

Alignment and Calibration

5

Required Equipment for Alignment and Calibration

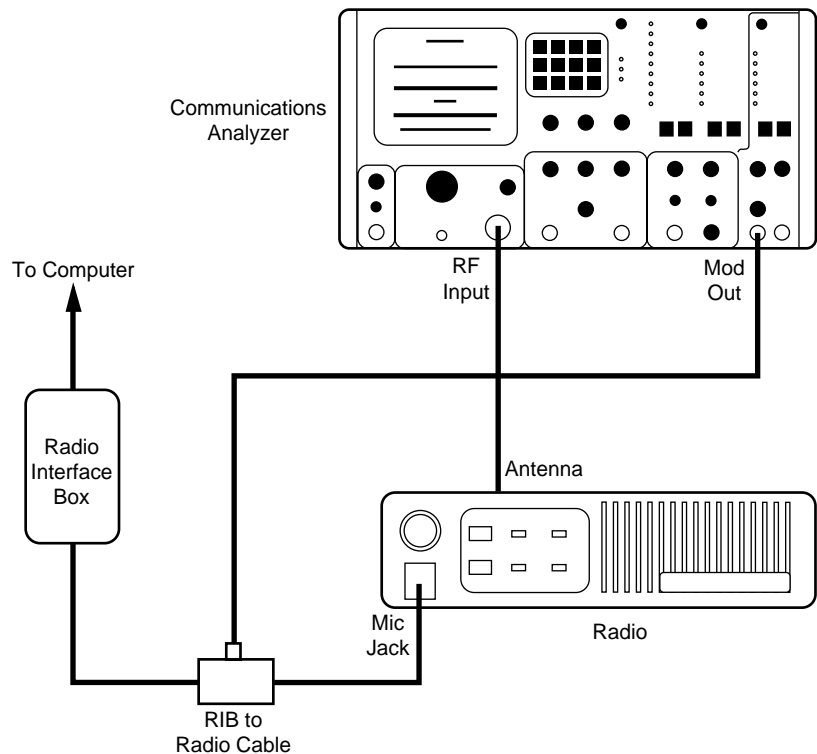
In order to align and calibrate the radio, you will need equipment to measure frequency, deviation, power and voltage. Below is a list of recommended equipment which can help with these measurements:

Alignment and Calibration Equipment

Description	Model Number
Communications System Analyzer	R2001D
Digital Volt Meter (DVM)	R1024A

Configuring the Alignment and Calibration Equipment

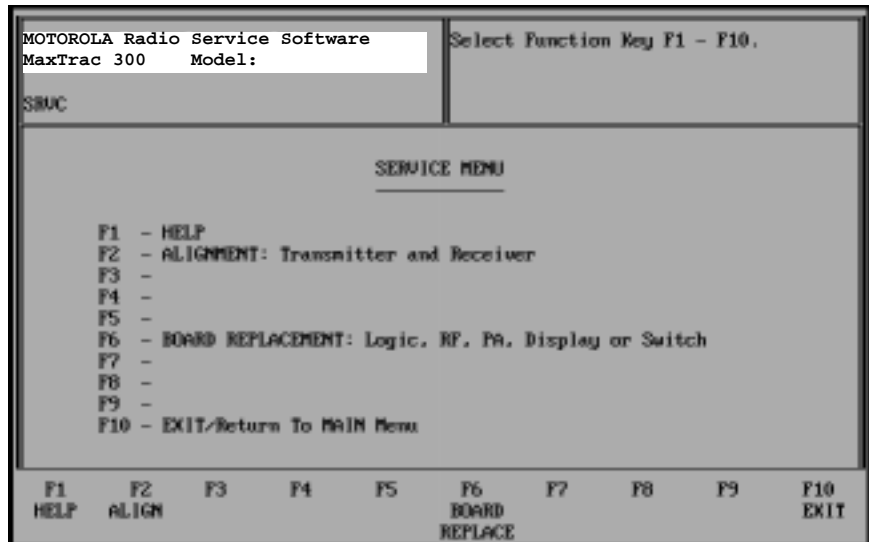
The Communications System Analyzer is connected to the antenna connector of the radio and its MOD OUT port is connected to the RIB-to-Radio cable at the junction box with a BNC connector.



Service Menu



Pressing **F2** at the MAIN MENU will display the SERVICE MENU screen. The radio must be connected to the RIB and turned on at this time. The SERVICE MENU screen has two functions available. Function **F2** is alignment of the transmitter power, deviation and reference oscillator. Function **F6** is used to calibrate a PC board after it has been replaced.



Alignment versus Calibration

The term “Alignment” refers to the RSS’s ability to adjust transmitter power, deviation and reference oscillator on a test frequency. The term “Calibration” refers to the RSS’s ability to adjust transmitter power, deviation and reference oscillator on sixteen calibration points that span the entire frequency band.

When the radio is calibrated at the factory, it will perform within specifications on any customer frequency within the frequency band. Therefore, any further alignment or calibration should not be necessary in the field. The only exception to this rule is the alignment of the reference oscillator. Because of aging characteristics of crystals, the frequency of the oscillator will change with time. This means that the reference oscillator needs to be re-aligned periodically. This is not true, however, for transmitter power and deviation.

Since transmitter power and deviation do not change with time, alignment for power and deviation is NOT recommended unless you feel it is absolutely necessary. If you find a radio that needs more than 2 Watts adjustment, first check your equipment, antenna loads and cables.

Note: Remember that setting a radio beyond its rated power will affect the radio's long term reliability.

If you find that a radio needs more than 500 Hz deviation adjustment, first check your equipment. If the radio is operating beyond these limits, it is recommended that calibration be performed instead of alignment.

The procedures for Alignment and Calibration are explained on the following pages.

Alignment of Radio



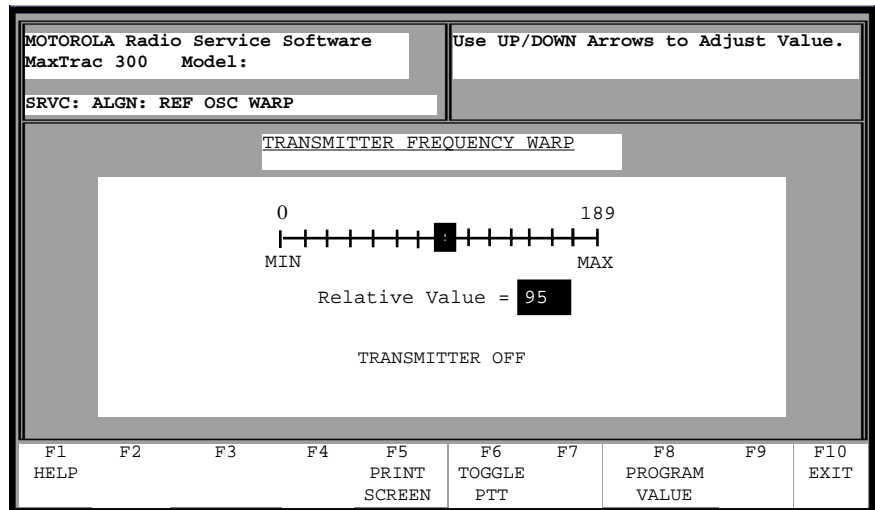
The ALIGNMENT screen has three functions available. These functions allow alignment of the reference oscillator (F5), transmitter power (F7) and transmitter deviation (F3).

MOTOROLA Radio Service Software MaxTrac 300 Model:					Select Function Key F1-F10.				
SRVC: ALGN									
<u>ALIGNMENT MENU</u>									
F1 - Help									
F2 -									
F3 - DEVIATION Adjustment									
F4 -									
F5 - REFERENCE OSCILLATOR WARP Adjustment									
F6 -									
F7 - TX POWER Adjustment									
F8 -									
F9 -									
F10 - EXIT/Return to SERVICE Menu									
F1	F2	F3	F4	F5	F6	F7	F8	F9	F10
HELP		DEVIA- TION SET		REF OSC WARP		TX POWER			EXIT

Reference Oscillator Warp Adjustment



The reference oscillator is aligned electronically in the field with the RSS. The MaxTrac radio is not aligned by a variable capacitor or inductor as were previous products. Alignment of the oscillator can be performed without opening the radio. The REFERENCE OSCILLATOR ALIGNMENT screen displays a relative scale of the alignment range available and the current position of the alignment inside that range.



Use the following procedure to align the reference oscillator:

1. Connect a frequency counter to the antenna connector of the radio.
2. Key the radio using the **F6** key. The screen will display "TRANSMIT ON".
3. Using the up/down arrow keys, set the radio to plus or minus 100 Hz of the customer's desired frequency. The relative position of the adjustment will be displayed on the scale. Note that it may take up to 10 seconds before the radio is updated.

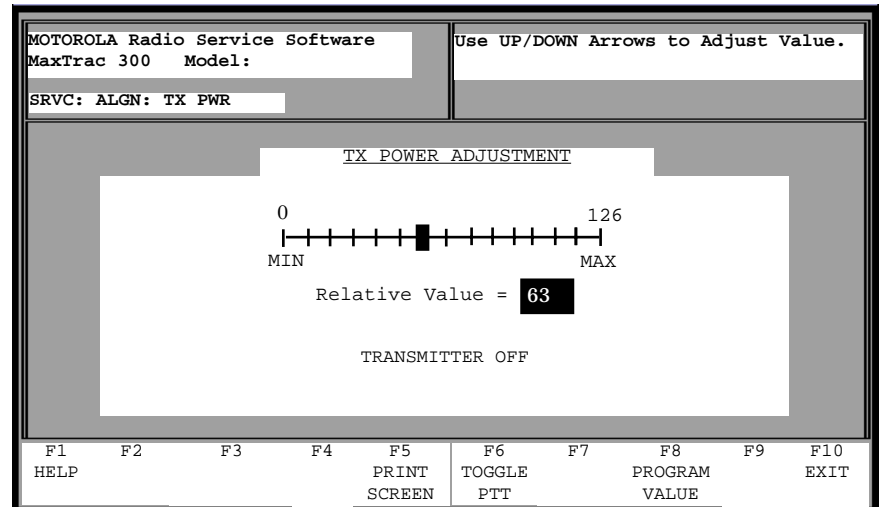
Note: If the radio cannot be adjusted for the correct frequency, and the relative position is a MIN or MAX position, you should refer to the Radio Service Manual for repair procedures.

4. De-key the radio using the **F6** key. The screen will display TRANSMIT OFF.
5. Press **F8** to save the new calibration value into the radio EEPROM and return to the ALIGNMENT screen.

Transmitter Power Adjustment



The TRANSMIT POWER ADJUSTMENT screen is similar to the REFERENCE OSCILLATOR ALIGNMENT except that, in this case, the scale represents a power adjustment instead of a frequency adjustment.



Use the following procedure to align the transmitter:

1. Connect a power meter to the antenna connector of the radio.
2. Key the radio using the **F6** key. The screen will display "TRANSMIT ON".
3. Using the up/down arrow keys, set the radio to rated power by reading the power meter. The relative position of the adjustment will be displayed on the scale.

Note: If the radio cannot be adjusted for rated power and the relative position is a MIN or MAX position, you should refer to the Radio Service Manual for repair procedures.

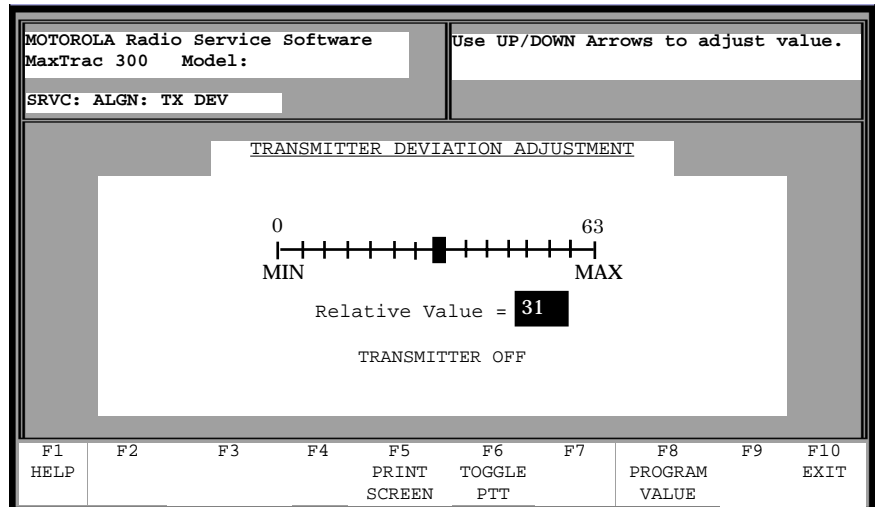
4. De-key the radio using the **F6** key. The screen will display "TRANSMIT OFF".
5. Press **F8** to save the new calibration value into the radio EEPROM and return to the ALIGNMENT screen.

Note: If the radio model has the Low Power TX option, steps 2 to 5 will be repeated before returning to the ALIGNMENT screen.

Transmitter Deviation Adjustment



The TRANSMIT DEVIATION ALIGNMENT screen is similar to the REFERENCE OSCILLATOR ALIGNMENT except that, in this case, the scale represents a deviation adjustment instead of a frequency adjustment.



Use the following procedure to align the transmitter deviation:

1. Connect the audio generator to the BNC connector on the RIB-to-Radio cable. Set the generator to 800 mV RMS at a frequency of 1000 Hz.
2. Connect a deviation meter to the antenna connector of the radio.
3. Key the radio using the **F6** key. The screen will display "TRANSMIT ON".
4. Using the up/down arrow keys, set the radio to rated deviation by reading the deviation meter. The relative position of the adjustment will be displayed on the scale.

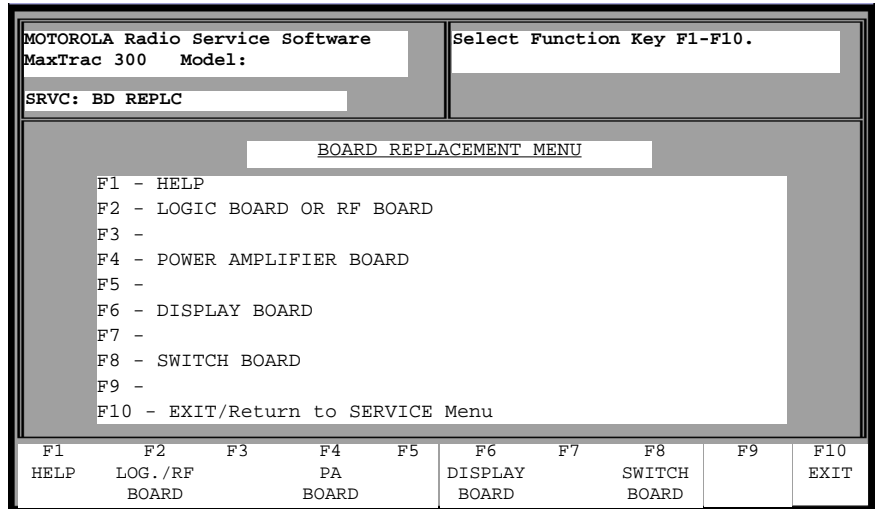
Note: If the radio cannot be adjusted for rated deviation and the relative position is a MIN or MAX position, you should refer to the service manual for repair procedures.

5. De-key the radio using the **F6** key. The screen will display "TRANSMIT OFF".
6. Press **F8** to save the new calibration value into the radio EEPROM and return to the ALIGNMENT screen.

Calibration After Board Replacement



Pressing the **F6** function key from the SERVICE screen will display the BOARD REPLACEMENT MENU. There are four functions available to cover every PC board in the radio. Since the microcomputer controls the reference oscillator, transmit deviation and transmit RF power, it must learn the characteristics of each board in the radio. Each board has its own set of unique characteristics. This is due to component and manufacturing tolerances. Data that describes these tolerances are entered from labels attached to the boards or determined by measuring certain radio parameters.



Note: While performing this test procedure, DO NOT key the transmitter for longer than one minute. If you do, it may affect the calibration setting. If the transmitter is keyed for one minute, you must allow four minutes of cooling time before continuing the calibration.

Some of the calibration is done over sixteen test frequencies that cover the band or eight frequencies for some 800 MHz models. Below is a description of the screens that follow the selection of one of the function keys.

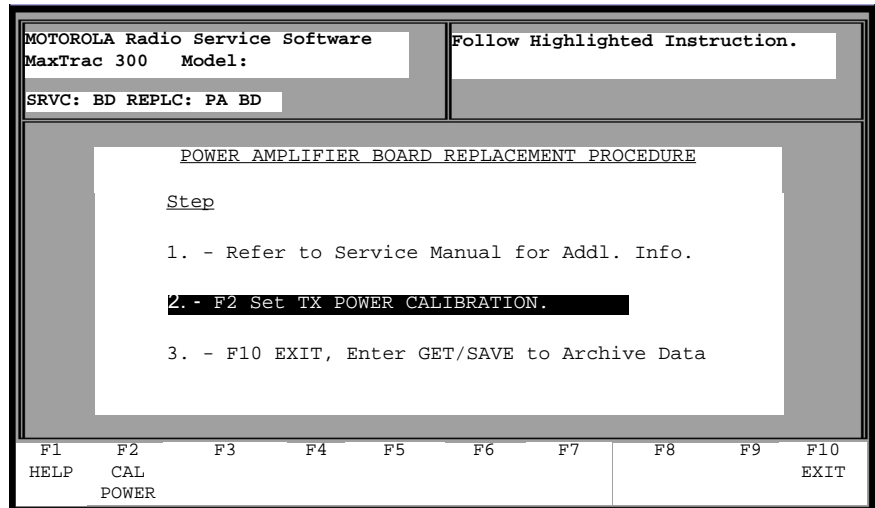
Replaced Switch or Display Board

Presently there are no parameters on these boards that require calibration. If you press **F6** or **F8**, the RSS will display a screen stating the same. Press **F10** to return to the BOARD REPLACEMENT MENU.

Replaced Power Amplifier Board



To calibrate the power amplifier board, first make sure that the radio is turned on and is connected to the RIB box, and the antenna connector of the radio is connected to a RF power meter.



Press **F2** at the BOARD REPLACEMENT MENU to display the TRANSMITTER POWER CALIBRATION screen. The radio has sixteen calibration points. Each point must be set to the rated power of the radio. Follow the steps below to perform this procedure.

1. Key the radio using the **F6** key. The screen will display "TRANSMITTER ON".
2. Using the up/down arrow keys, set the radio to the rated power by reading the power meter. The relative position of the adjustment will be displayed on the scale. The relative position may be entered directly from the keyboard. For instance, if the previous calibration points have been running about the relative value of 33, for the next calibration point you may start by entering 33 and then using the up/down arrows for the final adjustment.

Note: If the radio cannot be adjusted for muted power and the relative position is at the Min or Max position, you should refer to the Radio Service Manual for repair procedures.

3. Press **Tab** to move to the next calibration point. The calibration point number (1 to 16) will be highlighted.
4. Repeat steps 2 and 3 above until all sixteen points have been calibrated.

Note: If kit # HLE9310 (449 - 470 MHz) is installed, it is not necessary to calibrate points 1 through 5.

5. De-key the radio using the **F6** key. The screen will display "TRANSMITTER OFF".
6. The **Tab** keys will allow you to step to any desired calibration point to re-check a setting if necessary.

When the calibration is complete, press **F8** key to save the calibration to the radio and return to the BOARD REPLACEMENT screen.

MOTOROLA Radio Service Software
MaxTrac 300 Model:

SRVC: BD REPL:PA BD: TX PWR CAL

Use UP/DOWN Arrows to Adjust Value.

TRANSMITTER POWER CALIBRATION PROCEDURE

0 126

MIN MAX

POINT	VALUE	POINT	VALUE	POINT	VALUE	POINT	VALUE
1	63	5	63	9	63	13	63
2	63	6	63	10	63	14	63
3	63	7	63	11	63	15	63
4	63	8	63	12	63	16	63

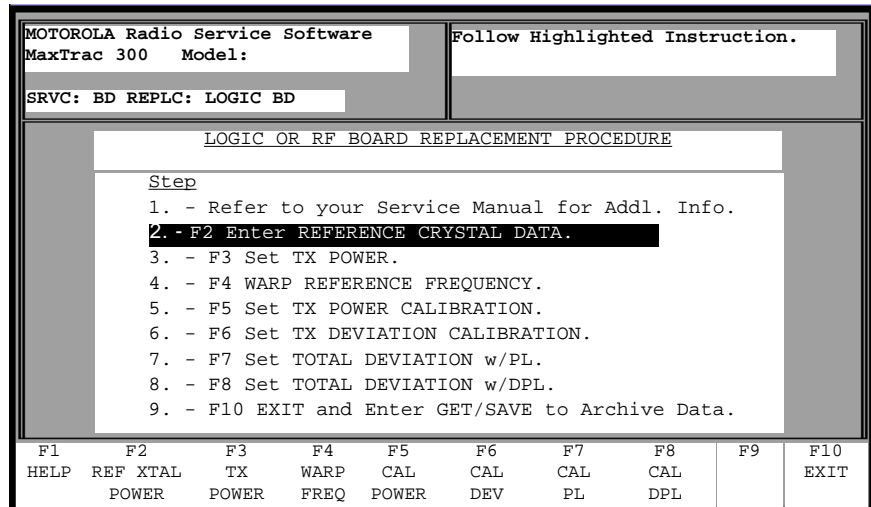
TRANSMITTER OFF

F1	F2	F3	F4	F5	F6	F7	F8	F9	F10
HELP				PRINT SCREEN	TOGGLE PTT		PROGRAM VALUE		EXIT

Replaced Logic Board or RF Board



To calibrate either the logic board or the RF board, first make sure the radio is turned on and connected to the RIB. Also, have an RF frequency counter, deviation meter, audio generator and power meter on hand to connect to the radio's antenna connector.



If you press **F2**, the RSS will determine whether or not the EEPROM of the logic board has been initialized. If the EEPROM has not been initialized, model definition data must first be programmed into the EEPROM according to the model of the radio. Upon detecting a non-initialized EEPROM, the RSS will display the BLANK BOARD INITIALIZATION screen.

Six pieces of information are need to initialize the EEPROM: Product Line, Model Name, Model Number, Frequency Range, Panel Number and Serial Number. Use the following procedure to initialize the EEPROM:

1. With the cursor on the Product Line data field, select the correct product line of the radio using the up/down arrow keys. Examples of product lines are "MaxTrac", "Radius" and "Trunked".
2. Move the cursor to the Model Name data field and select the correct model name using the up/down arrow keys.
3. Move the cursor to the Model Number data field and select the correct model number using the up/down arrow keys.
4. Move the cursor to the Range data field and select the correct frequency range for this radio using the up/down arrow keys.
5. Move the cursor to the Panel Number field and enter the correct panel number for the Model of this radio. Refer to Appendix G to find the correct panel number for your radio.

6. Move the cursor to the Serial Number field and enter the serial number from the radio label and then press the **Enter** key. It is important that the information on the BLANK BOARD INITIALIZATION screen is correct.



Caution

Once a non-initialized EEPROM is programmed with model definition data, it CANNOT be changed again. If the EEPROM is incorrectly initialized, the logic board will have to be replaced.

7. Review the information on the screen and edit the information if it is incorrect. Now press **F8** to program the model definition data into the radio's EEPROM.
8. Press **F10** to return to the BOARD REPLACEMENT MENU.

If the product line, model name, and/or frequency range of the radio you are trying to repair are not listed, then this version of the RSS is not compatible with this radio model.

Pressing **F2** with an initialized EEPROM in the radio will display the LOGIC BOARD AND RF BOARD REPLACEMENT PROCEDURE screen. This screen displays a menu that is arranged in the order that the board should be calibrated. The status message box (upper right box) will tell you which calibration function key is active. Only one of the calibration function keys will be active at a time. The operation of each function key in this screen will be described in the following pages.

Reference Crystal Data



The first calibration screen is “REFERENCE CRYSTAL DATA”. This screen requires that the radio be open and the RF and synthesizer shield be removed prior to calibration.

MOTOROLA Radio Service Software MaxTrac 300 Model:		Enter the Numbers Printed on Reference Oscillator Crystal (Y151).							
SRVC:BD REPLC:LOGIC BD:XTAL									
<u>CRYSTAL DATA</u>		<u>TUNING DATA</u>	<u>MEASURED 9.6V.</u>						
0000		000	9.60						
0000		0000							
		-							
F1 HELP	F2	F3	F4	F5	F6	F7	F8 PROGRAM RADIO	F9	F10 EXIT

Follow Procedure A unless the radio is a 900 Mhz model, in which case follow Procedure B. There are two labels inside the synthesizer compartment. The first is called the Crystal Label. This label is located on the crystal itself. It has two rows of four digits each. The second label is called the Tuning Label. This label is located in the synthesizer compartment near the crystal. Depending on the unit, the label will contain either seven or eight characters. Seven-character units will have a seven-digit number. Eight-character units will have seven numbers followed by an “H”. You will also need a DVM to measure regulator voltage. Use Procedure A or B to complete calibration from this screen:

Procedure A

1. Read the top four digits from the Crystal Label. Enter the digits in the top data entry field under the “Crystal Label” title.
2. Read the bottom four digits from the Crystal Label. Enter the digits in the bottom data entry field under the “Crystal Label” title.
3. Read the first three digits from the Tuning Label. Enter the digits in the top data entry field under the “Tuning Label” title.
4. Read the next four digits from the Tuning Label. Enter the digits in the second data entry field under the “Tuning Label” title. If there is an “H” following the seventh digit of the label, enter an “H” on the third row data entry field under the “Tuning Label” title; otherwise enter a dash (“-”).
5. Measure the voltage of the 9.6 volt regulator (Pin 1 of 16). Enter the voltage in the data entry field under “MEASURED 9.6V”.
6. Verify that the data that you have entered is correct. Press the **F8** key to save the new calibration values into the radio and return to the LOGIC BOARD AND R.F. BOARD CALIBRATION screen.

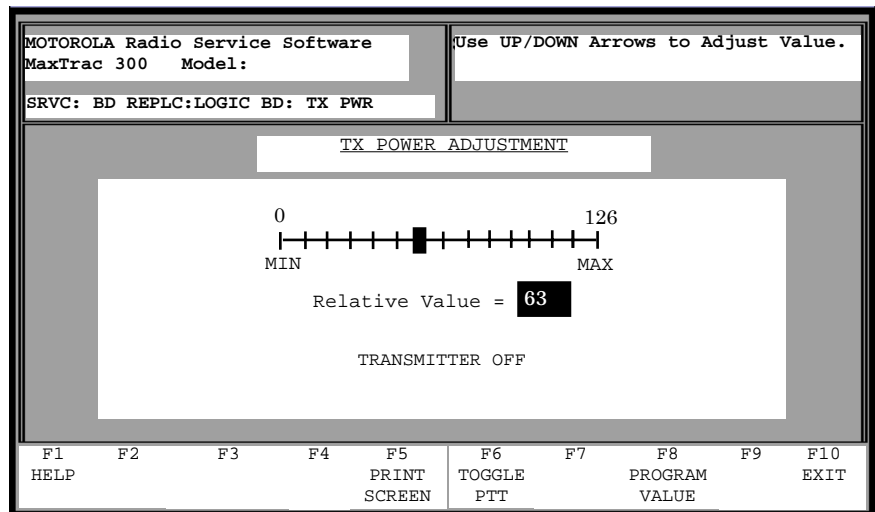
Procedure B

1. Measure the voltage at pin 43 of the microprocessor on the logic board (U802).
2. Enter the measured voltage in the data entry field under “VDIODE”.
3. Measure the voltage of the 9.6 volt regulator (Pin 1 of 16). Enter the voltage in the data entry field under “MEASURED 9.6V”.
4. Verify that the data that you have entered is correct. Press the **F8** key to save the new calibration values into the radio and return to the LOGIC BOARD AND R.F. BOARD CALIBRATION screen.

Set Transmitter Power



The next screen is the TRANSMIT POWER ALIGNMENT. This is the same screen that is used to align the transmitter power found in the ALIGNMENT screens.



Use the following procedure to align the transmitter:

1. Connect a power meter to the antenna connector of the radio.
2. Key the radio using the **F6** key. The screen will display “TRANSMIT ON”.
3. Using the up/down arrow keys, set the radio to rated power by reading the power meter. The relative position of the adjustment will be displayed on the scale.

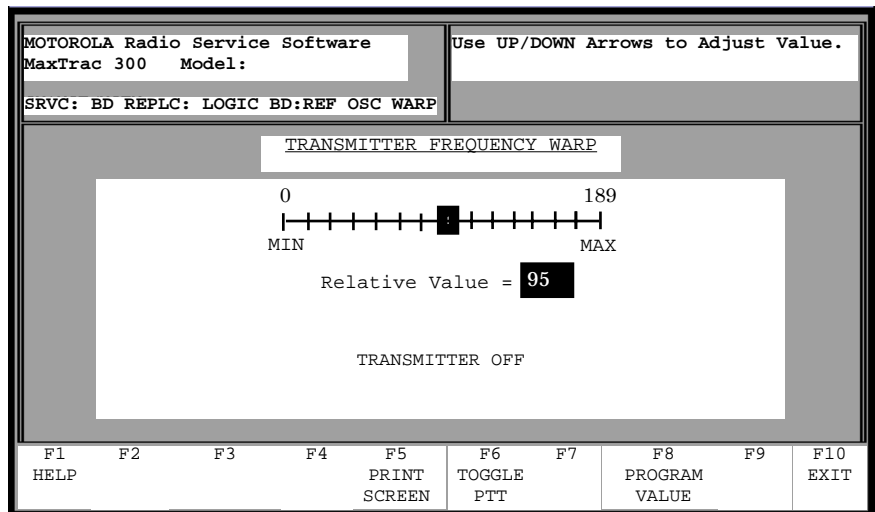
Note: If the radio cannot be adjusted for muted power, and the relative position is a MIN or MAX position, you should refer to the Radio Service Manual for repair procedures.

4. De-key the radio using the **F6** key. The screen will display “TRANSMIT OFF”.
5. Press **F8** to save the new calibration value into the radio EEPROM and return to the LOGIC BOARD AND R.F. BOARD CALIBRATION screen.

Reference Oscillator Alignment



The next screen is the **REFERENCE OSCILLATOR ALIGNMENT** screen. This screen is exactly the same as the **TRANSMITTER FREQUENCY WARP** found in the **ALIGNMENT** screens.



Use the following procedure to align the reference oscillator:

1. Connect a frequency counter to the antenna connector of the radio.
2. Key the radio using the **F6** key. The screen will display "TRANSMITTER ON".
3. Using the up/down arrow keys, set the radio to plus or minus 100 Hz of the displayed frequency. The relative position of the adjustment will be displayed on the scale. Note that it may take up to 10 seconds before the radio is updated.

Note: If the radio cannot be adjusted for correct frequency and the relative position is a MIN or MAX position, you should refer to the Radio Service Manual for repair procedures.

4. De-key the radio using the **F6** key. The screen will display "TRANSMIT OFF".
5. Press **F8** to save the new calibration value into the radio and return to the **LOGIC BOARD AND R.F. BOARD CALIBRATION** screen.

Calibrate Power



The next screen is the CALIBRATE POWER screen. This screen is the same as the one used in the Replace Power Amplifier section.

MOTOROLA Radio Service Software MaxTrac 300 Model:				Use UP/DOWN Arrows to adjust value.					
(SRVC: BD REPL: LOGIC BD: TX PWR CAL									
TRANSMITTER POWER CALIBRATION PROCEDURE									
0					126				
----- ----- ----- ----- ----- ----- ----- ----- ----- -----									
MIN					MAX				
POINT	VALUE	POINT	VALUE	POINT	VALUE	POINT	VALUE	POINT	VALUE
1	63	5	63	9	63	13	63		
2	63	6	63	10	63	14	63		
3	63	7	63	11	63	15	63		
4	63	8	63	12	63	16	63		
F1	F2	F3	F4	F5	F6	F7	F8	F9	F10
HELP				PRINT SCREEN	TOGGLE PTT		PROGRAM VALUE		EXIT

Use the following procedure to calibrate the power amplifier:

1. Make sure the radio is turned on. Connect a power meter to the antenna connector of the radio.
2. Key the radio using the **F6** key. The screen will display "TRANSMITTER ON".
3. Using the up/down arrow keys, set the radio to the noted power by reading the power meter. The relative position of the adjustment will be displayed on the scale. The relative position may be entered directly. For instance, if the previous calibration points have been running about the relative value of 33, for the next calibration point you may start by entering 33 and then using the up/down arrows for the final adjustment.

Note: If the radio cannot be adjusted for muted power and the relative position is at the Min or Max position, you should refer to the Radio Service Manual for repair procedures.

4. Press the **Tab** or **Enter** key to move to the next calibration point. The calibration point number (1 to 16) will be highlighted.
5. Repeat steps 3 and 4 above until all sixteen points have been calibrated.
6. De-key the radio using the **F6** key. The screen will display "TRANSMITTER OFF".
7. Use the **Tab** keys to step to any desired calibration point to re-check a setting if necessary.
8. When the calibration is complete, press **F8** to save the new calibration value into the radio and return to the LOGIC BOARD AND R.F. BOARD CALIBRATION screen.

Calibrate Deviation



The next screen is the CALIBRATE DEVIATION screen. This screen is similar to the CALIBRATE POWER screen. The exception in this case is that the scale represents the deviation adjustment instead of power.

MOTOROLA Radio Service Software MaxTrac 300 Model:					Use UP/DOWN Arrows to Adjust Value.				
SRVC: BD REPL: LOGIC BD: TX DEV CAL									
TRANSMITTER DEVIATION CALIBRATION PROCEDURE									
0 MIN					63 MAX				
POINT	VALUE	POINT	VALUE	POINT	VALUE	POINT	VALUE	POINT	VALUE
1	31	5	31	9	31	13	31		
2	31	6	31	10	31	14	31		
3	31	7	31	11	31	15	31		
4	31	8	31	12	31	16	31		
F1	F2	F3	F4	F5	F6	F7	F8	F9	F10
HELP				PRINT SCREEN	TOGGLE PTT		PROGRAM VALUE		EXIT

Use the following sequence to calibrate deviation:

1. Connect the audio generator to the BNC connector on the RIB-to-Radio cable. Set the generator to 800 mV RMS at a frequency of 1000 Hz.
2. Make sure the radio is turned on. Connect a deviation meter to the antenna connector of the radio. Now, key the radio using the **F6** key. The screen will display "TRANSMITTER ON".
3. Using the up/down arrow keys, set the radio to the noted deviation by reading the deviation meter. The relative position of the adjustment will be displayed on the scale. The relative position may also be entered directly. For example, if the previous calibration points have been running about the relative value of 33, for the next calibration point you may start by entering 33 and then use the up/down arrows for the final adjustment.

Note: If the radio cannot be adjusted for rated deviation and the relative position is at the Min or Max position, you should refer to the Radio Service Manual for repair procedures.

4. Press **Tab** or **Enter** to move to the next calibration point. The calibration point number (1 to 16) will be highlighted.
5. Repeat steps 3 and 4 above until all 16 points have been calibrated.

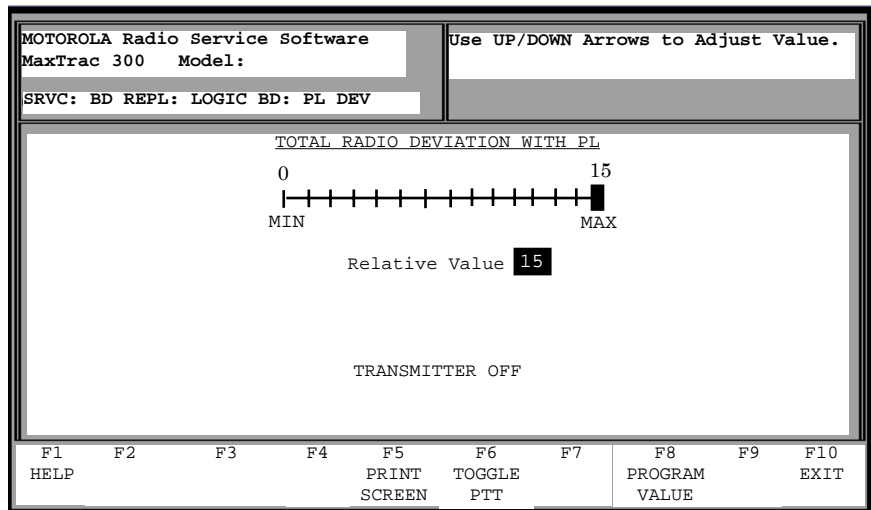
Note: If kit # HLE9310 (449 - 470 MHz) is installed, it is not necessary to calibrate points 1 to 5.

6. De-key the radio using the **F6** key. The screen will display "TRANSMITTER OFF".
7. Use the **Tab** keys to step to any desired calibration point to recheck a setting if necessary.
8. When the calibration is complete, press **F8** to save the new calibration value into the radio.

Calibrate Total Deviation with PL



The next screen is the CALIBRATE PL DEVIATION screen. This screen is similar to the CALIBRATE DEVIATION screen. On this screen, however, there is only one calibration point.



Follow the procedure below to calibrate PL deviation:

1. Make sure the radio is turned on. Connect a deviation meter to the antenna connector of the radio. Connect the audio generator to the BNC connector on the RIB-to-radio cable. Set the generator to 800 mV RMS at a frequency of 1000 Hz.
2. Key the radio using the **F6** key. The screen will display "TRANSMITTER ON".
3. Using the up/down arrow keys, set the radio to the rated deviation by reading the deviation meter. The relative position of the adjustment will be displayed on the scale.

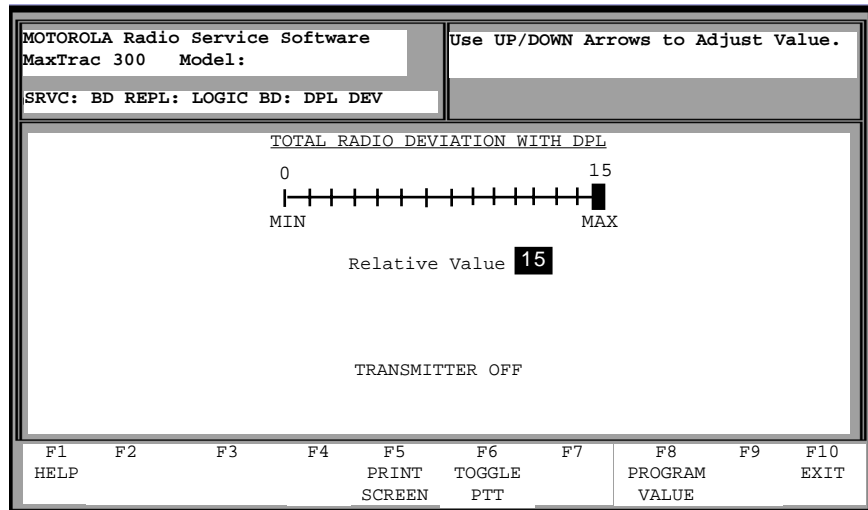
Note: If the radio cannot be adjusted for rated deviation and the relative position is at the Min or Max position, you should refer to the Radio Service Manual for repair procedures.

4. De-key the radio using the **F6** key. The screen will display "TRANSMITTER OFF".
5. When the calibration is complete, press **F8** to save the calibration into the radio and return to the LOGIC BOARD AND R.F. BOARD CALIBRATION screen.

Calibrate Total Deviation with DPL



The DPL CALIBRATE DEVIATION screen is exactly the same as the PL CALIBRATE screen. Use the previous PL deviation calibration procedure to perform DPL calibration.



The screenshot shows the Motorola Radio Service Software interface for DPL calibration. The top section contains the text: "MOTOROLA Radio Service Software", "MaxTrac 300 Model:", and "SRVC: BD REPL: LOGIC BD: DPL DEV". To the right, it says "Use UP/DOWN Arrows to Adjust Value." The main display area is titled "TOTAL RADIO DEVIATION WITH DPL" and features a horizontal scale from 0 to 15. The scale is labeled "MIN" at 0 and "MAX" at 15. A vertical bar on the scale indicates the current "Relative Value" is 15. Below the scale, it says "TRANSMITTER OFF". At the bottom, there is a function key menu:

F1	F2	F3	F4	F5	F6	F7	F8	F9	F10
HELP				PRINT	TOGGLE		PROGRAM		EXIT
				SCREEN	PTT		VALUE		

Exiting Calibration

This completes the calibration. Press **F10** to return to the REPLACED BOARD screen. It is recommended that you go to the GET/SAVE MENU to archive the personality and calibration points that have been saved in the EEPROM of the radio.

Note: Remember that the codeplug must first be read from the radio before it can be saved to the disk archive file.