

MFJ-214 Linear Amplifier Saver

The MFJ-214 Linear Amplifier Saver relieves temperature related stress on amplifiers, tuners, and dummy loads while allowing proper system adjustments. It allows amplifiers to be properly adjusted without the use of long steady carriers.

The MFJ-214 Linear Amplifier Saver allows tuning of an amplifier with full required drive from the transceiver without over-heating the finals or anything else in the RF line. It sends a series of pulses to the transceiver allowing the peak power to be high enough to drive the amplifier to full power, but with the average power being low enough not to over-heat the final(s).

The MFJ-214 Linear Amplifier Saver works with any solid state amateur transceiver or transmitter, and all other equipment using positive keying line voltages below 50 volts open circuit and 100 mA closed key current. It can also be used with negative voltage key lines (commonly found in older tube type radios) ***provided keying voltages are below 25 volts dc open circuit.***

The MFJ-214 Linear Amplifier Saver can also be used as a valuable troubleshooting and diagnostic aid. The MFJ-214 Linear Amplifier Saver can be used in performance tests of QSK systems, wattmeters, and other equipment (see appendix).

The MFJ-214 Linear Amplifier Saver uses a single 9-volt battery for power, with battery life dependent on operating and storage time. To install the battery remove the cover by removing the two screws (one on each side) that secure it. A battery clip and holder, located on the left side of the enclosure, are provided for installing the 9-volt battery.

Technical Description

The MFJ-214 Linear Amplifier Saver uses a 555 timer driving an FET open drain switch. Two internal controls allow independent adjustment of both pulse repetition rate (PULSE RATE) and on-to-off time duty cycle (DUTY CYCLE).

PULSE RATE is adjustable from about 17 to 40 pulses per second, while DUTY CYCLE is adjustable from about 10 to 90 percent. The keying time intervals are typically adjustable from 2- 40 mS "on" time, and a 24 to 60 mS pulse repetition time interval.

Minimum duty cycle and the slowest PULSE RATE occur at the full counterclockwise settings of both internal controls. The controls are designed to accept a small flat blade screwdriver.

The CARRIER TUNE button is a momentary contact switch that temporarily locks the transmitter in a continuous carrier transmit mode.

The PULSE TUNE button is a latching switch that activates the pulse circuit when pressed in and locked.

Speech Duty Cycle

The duty cycle of average power to peak envelope power varies widely in the real world. Every voice and system varies, no universal duty cycle of peak to average power applies to the many real-world combinations of voices and equipment.

Unprocessed speech usually has an average power between one percent and ten percent of peak envelope power. Sustained speech, such as a long "hello", produces average power levels that typically range from 10 to 30% of PEP.

Heavy speech processing increases the average power, pushing the short term average power of normal speech to 30% or more.

During normal voice operation, most equipment heat is generated by the quiescent current required to make the transmitting system linear. Proper amplifier or transmitter tuning require adjustments at maximum peak power, generally with maximum available drive from the exciter. A continuous tone or carrier is generally used during adjustment, and the amplifier is generally tuned for maximum output.

The continuous single tone carrier, commonly used to adjust the PA or tuner, will raise heat significantly. The MFJ-214 Linear Amplifier Saver allows proper tuning while driving the PA with a low duty cycle waveform. It is NOT necessary to use a peak reading meter when adjusting an amplifier or tuner with the MFJ-214 Linear Amplifier Saver, although the lack of a true peak reading meter will prevent you from knowing the amount of peak power produced.

PULSE RATE and DUTY CYCLE

The MFJ-214 has two internal controls that adjust Pulse rate and duty cycle. As indicated by the names, these controls adjust the rate at which the transmit keying pulses occur (pulse rate), and the ratio of on- to-off time (duty cycle). The left control adjusts the Pulse rate, while the right control adjusts the duty cycle.

Some care must be used to insure PULSE RATE is slow enough, and the DUTY CYCLE is long enough, to be within the keying response limits of the exciter

and meter. If the pulse rate is too fast and/or the duty cycle is too long, the pulses will blur into one long steady signal.

The typical exciter has a leading edge rise time and tailing edge decay time of a few milliseconds. This stretches the pulse duty cycle out, making the actual RF envelope have a longer duty cycle than the actual keying waveform from the MFJ-214. Because of this effect, the MFJ-214 Linear Amplifier Saver may actually produce a 100% duty cycle waveform at high (clockwise) PULSE RATES with longer (clockwise) on-time DUTY CYCLE settings.

If the pulse rate is too slow and/or the duty cycle too slow, peak power will not be reached. All exciters have a delayed response to the leading edge of the keying waveform. This delay may prevent full peak power from being reached if the duty cycle is too short. Most peak meters have limited response time, this causes lower power readings with short duty cycle pulses.

Another problem is nearly all meters have limited storage time, causing the meter to "fall-back" during the time interval between RF pulses. To obtain the most accurate *meter readings*, both PULSE RATE and DUTY CYCLE should be set far enough clockwise to allow maximum peak power to be indicated on a scope or peak reading meter.

Some peak meters do not read true peak power at all, instead reading something less than the true peak power. If your meter reads less power when the pulser is used, compared to the power when a steady or near steady carrier is produced, your meter is probably not a good peak reading meter. Nearly every radio and amplifier produces more peak power than steady carrier power, because of ALC response time and power supply voltage sag under load. Too much duty cycle on-time can cause unwanted component heating.

The ideal compromise (especially for tuning amplifiers) is achieved when the PULSE RATE and DUTY CYCLE controls are near the counter-clockwise end where the power drops off, but adjusted slightly clockwise from the point where the peak power meter starts to fall back. If such a setting can not be found, it is a strong indication the meter does not indicate peak power accurately.

The MFJ-214 Linear Amplifier Saver connects to the CW Key jack of your exciter via the MFJ-214 Linear Amplifier Saver rear panel jack labeled "Output". The Output jack is a standard RCA phono plug, with the center pin connected to the positive voltage keying line (less than 50 volts and 100 mA) and the outer shell grounded. If the case of the MFJ-214 Linear Amplifier Saver is kept isolated from ground, the MFJ-214 Linear Amplifier Saver can be used with negative keying line voltage radios ***provided radio keying line voltages are below 25 volts***. The primary concern is the shock hazard and potential of accidentally keying the rig if the cabinet of the MFJ-214 Linear Amplifier Saver or the operator comes in contact with grounded equipment.

WARNING: Never use the MFJ-214 with negative keying line rigs that have over 25 volts on the key jack.

Tuning Amplifiers

Nearly all power amplifiers (PA's) are properly tuned when maximum envelope power is obtained with full exciter output. Tuning the amplifier to match exciter peak power prevents gain compression (flat-topping), reduces splatter and distortion, and reduces the chance of PA damage from arcing.

Maximum average power is directly related to (although considerably less than) maximum peak power. While the lack of a good peak reading meter prevents measurement of true peak power, virtually any RF power meter will provide a correct indication of tuning. When the amplifier is tuned to produce maximum average power when driven with a constant rate and duty cycle pulse, it is almost certainly tuned for maximum peak power.

The least damaging and cleanest PA tuning condition generally occurs when the PA is peaked slightly beyond maximum output, in a direction that OPENS or UNMESHES the loading capacitor (this capacitor is sometimes called LOAD, ANTENNA, COUPLING, or MATCHING).

Caution: Be very careful to avoid applying full drive power to the PA without having the load control open far enough. When power amplifiers are undercoupled, tank voltages can be extremely high. This may cause tank components, such as the bandswitch or tuning capacitor, to arc and fail. It also stresses the tube and other components with needlessly high voltages. *The MFJ-214 Linear Amplifier Saver will NOT prevent voltage damage to components.*

Adjust the two front panel controls to a 10 o'clock position. With the amplifier in stand-by, push the Carrier Tune button and adjust the transceiver's power control to the rated drive power of the amplifier. Place the amplifier into operate

mode and depress the pulse tune button on the MFJ-214 Amplifier Saver. Tune the amplifier for peak output power.

Note: Due to the response time of most non-peak-reading RF watt meters, the meter will read a low average power, but the amplifier will be tuned for full peak power.

While momentarily pressing the carrier tune button, the RF watt meter should read full power of the amplifier. The amplifier is now tuned for full power.

For best linearity, it is best to reduce the transceiver's power slightly after tuning the amplifier.

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 Facsimile to 601-323-6551; or by email to 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

Parts List

| Designator | Description | P/N |
|-------------------|-----------------------------|------------|
| R3, R4 | Resistor, 1K OHM | 100-3100 |
| R5 | Resistor, 10K OHM | 100-4100 |
| R1 | Resistor, 47K OHM | 100-4470 |
| R6, R7 | Resistor, Trimpot, 500K OHM | 133-5500 |
| C1, C3 | Capacitor, .01uF | 200-0004 |
| C2, C4 | Capacitor, .1uF | 200-1017 |
| D1, D2, D3 | Diode, 1N4148 | 300-0003 |
| D4 | Diode, 1N4007 | 300-1005 |
| Q1 | FET, 2N7000 | 305-7000 |
| U1 | IC, Timer, NE555CN | 311-1003 |
| SW1 | Switch, Locking, 2P2P | 504-4022 |
| SW2 | Switch, Momentary, 2P2P | 504-4022M |
| J1 | Jack, RCA Phono | 600-1325 |

APPENDIX

Testing QSK Systems

The MFJ-214 Linear Amplifier Saver can be used to evaluate QSK systems. In one test configuration, a continuous signal source is loosely coupled to the dummy load. The receiver is tuned to this signal source, and the MFJ-214 Linear Amplifier Saver controls are adjusted until the test signal is clearly audible. The maximum QSK receive speed is found by measuring the PULSE RATE, and multiplying the PULSE RATE by 2.4. The DUTY CYCLE should be set for normal sounding CW dots during this test, or a 1:1 ratio.

The transmission waveshape can be checked by looking at the RF output on a scope, with the scope triggered or synchronized to the keying line signal. A normal CW signal has a smooth rise and fall time of about one millisecond, with no overshoot or undershoot. Switching from manual operation to full QSK should not disturb the keying waveform, or change the on and off time period.

Testing Wattmeters

Wattmeters can be tested by measuring the single tone power with a barefoot exciter running off of a regulated supply, and adjusting an oscilloscope to read near full screen with that carrier. By activating the MFJ-214 with the PULSE RATE set approximately mid-range, and adjusting the DUTY CYCLE control until the full peak envelope voltage is just displayed on the scope, the meter can be evaluated. A good peak reading meter should indicate the same amount of peak power with the MFJ-214 pulsing the carrier as it indicates with a continuous carrier, as long as the maximum scope deflection remains the same.

RFI and TVI Troubleshooting

The MFJ-214 Linear Amplifier Saver can be used to activate the transmitter with a pulsed signal of full peak power, without undue equipment heating. This will allow you to move to the location of the device being interfered with, while safely operating the transmitter at high power.

You can add filters, grounds, and move cables *on the device being interfered with* without fear of overheating your transmitter. The short duty cycle also reduces interference to other amateur operators.

Be sure to have a licensed operator attending your station, and to conform to all FCC rules regarding CW emissions.