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Palstar products are designed by Hams for Hams carrying on the Palstar tradition for high-quality products designed and manufactured in Ohio, USA.

HF-AUTO Automatic Antenna Tuner

Specifications Summary

- **2 watts to 1800 watts PEP**
- **160 m to 6m**
- **Tuning time 10 secs or less**
- **Large 4 line display**
- **12.5" x 6.5" x 16.5"**

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HF-AUTO RF NETWORK Technical Manual

Designed and Manufactured in the USA
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HF-AUTO SPECIFICATIONS

- **NETWORK CONFIGURATION:** High-Pass network, shunt variable 16 µH inductor, series fixed 10 µH inductor
- **DIFFERENTIAL CAPACITOR:** 470 pF - 10 pF - 470 pF; Voltage rating 5.5 kV
- **L AND C:** Stepper motor-controlled
- **FREQUENCY RANGE:** 1.8 MHZ to 54 MHZ
- **MATCHING RANGE:** 8:1
- **POWER RANGE:** 1800 watts PEP/CW 1.8-29.9 MHZ; 800 watts PEP 50-54 MHZ
- **TUNING LEVEL:** Minimum level 2 watts, single tone carrier up to 200 watts
- **TUNING ACESS TIME:** Typically <10 secs 80m to 6m; 3-5 secs 80m to 160m
- **DUTY CYCLE:** 100% SSB AND CW
- **DIGITAL DISPLAY:** RF Power, SWR, Frequency, Antenna selection, Position of L and C; Modes: Auto, Manual, Bypass, Setup
- **OUTPUT:** 3 Output connectors S0-239
- **CHASSIS & COVER:** 11 ga. .090 gold Iridite Treated Aluminium, Powder-coated top cover and front panel
- **DC POWER:** 12 - 13.8 VDC at 4 Amps Peak, 3 Pin Amphenol Type connector cord supplied
- **DIMINSIONS:** 12.5" W x 6.75" H x 14" D
- **WEIGHT:** 20 LBS, 9 Kg

THEORY OF OPERATION

The HF-AUTO is a matching system that is a complete stand-alone RF Tuneable Auto T Network tuner.

It is completely independent of data from an external source to determine frequency of tracking from Band to Band. As a result of this feature, the HF-AUTO will function with any transmitting device without interconnecting data cable attachments.

The HF-AUTO uses an RF Coupler that provides voltage and current information from 1.8 MHZ to 54 MHZ.

This informtion is then processed by a pair of processing devices that provide accurate phase oriented forward and reflected values that are used in two TI processors to calculate SWR.

This allows for detection of frequency and SWR at very low levels, typically 2 watts, and is scaled to read these levels up to 1800 watts.

The processors establish the threshold for tuning and uses this information to see if a tuning sequence is required.

A preset voltage for all the frequencies are used to determine the positions of the variable differential capacitor and the roller inductor by a precise mechanical sprocket and kevlar belt system.

This determines with great accuracy and repeatability the exact location of L&C needed to execute a tune sequence. This system samples DC voltage and compares this to the intended frequency band and sees that if the SWR is more than the preset tuning set by the user then the steppers for L & C will adjust to that voltage which will represent the mimimum SWR.

This will be better than 1.2:1, typically 1.05.

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SCREEN DISPLAY ON POWER-UP

ON INITIAL POWER-UP

Display will indicate rev level of software and Palstar copyright information.

```
AUTO     Ant#1 F=
    C=126   L= 370
              Ppk=      0
              SWR=1.00
```

TUNE - SELECT
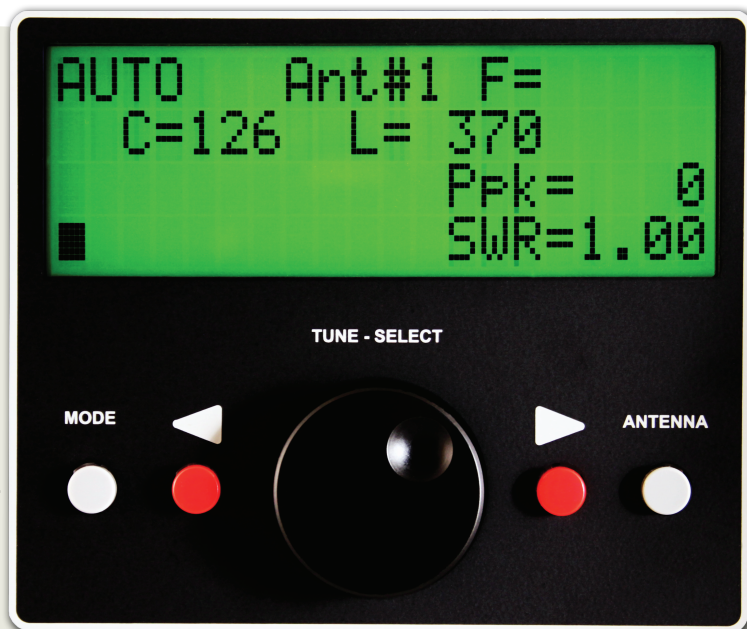
MODE   **ANTENNA**

PRESS **MODE**
- AUTO
- MANUAL
- BYPASS
- SETUP

PRESS **TUNE KNOB**
- TO SELECT C AND L
- TO SELECT SETUP ITEM

PRESS **ANTENNA**
- ANT #1
- ANT #2
- ANT #3

SETUP MODE

PRESS **TUNE KNOB** to SELECT MENU

◁ PRESS **RED BUTTONS** to ADJUST VALUES ▷

PRESS & ADJUST with **TUNE KNOB**

RANGE (WATTS):	**100** | 250 | 1000 | 2500		
TUNE LEVEL:			1.50
BACKLIGHT:	1 – DIM | **2 - BRIGHT**		
POWER UP MODE:	**AUTO** | MANUAL | BYPASS		
STEP SPEED:	**HIGH** | MED | LOW		
AUTO ANT SW:	ON | **OFF**		
RETUNE DELAY:	ADJ **1**-3 SECS		
POWER UP ANT:	ANT **1** | 2 | 3		
AUTO STORE:	**ON** | OFF		
DELAY TUNE SWR:	**ON** | OFF		
LAST SWR DISP:	**ON** | OFF		
LAST POWER DISP:	**ON** | OFF		
MARS MIN-MAX MARS FREQ ADJ	FOR LICENSED USERS ONLY		

*Recommended settings in bold.

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```
AUTO    Ant#1 F=
     C=126  L= 370
              Ppk=      0
              SWR=1.00
```

MODE   TUNE - SELECT   ANTENNA

REAR PANEL OF HF-AUTO

TRANSCEIVER

14.200

OUTPUT

**FIRMWARE UPDATE/
PROGRAM SWITCH**
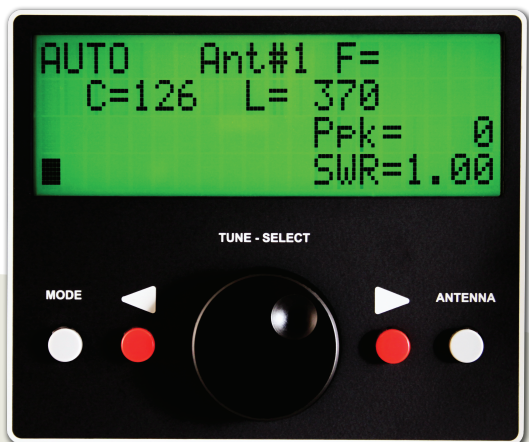
ANTENNA OUTPUTS

PLACE TUNER IN AUTO MODE WITH GREY MODE BUTTON

1. CONNECT the transceiver to the RF INPUT chassis connector at the rear of the back panel
2. CONNECT a dummy load to one of the coax outputs or your desired antenna
3. APPLY a single tone level greater than 5 watts (use FM MODE) typically 5 to 50 watts
4. DISPLAY will indicate Frequency, Power Level, SWR, and Numerical value for C and L

NOTE: To execute a tune sequence at another band or frequency lower the power of the transceiver or any other transmitting device to low power and change frequency and the tuner will immediately follow to the new location. You can also click the PTT button on your microphone in FM MODE and accomplish the same at the lowest power level

TUNING THE HF-AUTO

Applying only a short burst of single tone power to the HF-AUTO will allow the tuner to pretune to a memory segment containing the desired frequency. **ANOTHER** application of RF Power must be applied to complete the final tune condition where high power may be applied. You can also apply single tone power continuously until the final tune cycle has completed and get the same result. Trying to tune at high power without executing the final tune condition could damage the tuner.

RS-232

**CHASSIS GROUND
WING-NUT**

**DC INPUT
12 - 13.8 VDC
@ 4 AMPS**

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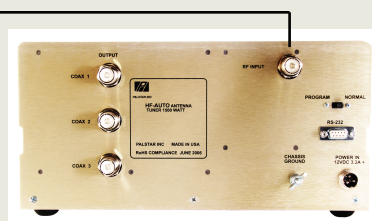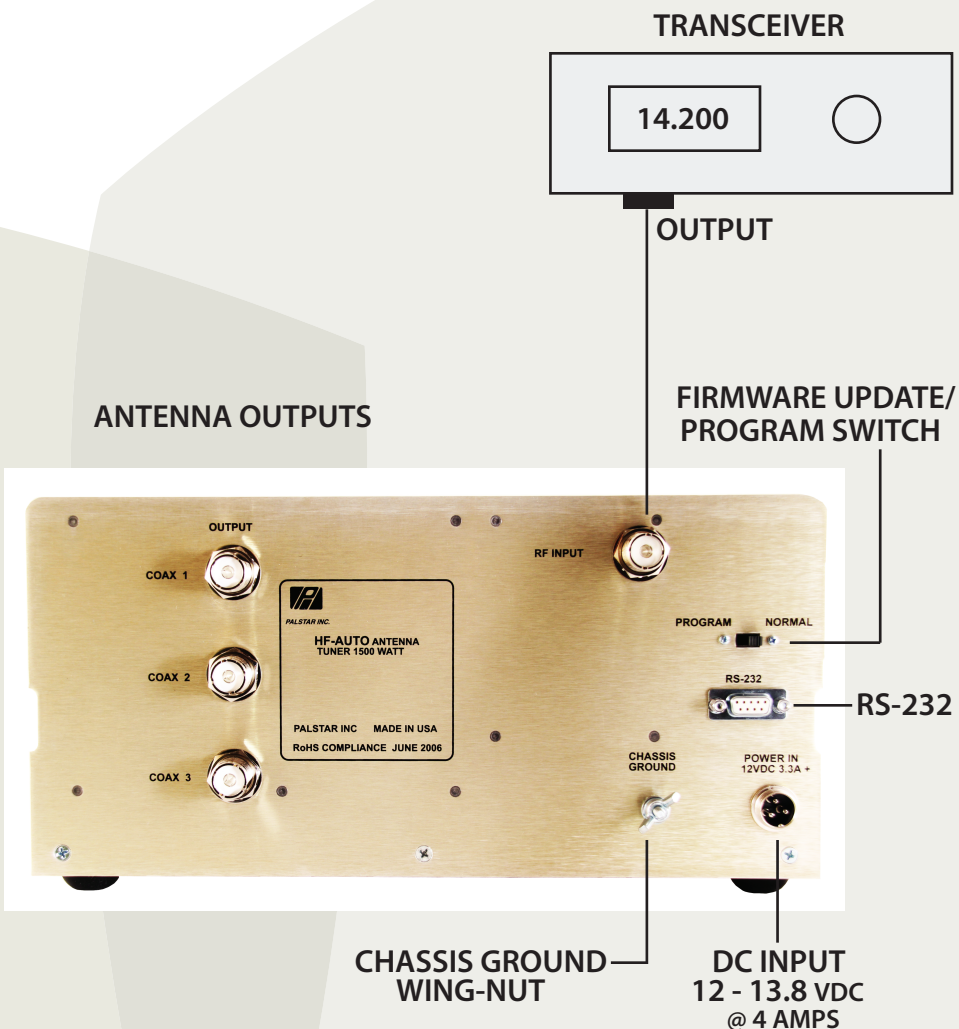
TUNING INSTRUCTIONS

The HF-AUTO is an automatic tuner for matching a transmitter to a nonresonant antenna. It was designed to fill the role of a differential tuner using an air variable capacitor and roller inductor both driven by stepper motors. It stores the C and L settings for memorized frequencies and memorizing can be automatic or manual.

Automatic tuning and memorizing:

Turn ON **Auto Store** in the Set-Up menu. Apply RF (2-200 watts) and allow the tuner to make the match. Once the lowest SWR achievable is found and that value is below the Tuning Level (usually 1.50) those settings are automatically memorized.

NOTE: When in AUTO mode, and RF is applied with a frequency that has been previously memorized, once the settings are achieved if the SWR is below that set in Tuning Level (Set-Up), the tuner will not initiate a tuning cycle. If the SWR is above that defined in Tuning Level, the tuner will retune for a better match.

If **Auto Store** is OFF the tuner will automatically tune to the lowest achievable SWR but will not memorize the settings. At this point one can memorize the settings as described in Manual Memorizing below.

Manual Tuning and Memorizing:

To put the tuner in **Manual mode** push the tuning knob to select the roller inductor (L). Rotate the tuning knob while watching the SWR reading for a dip. Then push the tuning knob again to select the differential capacitor (C) and rotate it to obtain a deeper SWR dip. Continue the process back and forth until a SWR value is achieved that suits your needs. Exact match usually can be found, but takes longer to set.

A quicker option is to put the tuner in **Auto mode** and let it find the match. Then put it in **Manual mode** and use the manual process to improve the SWR reading.

NOTE: When in **Manual mode**, the Left Arrow button will switch directly back to **Auto mode**.

Manually memorizing: once the SWR value for the frequency selected is achieved, with the tuner in **Manual** mode continue to apply RF (20-40 watts recommended) then hold the **Right Red Arrow** button until Settings Changed appears on the display. Now the settings have been memorized. Relsease the button and stop applying RF to the tuner.

NOTE: When in **Manual mode**, the **Left Arrow** button will switch directly back to **Auto mode**.

Antenna Selection: With Auto Antenna *Switch ON*, the antenna port (1-3) is selected based upon the amateur band for each antenna port that was defined in Set-Up. New in 1.29. With Auto Antenna *Switch OFF*, the port selection is manual using the gray Antenna button.

Bypass mode bypasses the matching network. Some users have the tuner in Bypass allowing them to use their radio's internal antenna tuner. *Caution is needed in this last case if an amplifier is in the circuit and turned off or in bypass. The standing waves (SWR) will potentially have high voltage nodes that can cause damage to the bypass components in the amplifier.*

Note: The SWR and Power Output display will not be accurate in this mode.

The **Auto Antenna Switch**, if ON, works in Bypass mode.

SET-UP MODE

The following provides a description of each menu item found in the Set-Up menu screens of a tuner with release 1.29 installed. Select SETUP using the MODE button.

Operation: push the tuning knob to step through the menu items. When a menu item is selected use either the **left** or **right** arrow buttons to select option. In the case of defining a digital value, rotate the tuning knob to make selections.

RANGE: 100/250/1000/2500

This sets the bar graph full scale display range for the RF output bar graph in the main display.

TUNING LEVEL: In **Auto mode**, if the SWR is above this level the tuner will retune for the lowest possible SWR. Palstar recommends 1.50.

Other settings for Tuning Level are **Retune Delay** and **Delay Tune SWR**.

BACKLIGHT: 1/2

Display window backlight setting #1 is dim, and #2 is bright.

PWR UP MODE: Auto/Manual/Bypass

This sets the mode the tuner will be in when it is turned on.

STEP SPEED: High/Med/Low

Determines the speed the stepper motors will operate at when searching for a match or memorized set of C & L settings. Palstar recommends HIGH.

AUTO STORE: ON/OFF

● When ON the unit will store new L & C settings after a good SWR value has been found; (AUTO MODE).
● When OFF the unit will not automatically store new L & C settings.
● The manual storing of the L & C position settings can still be done independent of this selection.
● Has no default - should be checked after updating the unit's software.

DELAY TUNE SWR: ON/OFF

The OFF setting causes the tuner to operate the same as it did before version 1.23.

● When OFF the SWR will be checked prior to moving the L & C positions. This can reduce the movement of the stepper motors when accessing two frequencies that are close.
● When ON the L & C positions will be recalled and set prior to checking the SWR to see if it exceeds the TUNING LEVEL. This will allow the unit to position to the last saved position for that frequency, thus, possibly obtaining a slightly better SWR value.

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SET-UP MODE

AUTO ANT SWITCH: On/Off

Turns ON or OFF the automatic selection of the antenna port as defined by the frequency of settings in the ANT menu.

NOTE: Pressing the grey **ANTENNA BUTTON FOR 2 SECONDS** or more will toggle the Auto Ant Switch OFF or ON, switch to Bypass and select antenna port #3. With the Auto Ant Switch OFF, the tuner will stay connected to port #3 regardless of the frequency. Handy if a dummy load is attached to port #3. Pressing the button again for 2 or more seconds will toggle the Auto Antenna Switch, put the tuner back in Auto mode and selects Antenna port #1.

BAND SELECTION: 160M/80M/40M/30M/20M/17M/15M/12M/10M/6M

This menu item is used to define the amateur band for each antenna port.

RETUNE DELAY: 1/2/3 seconds

Once the tuner has set the C and L from memorized settings for the applied RF frequency, the delay determines the period before checking the SWR again after high power is applied to see if retuning is needed.

Whether or not the new settings will be memorized depends upon whether **Auto Store** is ON or OFF.

POWER UP ANT: 1/2/3

This determines which antenna port will be connected when the tuner is turned on.

● Has no default - should be checked after updating the unit's software.

With FW Rel 1.25 a tuning error for L was fixed and the AMP menu items were deleted disabling the RCA amplifier phono jacks. Later production units do not have the two RCA phono jacks.

LAST SWR DISP: ON/OFF

If ON the last SWR value is left on the display screen.

LAST POWER DISP: ON/OFF

If ON th last Peak Power value is left on the display screen.

Acknowledgements: Thanks to **Bob Lanning W6OPO**, HF-AUTO owner, for the detailed instructions he created based on using the tuner and discussing with Paul Hrivnak CEO of Palstar about how to setup and use the tuner. These detailed notes are based on his summary of instructions, which was placed into the public domain.

SAVING MEMORY LOCATIONS

- TUNE the HF-AUTO using a low power FM or CW signal
- **MANUALLY** tune L&C for best SWR while power applied
- While power is still applied push red button to the right of the tuning knob and hold for 2 seconds or more until the display says **"SETTINGS CHANGED"**
- Remove power and release the red button
- The frequency is now saved
- To return to **AUTO MODE** push left red button

DIVISIONS IN THE FREQUENCY BANDS FOR SETTINGS

FREQUENCY IN MHZ	# OF SETTINGS	SPACED
1.8 MHZ to 20 MHZ	51	4 Khz
3.5 MHZ to 4.0 MHZ	51	10 Khz
7.0 MHZ to 7.3 MHZ	36	50 Khz
10.1 MHZ to 10.150 MHZ	2	50 Khz
14.0 MHZ to 14.350 MHZ	18	40 Khz
18.068 MHZ to 18.168 MHZ	3	50 Khz
21.0 MHZ to 21.450 MHZ	5	100 Khz
24.890 MHZ to 24.990 MHZ	1	500 Khz
28.0 MHZ to 29.70 MHZ	51	500 Khz
50.0 MHZ to 54.0 MHZ	101	40 Khz
MARS FREQUENCY	707	4 Khz to 500 Khz

FOR ALL TUNEABLE FREQUENCIES FROM 1.8 - 30 MHZ, 40 MHZ THROUGH 41 MHZ AND 50 MHZ TO 54 MHZ THERE ARE 1193 SUBDIVISIONS OR MEMORY POSITIONS.

INSIDE COMPONENTS

ROLLER INDUCTOR

PULLEY/BELT SYSTEM

VARIABLE CAPACITOR

STEPPER MOTOR SUPPORT SUB-PANEL
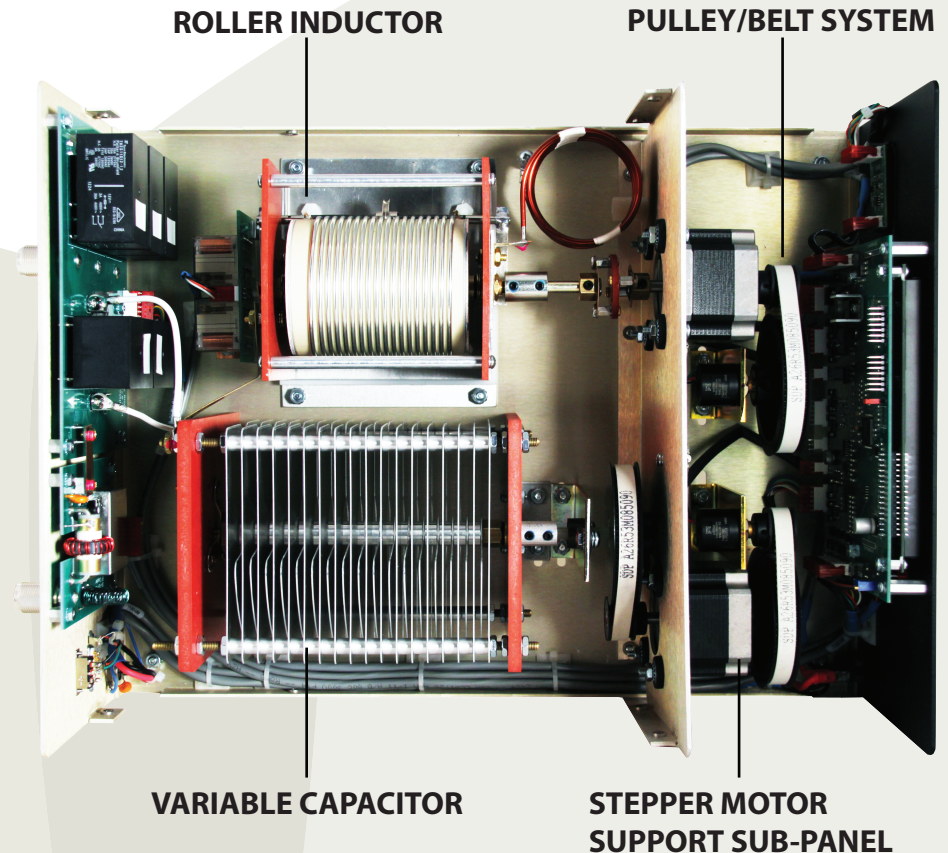
REMOTE OPERATION

PALSTAR will offer a fully remote version of the base version in the near future. However, in certain cases where there is DC power available at a reasonable distance you can operate this base version in the AUTO MODE. Other functions would of course not be available.

The base version is frequency sensing you need only to insert a metering device that could monitor reflected power in the transmitting location.

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HF-AUTO Firmware Summary

v1.18:   - new default position settings made for the positioning of the C and L with
          a given frequency range;
          - added menu option to clear out the memory offset positions for the C and L
          with a given frequency range;
          - removed limits on the C and L offset position values;
          - added menu selection of the Amp-Key relay state when no RF power is detected;
          - added ability in manual mode to store a memory position using the Right Arrow
          button;
v1.19:   - changes regarding operation with the MARS frequencies.
v1.20:   - allowed for the use of the new relay board with the proper jumper selection;
          - added additional memory presets between 7.0 MHz and 14.0 MHz;
          - manual mode now allowed the Left Arrow Button to return to Auto mode.
v1.21:   - corrected problem where the display was not being updated after pressing left arrow
          button and would make the unit go from Manual Mode to Auto Mode.
v1.22:   - minor display corrections: UNABLE TO TUNE message remained on display in error after a
          new tune operation started.
v1.23:   - added Setup Menu item to select AUTO STORE to be ON or OFF;
          - added Setup Menu item to select DELAY TUNE SWR to be ON or OFF;
          - provided for using Ant 3 selection with dummy load by changing to AUTO ANT
          SWITCH MODE state by pressing and holding of the ANTENNA button;
          - added memory locations to have memory settings every 50 kHz from 28 MHz to 29.7 MHz.
v1.24:   - removed Amp Key Relay Menu items;
          - corrected problem where the display could be blanked out after the unit remained in the
          Setup Menu for an extended time.
v1.25:   - corrected an occassional problem in Auto Tune Mode if the unit has AUTO ANT SWITCH
          set to ON;
          - made improvements in the Auto Tune operation to reduce the time needed to find the
          C and L tune
          - positions when a given frequency is first applied.
v1.26:   - corrected a problem where some units were incorrectly reading EEPROM calibration and
          setting values.
v1.27:   - removed restrictions in manual mode that prevent storing of new C and L positions when
          those changes are only of a minimal number of steps. The restriction is there to prevent the
          auto tune mode causing excessive writes to the EEPROM;
          - corrected occassional problems in finding the absolute best match when v1.25 changes
          were made;
          - added to the operation when holding the ANTENNA button to select BYPASS MODE when
          AUTO ANT SWITCH is turned OFF and select AUTO MODE when AUTO ANT SWITCH is turned ON.
v1.28   not released.
v1.29   - The selection of the antenna port in an auto frequency selection mode now is programmable
          for each of the ten different HF bands;
          - The INITIALIZE PRESETS menu option has been removed;
          - The QUICK TUNE menu option has been removed;
          - The last frequency of transmission is saved on power down and the inductor and antenna relay
          settings are restored for that same frequency at power up in auto antenna mode;
          - The power reading no longer has an option to be average power. Only peak power is displayed;
          - The accuracy of the peak power has been improved;
          - Added menu option to have last SWR reading remain on the display after power is removed;
          - Added menu option to have last Power reading remain on the display after power is removed.

HOW-TO UPDATE SOFTWARE

DOWNLOADING HF-AUTO FIRMWARE

● CREATE a folder on your computer's hard drive (but not desktop)

● NAME the folder HF_AUTOUPGRADE

● DOWNLOAD the Firmware file (Zip format) from the Palstar website -
   http://www.palstar.com/en/hf-auto/ - it is near the bottom of the page .
   The link to the file is named "HF-AUTO Firmware 1.x"

● SAVE the file to the folder you created in Step 1

● OPEN the folder by right-clicking on the Zip file and select "Extract All" -
   follow the steps in the Extraction wizard

INSTALLING THE FIRMWARE UPGRADE

● TURN-OFF the HF-AUTO
● CONNECT the RS-232 cable to the rear panel
● CONNECT the other end of the RS-232 cable to Com 1 or your computer
● TURN-ON the HF-AUTO
● SET Switch at rear of the HF-AUTO to "PROGRAM"
● Note: LED (PROGRAM MODE) on Front Panel is illuminated
● DOUBLE-CLICK "LOAD_HF_9600" from your HF_AUTOUPGRADE folder that
   you created in Step 2
● DOS Window appears - wait until DOS Window closes (approx. 1 min)
● TURN "PROGRAM" Switch to "NORMAL"
● REMOVE the RS-232 cable
● TURN HF-AUTO OFF and then ON again
● LOOK at HF-AUTO display to see new REV level at top-right corner when
   you first turn it on
● COMPLETE - you have now completed the update of the firmware

   NOTE: The HF-AUTO ships with a DB9 serial cable.
           You can order a USB to DB9 serial cable
           from Palstar for use with computers with no
           DB9 serial port to update the firmware.

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MAINTENANCE REQUIREMENTS

IF THERE IS MAINTENANCE REQUIRED IT WILL MOST LIKELY BE RELATED TO MECHANICAL ISSUES:

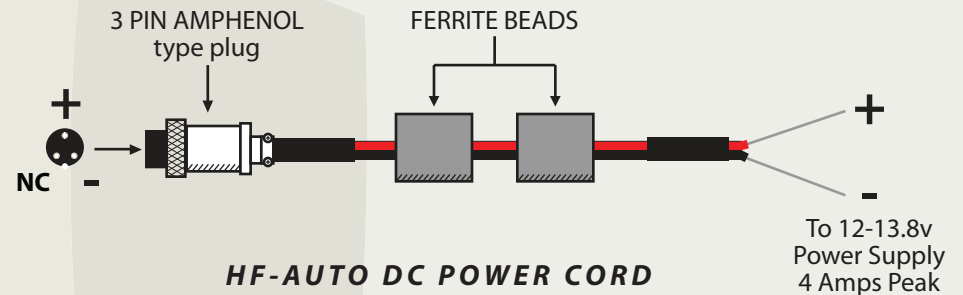● ROLLER SHAFT: the wheel rides should be lubricated with our factory-made conductive grease.
This grease is available from Palstar at NO CHARGE.

● DIOXIT-D5 spray is always very useful for cleaning the wire on the roller coil. Do not use the spray directly. Put a small amount on a cotton cloth and hand wipe the roller once a year while turning the roller crank.

● All set screws are the CAP POINT type and take care to carefully tighten these screws with a 5/16" allen key wrench, which is available from any hardware outlet.

REPAIR OR REPLACEMENT MODULES

● All PC Boards are removeable with standard American tools in case of failure.

● The rear panel (relay PCB) has custom S0-239 connectors that can be loosened witha 3/4" socket and 4 x 6-32 keps nuts. Remove these nuts and two connections from the variable and the entire relay PC Board is removable without a soldering iron.

● Both the front and rear panels can be lowered by removing the 3 countersink screws from the bottom edge of each panel.

HF-AUTO POWER CABLE

HF-AUTO DC POWER CORD

HF-AUTO SCHEMATIC

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Ant. #1 J1
Ant. #2 J2
Ant. #3 J3

RF Path PCB

SC3 — SC3
SC2 — SC2

Differential Tee Network

Stepper Motors

stepper
stepper
limit
limit
limit

SC1
P2 8 pin

Logic / Display/ Buttons PCB

P7 8 pin
P8 8 pin
P9 4 pin
P10 4 pin
P11 4 pin

SC1
SC1

Xmtr. J4

Pfwd/Prev Freq. PCB

P3 6 pin

P2 8 pin
P3 6 pin
P4 10 pin
P5 2 DC
P6 2 DC

J1-J4 = SO-239
J5 = DE-9 Female
SW1 = SPST recessed switch (open = RUN)
J6-J7 = RCA Phono Female
P1 = DC male connector (>5A)
PCB connectors are .1" male 4-10 pins
All mating cable connectors are female
P5-P6 = AMP mate-N-lok
P9-P11 = 4 pin 0.1" spacing
P3 = 6 pin 0.1" spacing
P2, P7-P8 = 8 pin 0.1" spacing
P4 = 10 pin 0.1" spacing
Stepper motors now have different wiring
with no pins having 2 wires. 8 pin connector
is compatible with old 6 pin cables if connect
to pins 2-7.

RS-232 J5
Program/ Run SW1

Interface PCB

P4 10 pin

J6
J7

DC P1

P5 2 DC

On/Off Switch

INSIDE VIEW

PALSTAR