AT-AUTO$_{(tm)}$ Operating Manual

Firmware Version 2.14

Kessler Engineering, LLC
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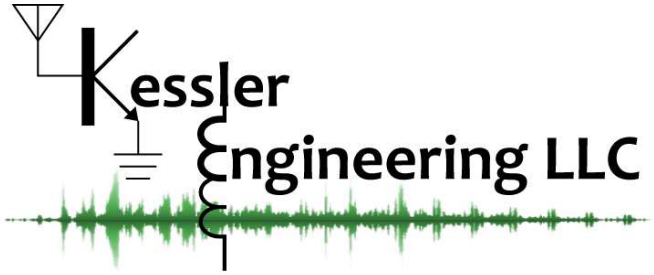

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Thank-You!

At Kessler Engineering, we endeavor to make your ham radio hobby more enjoyable and trust that our products will bring you many years of faithful service. We ***Thank-You*** for the confidence that you have placed in us and in our products. *73!*

Dr. Donald J. Kessler, Ph.D.,
President, Kessler Engineering, LLC

Introduction

Kessler Engineering is pleased to bring you the AT-AUTO$_{(tm)}$ - 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$_{(tm)}$ 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$_{(tm)}$ is well-suited for Amateur Radio, CAP, MARS, Military, and Government HF radio applications. Under microprocessor control, the AT-AUTO$_{(tm)}$ 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$_{(tm)}$ also enables the user to manually tune or adjust match settings 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$_{(tm)}$ controls are illustrated in Figure 1.1, and are described in Table 1.1 (page 4). An internal view of the AT-AUTO$_{(tm)}$ and component descriptions are shown in Figure 1.2 (page 5) and Table 1.2 (page 6), respectively, while the rear panel features are shown and described in Figure 1.3 (page 7) and Table 1.3 (page 7). A functional block diagram of the AT-AUTO$_{(tm)}$ is shown in Figure 1.4 on page 8. AT-AUTO$_{(tm)}$ hardware specifications are shown in Table 1.4 on page 9.

The AT-AUTO$_{(tm)}$ firmware is subject to periodic updates. As improvements are made and new features are added, the user may update the AT-AUTO$_{(tm)}$ firmware directly from the Kessler Engineering website. See page 70 for more detail.

Figure 1.1: Front Panel View

Table 1.1: Front Panel Controls as shown in Figure 1.1

Reference	Control Name or Function
1	**Master Power Switch**, Controls power to AT-AUTO$_{(tm)}$ 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$_{(tm)}$ status and user prompts
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.

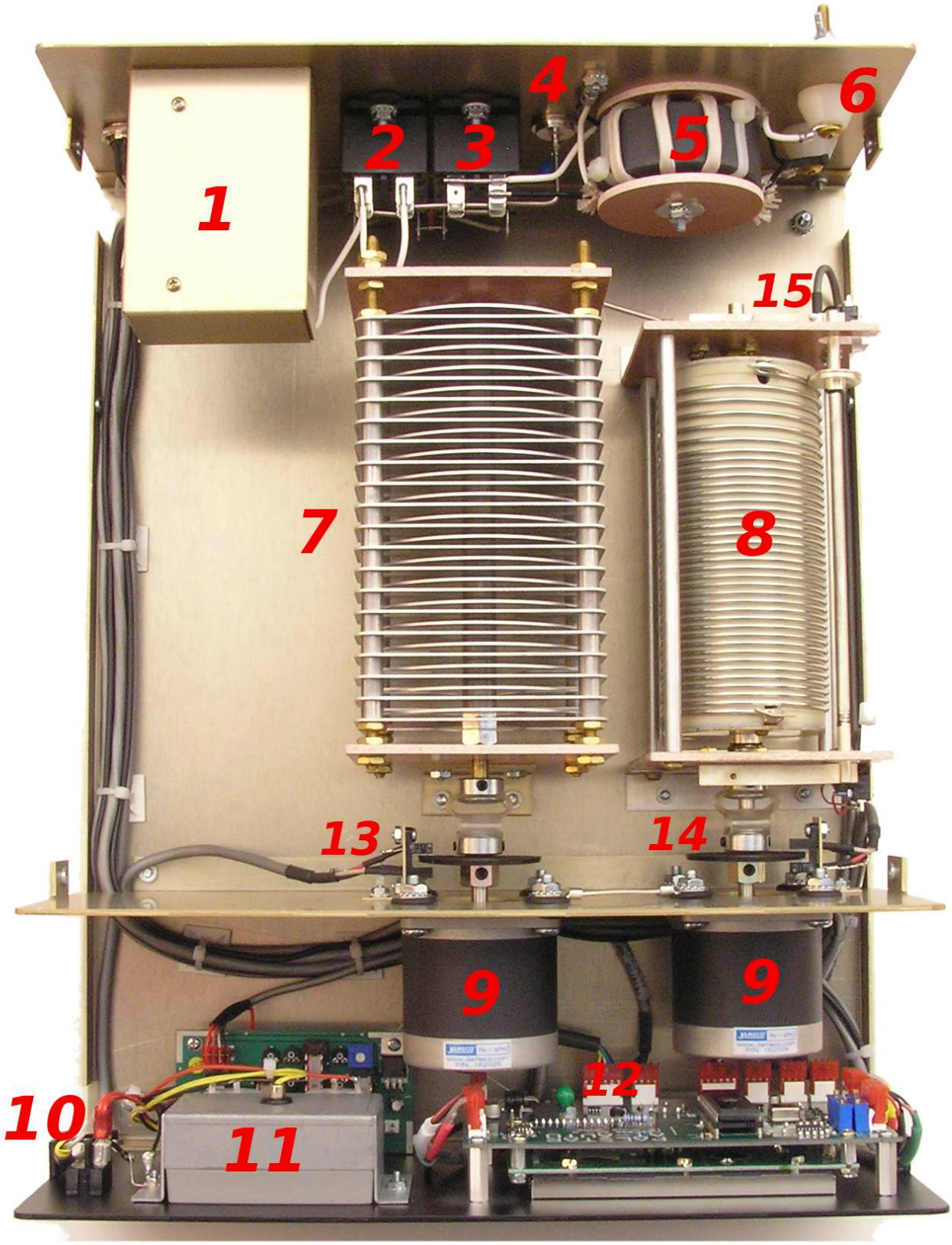


Figure 1.2: Top View (Cover Removed)

Table 1.2: Internal Components as shown in Figure 1.2

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 μH roller inductor
9	Stepper motor
10	Master power switch
11	Cross-needle power and SWR meter
12	AT-AUTO$_{(tm)}$ processor and display
13	Split-stator capacitor gap detector
14	Roller inductor gap detector
15	Roller inductor travel limit switch

Figure 1.3: Rear Panel View

Table 1.3: Rear Panel Components as shown in Figure 1.3

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 @ $\approx$ 3.5 A peak while tuning
9	QRO Keyline Input/Output (AT-AUTO$_{(tm)KL}$ only)

***Note:** Requires specific cable configuration. See Table 8.1 (page 77) for details.

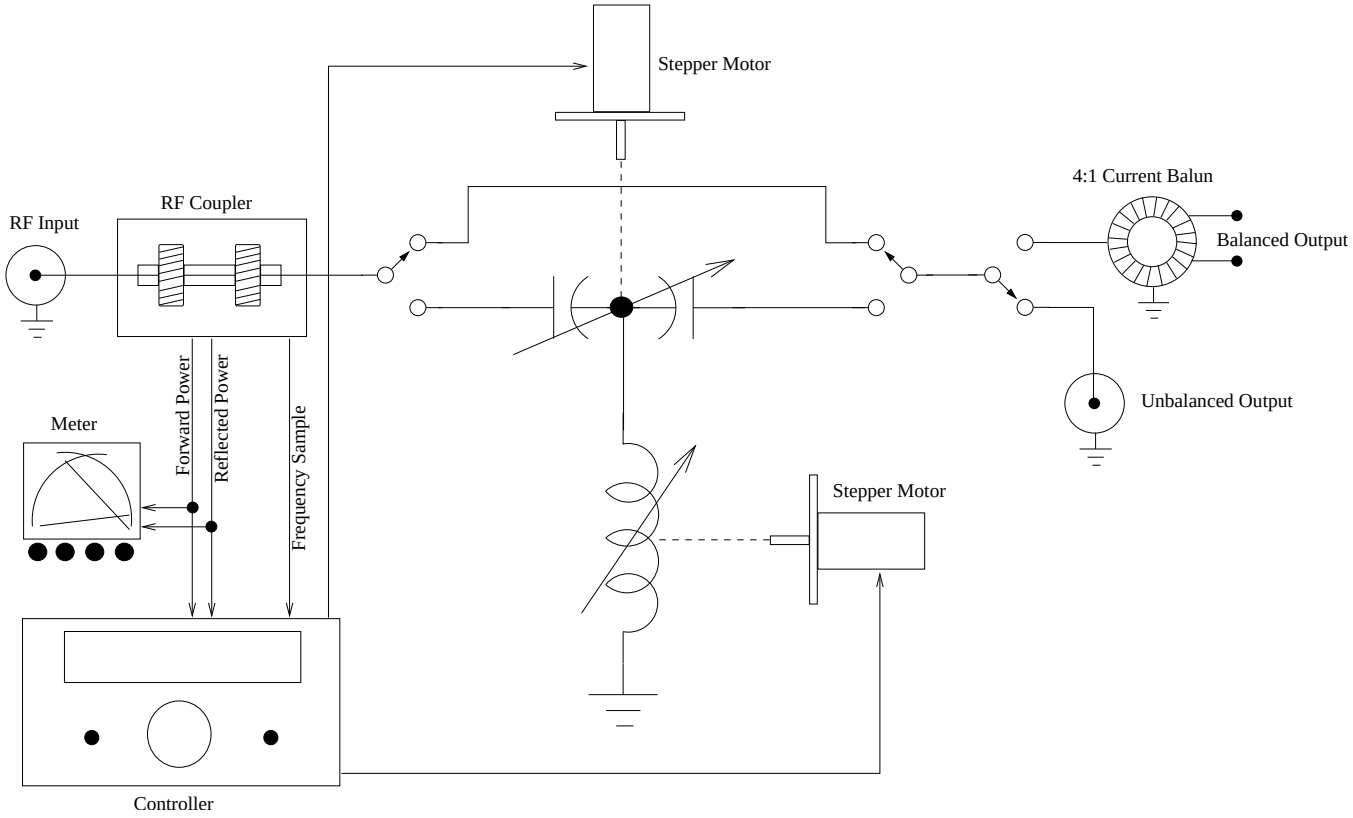


Figure 1.4: Functional Block Diagram

Table 1.4: 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 μH, 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 3 mm 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
QRO Keyline Input/Output	2 RCA Phono Jacks
General Specifications	
Frequency Range	1.8-54 MHz
Power Handling	1800 W PEP SSB, 1500 W single-tone continuous
Impedance Range	$15 - 1500\ \Omega$,$160 - 6$m
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, 6.25" High, 17" Deep (including terminals)
Weight	17 Lbs
Materials	Chassis and top cover are .090 ga. aluminum, gold iridite, Front panel powder coated and epoxy screened

Automatic Mode

2.1 Quickstart Guide

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$_{(tm)}$ switches to the antenna that had been in use when the AT-AUTO$_{(tm)}$ was last switched *Off*, and then (default) starts up in the *Automatic* mode. Here the AT-AUTO$_{(tm)}$ 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 tuning network. While in *Bypass* mode, momentarily pressing the **Mode** switch again returns the AT-AUTO$_{(tm)}$ to *Automatic* mode.

Momentarily depressing the **Output** button enables selection of either the coaxial or the balanced outputs.

Depending upon the mode of operation, the action currently taking place, the user-selected firmware options, and the type of radio attached/interfaced with the AT-AUTO$_{(tm)}$, the three primary controls (**Mode**, **Output**, and **Tune-Select** rotary encoder/pushbutton) will implement various AT-AUTO$_{(tm)}$ features. Generally each of these controls provide a different function depending upon the length of time that the particular button is depressed. Tables 2.1, 3.1, and 3.2, on pages 15, 18, and 20, lists the control function provided by each of these three controls when operating in *Automatic*, *Manual*, or *Bypass* mode, respectively. For operation in the *Automatic* mode, please follow these steps:

1. Connect the AT-AUTO$_{(tm)}$ input to the transceiver with a 50 Ω coaxial cable.
2. Connect the antenna to the AT-AUTO$_{(tm)}$ output (Coax or Ladder Line).
3. Connect the supplied DC Power Cable to a 12 VDC power source capable of supplying 4 A to the AT-AUTO$_{(tm)}$.

4. Turn *On* the AT-AUTO$_{(tm)}$. It 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. Some firmware versions require that the **Tune-Select** knob be rotated until the desired output is displayed, then momentarily depressing the **Tune-Select** knob.

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$_{(tm)}$ will measure the SWR, and if necessary, count the RF carrier frequency, preset the inductor and capacitor to positions appropriate for the band of operation, and then begin automatic 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$_{(tm)}$ 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**.

Warning: Wait at least 2 seconds after the last movement of the Inductor or Capacitor while their new positions are updated and saved in the microprocessor before removing DC power or turning *Off* the AT-AUTO$_{(tm)}$. Firmware version 2.01 (and subsequent) will automatically re-home L and C if the memory write was interrupted.

2.2 Detailed Operation

When first turned on, the AT-AUTO$_{(tm)}$ momentarily displays the firmware version in the Liquid Crystal Display (LCD), then automatically selects the RF output that had been in-use when the AT-AUTO$_{(tm)}$ was last switched-off. Approximately two seconds later, the AT-AUTO$_{(tm)}$ will enter *Automatic* mode (unless the default firmware configuration was changed) and will begin sampling Forward power.

Operator intervention is generally not required for normal *Automatic* mode operation. Merely select the intended RF output (Balanced or Coaxial), apply RF power, and observe/follow the prompts shown in the LCD.

While in *Automatic* Mode, the AT-AUTO$_{(tm)}$ continuously monitors Forward power. Whenever approximately 10 W of Forward power has been detected, the AT-AUTO$_{(tm)}$ 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$_{(tm)}$ displays "Good Match", 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$_{(tm)}$ will attempt to improve that match to the "Tune Stop SWR" threshold (default 1.05:1) or better. First, the AT-AUTO$_{(tm)}$ counts the RF frequency and then recalls the L and C match settings for that particular frequency segment. It then automatically repositions L and C to the recalled match settings and indicates to the user that this is taking place.

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

Once the inductor and capacitor have been repositioned, the AT-AUTO$_{(tm)}$ prompts the user to provide a steady carrier and 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) RF carrier (FM or CW). SSB or modulated AM are NOT appropriate.

Note: After 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.

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 tuning will be required. However, if the resultant SWR exceeds the 1.2:1 threshold, the AT-AUTO$_{(tm)}$ will commence automatic tuning. While automatic tuning is proceeding, the AT-AUTO$_{(tm)}$ displays the changing C and L positions and indicates that automatic tuning is taking place. Upon finding a good match, the AT-AUTO$_{(tm)}$ displays the matched SWR and immediately stores the match settings in non-volatile memory.

The automatic tuning is an iterative process which alternates adjustment of the L or C until the process either times out (approximately 20 seconds) 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$_{(tm)}$ displays **Good Match, SWR $\leq$ 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$_{(tm)}$ will display **Good Match, SWR $\leq$ 1.2:1**.

Note: Whenever a successful match is found the precise *L* and *C* settings are

stored into memory, and the AT-AUTO$_{(tm)}$ indicates that it is storing the match settings.

If the CW carrier is interrupted before tuning is complete, the AT-AUTO$_{(tm)}$ will immediately cease tuning and provide an error message indicating that the carrier was lost and that tuning was aborted. The user may also terminate the tuning process by momentarily pressing the "Mode" button.

In order for the tuning process to be successful, as L and C positions are adjusted, the corresponding variations in SWR must be discernible by the AT-AUTO$_{(tm)}$ controller circuitry. If the AT-AUTO$_{(tm)}$ is profoundly mis-tuned, such as attempting to tune on 10m while L and C are set for 160m operation, there may be NO discernible variation in SWR as L and C are manipulated, and automatic tuning will very likely fail. Therefore before commencing automatic tuning, the AT-AUTO$_{(tm)}$ always presets the L and C for positions appropriate to the frequency/band of operation.

There are 512 memories in the AT-AUTO$_{(tm)}$ for storing antenna, L, and C positions and are pre-populated with nominal settings. There are 256 memories for the balanced output and 256 memories for the coaxial output.

Warning! Wait until the AT-AUTO$_{(tm)}$ has finished saving the new match settings and the LCD is again displaying "Automatic Mode" before removing DC power or turning *Off* the AT-AUTO$_{(tm)}$.

Smart QSY

The AT-AUTO$_{(tm)}$ is designed to operate in a *Smart QSY* mode by automatically following frequency changes of those transceivers so equipped with a CI-V or CAT serial I/O interface. When operating in *Smart QSY* mode, the AT-AUTO$_{(tm)}$ 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 changes from frequency to frequency, or from band to band, the AT-AUTO$_{(tm)}$ 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 for Elecraft (K-2, K-3), Flex Radio (SDR-1000, FLEX-5000), TenTec (Omni VII, Jupiter), and many Kenwood and Yaesu radios with CAT interfaces.

External Tuner Handshake

For those Icom and Kenwood radios that provide for control of external tuners, the AT-AUTO$_{(tm)}$ is designed to utilize the transceiver's external tuner interface. This is normally via a button on the transceiver labeled, **TUNER**. During *Automatic* mode operation, whenever the radio's **TUNER** button is depressed, the radio signals the AT-AUTO$_{(tm)}$ (the external

tuner) which then automatically coordinates with 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$_{(tm)}$ that tuning is requested. The AT-AUTO$_{(tm)}$ then signals the transceiver to produce a 10W CW/FM carrier at which time the AT-AUTO$_{(tm)}$ samples the SWR and counts the frequency. This process takes approximately $\frac{1}{2}$ second. If the SWR exceeds the "Tune Start SWR" threshold, the AT-AUTO$_{(tm)}$ then recalls appropriate settings for the Capacitor and Inductor from memory and positions them accordingly.

Once the positioning of L and C are complete, the AT-AUTO$_{(tm)}$ 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$_{(tm)}$ signals the transceiver to cease transmitting and the AT-AUTO$_{(tm)}$ automatically stores the match settings.

When using *Smart QSY* and *External Tuner Handshake* modes together, the entire automatic tuning process is greatly streamlined. As the user returns to previously-matched frequency/antenna combinations, the AT-AUTO$_{(tm)}$ precisely recalls and returns to those matched settings, without requiring an RF carrier, and often without requiring subsequent re-tuning.

Note: *External Tuner Handshake* is implemented for Icom and Kenwood radios only.

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$_{(tm)}$ to perform 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$_{(tm)}$ has been configured for *External Tuner Handshake* 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$_{(tm)}$ memory.

If *External Tuner Handshake* is not established, the AT-AUTO$_{(tm)}$ will prompt the operator to produce a steady carrier as explained above and the fine tuning process will proceed.

Note: Fine Tune should only be initiated if the AT-AUTO$_{(tm)}$ has already performed an automatic tune in the present operating band. When Fine Tune is commanded, the AT-AUTO$_{(tm)}$ will use the present L and C positions as the starting point for the fine tuning process. 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$_{(tm)}$ to find a suitable match.

Table 2.1: Automatic Mode Control Functions

Mode Pushbutton	
Short Duration Press	If Tuning In Progress: Aborts automatic tuning attempt
	If Tuner Idle: Selects *Manual* mode
Medium Duration Press	No effect
Long Duration Press	Selects AT-AUTO$_{(tm)}$ "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$_{(tm)}$
	If not "auto-bypassed": Toggles output to COAX/Balanced
	If configured for "Output" CX-AUTO$_{(tm)}$, Initiates Antenna Selection Me
Medium Duration Press	If configured for "Input" CX-AUTO$_{(tm)}$, Initiates Radio Selection Menu
Long Duration Press	No effect
"Duration" Definition	
Short	$\leq$ 1 second
Medium	2-3 Seconds
Long	$\geq$ 10 seconds

Manual Mode

3.1 Quickstart Guide

While in *Automatic* mode, *Manual* mode is selected by momentarily depressing the **Mode** pushbutton. A subsequent momentary activation of the **Mode** pushbutton selects *Bypass* mode.

1. Follow steps 1-7 described above in *Automatic* mode (Page 10).
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$_{(tm)}$ display.
3. Generate a 10-100 W CW/FM carrier.
4. Adjust Capacitor and Inductor by turning **Tune-Select** knob while observing 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.

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

3.2 Detailed Operation

Manual mode is selected by momentarily pressing the **Mode** pushbutton until the AT-AUTO$_{(tm)}$ display shows "Manual Mode" (See Figure 3.1). Precise manual control of the matching network is achieved via the front panel controls and by observing the cross-needle SWR meter. The **Tune-Select** knob is the primary manual tuning control.

The operator manipulates the **Tune-Select** rotary encoder/pushbutton to provide positioning commands to the AT-AUTO$_{(tm)}$ microprocessor, which then drives the stepper motors and positions the inductor (L) and capacitor (C). There is no "heavy lifting" on the part of the operator. The microprocessor monitors the position of the roller inductor and automatically limits the range of inductor movement. The position of the capacitor, inductor and the selected output are constantly displayed to the user, such as shown in Figure 3.1.

External Tuner Handshake

The AT-AUTO$_{(tm)}$ 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$_{(tm)}$ which then controls the transceiver, forcing it to produce a low-power (nominal 10W FM or CW) carrier that the operator may then use to manually tune with.

Note: *External Tuner Handshake* is implemented for Icom and Kenwood radios only.

When so interfaced with such an Icom or Kenwood radio, the user may momentarily press the radio's **TUNER** button when initiating manual tuning. The radio's **TUNER** button signals the AT-AUTO$_{(tm)}$ that a steady low-power carrier is requested. The AT-AUTO$_{(tm)}$ then forces the radio to generate a low-level RF carrier (typically 10 W FM). The user then tunes the AT-AUTO$_{(tm)}$ 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 by pressing the AT-AUTO$_{(tm)}$ **Output** button for 2-3 seconds. If interfaced with an Icom radio with external tuner control, pressing the AT-AUTO$_{(tm)}$ **Output** button for 2-3 seconds will toggle the Icom radio's low-power carrier *On*/*Off*.

The transceiver TUNER button or the AT-AUTO$_{(tm)}$ **Output** button may be used to toggle the steady carrier on or off as needed.

Figure 3.1: Example Manual Mode Display

Table 3.1 (page 18) lists the control function provided by each of these three controls when operating in *Manual* mode.

Table 3.1: Manual Mode Control Functions

Mode Pushbutton	
Short Duration Press	Selects *Bypass* mode
Medium Duration Press	No effect
Long Duration Press	No effect
Tune-Select Knob	
Short Duration Press	Toggles C/L control
Medium Duration Press	If L Active: Causes L to turn continuously If C Active: Causes C to home to 000
Long Duration Press	If L Active: Causes L to home to 000 If C Active: No effect
Clockwise/counter-clockwise Rotation	Increase/Decrease relative C/L position
Output Pushbutton	
Short Duration Press	Toggles RF Output (Coax/Balanced) When configured for "Output" CX-AUTO$_{(tm)}$, Initiates Antenna Selection Menu
Medium Duration Press	Toggles 10 W carrier for manual tuning (Icom Radios with Tuner I/O only) When configured for "Input" CX-AUTO$_{(tm)}$, Initiates Radio Selection Menu
Long Duration Press	No effect
"Duration" Definition	
Short	$\leq$ 1 second
Medium	2-3 Seconds
Long	$\geq$ 10 seconds

3.3 Bypass Mode

Bypass mode is provided for those circumstances when the operator may not wish to route RF through the AT-AUTO's$_{(tm)}$ matching network, such as when using a StepIR type of antenna or other resonant antenna systems. *Bypass* mode operation of the AT-AUTO$_{(tm)}$ is nearly identical with the *Manual* mode, described previously.

Bypass mode in selected by momentarily pressing the **Mode** pushbutton until the AT-AUTO$_{(tm)}$ display shows "Bypass Mode" (See Figure 3.2). The AT-AUTO$_{(tm)}$ *Bypass* mode enables the user to completely bypass RF power around the AT-AUTO$_{(tm)}$ RF matching network, while permitting the user to manipulate *L* and *C*. While in *Bypass* mode, external tuner control provided by some Icom and Kenwood radios is not utilized.

During *Bypass* mode operation, the user provides control inputs to the AT-AUTO$_{(tm)}$ microprocessor 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 3.2.

Figure 3.2: Example Bypass Mode Display

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

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

Table 3.2 (page 20) lists the control functions available while operating in *Bypass* mode.

Table 3.2: Bypass Mode Control Functions

Mode Pushbutton	
Short Duration Press	Selects *Automatic* mode
Medium Duration Press	No effect
Long Duration Press	No effect
Tune-Select Knob	
Short Duration Press	Toggles C/L control
Medium Duration Press	If L Active: Causes L to turn continuously If C Active: Causes C to home to 000
Long Duration Press	If L Active: Causes L to home to 000 If C Active: No effect
Clockwise/Counter-Clockwise Rotation	Increase/Decrease Capacitance or Inductance
Output Pushbutton	
Short Duration Press	Toggles RF Output (Coax/Balanced) When configured for "Output" CX-AUTO$_{(tm)}$, Initiates Antenna Selection Menu
Medium Duration Press	When configured for "Input" CX-AUTO$_{(tm)}$, Initiates Radio Selection Menu
Long Duration Press	No effect
"Duration" Definition	
Short	$\leq$ 1 second
Medium	2-3 Seconds
Long	$\geq$ 10 seconds

Installation

4.1 Unpacking

Carefully remove the AT-AUTO$_{(tm)}$ from the shipping carton and inspect it for damage. If any damage is apparent, notify the transportation carrier or dealer immediately. We recommend keeping the packing carton for moving, storing, or reshipping.

4.2 Location

Select a location for the AT-AUTO$_{(tm)}$ that allows ready access to the various connectors and with unrestricted airflow for cooling.

WARNING: Balanced antennas will produce high RF voltages at the output post connectors. DO NOT TOUCH the balanced output connections while transmitting! – RF burns may result.

WARNING: Do not use more than 1500 Watts average (single tone) through the tuner and refrain from using high power with the tuner until it has been tuned at the frequency of operation with a low-power (10-100 Watt) carrier.

4.3 Electrical Connection and Setup

The AT-AUTO$_{(tm)}$ should always be connected **between** the antenna system and the station transmitter. For installations that also include an HF amplifier, the AT-AUTO$_{(tm)}$ should be connected **between** the HF amplifier and the antenna system.

4.3.1 DC Power

Kessler Engineering supplies a DC power cable for use with the AT-AUTO$_{(tm)}$. The DC power supply used should be capable of supplying 4 Amps at 12VDC. The AT-AUTO$_{(tm)}$

consumes ≈ 3.5 A whenever the stepper motors are in motion. This is anytime during *Automatic* tuning, or while the user is repositioning L or C during *Manual* or *Bypass* operation. When the motors are stationary, the AT-AUTO$_{(tm)}$ current consumption is ≈ 350 mA.

Warning: Avoid using switching power supplies with the AT-AUTO. The current drawn by the AT-AUTO during motor movement fluctuates rapidly, causing many switching power supplies to produce excessive voltage overshoots, resulting in hardware damage to the AT-AUTO. For this reason, we most strongly recommend using a linear power supply with the AT-AUTO.

4.3.2 Vintage Rig Setup

Transceivers lacking CAT/CI-V capability are considered "Vintage" rigs and include such classics the Kenwood TS-830, Drake TR4, everything Collins, and anything Heathkit.

Setup of the AT-AUTO$_{(tm)}$ for vintage rig operation is quite simple. Make the electrical connections as shown in Figure 4.1 and then set the radio type to "Vintage Rig" as described in the **Configure Radio** section on page 50.

Note: If using the AT-AUTO$_{(tm)}$ QRO Keyline, the transmit control line must be routed through the QRO Keyline connectors on the back of the AT-AUTO$_{(tm)}$. See AT-AUTO$_{(tm)}$ QRO Keyline section on page 42 to configure the QRO Keyline.

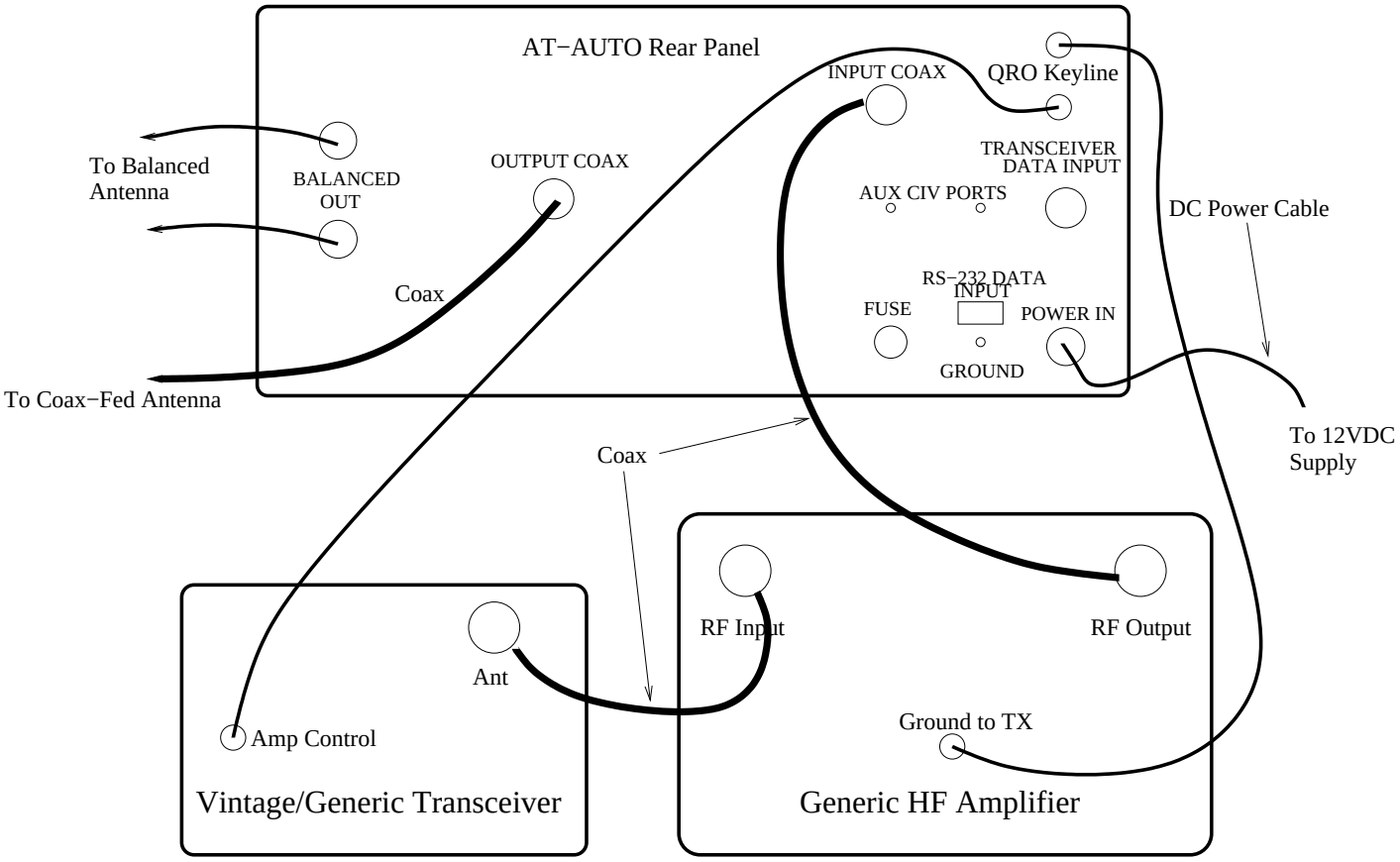


Figure 4.1: Vintage Transceiver /Amplifier to AT-AUTO$_{(tm)}$ Connection

4.3.3 Flex Radio Setup

The Flex Radios implement the Kenwood protocol. According to the good folks over at Flex Radio, please follow these steps to configure a Flex Radio to operate in *Smart QSY* fashion with the AT-AUTO$_{(tm)}$:

1. Load and configure the DDUtil software program per the instructions on the DDUtil website:
   http://k5fr.com/ddutilwiki/index.php?title=Main Page
2. Connect the AT-AUTO$_{(tm)}$ to a physical com port using a straight-through serial cable. Identify the com port number using Device Manager in Windows.
3. Remove the "Reset Enable" jumper shown in Figure 12.1 on page 93.
4. Set DDUtil "Passive Listen" to that physical com port number.
5. Set the AT-AUTO$_{(tm)}$ to Kenwood CAT Only, No Ext Tuner I/O"
6. Set the AT-AUTO serial baud to 9600, 8-N-1.

4.3.4 Icom Rig Setup

Icom radios often include a CI-V serial interface that the AT-AUTO$_{(tm)}$ may utilize to obtain frequency information from the radio. This interface is often labeled **Remote** on Icom radios. Most newer Icom radios (except IC-7800) also include a provision for controlling an external tuner via a button on the radio's front panel labeled **TUNER**. This interface connects to the external tuner (the AT-AUTO$_{(tm)}$) via a 4-pin Molex-style connector located on the radio's back panel.

Note: If the Icom radio includes multiple antenna connections, the external tuner should be connected to the connector labeled "Ant 1." Consult owner's manual for your specific Icom radio. A typical setup involving an Icom radio is shown in Figure 4.2.

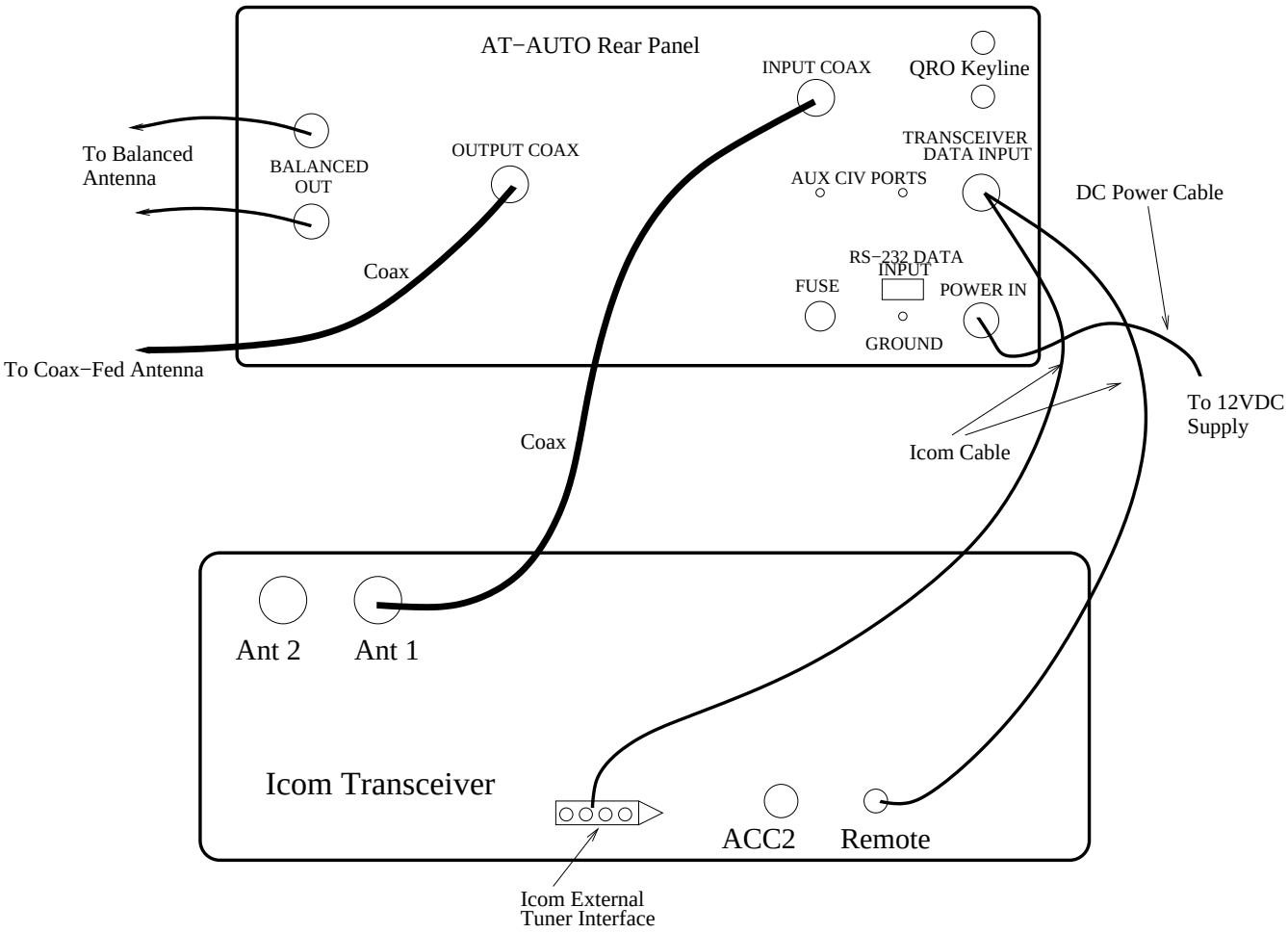


Figure 4.2: Icom Transceiver to AT-AUTO$_{(tm)}$ Connection

The Kessler Engineering-supplied Icom cable includes a male 3.5 mm monaural plug (CI-V) and a 4-pin male Molex-style plug (tuner control & handshaking) on one end and an Amphenol-style 5-pin female plug.

1. Insert the Amphenol plug into the **TRANSCEIVER DATA INPUT** socket on the rear of the AT-AUTO$_{(tm)}$ and twist the attachment ring until finger tight

2. Insert the male 3.5 mm plug into the **Remote** jack on the back of the Icom radio

3. Insert the 4-pin white plastic plug into the corresponding receptacle located on the back of the Icom radio. This receptacle is often not labeled on the radio, and some radios do not include the 4-pin receptacle (IC-7800 for example).

4. Configure the radio type as described in the **Configure Radio** section on page 50. The radio type should be set to "Icom Normal CI-V & Ext Tuner I/O" or set to "Icom CIV Only No Ext Tuner I/O" if using a radio without external tuner control, such as an IC-7800.

5. Configure the desired CI-V operation as described in the **Setup Icom CI-V** section on page 57

6. Configure the serial I/O baud rate as described in the **Configure AT-AUTO$_{(tm)}$ Serial Interface** section on page 48. Most Icom radios use a default of 9600 baud and the AT-AUTO$_{(tm)}$ is also set to 9600 baud by default from the factory.

4.3.5 Icom Rig With HF Amplifier Setup

Some amplifiers such as the Icom IC-PW1 and the Tokyo Hy-Power HL-1.5KFX amplifiers are designed to automatically obtain band/frequency information from CAT/CI-V equipped radios. Consult the respective owners manuals for your respective amplifier.

Icom Rig & IC-PW1 with AT-AUTO$_{(tm)}$

Connections for using an Icom radio and Icom IC-PW1 with the AT-AUTO$_{(tm)}$ are shown in Figure 4.3. See Figure 4.4 if intending to use the AT-AUTO$_{(tm)}$ QRO Keyline feature. The IC-PW1 and the AT-AUTO$_{(tm)}$ will receive frequency information via the CI-V bus whenever the radio's frequency changes. The radio should be set to CI-V Transceive mode (see your owner's manual).

Thoroughly read through the Icom IC-PW1 manual as well as the Icom radio manual, particularly the sections regarding CI-V (sometimes referred to as **Remote**) operation. Then read through the AT-AUTO$_{(tm)}$ manual. The following are suggested steps to setup the AT-AUTO$_{(tm)}$, IC-PW1, and Icom transceiver.

1. Insert the Amphenol plug into the **TRANSCEIVER DATA INPUT** socket on the rear of the AT-AUTO$_{(tm)}$ and twist the attachment ring until finger tight

2. Insert the male 3.5 mm plug into the **Remote** jack on the back of the Icom radio

3. Insert the 4-pin white Molex plug into the corresponding receptacle located on the back of the Icom radio. Some radios may not include the 4-pin receptacle (IC-7800 for example)

4. If using the optional QRO Keyline, the Icom-supplied cable must be modified. The transmit control line (ACC1 Pin3) must be routed through the QRO Keyline connectors on the back of the AT-AUTO$_{(tm)}$. See QRO Keyline section on page 42 to configure the QRO Keyline.

5. Set the radio type to either "Icom Normal CI-V & Ext Tuner I/O" or set to "Icom CIV Only No Ext Tuner I/O" as described in the **Configure Radio** section on page 50.

6. Setup the AT-AUTO$_{(tm)}$ to "CIV Transceive From Select Icom" and set the radio's CI-V address as described in the **Setup Icom CI-V** section on page 57. The IC-PW1 default CI-V address is 0x55 and the AT-AUTO$_{(tm)}$'s default CI-V address is 0xE0, neither of which should require changing.

7. Configure the AT-AUTO$_{(tm)}$ serial I/O to 9600 baud as described in the **Configure AT-AUTO$_{(tm)}$ Serial Interface** section on page 48. Most Icom radios use a default of 9600 baud and the AT-AUTO$_{(tm)}$ is also set to 9600 baud by factory default

8. Set the Icom radio to 9600 baud

9. Set the Icom radio to "CI-V Transceive" *On*

10. Confirm that the AT-AUTO$_{(tm)}$ and IC-PW1 are able to follow frequency changes on the Icom transceiver.

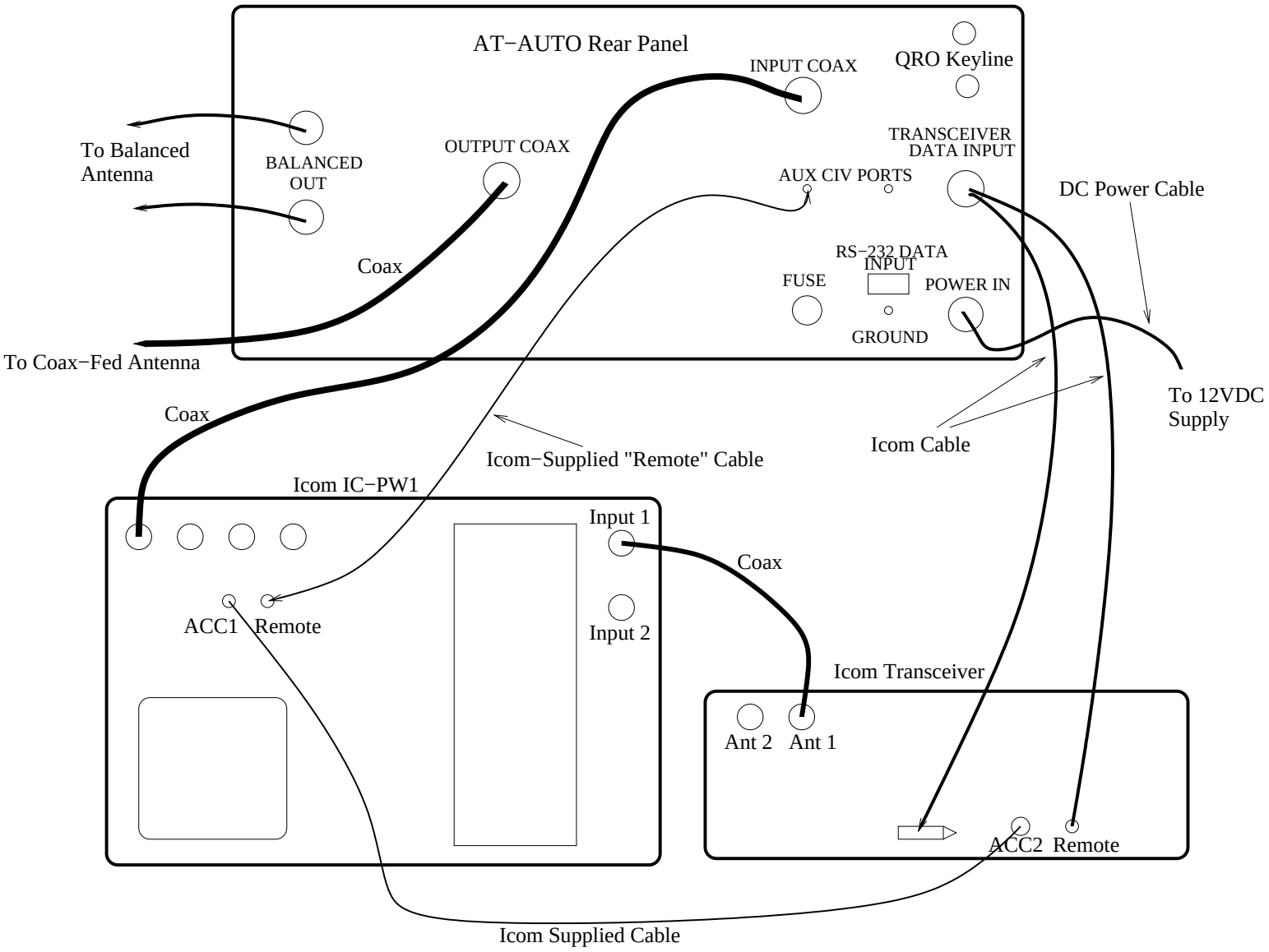


Figure 4.3: Icom Transceiver with IC-PW1 to AT-AUTO$_{(tm)}$ Connection

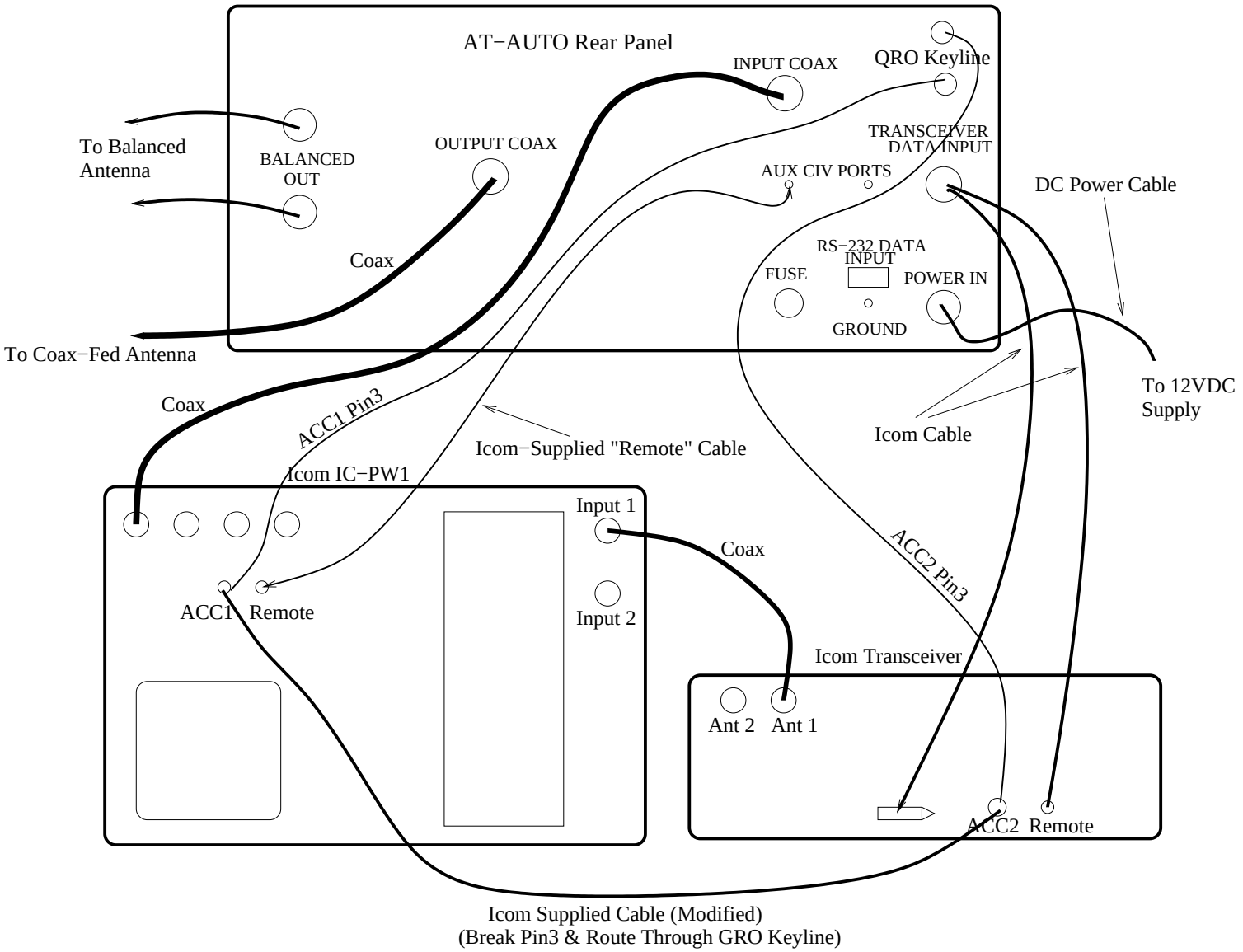


Figure 4.4: Icom Transceiver with IC-PW1 to AT-AUTO$_{(tm)}$ Connection and QRO Keyline Control

Icom Rig & Tokyo Hy-Power HL-1.5KFX with AT-AUTO$_{(tm)}$

Connections for using an Icom radio with a Tokyo Hy-Power HL-1.5KFX and an AT-AUTO$_{(tm)}$ are shown in Figure 4.5. The HL-1.5KFX and the AT-AUTO$_{(tm)}$ will receive frequency information via the CI-V bus whenever the radio's frequency changes. The radio should be set to CI-V Transceive mode (see your owner's manual).

Thoroughly read through the Tokyo Hy-Power HL-1.5KFX manual as well as the Icom radio manual, particularly the sections regarding CI-V (sometimes referred to as **Remote**) operation. Then read through the AT-AUTO$_{(tm)}$ manual. The following are suggested steps to setup the AT-AUTO$_{(tm)}$, HL-1.5KFX, and Icom transceiver.

1. Insert the Amphenol plug into the **TRANSCEIVER DATA INPUT** socket on the rear of the AT-AUTO$_{(tm)}$ and twist the attachment ring until finger tight

2. Insert the male 3.5 mm plug into the **Remote** jack on the back of the Icom radio

3. Insert the 4-pin white Molex plug into the corresponding receptacle located on the back of the Icom radio. Some radios may not include the 4-pin receptacle (IC-7800 for example)

4. If using the optional QRO Keyline, the transmit control line must be routed through the QRO Keyline connectors on the back of the AT-AUTO$_{(tm)}$. See AT-AUTO$_{(tm)}$ QRO Keyline section on page 42 to configure the QRO Keyline.

5. Set the radio type to either "Icom Normal CI-V & Ext Tuner I/O" or set to "Icom CIV Only No Ext Tuner I/O" as described in the **Configure Radio** section on page 50.

6. Setup the AT-AUTO$_{(tm)}$ to "CIV Transceive From Select Icom" and also set the radio's CI-V address to 0x5C as described in the **Setup Icom CI-V** section on page 57. The default AT-AUTO$_{(tm)}$ CI-V address is 0xE0, which should require changing.

7. Configure the AT-AUTO$_{(tm)}$ serial I/O to 9600 baud as described in the **Configure AT-AUTO$_{(tm)}$ Serial Interface** section on page 48. Most Icom radios use a default of 9600 baud and the AT-AUTO$_{(tm)}$ is also set to 9600 baud by default from the factory

8. Set the Icom radio to 9600 baud

9. Consult the radio user's manual and set the Icom radio CI-V address to 0x5C and "CI-V Transceive" to *On* and "CI-V with IC-731" to *Off*

10. Confirm that the AT-AUTO$_{(tm)}$ and HL-1.5KFX are able to follow frequency changes on the Icom transceiver.

Note! If the HL-1.5KFX is connected to the CI-V bus and the amplifier is turned *Off*, all CI-V communications will fail. Therefore, the HL-1.5KFX must be powered *On* in order for the Icom radio's frequency information to reach the AT-AUTO$_{(tm)}$.

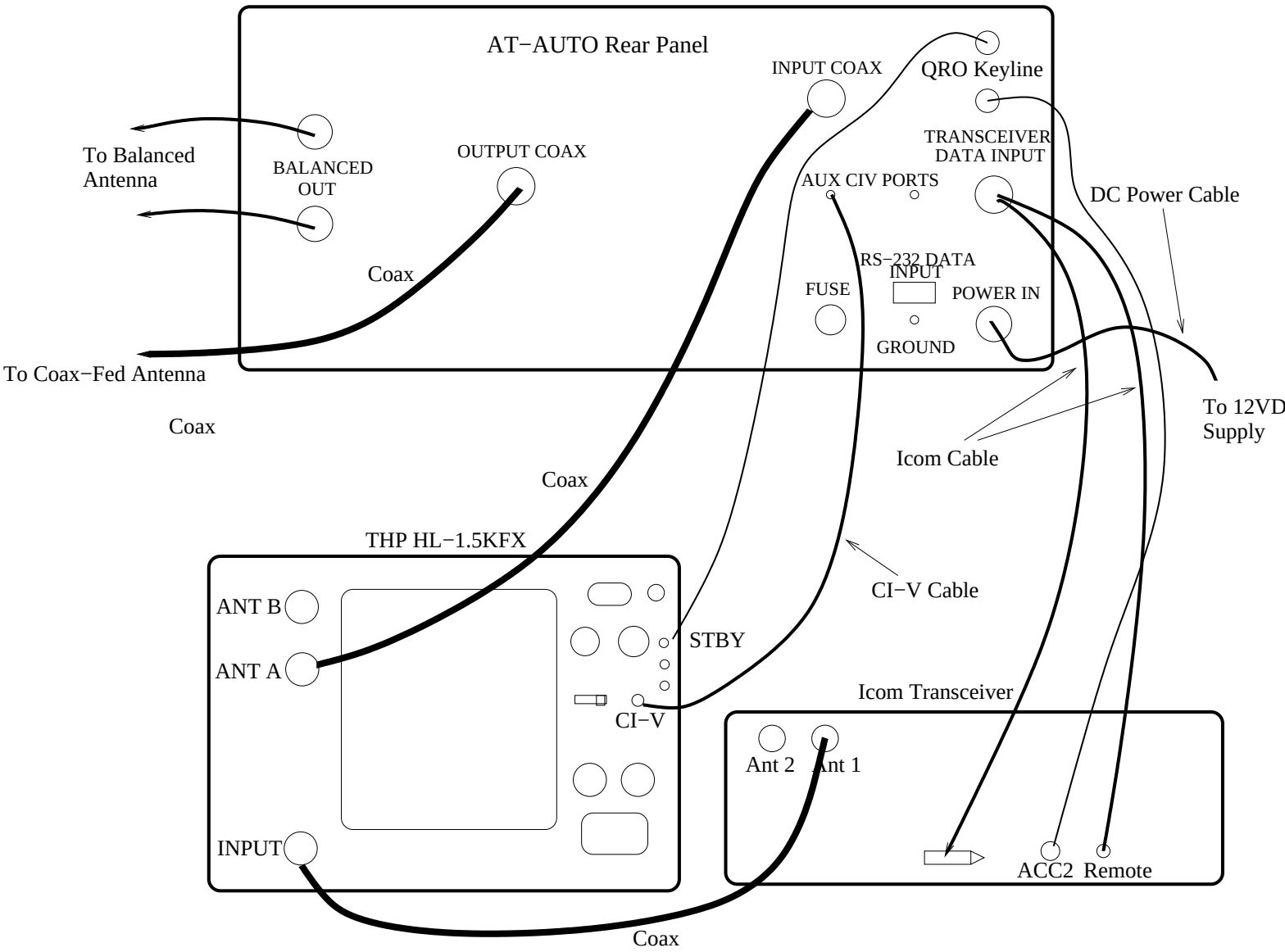


Figure 4.5: Icom Transceiver with Tokyo Hy-Power HL-1.5KFX to AT-AUTO$_{(tm)}$ Connection

4.3.6 Kenwood Rig Setup

Recent generation Kenwood radios include a serial interface that the AT-AUTO$_{(tm)}$ may utilize to obtain frequency information from the radio. This RS-232 interface is often labeled "COM" on Kenwood radios. Additionally, some newer Kenwood radios also include a provision for controlling an external tuner via a button on the radio's front panel labeled **TUNER**. This interface connects to the external tuner (the AT-AUTO$_{(tm)}$) via a 6-pin Molex-style connector labeled "AT" which is located on the radio's back panel.

Note: If the Kenwood radio includes multiple antenna connections, any external tuner should be connected to the connector labeled "Ant 1." Consult owner's manual for your specific radio. A typical setup involving a Kenwood radio is shown in Figure 4.6.

The following are suggested steps to setup the AT-AUTO$_{(tm)}$ to interface with a Kenwood transceiver:

1. Insert the Amphenol plug into the **TRANSCEIVER DATA INPUT** socket on the rear of the AT-AUTO$_{(tm)}$ and twist the attachment ring until finger tight

2. Insert the 6-pin white plastic plug into the corresponding receptacle labeled "AT" located on the back of the Kenwood radio. Some Kenwood radios may not include the "AT" connector

3. Set the radio type to either "Kenwood Normal CAT & Tuner I/O" or set to "Kenwood CAT Only No Ext Tuner I/O" as described in the **Configure Radio** section on page 50

4. Configure the AT-AUTO$_{(tm)}$ serial I/O as described in the **Configure AT-AUTO$_{(tm)}$ Serial Interface** section on page 48. The AT-AUTO$_{(tm)}$ and the Kenwood must both be set to the same baud rate, and the same number of stop bits

5. Confirm that the AT-AUTO$_{(tm)}$ is able to follow frequency changes on the Kenwood transceiver.

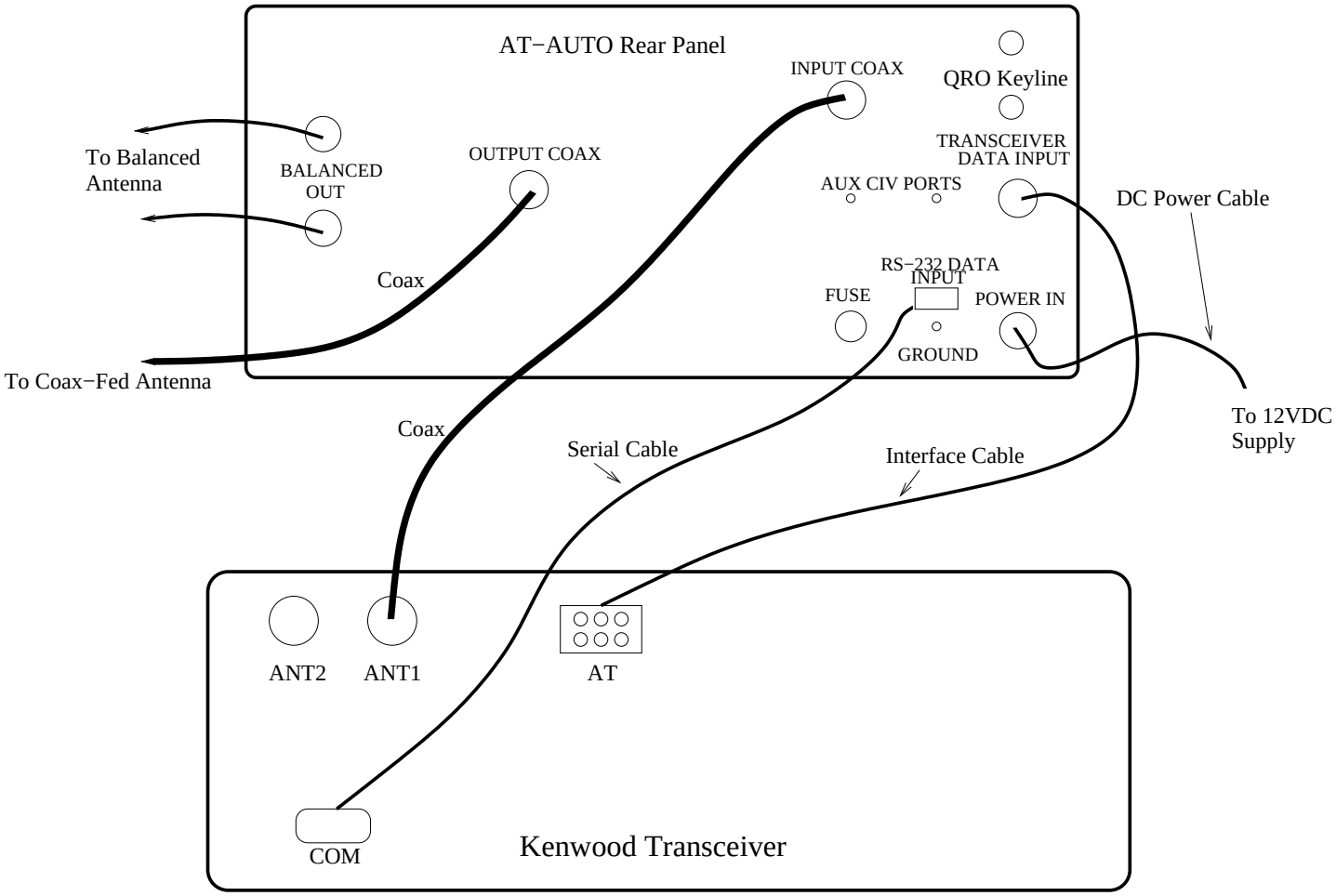


Figure 4.6: Kenwood Transceiver to AT-AUTO$_{(tm)}$ Connection

4.3.7 TenTec Omni VII/Jupiter Setup

The AT-AUTO$_{(tm)}$ is able to receive frequency information available via CAT (RS-232) when interfaced with either a TenTec "Omni VII" or TenTec "Jupiter" radio. The RS-232 port is labled "Serial" on the lower rear panel on the Omni VII.

Note: The Omni Vii radio includes multiple antenna connections. We recommend that the AT-AUTO$_{(tm)}$ be connected to "ANT 1". A typical setup involving a Omni VII is shown in Figure 4.7. Jupiter setup will be very similar.

The following are suggested steps to setup the AT-AUTO$_{(tm)}$ to interface with a TenTec Omni VII or Jupiter transceiver.

1. Set the radio type to "TenTec Omni VII/Jupiter" as described in the **Configure Radio** section on page 50.

2. Configure the AT-AUTO$_{(tm)}$ serial I/O port to 57600 baud, 8 data bits, no parity, 1 stop bit ("57600 8-N-1") as described in the **Configure AT-AUTO$_{(tm)}$ Serial Interface** section on page 48. The TenTec radios are setup for 57600 baud serial data and the AT-AUTO$_{(tm)}$ must be set to match the radio's data rate and number of stop bits.

3. Confirm that the AT-AUTO$_{(tm)}$ is able to follow frequency changes on the TenTec transceiver.

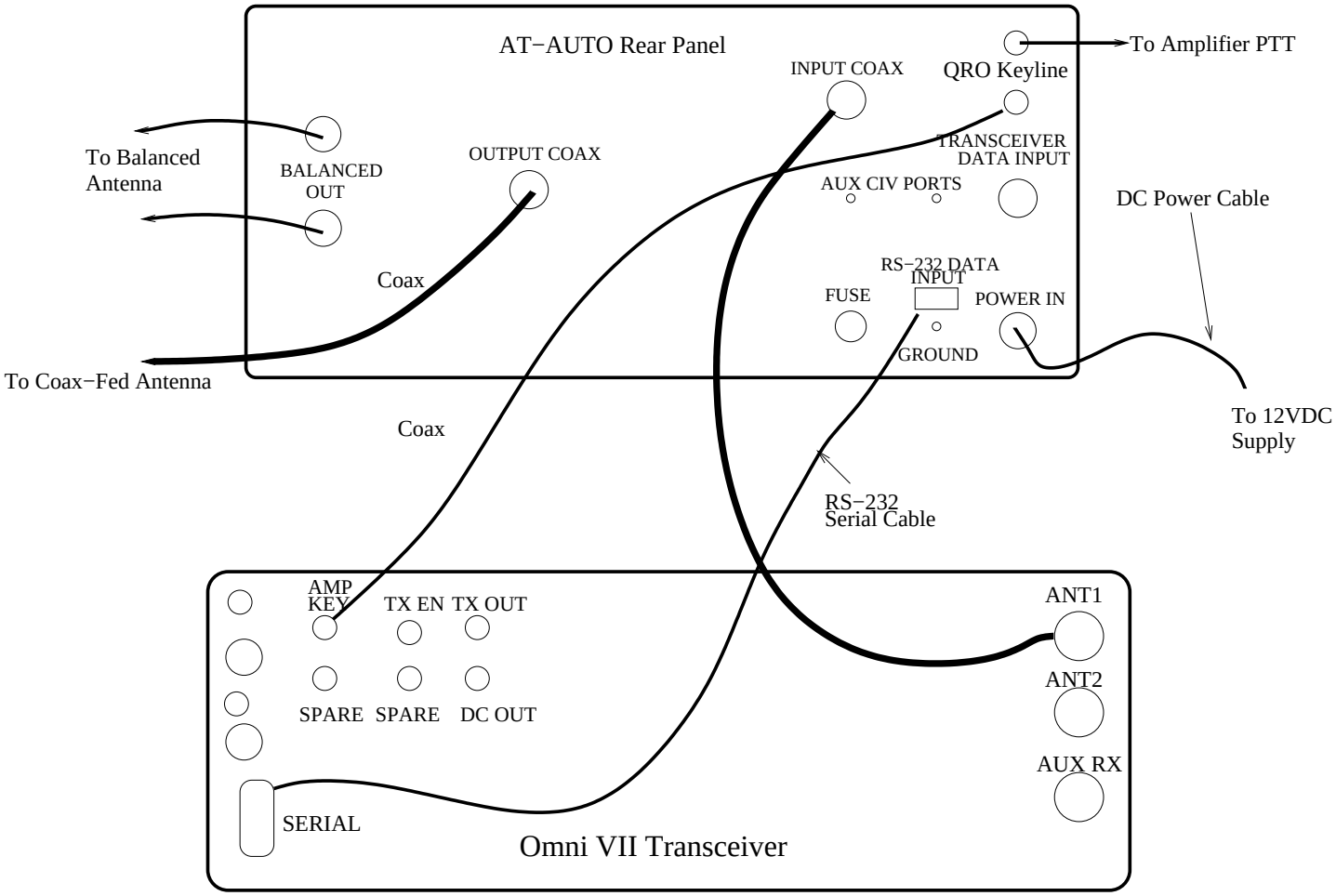


Figure 4.7: Omni VII Transceiver to AT-AUTO$_{(tm)}$ Connection

4.3.8 Yaesu Rig Setup

Many Yaesu radios include a serial interface that the AT-AUTO$_{(tm)}$ may utilize to obtain frequency information from the radio. On most newer generation Yaesu radios, this is generally an RS-232 interface, but some Yaesu radios have serial I/O ports that are TTL and require a level converter to work with the AT-AUTO$_{(tm)}$. This RS-232 interface is often labeled "CAT" on Yaesu radios. Check your radio owner's manual to determine the specifics of the radio's serial port.

Note: If the Yaesu radio includes multiple antenna connections, the external tuner should be connected to the connector labeled either "Ant 1" or "Ant A." Consult owner's manual for your specific radio. A typical setup involving a Yaesu radio outfitted with an RS-232 serial port is shown in Figure 4.8.

The following are suggested steps to setup the AT-AUTO$_{(tm)}$ to interface with a Yaesu transceiver.

1. Select the radio type that best corresponds to your specific model of Yaesu radio. The available menu choices are shown in the **Configure Radio** section on page 50. Please consult Table 6.2 on page 51 for additional information.

2. Configure the AT-AUTO$_{(tm)}$ serial I/O as described in the **Configure AT-AUTO$_{(tm)}$ Serial Interface** section on page 48. The AT-AUTO$_{(tm)}$ and the Yaesu radio must both be set to the same baud rate. Some Yaesu radios use 2-Stop bits, while others use 1-Stop bit.

3. Confirm that the AT-AUTO$_{(tm)}$ is able to follow frequency changes on the Yaesu transceiver.

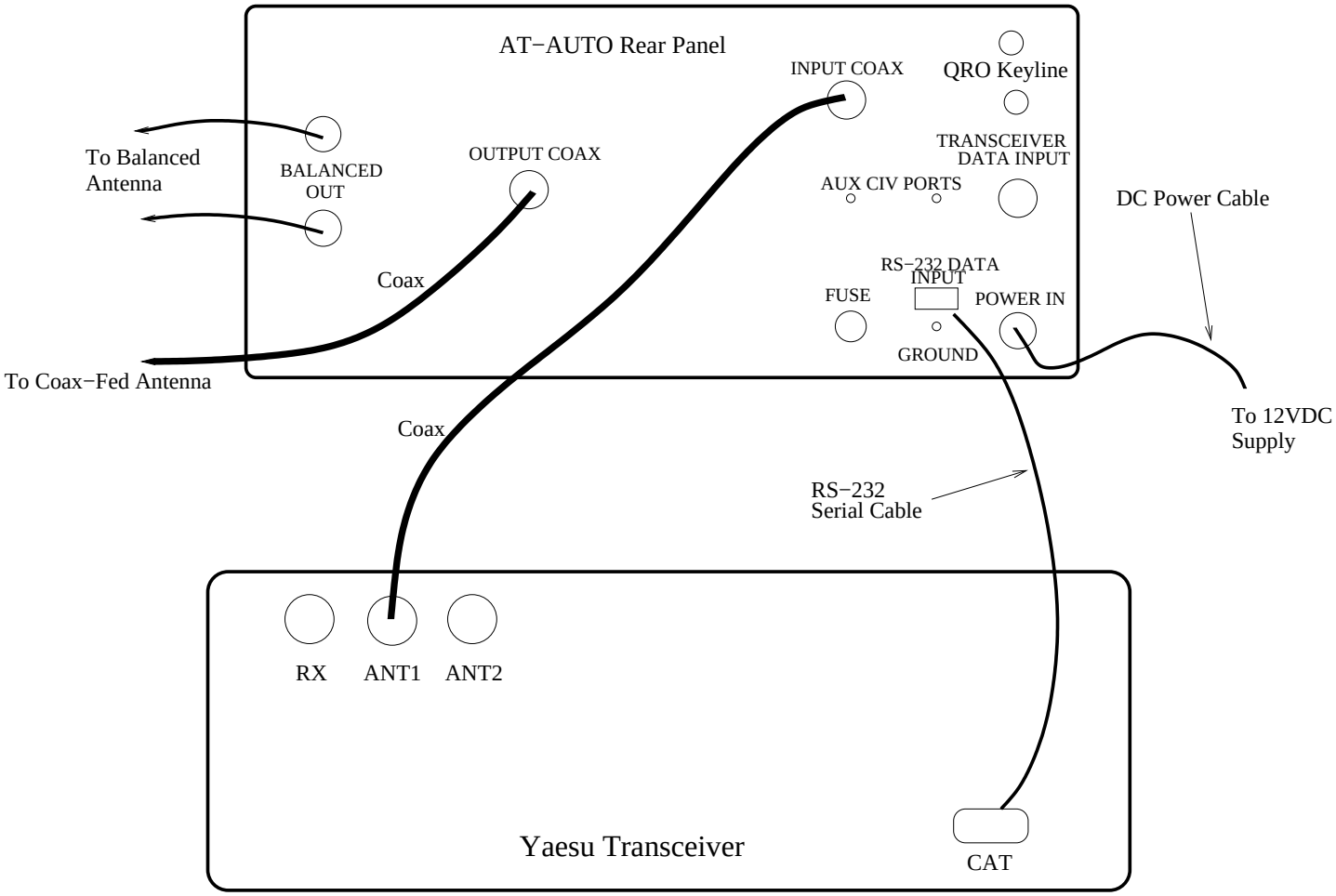


Figure 4.8: Yaesu Transceiver to AT-AUTO$_{(tm)}$ Connection

4.3.9 CX-AUTO$_{(tm)}$ Setup

Operation with Icom Rigs

Most Icom radios include a CI-V serial data interface that the AT-AUTO$_{(tm)}$ may utilize to obtain frequency information from the radio. When the AT-AUTO$_{(tm)}$ is properly connected and configured to operate with the CX-AUTO$_{(tm)}$ coaxial antenna switch, the AT-AUTO$_{(tm)}$ is capable of automatically selecting any 1-of-8 coaxial outputs based upon the frequency band of operation. The user may also manually select any of these outputs from the AT-AUTO$_{(tm)}$ front panel.

Figure 4.9 depicts the correct electrical connection between a CX-AUTO$_{(tm)}$, an AT-AUTO$_{(tm)}$, and an Icom CI-V equipped radio. Under normal operation, the Icom radio will provide frequency information to the AT-AUTO$_{(tm)}$ via the radio's CI-V port, and the AT-AUTO$_{(tm)}$ will utilize that frequency information to instantly switch bands, recall proper L and C match settings, as well as select the desired antenna, automatically, based upon the particular user's configuration settings.

Make the electrical connections as shown in Figure 4.9 and then follow the setup procedures described in the CX-AUTO$_{(tm)}$ manual. Then configure the AT-AUTO$_{(tm)}$ firmware for proper Icom radio operation as described in the **Icom Rig Setup** section on page 24.

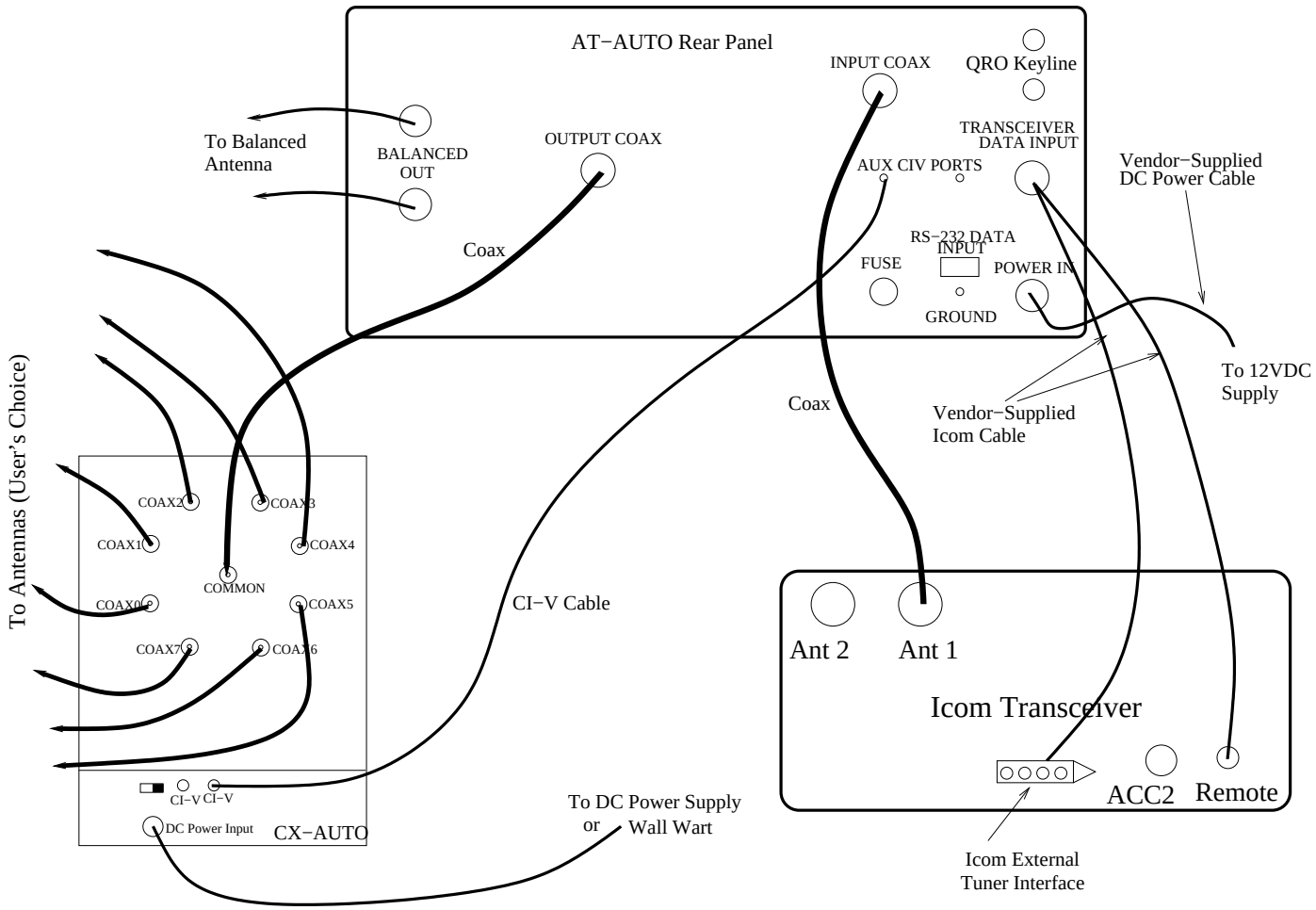


Figure 4.9: CX-AUTO$_{(tm)}$ to AT-AUTO$_{(tm)}$ electrical connections when operating Icom Transceivers

Operation with Vintage and other Non CI-V Equipped Rigs

In those instances when using non CI-V equipped radios (Drake, Collins, etc.), or non CI-V compatible radios (such as Yaesu, Kenwood, etc.), the AT-AUTO$_{(tm)}$ may be configured to determine frequency and band information by counting the transmitted RF frequency (requires AT-AUTO$_{(tm)}$ firmware version 2.13 or later) . When so configured and properly connected to a CX-AUTO$_{(tm)}$ coaxial antenna switch, the AT-AUTO$_{(tm)}$ is capable of automatically selecting any 1-of-8 coaxial outputs based upon the frequency band of operation. The user may also manually select any of these outputs from the AT-AUTO$_{(tm)}$ front panel.

Figure 4.10 depicts the correct electrical connection between a CX-AUTO$_{(tm)}$, an AT-AUTO$_{(tm)}$, and a generic, non CI-V equipped radio. Under normal operation, the AT-AUTO$_{(tm)}$ will count the transmitted RF frequency, recall proper L and C match settings, determine the band of operation and then select the desired antenna, automatically, based upon the particular user's configuration settings.

Make the electrical connections as shown in Figure 4.10 and then follow the set the setup procedures described in the CX-AUTO$_{(tm)}$ manual and setup of the AT-AUTO$_{(tm)}$ and CX-AUTO$_{(tm)}$ for operation by following the procedures described in the **Vintage Rig Setup** section on page 22

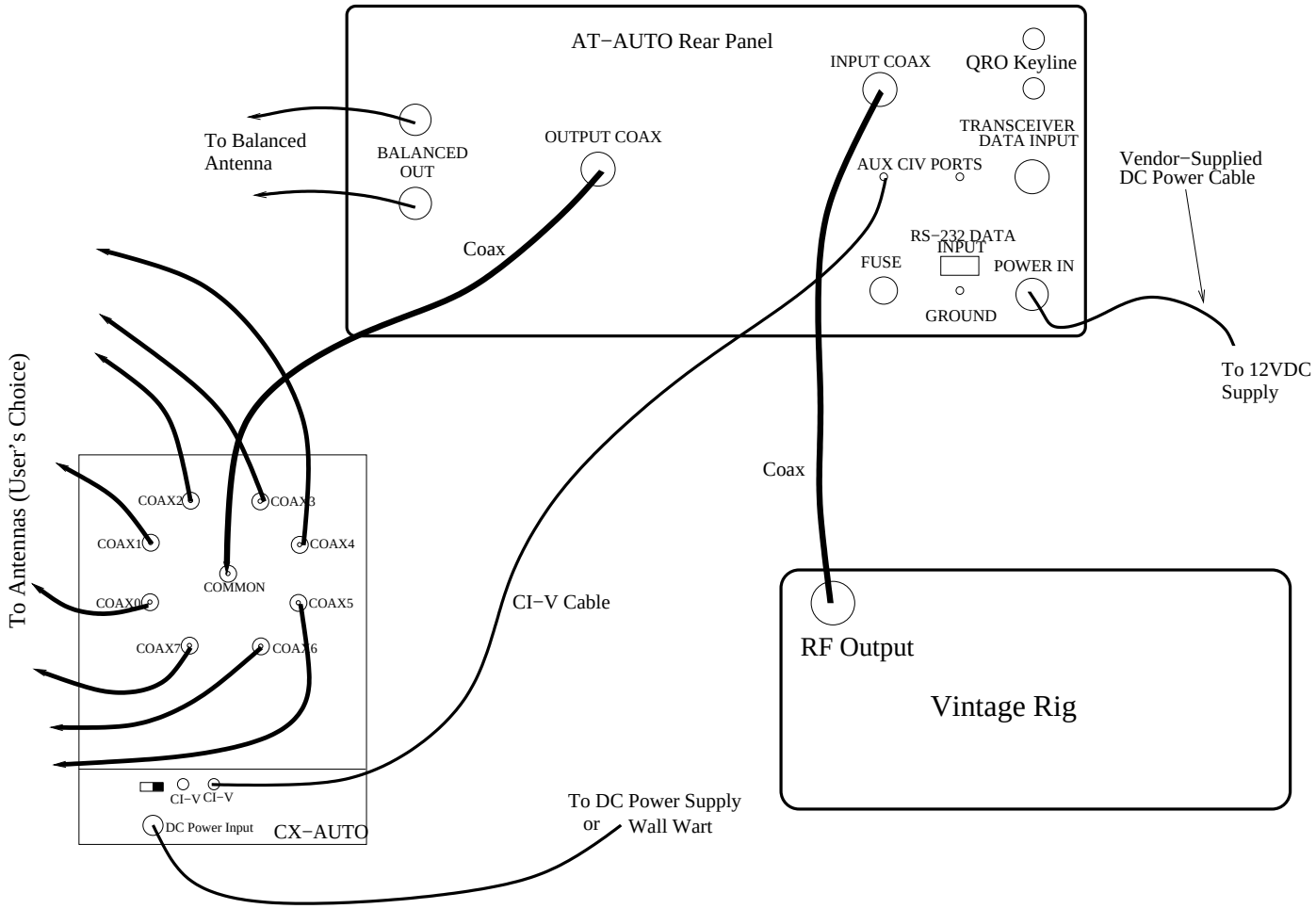


Figure 4.10: CX-AUTO$_{(tm)}$ to AT-AUTO$_{(tm)}$ electrical connections when operating without CI-V equipped Transceivers

Operation with Multiple Rigs

With the added features included in AT-AUTO$_{(tm)}$ firmware version 2.14, the user may also use a CX-AUTO$_{(tm)}$ coaxial antenna switch to switch between multiple radios via the AT-AUTO$_{(tm)}$ front panel controls. The radios used may consist of any transceiver make/model including icom CI-V equipped transceivers. The radios used need not be CI-V equipped.

Figure 4.11 shows the AT-AUTO$_{(tm)}$ connected to two CX-AUTO$_{(tm)}$ coaxial antenna switches, one for input rig selection and one for automatic antenna selection. Make the electrical connections as shown in 4.11 and configure the AT-AUTO$_{(tm)}$ per the instructions found in the *Setup Multi-Rig* section on page 68. When using the multi-rig setup, the AT-AUTO will utilize CI-V frequency information whenever an Icom CI-V equipped radio is selected, and when a non CI-V equipped radio is selected, will automatically revert to counting the RF frequency to determine band and frequency.

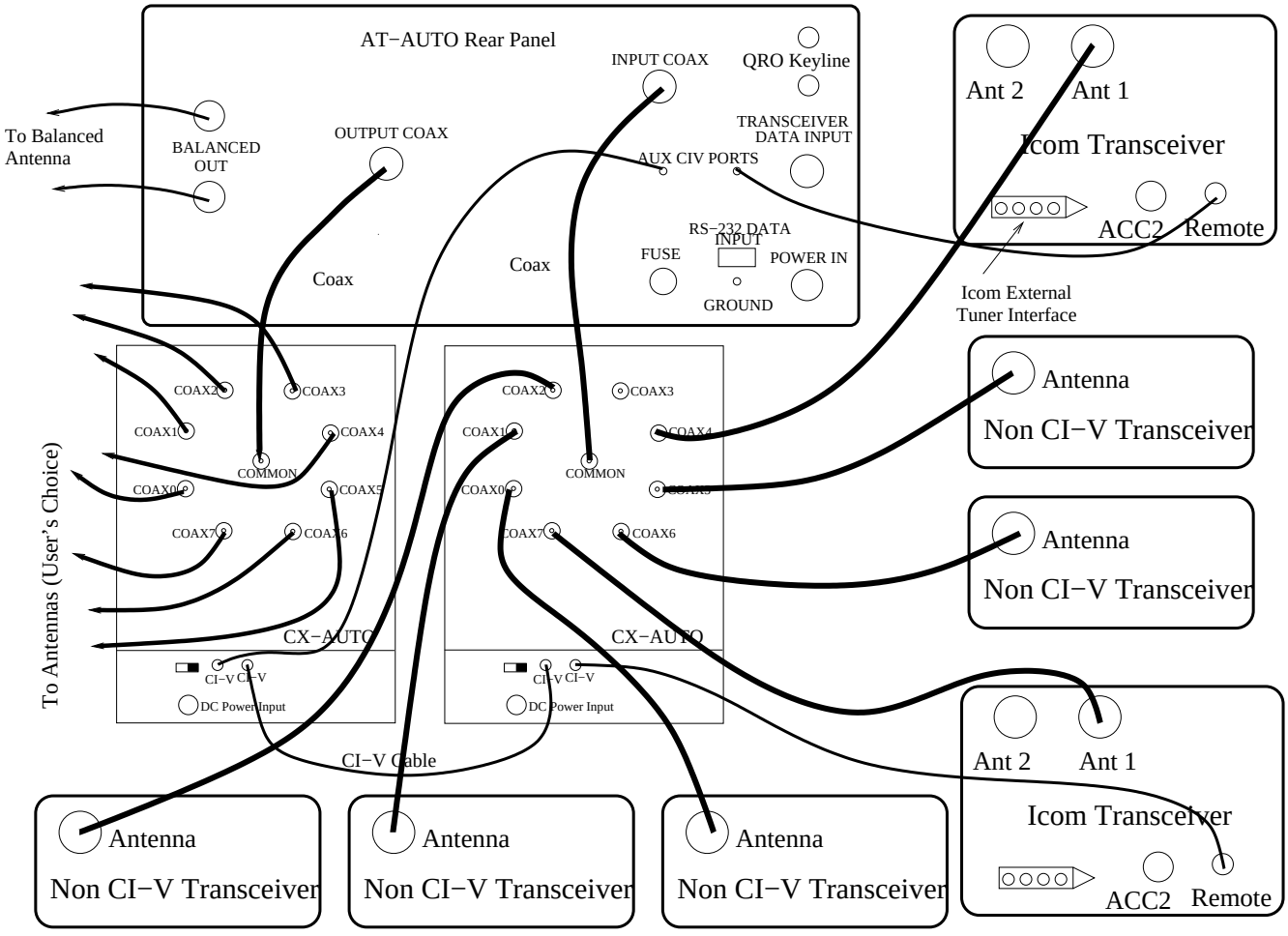


Figure 4.11: Dual CX-AUTO$_{(tm)}$ to AT-AUTO$_{(tm)}$ electrical connections for operating with multiple radios and multiple antennas

AT-AUTO$_{(tm)}$ QRO Keyline

The AT-AUTO$_{(tm)}$ may automatically permit/inhibit keying of an HF amplifier. Use of the QRO Keyline hardware is entirely ***optional*** and completely independent of the automatic tuning process. It does not otherwise change or alter the operation of the AT-AUTO$_{(tm)}$

The user may configure the AT-AUTO$_{(tm)}$ to automatically prevent the amplifier from being keyed if the SWR exceeds a user-selectable level, or while the AT-AUTO$_{(tm)}$ is tuning. This may be particularly advantageous when using the AT-AUTO$_{(tm)}$ with HF amplifiers that feature SWR protection circuitry. If the user neglected to unkey the amplifier while the AT-AUTO$_{(tm)}$ is tuning, the amplifier's self-protection circuitry would likely disable the amplifier, necessitating a reset of the amplifier itself.

The QRO Keyline hardware enables the AT-AUTO$_{(tm)}$ to unkey the amplifier if a predetermined SWR threshold is exceeded, or *prior* to initiating automatic tuning, and then to re-enable keying of the amplifier *after* automatic tuning is completed.

5.1 Retrofitting to Older AT-AUTOs$_{(tm)}$

The ***optional*** QRO Keyline hardware was not incorporated into the AT-AUTO$_{(tm)}$ until 2008 but may be retrofitted into the earlier model AT-AUTOs$_{(tm)}$ at the owner's expense. The retrofit involves replacement of the original processor board, installation of an additional cable harness, fitting two RCA phono connectors to the back panel, and re-calibration of the A/D converters. The retrofit is only available through Kessler Engineering in Beavercreek, Ohio. Owners wishing to have the QRO Keyline retrofitted should contact Kessler Engineering directly for pricing and scheduling.

5.2 Electrical Connection and Setup

Figure 5.1 shows a simplified illustration of the QRO Keyline hardware. The Keyline interface consists of a normally-open SPST relay which is controlled by the AT-AUTO's$_{(tm)}$ microprocessor.

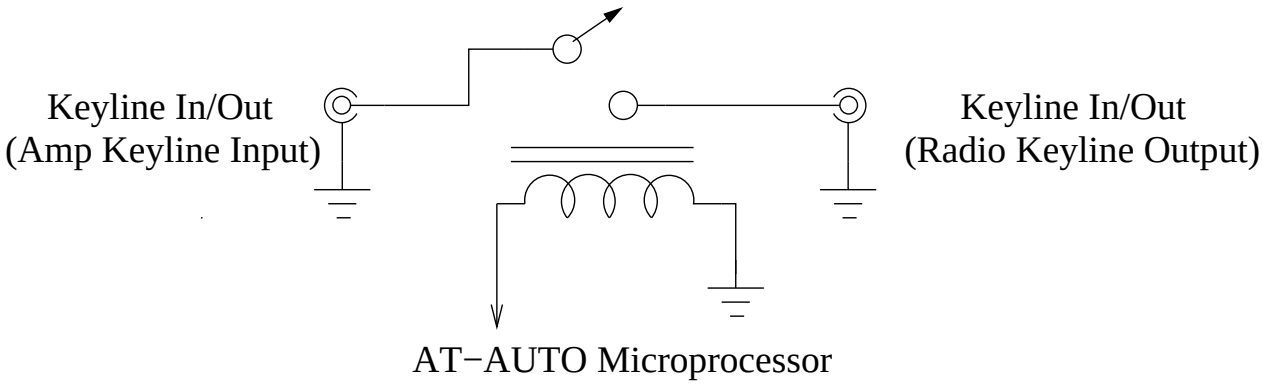


Figure 5.1: QRO Keyline

Please! Ensure that the radio can properly key and un-key the amplifier ***Before*** attempting to interface to the QRO Keyline!

The QRO Keyline's relay contacts connect directly to the two QRO Keyline phono jacks located on the rear panel of the AT-AUTO$_{(tm)}$. The transmitter's amplifier control ("keying") line is connected to either one of the AT-AUTO$_{(tm)}$ QRO Keyline jacks. The HF amplifier's transmit control line is then connected to the remaining AT-AUTO$_{(tm)}$ QRO Keyline jack as shown in Figure 5.2. The QRO Keyline relay is always *Open* whenever the AT-AUTO$_{(tm)}$ is *Off*, and as determined by QRO Keyline firmware configuration selected by the user.

The AT-AUTO$_{(tm)}$ firmware must be configured for proper QRO Keyline operation. Please see page 62.

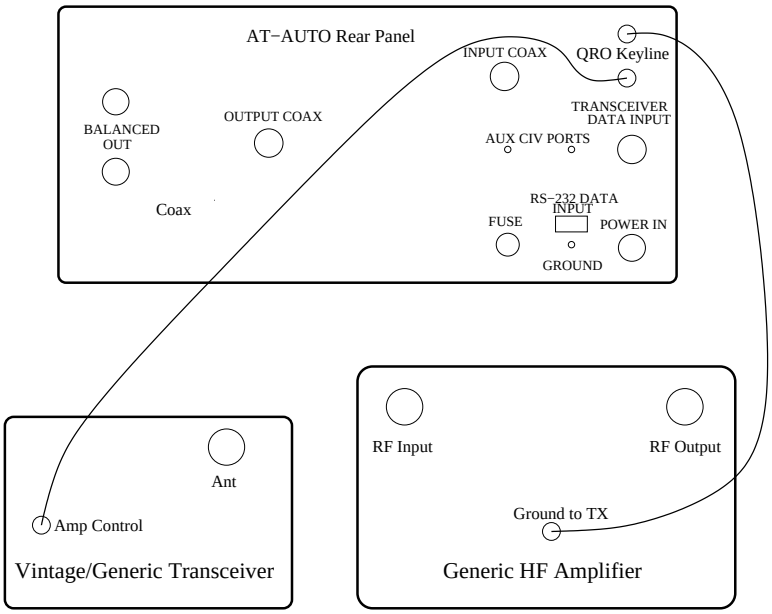


Figure 5.2: QRO Keyline Connections (Other Connections Omitted for Clarity)

5.3 Operation

The QRO Keyline control automatically enables or disables keying of an HF amplifier based upon user-selectable criteria. Whenever the QRO Keyline is enabled, an asterisk will be displayed in the upper-right corner of the LCD as shown in Figure 5.3. The asterisk provides

Figure 5.3: Automatic Mode with QRO Keyline Enabled

confirmation to the user that the QRO Keyline is enabled (asterisk displayed) or disabled (no asterisk displayed).

Note: The configuration/operation of the QRO Keyline has absolutely ***NO*** effect on either the *Automatic*, *Manual*, or *Bypass* operating modes.

Note! If the * is *not* shown in the display, then the QRO Keyline is *Open* and the radio will *not* be able to key the amplifier.

Firmware Configuration

6.1 General Description

The AT-AUTO$_{(tm)}$ firmware permits tailoring the AT-AUTO's$_{(tm)}$ behavior to better suit the users' specific requirements. The user may configure the AT-AUTO$_{(tm)}$ firmware via the AT-AUTO's$_{(tm)}$ service menu which is accessed from the AT-AUTO$_{(tm)}$ front-panel controls. This section of the users' manual provides detailed descriptions of the available firmware features as well as instructions for customizing the AT-AUTO$_{(tm)}$ behavior.

6.2 Accessing the Service Menu

User-selectable firmware options are accessed through the AT-AUTO$_{(tm)}$ firmware service menus. These menus and sub menus are described in this and subsequent sections. The various 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 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$_{(tm)}$.
2. Place the AT-AUTO$_{(tm)}$ in *Automatic* mode.
3. Press and hold the **Mode** button for 10 seconds and then release.

The AT-AUTO$_{(tm)}$ will display:

Figure 6.1: LCD Display - Service Menu Exit Prompt

The user-configurable service menu options are shown in Figure 6.2 (page 46). 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.

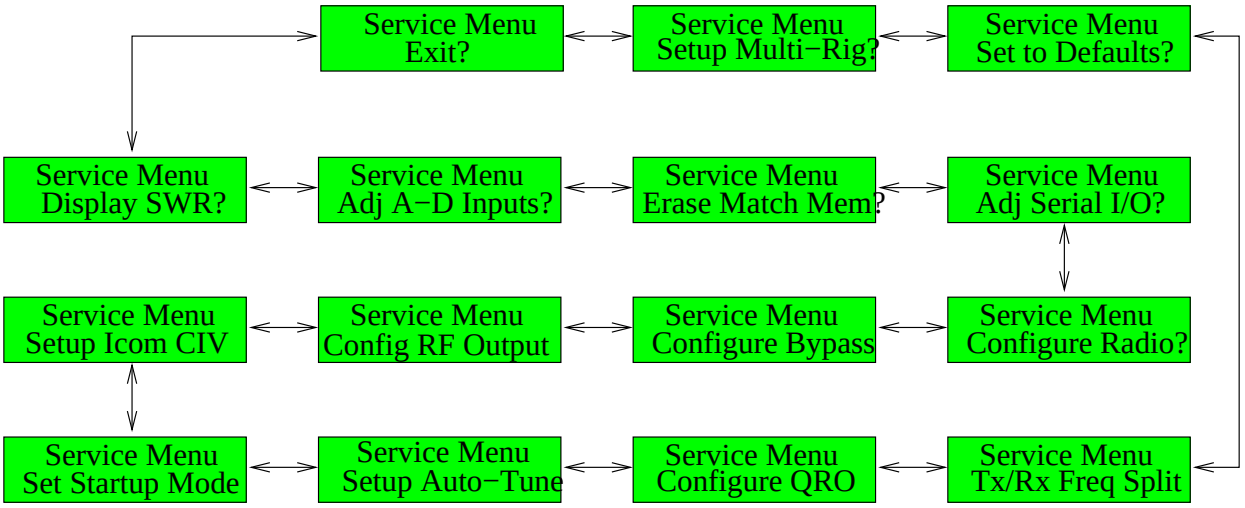


Figure 6.2: Service Menu Options and Flowchart

6.2.1 Display SWR

Figure 6.3: Service Menu Option – Display SWR

Note: Intended for factory use only during calibration of the Analog-to-Digital converters necessary for RF Power detection and determination of SWR. To exit, momentarily depress the *Mode* switch.

6.2.2 Adjust A-D Inputs

Figure 6.4: Service Menu Option – Adjust A-D Inputs

Note: Intended for factory use only during calibration of the Analog-to-Digital converters necessary for RF Power detection and determination of SWR. To exit, momentarily depress the *Mode* switch.

6.2.3 Erase Match Memory

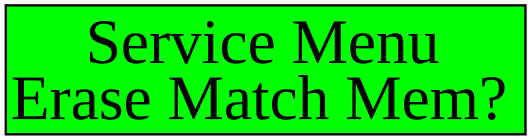


Figure 6.5: Service Menu Option – Erase Match Memory

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.

6.2.4 Adjust Serial I/O

Figure 6.6: Service Menu Option – Adjust Serial I/O

When this option is selected, the AT-AUTO$_{(tm)}$ will display the currently selected data rate and number of stop bits (1 or 2). Supported data rates are shown in Figure 6.7 and suggested data rates and types known to work with various radios are shown in Table 6.1. All serial data bytes are 8-bits long, no-parity and either one or two stop bits (8-N-1 or 8-N-2). Most radios use one stop bit, but some Yaesu radios utilize 2 stop bits. Rotate the **Tune-Select** knob until the desired baud rate and number of stop bits is displayed. Then momentarily press the **Tune-Select** knob.

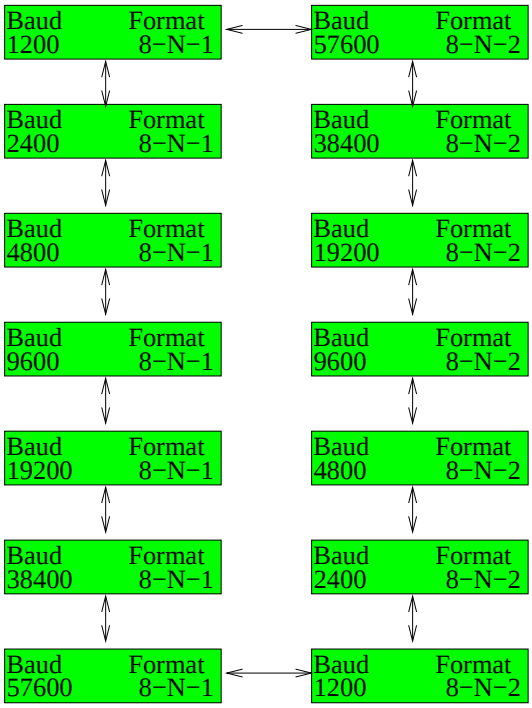


Figure 6.7: Service Menu Option – Baud Rate & Stop Bit Options

Table 6.1: Suggested Serial I/O Settings

Radio Model	**Baud**	**Protocol**	**Notes**
Elecraft K2/K3	9600	8-N-1	Uses Kenwood Protocols
Flex Radio SDR-1000	9600	8-N-1	Uses Kenwood Protocols
Flex Radio FLEX-5000	9600	8-N-1	Uses Kenwood Protocols
Icom IC-735	1200	8-N-1	Radio Hardwired to 1200 Baud
Icom (Most Models)	9600	8-N-1	See Note 1
Kenwood (Most Models)	9600	8-N-1	Common Default Setting
	4800	8-N-2	See Note 2
TenTec Omni VII & Jupiter	57,600	8-N-1	
Yaesu FT-450	9600	8-N-1	See Note 2
Yaesu FT-890	4800	8-N-2	
Yaesu FT-920	4800	8-N-2	
Yaesu FT-950	4800	8-N-1	Radio Default is 4800 Baud
Yaesu FT-980	4800	8-N-1	Radio Default is 4800 Baud
Yaesu FT-990	4800	8-N-2	
Yaesu FT-1000	4800	8-N-2	
Yaesu FT-2000	4800	8-N-1	Radio Default is 4800 Baud
Yaesu FT-9000	4800	8-N-1	Radio Default is 4800 Baud

Note 1: Will work with any of the Icom radio's Baud rates. Radio and AT-AUTO$_{(tm)}$ Baud must be set to same speed. 9600 Baud is a good compromise – especially if sharing the CI-V bus with multiple data devices.
Note 2: Various Baud and number of stop bit settings are available on several radio models via user menus. Radio and Tuner Baud and number of stop bits must match.

6.2.5 Configure Radio

Figure 6.8: Service Menu Option – Configure Radio

Once this option is selected, the AT-AUTO$_{(tm)}$ will display the currently selected rig type. The supported rig types are shown in Figure 6.9. Rotate the **Tune-Select** knob until the desired rig type is displayed, then momentarily press the **Tune-Select** knob.

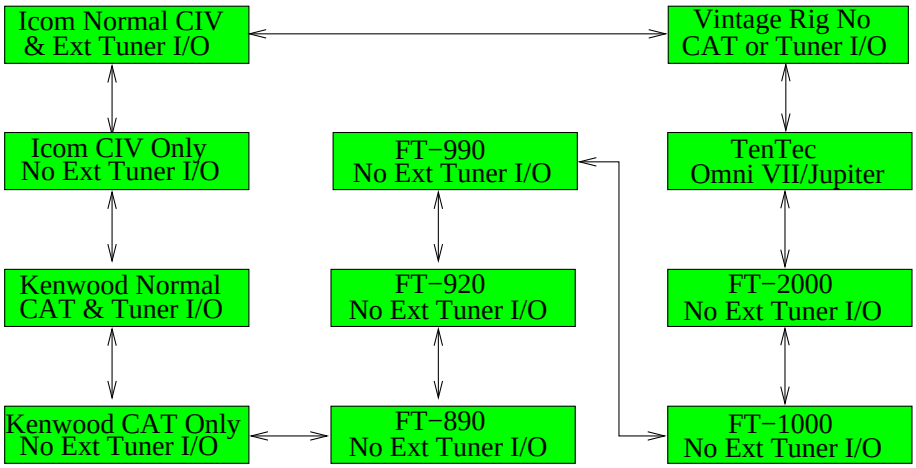


Figure 6.9: Service Menu Option – Rig Types

When the AT-AUTO$_{(tm)}$ is properly configured and correctly connected to a compatible CAT/CI-V equipped radio, the AT-AUTO$_{(tm)}$ will immediately follow any frequency change in the radio and then automatically preset C & L based upon match settings for the new frequency.

The AT-AUTO$_{(tm)}$ can also be controlled by those radios that provide for external tuner handshaking and control. In order to enable either of these features, the AT-AUTO$_{(tm)}$ must know what type of radio it is connected to as well as the CAT/CI-V serial data rate. Table 6.2 lists CAT/CI-V radios currently supported by the AT-AUTO$_{(tm)}$ firmware. The supported radio capabilities are shown in Table 6.3.

Table 6.2: AT-AUTO$_{(tm)}$ Compatible CAT/CI-V Radios

Make	**Model**	**Select**
Elecraft	K2	"Kenwood CAT Only, No Ext Tuner I/O"
	K3	"Kenwood CAT Only, No Ext Tuner I/O"
Flex Radio	SDR-1000	"Kenwood CAT Only, No Ext Tuner I/O"
	FLEX-5000	"Kenwood CAT Only, No Ext Tuner I/O"
Icom	IC-735	"Icom CIV Only, No Ext Tuner I/O"
	IC-706 - IC-7000, etc.	"Icom Normal CIV & Ext Tuner I/O"
	IC-7700/7800	"Icom CIV Only, No Ext Tuner I/O"
Kenwood	TS-480	"Kenwood Normal CAT & Tuner I/O"
	TS-570	"Kenwood Normal CAT & Tuner I/O"
	TS-2000	"Kenwood Normal CAT & Tuner I/O"
TenTec	Omni VII	" TenTec Omni VII/Jupiter"
	Jupiter	" TenTec Omni VII/Jupiter"
Yaesu	FT-450	"Yaesu FT-2000 No Ext Tuner I/O"
	FT-890	"Yaesu FT-890 No Ext Tuner I/O"
	FT-920	"Yaesu FT-920 No Ext Tuner I/O"
	FT-950	"Yaesu FT-2000 No Ext Tuner I/O"
	FT-980	"Yaesu FT-2000 No Ext Tuner I/O"
	FT-990	"Yaesu FT-990 No Ext Tuner I/O"
	FT-1000, etc.	"Yaesu FT-1000 No Ext Tuner I/O"
	FT-2000, FT-5000, FT-9000, etc.	"Yaesu FT-2000 No Ext Tuner I/O"

Table 6.3: Supported Radio Capabilities

Type	Capability
Elecraft K2/K3	QSY Following Only
Flex Radio SDR-1000/Flex-5000	QSY Following Only
Icom Normal	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
TenTec	QSY Following Only
Vintage Rig	No QSY Following, No External Tuner Control
Yaesu	QSY Following Only

Note: If you are using an older-style radio without a compatible CAT/CI-V or external tuner interface, you should configure the AT-AUTO$_{(tm)}$ to operate with a "Vintage Rig" (default).
Note: Flex Radio SDR-1000, Flex-5000, etc., should be configured as "Kenwood CAT Only"

6.2.6 Configure RF Bypass

Figure 6.10: Service Menu Option – Configure Bypass

All recent production AT-AUTOs$_{(tm)}$ have the ability to bypass the tuner's impedance matching network and to directly couple the RF input to the RF output. The first generation AT-AUTOs$_{(tm)}$ lacked the hardware necessary to provide this capability. Unless you own an older version of the AT-AUTO$_{(tm)}$ which lacks RF bypass capability, leave this option set to the factory default (bypass circuitry installed). AT-AUTOs$_{(tm)}$ without RF bypass hardware *MUST* should be set to *No* (bypass circuitry not installed) to ensure proper operation.

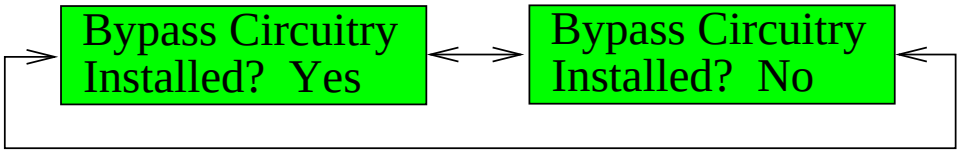


Figure 6.11: Configure RF Bypass Options

6.2.7 Configure RF Output

Figure 6.12: Service Menu Option – Configure RF Output

The AT-AUTO$_{(tm)}$ may be configured to automatically select (based upon operating frequency) either the coaxial or balanced RF output and to route the RF through, or to bypass the tuning network . Additionally, if the Kessler Engineering CX-AUTO$_{(tm)}$ external Coaxial or BL-AUTO$_{(tm)}$ external Balanced antenna switches are attached, the AT-AUTO$_{(tm)}$ can also automatically select any 1-of-8 coaxial outputs and/or 1-of-4 balanced outputs. These external antenna switches are controlled by the AT-AUTO$_{(tm)}$ via CI-V or RS-422 data bus.

During bandchanges the AT-AUTO$_{(tm)}$ may also *temporarily* bypass the RF matching network 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 and will automatically de-energize when the inductor and capacitor are finished being repositioned for the new band. If the user has selected a particular band for automatic bypassing either to the Coax or Balanced outputs, the inductor and capacitor will not be repositioned while operating in this band. Automatic antenna and RF bypass/through selection utilizes serial frequency data available from the radio's CAT/CI-V data port, and by counting RF frequency when using "Vintage" rigs.

The various *Configure RF Output* options are shown in Figure 6.13 and are summarized in Table 6.4.

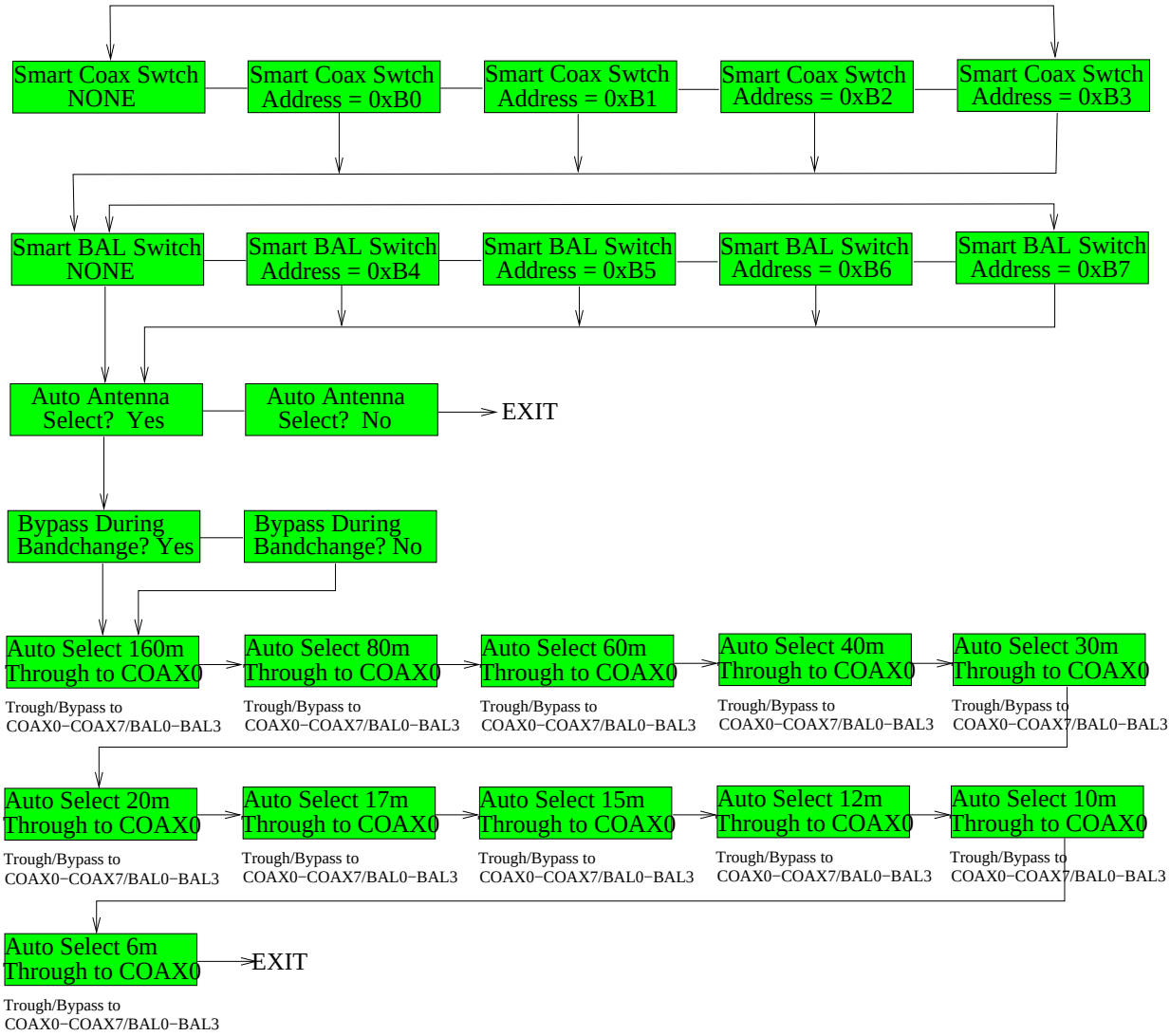


Figure 6.13: Configure RF Output User-Options

Table 6.4: Configure RF Output Options

Submenu	Option	Note
Smart COAX Switch	NONE, 0xB0, 0xB1, 0xB2, or 0xB3	1
Smart Balance Switch	NONE, 0xB4, 0xB5, 0xB6, or 0xB7	2
Auto Antenna Select	*Yes* or *No*	3
Bypass During Bandchange?	*Yes* or *No*	4
Auto Select 160m	*Through* or *Bypass*	5
Auto Select 80m	to *COAX* or *BAL*	6
Auto Select 60m	or	
Auto Select 40m	to *COAX 0-7* or *BAL 0-3*	7, 8
Auto Select 30m		
Auto Select 20m		
Auto Select 17m		
Auto Select 15m		
Auto Select 12m		
Auto Select 10m		
Auto Select 6m		

Note 1: Select the actual CI-V address of the CX-AUTO$_{(tm)}$ coaxial antenna switch. If CX-AUTO is *Not* present, select *NONE*.

Note 2: Select the actual CI-V address of the BL-AUTO$_{(tm)}$ balanced antenna switch. If the BL-AUTO$_{(tm)}$ is *Not* present, select *NONE*.

Note 3: Select *No* if automatic antenna selection by band is not desired. If *No* is selected, the other submenu items will not be available. Select *Yes* if automatic antenna selection by band is desired.

Note 4: Select *Yes* if you want the AT-AUTO$_{(tm)}$ to *temporarily* bypass RF while the AT-AUTO$_{(tm)}$ is transitioning from band to band. If *No* is selected, RF will be routed through the tuning network during bandchanges.

Note 5: Per band selection, RF will route *Through* or *Bypass* the tuning Network.
Note 6: Per selection, RF will to *Coaxial* or *Balanced* output.
Note 7: If CX-AUTO$_{(tm)}$ present, RF will be routed to 1 of 8 coaxial outputs.
Note 8: If BL-AUTO$_{(tm)}$ present, RF will routed to 1 of 4 balanced outputs.

6.2.8 Setup Icom CI-V

Figure 6.14: Service Menu Option – Setup Icom CI-V

This service menu area is only applicable if the AT-AUTO$_{(tm)}$ is connected to a CI-V equipped Icom radio, or if intending to remotely control the AT-AUTO$_{(tm)}$. If not, then this section should be ignored. The various *Setup Icom CI-V* options are shown in Figure 6.15 and are summarized in Table 6.5.

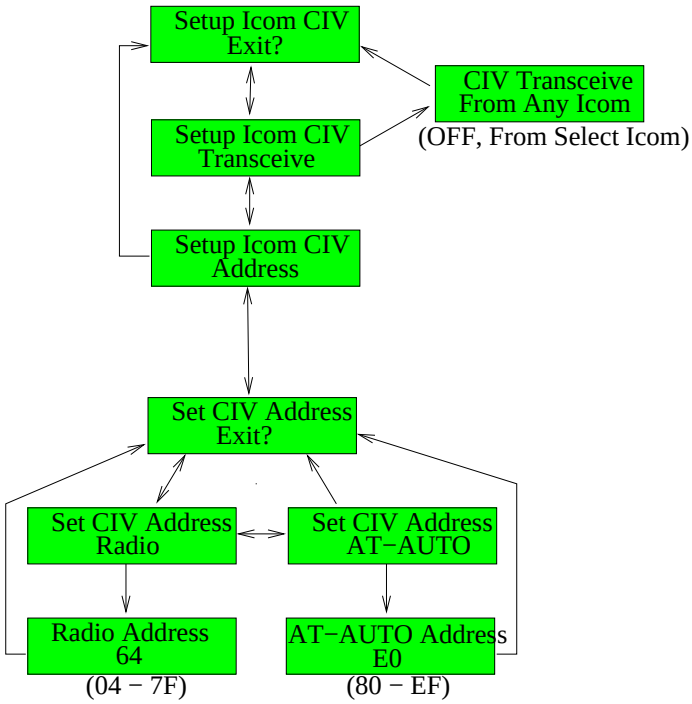


Figure 6.15: Setup Icom CI-V Sub Menus

Table 6.5: Setup Icom CI-V Submenu Options

Submenu	Option	Note
Exit	Return to Main Setup Menu	
Transceive	Off, From Any Icom, From Select Icom	1
Address	Radio	2
	AT-AUTO	3

Note 1: *OFF* – AT-AUTO$_{(tm)}$ transmits frequency query commands to the attached Icom radio as determined by the Icom radio's specific CI-V address, and only accepts frequency information from this specific Icom radio.

From Select Icom – AT-AUTO$_{(tm)}$ passively listens for frequency data from a specific radio only, as determined by the Icom radio's CI-V address.

From Any Icom – AT-AUTO$_{(tm)}$ passively listens for frequency data from *any* Icom radio regardless of the radio's specific CI-V address.

Note 2: Use this option to select the CI-V address of the attached Icom radio. Valid radio CI-V addresses may range of 0x04 to 0x7F.

Note 3: Use this option to select the CI-V address of the AT-AUTO$_{(tm)}$. Any address within the range of 0x80 to 0xEF may be selected. Default is 0xE0.

Note! All devices connected to the CI-V bus ***MUST*** be assigned unique CI-V addresses!

The AT-AUTO$_{(tm)}$ default mode of operation with "Vintage Rigs" and Icom radios is to receive and decode CI-V frequency broadcast data from any CI-V equipped Icom radio(s) operating in the "data transceive" mode. The AT-AUTO$_{(tm)}$ listens for frequency information sent over the CI-V serial data bus and then positions the inductor and capacitor to settings appropriate to the operating frequency. The CI-V data transceive operation is completely passive on the part of the AT-AUTO$_{(tm)}$. Refer to your applicable Icom radio manual for further details on CI-V data transceive operation.

When connected to the CI-V bus, the AT-AUTO$_{(tm)}$ responds to frequency changes made on any Icom radio attached to the CI-V bus. If there are multiple Icom radios setup for "data transceive" operation and attached to the CI-V bus, the AT-AUTO$_{(tm)}$ will respond to any frequency changes made on any of the radios.

It is possible to limit the AT-AUTO$_{(tm)}$ response to just a single Icom radio in data transceive mode by setting the AT-AUTO$_{(tm)}$ to follow CI-V data from a specific radio address only. The AT-AUTO$_{(tm)}$ can also be setup to query a specific Icom radio based upon the radio's CI-V address. If the user turns the CI-V transceive to *OFF*, the AT-AUTO$_{(tm)}$ will no longer listen or respond to any CI-V frequency data generated from a CI-V data transceive operation. Instead, the AT-AUTO$_{(tm)}$ 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$_{(tm)}$ from the specific radio. Valid Radio CI-V addresses are in the range of 0x04 to 0x7F and the AT-AUTO$_{(tm)}$ may be assigned an address in the range of 0x80 to 0xEF. In order for the AT-AUTO$_{(tm)}$ to transmit over the CI-V bus, the internal jumpers on the AT-AUTO$_{(tm)}$ controller board must be configured correctly. See Table 12.1 on page 94 for details.

6.2.9 Set Startup Mode

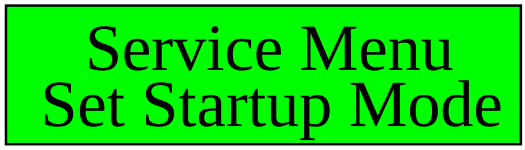


Figure 6.16: Service Menu Option – Set Startup Mode

When powered *On*, the AT-AUTO$_{(tm)}$ enters *Automatic* Mode (default). The user may configure the AT-AUTO$_{(tm)}$ to startup in *Automatic*, *Manual*, *Bypass*, or the mode in use when the AT-AUTO$_{(tm)}$ was turned *Off*. Rotate the **Tune-Select** knob until the desired startup mode is displayed, then momentarily press the **Tune-Select** knob.

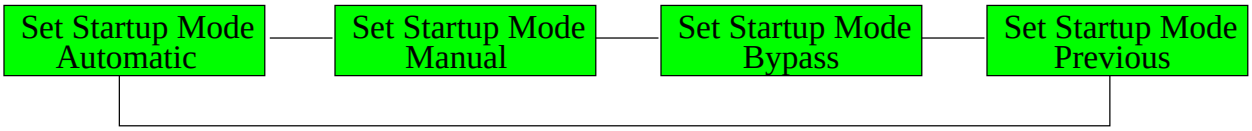


Figure 6.17: Set Startup Mode Submenu Options

6.2.10 Setup Auto-Tune

Figure 6.18: Service Menu Option – Setup Auto-Tune

While in *Automatic* Mode, the AT-AUTO$_{(tm)}$ monitors forward and reflected power and *autonomously* commences tuning whenever the SWR exceeds the "Tune Start SWR" (default 1.2:1) and ceases tuning whenever the SWR falls below the "Tune Stop SWR" (default 1.05:1).

The "Tune Start" and "Tune Stop" SWR thresholds are user-selectable as shown in Table 6.6, and the AT-AUTO's$_{(tm)}$ *autonomous* tuning may be disabled as shown in Figure 6.19. When "User-Prompted" is selected, the AT-AUTO$_{(tm)}$ will provide a warning to the user but will not start auto-tuning unless the user consents by momentarily pressing the **Tune-Select** knob.

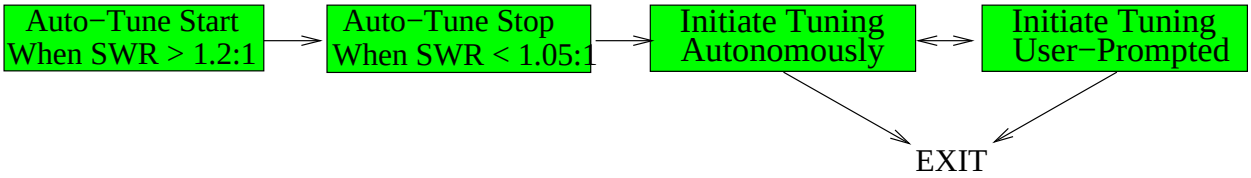


Figure 6.19: Setup Auto-Tune Submenu

Rotate the **Tune-Select** knob until the desired tuning initiation option is displayed and then depress the **Tune-Select** knob.

Table 6.6: 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 $\leq 2.5:1$

6.2.11 Configure QRO Keyline

Figure 6.20: Service Menu Option – Configure QRO Keyline

This service menu area is only applicable if the AT-AUTO$_{(tm)}$ QRO Keyline hardware is installed and the user intends to use an external RF power amplifier with the AT-AUTO$_{(tm)}$.

Note! Configuration changes made to, and use of the QRO Keyline have absolutely *No* affect on overall tuner operation.

The various *Configure QRO Keyline* options are shown in Figure 6.21 and are summarized in Table 6.7.

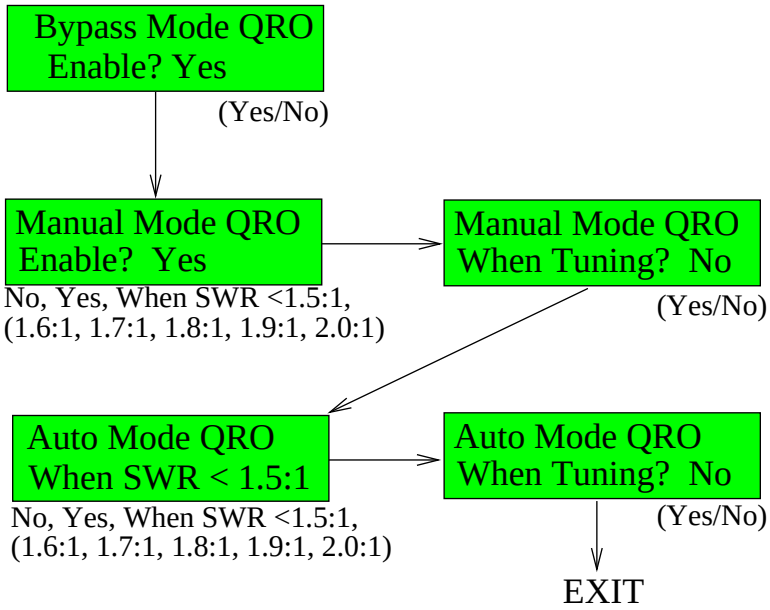


Figure 6.21: Configure QRO Keyline Submenu Options

Table 6.7: Configure QRO Keyline Submenu Options

Submenu	**Option**	**Note**
Bypass Mode QRO Enable?	*Yes*, *No*	1
Manual Mode QRO Enable?	*Yes*, *No*, *SWR Threshold*	1,2
Manual Mode QRO When Tuning?	*Yes*, *No*	3
Automatic Mode QRO Enable?	*Yes*, *No*, *SWR Threshold*	1,2
Automatic Mode QRO When Tuning?	*Yes*, *No*	3

Note 1: *Yes* – QRO Keyline is *Always* enabled regardless of SWR level. *No* – QRO Keyline is *Never* enabled. The Amplifier will *Never* be keyed.

Note 2: *When SWR* $\leq$ *1.5:1* – QRO Keyline will *Not* be enabled until the measured SWR is below user-selected SWR threshold. User selectable SWR thresholds are 1.5:1, 1.6:1, 1.7:1, 1.8:1, 1.9:1, or 2.0:1

Note 3: *No* – QRO Keyline is *Always* disabled while tuning. *Yes* – QRO Keyline *may* be enabled while tuning.

6.2.12 Tx/Rx Freq Split

Figure 6.22: Service Menu Option – Tx/Rx Frequency Split

The AT-AUTO$_{(tm)}$ is capable of following frequency information provided by the radio's CAT/CI-V port. Under normal circumstances, the AT-AUTO$_{(tm)}$ will follow *ALL* frequency changes and reposition *L* and *C* accordingly. However when utilizing separate and distinct transmit and receive frequency "windows", it is impractical and undesired for the AT-AUTO$_{(tm)}$ to reposition *L* or *C* whenever the radio switches back and forth between transmit to receive. The AT-AUTO$_{(tm)}$ can be configured to *ignore* frequency changes within the receive frequency window, yet to automatically call up match settings whenever the radio's transmit frequency changes. Split frequency operation is enabled or disabled for each band as shown in Figure 6.23. Split frequency is normally disabled (default).

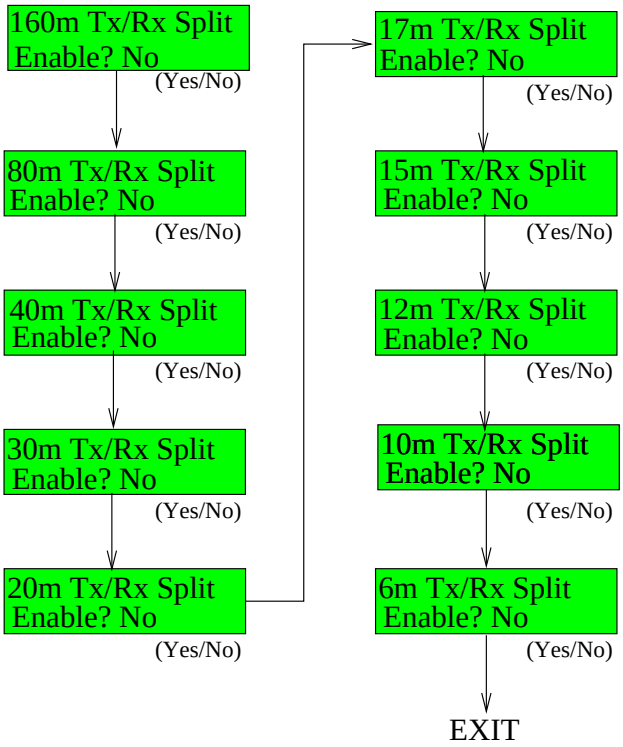


Figure 6.23: Tx/Rx Frequency Split Enable/Disable by Band

Split Tx/Rx frequency operation may be enabled for any amateur band except 60m. The Tx/Rx frequency boundary is user adjustable. Once split frequency operation is enabled for a particular band, the user may adjust the precise Tx/Rx frequency boundary as well as the Tx/Rx orientation (transmit high, receive low) or (transmit low, receive high). For example, assuming that split frequency operation had been enabled on the 160m band, upon exiting the subroutine shown in Figure 6.23, the user would have the option of selecting the transmit direction (transmit high or low in the band). The split direction may be toggled by momentarily depressing the *Mode* button. Likewise the actual Tx/Rx frequency boundary is adjusted by rotating the *Tune-Select* knob. Once the desired split direction and Tx/Rx frequency boundary is established, momentarily depress the *Tune-Select* knob.

Figure 6.24 illustrates toggling the transmit direction (transmit low/high) by momentarily depressing the *Mode* button, while Figure 6.25 shows how the Tx/Rx frequency boundary may be adjusted by rotating the *Tune-Select* knob.

Figure 6.24: Toggling Tx/Rx Window Direction via *Mode* Pushbutton

Figure 6.25: Adjusting Tx/Rx Frequency Boundary via *Tune-Select* Knob

Primary Tx/Rx split frequency configuration controls are shown in Figure 6.26.

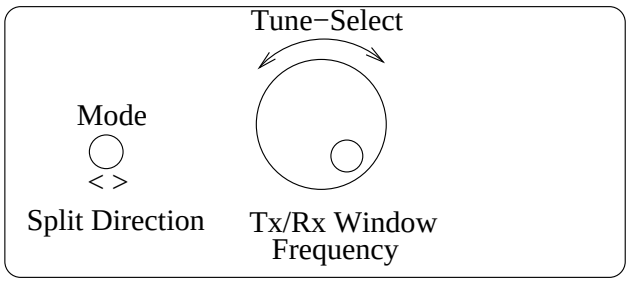


Figure 6.26: Tx/Rx Window Direction and Frequency Controls

6.2.13 Set to Defaults

Figure 6.27: Service Menu Option – Set to Defaults?

When leaving the Kessler Engineering factory and whenever the user uploads new firmware, the AT-AUTO$_{(tm)}$ firmware will be reset to the default settings listed below. The user is encouraged to explore and configure the AT-AUTO$_{(tm)}$ operation to fit their particular requirements. However, the *Set to Defaults?* feature was added to enable the user to rapidly restore the unit back to a known, default configuration. Returning the AT-AUTO$_{(tm)}$ to default settings does not erase previously stored match settings.

1. Serial I/O - 9600 Baud, 8 Bit, No Parity, 1 Stop Bit
2. Radio - "Icom Normal CI-V & Ext Tuner I/O"
3. Bypass Circuitry Installed - Yes
4. Auto Antenna Select - No
   Smart Coax Switch - None
   Smart Bal Switch - None
   Bypass During Bandchange - Yes
   Auto Select 160m, 80m, etc., - Through to Coax
5. Icom CI-V
   Transceive from Any Icom
   AT-AUTO$_{(tm)}$ CI-V Address - 0xE0
   Rig CI-V Address - 0x64
6. Startup Mode - *Automatic*
7. Auto Tune
   Initiate Tuning Autonomously
   Autotune Start SWR 1.2:1
   Autotune Stop SWR 1.05:1
8. QRO Keyline
   Bypass Mode QRO Enable - Yes
   Manual Mode QRO Enable - Yes
   Manual Mode QRO When Tuning - No
   Automatic Mode QRO Enable - When SWR $\leq 1.5:1$
   Automatic Mode QRO When Tuning - No

9. Tx/Rx Frequency Split 160m, 80m, etc., Enable - No
   160m Split Frequency - 1850 kHz
   80m Split Frequency - 3800 kHz
   40m Split Frequency - 7150 kHz
   30m Split Frequency - 10120 kHz
   20m Split Frequency - 14175 kHz
   15m Split Frequency - 21200 kHz
   10m Split Frequency - 28500 kHz
   6m Split Frequency - 50110 kHz
10. Multi-Rig Switching Enabled - No
    Input COAX Switch Address - NONE
    Rig #0 Type - Vintage Rig
    Rig #1 Type - Vintage Rig
    Rig #2 Type - Vintage Rig
    Rig #3 Type - Vintage Rig
    Rig #4 Type - Vintage Rig
    Rig #5 Type - Vintage Rig
    Rig #6 Type - Vintage Rig
    Rig #7 Type - Vintage Rig

6.2.14 Setup Multi-Rig

Figure 6.28: Service Menu Option – Setup Multi-Rig?

The AT-AUTO$_{(tm)}$ is able to control a CX-AUTO$_{(tm)}$ configured as an input switch to enable up to any 1-of-8 radios to be used with the AT-AUTO$_{(tm)}$. This feature is intended for those stations with multiple transceivers. After configuring the various rig types (See Figure 6.29), the user may select a particular radio by depressing the "Output" pushbutton for ≈ 2 Seconds.

The various *Setup Multi-Rig* options are shown in Figure 6.29.

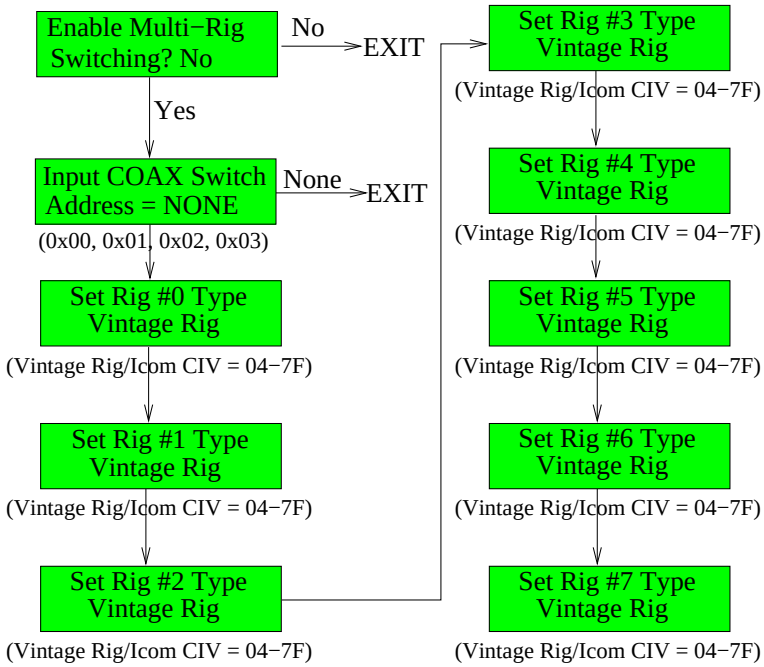


Figure 6.29: Configure QRO Keyline Submenu Options

After depressing the "Output" button for ≈ 2 Seconds, the AT-AUTO$_{(tm)}$ will display a radio selection menu (See Figure 6.30), showing the currently selected radio, radio type ("Vintage Rig" or "Icom CIV"), and the currently selected radio's CI-V address, when applicable. Rotate the "Tune-Select" knob to select the intended radio. As the"Tune-Select"

knob is rotated, the CX-AUTO$_{(tm)}$ that has been hardware configured to handle input rig switching, will route RF to/from the displayed radio. Once the desired radio is displayed, momentarily press the "Tune-Select" knob.

Figure 6.30: Radio Selection Menu

Each CX-AUTO$_{(tm)}$ in use as well as every other device (radio, etc.) attached to the CI-V bus *MUST* each have their own unique - unshared CI-V address.

All radios to be used in the Multi-Rig setup must either be configured as "Vintage Rig" or "Icom CIV". If the radio to be used does not have a CI-V port, configure it as a "Vintage Rig". If the radio is an Icom with CI-V port, be sure to configure it as "Icom CIV" and ensure that the radio's actual CI-V address is used.

Whenever multiple Icom CI-V radios are present on the same CI-V bus, we recommend turning each radio's *CI-V Transceive* feature *Off*. The *CI-V Transceive* feature is usually controlled by a setting in the respective radio's user menus.

During Multi-Rig operation, if the radio in use is a "Vintage Rig", all automated frequency/band changes are accomplished by counting the RF frequency from the selected "Vintage Rig." However, when the selected radio is an "Icom CIV" radio, all automatic frequency/band changes are accomplished by querying that particular Icom radio at 1Hz intervals, utilizing the selected Icom radio's specific CI-V address.

Note 1: When Multi-Rig switching is enabled, External Tuner I/O control from any Icom rig is disabled.

Note 2: Multi-Rig operation is automatically disabled whenever the *Configure Radio* firmware setup (page 50) is selected.

Firmware Update Guide

Your Kessler Engineering AT-AUTO$_{(tm)}$ 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 upload your AT-AUTO$_{(tm)}$ with the latest firmware version or to revert back to a previous firmware version.

Warning: The AT-AUTO$_{(tm)}$ microprocessor has been programmed with a firmware bootloader (either Version I or Version II). AT-AUTOs$_{(tm)}$ shipped prior to $\approx$ October 2009 were programmed with the Version I bootloader. After October, 2009, all AT-AUTOs$_{(tm)}$ were supplied with the Version II bootloader. While either bootloader is fully compatible with all versions of AT-AUTO firmware, etc., special precautions should be observed when uploading firmware if using the Version I bootloader.

If you have an AT-AUTO$_{(tm)}$ produced prior to $\approx$ October 2009 (Version I bootloader), the stepper motors should be unplugged from the AT-AUTO$_{(tm)}$ control board prior to initiating the upload process. Failure to do so may cause damage to the control board motor driver ICs.

The AT-AUTO$_{(tm)}$ microprocessor chip may be returned to Kessler Engineering for re-programming with the Version II bootloader to prevent this problem in the future. Once the microprocessor is reprogrammed with the Version II bootloader, the user need not disconnect the stepper motors when uploading AT-AUTO$_{(tm)}$ firmware. Contact Kessler Engineering for specifics.

1. Ensure AT-AUTO's$_{(tm)}$ internal hardware jumpers are configured correctly (See Table 12.1 on page 94).

2. **Completely disconnect the "Transceiver Data" and any CI-V connections at the rear of the AT-AUTO$_{(tm)}$!**

3. Download "Kessler Engineering - Firmware Uploader" software from our website at:

www.KesslerEngineeringLLC.com

http://www.Kessler EngineeringLLC.com. The software is located in the "Downloads" section.

4. Unzip the software and place it in a folder on you PC desktop or hard drive.

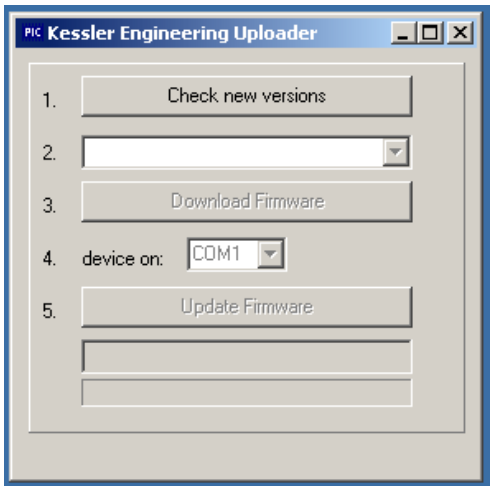
5. Connect your AT-AUTO$_{(tm)}$ to your PC's RS-232 serial port with the Kessler Engineering-supplied "Firmware Upload Cable" (See Figure 8.1 on page 78).

6. Turn *On* your Kessler Engineering AT-AUTO$_{(tm)}$.

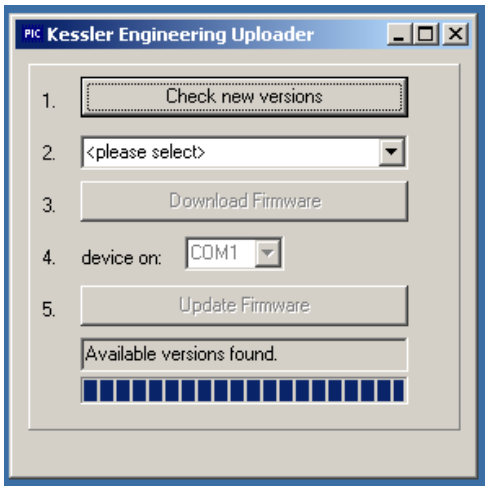
7. Make sure your PC is connected to the Internet.

8. Locate the "Firmware Uploader" software and double click on the icon to start the software

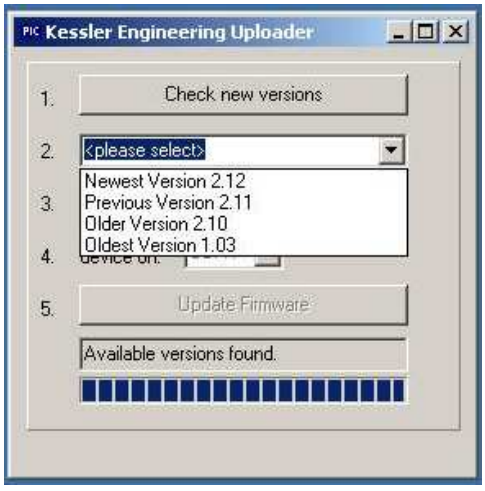
9. The program will start and you should see the following screen:



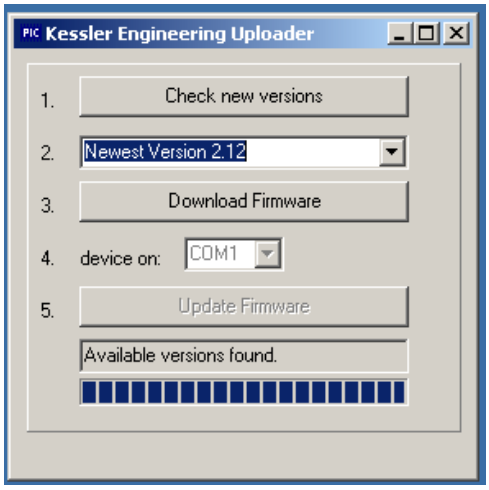
10. Click on the "Check new version" button to check availability of uploadable firmware for your AT-AUTO$_{(tm)}$. Afterward you should see something similar to the following screen indicating that firmware is available and for you to select the desired version:



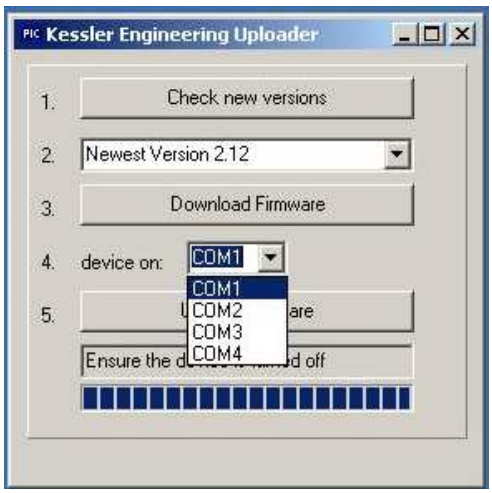
11. Click the arrow in the "<please select>" block and you will be presented with all a selection of available firmware versions:



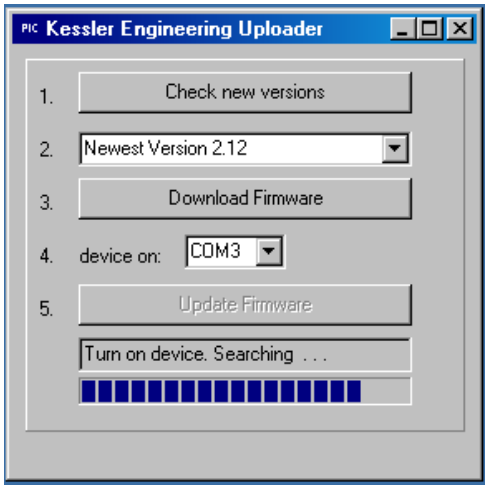
12. Click on the desired firmware version and you will then be prompted to download the selected firmware:



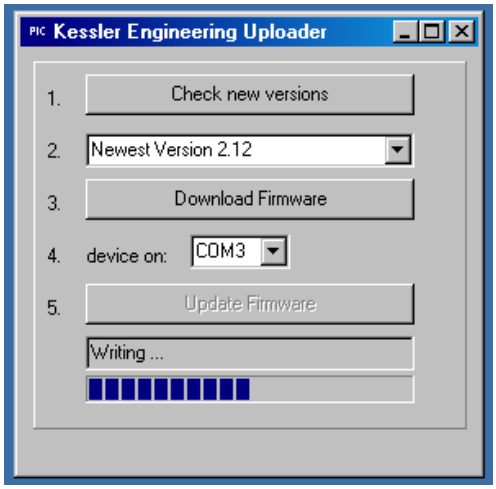
13. Click on the "Download firmware" tab. Once the firmware is downloaded, select the com port that the AT-AUTO$_{(tm)}$ is connected to:



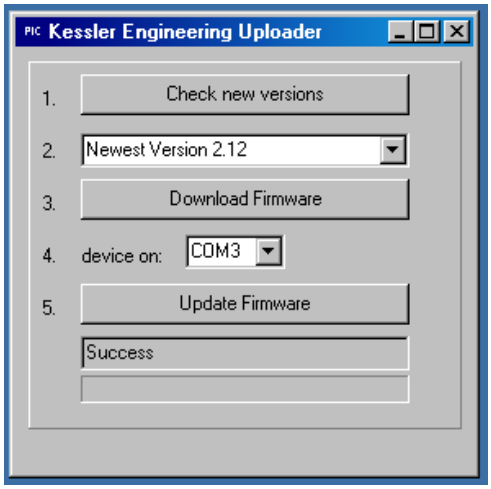
14. Click on the "Update Firmware" and the bootloader will begin searching for the AT-AUTO$_{(tm)}$:



15. Firmware should soon start writing to the AT-AUTO$_{(tm)}$:



16. Once the process completes:



The AT-AUTO$_{(tm)}$ should automatically reset itself, re-home L and C, and then momentarily display the firmware version that is now installed.

17. Your firmware is now updated and you should exit the bootloader program.

Note: If the stepper motors were be unplugged from the AT-AUTO$_{(tm)}$ control board prior to initiating the upload process, switch the AT-AUTO$_{(tm)}$ *Off*, reconnect the stepper motors, and then switch the AT-AUTO$_{(tm)}$ back *On* again, and let the homing process complete.

Hardware Requirements for Firmware Updating

The PC serial port is often labeled "COM1", "COM2", etc. Some newer computers no longer come with RS-232 serial ports included, but USB to RS-232 serial adapters are available. If your computer does not have a serial port, these adapters may be purchased relatively inexpensively from your local computer hardware supplier.

Note: The AT-AUTO$_{(tm)}$ firmware updating works best when directly connected to a genuine RS-232 serial port. Some of the USB to RS-232 converts have proven problematic and may be unsuitable for firmware updating. However, the quality of USB to RS-232 serial converters in general seems to have improved and you might not encounter problems.

The serial cable used for the firmware update must include the "RTS" (Request to Send) handshake line. The Kessler Engineering-supplied serial cable is intended for this purpose.

Rear-Panel Pinouts and Interface Cables

8.1 External Tuner Handshake

The AT-AUTO$_{(tm)}$ is capable of controlling the low-power, constant carrier generation capability built into some Icom and Kenwood radios. This *External Tuner Handshake* requires connection of the AT-AUTO$_{(tm)}$ with either the Icom's "tuner" interface or the Kenwood's "AT" interface. Do NOT attempt AT-AUTO$_{(tm)}$ - radio interfacing via the "Data/Handshake" connector with non-Icom or non-Kenwood radios. Kenwood radios require additional external circuitry (built into the Kessler Engineering-supplied interface cable) in order for the handshake feature to operate. Figure 8.1 on page 78 illustrates the handshaking cables used for Icom and Kenwood radios.

8.2 Radio/Computer Serial Data Interface

The AT-AUTO$_{(tm)}$ interfaces with a computer's serial port in order upload new firmware, and in order to enable PC remote control of the AT-AUTO$_{(tm)}$. The AT-AUTO$_{(tm)}$ also incorporates unique operating enhancements that are only available when properly interfaced to a (firmware supported) CI-V/CAT capable transceiver.

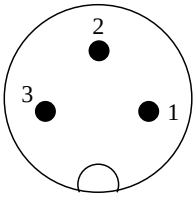
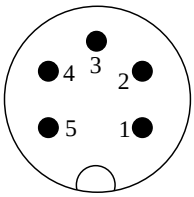
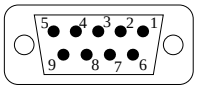
The AT-AUTO$_{(tm)}$ is directly compatible with most popular transceivers via it's CI-V (Icom) interface and RS-232 interface (Kenwood, Yaesu, TenTec, & Elecraft rigs). The AT-AUTO$_{(tm)}$ is NOT directly compatible with CAT radios that use TTL data levels. In this case, the owner will need to supply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

Kessler Engineering supplies interface cables that are suitable for use with either Icom transceivers, most Kenwood, some Yaesu, several TenTec and Elecraft transceivers. The information supplied in this section is provided to enable AT-AUTO$_{(tm)}$ owners to construct their own interface cables. Rear panel connector pinouts are provided in Table 8.1 on page 77, and Figure 8.1 (page 78) provides illustrations of the serial date interfacing cabling.

Warning: When interfacing the AT-AUTO$_{(tm)}$ with CAT capable radios via the RS-232 port, Pin 7 (AT-AUTO$_{(tm)}$ processor reset) must remain unconnected, or the "Reset Enable" jumper must be *Open* (See Figure 12.1 on page 93).

Warning: When interfacing the AT-AUTO$_{(tm)}$ with an Elecraft radio via the radio's I/O port, Pins 7 & 8 must on the remain unconnected or internal damage to the radio will likely occur.

Table 8.1: 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$_{(tm)}$) Pin 3 - Serial Data Input (To AT-AUTO$_{(tm)}$) Pin 4 - No Connection Pin 5 - Signal Ground Pin 6 - No Connection Pin 7 - AT-AUTO$_{(tm)}$ Processor Reset Pin 8 - No Connection Pin 9 - No Connection

***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.

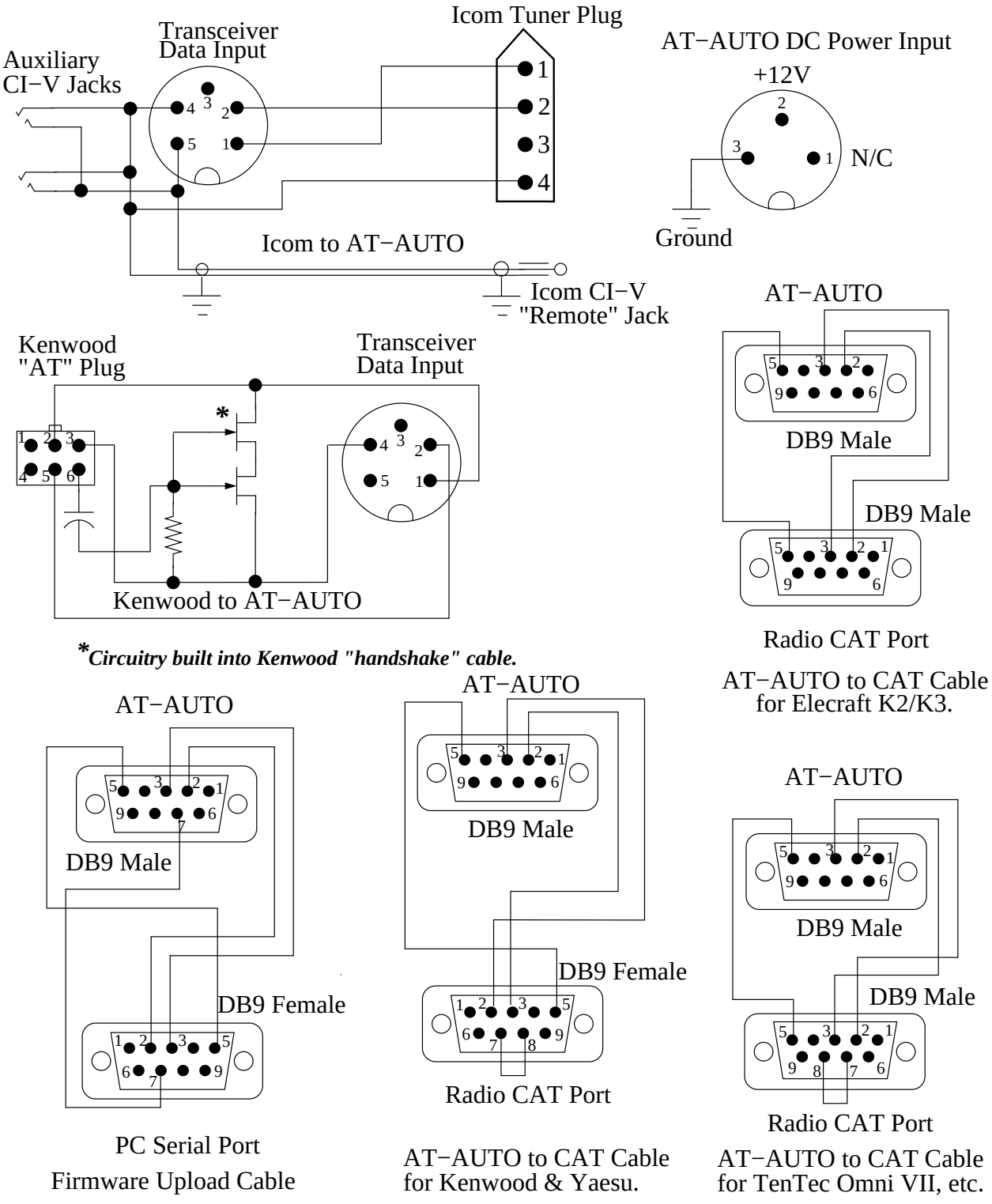


Figure 8.1: Interface Cable Diagrams

8.3 Radio/Computer Serial Data "Y" Interface

The RS-232 protocol used by many CAT transceivers is only designed to connect two serial data devices together – One master device (the AT-AUTO$_{(tm)}$) and one slave device (the HF transceiver). Each device has a dedicated data transmit line which is connected to the other devices' data receive line. Each serial data line can only have one data transmitting device.

The AT-AUTO$_{(tm)}$ and HF transceivers work well together via the RS-232 serial interface. However, logging and control software have become very popular and in many shacks, the HF transceiver simply must be connected to the PC (via the RS-232 serial interface). The "Y" serial data cable should enable the AT-AUTO$_{(tm)}$ to listen-only to the serial data sent from an HF transceiver to the PC. So long as the PC sends the appropriate frequency query command to the HF transceiver, and the AT-AUTO$_{(tm)}$ is able to receive and decode the frequency data information sent by the HF receiver back to the PC, frequency following by the AT-AUTO$_{(tm)}$ should still work as intended.

Figure 8.2 on page 80 is provided so that the user may implement the "Y" data cable interface and attempt to enable AT-AUTO$_{(tm)}$ frequency following in those instances when the HF radio must be connected to the shack PC.

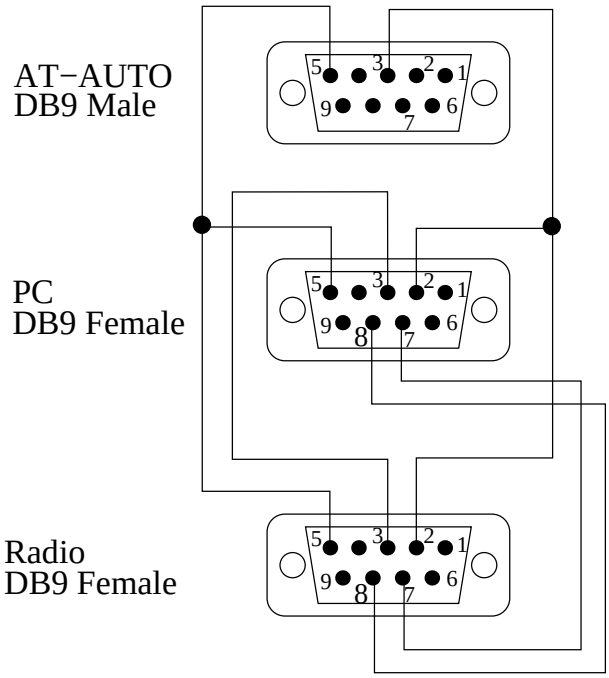


Figure 8.2: Radio/Computer Serial Data "Y" Interface Cable Diagrams

Note: Although some users report success with the "Y" serial data cable, Kessler Engineering makes no claim that it will work for your particular application.

Note! Some radios do NOT provide data headers in their serial data strings which causes erratic frequency following whenever non-frequency serial data is sent by the HF transceiver. The Yaesu FT-990 and FT-1000 are known to cause erratic frequency following by the AT-AUTO$_{(tm)}$ when using a "Y" serial data cable. Users report success with the FT-2000 and Kenwood radios.

Remote Control

Warning! Damage to the AT-AUTO$_{(tm)}$ may result if the AT-AUTO$_{(tm)}$ microprocessor is reset or held in reset by the RTS handshake control from the user's PC RS-232 port. To prevent such damage, ensure the "Reset Enable" jumper (see page 94) is open.

9.1 General Description

The AT-AUTO$_{(tm)}$ is remotely controllable from a computer serial port, or via the Icom CI-V bus, and the AT-AUTO$_{(tm)}$ command syntax has been designed to be compatible with the Icom protocols.

The AT-AUTO$_{(tm)}$ has a specific CI-V address (default 0xE0) (hexadecimal). The AT-AUTO$_{(tm)}$ 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$_{(tm)}$ CI-V address. Any of the AT-AUTO's$_{(tm)}$ commands may be sent to the AT-AUTO$_{(tm)}$, regardless of its current operating mode (*Automatic*, *Manual*, or *Bypass*).

In order to enable remote control operation, the AT-AUTO$_{(tm)}$ must be configured to operate with either a "Vintage Rig" or with an Icom radio configured as "Icom Normal CI-V & Tuner I/O" or "Icom CI-V Only...". If the radio that the AT-AUTO$_{(tm)}$ is connected to does not have an Icom CI-V bus, select "Vintage Rig". If using an Icom radio that lacks the external tuner handshake interface (the 4-pin Molex connector), select "Icom CI-V Only...". Otherwise select "Icom Normal CI-V & Tuner I/O". Additionally, ensure that the AT-AUTO's$_{(tm)}$ internal hardware jumpers are configured appropriately (See Table 12.1 on page 94).

All CI-V 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$_{(tm)}$ command set is shown in Table 9.1 on page 83.

Note: When controlling the AT-AUTO$_{(tm)}$, the CI-V From-Address *MUST NOT* be identical to the radio's CI-V. The AT-AUTO$_{(tm)}$ *WILL* ignore any commands sent to it from the radio (anytime the From-Address matches the radio's CI-V address).

9.1.1 Example Command Strings

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

To command the AT-AUTO$_{(tm)}$ to switch to *Manual* mode, the PC must send the following command string:

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

The AT-AUTO$_{(tm)}$ 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$_{(tm)}$ will immediately switch to the *Balanced* RF output and acknowledge the command by sending:

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

9.1.2 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.

The QSY command involves sending frequency information to the AT-AUTO$_{(tm)}$. The AT-AUTO$_{(tm)}$ 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$_{(tm)}$ to 28.725,168 MHz, the command string would be:

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

Table 9.1: 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 *Automatic* Mode	0x07 0x00
Set *Manual* Mode	0x07 0x01
Set *Bypass* Mode	0x07 0x02
Select Coax	0x08 (0x00 - 0x07)
Select Balanced	0x08 (0x10 - 0x13)
Home L &C	0x0B
Set C (0-397)	0x09 BCD-Lo BCD-Hi
Set L* (0-13,120)	0x0A BCD-Lo BCD-Hi
Fine Tune	0x0C
Select Radio	0x0D (0x00 - 0x07)

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$_{(tm)}$ will respond to a "Read Status" command with the following string:

0xFE, 0xFE, 0x3A, 0xE0, 0x06, 0x05, Output, Mode, Motor, L-Position, C-Position, Status, 0xFD

Definitions of the information returned after a "Read Status" command are contained in Table 9.2.

Table 9.2: AT-AUTO$_{(tm)}$ Response to Read Status Command

Byte	**Value/Bit Definitions**
Output	0x00 - Through to Coax
(Selected Output)	0x10 - Through to Balanced
	0x80 - Bypass to Coax
	0x90 - Bypass to Balanced
Mode	0x00 - *Automatic* Mode
(Active Mode)	0x01 - *Manual* Mode
	0x02 - *Bypass* Mode
Motor	Bit 7 - Set if *C* is commanded to a specific position
(Stepper Motors)	Bit 6 - Set if *C* is turning
	Bit 5 - Always Clear/No Meaning
	Bit 4 - Set if *L* is commanded to a specific position
	Bit 3 - Set if *L* is turning
	Bit 2 - Always Clear/No Meaning
	Bit 1 - Set if *C* movement was/is Clockwise
	Bit 0 - Set if *L* 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 - *Automatic* 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$_{(tm)}$ uses four 10-bit hardware analog-to-digital converters. Two of the A/D converters are used to provide high SWR resolution when operating at low RF input power levels. Likewise the remaining two A/D converters are used 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 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$_{(tm)}$ "Read Power" command returns the conversion results for all four A/D converters in the following format:

0xFE, 0xFE, 0x3A, 0xE0, 0x06, 0x06, Forward-High, Reflected-High, Forward-Low, Reflected-Low, 0xFD

Definitions of the individual bytes returned from a "Read Power" command are contained in Table 9.3.

Table 9.3: AT-AUTO$_{(tm)}$ 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$_{(tm)}$ cross-needle Power/SWR meter is capable of reading peak-envelope-power (PEP) in SSB mode. The Wattmeter is provided as an operator convenience and the AT-AUTO$_{(tm)}$ controller circuitry is completely independent from the Wattmeter circuitry. The Wattmeter also has an operator-selectable dual-range power level switch (300 W or 3000 W). Wattmeter switch settings have no effect on operation of the AT-AUTO$_{(tm)}$.

Reading Peak Power

The **LAMP** button controls both the SWR meter illumination as well as power to the **PEAK** and **PEAK/HOLD** circuitry. It 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 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.

Calibration

The meter was calibrated at the Kessler Engineering factory. However, it may be calibrated with the following procedure:

1. Connect the AT-AUTO$_{(tm)}$ 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$_{(tm)}$ 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$_{(tm)}$ Wattmeter to the 300 W power range.
   (b) Set the AT-AUTO$_{(tm)}$ Wattmeter to read **AVG** power.
   (c) Connect the output of an HF transmitter to the AT-AUTO$_{(tm)}$ RF input.
   (d) Apply an approximate 100 W CW carrier to the AT-AUTO$_{(tm)}$.
   (e) Adjust the **FOR LO** potentiometer (Figure 10.1, page 89) so that the AT-AUTO$_{(tm)}$'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$_{(tm)}$ Wattmeter to read **PEAK** power.
   (b) Apply an approximate 100 W CW carrier to the AT-AUTO$_{(tm)}$.
   (c) Adjust the **PEAK LO** potentiometer (Figure 10.1) so that the AT-AUTO$_{(tm)}$'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$_{(tm)}$ Wattmeter to the 3000 W power range.
   (b) Apply an approximate 500-1000 W CW carrier to the AT-AUTO$_{(tm)}$.
   (c) Adjust the **PEAK HI** potentiometer (Figure 10.1) so that the AT-AUTO$_{(tm)}$'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$_{(tm)}$ Wattmeter to read **AVG** power.

   (b) Apply an approximate 500-1000 W CW carrier to the AT-AUTO$_{(tm)}$.

   (c) Adjust the **FOR HI** potentiometer (Figure 10.1) so that the AT-AUTO$_{(tm)}$'s forward power indication matches that shown on the calibrated Wattmeter.

10. Reverse the AT-AUTO$_{(tm)}$ coaxial input and output (connect transmitter output to AT-AUTO$_{(tm)}$ coaxial output, connect AT-AUTO$_{(tm)}$ 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$_{(tm)}$.

   (b) Adjust the **REV HI** potentiometer (Figure 10.1) so that the AT-AUTO$_{(tm)}$'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$_{(tm)}$ Wattmeter to the 300 W power range.

   (b) Apply an approximate 10-20 W CW carrier to the AT-AUTO$_{(tm)}$.

   (c) Adjust the **REV LO** potentiometer (Figure 10.1) so that the AT-AUTO$_{(tm)}$'s reflected power indication matches the forward power displayed on the calibrated Wattmeter.

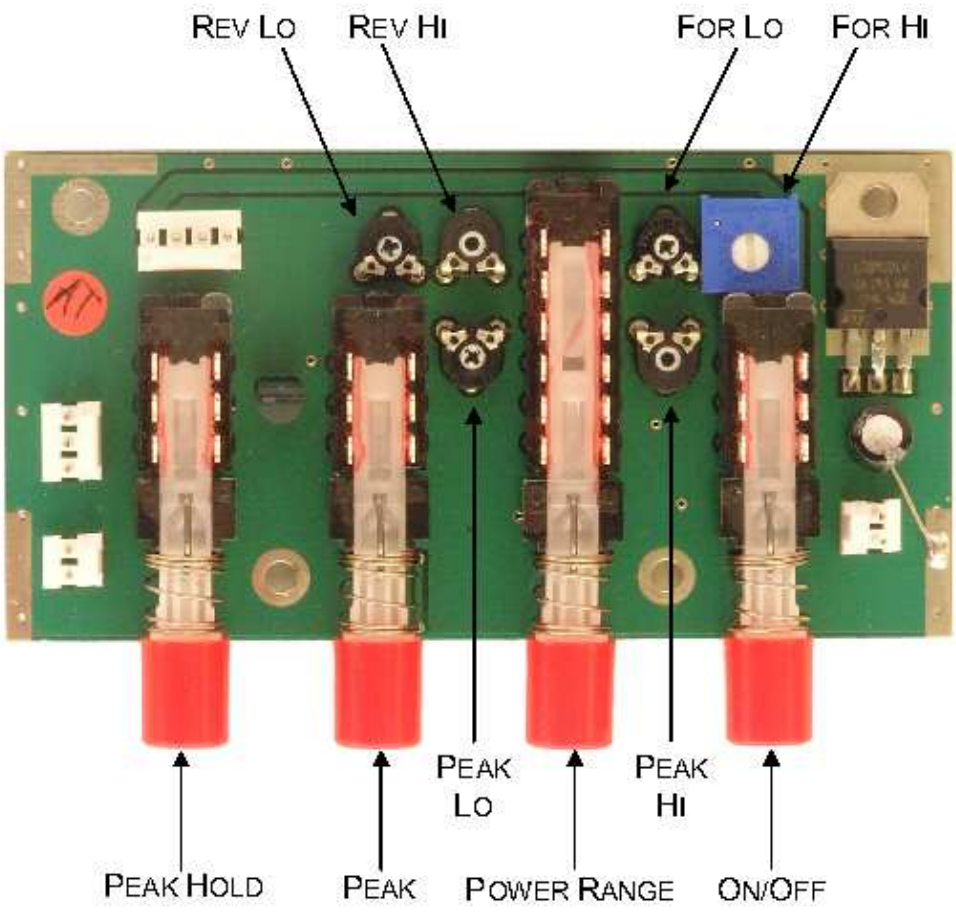


Figure 10.1: Meter Board Adjustment Locations

Operating Tips

11.1 QRO Operation

When using a high-power amplifier with the AT-AUTO$_{(tm)}$, the AT-AUTO$_{(tm)}$ would occasionally 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$_{(tm)}$ has successfully completed the automatic tuning attempt.

11.2 CI-V Passive Listening

When the AT-AUTO$_{(tm)}$ is configured to support Icom CI-V radios and the AT-AUTO$_{(tm)}$ is set to CI-V Transceive *Off*, it will send frequency query commands to the Icom transceiver every second. The Icom transceiver should respond by sending its frequency data back to the AT-AUTO$_{(tm)}$.

Whenever multiple controllers attempt to control (query) the same transceiver, data collisions are much more likely to occur. These data collisions may corrupt the frequency data that was sent over the CI-V bus and could sometimes result in erratic/erroneous AT-AUTO$_{(tm)}$ frequency-following. Although this was an infrequent problem with early generation AT-AUTO$_{(tm)}$ firmware, the AT-AUTO$_{(tm)}$ firmware has since been greatly improved to better detect and ignore data collisions. In the very unlikely event that data collisions are causing erratic AT-AUTO$_{(tm)}$ frequency following errors, you may try the following:

The solution is to ensure that only one device (AT-AUTO$_{(tm)}$ or computer logging software, etc.) is permitted to query the radio for frequency information, while the AT-AUTO$_{(tm)}$, 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$_{(tm)}$ 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$_{(tm)}$ 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$_{(tm)}$ 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$_{(tm)}$'s "CI-V query enable" jumper removed, the AT-AUTO$_{(tm)}$'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$_{(tm)}$ 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$_{(tm)}$, 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.

11.3 CAT Passive Listening

In order for the AT-AUTO$_{(tm)}$ to follow frequency changes in CAT-equipped radios, it must receive frequency data from the radio (normally in direct response to the AT-AUTO's$_{(tm)}$ 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$_{(tm)}$'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$_{(tm)}$. The AT-AUTO$_{(tm)}$ 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$_{(tm)}$ has two user-selectable hardware jumpers. The default jumper settings are appropriate for most AT-AUTO$_{(tm)}$ applications. Some circumstances may require alternate jumper settings. The jumpers are located on the AT-AUTO$_{(tm)}$ controller circuit board and their relative locations are indicated in Figure 12.1 on page 93 . Jumper settings are listed in Table 12.1 on page 94.

Reset Enable

The AT-AUTO$_{(tm)}$ 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$_{(tm)}$ microprocessor requires the ability to reset the AT-AUTO$_{(tm)}$ microprocessor. **Warning:** Remote control programs that routinely assert the RTS line *will* cause damage to the AT-AUTO$_{(tm)}$ if the "Reset-Enable" jumper is in-place. Remove the "Reset-Enable" jumper anytime the RS-232 port is to be used for remote control!

CI-V Tx Enable

In it's default jumper configuration, the AT-AUTO$_{(tm)}$ 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$_{(tm)}$ 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$_{(tm)}$ must actively query the radio, and the CI-V Tx Enable jumper must be Closed.

Jumper Access

Remove DC power from the AT-AUTO$_{(tm)}$. Then remove the screws along the left and right sides of the AT-AUTO$_{(tm)}$ 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.

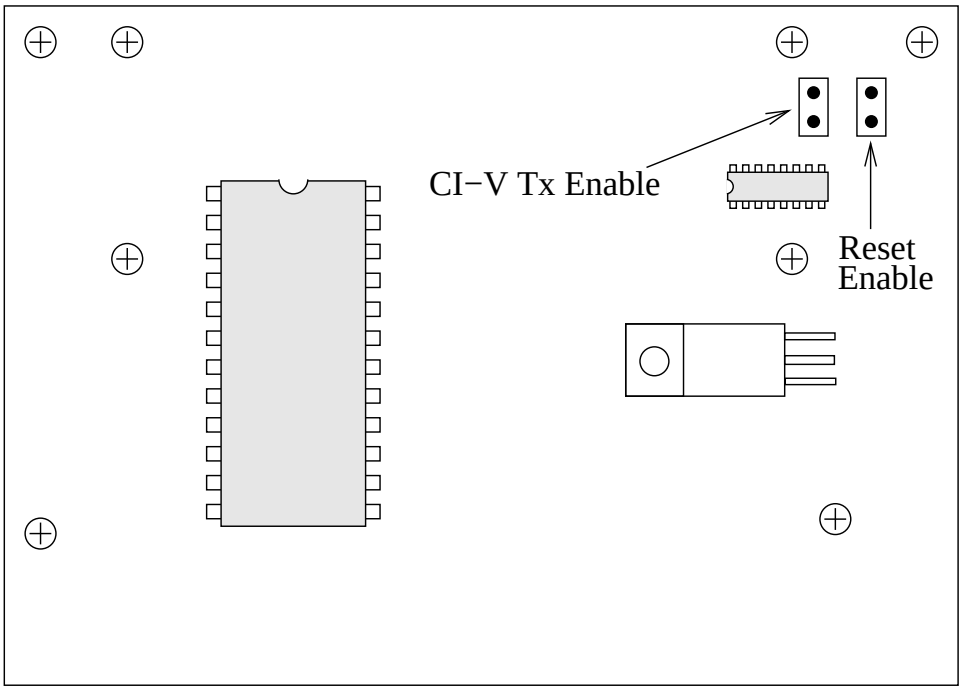


Figure 12.1: Jumper Locations

Table 12.1: 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 QSY with CI-V Transceive OFF	Open	Closed
Smart QSY via CAT*	Closed	Open
Smart QSY 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$_{(tm)}$ to CAT" cable illustrated in Figure 8.1 on page 78.

****Warning:** *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*. Repeated assertion of RTS by PC software may cause permanent damage.

Firmware Revision Summary of Changes

The AT-AUTO$_{(tm)}$ 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. Firmware version 1.10 was the last firmware update prior to version 2.0.

Version 2.0 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. Kessler Engineering, LLC. encourages all AT-AUTO$_{(tm)}$ owners to update their AT-AUTOs$_{(tm)}$ with the latest firmware which as of this writing is version 2.14.

13.1 New Firmware Features / Changes

Version 2.14

AT-AUTO$_{(tm)}$ firmware version 2.14 includes the following feature:

1. Multiple Input Rig Switching. With Version 2.14 Firmware, the user may now add a CX-AUTO$_{(tm)}$, automatic coaxial antenna switch to the "input side" of the AT-AUTO$_{(tm)}$ to enable the operator to quickly select of any 1-of-8 radios to be used with the AT-AUTO$_{(tm)}$. The user simply configures the firmware with the specific radio types to be used then may select the radio to be used via the front-panel "Tune-Select" and "Output" controls.

Version 2.13

AT-AUTO$_{(tm)}$ firmware version 2.13 includes the following features:

1. Yaesu FT-890 Support. The AT-AUTO$_{(tm)}$ is able to follow frequency information provided by the FT-890's serial data port.

2. Restore to Defaults. The user can restore all firmware configuration settings to factory defaults without needing to upload new firmware and without erasing match memory settings.

3. Enhanced "Vintage Rig" opertion. The AT-AUTO$_{(tm)}$ now uses counted RF frequency when operating with 'Vintage Rigs" to enable automatic antenna selection and control the CX-AUTO$_{(tm)}$ 8-output, automatic coaxial antenna switch.

Version 2.12

AT-AUTO$_{(tm)}$ firmware version 2.12 includes the following changes:

1. Output Selection. The default operation of the **Output** button will now cause the AT-AUTO$_{(tm)}$ to toggle between the Coaxial and the Balanced output. Prior to this, the user had to make the actual selection using the **Tune-Select** knob. This change makes switching from Coaxial to Balanced and Balanced to Coaxial outputs more convenient.

2. CX-AUTO$_{(tm)}$ Coaxial output selection. When configured to operate with the CX-AUTO$_{(tm)}$ 8-output, automatic coaxial switch, pressing the **Output** button will provide the user with a prompt to select the desired RF output. Whenever the user rotates the "Tune-Select" knob to a new selection, that selection is immediately sent to the CX-AUTO$_{(tm)}$ and is made active. To exit from the antenna selection, the user must depress the "Tune-Select" knob.

Version 2.11

AT-AUTO$_{(tm)}$ firmware version 2.11 includes the following new features:

1. Split frequency operation. The AT-AUTO$_{(tm)}$ is capable of following frequency information via the radio's CAT/CI-V port and automatically positioning the L and C. However, during split frequency operation it is impractical if the AT-AUTO$_{(tm)}$ repositions L and C whenever switching from the transmit to receive frequency. The firmware is now configurable to enable the AT-AUTO$_{(tm)}$ to ignore serial frequency data for the receive frequency window, while responding to frequency changes in the transmit window.

2. Remote control "Fine Tune" command. "Fine Tune" command re-initiates tuning, but uses the present L and C settings. Commanding "Fine Tune" while in Automatic mode, will cause the established L and C match settings to be stored in non-volatile memory. This feature may also be utilized to store user-derived match settings.

Version 2.10

AT-AUTO$_{(tm)}$ firmware version 2.10 includes these changes:

1. Corrections to the operation of the QRO Keyline:

   (a) The QRO keyline required many SWR samples before the keyline would be re-enabled. Version 2.10 improves the responsiveness of the QRO keyline.

   (b) The QRO keyline would open for frequency changes within a particular band, but would (erroneously) remain enabled when changing from band to band. This problem has been corrected in version 2.10.

2. Changed the Remote Control data returned by the AT-AUTO$_{(tm)}$ during "Read Status" and "Read Power" commands to include the Command and Sub-Command identifiers.

Version 2.08

AT-AUTO$_{(tm)}$ firmware version 2.08 includes the following new features:

1. TenTec Omni VII and Jupiter CAT support. The AT-AUTO$_{(tm)}$ firmware now includes the ability to follow frequency changes in the Onmi VII and Jupiter radios via the radio's CAT port.

2. Control of external Coaxial and Balanced antenna switches. The AT-AUTO$_{(tm)}$ will permit selection of any one of eight Coaxial outputs as well any one of four Balanced antenna outputs. The external Coaxial switch and external Balanced switch are recent AT-AUTO$_{(tm)}$ accessories. Contact Kessler Engineering for pricing and availability.

Version 2.07

AT-AUTO$_{(tm)}$ firmware version 2.07 includes the following new features:

1. Yaesu FT-920 support. The AT-AUTO$_{(tm)}$ firmware now includes the ability to follow frequency changes in the FT-920 via the radio's CAT port.

2. Revised tuning algorithm. The AT-AUTO$_{(tm)}$ firmware includes a minor change in the automatic tuning algorithm which improves the likelihood of finding a successful match as well as reduce the time needed to find the match.

3. QRO keyline control. The AT-AUTO$_{(tm)}$ firmware now includes provision to enable/disable the keying of an external HF RF power amplifier based upon user-selectable SWR levels. The AT-AUTO$_{(tm)KL}$ includes additional hardware necessary to implement QRO keyline control. Additionally, the external amplifier can be prevented from being keyed while the AT-AUTO$_{(tm)KL}$ is tuning (*Automatic* or *Manual* mode). Retrofitting this capability to existing AT-AUTO$_{(tm)}$s is possible but requires hardware replacement/modification by Kessler Engineering. Contact Kessler Engineering for pricing and availability.

Version 2.05

AT-AUTO$_{(tm)}$ firmware version 2.05 includes the following new feature:

1. Kenwood and Yaesu serial data header decoding. This improves the operation of the AT-AUTO$_{(tm)}$ when used with a "Y" cable configuration when controlling the radio with a computer. This only works with Yaesu radios that provide headers that identify the type of information contained in the serial data string. The Yaesu FT-1000, for example, does not provide this information and thus "Y" cable operation with the FT-1000 is still problematic.

Version 2.04

AT-AUTO$_{(tm)}$ firmware version 2.04 includes the following new features:

1. Continuous display of the selected RF output (balanced/coax) while in *Automatic* mode.

2. Elimination of the ability of the user to rotate the roller inductor past the '000' position, thereby removing the likelihood that the roller inductor will be driven past the '000' position and strike the physical stop.

Version 2.01

AT-AUTO$_{(tm)}$ 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$_{(tm)}$ will home L and C, and then preset C to 250.

2. L and C synchronization tracking - If the user switched the AT-AUTO$_{(tm)}$ *Off* before L or C position information was successfully written to non-volatile memory, then the

AT-AUTO$_{(tm)}$ will automatically home *L* and *C* when the AT-AUTO$_{(tm)}$ is next turned *On*. After completion of the homing operation, *C* will automatically be repositioned to 250.

Version 2.00

AT-AUTO$_{(tm)}$ 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$_{(tm)}$ enters upon initial power-up. User may opt to have the AT-AUTO$_{(tm)}$ always startup in either the *Automatic*, *Manual*, *Bypass*, or the mode last in-use when the AT-AUTO$_{(tm)}$ 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$_{(tm)}$ may be configured to automatically bypass the tuner while the AT-AUTO$_{(tm)}$ is changing bands. When enabled, if QSYing from one band to another (40m to 160m for example), the AT-AUTO$_{(tm)}$ 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$_{(tm)}$ 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$_{(tm)}$ to follow only CI-V transceive frequency data from a specific radio (based

upon the radio's CI-V address). Furthermore, the AT-AUTO$_{(tm)}$ can be configured to completely ignore CI-V transceive data and to poll a specific Icom radio.

8. Remote Control Operation - The AT-AUTO$_{(tm)}$ may be remotely controlled via the Icom CI-V bus. The AT-AUTO$_{(tm)}$ 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$_{(tm)}$.

   (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$_{(tm)}$'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$_{(tm)}$ autonomously initiates tuning. The user may now configure the AT-AUTO$_{(tm)}$ for "Non-Autonomous" tuning initiation. When so configured, the AT-AUTO$_{(tm)}$ 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$_{(tm)}$ 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 *A*utomatic mode, the AT-AUTO$_{(tm)}$ 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$_{(tm)}$ 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$_{(tm)}$'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).

13.2 Bug Corrections

Version 2.11

AT-AUTO$_{(tm)}$ firmware version 2.11 includes these changes/corrections:

1. QRO keyline Relay chatter: During *B*ypass mode operation, while adjusting the *L* or *C*, the QRO Keyline would momentarily open and close at a very high rate. This is now corrected.

2. QRO keyline erratic operation: During *M*anual mode, with the QRO keyline configured to be permanently enabled ("QRO keyline Enable – Yes"), the keyline would open whenever high SWR was encountered. This problem is now fixed

3. When remotely controlling the AT-AUTO$_{(tm)}$, the LCD did not always display correct information. The LCD operation during remote control operation has been corrected.

Version 2.09

AT-AUTO$_{(tm)}$ firmware version 2.09 includes these changes/corrections:

1. QRO keyline was sometimes unpredictable when in automatic mode, if the firmware was configured with QRO Enable == Yes, and QRO While Tuning == No. Version 2.09 corrected this.

2. .When configured to automatically bypass a specific band, if several band changes were made in rapid succession, automatic band bypassing was sometimes erratic and unpredictable. This problem has been corrected in version 2.09.

Version 2.07

AT-AUTO$_{(tm)}$ firmware version 2.07 includes this change/correction:

1. A bug was found that affected the initial recall of match settings when switching the RF outputs. This problem only manifested when the AT-AUTO$_{(tm)}$ had received frequency information via the CAT/CI-V interface and had subsequently recalled and set the *L* and *C* to the appropriate match settings for the selected output (the coax

output for example). If the user then switched the AT-AUTO$_{(tm)}$ to balanced output for example, the AT-AUTO$_{(tm)}$ would not recall and reposition L or C for the balanced output unless either the frequency was subsequently changed or unless an RF carrier was produced and the AT-AUTO$_{(tm)}$ subsequently detected a mismatch. This bug has been corrected. Now whenever the RF output is changed, the AT-AUTO$_{(tm)}$ will immediately reposition L and C for the active RF output.

Version 2.06

AT-AUTO$_{(tm)}$ firmware version 2.06 includes this change/correction:

1. A bug was found that occasionally affected storage of match settings after "fine tune" had been commanded. Under some very specific circumstances the revised match setting was either not updated in memory, or else an incorrect setting was occasionally stored. The "fine tune" bug affected all previous firmware versions. Version 2.05 contains this bug fix but no other changes.

Version 2.03

AT-AUTO$_{(tm)}$ 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.

Version 2.02

AT-AUTO$_{(tm)}$ 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$_{(tm)}$ 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.

Version 2.01

AT-AUTO$_{(tm)}$ 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 9.1).

2. CI-V bus collision detection - In earlier firmware releases, the AT-AUTO$_{(tm)}$ 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$_{(tm)}$ remote-control command execution.

Version 2.00

The following is a partial summary of bugs found in previous firmware versions (in no particular order of significance) and corrected with AT-AUTO$_{(tm)}$ 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$_{(tm)}$ 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$_{(tm)}$ would detect reflected power prior to detection of forward power, causing AT-AUTO$_{(tm)}$ to interpret this as excessive SWR and initiate retuning.

7. Failure to recognize excessive SWR - Under some circumstances with very excessive SWR, AT-AUTO$_{(tm)}$ 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$_{(tm)}$ 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$_{(tm)}$ to step past good match points. Occasionally the AT-AUTO$_{(tm)}$ 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.

Software License Agreement

The AT-AUTO$_{(tm)}$ firmware and all derivatives are copyright, Kessler Engineering, LLC. The User is permitted to use the AT-AUTO$_{(tm)}$ firmware as part of normal AT-AUTO$_{(tm)}$ operation, but is strictly prohibited from extracting, decompiling, or otherwise accessing, or utilizing any portion of this Copyrighted work. To do so will be deemed intentional infringement of Copyright. Kessler Engineering, LLC takes such Copyright infringement seriously and shall take whatever steps necessary to protect its intellectual property.

By powering on the AT-AUTO$_{(tm)}$ and or uploading firmware to the AT-AUTO$_{(tm)}$ via the Kessler Engineering website *www.KesslerEngineeringLLC.com*, you acknowledge and agree to honor Kessler Engineering, LLC's Copyright.

Service and Warranty

Warranty

Kessler Engineering, LLC. warrants all of our products to be free from defects in material and workmanship under normal use for a period of one year from the date of purchase. During this one-year warranty period, Kessler Engineering will either repair or replace the product at it's option at the Kessler Engineering facility in Beavercreek, Ohio.

This warranty will be void if the product has been repaired or altered by anyone other than the staff at Kessler Engineering. This warranty does not apply to products damaged due to improper installation or abuse/misuse.

Repair Policy

Please contact our service department for return authorization and shipping instructions prior to sending any product for service or repair. All items shipped to Kessler Engineering, must be packed appropriately and insured against damage. Kessler Engineering is not responsible for merchandise damaged in shipment. Be sure to include a note describing the problem in detail and include your contact information (phone number and e-mail).

Return Policy

All returns must receive prior authorization. Returned items must also include a copy of the original sales receipt and be returned with the original box, manuals, and accessories. Returns must be received within 7 days of purchase and are subject to a restocking fee. Shipping expenses are not refundable.

Frequently Asked Questions

16.1 Serial Port Related Questions

Why is there a serial port on the AT-AUTO$_{(tm)}$?

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

Answer: Remote control operation has been included since Version 2.0 (and subsequent) firmware versions. See "Remote Control" section on page 81 for details.

Will the AT-AUTO$_{(tm)}$ work with my Collins KWM1 and others without a computer interface?

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

Why does the AT-AUTO$_{(tm)}$ have an RS-232 port instead of a USB port?

Answer: The AT-AUTO$_{(tm)}$ 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$_{(tm)}$ 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$_{(tm)}$ 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$_{(tm)}$. Depending upon the radio, this data stream may be less than 20-bytes. Clearly the expense and complexity of USB is unwarranted.

16.2 Memory-Related Questions

How can I clear the AT-AUTO$_{(tm)}$ memories?

Our local club was conducting an emergency communications drill. I brought my AT-AUTO$_{(tm)}$ to the simulated emergency location and want to use the clubs G5RV antenna but a lot of the memories contain match settings for my 160m dipole at home.

Answer: The AT-AUTO$_{(tm)}$ 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 "Tune-Select" rotary knob.

What happens when I select "Erase Match Mem?" How do the memories work?

Answer: Selecting "Erase Match Mem?" erases all of the users match settings that were stored in the AT-AUTO's$_{(tm)}$ 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$_{(tm)}$ 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.

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.

How do I control which memory is recalled and used?

Answer: You really can't - The AT-AUTO$_{(tm)}$ manages all of the memories automatically

based upon operating frequency and which output is selected.

16.3 Radio-Interfacing Questions

Why doesn't the AT-AUTO$_{(tm)}$ work in *Smart QSY* and *External Tuner Handshake* modes with other radios?

Answer: We designed the AT-AUTO$_{(tm)}$ to interface with ALL radios that incorporated a CAT/CI-V interface and or included an external tuner interface. Version 2.0 firmware provided Icom, Kenwood, and limited Yaesu support. Support for other radios continues to be expanded and included in newer firmware versions.

The AT-AUTO$_{(tm)}$ 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. However, we now also support an increasing variety of radios, including Elecraft, Flex, newer Kenwood, several TenTec, and many Yaesu radios, etc.

Will the AT-AUTO$_{(tm)}$ automatically follow frequency changes in the IC-735?

Q: I want to use my Icom IC-735 with the AT-AUTO$_{(tm)}$. 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$_{(tm)}$ 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$_{(tm)}$ 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$_{(tm)}$ automatically follow IC-735 QSY operations the AT-AUTO$_{(tm)}$ must be configured for 1200 baud, and should be setup for Icom "CI-V Only" operation. See the "Configuration" section on page 57 for details.

How can I make the AT-AUTO$_{(tm)}$ 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$_{(tm)}$ working perfectly with one of the PROIII radios. However, the AT-AUTO$_{(tm)}$ 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$_{(tm)}$ which is actually connected to a PROIII, changes to the frequency of the IC-7800.

Answer: What you are describing is selective CI-V addressing by the AT-AUTO$_{(tm)}$ and has been included in the AT-AUTO$_{(tm)}$ firmware since Version 2.0. Please see the "Icom CI-V Configuration" section on page 57 for specific instructions.

Why doesn't "Fine Tune" work with my Collins S-Line?

The AT-AUTO$_{(tm)}$ was working just fine with my IC-7000, but there is a problem with the "Fine Tune" feature when I use the AT-AUTO$_{(tm)}$ 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$_{(tm)}$ complaining about a no-power abort. Is this a problem with the AT-AUTO$_{(tm)}$?

Answer: When using the AT-AUTO$_{(tm)}$ with any radio that lacks CAT/CI-V capability, the AT-AUTO$_{(tm)}$ should be configured for "Vintage Rig" via the configuration menu. Please reconfigure the AT-AUTO$_{(tm)}$ for "Vintage Rig" and this will solve this problem.

16.4 General Usage Questions

How should I setup the Peak-Hold metering for the AT-AUTO$_{(tm)}$ to work automatically?

Answer: The AT-AUTO$_{(tm)}$ control circuitry does not use any of the Peak-Hold metering. All circuitry used by the AT-AUTO$_{(tm)}$ 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$_{(tm)}$ during the process of automatic tuning.

How does the AT-AUTO$_{(tm)}$ 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$_{(tm)}$ 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.

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

Answer: The AT-AUTO$_{(tm)}$ 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$_{(tm)}$ firmware.

Why does the AT-AUTO$_{(tm)}$ take up to 30 seconds to tune?

Answer: The actual tune time of the AT-AUTO$_{(tm)}$ 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$_{(tm)}$ 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 QSY* mode, the AT-AUTO$_{(tm)}$ automatically recalls its matched settings from non-volatile memory and subsequent tuning is likely not necessary.

Why does the AT-AUTO$_{(tm)}$ retune at high power when it found a match at low power?

After I QSY if the SWR is bad, the AT-AUTO$_{(tm)}$ 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$_{(tm)}$ 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$_{(tm)}$ 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$_{(tm)}$. This is most often manifested when the AT-AUTO$_{(tm)}$ 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) ($\approx$ 15 W) while others less ($\approx$ 6-7W) (problematic).

The tuner sometimes retunes after autotuning using the radio's TUNER button. Why?

My AT-AUTO$_{(tm)}$ 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$_{(tm)}$ 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$_{(tm)}$?

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.

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$_{(tm)}$ 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$_{(tm)}$ 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$_{(tm)}$ provides the user with an 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 $\frac{1}{2}$ 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$_{(tm)}$ 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$_{(tm)}$ 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 16.1: The "matched loss" is the expected power loss due to the resistive and dielectric

Table 16.1: 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 feed-

line 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 50 Ω 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 50 Ω 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 50 Ω load will dissipate as heat approximately 24% of the transmitter power.

Table 16.2: 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$_{(tm)}$ 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 16.3 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 16.3: 100' Feedline Match Loss for various SWR

Feeder	SWR at Ant	SWR at AT-AUTO$_{(tm)}$	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$_{(tm)}$ 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$_{(tm)}$ 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$_{(tm)}$ is. The AT-AUTO$_{(tm)}$ 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$_{(tm)}$ 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$_{(tm)}$ 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$_{(tm)}$.

16.5 Firmware-Specific Questions

Does the latest version of the firmware only work with the AT-AUTOs$_{(tm)}$ that have the QRO Keyline hardware?

Someone posted a message on one of the user reflectors saying that earlier versions of the AT-AUTO$_{(tm)}$ are not upgradeable. Is this true?

Answer: No. By design, *ALL* versions of AT-AUTO$_{(tm)}$ firmware work with *ALL* versions of the AT-AUTO$_{(tm)}$. All AT-AUTOs$_{(tm)}$ are indeed firmware upgradeable by the user, free of charge. Firmware version 2.07 (and subsequent) include an ability to control some ***optional*** hardware to disable/enable keying of an external HF power amplifier. This and all subsequent firmware versions remain fully compatible with every hardware version of the AT-AUTO$_{(tm)}$. If your AT-AUTO$_{(tm)}$ does not include the ***optional*** QRO Keyline hardware, you should merely leave QRO Keyline disabled in the firmware.

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$_{(tm)}$. I would like to add some of my own refinements to the AT-AUTO$_{(tm)}$. Where can I get a copy of the source code?

Answer: The license agreement you accepted when you purchased the AT-AUTO$_{(tm)}$ prevents you from accessing, revising, reverse-engineering, sharing, etc., the AT-AUTO$_{(tm)}$ firmware. The Copyrighted AT-AUTO$_{(tm)}$ firmware is wholly-owned intellectual property of Kessler Engineering, LLC. It represents a significant investment and we must protect it accordingly. Our legal department has taken legal action in the past to protect it and will do so again when necessary. You should realize that considerable time and expense has gone into its development. 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 coping or otherwise reverse-engineering our firmware. We therefore regret that we are unable to divulge any of the firmware specifics.

Why should I update to the newer AT-AUTO$_{(tm)}$ firmware?

Answer: You might not need to, but you will probably want to. When I started design on the AT-AUTO$_{(tm)}$, I intended that the firmware would an "evolutionary" process. I am attempting to provide a high-quality, effective, QRO, automatic antenna tuner. I knew from the onset that while I had invested considerable time into the development of our firmware, there would likely be improvements and enhanced features that I would want to make available to customers. Additionally, if problems were later discovered and as

improved algorithms are designed, I wanted the customer to be able to take advantage of these improvements at no additional cost.

This is the reason I included the ability to upload the firmware to the AT-AUTO$_{(tm)}$. The design of the AT-AUTO$_{(tm)}$ permits continual improvement to the AT-AUTO$_{(tm)}$ operation by adding new firmware features. The AT-AUTO$_{(tm)}$ is an evolutionary product with sufficient firmware flexibility to permit continued product improvement. Furthermore, since introducing the AT-AUTO$_{(tm)}$, users have requested several features that I simply did not anticipate, but was very happy that to meet those requests through improvements in the firmware. If building a QRO, fully-automatic tuner were simple, others would have done so already.