

AT-AUTO Operating Manual

Firmware Version 2.00 – 2.03



Multi-Part Owners Manual Consisting of:

Quickstart Guide
Principals of Operation
Firmware Update Guide
Frequently Asked Questions

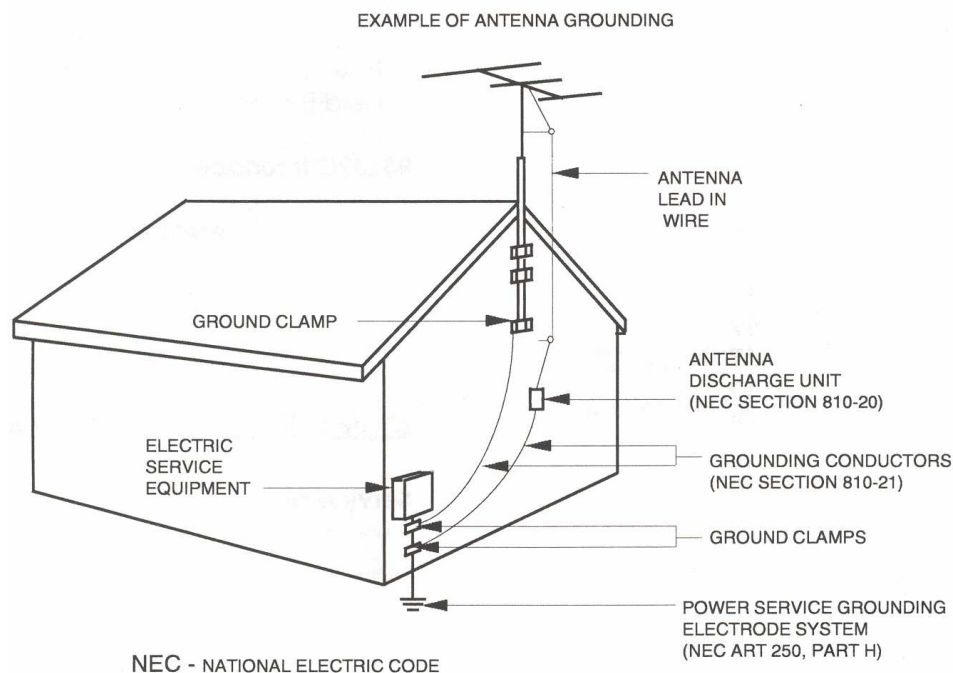
Palstar, Inc.,
Piqua, Ohio
1 June, 2007

Important Safeguards

WARNING: To reduce the risk of fire or electric shock, do not expose this device to rain or moisture. Do not open the cabinet while operating. Refer servicing to qualified personnel only.

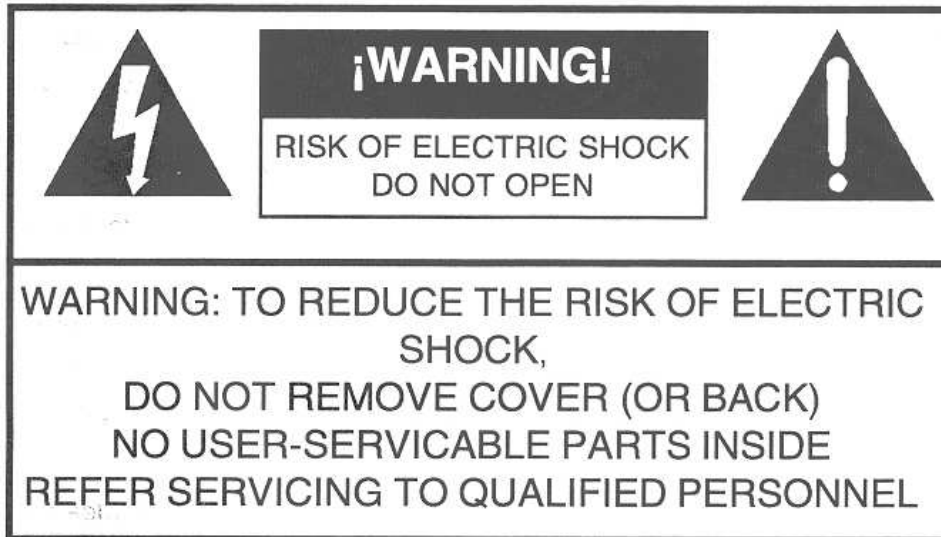
1. Read Instructions-All the safety and operating instructions should be read before the tuner is operated.
2. Retain Instructions-The safety and operating instructions should be retained for future reference.
3. Heed Warnings-All warnings on the tuner and in the instruction manual should be adhered to.
4. Follow Instructions-All operating and use instructions should be followed.
5. Cleaning-Unplug the tuner appliance from electrical power before cleaning. Do not use liquid or aerosol cleaners. Use a damp cloth for cleaning.
6. Water and Moisture-Do not use this product near water.
7. Accessories-Do not place this product on an unstable cart, stand, tripod, bracket, or table. The product may fall, causing serious personal injury, and serious damage to the tuner.
8. Ventilation-This product should never be placed near or over a radiator or heat register. This product should not be placed in a built-in installation such as a bookcase or rack unless proper ventilation is provided or the manufacturer's instructions have been adhered to. Any slots or openings in the cabinet are provided for ventilation. To ensure reliable operation and to protect it from overheating, these openings must not be blocked or covered. The openings should never be blocked by placing the product on a bed, sofa, rug, or other similar surface.
9. Grounding-this product is equipped with a ground terminal, intended for use with a proper station ground.
10. Power Sources-This product should be operated only from the type of power source indicated on the marketing label.
11. Lightning-For added protection for this product during a lightning storm, or when it is left unattended and unused for long periods of time, disconnect it from the station antenna feedline.
12. Power Lines-An outside antenna system should not be located in the vicinity of overhead power lines, other electric light or power circuits, where it can fall into such power lines or circuits. When installing an outside antenna system, extreme care should be taken to keep from touching such power lines or circuits as contact with them may be fatal.
13. Object and Liquid Entry-Never push objects of any kind into this product through openings as they may touch dangerous voltage points or short-out parts that could result in a fire or electric shock. Never spill liquid of any kind on the product.

14. Servicing-Do not attempt to service this product yourself as opening or removing covers may expose you to dangerous voltage or other hazards. Refer all servicing to Palstar service personnel.
15. Damage Requiring Service-Disconnect this product completely and refer servicing to qualified service personnel under the following conditions:
 - (a) When the power-supply cord or plug is damaged.
 - (b) If liquid has been spilled, or objects have fallen into the tuner.
 - (c) If the tuner has been exposed to rain or water.
 - (d) If the product does not operate normally by following the operating instructions. Adjust only those controls that are covered by the operating instructions. An improper adjustment may result in damage and will often require extensive work by a qualified technician to restore the tuner to its normal operation.
 - (e) If the tuner has been dropped or the cabinet has been damaged.
 - (f) When the tuner exhibits a distinct change in performance-this indicates a need for service.
16. Replacement Parts-when replacement parts are required, be sure the service technician has used replacement parts specified by Palstar or have the same characteristics as the original parts. Unauthorized substitutes may result in fire, electric shock or other hazards.
17. Antenna Grounding-Before attempting to install this tuner, be sure the antenna and feedline are properly grounded so as to provide protection against voltage surges and built-up static charges.



- (a) Use No.10 AWG copper, No.8 AWG aluminum, No.17 AWG copper-clad steel or bronze wire or larger, as ground wire.
- (b) Secure antenna lead-in and ground wires to house with stand-off insulators spaced from 4 feet to 6 feet apart.

- (c) Mount lightning arrestors and antenna discharge units as close as possible to where the lead-in enters the station.
- (d) A driven rod may be used as the grounding electrode where other types of electrode systems do not exist. Refer to the National Electric Code, ANSI/NFPA 70-1990 for information.
- (e) Use jumper wire not smaller than No.6 AWG copper or equivalent, when a separate antenna grounding electrode is used.



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Introduction

2.1 General Description

Palstar is pleased to bring you the AT-AUTO - An American made, fully-automatic impedance matching network designed to tune antenna systems from 1.8 MHz to 54 MHz. Featuring a robust, precision roller inductor with silver-plated hardware, and a high-voltage differential variable capacitor in a classic T-Match circuit configuration, the AT-AUTO provides a very broad impedance matching range and includes both unbalanced (coaxial) and balanced RF outputs.

Designed to handle a 1500 W continuous carrier, and with no gaps in frequency coverage, the AT-AUTO is well-suited for Amateur Radio, CAP, MARS, Military, and Government HF radio applications. Under microprocessor control, the AT-AUTO continuously monitors forward and reflected power, and when appropriate, automatically adjusts the T-Match circuit for optimum performance without requiring operator intervention.

Although designed for fully automatic operation, the AT-AUTO also enables the user to manually tune or adjust match settings, if desired via the uncluttered front-panel controls. The meter circuitry features Average, Peak, and Peak & Hold display of forward and reflected power, along with SWR. The meter power range (300 W/3000 W) is selected by a front-panel pushbutton.

The AT-AUTO controls are illustrated in Figure 2.1, and are described in Table 2.1 (page 4). An internal view of the AT-AUTO and component descriptions are shown in Figure 2.2 and Table 2.2 (page 6), respectively, while the rear panel features are shown and described in Figure 2.3 and Table 2.3 (page 7), respectively. A functional block diagram of the AT-AUTO is shown in Figure 2.4 on page 8.

The primary tuner controls are the “Mode”, “Output”, and “Tune-Select” momentary pushbuttons. The “Tune-Select” is also a rotary encoder, used for selection of menu items and control of the inductor and capacitor while in *Manual* or *Bypass* mode. When switched on, the AT-AUTO (default) starts up in the *Automatic* mode. Here the AT-AUTO constantly monitors SWR and will commence tuning when appropriate.

Manual mode is selected by momentarily depressing the “Mode” pushbutton. A subsequent activation of the “Mode” pushbutton selects *Bypass* mode, whereby the RF bypasses the tuner and is passed directly to either the coaxial or the balanced output. From *Bypass* mode, momentarily pressing the “Mode” switch again returns the AT-AUTO to *Automatic* mode.

In any operating mode, momentarily depressing the “Output” button alternates between the coaxial and the balanced outputs.

The AT-AUTO firmware is subject to periodic updates and as improvements are made and new features are added, the user may update the AT-AUTO firmware directly from the Palstar website.

Upon turning-on the AT-AUTO, it displays the current firmware version, then enters *Automatic* mode (default), and switches to the antenna that had been selected when it was last switched off.

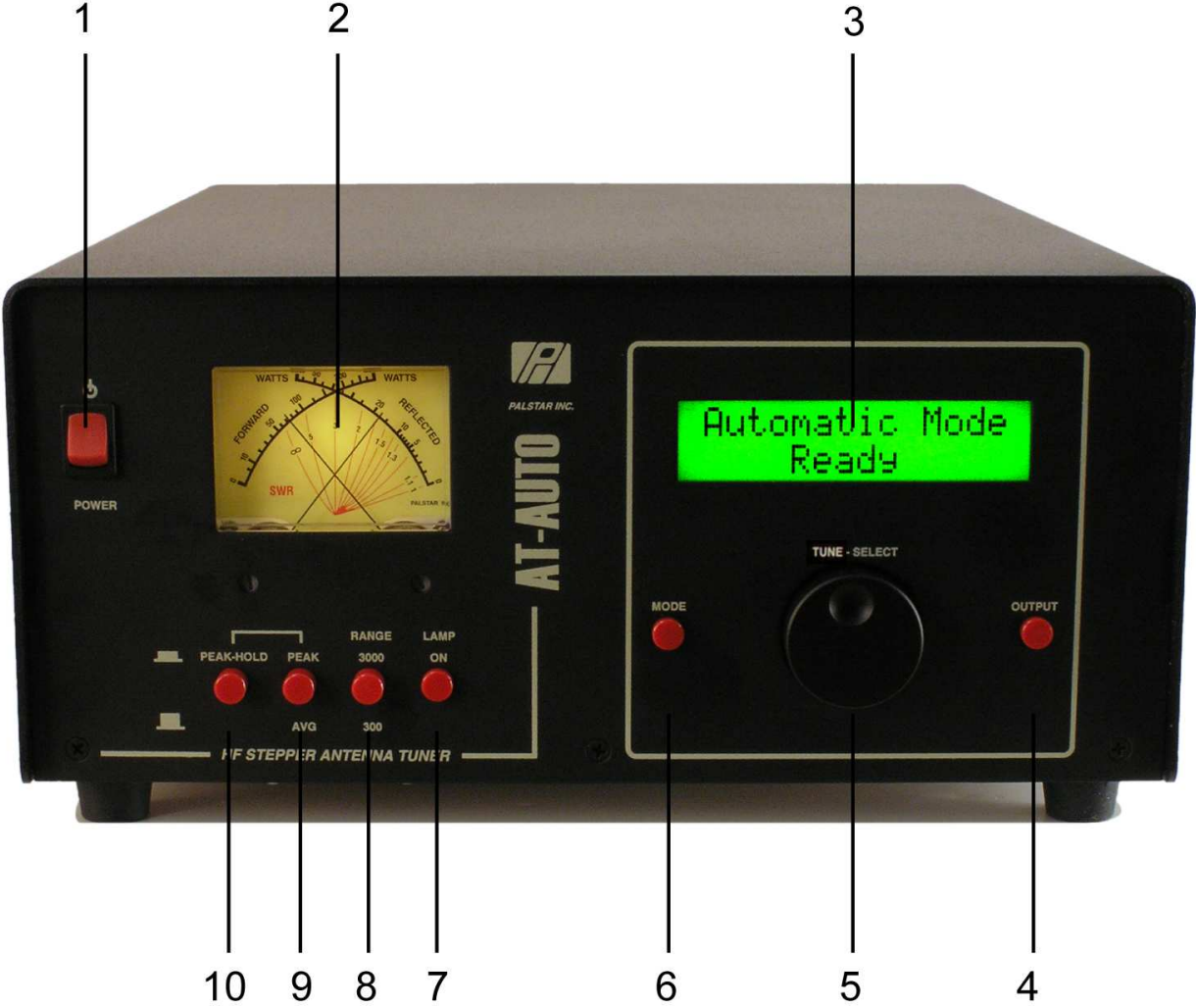


Figure 2.1: Front Panel View

Table 2.1: Front Panel Controls as shown in Figure 2.1

Reference	Control Name or Function
1	Master Power Switch , Controls power to AT-AUTO processor peak-hold meter circuitry, and the meter lamp
2	Power/SWR Meter , Dual-needle meter displays forward and reflected power in Watts. The SWR is displayed on a line beneath the intersection of forward and reflected power needles
3	Main Display , provides AT-AUTO status and user prompts, etc.
4	Output , toggles between Coax or Balanced outputs*
5	Tune-Select , Tuning network settings and configuration options*
6	Mode , user selection of operating mode and setup menu access*
7	Lamp , controls power to the Peak and Peak-Hold meter circuitry and illumination of the Power/SWR meter
8	Range , selection of 3000 Watt (in) or 300 W (out) meter scale
9	Peak , displays peak forward power (in) or average forward power (out)
10	Peak-Hold , holds and displays the highest peak forward power (in)

***Note:** Operating mode determines the actual control function. See the respective operating mode descriptions for actual control function and usage.

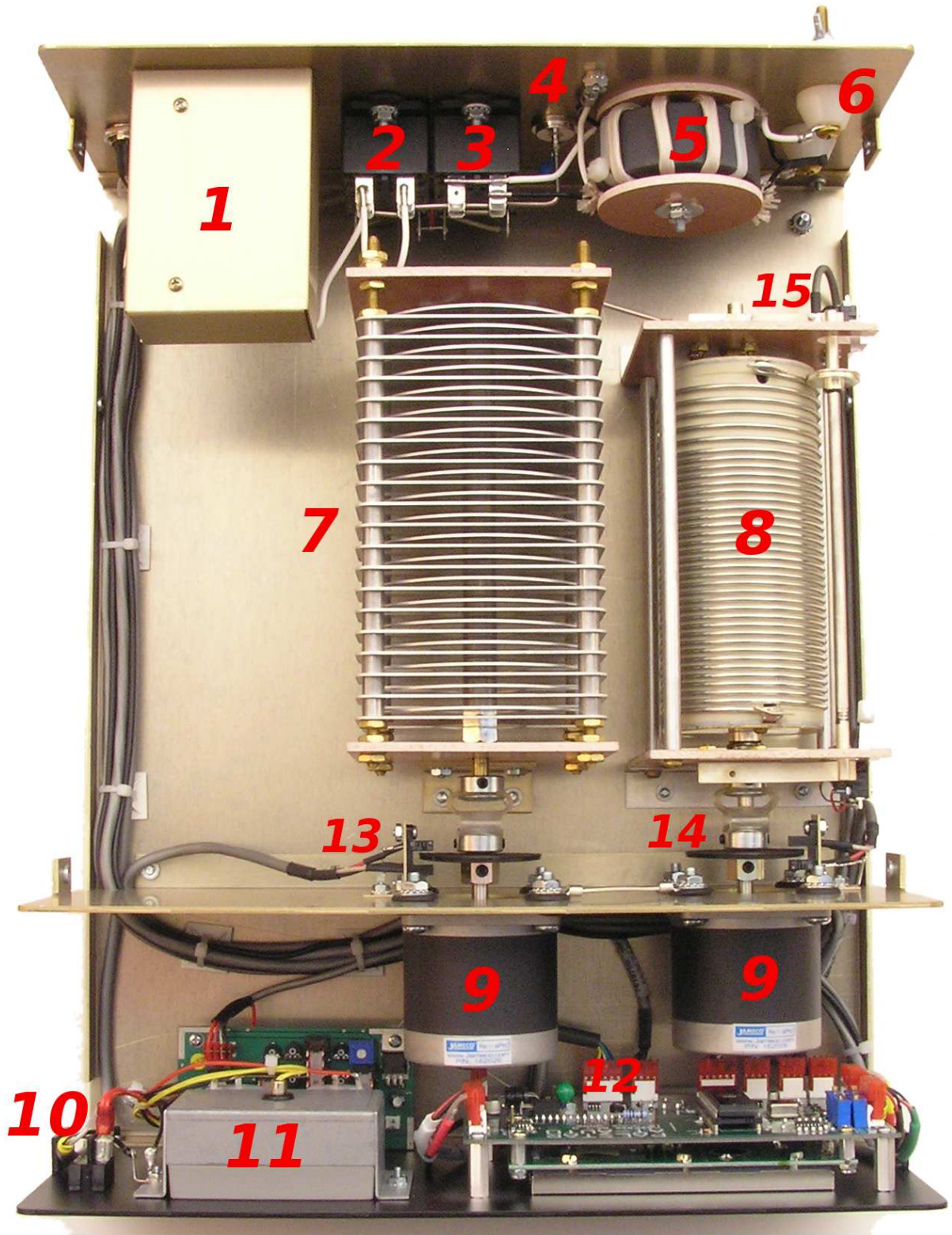


Figure 2.2: Top View (Cover Removed)

Table 2.2: Internal Components as shown in Figure 2.2

Reference	Description
1	RF input and RF directional coupler
2	RF bypass relay
3	RF output selection relay
4	Unbalanced (Coax) RF output
5	4:1 current balun
6	Balanced RF output
7	340-14-340 pF split-stator capacitor
8	26 μ H roller inductor
9	Stepper motor
10	Master power switch
11	Cross-needle power and SWR meter
12	AT-AUTO processor and display
13	Split-stator capacitor gap detector
14	Roller inductor gap detector
15	Roller inductor travel limit switch

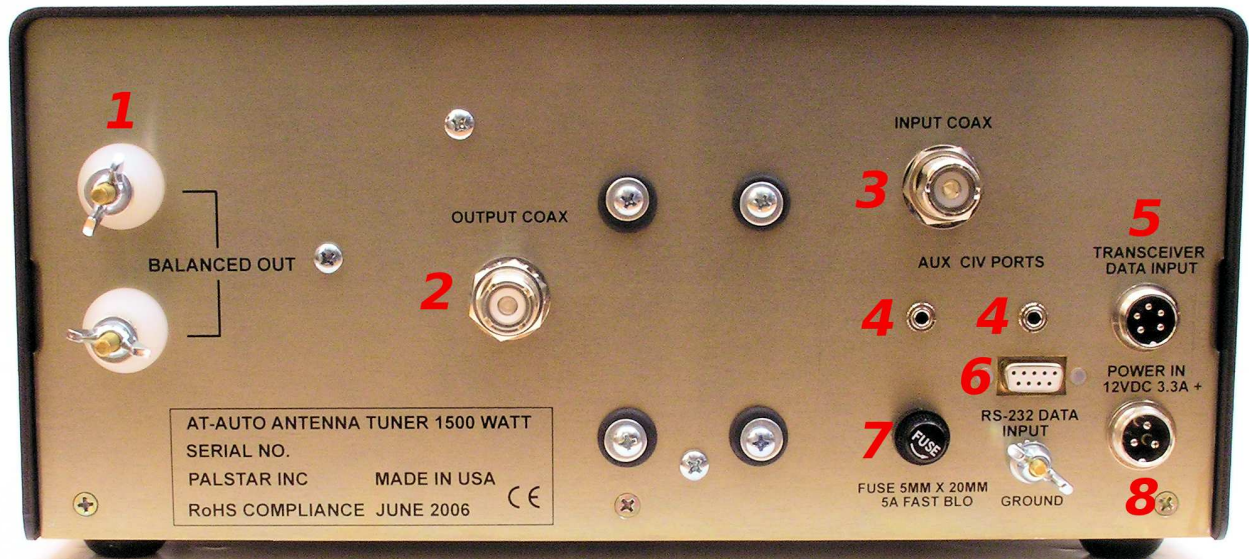


Figure 2.3: Rear Panel View

Table 2.3: Rear Panel Components as shown in Figure 2.3

Reference	Description
1	Balanced RF output
2	Unbalanced (Coax) RF output
3	RF input
4	Auxiliary CI-V jacks
5	Transceiver Data Input. Icom CI-V and external tuner I/O* Kenwood external tuner I/O*
6	RS-232 I/O port. For firmware upgrades and CAT radio interface*
7	5mm X 20mm, 4A 125VAC fast-blow fuse
8	12 VDC input @ ≈ 3.5 A peak while tuning

*Note: Requires specific cable configuration. See Table 7.1 for details.

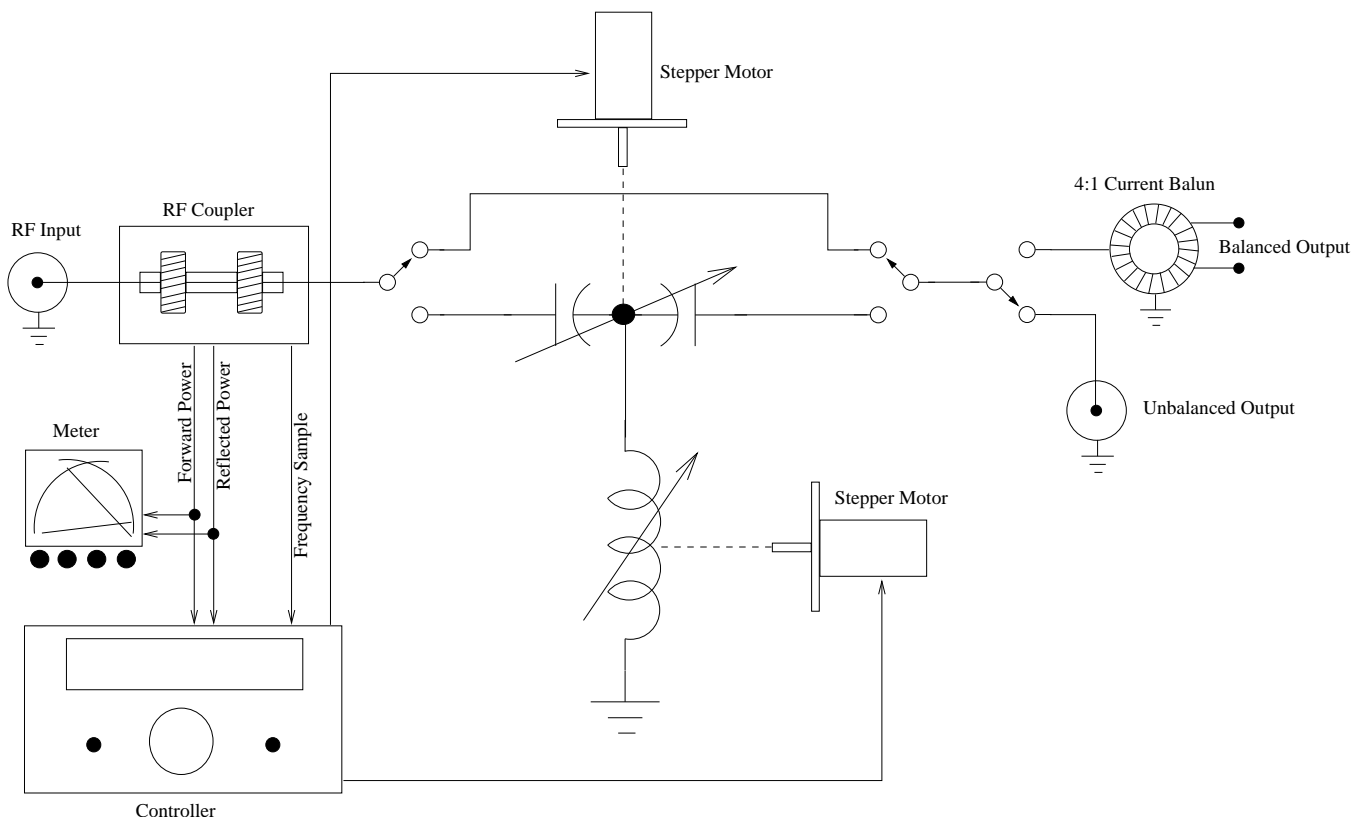


Figure 2.4: Functional Block Diagram

2.2 Principal Of Operation

2.2.1 Automatic Mode

The AT-AUTO is a fully-automatic QRO antenna tuner. It is designed to operate completely without operator intervention, but does provide status and user prompts (if required).

While in *Automatic* mode, the tuner continuously samples forward and reflected power. When forward power exceeds a minimum threshold level of approximately 8-10W, the AT-AUTO calculates the corresponding SWR and initiates automatic tuning if required. If the SWR is below the “Tune Start SWR” threshold (default 1.2:1), the AT-AUTO displays the detected good match along with the numerical capacitor and inductor positions, and the selected RF output.

When/if the SWR exceeds the “Tune Start SWR” (default 1.2:1), the AT-AUTO counts the RF carrier frequency, recalls match settings based upon the carrier frequency and the selected antenna, and then repositions/pre-positions the inductor and capacitor. There are over 500 such memories in the AT-AUTO for storing antenna, L , and C positions. These

memories have been pre-populated with nominal settings at the Palstar facility. Half of these memories are for the balanced output port, and the other half of the memory is for the coaxial output port.

The AT-AUTO uses a roller-inductor for tuning and the initial positioning process may take up to 30 seconds (for example, when repositioning from a setting appropriate for the low-end of the 160m band to something appropriate for the 10m band). During this *L* and *C* positioning process, the RF carrier is not required and in order to minimize potential QRM, the AT-AUTO indicates that the carrier is not required by displaying **Prepositioning L & C, Please QRT**.

Once the capacitor and inductor are positioned within the operating band, the SWR is sampled again and if it is still above the "Tune Start SWR" threshold (default 1.2:1), the tuning process begins (See note below). In order to do this, the AT-AUTO requires a steady carrier to tune against and therefore prompts the user by displaying **PLS TX 10 W CW**. The AT-AUTO will wait in this state indefinitely until it senses a carrier. If the SWR is still above the "Tune Start SWR" threshold, then tuning will begin by adjusting the capacitor and inductor for minimum SWR.

The tuning process continues until it either times out or an SWR at or below the "Tune Stop SWR" (default 1.05:1) is obtained. If the resulting match is at or below the "Tune Stop SWR", the AT-AUTO displays **Good Match, SWR ≤ 1.05:1**. However, if the tuning times out because it was not able to find a match at or below the "Tune Stop SWR", but the resulting match was below the "Tune Start SWR", the AT-AUTO will display **Good Match, SWR ≤ 1.2:1. Whenever a successful match is found the precise L and C settings are stored into memory, and the AT-AUTO indicates that it is storing the match settings**.

If the CW carrier is interrupted before tuning is complete, the AT-AUTO will immediately cease tuning and provide a message indicating that the carrier was lost and that tuning was aborted. Tuning may also be terminated by momentarily pressing the "Mode" button.

The AT-AUTO performs the tuning process in an iterative fashion by alternating adjustment of the *L* or *C* and determining what change in SWR resulted, then by continuing adjustment of the same component until no further improvement in the SWR is made. It then adjusts the alternate component (*C* or *L*) in a similar fashion. The tuning stops when the SWR is below the "Tune Stop SWR" or if the tuning process times out (less than 20 seconds).

In order for the tuning process to be successful, as *L* and *C* positions are adjusted, the corresponding variations in SWR must be discernable by the AT-AUTO controller circuitry. If the AT-AUTO is profoundly mistuned, such as attempting to tune on 10m while *L* and *C* are set for 160m operation, there may be NO discernable variation in SWR as *L* and *C*

are manipulated, and automatic tuning will very likely fail. Therefore before commencing automatic tuning, the AT-AUTO ordinarily presets the L and C for positions appropriate to the frequency/band of operation.

Note: When recalling the end-users previously stored match settings, it is very likely (indeed expected!) that the subsequent SWR will be very low and subsequent tuning will rarely be required.

Smart Mode

The AT-AUTO is designed to operate in a “Smart” mode with those transceivers so equipped with a CI-V or CAT serial I/O interface. When operating in Smart mode, the AT-AUTO continuously determines the transceiver operating frequency via the serial I/O interface and then recalls L and C match settings from memory and rapidly presets L and C as appropriate. As the transceiver operator QSYs from frequency to frequency, or from band to band, the AT-AUTO automatically follows along and presets L and C without the need for the an RF carrier or other operator intervention. This is presently implemented for Icom radios with CI-V interface and Kenwood (TS-570, etc.) and Yaesu (FT-990, FT-1000MP, FT-2000) radios with CAT interfaces.

Handshake Mode

For those radios that provide for control of external tuners, the AT-AUTO is designed to utilize the transceiver’s tuner interface. This is normally via a button on the transceiver labeled, “TUNER.” In Handshake mode, during *Automatic* mode operation, the AT-AUTO is able to signal the transceiver to produce a CW carrier for tuning. The net effect is that the amount of time that the transceiver is required to produce a carrier for tuning is greatly reduced, thereby minimizing potential for QRM. Here is how it works: When the operator presses the TUNER button on the transceiver, the transceiver signals the AT-AUTO that tuning is requested. The AT-AUTO then signals the transceiver to produce a 10W CW/FM carrier at which time the AT-AUTO samples the SWR and counts the frequency (and signals Icom transceivers to stop the carrier). This process takes approximately $\frac{1}{2}$ second. If the SWR exceeds the “Tune Start SWR” threshold, the AT-AUTO then recalls from memory, the appropriate settings for the Capacitor and Inductor and positions them accordingly.

Once the positioning of L and C are complete, the AT-AUTO again signals the transceiver to produce the 10W CW carrier. If the SWR is still excessive, automatic tuning begins. The moment a good match is found, the AT-AUTO signals the transceiver to cease transmitting and the AT-AUTO automatically stores the match settings.

When using Smart and Handshake modes together, the entire automatic tuning process is greatly streamlined. As the user returns to previously-matched frequency/antenna combinations, the AT-AUTO precisely recalls and returns to those matched settings, without

requiring an RF carrier, and often without requiring subsequent re-tuning.

Currently Handshake mode is implemented for Icom and Kenwood radios only. Support for Yaesu and others may follow thereafter.

Fine Tuning

There will be occasions, when the SWR is well below the “Tune Start SWR” threshold, but the operator may wish to improve the match. This may occur when the operator decides to QSY away from the previously matched frequency, but remain in the same band. Rather than repositioning L and C positions from memory, all that is required is for the AT-AUTO to begin tuning by performing fine adjustments of L and C from their present positions.

Fine Tuning is commanded by momentarily pressing the “Tune-Select” rotary knob, when in *Automatic* mode. If the AT-AUTO has been configured for Handshake mode with the transceiver, the entire fine tune process will complete automatically without further intervention (presently only Icom radios support this feature), and the new match settings will be stored in the AT-AUTO memory.

If Handshake mode is not established, the AT-AUTO will prompt the operator to produce a steady carrier as explained above and the fine tuning process will proceed.

Note: When Fine Tune is commanded, the AT-AUTO will use the present L and C positions as the starting point for the fine tuning process. However, if L and C are at grossly inappropriate positions for the current band of operation, commanding Fine Tune will likely result in inability of the AT-AUTO to find a suitable match. For example, if the AT-AUTO was last tuned for 80m operation and then the operator subsequently QSY-ed to 12m without going through the automatic tuning process (or NOT operating in SMART mode!), the L and C are still at their respective 80m settings. Subsequent Fine Tuning does not force repositioning of L and C to the 12m band and tuning will probably fail.

2.2.2 Manual Mode

The AT-AUTO is also a world-class manual tuner, providing the user with precise manual control of the matching network via the front panel controls and the cross-needle SWR meter. The operator manipulates the “Tune-Select” rotary encoder/pushbutton to provide positioning commands to the AT-AUTO microprocessor, which then drives the stepper motors and positions the inductor and capacitor. There is no “heavy lifting” on the part of the operator. The microprocessor monitors the position of the roller inductor and automatically limits the inductor travel to prevent the roller inductor’s contact wheel from striking the hard stops at the ends of the roller inductor coil.

Automatic mode is the default startup mode, but *Manual* mode or *Bypass* mode can be made the default startup mode by appropriate configuration of the AT-AUTO firmware (See

Firmware Configuration section).

The primary control is the “Tune-Select” knob. Turning this knob will force the microprocessor to move L or C , depending upon which one was selected. Momentarily pressing the “Tune-Select” knob toggles between control of the capacitor or inductor.

Handshake Mode

The AT-AUTO is able to signal some Icom and Kenwood transceivers to produce a CW carrier for tuning. When the operator presses the TUNER button on the transceiver, this action is conveyed via the tuner handshaking lines to the AT-AUTO which then controls the transceiver, forcing it to produce a low-power (nominal 10W FM) carrier that the operator may then use to manually tune with.

Once the operator has completed manual tuning, he may then force the transceiver to drop the carrier by either pushing the radio’s TUNER button again or by pressing the “Output” knob on the AT-AUTO for approximately 2 seconds. Icom radios may also be commanded to produce a constant carrier by pressing the AT-AUTO’s “Output” knob for 2 seconds.

When tuning manually, the user will be at the front controls of the AT-AUTO. It therefore makes sense that the user be able to control the carrier directly from the AT-AUTO. The transceiver TUNER button or the AT-AUTO “Output” button may then be used to toggle the steady carrier on or off as needed.

2.2.3 Bypass Mode

Bypass mode is provided for those circumstances when the RF should not be routed through the RF matching network, such as when using a StepIR type of antenna or otherwise resonant antenna systems. *Bypass* mode operation of the AT-AUTO is nearly identical with the *Manual* mode, described previously.

While in *Bypass* mode, the RF matching network may be adjusted via the “Tune-Select” knob, but will have absolutely no effect on the apparent SWR until RF is routed through the AT-AUTO by switching to *Automatic* or *Manual* mode. Handshaking operation is not available when in *Bypass* mode.

The operator manipulates the “Tune-Select” rotary encoder/pushbutton to provide positioning commands to the AT-AUTO microprocessor, which then drives the stepper motors and positions the inductor and capacitor. The microprocessor monitors the position of the roller inductor and automatically limits the inductor travel to prevent the roller inductor’s wheel contact from striking the hard stops at the ends of the roller inductor coil.

The primary control is the “Tune-Select” knob. Turning this knob will force the micro-

processor to move L or C , depending upon which one was selected. Momentarily pressing the “Tune-Select” knob toggles between control of the capacitor or inductor.

Bypass mode may be made the default startup mode by appropriate configuration of the AT-AUTO firmware (See Firmware Configuration section).

Table 2.4: Specifications

Metering/Display	Dual movement cross-needle with Peak, Peak-Hold, power and frequency compensated coupler, 2X16 LCD alpha-numeric display
Front Panel Controls	
Capacitor	Variable 340pF-14pF-340pF, 5KV Differential
Inductor	26 μ H, 12 ga. wire wound on steatite ceramic core, silver-plated shaft & hardware
Power Range Switch	2-Position, 300/3000 W, manually switched
Real Panel Connectors	
Input Coax	SO239 Teflon connector
Output Coax	SO239 Teflon connector
Balanced Out	Dual high-voltage Nylon66 terminal posts
12 VDC Input	3-Pin Amphenol connector
Aux CIV Ports	Standard $\frac{1}{8}$ " mono jacks
Transceiver Data Input	5-Pin Amphenol connector
RS-232 Data Input	DB-9 Female
Fuse Holder	5mm X 20mm, 4A 125VAC fast-blo
General Specifications	
Frequency Range	1.8-54 MHz
Power Handling	1800 W PEP SSB, 1500 W single-tone continuous
Impedance Range	15 – 1500 Ω , 160 – 6m
Balanced Output	4:1 current balun
Tuning Time	\approx 1 – 30 seconds
Tuning Method	Microprocessor-controlled, stepper motor-driven differential T impedance matching network
Dimensions	12.5" Wide, 5.5" High, 16" Deep (including terminals)
Weight	17 Lbs
Materials	Chassis and top cover are .090 ga. aluminum, gold iridite, Front panel powder coated and epoxy screened

Quickstart Guide

Note: The AT-AUTO default behavior is to always enter the automatic mode when power is applied. The antenna last selected as well as the positions of the roller inductor and capacitor are automatically stored and subsequently recalled when the AT-AUTO is turned on. The AT-AUTO default behavior is user configurable – See the Firmware Configuration section for more details.

In *Automatic* mode, the AT-AUTO autonomously controls when tuning should start and stop, prompting the user if necessary. During *Manual* mode operation, the user controls the tuning network via the “Tune-Select” rotary knob. *Bypass* mode is similar to *Manual* mode except that RF never flows through the RF matching network.

Note! Wait at least 2 seconds after the last movement of the Inductor or Capacitor before removing DC power or turning *Off* the AT-AUTO. The AT-AUTO saves the Inductor and Capacitor positions in non-volatile EEPROM. **If this process is interrupted or otherwise not permitted to complete, synchronization of the inductor and capacitor will be lost and any subsequent automatic tuning attempt will likely fail. If this happens, re-home the inductor and capacitor.** Firmware version 2.01 (and subsequent) will automatically re-home L and C if the memory write was interrupted.

Note: Always consult your transceiver manufacturer’s instruction manual prior to attempting to interface/operate the radio with the AT-AUTO.

Kenwood Owners: The following information is taken from the Kenwood TS-570S instruction manual.

1. Page 48: “Note: Connect an external antenna tuner to the ANT 1 connector only. After connecting this tuner correctly and selecting ANT 1, the internal tuner will always be bypassed.”
2. Page 61: “Note: While using an external antenna tuner with the TS-570S, you cannot use the 6m band to transmit. Connect your 6 m band antenna to the ANT 2 connector.”

3.1 Automatic Mode

For operation in the *Automatic* mode, please follow these steps:

1. Connect the tuner input to the transceiver with a 50 Ω coaxial cable.
2. Connect the antenna to the tuner output (Coax or Ladder Line).
3. Connect the supplied external power supply to the tuner.
4. Turn *On* the AT-AUTO. The AT-AUTO will display the installed firmware version for 2 seconds and then enter the *Automatic* (default) mode.
5. Select the desired tuner output (balanced/coax) by momentarily pressing the “Output” button.
6. Set the transceiver to the intended operating frequency.
7. Generate a 10-100 W CW/FM carrier on the intended operating frequency.

Note: The AT-AUTO will measure the SWR, and if necessary preset the inductor and capacitor to positions appropriate for the band of operation and then will begin tuning. The presetting operation may take up to 30 seconds when switching from very-low to very-high or from very-high to very-low frequency bands (such as QSYing from 160m to 10m).

8. Follow the prompts on the AT-AUTO display.

Note: When the tuner displays **PLS TX 10 W CW**, you should continuously transmit the FM/CW carrier until tuning is completed. Once tuning is complete, stop transmitting the carrier. **The position of the inductor and capacitor are automatically stored for future retrieval when returning to the same operating frequency.**

3.2 Manual Mode Operation

1. Follow steps 1-7 described above in *Automatic* mode.
2. Select Manual-Mode by momentarily depressing the “Mode” switch.

Note: The display will show *Manual* mode as well as indicate the position of the capacitor, the currently selected antenna, and the position of the inductor in 2nd line of the AT-AUTO display.

3. Generate a 10-100 W CW/FM carrier.

4. Adjust Capacitor and Inductor while observing the SWR on the meter by turning “Tune-Select” knob. The respective C and L positions are shown on the LCD. Switch between Capacitor and Inductor control by momentarily depressing the “Tune-Select” knob.

Note: Wait at least 2 seconds after the last movement of the Inductor or Capacitor before removing DC power or turning *Off* the AT-AUTO. Firmware version 2.01 (and subsequent) will automatically re-home L and C if the memory write was interrupted.

3.3 Bypass Mode Operation

1. Follow steps 1-7 described above in *Automatic* mode.
2. Select Bypass-Mode by repeatedly depressing the “Mode” switch.

Note: The display will show *Bypass* mode as well as indicate the position of the capacitor, the currently selected antenna, and the position of the inductor in 2nd line of the AT-AUTO display.

3. User may adjust Capacitor and Inductor but because RF bypasses the tuning network, repositioning L or C will have **NO** effect on the SWR. The respective C and L positions are shown on the LCD. Switch between Capacitor and Inductor control by momentarily depressing the “Tune-Select” knob.

Note: Wait at least 2 seconds after the last movement of the Inductor or Capacitor before removing DC power or turning *Off* the AT-AUTO. Firmware version 2.01 (and subsequent) will automatically re-home L and C if the memory write was interrupted.

Detailed Operation

Note: Always consult your transceiver manufacturer’s instruction manual prior to attempting to interface/operate your radio with the AT-AUTO.

Kenwood Owners: The following information is taken from the Kenwood TS-570S instruction manual.

1. Page 48: “Note: Connect an external antenna tuner to the ANT 1 connector only. After connecting this tuner correctly and selecting ANT 1, the internal tuner will always be bypassed.”
2. Page 61: “Note: While using an external antenna tuner with the TS-570S, you cannot use the 6m band to transmit. Connect your 6 m band antenna to the ANT 2 connector.”

4.1 General Description

The AT-AUTO has three primary controls, the “Mode” and “Output” pushbuttons, and the “Tune-Select” rotary encoder/pushbutton, respectively. Depending upon the mode of operation, the action currently taking place, user-selected firmware options, and the type of radio attached/interfaced with the AT-AUTO, these buttons provide various AT-AUTO control features. Generally each button will provide a different function depending upon the length of time that the particular button is depressed. Tables 4.1, 4.2, and 4.3, on pages 20, 23, and 26, lists the control function provided by each of these three controls when operating in *Automatic*, *Manual*, or *Bypass* mode, respectively.

4.2 Automatic Mode

When first turned on, the AT-AUTO momentarily displays the firmware version in the LCD. Approximately two seconds later, the AT-AUTO will enter *Automatic* mode (unless the default firmware configuration was changed) and will begin sampling Forward power.

For normal *Automatic* mode operation, no operator intervention is intended/required other than selection of the intended RF output (Balanced or Coaxial). Merely apply RF power and observe/follow the prompts shown in the Liquid Crystal Display (LCD). The automatic tuning process is shown in flow-chart style in Figure 4.1 on page 21.

The AT-AUTO remembers and automatically selects the RF output that had been in-use when the AT-AUTO was last switched-off. While in *Automatic* Mode, the AT-AUTO continuously monitors Forward power. Whenever approximately 10 W of Forward power has been detected, the AT-AUTO calculates the corresponding SWR and responds appropriately.

If the SWR is determined to be less than the “Tune Start SWR” threshold (default 1.2:1) or better, the AT-AUTO displays “Good Match” on the LCD display as well as the relative *C* and *L* positions and the selected RF output.

Should the SWR exceed the “Tune Start SWR” threshold (default 1.2:1), the AT-AUTO will attempt to improve that match to the “Tune Stop SWR” threshold (default 1.05:1) or better. First, the AT-AUTO counts the RF frequency and then recalls the *L* and *C* match settings. It then automatically repositions *L* and *C* to the recalled match settings and the AT-AUTO the user that this is taking place. If the recalled *L* setting is far removed from its present setting, the AT-AUTO will prompt the user to temporarily drop the carrier.

Once the inductor and capacitor have been repositioned, the AT-AUTO prompts the user to provide a steady carrier. The AT-AUTO will wait indefinitely until either a carrier is applied or the user aborts the automatic tuning. The user should apply a steady 10 W minimum carrier (FM or CW). SSB or modulated AM are NOT appropriate.

If the recalled *L* and *C* settings were for a previously derived match, it is indeed very likely that the preset *L* and *C* settings will provide a good match and the SWR will be less than the “Tune Start” threshold (default 1.2:1) and no further tuning will be required. However, if the resultant SWR exceeds the 1.2:1 threshold, the AT-AUTO will commence automatic tuning. While automatic tuning is proceeding, the AT-AUTO displays the changing *C* and *L* positions and indicates that automatic tuning is taking place. Upon finding a good match, the AT-AUTO displays the matched SWR and immediately stores the match settings in non-volatile memory.

Note! Wait until the AT-AUTO has finished saving the new match settings and the LCD is again displaying “Automatic Mode, Ready” before removing DC power or turning *Off* the AT-AUTO. The new match settings are permanently stored by overwriting sections of the AT-AUTO firmware. **If this process is interrupted or otherwise not permitted to complete, the firmware may become corrupted, requiring reloading the firmware and/or completely reprogramming the microprocessor at the Palstar facilities.**

When interfaced with a CI-V or CAT-supported radio, the AT-AUTO will also automatically follow the radio’s frequency changes by immediately recalling the corresponding match

settings and presetting the inductor and capacitor accordingly.

When interfaced with a radio that also provides control of an external tuner such as an Icom AH-4, or Kenwood AT-300, the radio's external tuner control circuitry provides hardware handshaking between the radio and the AT-AUTO. The user may then momentarily press the radio's **TUNER** button to initiate automatic tuning. When this happens, the **TUNER** button signals the AT-AUTO that tuning is requested. The AT-AUTO then forces the radio to generate a low-level RF carrier (typically 10 W FM). Once the AT-AUTO senses the RF carrier, it calculates SWR and follows the automatic tuning process previously described. Once the RF carrier is no longer required, the AT-AUTO causes the radio to drop the RF carrier.

When interfaced with an Icom radio with external tuner I/O control, the AT-AUTO is likewise capable of controlling RF carrier generation whenever "fine tune" is commanded.

Table 4.1: Automatic Mode Control Functions

"Mode" Pushbutton	
Short Duration Press	If Tuning In Progress: Aborts automatic tuning attempt If Tuner Idle: Selects <i>Manual</i> mode
Medium Duration Press	No effect
Long Duration Press	Selects AT-AUTO "Configuration Menu"
"Tune-Select" Knob	
Short Duration Press	If Tuner Idle: Commands "Fine Tune" If Prompted: Give user consent to attempt automatic tuning
Medium Duration Press	No effect
Long Duration Press	No effect
Turn CW or CCW	No Effect
"Output" Pushbutton	
Short Duration Press	If band was "auto-bypassed": Routes RF through AT-AUTO If not "auto-bypassed": Toggles output to COAX/Balanced
Medium Duration Press	No effect
Long Duration Press	No effect
"Duration" Definition	
Short	\leq 1 second
Medium	2-3 Seconds
Long	\geq 10 seconds

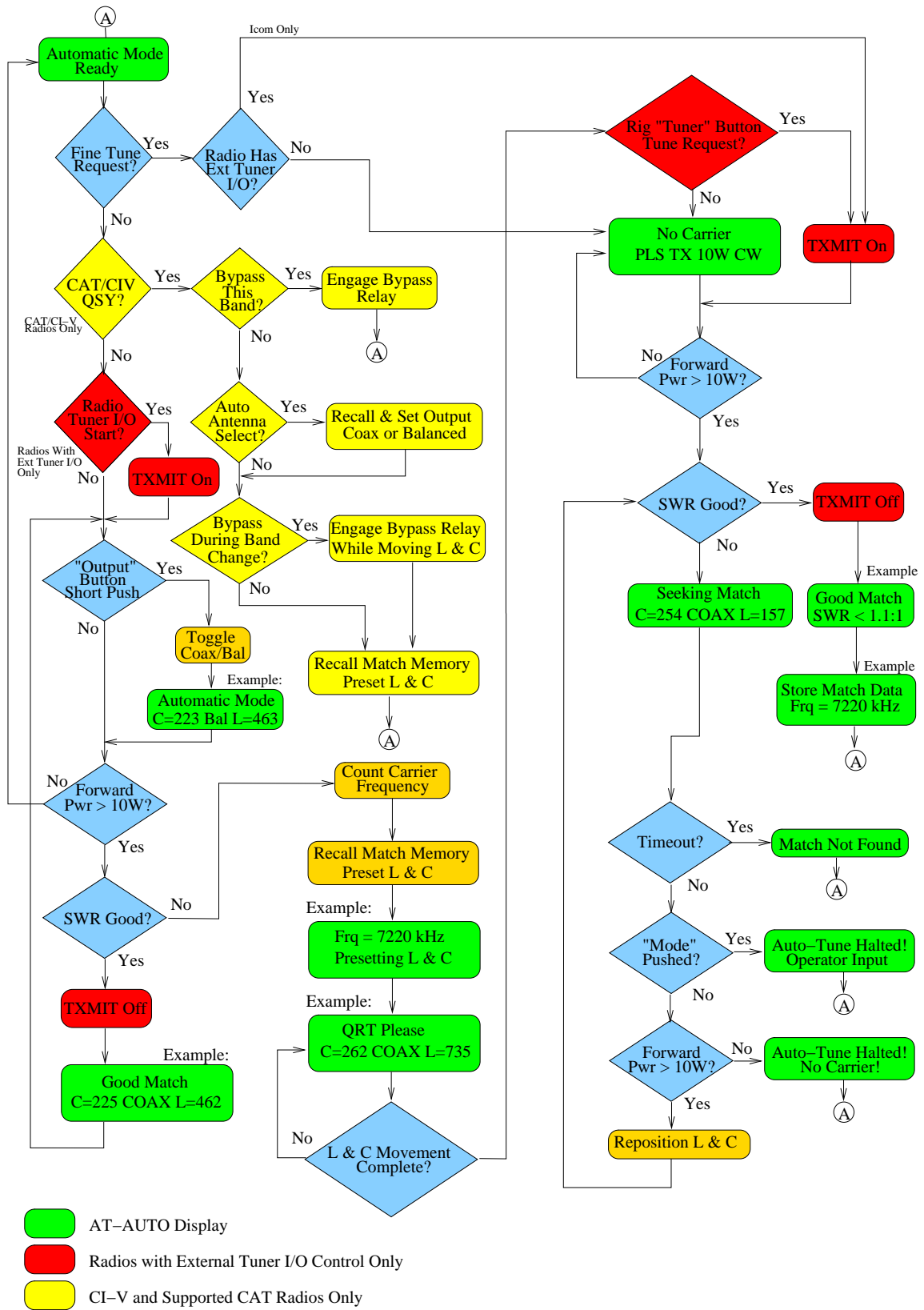


Figure 4.1: Automatic Mode Process

4.3 Manual Mode

The AT-AUTO is world-class manual tuner. *Manual* mode is selected by momentarily pressing the “Mode” pushbutton until the AT-AUTO display shows “Manual Mode” (See Figure 4.2).

During *Manual* mode operation, the user provides control inputs via the “Tune-Select” rotary knob/pushbutton to the AT-AUTO microprocessor, which then actuates the stepper motors and repositions the inductor and capacitor. The position of the capacitor, inductor and the selected output are constantly displayed to the user, such as shown in Figure 4.2.



Figure 4.2: Example Manual Mode Display

By observing the Forward and Reflected power on the AT-AUTO cross-needle display, and by simple manipulation of the “Tune-Select” knob the user is afforded the ability to readily effect manual tuning of the AT-AUTO. Furthermore, when interfaced with a radio that also provides control of an external tuner such as an Icom (AH-4), or Kenwood (AT-300), the radio’s external tuner control circuitry provides the AT-AUTO with a means of radio hardware control and may be used to produce a low-power RF carrier to facilitate tuning the AT-AUTO.

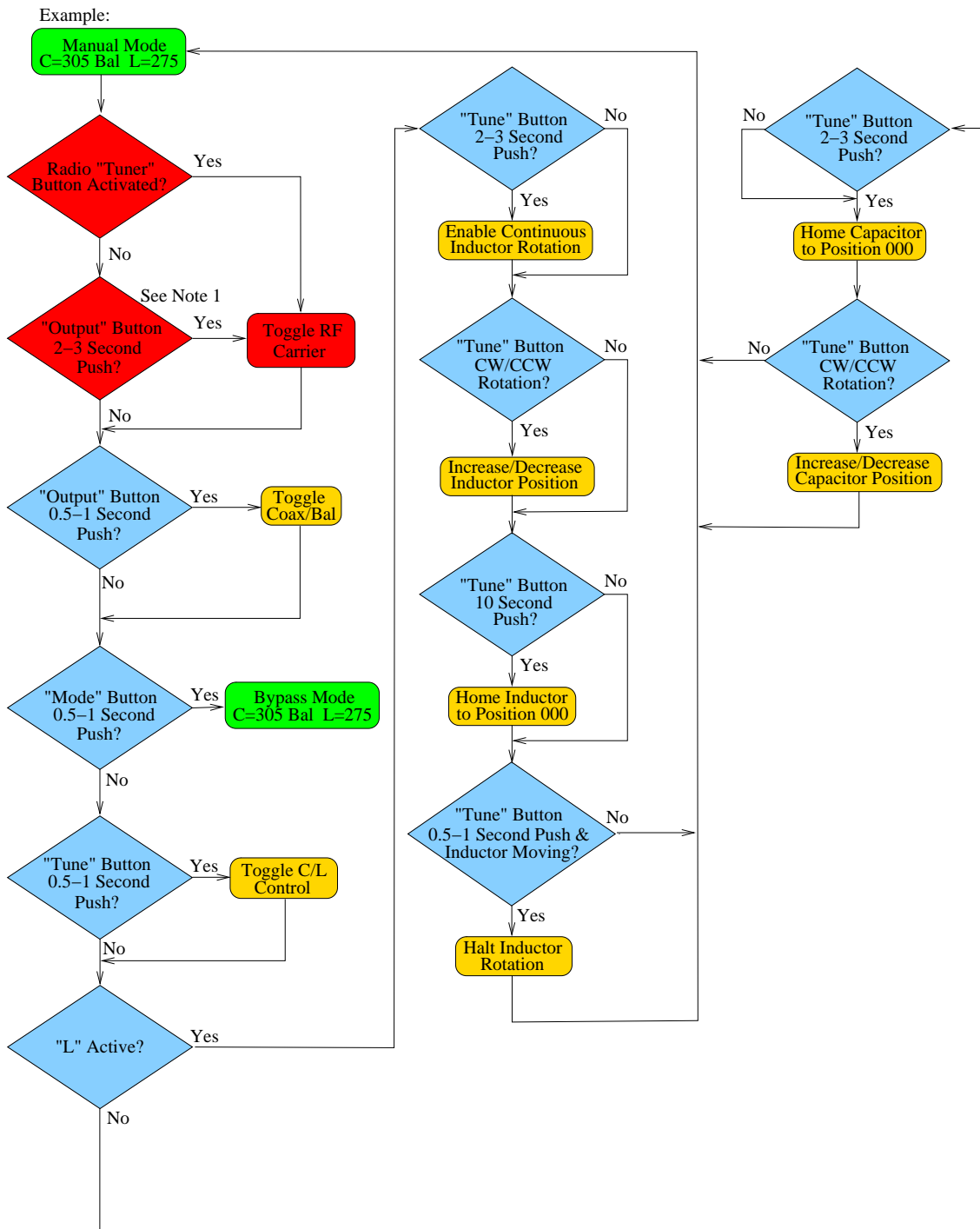
The user may momentarily press the radio’s **TUNER** button when initiating manual tuning. The radio’s **TUNER** button signals the AT-AUTO that a steady low-power carrier is requested. The AT-AUTO then forces the radio to generate a low-level RF carrier (typically 10 W FM). The user then tunes the AT-AUTO by repositioning the *L* and *C* and observing the variation in SWR on the cross-needle meter.

When tuning is complete, the carrier may be stopped by pressing the radio’s **TUNER** button, or the pressing the AT-AUTO “Output” button for 2-3 seconds. Pressing the AT-AUTO “Output” button for 2-3 seconds, when interfaced with an Icom radio with external tuner control, will toggle the Icom radio’s low-power carrier *On/Off*.

Table 4.2 lists the control function provided by each of these three controls when operating in *Manual* mode, and Figure 4.3 on page 24 illustrates the AT-AUTO *Manual* mode process.

Table 4.2: Manual Mode Control Functions

“Mode” Pushbutton	
Short Duration Press	Selects <i>Bypass</i> mode
Medium Duration Press	No effect
Long Duration Press	No effect
“Tune-Select” Knob	
Short Duration Press	Toggles <i>C/L</i> control
Medium Duration Press	If <i>L</i> Active: Causes <i>L</i> to turn continuously If <i>C</i> Active: Causes <i>C</i> to home to 000
Long Duration Press	If <i>L</i> Active: Causes <i>L</i> to home to 000 If <i>C</i> Active: No effect
Clockwise/counter-clockwise Rotation	Increase/Decrease relative <i>C/L</i> position
“Output” Pushbutton	
Short Duration Press	Toggles RF Output (Coax/Balanced)
Medium Duration Press	Toggles 10 W carrier for manual tuning (Icom Radios with Tuner I/O only)
Long Duration Press	No effect
“Duration” Definition	
Short	\leq 1 second
Medium	2-3 Seconds
Long	\geq 10 seconds



- AT-AUTO Display
- Radios with External Tuner I/O Control Only

Note 1: Able to repeatedly toggle Icom transmitter On/Off.
Kenwood Radios do not support transmitter turn On from remote tuner.

Figure 4.3: Manual Mode Process

4.4 Bypass Mode

The AT-AUTO *Bypass* mode is designed to permit the user to completely bypass RF power around the AT-AUTO RF matching network, while also permitting the user to manipulate L and C . *Bypass* mode operation is nearly identical to Manual mode operation, except that the AT-AUTO does not utilize external tuner control provided by some Icom and Kenwood radios. *Bypass* mode is selected by momentarily pressing the “Mode” pushbutton until the AT-AUTO display shows “Bypass Mode” (See Figure 4.4).

During *Bypass* mode operation, the user provides control inputs to the AT-AUTO micro-processor via the “Tune-Select” rotary knob/pushbutton, which then actuates the stepper motors and repositions the inductor and capacitor. The position of the capacitor, inductor and the selected output are constantly displayed to the user, such as shown in Figure 4.4.



Figure 4.4: Example Bypass Mode Display

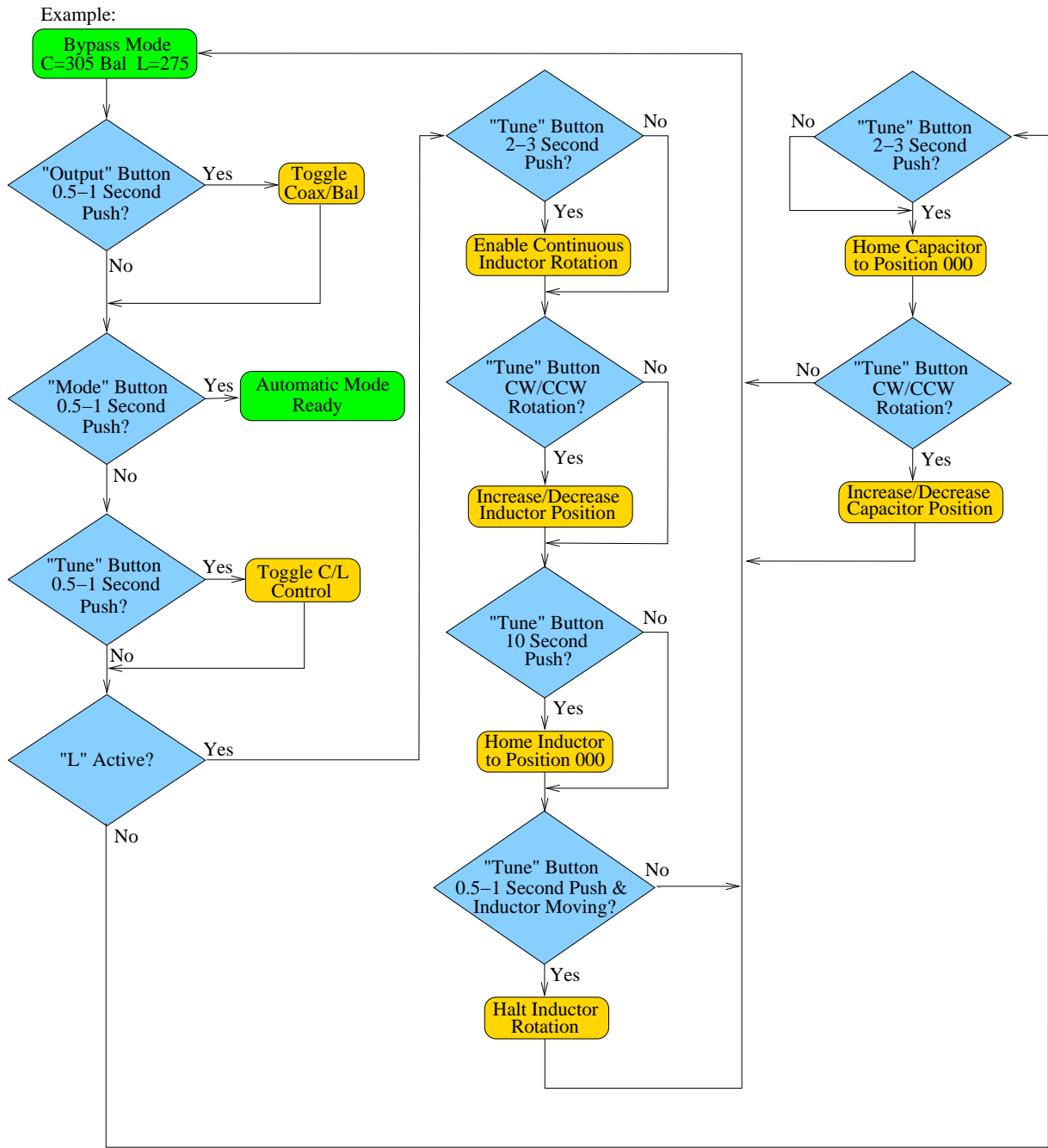
While in *Bypass* mode, repositioning L or C will have NO effect on observed SWR.

Table 4.3 lists the control function provided by each of these three controls when operating in *Bypass* mode, and Figure 4.5 illustrates the AT-AUTO *Bypass* mode.

Note: *Bypass* mode and bypass capability are only possible if the RF bypass hardware is installed in the AT-AUTO. 1st generation AT-AUTOs lacked bypass capability. All current production AT-AUTOs support *Bypass* mode.

Table 4.3: Bypass Mode Control Functions

“Mode” Pushbutton	
Short Duration Press	Selects <i>Automatic</i> mode
Medium Duration Press	No effect
Long Duration Press	No effect
“Tune-Select” Knob	
Short Duration Press	Toggles <i>C/L</i> control
Medium Duration Press	If <i>L</i> Active: Causes <i>L</i> to turn continuously If <i>C</i> Active: Causes <i>C</i> to home to 000
Long Duration Press	If <i>L</i> Active: Causes <i>L</i> to home to 000 If <i>C</i> Active: No effect
Clockwise/counter-clockwise Rotation	Increase/decrease capacitance or inductance
“Output” Pushbutton	
Short Duration Press	Toggles RF Output (Coax/Balanced)
Medium Duration Press	No effect
Long Duration Press	No effect
“Duration” Definition	
Short	\leq 1 second
Medium	2-3 Seconds
Long	\geq 10 seconds



 AT-AUTO Display

Figure 4.5: Bypass Mode Process

Firmware Configuration

5.1 General Description

The AT-AUTO firmware feature set has been expanded to further enable tailoring AT-AUTO's behavior to better suit the users' specific requirements. The user may configure the AT-AUTO firmware via the AT-AUTO's service menu. The service menu is accessed from the AT-AUTO front-panel controls. This section of the users' manual provides detailed instructions for customizing the AT-AUTO behavior.

5.2 Default AT-AUTO Settings

When leaving the Palstar factory and whenever the user uploads new firmware, the AT-AUTO firmware will be reset to default settings. The default settings are shown in Figure 5.2 on page 30 and listed here:

1. Initiate Tuning Autonomously
 - Autotune Start SWR 1.2:1
 - Autotune Stop SWR 1.05:1
2. Radio - "Vintage Rig"
3. Startup Mode - *Automatic*
4. Icom CI-V
 - Transceive from Any Icom
 - AT-AUTO CI-V Address - 0xE0
 - Rig CI-V Address - 0x64
5. Auto Antenna Select - No
 - Bypass During Bandchange - Yes
 - Auto Select 160m, 80m, etc., - Through to Coax
6. Bypass Circuitry Installed - Yes
7. Serial I/O - 9600 Baud, 8 Bit, No Parity, 1 Stop Bit

5.3 Accessing the Service Menu

All of the user firmware options are accessed through the AT-AUTO firmware service menus. The configuration menus and sub menus are fairly self-explanatory but are described in this and subsequent sections. The configuration settings are all selected and controlled from the front panel “Tune-Select” knob. Different menus are accessed by turning the rotary “Tune-Select” knob and configuration options are selected or enabled/disabled by momentarily pressing the “Tune-Select” knob.

Follow these steps to access the service menu:

1. Turn *ON* the AT-AUTO.
2. Place the AT-AUTO in *Automatic* mode.
3. Press and hold the “Mode” button for 10 seconds and then release.

The AT-AUTO will display:



Figure 5.1: LCD Display - Service Menu Exit Prompt.

The service menu configuration options are shown in Figure 5.2. To access the various sub menus, merely rotate the “Tune-Select” knob in either direction. When the desired sub-menu item is displayed, momentarily depress the “Tune-Select” knob. Whenever “Exit?” is displayed, momentarily pressing the “Tune-Select” knob will exit that particular menu. Some sub-menus will exit automatically after running through all of the user options.

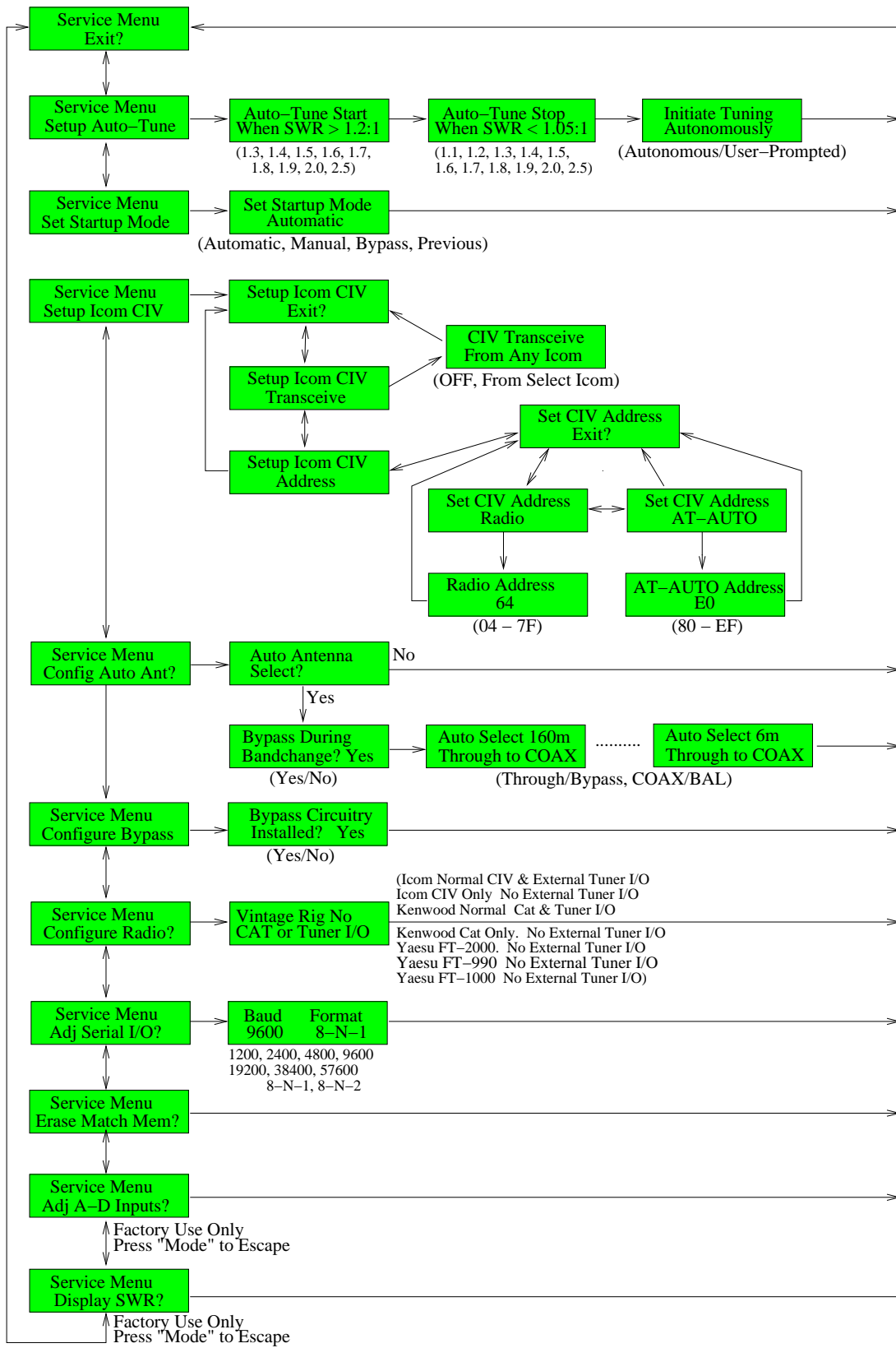


Figure 5.2: Setup: Configuration Options and Flowchart.

5.3.1 Setup Auto-Tune

The AT-AUTO is designed to automatically monitor Forward and Reflected power and then to autonomously commence tuning whenever the SWR exceeds the “Tune Start SWR” (default 1.2:1) and then to stop tuning whenever the SWR is below the “Tune Stop SWR” (default 1.05:1). The default thresholds are very aggressive as the AT-AUTO will attempt to tune whenever the SWR exceeds 1.2:1 and will not stop tuning until the SWR is less than 1.05:1.

Depending upon the particular circumstances, the user may prefer other tune starting and stopping thresholds, particularly if the antenna is subject to significant variations in resonance such as might be encountered with a long-wire antenna being blown around in a strong wind. The SWR thresholds are therefore now user selectable.

The user may set the “Tuning Start SWR” from between 1.1:1 to 2.5:1 and the “Tuning Stop SWR” from between 1.05:1 to 2.0:1. The firmware is designed to prevent selection of a tuning-stop SWR that exceeds the tuning-start SWR.

The user may also disable autonomous tuning initiation by configuring the AT-AUTO to require operator concurrence before commencing automatic tuning – This is particularly useful if the user wishes to prevent autonomous tuning commencement when using an RF linear amplifier.

To configure the automatic tuning SWR thresholds as well as enable/disable autonomous tuning initiation, from the “Service” menu, follow these steps:

1. Turn the front-panel “Tune-Select” knob until Figure 5.3 is displayed.



Figure 5.3: Automatic Tuning Menu

2. Momentarily press the “Tune-Select” knob.

The AT-AUTO will then enter the automatic tuning configuration setup and will display the currently selected SWR level necessary to initiate autonomous tuning. The user-selectable SWR thresholds are shown in Table 5.1.

Rotate the “Tune-Select” knob in a clock-wise direction until the desired SWR level to initiate automatic tuning is displayed. Then momentarily press the “Tune-Select” knob.

Table 5.1: Supported SWR Tuning Thresholds

Tune Start	Tune Stop
SWR $\geq 1.2 : 1$	SWR $\leq 1.05 : 1$
SWR $\geq 1.3 : 1$	SWR $\leq 1.1 : 1$
SWR $\geq 1.4 : 1$	SWR $\leq 1.2 : 1$
SWR $\geq 1.5 : 1$	SWR $\leq 1.3 : 1$
SWR $\geq 1.6 : 1$	SWR $\leq 1.4 : 1$
SWR $\geq 1.7 : 1$	SWR $\leq 1.5 : 1$
SWR $\geq 1.8 : 1$	SWR $\leq 1.6 : 1$
SWR $\geq 1.9 : 1$	SWR $\leq 1.7 : 1$
SWR $\geq 2.0 : 1$	SWR $\leq 1.8 : 1$
SWR $\geq 2.5 : 1$	SWR $\leq 1.9 : 1$
	SWR $\leq 2.5 : 1$

This will cause your particular selection to be stored into nonvolatile memory and the display will advance to enable selection of the desired level to cause automatic tuning to stop.

Now select the SWR level at which tuning is considered successful and automatic tuning should cease by rotating the “Tune-Select” knob in a clock-wise direction until the desired SWR level is displayed. Then momentarily press the “Tune-Select” knob. This will save this setting in nonvolatile memory and the display will then advance to permit disabling/enabling (default) autonomous tuning initiation.

The user may disable autonomous tuning initiation by selecting “User-Prompted”. When “User-Prompted” is selected, the AT-AUTO will provide a warning to the user and will not start tuning without an input from the user. Rotate the “Tune-Select” knob until the desired tuning initiation option is displayed and then depress the “Tune-Select” knob. The selection will be saved and the display will return to the exit prompt as shown in Figure 5.1.

5.3.2 Set Startup Mode

When powered *ON*, the AT-AUTO enters the *Automatic* Mode by default. The user may configure the AT-AUTO to instead enter either *Manual* or bypass *Bypass*, or the mode last in use when the AT-AUTO was turned *OFF*. To set the startup mode, from the service menu, rotate the “Tune-Select” knob until Figure 5.4 is displayed. Momentarily press the “Tune-Select” knob and the startup mode submenu will open and display the current startup mode setting. Rotate the “Tune-Select” knob until the desired startup mode is displayed.

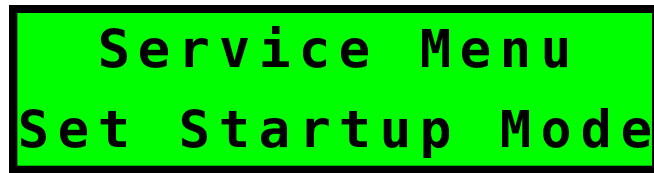


Figure 5.4: Startup Mode Menu.

When the desired startup mode is displayed, momentarily press the “Tune-Select” knob and that setting is automatically saved and the user is brought back to the service menu exit prompt as shown in Figure 5.1.

5.3.3 Setup Icom CI-V

This submenu is only applicable if the AT-AUTO is connected to a CI-V equipped Icom radio, or if intending to remotely control the AT-AUTO. If not, then this section should be ignored.

The AT-AUTO default mode of operation (with Icom radios) is to receive and decode CI-V frequency broadcast data from CI-V equipped Icom radios operating in the “data transceive” mode. The AT-AUTO listens for frequency information sent over the CI-V serial data bus and then sets the inductor and capacitor to settings appropriate to the operating frequency (obtained from the CI-V bus). see your applicable Icom radio manual for further details on CI-V data transceive operation.

When connected to the CI-V bus, the AT-AUTO will respond to frequency changes made on any Icom radio (set for “data transceive” operation) attached to the CI-V bus. If there are multiple Icom radios setup for “data transceive” operation attached to the CI-V bus, the AT-AUTO will respond (by default) to any frequency changes made on any of the radios.

It is also possible to limit the AT-AUTO response to a single Icom radio in data transceive mode by setting the AT-AUTO to follow CI-V data from a specific radio address only. The data transceive operation is completely passive on the part of the AT-AUTO. However, if passive “data transceive” operation is not appropriate, the AT-AUTO can be setup to query a specific Icom radio based upon the radio’s CI-V address.

To setup the Icom CI-V options, from the service menu, rotate the “Tune-Select” knob until the display matches Figure 5.5

The immediate menu and sub-menu options are shown in Figure 5.2. Rotate the “Tune-Select” knob to scroll to the desired menu option and then select the desired option by



Figure 5.5: Setup Icom CI-V Menu.

momentarily pressing the “Tune-Select” button. Valid Radio CI-V addresses are in the range of 0x04 to 0x7F and the AT-AUTO may be assigned an address in the range of 0x80 to 0xEF.

If the user turns the CI-V transceiver to *OFF*, the AT-AUTO will no longer listen or respond to any CI-V frequency data generated from a CI-V data transceiver operation. Instead, the AT-AUTO will query the specific radio (based upon the radio CI-V address) at approximately 1 Hz intervals and only responds to frequency data addressed directly to the AT-AUTO from the specific radio. In order for the AT-AUTO to transmit over the CI-V bus, the internal jumpers on the AT-AUTO controller board must be configured correctly. See Table 11.1 for details.

5.3.4 Configure Automatic Antenna Selection

This feature uses frequency information available only from compatible CAT/CI-V equipped radios. This section is not applicable if your radio does not have a compatible CAT/CI-V data port.

The AT-AUTO may be configured to automatically select (based upon frequency of operation) either tuner output (coaxial or balanced) and to route the RF through, or to bypass the tuning network.

The AT-AUTO may also be configured to temporarily bypass the RF matching network during band changes while the inductor and capacitor are being repositioned for the new operating band. When this option is enabled, the bypass relay will be energized (RF bypasses the RF matching network) while changing from band to band. When the inductor and capacitor are finished being repositioned for the new band, the RF will then be routed through the tuner. However, if the user has selected this band for bypassing either to the Coax or Balanced outputs, the inductor and capacitor will not be repositioned while operating in this band.

5.3.5 Configure Bypass

There are two slightly different hardware versions of the AT-AUTO. The first version did not include hardware necessary to permit bypassing the tuning network. All current production AT-AUTOs have RF bypass capability. Unless you own an older version of the AT-AUTO which is without bypass capability, leave this option set to the factory default (bypass circuitry installed). AT-AUTOs without bypass hardware should be set to “No” (bypass circuitry not installed).

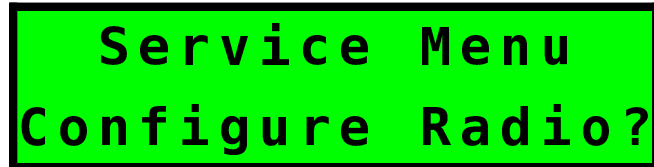
5.3.6 Configure Radio

If the AT-AUTO is properly interfaced to a compatible CAT/CI-V equipped radio, the AT-AUTO may be setup to follow any frequency changes in the radio and to automatically preset C & L based upon match settings for the new frequency.

In order to enable either of these features, the AT-AUTO must know what type of radio it is connected to as well as the CAT/CI-V serial data rate. However, If you are using an older-style radio without a compatible CAT/CI-V or external tuner interface, you should configure the AT-AUTO to operate with a “Vintage Rig” (default).

To configure the firmware for a particular make/brand of radio, from the “Service” menu, follow these steps:

1. Turn the front-panel “Tune-Select” knob until is displayed.



2. Momentarily press the “Tune-Select” knob.

The AT-AUTO will then enter the Configure Radio sub-menu and will display the currently selected radio type. The supported radio types are shown in Table 5.2. Rotate the “Tune-Select” knob in either direction until the appropriate setting for your particular radio is displayed. Then momentarily press the “Tune-Select” knob. This will cause your particular selection to be stored into nonvolatile memory and the display will return to the exit menu as shown in Figure 5.1

Table 5.2: Supported Radio Types and Capabilities

Type	Capability
Vintage Rig	No QSY Following, No External Tuner Control
Icom Normal CI-V	QSY Following & External Tuner Control
Icom CI-V Only	QSY Following Only
Kenwood Normal	QSY Following & External Tuner Control
Kenwood CAT Only	QSY Following Only
Yaesu FT-2000	QSY Following Only
Yaesu FT-990	QSY Following Only
Yaesu FT-1000	QSY Following Only

5.3.7 Configure AT-Auto Serial Interface

In order for the AT-AUTO to communicate with the CAT/CI-V-enabled radio, the AT-AUTO serial port configuration must match the serial data rate and number of stop bits used by the radio. The AT-AUTO supports serial data rates from 1200 to 57,600 baud. All serial data words are 8-bits long, no-parity and either one or two stop bits (8-N-1 or 8-N-2). The default settings are 9600 baud, 8-N-1. Most radios use one stop bit, but some Yaesu radios utilize 2 stop bits.

To configure the AT-AUTO serial interface, from the initial the “Service” menu, follow these steps:

1. Turn the front-panel “Tune-Select” knob until



is displayed.

2. Momentarily press the “Tune-Select” knob.

The AT-AUTO will then enter the serial configuration sub-menu and will display the currently selected data rate and type. The supported data rates are shown in Table 5.3. Rotate the “Tune-Select” knob in either direction until the desired baud rate and number of stop bits is displayed. Then momentarily press the “Tune-Select” knob. This will cause your particular selection to be stored into nonvolatile memory and the display will return to the exit menu as shown in Figure 5.1

5.3.8 Erase Match Memory

This option will erase all user match settings and restore the memories to factory defaults. Select this option and momentarily depress the “Tune-Select” knob.

5.3.9 Adjust A-D Inputs?

Factory use only. Momentarily press the “Mode” knob to return to the configuration menus.

5.3.10 Display SWR?

Factory use only. Momentarily press the “Mode” knob to return to the configuration menus.

Table 5.3: Serial Data Configuration Options

Baud	Protocol
1200	8-N-1
2400	8-N-1
4800	8-N-1
9600	8-N-1
19200	8-N-1
38400	8-N-1
57600	8-N-1
1200	8-N-2
2400	8-N-2
4800	8-N-2
9600	8-N-2
19200	8-N-2
38400	8-N-2
57600	8-N-2

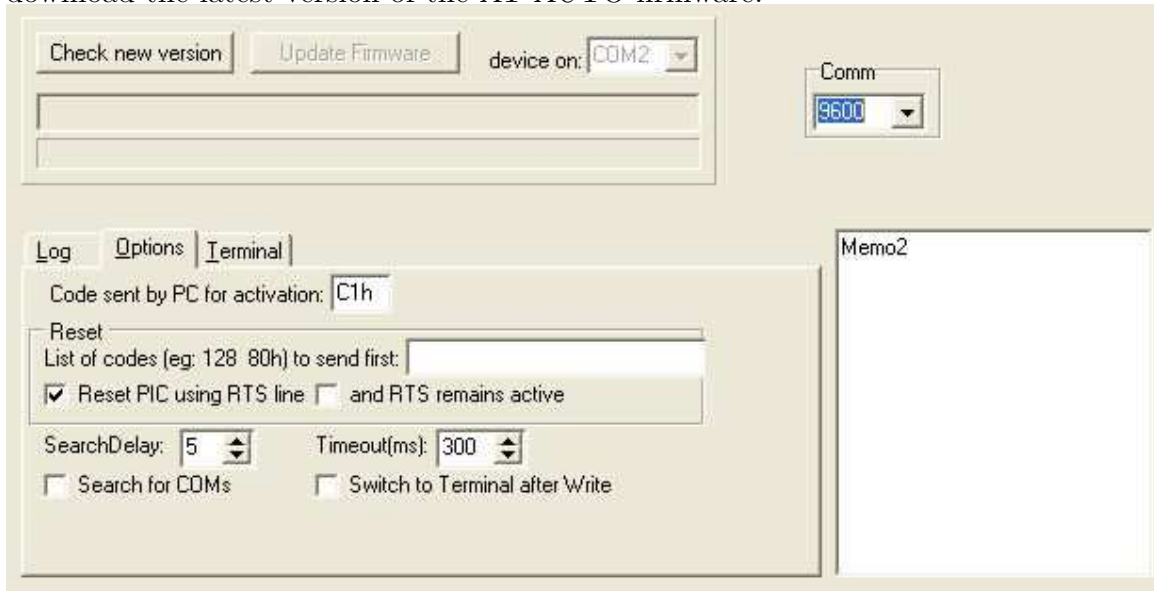
Firmware Update Guide

Your Palstar AT-AUTO automatic antenna tuner features field upgradeable firmware that can be updated from anywhere you have a PC with an Internet connection and an RS-232 serial port. Follow these steps to update your Palstar AT-AUTO with the latest firmware version.

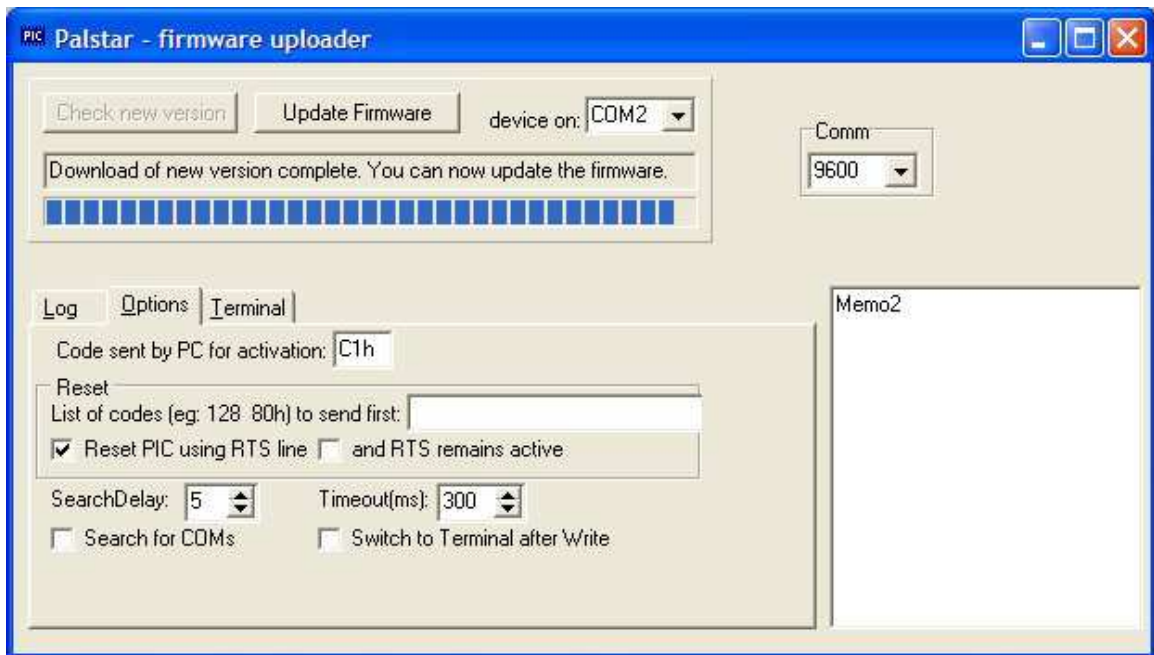
1. Ensure AT-AUTO's internal hardware jumpers are configured correctly (See Table 11.1).
2. **Completely disconnect the "Transceiver Data" and any CI-V connections at the rear of the AT-AUTO!! Failure to do so *WILL* corrupt the uploaded firmware, causing the process to fail and possibly corrupting the installed bootloader, requiring that the AT-AUTO processor be reprogrammed at the Palstar factory.**
3. Download "Palstar - Firmware Uploader" software from our website at:
<http://www.palstar.com/at-auto.php>
4. Place the downloaded software into a folder on you PC desktop or hard drive.
5. Unzip the software. It is now ready to use.
6. Connect your AT-AUTO to your PC's RS-232 serial port with the Palstar-supplied "Firmware Upload Cable" (See Figure 7.1).
7. Turn *On* your Palstar AT-AUTO.
8. Locate the "Firmware Uploader" software and double click on the Palstar - Firmware Uploader icon to start the software



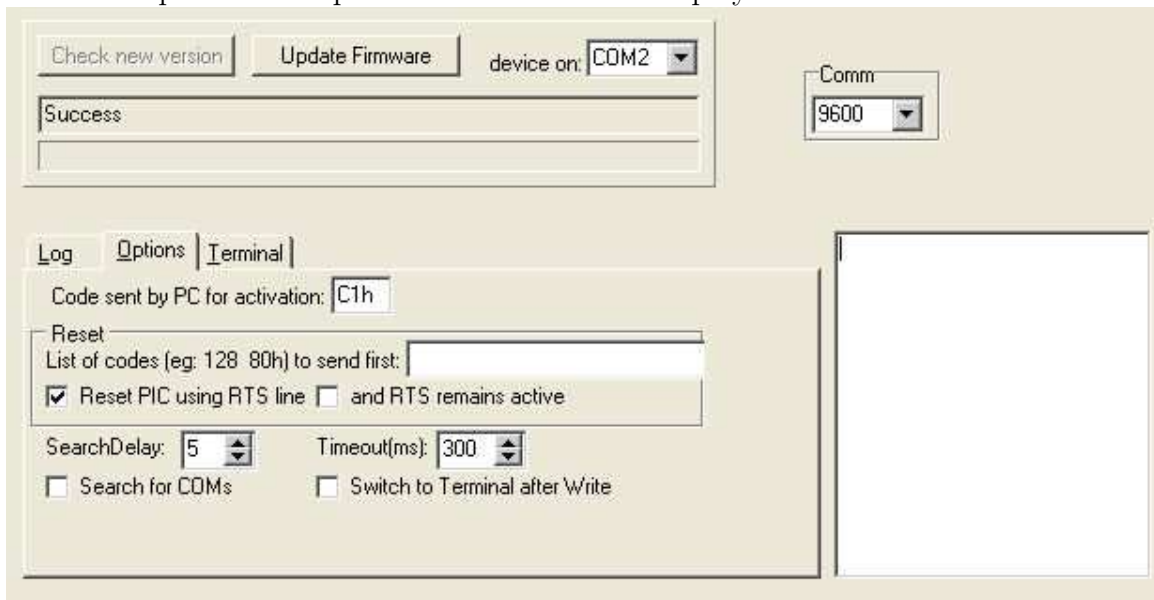
9. Switch to the “Options” tab and set “Options” as follows:
 - (a) Comm = 9600 Code sent by PC for activation: C1h
 - (b) Reset PIC using RTS line = checked
 - (c) SearchDelay = 5 Timeout(ms) = 300
10. Make sure your PC is connected to the Internet.
11. Set device on: COM2 (or as applicable on your PC).
12. Ensure that the software “Options” settings are identical to what is pictured here, and then click on the “Check new version” button to access the Palstar website and download the latest version of the AT-AUTO firmware:



13. Click on the “Log” tab to switch from “Options” view to see the current status of the download:



14. Click on the “Update Firmware” button to upload the newly downloaded firmware to your AT-AUTO.
15. Select the “Log” tab to display the status of the firmware update process
16. After the update is complete “Success” will be displayed:



17. Check the display on your AT-AUTO and it will momentarily display the firmware version that is now installed. It will appear as below, but with the most recent firmware version number displayed. If you just installed firmware version 1.08, for example, the

display would show:



18. Your firmware is now updated.
19. To check for future firmware updates, click on “Check new version” or visit Palstar.com

6.1 Hardware Requirements for Firmware Updating

The AT-AUTO must be directly connected to a PC’s RS-232 serial port. Due to the stringent timing requirements between the firmware uploading program and the AT-AUTO microprocessor, only a genuine RS-232 serial port will work. **USB to Serial converters have proven to be unsuitable for uploading AT-AUTO firmware.**

The PC serial port is often labeled “COM1”, “COM2”, etc. Some newer computers no longer come with RS-232 serial ports included, but add-on cards are available that plug directly into the computer’s PCI bus and provide one, two, or more RS-232 serial port(s). If your computer does not have a serial port, these cards can be purchased relatively inexpensively from your local computer hardware supplier.

The serial cable used for the firmware update must include the “RTS” (Request to Send) handshake line. The Palstar-supplied serial cable is intended for this purpose. For further details, see Figure 7.1

Note: The computer printer port, often labeled “LPT” or “Printer” is a NOT a serial port and is absolutely NOT compatible with the RS-232 protocol. Make NO attempt to use the printer port to update the AT-AUTO firmware - damage to your computer may result.

Rear-Panel Pinouts and Interface Cables

7.1 Radio/Computer Serial Data Interface

The AT-AUTO is designed to interface with a computer's serial port in order to enable the owner to load new firmware updates as they become available, and as a method of remotely controlling the AT-AUTO. The AT-AUTO firmware also includes unique operating enhancements that are only available when properly interfaced to a (firmware supported) CI-V/CAT capable transceiver.

At the time of purchase, Palstar supplies an interface cable that is suitable for use with either Icom transceivers, most Kenwood, or some Yaesu transceivers. The information supplied in this section is provided to enable the AT-AUTO owner to construct interface cables suitable for his particular model of radio. Icom has had a standard serial communications interface (CI-V) for quite a few years, and Kenwood appears to have standardized on a common RS-232 serial connector and protocol. However, other manufacturers appear to randomly vary the CAT connector type (DIN, mini-DIN, DB9, etc.) as well as command syntax, and interface protocol (TTL/RS-232) from model to model.

The AT-AUTO is directly compatible with most popular transceivers via its CI-V (Icom) interface and RS-232 interface (Kenwood, and many Yaesu rigs). The AT-AUTO is NOT directly compatible with CAT radios that use TTL data levels. In this case, the owner will need to supply an RS-232 to TTL level converter. Connecting the AT-AUTO's RS-232 serial output to a radio that expects TTL voltage levels will very likely damage the radio. Palstar is not liable for damage caused by improper tuner to radio interfacing.

Rear panel connector pinouts are provided in Table 7.1, and Figure 7.1 provides illustrations of the interfacing cabling.

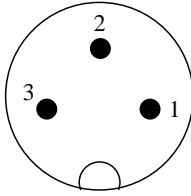
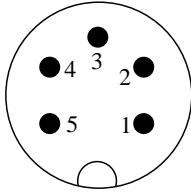
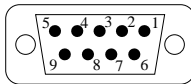
Note: When interfacing the AT-AUTO with CAT capable radios via the RS-232 port,

Pin 7 (AT-AUTO processor reset) must remain unconnected, or the “Reset Enable” jumper must be *Open* (See Figure 11.1).

7.2 Radio Tuner Handshake

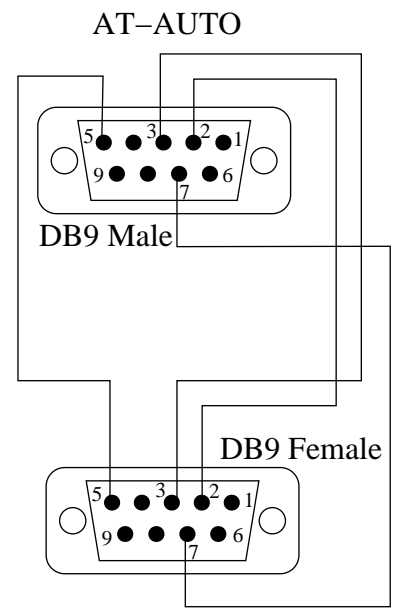
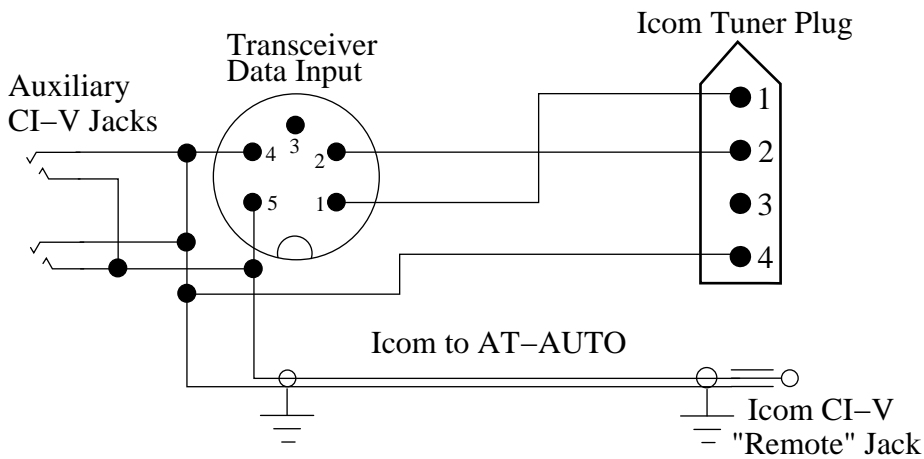
The AT-AUTO is capable of controlling the low-power, constant carrier generation capability built into some Icom and Kenwood radios. This “Handshake” mode of operation requires connection of the AT-AUTO with either the Icom’s “tuner” interface or the Kenwood’s “AT” interface. The AT-AUTO firmware must be configured to support the specific type of radio, and is currently ONLY compatible with Icom and Kenwood. Do NOT attempt AT-AUTO - radio interfacing via the “Data/Handshake” connector with non-Icom or non-Kenwood radios. Kenwood radios require additional external circuitry (built into the Palstar-supplied interface cable) in order for the handshake feature to operate.

Table 7.1: Rear Panel Connector Descriptions

Outline	Name	Pinout
	Power	Pin 1 - No Connection Pin 2 - +12 VDC (≈ 3.5 A max while tuning) Pin 3 - DC Ground
	Transceiver Data	Pin 1 - TTL I/O Pin 2 - TTL I/O Pin 3 - No Internal Connection* Pin 4 - Signal Ground Pin 5 - Icom CI-V Bus I/O (Open Collector)
	RS-232/CAT**	Pin 1 - No Connection Pin 2 - Serial Data Output (From AT-AUTO) Pin 3 - Serial Date Input (To AT-AUTO) Pin 4 - No Connection Pin 5 - Signal Ground Pin 6 - No Connection Pin 7 - AT-AUTO Processor Reset Pin 8 - No Connection Pin 9 - No Connection

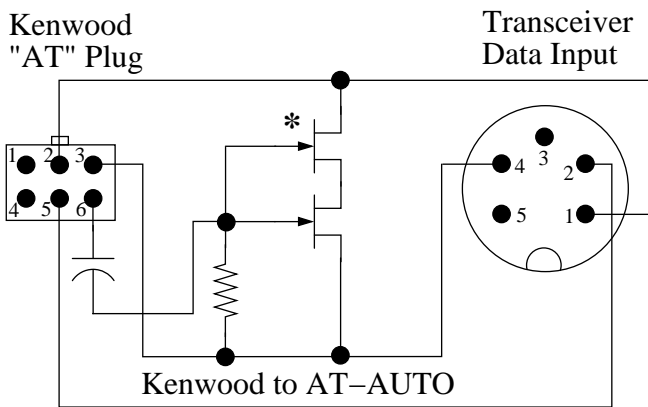
***Note:** Some Palstar-supplied Icom interface cables include a wire which is connected between Pin 3 of the Transceiver Data Input and Pin 3 of Icom Tuner plug. However, within the AT-AUTO, there is no internal connection to Pin 3 of the Transceiver Data Input.

****Note:** Voltages are RS-232 compliant and are NOT TTL compatible. If the intended radio uses TTL signal levels, a Level Converter is required. Consult your owner's manual prior to connecting to this port.



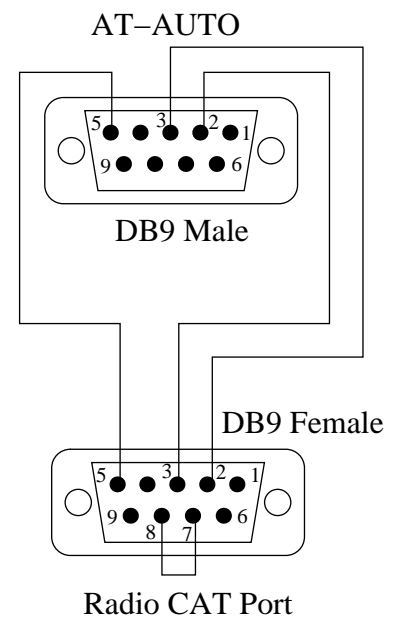
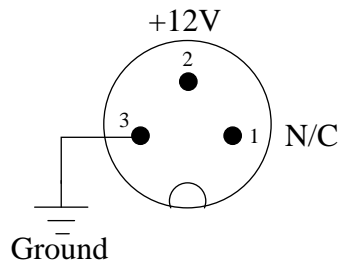
PC Serial Port

Firmware Upload Cable



**Circuitry built into Palstar-Supplied Kenwood "handshake" cable.*

AT-AUTO DC Power Input



Radio CAT Port

AT-AUTO to CAT Cable for Kenwood, Yaesu, etc.

Figure 7.1: Interface Cable Diagrams

Remote Control

8.1 General Description

The AT-AUTO is remotely controllable from a computer serial port, or via the Icom CI-V bus. The Icom CI-V bus and protocol permit multiple transceivers and computers to operate nearly simultaneously, and the AT-AUTO command syntax has therefore been designed to be compatible with the Icom protocols.

The AT-AUTO has a specific CI-V address (default 0xE0) (hexadecimal). The AT-AUTO will ignore any commands not addressed specifically to it. Additionally, all commands should originate from a specific CI-V address, that is different from the AT-AUTO CI-V address. Any of the AT-AUTO's commands may be sent to the AT-AUTO, regardless of its current operating mode (*Automatic*, *Manual*, or *Bypass*).

In order to enable remote control operation, the AT-AUTO must be configured to operate with either an "Icom Normal CI-V & Tuner I/O" or "Icom CI-V Only...". If the radio that the AT-AUTO is connected to is NOT an Icom model, select "Icom CI-V Only...". Additionally, ensure that the AT-AUTO's internal hardware jumpers are configured appropriately (See Table 11.1).

All commands are preceded by two identical header bytes (0xFE), and then followed by one trailer (end-of-command) byte which is always 0xFD. All commands are therefore of this format (commas added for clarity only):

0xFE, 0xFE, To-Address, From-Address, Command, Command-Sub Byte(s), 0xFD. The AT-AUTO command set is shown in Table 8.1.

8.1.1 Example Command Strings

The controlling PC may be assigned any CI-V address. For these examples, assume that the controlling PC is assigned a CI-V address of 0x3A.

To command the AT-AUTO to switch to *Manual* mode, the PC would send the following command string:

0xFE 0xFE 0xE0 0x3A 0x07 0x01 0xFD

The AT-AUTO will switch to *Manual* mode and acknowledge the command by sending:

0xFE 0xFE 0x3A 0xE0 0xFB 0xFD.

Likewise, to remotely select the *Balanced* RF output, the command from the PC would be:

0xFE 0xFE 0xE0 0x3A 0x08 0x10 0xFD

The AT-AUTO will immediately switch to the *Balanced* RF output and acknowledge the command by sending:

0xFE 0xFE 0x3A 0xE0 0xFB 0xFD

8.1.2 Sub-Command Structure and Data Syntax

Generally, most commands include sub-command data bytes. For example, when commanding a Capacitor position, the position is encoded into the command string. Sub-command bytes are always encoded as Binary-Coded-Decimal (BCD). Failure to encode them in BCD format will corrupt the command decoding and the command will fail.

The sub-command data (frequency, *C* or *L* position, etc.) encoded in BCD format, is transmitted LSB (least significant byte) first. For example, to command *C* to position of 274, the position (sub-command) bytes would be 0x74, and 0x02. The command string would therefore be:

0xFE 0xFE 0xE0 0x3A 0x09 0x74 0x02 0xFD.

Sending the QSY command (requires frequency information) to the AT-AUTO, the AT-AUTO will recall match settings for that frequency and automatically position *C* and *L* to their corresponding match positions. For example, to QSY the AT-AUTO to 28.725,168 MHz, the command string would be:

0xFE 0xFE 0xE0 0x3A 0x05 0x68 0x51 0x72 0x28 0x00 0xFD.

The AT-AUTO will respond to a “Read Status” command with the following string:

0xFE, 0xFE, 0x3A, 0xE0, Output, Mode, Motor, L-Position, C-Position, Status, 0xFD

Definitions of the information returned after a “Read Status” command are contained in Table 8.2.

Table 8.1: Remote Control Command Set

Command	Command String (Header + the following string + Trailer)
QSY	0x05 BCD0 BCD1 BCD2 BCD3 BCD4
Read Status	0x06 0x05
Read Power	0x06 0x06
Set <i>Automatic</i> Mode	0x07 0x00
Set <i>Manual</i> Mode	0x07 0x01
Set <i>Bypass</i> Mode	0x07 0x02
Select Coax	0x08 0x00
Select Balanced	0x08 0x10
Home <i>L & C</i>	0x0B
Set <i>C</i> (0-397)	0x09 BCD-Lo BCD-Hi
Set <i>L*</i> (0-13,120)	0x0A BCD-Lo BCD-Hi

Note*: The position displayed in the LCD is the actual inductor position divided by 16. Valid range of inductor position is 0-13,120 (Shown on the LCD as 0-820).

Table 8.2: AT-AUTO Response to Read Status Command

Byte	Value/Bit Definitions
Output (Selected Output)	0x00 - Through to Coax 0x10 - Through to Balanced 0x80 - Bypass to Coax 0x90 - Bypass to Balanced
Mode (Active Mode)	0x00 - <i>Automatic</i> Mode 0x01 - <i>Manual</i> Mode 0x02 - <i>Bypass</i> Mode
Motor (Stepper Motors)	Bit 7 - Set if <i>C</i> is commanded to a specific position Bit 6 - Set if <i>C</i> is turning Bit 5 - Always Clear/No Meaning Bit 4 - Set if <i>L</i> is commanded to a specific position Bit 3 - Set if <i>L</i> is turning Bit 2 - Always Clear/No Meaning Bit 1 - Set if <i>C</i> movement was/is Clockwise Bit 0 - Set if <i>L</i> movement was/is Clockwise
Inductor Position*	3 Bytes in BCD format. Example: 8,926 – 0x26 0x89 0x00
Capacitor Position	2 Bytes in BCD format. Example: 257 – 0x57 0x02
Status	0x00 - Stepper motors commanded to stop 0x01 - <i>Automatic</i> mode idle 0x02 - Automatic tuning in progress 0x03 - Match not found 0x04 - Match found, $SWR \leq$ “Tune Stop SWR”, saving match settings 0x05 - Match found, $SWR \leq$ “Tune Start SWR”, saving match settings 0x06 - Automatic mode QSY in progress 0x07 - Automatic tuning aborted/timed out

Note*: The position displayed in the LCD is the actual inductor position divided by 16. Valid range of inductor position is 0-13,120 (Shown on the LCD as 0-820).

The AT-AUTO has four 10-bit hardware analog-to-digital converters. In order to improve SWR resolution at low input power levels, two of the A/D converters are configured and adjusted to provide high SWR resolution when using low RF input power levels. Likewise the remaining two A/D converters are intended for use when using high RF input power levels, when the low-power A/D converters would likely be saturated. If specific SWR information is required, the user's particular computer application may calculate SWR from the available A/D converters. The output of the A/D converters is relative and not absolute. If specific power calibration is required, this may also be accomplished with custom user application software. The AT-AUTO "Read Power" command returns the conversion results for all four A/D converters in the following format:

0xFE, 0xFE, 0x3A, 0xE0, Forward-High, Reflected-High, Forward-Low, Reflected-Low, 0xFD

Definitions of the individual bytes returned from a "Read Power" command are contained in Table 8.3.

Table 8.3: AT-AUTO Response to Read Power Command

Power (2 Bytes Each)	Value
Forward Power High (0-1024)	Example: 374 - 0x74 0x03
Reflected Power High (0-1024)	Example: 12 - 0x12 0x00
Forward Power Low (0-1024)	Example: 927 - 0x27 0x09
Reflected Power Low (0-1024)	Example: 36 - 0x36 0x00

Analog Power Meter

The AT-AUTO includes a cross-needle Power/SWR meter based upon the popular Palstar PM2000A. The Wattmeter is provided as an operator convenience and is capable of reading peak-envelope-power (PEP) in SSB mode. The AT-AUTO controller circuitry is completely independent from the Wattmeter circuitry and the Wattmeter switch settings have no effect on operation of the AT-AUTO. There is also an operator-selectable dual-range power level switch (300 W or 3000 W) in order to improve the displayed power resolution.

9.1 Reading Peak Power

The **LAMP** button controls both the SWR meter illumination as well as power to the **PEAK** and **PEAK/HOLD** circuitry and must be *On* in order to read peak power. Depressing the front panel **PEAK** button will activate the active peak power circuitry and the meter will then display PEP and exhibit fast attack and approximately 1.5 second delay time. The displayed PEP will be approximately 95-100% of the SSB signal PEP, but may vary depending upon the tonal and inflection characteristics of the user's voice (displayed power may be greater). If the **PEAK/HOLD** button is depressed, the maximum PEP measured will be "held" on the meter display for approximately two seconds. This feature is provided to make it easier to observe the actual peak output power.

For CW signals, the peak power is synonymous with average power. Therefore, a transmitter's single tone (CW) signal should yield the same displayed power level regardless of whether the meter is set to display the average or peak power (switch selection set to **AVG** or **PEAK**, respectively).

Note: The **PEAK/AVG** switch must be depressed in order for the **PEAK/HOLD** feature to function properly.

9.2 Calibration

The meter was calibrated at the Palstar factory. However, if the user determines that calibration is required, please follow this procedure:

1. Connect the AT-AUTO coaxial output to another calibrated Wattmeter of known accuracy.
2. Terminate the output of the calibrated Wattmeter into a 50 Ω dummy load.
3. Set the AT-AUTO to *Bypass* mode.
4. Deselect the **PEAK/HOLD** feature.
5. Turn *On* the meter **LAMP** (to supply DC power to the meter circuitry).
6. Calibrate the low-range **AVG** forward power display
 - (a) Set the AT-AUTO Wattmeter to the 300 W power range.
 - (b) Set the AT-AUTO Wattmeter to read **AVG** power.
 - (c) Connect the output of an HF transmitter to the AT-AUTO RF input.
 - (d) Apply an approximate 100 W CW carrier to the AT-AUTO.
 - (e) Adjust the **FOR LO** potentiometer (Figure 9.1) so that the AT-AUTO's forward power indication matches that shown on the calibrated Wattmeter.
7. Calibrate the low-range **PEAK** forward power display
 - (a) Set the AT-AUTO Wattmeter to read **PEAK** power.
 - (b) Apply an approximate 100 W CW carrier to the AT-AUTO.
 - (c) Adjust the **PEAK LO** potentiometer (Figure 9.1) so that the AT-AUTO's forward power indication matches that shown on the calibrated Wattmeter.
8. Calibrate the high-range **PEAK** forward power display
 - (a) Set the AT-AUTO Wattmeter to the 3000 W power range.
 - (b) Apply an approximate 500-1000 W CW carrier to the AT-AUTO.
 - (c) Adjust the **PEAK HI** potentiometer (Figure 9.1) so that the AT-AUTO's forward power indication matches that shown on the calibrated Wattmeter.

9. Calibrate the high-range **AVG** forward power display
 - (a) Set the AT-AUTO Wattmeter to read **AVG** power.
 - (b) Apply an approximate 500-1000 W CW carrier to the AT-AUTO.
 - (c) Adjust the **FOR HI** potentiometer (Figure 9.1) so that the AT-AUTO's forward power indication matches that shown on the calibrated Wattmeter.
10. Reverse the AT-AUTO coaxial input and output (connect transmitter output to AT-AUTO coaxial output, connect AT-AUTO coaxial input to calibrated Wattmeter, which terminates into a 50 Ω dummy load).
11. Calibrate the high-range reflected power display
 - (a) Apply an approximate 20-50 W CW carrier to the AT-AUTO.
 - (b) Adjust the **REV HI** potentiometer (Figure 9.1) so that the AT-AUTO's reflected power indication matches the forward power displayed on the calibrated Wattmeter.
12. Calibrate the low-range reflected power display
 - (a) Set the AT-AUTO Wattmeter to the 300 W power range.
 - (b) Apply an approximate 10-20 W CW carrier to the AT-AUTO.
 - (c) Adjust the **REV LO** potentiometer (Figure 9.1) so that the AT-AUTO's reflected power indication matches the forward power displayed on the calibrated Wattmeter.

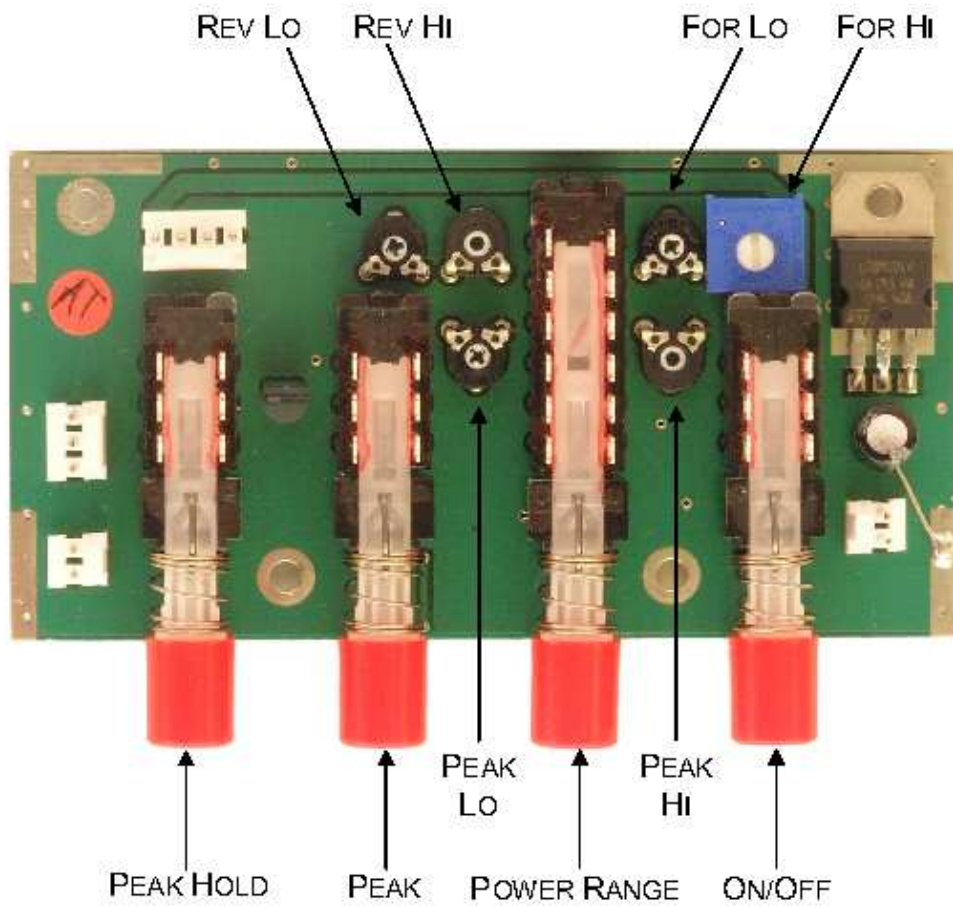


Figure 9.1: Meter Board Adjustment Locations

Operating Tips

10.1 QRO Operation

When using a high-power amplifier with the AT-AUTO, the AT-AUTO would occasionally automatically attempt to retune during SSB transmissions. This problem was addressed in firmware version 2.0, and testing shows that the problem is greatly mitigated. However, to prevent this from happening, the user may disable “Autonomous” automatic tuning (See Configuration Section), or else select *Manual* mode after the AT-AUTO has successfully completed the automatic tuning attempt.

10.2 CI-V Passive Listening

When multiple controllers attempt to control (query) the same transceiver, data collisions often occur. The data collisions corrupt the frequency data and manifest as erratic/erroneous AT-AUTO frequency-following.

The solution is ensure that only one device (AT-AUTO or computer logging software, etc.) is permitted to query the radio for frequency information, while the AT-AUTO, computer software, and any other controller on the data bus merely “listen” for the radio’s response to the singular frequency queries.

For example, if the user has a computer logging program which accesses the CI-V bus and queries the radio at regular intervals, the user may reduce the likelihood of CI-V data bus collisions by preventing the AT-AUTO from querying the radio, and preventing the radio from autonomously placing uncommanded data on the CI-V bus (set data transceive to *Off*). The AT-AUTO will now follow frequency information sent as a result of a query generated by the computer logging program. In this case, the user should set the AT-AUTO CI-V address to match the CI-V address of the computer running the logging program, and CI-V transceive to *Off*. With the AT-AUTO’s “CI-V query enable” jumper removed, the

AT-AUTO's query attempt will never reach the CI-V bus. It will only be able to listen for CI-V data but will not transmit on the CI-V bus. The Icom radio should then also be set to data transceive *Off*. Conversely, if the computer logging software can be configured to listen only, the the AT-AUTO may be setup to provide the radio frequency queries.

Alternatively, if using an Icom CI-V equipped radio, configured for data transceive *On*, the radio will automatically send frequency data anytime its frequency changes. All of the other controllers (AT-AUTO, computer, etc.,) should be configured to receive only. In this manner, data collisions are prevented because the radio is the only device placing data on the serial databus. All other devices are passive listeners.

10.3 CAT Passive Listening

The AT-AUTO is intended to interface with CAT-equipped transceivers. A significant problem exists when also attempting to simultaneously control or query the radio via computer software (example: computer logging software). The RS-232 protocol is intended to link two devices only.

In order for the AT-AUTO to follow frequency changes in CAT-equipped radios, it receives data sent back to the AT-AUTO from the radio (normally in direct response to the AT-AUTO's querying of the radio's frequency). The radio's response may also be generated as a result of computer logging software generating the radio query command. The user may fabricate a serial "Y" cable, whereby the AT-AUTO's serial data transmit line is omitted, but where the serial data line from the radio is shared between the computer and the AT-AUTO. The AT-AUTO and the computer will both be able to receive the radio's frequency data, transmitted as a result of the computer-generated query command.

Internal Jumper Settings

The AT-AUTO has two user-selectable hardware jumpers. The default jumper settings are appropriate for most AT-AUTO applications. However, some circumstances may require alternate jumper settings. The jumpers are located on the AT-AUTO controller circuit board and their relative locations are indicated in Figure 11.1 on page 59 . Jumper settings are listed in Table 11.1 on page 60.

11.1 Reset Enable

The AT-AUTO incorporates a microprocessor reset-via-RTS signal from a computer serial port. The software used by the computer to upload firmware to the AT-AUTO microprocessor requires the ability to reset the AT-AUTO microprocessor.

11.2 CI-V Tx Enable

In it's default jumper configuration, the AT-AUTO is able to transmit and receive data over the RS-232 port and receive data from the CI-V bus, but is unable to transmit data over the CI-V bus. This is generally immaterial because when an Icom radio is setup for CI-V data transceive operation, it will automatically send frequency data over the CI-V bus, and does not require the AT-AUTO to transmit data over the CI-V bus or otherwise query the Icom radio. However, if the Icom radio is configured with CI-V data transceive *Off*, then the AT-AUTO must actively query the radio, and the CI-V Tx Enable jumper must be Closed.

11.3 Jumper Access

Remove DC power from the AT-AUTO. Then remove the screws along the left and right sides of the AT-AUTO to remove the top cover. The controller circuit board is located

immediately behind the Liquid Crystal Display (LCD). Observe anti-static precautions when working on/near the controller circuit board.

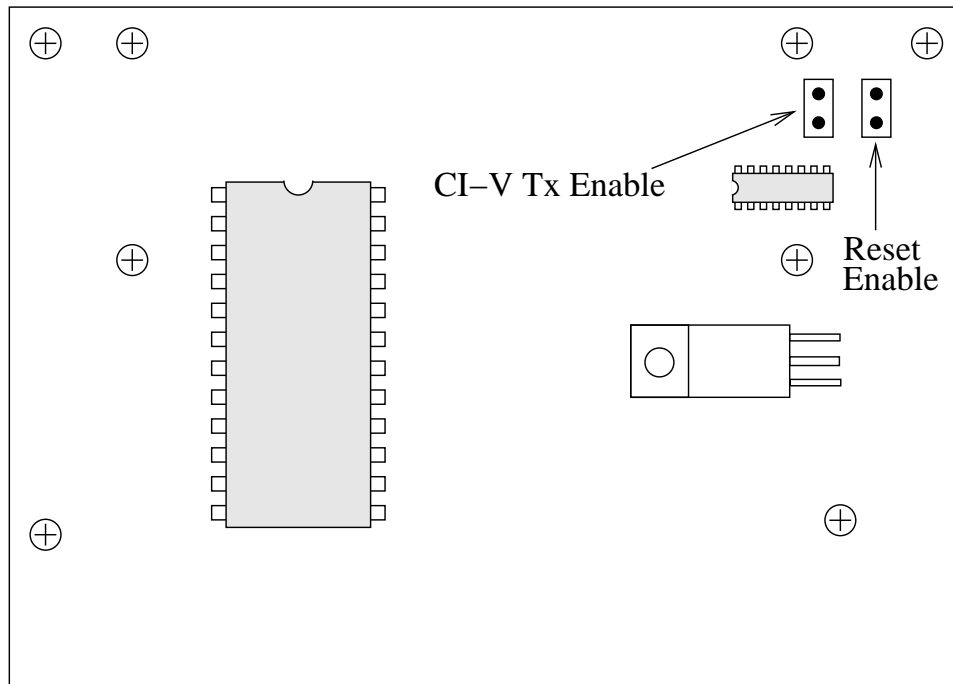


Figure 11.1: Jumper Locations

Table 11.1: Jumper Settings

Operation	Reset Enable	CI-V Tx Enable
CI-V Transceive from Any Icom	Don't Care	Don't Care
CI-V Transceive from Specific Icom	Don't Care	Don't Care
Smart with CI-V Transceive OFF	Open	Closed
Smart via CAT*	Closed	Open
Smart Via CAT**	Open	Open
Firmware Update	Closed	Open
Remote Control via CAT	Open	Open
Remote Control via CI-V	Open	Closed
Default	Closed	Open

***Note:** *Reset Enable* jumper may be Closed if using the “AT-AUTO to CAT” cable illustrated in Figure 7.1 on page 46.

****Note:** *Reset Enable* must be Open if hardware flow control line (RTS) is present in the CAT cable. If unsure, remove the jumper from *Reset Enable*.

Firmware Revision Summary of Changes

The AT-AUTO was first released with Firmware version 1.01. Firmware versions 1.02 through 1.10 consisted mainly of minor bug fixes and some other minor firmware enhancements. Version 2.0 however is significantly different from versions 1.01-1.10, incorporating new operating features and refinements along with a considerable number of minor, not-so-minor, and semi-critical bug fixes.

Firmware version 1.10 was the last firmware update prior to version 2.0. Version 2.0 incorporates many bug fixes and enhanced operating features. Palstar, Inc. encourages all AT-AUTO owners to update their AT-AUTOs with this latest firmware revision. As of this writing, the latest firmware release is version 2.03.

12.1 Version 2.00 Bug Corrections

The following is a partial summary of bugs found in previous firmware versions (in no particular order of significance) and corrected with AT-AUTO firmware version 2.0:

1. Configuration/Data EEPROM write - Bug forced configuration and data settings to be continuously written to EEPROM at a 1 Hz rate. Data should only have been written to EEPROM if the data had changed. This was a hidden bug (now fixed) and was not apparent to user.
2. Non-Initialized Fine Tuning - Bug manifested whenever “fine tune” commanded without prior automatic tuning in the band of operation. Under these conditions, the AT-AUTO would motor the inductor to the maximum inductance and stop.
3. Runaway Inductor - Occasionally during automatic tuning, the Inductor would motor to maximum L and stop.

4. Runaway Capacitor - Occasionally during automatic tuning the Capacitor would repeatedly turn to position 397, then continue to approximately 004, and repeat sequence indefinitely.
5. LCD Blanking - LCD would momentarily blank during auto-tune initiation.
6. Uncommanded/Unintentional retuning while in SSB mode - During SWR/Power sampling AT-AUTO would detect reflected power prior to detection of forward power, causing AT-AUTO to interpret this as excessive SWR and initiate retuning.
7. Failure to recognize excessive SWR - Under some circumstances with very excessive SWR, AT-AUTO would report “Good Match” and fail to initiate automatic tuning despite the very obvious (via the analog meter) antenna mismatch.
8. Frequency Error - Under conditions of very high SWR, AT-AUTO would occasionally be unable to discern the operating frequency from the RF sample. Firmware and hardware changes have considerably improved this problem. Problems might still occur albeit rarely.
9. Autotuning Past Low SWR Points - During automatic tuning, the positioning of L or C was too coarse causing the AT-AUTO to step past good match points. Occasionally the AT-AUTO would then be unable to find a successful match although subsequent matching attempts (manual or automatic) would find suitable matches. Addressed in revised tuning algorithms.

12.2 Version 2.00 New Firmware Features

AT-AUTO firmware version 2.00 includes the following new features:

1. Kenwood CAT support - Provides QSY-following of Kenwood CAT-enabled radios by polling frequency information via the Kenwood CAT (serial data) port (Tested with TS-570D).
2. Yaesu CAT support - Provides QSY-following of the FT-2000 as described above for Kenwood. (Tested with FT-990, and FT-2000).
3. Kenwood Tuner Interface - Enables automatic tuning initiation via the “TUNER” button and “AT” interface present on some Kenwood HF radios (Tested with TS-570D).

4. User-Selectable Startup Mode of Operation - User may select (via firmware configuration menu) the startup mode that the AT-AUTO enters upon initial power-up. User may opt to have the AT-AUTO always startup in either the *Automatic*, *Manual*, *Bypass*, or the mode last in-use when the AT-AUTO was turned-off.
5. Automatic Antenna & Bypass Selection - User may specify which output to automatically select (Coax/Balanced) based upon band of operation as well as whether the RF is to pass through or bypass the tuning network. This feature requires a supported CAT/CI-V equipped radio.
6. Bypass during Band Change - AT-AUTO may be configured to automatically bypass the tuner while the AT-AUTO is changing bands. When enabled, if QSYing from one band to another (40m to 160m for example), the AT-AUTO will route the antenna directly to the radio (RF does not pass through the tuning network) until the *L* and *C* have been repositioned to the band of operation (160m in this example). This feature requires a supported CAT/CI-V equipped radio.
7. Enhanced Icom CI-V transceive operation - The normal (default) AT-AUTO CI-V data transceive scheme is to constantly follow all frequency data sent via the CI-V bus from any CI-V equipped Icom radio. The user may however, configure the AT-AUTO to follow only CI-V transceive frequency data from a specific radio (based upon the radio's CI-V address). Furthermore, the AT-AUTO can be configured to completely ignore CI-V transceive data and to poll a specific Icom radio.
8. Remote Control Operation - The AT-AUTO may be remotely controlled via the Icom CI-V bus. The AT-AUTO CI-V address is user selectable and remote control operation permits the user to:
 - (a) Set specific *L* and *C* positions.
 - (b) Position *L* & *C* by sending frequency data to the AT-AUTO.
 - (c) Select tuner output (Coax/Balanced).
 - (d) Select operating mode (Automatic, Manual, Bypass).
 - (e) Read *L* & *C* positions, as well as forward and reflected power.
 - (f) Home *L* & *C*.
9. Autonomous/Non-Autonomous Tuning Initiation - The AT-AUTO's normal (default) behavior while in *Automatic* mode is to constantly monitor Forward and Reflected

power, calculate and monitor SWR. Then whenever SWR exceeds a set threshold (default 1.2:1 SWR), the AT-AUTO autonomously initiates tuning. The user may now configure the AT-AUTO for “Non-Autonomous” tuning initiation. When so configured, the AT-AUTO continues to monitor Forward & Reflected power and to calculate and monitor the SWR. However, whenever the SWR exceeds a preset threshold (default 1.2:1 SWR), instead of initiating automatic tuning, the AT-AUTO displays a warning to the user. Whenever this warning is displayed, the user may consent to automatic tuning initiation by momentarily press the rotary “Tune-Select” knob. Momentarily pressing the “Tune-Select” knob signals the user’s consent to initiate automatic tuning. This feature was added to provide a means to completely prevent automatic re-tuning, especially when using an HF amplifier.

10. Selectable SWR Tuning Thresholds - While in *Automatic* mode, the AT-AUTO initiates automatic tuning whenever the SWR exceeds 1.2:1 (default). Automatic tuning continues until the SWR is at/below 1.05:1 (default). The user may configure the AT-AUTO to use other SWR thresholds to indicate when tuning should be initiated and at what SWR level automatic tuning should be considered successful. The AT-AUTO’s SWR defaults are quite stringent especially since most other auto-tuners cease tuning when SWR is less than 1.5:1. By setting higher thresholds, a user may opt to minimize retuning when operating with antennas experiencing frequent resonance changes (Example: a long dipole antenna blowing around in a strong wind).

12.3 Version 2.01 Firmware Features

AT-AUTO firmware version 2.01 includes the following new features:

1. Automatic *L* and *C* homing - During installation of firmware version 2.01 (and newer), the AT-AUTO will home *L* and *C*, and then preset *C* to 250.
2. *L* and *C* synchronization tracking - If the user switched the AT-AUTO *Off* before *L* or *C* position information was successfully written to non-volatile memory, then the AT-AUTO will automatically home *L* and *C* when the AT-AUTO is next turned *On*. After completion of the homing operation, *C* will automatically be repositioned to 250.

12.4 Version 2.01 Bug Corrections

AT-AUTO firmware version 2.01 includes these changes/corrections:

1. Change to the remote control *C* positioning command - Correct operation required a third position byte (0x00) or else the command failed. Positioning command is now in accordance with the description provided in the operating manual (See Table 8.1).
2. CI-V bus collision detection - In earlier firmware releases, the AT-AUTO would sometimes spontaneously QSY based upon collision-corrupted CI-V bus data, which manifested as an illogical/erroneous QSY frequency. Likewise other bus collisions would occasionally cause erroneous/unintended AT-AUTO remote-control command execution.

12.5 Version 2.02 Bug Corrections

AT-AUTO firmware version 2.02 includes these changes/corrections:

1. Delayed CI-V command execution bug in version 2.01 - In version 2.01, CI-V bus collision detection was incorporated by providing a fixed delay between decoding of the command and execution of the command. After the delay, if the CI-V bus jamming sequence (0xFC) had not detected, then the command was executed. However, the very last command was not being executed until the subsequent data string had decoded, causing the the AT-AUTO to be one frequency change behind. This was particularly noticeable when changing bands using the Icom radio's band buttons and was not observed when turning the VFO knob. CI-V data decoding and frequency following is now corrected. This problem did not affect CAT operation with non-Icom radios.

12.6 Version 2.03 Bug Corrections

AT-AUTO firmware version 2.03 includes this change/correction:

1. A bug introduced in version 2.02 effectively disabled frequency following via the CAT port of Kenwood and some Yaesu radios. Version 2.03 fixed this bug, restoring normal CAT operation with the affected radio types. No other changes were made in version 2.03.

Software License Agreement

IMPORTANT – READ CAREFULLY. Notice to user: To download or read the entire Software End-User License Agreement visit:

<http://www.palstar.com/at-auto.php>

The End User License Agreement (“Software License Agreement”) is a legal agreement between you, the User, and Palstar. By powering on the AT-AUTO and or installing future updates to the AT-AUTO firmware via the Palstar website (www.palstar.com) you agree to be bound by the terms of the Palstar AT-AUTO Software License Agreement including, without limitation, the warranty disclaimers, and limitation of liability. You agree that this agreement is enforceable like any written agreement negotiated and signed by you. If you do not agree, you are not licensed to use the Software, and must destroy any downloaded copies of the Software in your possession or control.

Service and Warranty

14.1 Limited Warranty

Palstar Inc. warrants products manufactured by it to be free from defects in material and workmanship under normal user and service **for a period of three (3) years for the AT-AUTO, AT5K, AT4K, BT1500A, R30, and ZM30 and all other products for one (1) year from the date of delivery to the first buyer** (the “Warranty Period”). Palstar Inc’s obligation under this warranty is limited to repair or replacement of the product at it’s option at the Palstar factory in Piqua, Ohio.

Effective only when the product is returned to the factory with all transportation charges prepaid and examination of the produce discloses in Palstar’s judgment, to have been defective during the Warranty Period.

The Warranty Period shall not extend beyond its original term with respect to interim in-warranty repairs by Palstar. This Warranty Period shall not apply to any product which has been repaired or altered by anyone other than Palstar without prior written authorization. Warranty does not extend to any products which have been subject to damage from improper installation, application or maintenance in accordance with the operating specification. Palstar neither assumes nor authorizes any person to assume for it any obligation or liability other than herein stated.

14.2 Repair Policy

When sending in a product for service, please “double” box it carefully and ship it insured for your protection. Please include a note clearly describing the problem, how you wish the item returned and how you wish to pay for the service. Package your equipment properly. Palstar, Inc. is not responsible for merchandise damaged in shipment. Our service rate is \$30 per hour ($\frac{1}{2}$ hour minimum).

14.3 Return Policy

All returns must receive prior authorization from Palstar. Returned items must be received in original-AS SHIPPED-condition including the original box, manuals, accessories, and copy of sales receipt. Returns must be within 14 days of purchase. Returned items are subject to a 25% restocking fee. Shipping is not refundable.

Frequently Asked Questions

15.1 Serial Port Related Questions

15.1.1 Why is there a serial port on the AT-AUTO?

Does this mean that I can remotely control it? What is the control protocol?

Answer: The AT-AUTO was originally designed only to permit the user to upgrade the firmware as new features became available. As firmware enhancements are made, they are be available to the user directly from the Palstar website. Watch the Palstar website for firmware updates and instructions how to load revised firmware into the AT-AUTO.

Previous firmware versions did not provide for remote control of the AT-AUTO. However, remote control operation is included in Version 2.0 (and subsequent) firmware versions. See “Remote Control” section for details.

15.1.2 Will the AT-AUTO work with my Collins KWM1 and others without a computer interface?

Answer: Yes! The AT-AUTO is a fully automatic antenna tuner. It works fine with all HF radios. It includes the CAT and external tuner interface circuitry merely as an operating convenience, but they are NOT necessary for automatic tuner operation.

15.1.3 Why does the AT-AUTO have an RS-232 port instead of a USB port?

Answer: The AT-AUTO interfaces with an HF radio and with your computer via a conventional RS-232 port. Most modern HF radios that have CAT capability, do so via an RS-232 serial port (an exception: Icom uses a simple single line, bidirectional, open-collector, serial interface). Using an USB port instead of an RS-232 port in the AT-AUTO would have meant

that our customers would need to purchase a USB-RS232 converter in order to achieve the CAT interface capability that the AT-AUTO already provides. The CAT (RS-232) interface is only used to provide low-data-rate frequency information and remote control commands to the AT-AUTO. Depending upon the radio, this data stream may be less than 20-bytes. Clearly the expense and complexity of USB is unwarranted.

15.2 Memory-Related Questions

15.2.1 How can I clear the AT-AUTO memories?

Our local club was conducting an emergency communications drill. I brought my AT-AUTO to the simulated emergency location and want to use the club's G5RV antenna but a lot of the memories contain match settings for my 160m dipole at home.

Answer: The AT-AUTO firmware includes over 500 non-volatile memories. The memory is split evenly with 250+ memories each for the balanced and coaxial outputs. The memory can be reset to the factory defaults by entering the “configuration” menu, and then scrolling to the “Erase Match Mem?” option and pressing the “Mode-Tune” rotary knob.

15.2.2 What happens when I select “Erase Match Mem?” How do the memories work?

Answer: Selecting “Erase Match Mem?” erases all of the user's match settings that were stored in the AT-AUTO's non-volatile memory and restores all 500+ memories to original factory defaults.

The factory defaults are mere starting points for tuning operation based upon operating frequency. Each memory default when “coax” output is selected is for a nominal 50 Ω load. Likewise, the “balanced” output default is for a nominal 200 Ω load. Based upon frequency and selected output, if the SWR exceeds an approximate 1.2 : 1 threshold, the AT-AUTO recalls from memory the respective inductor and capacitor settings and presets them accordingly. Then if the SWR is still excessive and if subsequent tuning occurs and a successful match is found, that memory's default settings are overwritten with the actual match settings.

15.2.3 Can I manually edit the memory settings?

Answer: Short answer – No.

Long answer – Yes, but only indirectly. The manner in which this may be done is to operate the tuner in manual mode and manually adjust the tuner for a suitable match. Then

switch the tuner to automatic mode and command a “fine tune” by momentarily pressing the Mode-Tune rotary knob. The tuner will attempt to fine tune, but finding the good match, will instead store your match settings.

15.2.4 How do I control which memory is recalled and used?

Answer: You really can't - The AT-AUTO manages all of the memories automatically based upon operating frequency and which output is selected.

15.3 Radio-Interfacing Questions

15.3.1 Why is the AT-AUTO frequency following always one-band-behind my IC-7800?

I have the AT-AUTO connected to the CI-V port on my IC-7800, but the AT-AUTO is on the wrong band! When I press the 40m band button, the AT-AUTO switches to 20m (the previous band I was on), and when I then press the 20m band button, the AT-AUTO switches to 40m?!? What is going on? Why doesn't this work right?!?

Answer: We apologize – This was a bug introduced in version 2.01 of the firmware that affected CI-V operation but not CAT operation and has been fixed. This was an unintended consequence of adding CI-V bus collision detection, and once the problem was brought to our attention, it was fixed. Please upload version 2.03 into the AT-AUTO.

15.3.2 Why doesn't the AT-AUTO work in Smart and Handshake modes with other radios?

Answer: It will eventually. We designed the AT-AUTO to interface with ALL radios that incorporated a CAT interface and or included an external tuner interface. Version 2.0 firmware provides Icom, Kenwood, and limited Yaesu support. Support for other radios will continue to be expanded and included in never firmware versions.

The AT-AUTO hardware should be capable of supporting most radios. The decision to support Icom radios first was made because the Icom interfaces are well documented and standardized across the entire Icom transceiver product line. We have only recently included support for Kenwood, but Yaesu support is still limited and undergoing development.

15.3.3 Why doesn't the AT-AUTO serial handshake work with the IC-7800?

I have the AT-AUTO working perfectly in handshake mode with my Icom IC-756PROII. However, whenever I try using it with my IC-7800, the AT-AUTO does not follow the IC-7800 frequency changes. I have tried everything I can think of, and yes, the IC-7800 is set for CI-V transceiver at 9600 baud just as it is on the PROII. Why doesn't this work?!?

Answer: We apologize-This was a bug in Ver 1.01 (first release version) of the AT-AUTO firmware and has subsequently been fixed in more recent firmware versions (available for free from Palstar). Ver 1.01 firmware automatically configured the AT-AUTO Icom CI-V operation whenever it was aware of an Icom radio by sensing the Icoms external tuner jack. However, the IC-7800 does not have an external tuner interface and hence this scheme was inappropriate for use with an IC-7800. Please install Ver 2.00 firmware (or later).

15.3.4 Will the AT-AUTO automatically follow frequency changes in the IC-735?

Q: I want to use my Icom IC-735 with the AT-AUTO. I know that the IC-735 uses a 4-byte CI-V frequency protocol, whereas newer Icom radios use a 5-byte CI-V frequency protocol. Will the AT-AUTO automatically follow frequency changes in the IC-735? Do I need change the firmware setup?

Answer: You are correct, the earlier Icom radios used 4-byte frequency data, but newer Icom radios pass 5 bytes of frequency data over the CI-V bus. The AT-AUTO works just fine with both the 4 and 5 byte frequency protocols. However, the IC-735 is (hardware) configured to operate at 1200 baud, whereas most newer Icom radios support a broad range of data rates. To make the AT-AUTO automatically follow IC-735 QSY operations the AT-AUTO must be configured for 1200 baud, and should be setup for Icom CI-V operation. See the "Configuration" section for details.

15.3.5 How can I make the AT-AUTO follow a specific Icom radio in a multi-radio setup?

I have a contest station consisting of multiple Icom IC-756PROIII and IC-7800 radios. These radios are networked via the Icom CI-V bus and under software control from a PC. I have an AT-AUTO working perfectly with one of the PROIII radios. However, the AT-AUTO follows all frequency commands sent from the PC to any of the other radios. For example, when I command the IC-7800 to QSY, the AT-AUTO which is actually connected to a PROIII, changes to the frequency of the IC-7800.

Answer: Congratulations on such a nice setup! What you are describing is selective CI-V addressing by the AT-AUTO and was not even considered in the original firmware. However, Ver 2.0 and late firmware provides selective CI-V addressing. Please see the “Icom CI-V Configuration” section for specific instructions.

We did not anticipate a setup as elaborate as yours, nor did we envision the AT-AUTO as part of a much larger CI-V network. We designed the firmware to respond to any CI-V transceiver broadcasts as well as frequency commands sent by a PC over the CI-V bus, regardless of the intended recipient of such commands. The good news is that selective addressing is implemented in the Ver 2.0 firmware.

15.3.6 Why doesn’t “Fine Tune” work with my Collins S-Line?

The AT-AUTO was working just fine with my IC-7000, but there is a problem with the “Fine Tune” feature when I use the AT-AUTO with my Collins S-Line. Basically when using it with the Collins station, pressing the “Mode-Tune” button when in Automatic Mode, produces an error with the AT-AUTO complaining about a no-power abort. Is this a problem with the AT-AUTO?

Answer: When using the AT-AUTO with any radio that lacks supported CAT/CI-V capability, the AT-AUTO should be configured for Vintage Rigs via the configuration menu. Please reconfigure the AT-AUTO for “Vintage Rig” and this will solve this problem.

15.3.7 Does the AT-AUTO support ALE operation? Will it in the future?

Answer: NO and NO.

15.4 Configuration Questions

15.4.1 How should I setup the Peak-Hold metering for the AT-AUTO to work automatically?

Answer: The AT-AUTO control circuitry does not use any of the Peak-Hold metering. All circuitry used by the AT-AUTO for manual/automatic tuning is independent of the Peak-Hold metering circuitry. The Peak-Hold circuitry and the SWR meter are included as an operator convenience only during manual tuning operation and are not used by the AT-AUTO during the process of automatic tuning.

15.5 General Usage Questions

15.5.1 How does the AT-AUTO differ from other automatic tuners available to the amateur radio community?

Answer: This is the ONLY fully-automatic antenna tuner purposefully designed and built to conservatively handle a continuous 1500 W CW carrier. Most other automatic tuners are a mere collection of fixed inductors and capacitors that are switched in/out by relay and as such are generally limited to 600W PEP or less.

The AT-AUTO uses the same high-quality roller inductor and split-stator capacitor used in our highly-acclaimed manual tuners, but they now are adjusted by stepper motors under microprocessor control.

15.5.2 Is this a Ham-Band only tuner? Will this work on the MARS frequencies?

Answer: The AT-AUTO will match antennas operating in the 1.8 - 54 MHz range. There are match memories dedicated to the entire match range of the tuner. Non-volatile memories for MARS frequencies as well as other Federal/Civil frequencies are incorporated into the AT-AUTO firmware.

15.6 Tuning Algorithm-Related Questions

15.6.1 Why does the AT-AUTO take up to 30 seconds to tune?

Answer:The actual tune time of the AT-AUTO is very fast; 1-3 second tuning time is very typical. The 30 seconds quoted is due to the transit time it takes for the AT-AUTO to reposition the roller inductor from one extreme to another such as QSYing from 160m to 10m.

The actual tuning starts once the inductor and capacitor have been pre-positioned for the frequency/band of operation. When operating in Smart mode, the AT-AUTO automatically recalls its matched settings from non-volatile memory and subsequent tuning is likely not necessary.

15.6.2 Why does tuning sometimes fail when “Fine Tune” is commanded?

Sometimes when I command a “Fine Tune”, that the inductor and capacitor will to the “000” positions and when the AT-AUTO starts tuning, the tuning fails. However, on subsequent

attempts it works fine. Am I doing something wrong? I noticed that this always seems to happen whenever Fine Tune was commanded immediately after I turn on the AT-AUTO.

Answer: No-You are doing this properly. This was a bug in the original firmware that erroneously commanded the *L* and *C* to their minimum positions instead of using the existing *L* and *C* positions with which to commence tuning. This bug has since been corrected. Please update your firmware.

15.6.3 I accidentally turned off my AT-AUTO while auto-tuning and now it won't tune. How do I fix it?

Answer: No problem-You didn't break anything, but the AT-AUTO no longer knows exactly where the *L* and *C* are positioned. For ordinary operation, the AT-AUTO must know the approximate *L* and *C* are positions.

Within 1 second after completing any movement of the *L* or *C*, the AT-AUTO saves the new *L* and *C* positions in non-volatile memory for subsequent recall. When you turned off the AT-AUTO during the automatic tuning process, the AT-AUTO had repositioned *L* and *C*, but had not updated the memory with the newest *L* and *C* positions. When the AT-AUTO was next turned on, it (correctly) recalled the last-stored but incorrect *L* and *C* positions.

The remedy is simple - the *L* and *C* positions merely need to be resynchronized. To do this, enter manual mode and turn the capacitor one complete revolution through the "000" position this will automatically resynchronize the capacitor. Next, synchronize the inductor by returning it to the minimum *L* position. Do this by selecting the inductor with the "Tune" knob, and repeatedly turning the knob in a counter-clockwise direction until the inductor stops rotating. When the inductor reaches the minimum position, it will engage a limit switch, completing the synchronization process.

Alternatively, (with the inductor selected) you may opt to depress the "Tune" knob for two seconds and then momentarily turn the knob counter-clockwise the inductor should turn automatically to the minimum position and stop. To avoid this in the future, please wait one second after *L* and *C* have stopped moving before turning off the AT-AUTO.

15.6.4 Why does the AT-AUTO tune right past good match points?

Not to be too picky, but I have noticed quite often that during automatic tuning, it appears that the AT-AUTO will tune right past dips in the SWR, but it still finds very good match settings. Is this normal?

Answer: What you described was a particular tuning algorithm employed in earlier firmware versions. We observed this quite often, and it was intentional. That particular

tuning algorithm attempted to bound the positions of minimum SWR then moving either the L or C . If this movement caused SWR to increase, the direction of rotation was reversed. The component was then commanded to rotate until the SWR stopped decreasing. The component movement could indeed pass the minimum SWR point, but this component was then commanded to a position between the two SWR peaks. The other component then went through the same process. Each iteration successfully bounded the minimum SWR. The actual tuning process was pretty quick, but the algorithm intentionally does not attempt to smoothly approach the minimum SWR. While this particular tuning algorithm you observed was very successful, we have been constantly improving it through design and experimentation, and have further optimized both the rate of the match convergence as well as the number of iterations involved in arriving at the particular match conditions. Please upload the latest version of the firmware to the AT-AUTO.

15.6.5 Why does the AT-AUTO sometimes report “Match Not Found”, but when I transmit again, it shows “Good Match”?

Answer: The tuning algorithm employs hysteresis: Tuning is initiated whenever SWR is determined to be above the “Tune Start SWR” of 1.2:1 (default), and the tuning process stops upon achieving a 1.05:1 SWR (default), or if the AT-AUTO times out (a prescribed number of tuning iterations has failed to achieve the 1.05:1 SWR). For our purposes, we considered a 1.2:1 SWR (or better) an extremely good match.

There was an oversight in earlier versions of the firmware (including REV 1.01) that would report “Match Not Found” whenever the tuning process failed to achieve a 1.05:1 or better SWR, regardless of whether the SWR was below the default “Tune Start SWR” (hysteresis) level of 1.2:1. For example, if the best SWR that the auto tuner achieved was 1.1:1, the algorithm would report that tuning failed, but because 1.1:1 is below the 1.2:1 hysteresis threshold to initiate tuning, upon subsequent key-up, the auto tuner would correctly report the “Good Match”.

This bug had been corrected in an interim firmware version. Now when the match is 1.05:1 or better, the AT-AUTO displays “Good Match” on the 1st line of the LCD, along with $\text{SWR} \leq 1.05:1$ on the 2nd line of the LCD. In the event that tuning did not achieve 1.05:1 SWR, but upon timing out did match to 1.2:1 SWR or better, LCD now displays “Good Match” and $\text{SWR} \leq 1.2:1$ (or whatever the auto-tune stop SWR threshold has been set to).

15.6.6 Why does the AT-AUTO retune at high power when it found a match at low power?

After I QSY if the SWR is bad, the AT-AUTO gets a low-power carrier from my Icom radio to tune against. The tuning process seems to work fine, but occasionally when I subsequently transmit, the AT-AUTO starts re-tuning. Why does it do this if it found a match at low power?

Answer: The output of the RF bridge rolls off non-linearly at very low power levels. This is the reason that the AT-AUTO sometimes retunes upon application of QRO although a good match was previously found at QRP levels. The tuning algorithm is intentionally extremely conservative (attempting to match to 1.05:1 or better). At 10 W input to a load matched to 1.2:1 or better SWR, the reflected power levels are indeed very low and approach the hardware's limit to detect these power levels. However, when QRO is applied, the reflective power may be sufficiently increased (even at extremely good SWR) and detected by the AT-AUTO. This is most often manifested when the AT-AUTO is coupled to an radio that is configured to utilize the radios external tuner interface and rely upon the radio to produce a steady 10W carrier. From experience, it turns out that this power level may vary from radio to radio with some radios producing a stronger carrier (fine) (≈ 15 W) while others less ($\approx 6-7$ W) (problematic).

15.6.7 Why does the AT-AUTO sometime start retuning when operating SSB?

When operating SSB, occasionally the AT-AUTO will start automatically retuning even though I know the match is good. Why is this happening? And how do I prevent it? This is really annoying!

Answer: The SWR polling algorithm has been revamped in firmware Version 2.0 and this problem has been fixed. Furthermore, the user can also configure the AT-AUTO to require operator approval before initiating automatic tuning.

The reason that this happened was partly due to the nature of the SSB waveform and the SWR sampling process. The AT-AUTO constantly samples Forward power and then samples Reflected power. While the process happens very quickly, it is possible during the sampling process to start the Forward sample during the initial rise in power during the SSB waveform and then to subsequently sample the Reflected power during the peak of the SSB waveform, occasionally resulting in erroneous SWR indications.

This problem has been identified and is corrected in subsequent firmware releases (Ver 1.04 and later). While there are two ways to prevent this from happening, we highly recommend that you permanently remedy this issue by uploading the latest firmware revision to the AT-AUTO. The other method is to switch to the AT-AUTO's "Manual Mode" whenever

you wish to prevent the AT-AUTO from autonomously retuning.

15.6.8 The tuner sometimes retunes after autotuning using the radio's "Tuner" button. Why?

My AT-AUTO seems to work fine if I tune in high power and then operate. However, if I tune using the Tuner button on the Icom radio, the AT-AUTO quite often wants to re-tune once I switch to high power operation. It does this about 30% of the time when using the coax-fed loop, but rarely does this when using a similar loop which is fed directly with ladder line. Why does it do that? Is there something wrong with my AT-AUTO?

Answer: Tuning at low power has a couple of advantages. It reduces QRM and it places less stress on the transmitter while a match is being sought. It is also convenient when using an Icom or Kenwood radio—you merely press the rigs' Tuner button and it all happens automatically... However, if there are losses in the antenna system greater than the resolution of the Forward/Reflected power sampling, then tuning might need to be re-accomplished when subsequently operating at higher power output levels.

15.6.9 Why is tuning different depending upon whether using coax-fed or balanced-fed antennas?

OK But Why? And why does it seem to be different depending upon whether it is a coax-fed or balanced-fed antenna?

Answer: Several factors contribute to this behavior, including the power losses within the feed line and feed line connectors, the linearity of the RF sampling network and the bit-resolution of the analog-to-digital converters used to quantify the Forward and Reflected power samples.

The AT-AUTO firmware includes an SWR hysteresis feature. That is, it measures the Forward and Reflected power and if the SWR is less than 1.2:1 (default), then it does not automatically tune. However, if the SWR is determined to be greater than 1.2:1, then automatic tuning is initiated. During the automatic tuning process, the AT-AUTO attempts to improve the SWR to 1.05:1. As soon as an SWR of 1.05:1 (or better) is achieved, the tuning is halted and the match settings are stored. If 1.05:1 (or better) is NOT achieved, the tuning process continues until it times out. At that time, if the SWR is still greater than 1.05:1, but less than 1.20:1, the automatic tuning process is deemed successful and the match settings are stored. The AT-AUTO provides the user with a visual indication of which criterion was met by displaying either "SWR \leq 1.05 : 1" (default) or "SWR \leq 1.2:1" (default), or "Match Not Found."

The SWR is calculated using the following equation:

$$SWR = \frac{P_{Fwd} + P_{Ref}}{P_{Fwd} - P_{Ref}}$$

Given a Forward power of 10W (as provided when using the “Tuner” button on the radio), an SWR of 1.20:1 is observed if 0.90W of Reflected power is sensed at the SWR bridge. If the Reflected power sensed is 0.95W, the observed SWR is 1.21:1 which now exceeds the hysteresis threshold needed for automatic tuning initiation. Conversely, if the Reflected power sensed is only 0.85W, the observed SWR is 1.19:1. Therefore a variation in Reflected power of 0.05W is all that is required to vary the observed SWR and may initiate automatic tuning. Losses in cables or connectors will easily exceed this threshold.

If a 100W carrier is used for tuning instead, 9W of observed Reflected power will result in a 1.20:1 SWR. Likewise 9.5W of observed Reflected power yields an observed SWR of 1.21:1. The difference now is that it requires an approximate Watt increase in Reflected power to achieve an SWR that exceeds the automatic tuning threshold. Therefore, when tuning at 10W, a 0.05W change in observed Reflected power may be all that is required to vary the observed SWR from 1.20:1 to 1.21:1 (exceeding threshold and triggering automatic tuning). However, when tuning at 100W, a $\frac{1}{2}$ W change in observed Reflected power may be required to vary the SWR around the hysteresis threshold level.

The AT-AUTO is capable of quantifying observed power levels ranging from approximately 5-1500W with a resolution of approximately 0.1W. When tuning with a 10W carrier, this resolution is slightly coarse for differentiating 0.05W variations in observed Reflected power, but is well suited for resolving $\frac{1}{2}$ W variations in observed Reflected power when tuning with a 100 W carrier. While the AT-AUTO power resolution at low power may seem limited, the most detrimental factor is the overall feedline loss and the actual SWR at the antenna feed point. From the ARRL Handbook, the matched losses for several feed lines are Table 15.1: The “matched loss” is the expected power loss due to the resistive and dielectric

Table 15.1: Feedline Match Losses

Feeder Type	Loss per 100'
RG-58	2.25 dB
RG-8	1.25 dB
Open-Wire	0.1 dB

losses with the feedline when the feedline is terminated in its characteristic impedance. For

an RG-58 type coaxial cable, if that cable is terminated into a perfect 50Ω load, then for every 100' of feedline, 2.25dB of power loss is expected.

These losses increase significantly if there exists a significant mismatch between the feedline and the intended load. The matched loss in dB is:

$$Loss = 10Log\frac{P_{Fwd}}{P_{Ref}}.$$

For a 100' length RG-58 coaxial cable terminated into a 50Ω load, the expected loss is approximately 40% when operating at 30 MHz. If the input power is 10W, only 5.9W will be supplied to the 50Ω load. Conversely, for a 100' length of Ladder Line, when terminated in its characteristic impedance, the expected loss is only 2.3%! A similar length of RG-8 coaxial cable driving a 50Ω load will dissipate (lose) as heat, approximately 24% of the transmitter power.

Table 15.2: 100' Feedline Match Loss for 1.0:1 SWR

Feeder Type	Loss (dB)	Power Loss	Power at Antenna
RG-58	2.25 dB	40.4%	59.6%
RG-8	1.25 dB	25.0%	75.0%
Open-Wire	0.1 dB	2.3%	97.7%

When the feedline is NOT terminated in its' characteristic impedance, some power will be reflected back from the load toward the transmitter, increasing the feedline losses. The following table serves to illustrate the observed SWR that would be observed by the AT-AUTO when coupled to various feed lines, and when those feedline terminations produce reflections ($SWR \geq 1.0:1$). This table assumes 100' feedline length, and operation at 30 MHz with 100 W drive power. See the ARRL Handbook for a more detailed explanation and associated equations.

Table 15.3 is intended to illustrate that coaxial cables, while very convenient are extremely lossy when operated at high SWR and serve to very effectively mask the magnitude of the actual load SWR.

To summarize and to answer to the original question of why this happens and why does it seem to vary with different feedline types, one must understand that when tuning with very low power levels (such as 10 W) that the losses in the antenna system due to feedline and connector losses may easily be greater than the power levels required to initiate automatic tuning. When using open wire line, the losses are indeed minimal and observed and actual SWR are very closely correlated.

Table 15.3: 100' Feedline Match Loss for various SWR

Feeder	SWR at Ant	SWR at AT-AUTO	Feeder Loss	Power at Antenna
RG-58	1.36:1	1.20:1	41.3 W	58.7 W
RG-58	10.0:1	2.90:1	74.2 W	25.8 W
RG-8	1.27:1	1.20:1	25.5 W	74.5 W
RG-8	10.0:1	4.18:1	39.8 W	60.2 W
Open Wire	1.20:1	1.20:1	2.3 W	97.7 W
Open Wire	10.0:1	8.98:1	10.4 W	89.6 W

Why don't I see this same effect with my Icom AH-4 tuner?

OK - I think I followed all of that. However, I don't see this same effect when I use my Icom AH-4 automatic tuner. I tune it at low power using the Icom Tuner button, but it does not automatically re-tune when I switch to high power and the SWR is always around 1.5:1. Why?

Answer: The AT-AUTO and the AH-4 are very different tuners. Among the significant differences is the fact that the AH-4 (like the AH-3, AH-2 and most of the other mobile random-wire tuners) does not drive a feedline such as a coaxial cable or open-wire line that in-turn feeds an antenna. It therefore is not affected by the match loss of the coaxial cable feeding the AH-4. Because the random wire (the antenna) attaches directly to the AH-4, it is able to sample the swr directly at the antennas' feed point. The AT-AUTO samples SWR at some distance from the antenna feed point, which is affected by the match loss of the feedline. However, using low-loss feeders will mitigate this effect. The AH-4 is also NOT an autonomous antenna tuner the AT-AUTO is. The AT-AUTO constantly monitors SWR and automatically re-tunes if necessary. The AH-4 only tunes when commanded, and then only tunes to reduce SWR to 1.5:1. The AT-AUTO strives for a much better match of 1.05:1, but a match of 1.2:1 or better is automatically considered a success. The 1.05:1 SWR criteria is much more challenging to achieve, but is readily achievable with the AT-AUTO firmware and variable capacitor and roller inductor. The AH-4 uses lumped capacitance and inductor values which often do not yield sufficiently fine resolution of capacitance and inductance necessary to provide the precise tuning match achieved with the AT-AUTO.

15.7 Firmware-Specific Questions

15.7.1 Where can I get a copy of the firmware source code?

I am a software engineer and have experience with the Atmel-type processor used in the AT-AUTO. I would like to add some of my own refinements to the AT-AUTO. Where can I get a copy of the source code?

Answer: The license agreement you accepted when you purchased the AT-AUTO prevents you from accessing, revising, reverse-engineering, sharing, etc., the AT-AUTO firmware. The AT-AUTO firmware is wholly-owned Palstar, Inc. intellectual property. We are protecting it accordingly. Our legal department is poised to take whatever legal action if necessary to do so. You should realize that considerable time and expense has gone into its development. Some of our competitors may very likely attempt to bring similar products to the market, and in so doing attempt to circumvent much of the development costs by copying or otherwise reverse-engineering our firmware. We therefore regret that we are unable to divulge any of the firmware specifics.

15.7.2 Why should I update to the newer AT-AUTO firmware?

Answer: You might not need to, but you will probably want to. When we started design on the AT-AUTO, we understood that the firmware would likely be an “evolutionary” process. We are in good faith attempting to provide a high-quality, effective, QRO, automatic antenna tuner. We knew from the onset that while we invested considerable time and resources into the development of our firmware, there would likely be improvements and enhanced features that we will want to make available to our customers. Additionally, if problems were later discovered and as improved algorithms are designed, we wanted the customer to be able to take advantage of these improvements (at no additional cost).

This is the reason we included the ability to upload the firmware to the AT-AUTO. The design of the AT-AUTO permits us to continually improve the AT-AUTO operation and add new features. We look upon the AT-AUTO as an evolutionary product with sufficient firmware flexibility to permit continued product improvement. Furthermore, since introducing the AT-AUTO, our customers have requested several features that we simply did not anticipate, but we are very happy that we were able to meet those requests through improvements in the firmware. If building a QRO, fully-automatic tuner were simple, others would have done so already.

User Notes

16.1 User Notes - Continued

16.2 User Notes - Continued

16.3 User Notes - Continued