

# **MFJ-1025**

## **Noise and Interference Canceler / Signal Enhancer**

### **Instruction Manual**

## **INTRODUCTION**

The MFJ-1025 is designed to cancel noise or interference, or boost signal-to-noise ratio, before the noise affects sensitive receiver circuits. Unlike conventional noise blankers, the MFJ-1025 can be effective on all types of noise, including unwanted signals. The MFJ-1025 provides user adjustment of phase and amplitude of two antenna inputs. Both phase and level is adjustable allowing signals to be combined. The resulting signal product is the vector addition or subtraction of the two antenna inputs.

The circuitry in the MFJ-1025 has exceptional phase amplitude flatness, making adjustments easy and very repeatable. Gain shift with full phase rotation is less than 2 dB, and typically less than 1 dB.

This method of signal enhancement has several advantages over conventional noise blankers. The advantages are:

- Interference can be much stronger than the signal and be completely removed without affecting the desired signal.
- The MFJ-1025 is effective with all types of interference and on all modes.
- Signals can be added instead of subtracted with the simple push of a button.

Effective and proper operation occurs only if the noise (for nulling noise) or the desired signal (for signal enhancement) is present on both the auxiliary (AUX) and main antennas.

The MFJ-1025 contains interface circuitry necessary for operation with most modern HF transceivers. It has built in RF sensing, as well as provisions for external keying from an external control line.

## **THEORY OF OPERATION**

It is commonly perceived that noise interacts with an antenna differently than a "desired" signal. Since noise is an electromagnetic wave, it influences the antenna exactly the same as desired signals. Noise also follows the same rules of propagation as the signals from our transmitters. Noise does not have to be local in origin, it can also arrive by ionospheric propagation from distant sources. This effect can allow noise from sources thousands of miles away to accumulate at the receiving location and "mask" weak signals.

A phased or directional antenna system cancels or nulls unwanted signals, noise, or interference. The MFJ-1025 turns any two antennas into a phased antenna system. The MFJ-1025 has four primary advantages over typical phased antenna systems:

1. The user can electrically "rotate" the array even though the antennas remain physically stationary.
2. The user can adjust both direction and wave angle of the null or peak.
3. The user can change from nulling to peaking a signal with the push of a button.
4. Mutual coupling effects can be ignored as phase or level are adjusted.

In all signal or noise *canceling* situations, the noise and main antennas must "hear" the same signals. It is preferable that the antennas be reasonably close together and share the same polarization. This allows both antennas to clearly "hear" the same undesired signals, and the phasing circuit to completely null or subtract interference.

If the primary problem is local noise, it is preferable the noise antenna "hear" the noise much louder than desired signals. In this case, the noise antenna should be located as close to the noise source as possible.

When peaking or adding signals, best performance occurs when signals have equal and the best possible signal to noise ratios on both antennas. In this case, it is preferable to locate the antennas as far from any noise sources as possible.

## CIRCUIT DESCRIPTION

The MFJ-1025 contains a noise amplifier, bridge-type phasing circuit, active combiner, and transmitter change over relay circuit in one package. The noise amplifier consists of Q8. Q8 drives the bridge-type phasing control.

The PHASE control (R16) allows signals from the auxiliary antenna to be rotated in phase nearly 180 degrees ( $\phi > 145$  degrees) over the entire HF spectrum. The PHASE switch (SW3) allows the selection of a normal or inverted phase by selecting the signal from Q7's source or drain. The total phase shift range is the sum of the PHASE control amount and the amount selected by the PHASE switch.

Q5 and Q6 form the active combiner. Q4 is the line driver that supplies output to the receiver.

Q1, Q2 and Q3 are part of RF sensing circuitry. They are included to automatically bypass the MFJ-1025 during transmissions.

## REAR PANEL CONNECTIONS

From left to right (rear view) the connections are:

**MAIN ANTENNA** (antenna input): This SO-239 has a direct connection to the RADIO connector when power is removed, if the external RELAY jack is grounded, or transmitter power is applied.

**RADIO** (transmitter input): This SO-239 has a direct connection to the MAIN SO-239 connector when power is removed, if the external RELAY jack is grounded, or transmitter power is applied. This connector always connects to the receiver input.

**T/R CONTROL:** This RCA phono connector can be used to switch the MFJ-1025 to a standby mode. It switches when pulled low. *Never* apply voltage to this jack.

**AUX ANTENNA** (antenna): This SO-239 and the adjacent RCA phono jack to its immediate right are inputs for the high gain receive amplifier system.

**POWER:** This 2.1 mm power connector requires a nominal supply voltage of twelve volts at approximately 150 mA. The center pin is positive.

**WARNING:** Do not reverse the power connections or damage will result. Remember, the center pin is positive, and the outer shell is negative.

## INSTALLING THE MFJ-1025

*Please read the following suggestions and examples.*

The best location for this unit is at the operating position next to or above the transceiver or receiver. The MFJ-1025 controls must be adjusted during normal operation while listening to the receiver or watching the receiver's S meter.

For most installations, connect the MFJ-1025 as follows:

1. Connect the MFJ-1025 "TRANSMITTER" connector to the transceiver or receiver's antenna terminal with a short coaxial jumper cable.
2. Connect the lead that used to go to the transceiver or receiver's antenna terminal to the MFJ-1025 connector labeled "MAIN ANTENNA".
3. Connect the noise antenna to the MFJ-1025 connector labeled "AUXILIARY ANTENNA".

## POWER SUPPLY

This unit requires 10 to 15 volts dc from a negative ground supply. It consumes less than 150 mA current. The power jack is a 2.1 mm coaxial power receptacle. The outer connection is grounded and the center pin is the positive terminal.

While we have made every effort to decouple this line for unwanted noise or RF, it is still possible for unwanted signals to pass from the power or relay control lines to the receiving system. We recommend testing for unwanted noise ingress by disconnecting all antennas from the unit, and listening to the noise. You should hear only a smooth low level hiss with the unit turned on and both gain controls at maximum.

MFJ recommends a 120 Vac to 12 Vdc (nominal voltage) adapter, model number MFJ-1312B, to power this unit. This power supply has good RF noise immunity.

## NOISE ANTENNA

The noise antenna can be a special antenna, or a spare antenna not in use at the moment.

LAMP 1 is a 50 mA 12 volt dial lamp used to protect the AUXILIARY ANTENNA input from excessive voltage. Illumination or failure of LAMP 1, near the AUXILIARY antenna jack, indicates excessive RF voltages at the AUXILIARY ANTENNA connector. Excessive voltage from the transmitter can, under extreme conditions, burn out LAMP 1. If using an external AUXILIARY antenna causes LAMP 1 to illuminate or burn out, discontinue using that particular antenna or relocate it further from the transmitting antenna.

## USE WITH BEVERAGE OR OTHER LOW NOISE ANTENNAS

The MFJ-1025 can be used to enhance reception on 160 and 80 meters, even if the station already employs low noise directional receiving arrays. If the receiving antennas connect to the receiver through a special receiving antenna input connection (a receive antenna jack), the MFJ-1025 should be inserted in that lead.

A suggested method follows:

1. Connect the MFJ-1025 TRANSMITTER connector to the receiver's input line.
2. Connect the MFJ-1025 AUXILIARY ANTENNA connector to the noise antenna.
3. Connect the MFJ-1025 MAIN ANTENNA connector to the Beverage or receiving array.

**Note:** The AUXILIARY ANTENNA input has different gain distribution than the MAIN ANTENNA input. The MAIN ANTENNA input has less internal noise, but also has less available gain than the AUXILIARY ANTENNA input.

In some cases weak signal performance can be improved by swapping MAIN and AUXILIARY antenna inputs. Remember the transmitter output only appears on the MAIN antenna connector, so if you are trying to transmit through the MFJ-1025 (in other words if it is connected to the main antenna output of a transceiver) you will not be able to swap connections to the MAIN and AUXILIARY antennas.

Remember in order to null or peak a signal both the MAIN antenna and the AUXILIARY antenna must "hear" the same signal. If the same noise or signal is not present on both antennas, noise or signals can not be nulled or peaked. This may require adding a special antenna near the source of the unwanted signal, or a separate good receiving antenna.

## GROUNDING CONSIDERATIONS

Connect the MFJ-1025 to the station ground buss with a short ground connection. Always use a good station ground connection to reduce the risk of lightning damage to station equipment, improve performance, and to improve operator safety.

Adequate lightning protection can be obtained by burying coaxial feedlines *directly* in the ground for 20 feet long (or more) before the feedline enters the building. In addition, the feedline's shield should be grounded to the station ground at the point where the feedline enters the building. Failure to follow these precautions will increase the risk of lightning damage to equipment and reduce safety.

The station's ground should consist of at least one copper ground rod driven into the earth a minimum of 6 feet. Multiple ground rods and buried wires are superior to a single rod for lightning and RF protection.

Never use woven flexible braiding for ground connections unless *absolutely necessary*. Braiding has high resistance to RF and lightning. Copper flashing, wide copper foil, or large gauge solid copper wires are the proper materials for use in RF and lightning grounding applications. Never ground the feedline on the antenna side of a balun.

In-line coaxial lightning arrestors offer a minimal improvement in lightning protection. The best method of protecting station equipment is to disconnect the feedline outside the building.

## CONTROL FUNCTIONS

The front panel contains three switches, four potentiometers, and one LED.

From left to right the controls are as follows:

- a. The POWER OFF/ON switch turns the MFJ-1025 off or on.
- b. The T/R DELAY control is marked from 0-10. It adjusts the hang time of transmit receive relay. When rotated clockwise receive recovery delay is extended, when rotated counter-clockwise receive recovery delay is reduced. Use this control to prevent unwanted and unnecessary MFJ-1025 receive relay chatter.
- c. The AUXILIARY ANTENNA GAIN control adjusts signal levels from the AUXILIARY ANTENNA connector. This control is marked from 0 to 10, with 10 having the most gain.
- d. The FREQ HIGH/LOW switch selects phase components for LOW frequencies (below 7-12 MHz) OUT, or HIGH frequencies (above 7-12 MHz) IN. In the range of 7-12 MHz, either setting may work.
- e. The PHASE control is marked from 0-10, and adjusts AUX signal phase delay over a wide range. Phase is advanced as the control is rotated clockwise to higher numbers.

- f. The PHASE switch selects either normal (IN) or inverted (OUT) signal phase control.
- g. The MAIN ANTENNA GAIN control is marked from 0-10, gain increases as the control is advanced to ten. This control adjusts signal levels from the MAIN ANTENNA connector.

## OPERATION

*This unit requires 10 to 15 volts dc, available from your station supply or an optional MFJ-1312 B power supply.*

If you have a general coverage receiver, select a strong steady signal between 1.5 and 30 MHz. The ideal signal would be ground wave, although the time and frequency standards on 5 , 7.335, and 10 MHz are good alternatives. It important to select a signal with little or no fading for initial practice.

1. Connect the MFJ-1025 to your station and a suitable power source. See the Installation instructions on page 3.
2. From left to right:
  - a. Turn the T/R DELAY control fully clockwise.
  - b. Press and release the POWER switch to place it in the off or out position.
  - c. Turn the AUXILIARY ANTENNA GAIN control fully counter-clockwise.
  - d. Release the frequency range for operation below 7-12 MHz, or press and lock it for operation above 7-12 MHz. In the range of 7-12 MHz, either setting may work.
  - e. Adjust the MAIN ANTENNA GAIN control fully clockwise.
3. Tune in a strong steady signal.
4. Turn the MFJ-1025 power switch on. The red LED should light and you should hear the internal relay click.
5. You should still hear the same signal. Observe and remember it's strength. Adjust the MAIN ANTENNA GAIN control counter-clockwise, signal strength should decrease. Turn the control fully counter-clockwise.
6. Advance the AUXILIARY ANTENNA GAIN control clockwise. You should hear signals from the AUX antenna.
7. Adjust the AUXILIARY ANTENNA GAIN until the signal is just slightly weaker than the level observed on the MAIN antenna, or as high as possible.
8. Advance the MAIN ANTENNA GAIN until you just see the S meter change.
9. Adjust the PHASE control for minimum signal. If the signal strength increases, change the position of the PHASE switch.

10. Go back and forth between the PHASE and either GAIN control that isn't totally against the stop while watching for a null. Adjust only one GAIN control, do not adjust the control that is fully advanced. This step may take some practice.
11. Practice nulling several steady signals until you are comfortable with the action of the controls.
12. Try peaking a signal. The strongest peak will usually be very near the setting of the PHASE control that produces a null in the same signal, but the PHASE switch will be in the opposite position from the null position. When peaking a signal, never adjust gain setting. Adjust the PHASE control and PHASE switch only.
13. After gaining experience on strong steady signals, practice nulling background noise or unwanted signals.

Remember, you can only null a signal or noise if it is present on both the noise and main antennas. Fading will make it difficult to obtain a complete null on skywave signals. The most consistent null will occur if the antennas are close together and of the same polarization.

This device contains a circuit that automatically disables it when transmitting. The T/R DELAY control adjust the recovery time of this circuit. If the unit is off, or if the T/R CONTROL line is grounded, the MAIN ANTENNA port is directly connected to the TRANSMITTER port.

**WARNING:** When transmitting with high power and using external antennas located close together, excessive RF may illuminate or burn out the fuse lamp at the AUXILIARY ANTENNA connector. This bulb is rated at 50 mA of current. Never replace this bulb with higher current bulbs. If fuse lamp burn out is a problem, the antennas must be moved further apart or an external relay must be used to disconnect the AUX antenna while transmitting.

## UNWANTED INTERFERENCE

This unit contains pi-type high pass filters on both the MAIN and AUXILIARY ANTENNA inputs to prevent broadcast station overload.

## OTHER APPLICATIONS

This unit can be used as an adjustable phasing network that combines two antennas to give various directional patterns. It will improve receiving signal levels even in the absence of strong noise. For example:

1. Two parallel Beverage antennas spaced an eighth to quarter wave apart with an eighth to quarter wave stagger in the desired direction can be combined to improve front to back, steer nulls, or add desired signals.
2. Two verticals or dipoles can be combined producing a steerable array peaking or nulling signals at will.

3. A Beverage and a quiet main transmitting antenna can be combined to enhance weak signals.

Many other combinations are possible. The best system is found by experimentation.

## 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., 300 Industrial Park Road, Starkville, MS 39759; by FAX to 601-323-6551; or by email to [techinfo@mfjenterprises.com](mailto:techinfo@mfjenterprises.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.

## SCHEMATIC



