to right as they appear on the panel.

Center Frequency Button
This button allows you to choose two different groups of filters with the **Filter Select** switch.

With the **Center Frequency** button "in," the **Filter Select** switch selects one of 4 CW filters, one of 4 DATA filters, the VHF PACKET filter, or the SSTV filter.

With the **Center Frequency** button "out," the **Filter Select** switch selects one of 4 CW filters, one of 4 DATA filters, the CLOVER filter, or the WeFAX filter.

Input Level LED
This LED lights two different colors, red and green. It tells you if the DSP is getting the correct audio level from the receiver.

The volume of the audio from your receiver will change with different signals. Please remember that sometimes there may be a lot of receiver audio, and sometimes there may not. For example, the station you are listening to will probably not be sending all the time, or may be fading in and out.

The use of this LED is very simple. When you are listening to a loud signal, adjust the receiver's volume control so the LED lights the most steady and brightest green possible without ever going red. If the LED doesn't light green on good signals, the receiver volume is too low for the best filter performance. With a properly designed receiver that has a good AGC circuit, you won't have to adjust the receiver volume control very often. You will only have to adjust it when (or if) the **Input Level** LED indicates improper level by flashing red or failing to light an almost steady green color. See page 2-4.

Filter Select Switch
This switch selects the bandpass filter used to process the input signal. It is used in conjunction with the **Center Frequency** button discussed on page 2-5. See the table below.

When the **Center Frequency** button is "in," the **Filter Select** switch selects one of the 4 CW filters, one of 4 DATA filters, the VHF PACKET filter, or the SSTV filter.

When the **Center Frequency** button is "out," the **Filter Select** switch selects one of 4 CW filters, one of 4 DATA filters, the CLOVER filter, or the WeFAX filter.

Chapter 3, Filter Description, gives more detailed information on each filter type available with this switch.

Filter Switch & Center Frequency Button Functions

Filter Switch Position	Center Frequency Button	
	In	Out
1	CW (A) 50 Hz Bandwidth	CW (B) 50 Hz Bandwidth
2	CW (A) 100 Hz Bandwidth	CW (B) 100 Hz Bandwidth
3	CW (A) 200 Hz Bandwidth	CW (B) 200 Hz Bandwidth
4	CW (A) 500 Hz Bandwidth	CW (B) 500 Hz Bandwidth
5	DATA (A) 45 Baud	DATA (B) 45 Baud
6	DATA (A) 100 Baud	DATA (B) 100 Baud
7	DATA (A) 200 Baud	DATA (B) 200 Baud
8	DATA (A) 300 Baud	DATA (B) 300 Baud
9	VHF PACKET	CLOVER
10	SSTV	WeFAX

PWR LED
This LED lights red to indicate the power is on.

Power Button
This button controls the power to the DSP. When this button is in the "OFF" position, the audio input is connected directly to the audio output.

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Filter Description

Contents of This Chapter

The following section describes the various filters available in the ten **Filter Select** switch positions in details.

CW Filters

Operational Modes: CW, Memory Keyer, and Modulated CW.

These filters are jumpers & switch selectable bandpass filters that can be set over the normal frequency range preferred by most CW enthusiasts. The center frequency (or pitch) is set using jumpers with choices of 300 to 1000 Hz in 100 Hz increments. The bandwidth is selected using the **Filter Select** switch with choices of 50, 100, 200, and 500 Hz.

These filters are very steep with attenuation of 50 dB at 50 Hz outside the passband and have a time delay of 29 milli-seconds.

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.

DATA Filters

Operational Modes: HF Packet, Baudot RTTY & ASCII @ 170, 200, 425 and 850 Hz Shift, AMTOR, SITOR, and NAVTEX.

These filters are jumpers & switch selectable bandpass filters that can be set among 16 different mark-space frequency pairs. The mark-space frequency pairs include 170, 200, 425, and 850 Hz shifts. The baud rate is selected using the **Filter Select** switch with choices of 45, 100, 200, and 300 bauds.

The filter's center frequency is centered between the mark and space frequencies

$$\text{center frequency} = (\text{mark} + \text{space}) \div 2$$

and the bandwidth is

$$\text{bandwidth} = (1.2 \times \text{shift}) + (\text{baud rate})$$

These filters are very steep with attenuation of 40 dB at 60 Hz outside the passband and have a time delay of 19 milli-seconds.

Default Settings for Optimum Performance of Data Modes

Filter Switch Position	Center Frequency Button	
	In[1]	Out[2]
RTTY	HF Baudot RTTY	VHF Baudot RTTY
AMTOR	AMTOR, NAVTEX, HF ASCII	VHF ASCII
PACTOR	PacTOR	-
HF PACKET	HF Packet	-

Note 1: Factory pre-set to the standard 170 Hz shift mark-space frequency of 2125-2295 Hz.
Note 2: Factory pre-set to the standard 850 Hz shift mark-space frequency of 2125-2975 Hz.

VHF PACKET Filter
Operational Mode: VHF Packet.

This filter is a bandpass filter that allows a wide frequency range to pass through the filter. The signal content (mark-space frequency pair of 1200-2200 Hz) is passed by a filter at 500 to 2900 Hz. This filter is non-adjustable and cannot be programmed to different frequencies. This filter is very steep with attenuation of 45 dB at 75 Hz outside the passband and has a time delay of 16 milli-seconds.

CLOVER Filter
Operational Mode: Clover.

This filter is a bandpass filter that allows a wide frequency range to pass through the filter. The signal content (2000-2500 Hz) is passed by a filter at 1950 to 2550 Hz. This filter is non-adjustable and cannot be programmed to different frequencies. This filter is very steep with attenuation of 45 dB at 75 Hz outside the passband and has a time delay of 16 milli-seconds.

SSTV Filter
Operational Mode: Slow Scan.

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 1325 Hz for the synch tone (1200 Hz) and the Vertical Interval Signal (VIS) tones (1100 & 1300 Hz). The picture content (1500-2300 Hz) is passed by a second filter at 1475 to 2350 Hz. This filter is non-adjustable and cannot be programmed to different frequencies. This filter is very steep with attenuation of 45 dB at 75 Hz outside the passband and has a time delay of 16 milli-seconds.

WeFAX Filter

Operational Mode: Facsimile.

This filter is a bandpass filter that allows a wide frequency range to pass through the filter. The picture content (1500-2300 Hz) is passed by a filter at 1450 to 2350 Hz. This filter is non-adjustable and cannot be programmed to different frequencies. This filter is very steep with attenuation of 45 dB at 75 Hz outside the passband and has a time delay of 16 milli-seconds.

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Jumper Description

Contents of This Chapter

Jumper Settings

Some features of the MFJ-781 are varied by internal plug-in jumpers. These jumpers are used for:

- CW mode: set tone (pitch) frequencies for the CW filters
- DATA mode: set mark-space frequencies for the data filters
- AGC control: enables / disables the automatic gain control

CW Mode

We have set the tone frequencies to the most common ones. If you wish to change from the factory defaults, you must change the jumper settings. You may set the CW filters to one of 8 tone frequencies.

Note: *DO NOT set both tones to the same frequency, because these jumper positions are reserved for future expansion and manufacturing tests.*

DATA Mode

We have set the mark-space frequencies to the most common ones. If you wish to change from the factory defaults, you must change the jumper settings. You may set the data filters to any two mark-space frequencies (or shifts). The baud rate setting, selected with the **Filter Select** switch, controls the bandwidth of the filter. Depending on conditions, it is possible to run higher baud rates than are calculated.

Automatic Gain Control

Jumper JP15 controls an automatic gain control (AGC) program. The AGC program automatically adjusts the DSP's internal gain. It tries to make all signals have exactly the same volume.

The AGC is activated by setting JP15 to the "ON" position. If the DSP is on and operating, enabling the AGC will make every signal have nearly the same volume level, if the input signal level changes less than 18 dB.

If there is a lot of noise on the signal, you may not want to use the AGC function by setting JP15 to the "OFF" position. It will increase the volume of the noise during long pauses in the signal you are listening to. That can distract you or make it difficult to copy the signal you are trying to decode.

Setting the Jumpers

WARNING: *Remove power plug from the MFJ-781 before removing the cover.*

To set the tone frequencies or mark-space frequencies:

1. Turn the power off and ***remove the power plug***.
2. Remove the unit's cover (2 screws).
3. Set the jumpers for the selected frequency according to the jumper tables on the following pages.
4. Replace the unit's cover (2 screws).
5. Reconnect the power cable and resume normal operation.

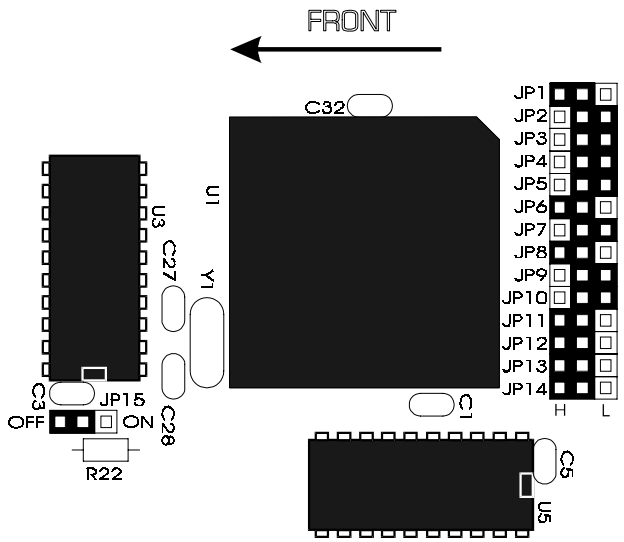
CW Mode Jumper Settings Chart

JP 1	JP 2	JP 3		Tone Freq A
L	L	L		300 Hz
L	L	H		400 Hz
L	H	L		500 Hz
L	H	H		600 Hz
H	L	L		* 700 Hz
H	L	H		800 Hz
H	H	L		900 Hz
H	H	H		1000 Hz

JP 4	JP 5	JP 6	Tone Freq B
L	L	L	300 Hz
L	L	H	* 400 Hz
L	H	L	500 Hz
L	H	H	600 Hz
H	L	L	700 Hz
H	L	H	800 Hz
H	H	L	900 Hz
H	H	H	1000 Hz

* Factory defaults

The diagram on the right shows what the jumpers should look like for the default settings.



Data Mode Jumper Settings Chart

JP 7	JP 8	JP 9	JP 10		Mark-Space Freq A (Shift)
L	L	L	L		1215-1385 Hz (170)
L	L	L	H		1275-1445 Hz (170)
L	L	H	L		1415-1585 Hz (170)
L	L	H	H		1615-1785 Hz (170)
L	H	L	L		* 2125-2295 Hz (170)
L	H	L	H		1200-1400 Hz (200)
L	H	H	L		1260-1460 Hz (200)
L	H	H	H		1430-1630 Hz (200)
H	L	L	L		1600-1800 Hz (200)
H	L	L	H		2025-2225 Hz (200)
H	L	H	L		2110-2310 Hz (200)
H	L	H	H		2125-2325 Hz (200)
H	H	L	L		1275-1700 Hz (425)
H	H	L	H		2125-2550 Hz (425)
H	H	H	L		1275-2125 Hz (850)
H	H	H	H		2125-2975 Hz (850)

JP 11	JP 12	JP 13	JP 14	Mark-Space Freq B (Shift)
L	L	L	L	1215-1385 Hz (170)
L	L	L	H	1275-1445 Hz (170)
L	L	H	L	1415-1585 Hz (170)
L	L	H	H	1615-1785 Hz (170)
L	H	L	L	2125-2295 Hz (170)
L	H	L	H	1200-1400 Hz (200)
L	H	H	L	1260-1460 Hz (200)
L	H	H	H	1430-1630 Hz (200)
H	L	L	L	1600-1800 Hz (200)
H	L	L	H	2025-2225 Hz (200)
H	L	H	L	2110-2310 Hz (200)
H	L	H	H	2125-2325 Hz (200)
H	H	L	L	1275-1700 Hz (425)
H	H	L	H	2125-2550 Hz (425)
H	H	H	L	1275-2125 Hz (850)
H	H	H	H	* 2125-2975 Hz (850)

* Factory defaults

Data Filter Center Frequency = (mark + space) ÷ 2
Data Filter Bandwidth = (1.2 x shift) + (baud rate)

A

Appendix

Contents of This Appendix

Self-Test

This self-test is used to test all the digital circuitry, switch, and button of the MFJ-781.

To perform the self-test:

1. Turn the unit off by placing the **Power** button in the "out" position.
2. Turn the **Filter Select** switch to the second position CW 2.
3. Press **Center Frequency** button so it is in the "out" position.
4. Remove the unit's cover (2 screws; 1 located on each side of the unit).
5. Record the positions of jumpers JP1 to JP15 for re-configuring the unit after the self-test (factory default settings are on page 4-4).
6. Place jumpers JP1 to JP14 in the "H" positions and jumper JP15 in the "OFF" position.
7. Connect the unit to the TNC.
8. Set the TNC to CW mode at 10 WPM using 700 Hz tone (pitch) frequency.
9. Turn the unit on by placing the **Power** button in the "in" position.
10. The unit sends *SELF TEST* in Morse code at 10 WPM. For the entire test, the **Input Level** LED should blink green once after each operation. If the LED blinks red the unit fails the test and a Morse code message is sent to indicate the nature of the failure.
11. Test the **Center Frequency** button by pressing it in. The **Input Level** LED should blink green once after the button push.
12. Test the **Filter Select** switch by turning it to each position: CW 1, CW 2, CW 3, CW 4, RTTY, AMTOR, PACTOR, HF PACKET, VHF PACKET / CLOVER, and SSTV / WeFAX. The **Input Level** LED should blink green once after each turn of the switch.
13. Test the jumper connections by placing plug-in jumpers in the "L" positions of JP1 to JP14 and then in the "ON" position of JP15. The **Input Level** LED should blink green once for each jumper.
14. If you've pressed the button, turned the switch, and placed the jumpers in the correct order and the unit is working properly, the unit repeatedly sends *OK-781* (with blinking green LED) in Morse code. A repetitive message such as *S4 FAIL* (with blinking red LED) indicates that you didn't follow the correct order or the unit failed the test. The prefix and the number indicate the nature of the failure (see table on next page).
15. Turn the unit off by placing the **Power** button in the "out" position and ***remove the power plug***.
16. Replace all jumpers from JP1 to JP15 back to their original positions.
17. Replace the unit's cover (2 screws).
18. Reconnect power and resume with normal operation.

Prefix-Number and Its Designation

B1 = CENTER FREQUENCY button
B2 = POWER button

S1 = CW 1 switch position
S2 = CW 2 switch position
S3 = CW 3 switch position
S4 = CW 4 switch position
S5 = RTTY switch position
S6 = AMTOR switch position
S7 = PACTOR switch position
S8 = HF PACKET switch position
S9 = VHF PACKET / CLOVER switch position
S10 = SSTV / WeFAX switch position

J1 = JP1 jumper
J2 = JP2 jumper
J3 = JP3 jumper
J4 = JP4 jumper
J5 = JP5 jumper
J6 = JP6 jumper
J7 = JP7 jumper
J8 = JP8 jumper
J9 = JP9 jumper
J10 = JP10 jumper
J11 = JP11 jumper
J12 = JP12 jumper
J13 = JP13 jumper
J14 = JP14 jumper
J15 = JP15 jumper

In Case of Difficulty

If you experience low volume or distortion:
Double check the wiring used to connect the DSP to the receiver's speaker or headphones jack. 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 audio output jack. If the DSP is properly connected and the wiring is good, the audio 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 jack.

If the DSP fails to process properly when using the Automatic Gain Control or if the DSP audio is distorted intermittently:
The receiver's volume or the DSP's level control may need to be adjusted. Check the **Input Level** LED.

If the DSP won't start or shuts off intermittently:
The power supply may not be within the required 10-16 volt range. If the power supply drops below 10 volts from poor regulation or a bad connection, the DSP may operate 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 Technical Service* at **601-323-0549**. or the *MFJ Factory* at **601-323-5869**. You will be best helped 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., P. O. Box 494, Mississippi State, MS 39762; by FAX to 601-323-6551; through Compuserve at 76206,1763; or by email to 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.

CW and Data Filters Settings Chart

Copy this chart and use it to record your CW and data filters settings.

CW Mode Tone Freq #1 ____________________ Tone Freq #2 ____________________	**DATA Mode** Mark-Space #1 ___________________ Mark-Space #2 ___________________
CW Mode Tone Freq #1 ____________________ Tone Freq #2 ____________________	**DATA Mode** Mark-Space #1 ___________________ Mark-Space #2 ___________________
CW Mode Tone Freq #1 ____________________ Tone Freq #2 ____________________	**DATA Mode** Mark-Space #1 ___________________ Mark-Space #2 ___________________
CW Mode Tone Freq #1 ____________________ Tone Freq #2 ____________________	**DATA Mode** Mark-Space #1 ___________________ Mark-Space #2 ___________________
CW Mode Tone Freq #1 ____________________ Tone Freq #2 ____________________	**DATA Mode** Mark-Space #1 ___________________ Mark-Space #2 ___________________
CW Mode Tone Freq #1 ____________________ Tone Freq #2 ____________________	**DATA Mode** Mark-Space #1 ___________________ Mark-Space #2 ___________________
CW Mode Tone Freq #1 ____________________ Tone Freq #2 ____________________	**DATA Mode** Mark-Space #1 ___________________ Mark-Space #2 ___________________
CW Mode Tone Freq #1 ____________________ Tone Freq #2 ____________________	**DATA Mode** Mark-Space #1 ___________________ Mark-Space #2 ___________________
CW Mode Tone Freq #1 ____________________ Tone Freq #2 ____________________	**DATA Mode** Mark-Space #1 ___________________ Mark-Space #2 ___________________
DATA Mode Mark-Space #1 ___________________ Mark-Space #2 ___________________	**DATA Mode** Mark-Space #1 ___________________ Mark-Space #2 ___________________
CW Mode Tone Freq #1 ____________________ Tone Freq #2 ____________________	**DATA Mode** Mark-Space #1 ___________________ Mark-Space #2 ___________________
CW Mode Tone Freq #1 ____________________ Tone Freq #2 ____________________	**DATA Mode** Mark-Space #1 ___________________ Mark-Space #2 ___________________

NOTES: