

DESCRIPTION OF ANTENNA TUNER F2260

GENERAL DESCRIPTION 1.

The Tuner Unit (ATU) model F2260 is an automatic antenna matching network that provides efficient RF power transfer from the radio system to the antenna.

The ATU handles up to 125 watts Peak Envelope Power (PEP) . It is used for voice and CW morse code communications.

ATU F2260B matches the antenna impedance to the 50 output impedance of the radio system, with a nominal VSWR of 1.5 in the 1.6 to 30 MHz frequency range.

The ATU is housed in a weatherproof case, allowing outdoor installation, such as open roofs.

FUNCTIONAL DESCRIPTION 2.

The F2260B Automatic Antenna Tuner (ATU) operates in the 1.6 to 30MHz frequency range at 125 watts peak envelope power (PEP). The ATU automatically selects the network components for the antenna matching, thus eliminating the need for programming, presenting, manual tuning and adjustments during the installation and the operation.

A microprocessor circuit checks the antenna matching each time the channel is changed and then automatically switches inductors and capacitors in and out of the matching network. The tuning data for a given channel is stored in a memory and kept as long as the ATU is on. The next time the channel is used, the stored tuning data for that channel is used, considerably reducing the tuning time (provided that the VSWR is within the specified limits).

The microprocessor circuit provides an internal RS-232 communications connector that allows for connecting the ATU to a PC for factory troubleshooting.

INSTALLATION

GENERAL 1.

The radio and ATU are factory preset for proper tuning operation and require no additional adjustment or programming during installation.

RECOMMENDED EQUIPMENT 2.

TOOLS 2.1

- Nut driver 7/16"
- Nut driver 5/16"
- Flat blade screwdriver 7/16"

ACCESSORIES 2.2

For mobile installations:

FKN4314A High voltage cable kit (supplied with the ATU)

TKN8123B 17ft cable kit (supplied with the ATU)

For base station installations:

FKN431A High voltage cable kit (supplied with the ATU)

TKN8120A 30ft cable kit

TKN8121A 100ft cable kit

MOBILE INSTALLATION INSTRUCTIONS 3.

DRAIN SCREW REMOVAL 3.1

The ATU provides two drain screws for condensation removal. One screw is positioned on the bottom of the housing and the other is positioned on the unit side panel. Appropriate drain hole selection is essential for proper ATU operation. Remove and discard the screw that is lower in the specific mounting orientation.

Caution: The selected drain hole must face downward , regardless of the ATU mounting orientation.

CABLE KITS 3.2

The ATU basic model is supplied with the FKN4314A. High Voltage Cable Kit and the TKN8123A 17ft Control and RF Cable Kit. A special RF Choke is incorporated in the RF cable assembly to eliminate grounding problems.

INSTALLATION INSTRUCTIONS 3.3

NOTE

The installation instructions included in the label on the unit cover apply to base station installations. Disregard these instructions in case of a mobile installation.

ANTENNA AND ATU LOCATION 3.3.1

The antenna and ATU locations on a vehicle are the most critical parts of a mobile installation, since they have a great influence on the effective radiated power.

ANTENNA LOCATION 3.3.1.1.

The ATU tunes mobile whip antennas as specified in the Performance Specifications section. However, 15 foot whip is recommended for best efficiency.

For short range communications (ground waves), a vertical (non-bent) antenna is preferred. For long range communications (sky-waves), a bent antenna is preferred. The antenna may be bent and tied down to the vehicle's body with a nylon cord.

The best antenna location is the vehicle's rooftop, where the antenna is not obstructed by metal objects. Roof center installation provides good symmetrical -omni directional radiation patterns.

If rooftop installation is impossible, a side wall installation with the antenna as far away from the side wall and as high as possible, will suffice.

If the antenna's height above ground is limited, it is preferred to install the antenna as high as possible and to bend and strap it down to the required height (as opposed to installing the antenna close to the ground, such as in a bumper mounted installation).

THE ATU LOCATION 3.3.1.2

The ATU should be mounted in a location, where the ATU output (antenna) connector is as close as possible to the antenna input connector.

The maximum allowed lead-in wire length is 30cm. Any reduction in the lead-in wire length improves the system performance. A 10cm wire ensures good radiation results.

NOTE

If installation restrictions exist, the ATU may be installed on the vehicle's exterior.

IMPORTANT

A properly installed ATU adds noise immunity to the radio system.

ANTENNA ATU INTERCONNECTIONS 3.3.2.

WHIPS LONGER THAN 16FT AND WIRE ANTENNAS

3.3.2.1.

STEP 1 .

Connect the ATU output connector to the antenna connector with the shortest wire possible. A 12 AWG insulated wire is sufficient for this purpose. The lead-in wire should have about 3" of clearance from metal walls, grounding braids etc. You may use the FKN4314A High Voltage Cable Kit supplied with the ATU.

STEP 2.

Connect the ATU ground terminal to the vehicle body with a wide grounding braid. Ensure that the grounding braid is as short as possible. If the ATU is installed on the inner side of the vehicle's body , a second grounding braid should be placed beneath the ATU and connected to one of the bolts securing the antenna base.

16ft OR SHORTER WHIPS 3.3.2.2.

When connecting a 16ft or a shorter whip to the ATU, you must use the high voltage cable kit FKN4314A supplied with the ATU.

NOTE

It is recommended to shorten the high voltage cable as much as possible, providing that the distance between the antenna base and the ATU is short enough. Use the appropriate ring lug, provided separately in the kit, to reassemble the shortened cable.

STEP 1.

Attach the high voltage cable conductor to the ATU RF output . While holding the high voltage cable, push the rubber yoke cover until it slips on the yoke.

STEP 2.

Attach the grounding braid of the high voltage cable kit to the ATU ground terminal.

STEP 3.

Route the grounding braid between the ATU mounting rails and the mounting surface. Align the grounding braid eyelets with the holes in the mounting rails and mount the ATU using the tapping screws provided.

STEP 4.

If the grounding braid does not provide a good ground to the vehicle's body, connect the supplied grounding wire between the ATU ground terminal and a good grounding point near the antenna base using the supplied tapping screw and split washer.

STEP 5.

Attach the other end of the high voltage cable to the antenna base.

CABLE INTERCONNECTIONS. 3.3.3

STEP 1.

Route the RF and Control cables between the ATU and the radio.

STEP 2.

Connect the control cable terminals to the ATU input. Attach the terminal housing with the mounting screw.

STEP 3.

Connect the RF coaxial cable to the ATU RF input.

STEP 4.

Connect the control and RF cables to the radio.

STEP 5.

Perform the operational check given in paragraph 3.4.

OPERATIONAL CHECK 3.4.

When the system installation is completed, perform the following operational check.

STEP 1.

Install an in-line wattmeter between the radio and the ATU.

STEP 2.

Turn on the radio.

STEP 3.

Key the radio and whistle into the microphone; observe the forward and reverse power reading on the wattmeter. The forward power should be at least three times greater than the reverse power.

STEP 4.

Perform step 3 for each channel used.

BASE STATION INSTALLATION INSTRUCTIONS 4.

ANTENNA INSTALLATION 4.1

The recommended length of antennas for base stations is 23 to 60 feet for long wire antennas and 23 to 35 feet for whips, in the specified frequency range. Shorter antennas are recommended for mobile installations only.

23 TO 35 FEET WHIP ANTENNAS 4.1.1

23 to 35 feet whip antennas are suitable for medium-to long-range communications. The antenna should be located away from interfering structures, such as metal masts, buildings and metal wires parallel to the antenna. The distance from these interfering structures should be about one wavelength (see footnote below) of the lowest frequency used.

4.1.2 23 TO 60 FEET WIRE ANTENNAS

The wire antenna can be installed in one of the following configurations: inverted "L" and sloping wire.

Optimum antenna performance is achieved when the antenna is approximately a quarter of a wavelength long (see footnote below). The antennas illustrated in these figures are suitable For systems using frequencies below 5 Mhz. If the lowest used frequency is higher than 5 mhz, a good practice is to shorten the overall antenna length to approximately a quarter of a wavelength with the configuration and the wire length ratio as in Figures 6 and 7.

ANTENNA GROUND PLANE 4.2

GENERAL 4.2.1

The ground plane provides an RF current return path for the antenna. For efficient operation, the loss resistance in the ground must be small in comparison to the antenna radiation resistance. Furthermore, the effective length of the ground system largely affects the shape of the antenna radiation pattern. A poor ground will cause an otherwise good radio to perform poorly.

This section provides a description of a ground plane and explains its installation.

4.2.2 LOCATION

A good ground plane must be spread out with the antenna located normally in the center.

GROUND PLANE FOR WHIP ANTENNAS 4.2.2.1

(23 to 35 feet, 7 to 11 meters, non-roof mounted)

12 radials, 35 to 60 feet long, form an adequate ground plane. The 60 feet radials are used for the longer communication ranges. A ground rod should be driven into a ground near the base of the antenna to provide a lightning discharge.

CAUTION

Do not install the ATU without the earth ground. The earth ground is required both for the ATU efficient operation and for lightning protection.

Step 5. Route the RF and Control cables between the ATU and the radio.

Step 6. Connect the control cable terminals to the ATU input. Attach the terminal housing with the mounting screw.

Step 7. Connect the RF coaxial cable to the ATU RF input.

Step 8. Connect the control and RF cables to the radio.

Step 9. Perform the operational check given in paragraph 3.4.

GROUND PLANE FOR WIRE ANTENNAS 4.2.2.2 (non-roof mounted)

Twelve radials, 35 to 60 feet long, will form a good ground plane. A ground rod should be driven into the ground close to the antenna base to provide a lightning discharge path.

The ground plane shape for an Inverted "L" wire antenna should be distorted with most of the surface area placed under the antenna (see Figure 9). The sloping wire antenna should have a circular ground plane shape with the antenna feed point at the center.

GROUND PLANE FOR ROOF MOUNTED WHIPS AND WIRE ANTENNAS 4.2.2.3

A fairly effective ground can also be achieved by grounding to the building structure or metal roof (see Figure 10), provided that the roof pieces are electrically bound together. Antennas far from earth on insulated structures require a ground plane (or radial system).

Two or four radials cut to a quarter or half wavelength for each frequency used ($3/8$ x wavelength is a fair optimum) form an effective ground plane above 7 MHz. Below 7 MHz, the required length gets unreasonably long; however, more than four radials 30 to 70 feet (9.1 to 21.3 m) long are recommended. A direct connection to a ground rod driven into the earth, or connection to a water pipe of the building, is required for lightning protection.

ATU INSTALLATION INSTRUCTIONS 4.3

Step 1. Located the ATU as close as possible to the antenna and close enough to the ground system so that the ground lead is less than 5 ft (1.5 m).

Step 2. Attach the ground braid of the high voltages cable kit to the ATU ground terminal (see Figure 4).

Step 3. If a wire antenna is used, connect it directly to the ATU RF output terminal. Use mechanical strain relief similar to the one shown in Figure 11.

Step 4. Connect the shortest possible ground lead between the antenna ground plane and ATU ground terminal. The base station ground, ATU ground and the antenna ground plane must be bond to the earth ground.

THEORY OF OPERATION

FUNCTIONAL DESCRIPTION 1.

ATU FUNCTION 1.1

The ATU allows for an effective energy transfer between the radio and the antenna. This is basically achieved by meeting the following requirements:

- Minimizing the insertion loss of the matching network.
- Preventing mismatch losses by presenting appropriate impedances to the radio power amplifier and the antenna.

ATU OPERATION 1.2

When a channel is changed in the radio, the radio sends the channel Change signal to the ATU. This signal turns on the Tuner Control circuit, which initiates and controls the ATU operation.

The tuner control circuit sends the TUNE signal to the radio to instruct the radio to generate an output signal at a tune level (3.5-5.5 W) and starts the tuning process)

First, the ATU verifies that the tune power at its input (V-FORWARD) is within the predefined range (3.5-5.5W). Power above this range can damage the relays during the Hot Switching, while power below this predefined range can cause inaccurate tuning.

If the tune power is within the specified range, the ATU captures a 20 MS sample of the signal. The sample signal frequency is divided by 128 and measured by a counter.

The ATU reads tuning data corresponding to the measured frequency from its internal memory (such data exists if tuning was previously performed for this frequency). The ATU sets the tuning network according to that data and measures the resulting VSWR. If VSWR <2 the tuning is completed. If it is higher, a new tuning cycle is started.

The tuning process principle is based on crossing the G=1 circle in the positive part of the Smith Chart using a series inductance, and then moving towards VSWR=1.5 using a parallel capacitance at the input.

When the ATU completes the tuning process it stores the tuning network data in memory in a location corresponding to the current frequency. It deactivates the TUNE signal to indicate that the tuning process has been completed and the radio can transmit at full power.

The ATU shorts its sensor terminals to ground to protect them from high power and its up enters an idle state to prevent noise from the receive channel. The relay's state is maintained by using latches on the relay control line.

OPERATION WITH MICOM-1/RDP 1.3

The power and control signals are transferred between the radio and the ATU via a control cable. However, when the ATU operates with an RDP, a control cable is not used and the power and control functions are performed alternately.

The DC power is supplied to the ATU via the RF cable.

In the absence of the control cable there are no Channel Change and tune signals. After changing the frequency the radio interrupts the dc power supply via the RF cable for about 50 milliseconds. After the power returns the ATU performs the power-on tuning process. During the power interruption, a special backup power is supplied to the tuning data storage, to prevent data loss.

RS-232 COMMUNICATIONS INTERFACE 1.4

The ATU supports an RS-232 interface to a PC for automatic troubleshooting (and debugging). The interface is provided at port J1, which is accessible with the top cover removed.

BLOCK DIAGRAM DESCRIPTION 2.

The ATU block diagram is described in the following sections:

RF MATCHING NETWORK 2.1

The RF signal from the radio is applied to the RF Matching Network via the RF Sensor. The RF matching network is a combination of inductors and capacitors. The ATU changes the network parameters by switching the inductors and capacitors in and out of the network.

The quality of the network and its components determines the effectiveness of the energy transfer between the radio and the antenna. Therefore, the network components have high Q (quality factor) and the tuning algorithm is very sophisticated.

RF SENSOR 2.2

The RF sensor samples the RF signal, converts the samples to analog levels (between 0-5V) and transfers the data to the Tuner Logic. The following data is provided on the RF signal:

- PH-L and PH-C signals indicate whether the load is inductive or capacitive.
- Vg signal indicates on which G circle on the Smith Chart the load is located (G=1).
- Vf signal indicates the forward power.
- Vr signal indicates the reverse power.
- An RF sample for calculating the signal frequency.

TUNER LOGIC 2.3

The Tuner Logic circuit performs the following functions:

- Detects channel change in the radio (based on the Channel Change signal).
- Generates a command (TUNE signal) to the radio to enter the tuning mode.
- Calculates the frequency of the RF signal sample provided by the RF sensor.
 - Controls the tuning process: it implements the tuning algorithm and sends commands to the relay drivers that control the matching network components.

- Stores the tuning state for each frequency.
- Shorts the RF sensor outputs to the ground after completing the tuning process. This grounding is required for protecting the Tuner Logic circuits and the sensor components from high power during the normal radio transmission.
- Controls the RS-232 communications link to a PC computer for troubleshooting purposes.

When the tuning is completed, the Tuner Logic circuit deactivates the relay control commands and enters an idle state.

LATCHES AND RELAY DRIVERS 2.4

The latches and Relay Drivers control the components of the matching network. The relay drivers activate the RF relays that switch inductors and capacitors in and out of the network. The latches keep the relays activated after the tuning has been completed and the relay commands have been removed.