PARTS LIST AND TUNE-UP INFORMATION

This exhibit contains a list of the semiconductor devices used in the transceiver and the test equipment and tuning procedures for maintaining the transceiver.

EXHIBIT 11A Functions of RF Semiconductors and Other Active Devices

EXHIBIT 11B List of Recommended Test Equipment for Servicing

EXHIBIT 11A Tune-up Information

FUNCTION OF RF SEMICONDUCTORS AND OTHER ACTIVE DEVICES

REF NUMBER	PART NUMBER	CIRCUIT APPLICATION	OPERATING FREQUENCY	INDUSTRY EQUIVALENT
DIODES:				
CR150	4813833C02	Analog logic OR	DC	MMBD6100L
CR151	4813833C02	Analog logic OR	DC	MMBD6100L
CR721	4813833C02	Analog logic OR	DC	MMBD6100L
CR5700	4802233J09	Voltage drop	DC	TRIPLE_DIODE
CR5701	4862824C01	Varactor	806-870 MHz	1SV229
CR5702	4862824C01	Varactor	806-870 MHz	1SV229
CR6501	4813833C02	PA driver protection	DC	MMBD6100L
CR6502	4802482J02	Pin diode	806-870 MHz	MA4P1250
CR6503	4802482J02	Pin diode	806-870 MHz	MA4P1250
CR6508	4813832B35	Reverse polarity protection	DC	1.5SMC24A
CR6509	48805218N57	Coupler	806-870 MHz	R87151
D101	4813833C02	Boot strap circuit	DC	MMBD6100L
D102	4813833C02	Programming circuit	DC	MMBD6100L
D200	4813833C02	Reverse polarity protection	DC	MMBD6100L
D401	4880939T01	Analog logic	DC	HSMS2820
D402	4880939T01	Analog logic	DC	HSMS2820
D403	4813833C02	Analog logic	DC	MMBD6100LOR
D611	4813833C02	Analog logic OR	DC	MMBD6100L
D621	4813833C02	Reverse polarity protection	DC	MMBD6100L
D631	4813833C02	Analog logic OR	DC	MMBD6100L
D5201	4880154K03	Limiter	45.1 MHz	DIOD353L
D5203	4880154K03	Limiter	45.1 MHz	DIOD353L
VR101	4813830A23	Voltage reduction	45.1 MHz	MMBZ5240BL
VR410	4813830A14	Protection	DC	MMBZ5231B
VR412	4813830A40	Protection	DC	MMBZ5257B
VR415	4813830A27	Protection	DC	MMBZ5244L
VR416	4813830A27	Protection	DC	MMBZ5244L
VR421	4813830A27	Protection	DC	MMBZ5244L
VR422	4813830A27	Protection	DC	MMBZ5244L
VR425	4813830A14	Protection	DC	MMBZ5231B
VR426	4813830A27	Protection	DC	MMBZ5244L
VR427	4813830A27	Protection	DC	MMBZ5244L
VR430	4813830A14	Protection	DC	MMBZ5231B
VR431	4813830A27	Protection	DC	MMBZ5244L
VR441	4813830A40	Protection	DC	MMBZ5257B
VR451	4813830A14	Protection	DC	MMBZ5231B

REF NUMBER	PART NUMBER	CIRCUIT APPLICATION	OPERATING FREQUENCY	INDUSTRY EQUIVALENT
VR621	4813830A14	5 Vdc regulator	DC	MMBZ5231B
VR641	4813830A14	Protection	DC	MMBZ5231B
VR6501	4813830A25	Protection	DC	MMBZ5242L
TRANSISTORS:				
Q101	4880048M01	HOOK	DC	DTC144EK
Q102	4880048M01	Vpp	DC	DTC144EK
Q103	4880048M01	Vpp	DC	DTC144EK
Q141	4880048M01	LCD enable	DC	DTC144EK
Q150	4882033T01		DC	DTC114YK
Q200	4880214G02	5 Vdc switch	DC	MMBT3904
Q401	4880214G02	Audio PA enable	DC	MMBT3904
Q410	4880048M01	Analog logic inverter	DC	DTC144EK
Q411	4880052M01	External alarm	DC	A28_T200
Q415	4880494M01	Analog logic inverter	DC	DTA144EK
Q450	4880048M01	Ignition control	DC	DTC144EK
Q460	4880048M01	Fast_Off_Ign	DC	DTC144EK
Q461	4880048M01	B+_Control	DC	DTC144EK
Q601	4880214G02	9. 1 Vdc regulator	DC	MMBT3904
Q611	4805128M27	SW B+ switch	DC	BSR33
Q612	4880214G02	On/Off switch	DC	MMBT3904
Q731	4880214G02	PA enable switch	DC	MMBT3904
Q741	4880048M01	K9.1 enable switch	DC	DTC144EK
Q742	4805128M27	K9.1 enable switch	DC	BSR33
Q5201	4813827A07	IF amplifier	45.1 MHz	MMBR941
Q5230	4813824A17	RX 5 Vdc switch	DC	2N3906L
Q5301	4813827A18	LNA	806-870 MHz	MRF9411L
Q5700	4880048M01	VCO switch	DC	DTC144EK
Q5701	4813824A17	TX pre-driver bias	DC	2N3906L
Q5702	4909527E01	VCO first buffer	806-870 MHz	NE85633
Q5703	4909527E01	VCO feedback buffer	806-870 MHz	NE85633
Q5704	4909527E01	TX talk-around VCO	806-870 MHz	NE85633
Q5705	4804188K01	TX PA pre-driver	806-870 MHz	NE85634
Q5706	4909527E01	VCO	806-870 MHz	NE85633
Q5707	4909527E01	VCO third buffer	806-870 MHz	NE85633
Q6501	4813827A26	TX PA driver	806-870 MHz	MRF8372
Q6505	4880225C17	TX PA	806-870 MHz	SRFM25C17
Q6506	4813824B01	PA control voltage	DC	PZT2222AT1

REF NUMBER	PART NUMBER	CIRCUIT APPLICATION	OPERATING FREQUENCY	INDUSTRY EQUIVALENT
INTEGRATED CIRCUITS:				
U101	5180421V01	Microcomputer	7.3728 MHz	MC68HC11K1
U102	5108444S61	Flash	PULSE	AM28F010-120
U103	5185963A21	SRAM	PULSE	MB84256A
U104	5108444S49	EEPROM	PULSE	X25320SI
U105	5113805A30	Multiplexer	DC	74HC138A
U106	5113808A07	AND logic	DC	74HC08D
U201	5105835U45	Audio signaling & filtering	AUDIO	CUSTOM
U202	5113819A04	Operational amplifier	AUDIO	MC3303
U203	5109522E13	Operational amplifier	AUDIO	TC7S66FU
U251	5113818A03	Operational amplifier	DC	MC33072D
U401	5109699X01	Audio PA	AUDIO	TDA1519C
U402	5180173M02	Analog swsitch	AUDIO/DC	MC14551
U403	5113818A10	Operational amplifier	AUDIO	MC4558
U601	5105625U25	9.1 Vdc regulator	DC	LM2941T
U631	5105469E65	5 Vdc regulator	DC	LP2951AC
U701	5113819A0	Operational amplifier	DC	LM2902
U702	5113811G02	D/A converter	DC	MC144111
U5201	5180207R01	Receiver system	45.1 MHz & 455 kHz	CUSTOM
U5211	5185670L01	Double balanced mixer	851-870 MHz & 45.1 MHz	ADE-93
U5700	5105279V31	Reference oscillator	16.8 MHz	CUSTOM
U5701	5105109Z59	MMIC	806-870 MHz	UPC1678
U5702	5105457W46	Frac-N synthesizer	806-870 MHz	CUSTOM
U5703	5113816A07	5 Vdc regulator	DC	MC78M05
U5704	4805921T02	Talk-around VCO switch	DC	FMC_2
U5705	4805921T02	VCO switch	DC	FMC_2
U6501	5113829D22	TX driver module	806-870 MHz	MHW2821-1
U6502	4805921T02	Switch	DC	FMC_2

COMMENTS: The Motorola designators are special code numbers for active devices used in Motorola radios. These devices are either identical or derived from the device family listed under Industry Equivalent, by the manufacturer or are proprietary to Motorola. Service people do not have access to any cross-references or given any information on proprietary devices and are prevented from making unauthorized substitution.

LIST OF RECOMMENDED TEST EQUIPMENT FOR SERVICING

Instrument	Recommended Type	Application
RF Signal Generator *	HP 8656B or equivalent	Receiver Measurements
Modulation Analyzer *	HP 8901B or equivalent	Frequency and Deviation Measurements
Audio Analyzer *	HP 8903A or equivalent	Receiver Measurements
Power Meter *	HP 438A or equivalent	Transmitter Power Output
Power Sensor *	HP 8482A or equivalent	Transmitter Power Output
DC Power Supply	0-20 volts at 15 amps	
Attenuator Pad *	50 Ω, 75 Watts, 30 dB	Transmitter Measurements
DC Ammeter	30 mA to 20 A	Current Drain Measurements
Computer	IBM PC, PC/XT or PC/AT	Radio Alignment
Radio Interface Box (RIB)	RLN-4008	Computer to Radio Interface
Cable	30-80369B71 (25-pin) or 30-80369B72 (9-pin)	RIB to Computer
Cable	01-80300B10	RIB to Radio
Software	RVN-4150	Radio Alignment

* These items can be replaced by a Motorola 2000 Series Communications System Analyzer or equivalent piece of integrated communications test equipment.

TUNE-UP INFORMATION

This exhibit contains the tuning procedure in the same general format as will appear in the service manual.

All transmitter adjustments are performed by electronic means. The transmitter contains no electromechanical components for the purpose of transmitter tuning or adjustment.

The tuning elements that are used for transmitter adjustment are:

Location	Type of Element	Function
U101	Microcomputer	Monitors Output of Power Sampling and Current Limiting Circuits and Supplies data to Attenuators, Temperature Compensated Crystal Oscillator, and Digital to Analog Converter for Transmitter Modulation, Frequency and Power Adjustment
U105	EEPROM	Data Storage of all Tuning Parameters
U201	Programmable Attenuator	Deviation Adjustment
U5700	Temperature Compensated Crystal Oscillator	Transmitter Frequency Adjustment
U5702	Programmable Attenuator	VCO Modulation Sensitivity
U5702	Programmable Attenuator	Reference Modulation Sensitivity

The value of a particular tuning element is determined by data sent to that tuning element by microcomputer U101. This data is generated by the microcomputer based on tuning information that is stored in an Electrically Erasable Programmable Read Only Memory (EEPROM), U105.

Tuning information is stored in the EEPROM during factory adjustment or by qualified field service facilities, using the attached procedure and recommended test equipment.

TUNING PROCEDURE

The tuning procedure assumes that an integrated piece of test equipment is being used. This test equipment is usually referred to as a Communications Systems Analyzer (CSA) and combines the functions of many separate pieces of test equipment. The Radio Service Software (RSS) allows a Service Technician to electronically adjust or calibrate the radio without opening the radio housing to gain access to manual controls (potentiometers, variable capacitors, etc.).

Alignment versus Calibration

The term “Alignment” is defined as the ability, through the RSS, to adjust the maximum deviation, the frequency of the reference oscillator and the coarse output power of the transmitter. Alignment is performed at a single frequency that is normally at the center of the operating range.

The term “Calibration” is defined as the ability, through the RSS, to adjust the RF output power and the maximum system deviation of the transmitter on sixteen (16) frequency points that span the entire bandwidth of the radio.

When the radio is calibrated at the factory, it will perform within specification on any customer frequency within the frequency band. Therefore, any further adjustment or calibration should not be necessary in the field. The only exception is the alignment of the reference oscillator. Due to the aging characteristics of quartz crystals, the frequency of the oscillator may change over time. This requires that the frequency of the reference oscillator is periodically readjusted.

Periodic adjustment is not necessary for the output power and the maximum deviation of the transmitter. These operational characteristics of the transmitter do not change over time. It is not recommended to use the adjustment windows for output power and deviation unless absolutely necessary. If an output power adjustment greater than 10 percent is encountered, then the test equipment, cables and antenna loads should be verified as not being defective. If the maximum deviation adjustment is greater than 10 percent, the test equipment should be checked. If the radio is operating beyond these limits, it is recommended that the calibration be performed instead of alignment.

The procedures for Alignment and Calibration are explained in the next paragraphs.

Alignment

A. Test Setup and Initial Reading of Radio Data

1. Connect the radio to an IBM® PC or compatible computer using the Radio Interface Box (RIB) and the appropriate cables.
2. Connect the “RF In/Out” of the CSA to the antenna connector of the radio.
3. Connect the CSA “Mod Out” port to the audio input connector of the breakout box in the cable from the RIB to the radio
4. Turn on power to all equipment.
5. Start the Radio Service Software (RSS) for the radio.
6. From the “Main Menu”, press F2, “ SERVICE Alignment, Service Aids, Board Replacement”. The “Alignment Menu” is shown in Figure 11.1.

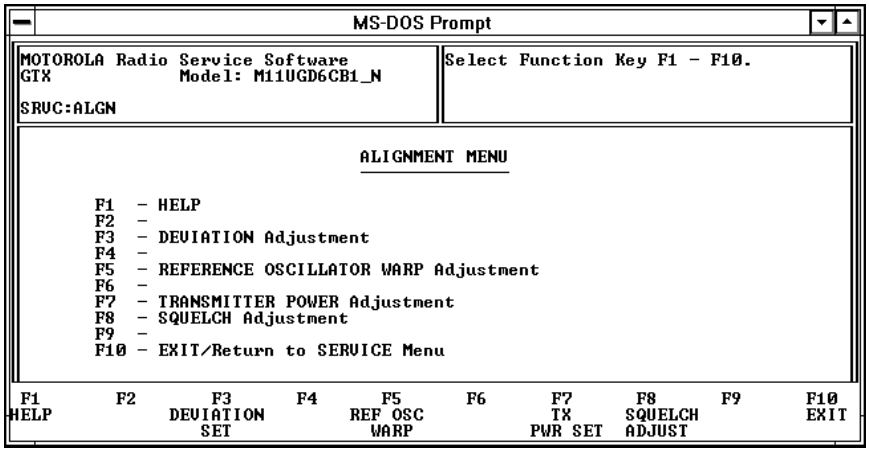

Figure 11.1 – Alignment Menu

B. Transmitter Deviation Adjustment

The Transmit Deviation Adjustment allows adjustment of the maximum deviation. This adjustment affects all of the frequencies within the operating bandwidth of the radio.

1. Press F3, “DEVIATION Adjustment”. The adjustments for the “Balance” and “Deviation” attenuators are shown in Figure 11.2.

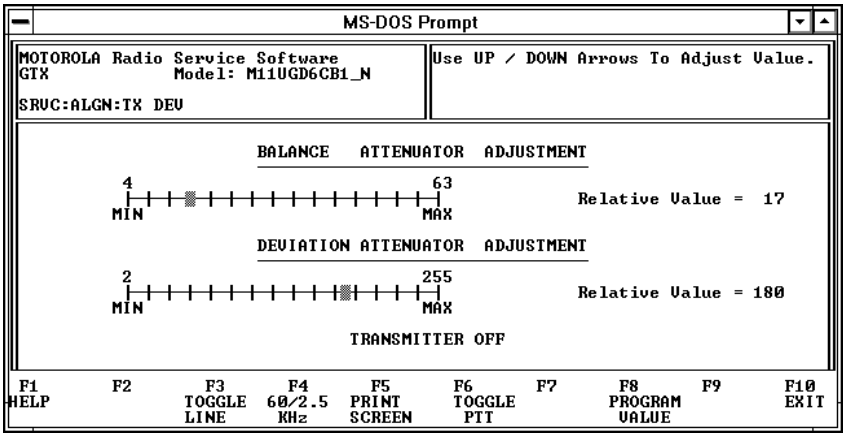

Figure 11.2 – Transmit Deviation Adjustments

2. The “Balance” attenuator is adjusted first. Key the transmitter by pressing F6, “Toggle PTT”.
3. Measure the deviation of the 60 Hz modulating tone of the transmitter with the CSA.
4. Press F4, “60/2.5 kHz”, to change to the 2.5 kHz modulating tone.
5. Measure the deviation of the 2.5 kHz modulating tone of the transmitter with the CSA.
6. Use the Up/Down arrow keys to equalize the deviation for the 60 Hz and 2.5 kHz tones.
7. Press F3, “Toggle Line” to select the “Deviation Attenuator Adjustment”.
8. Adjust the output level of the “Mod Out” of the 1 kHz tone output of the CSA to 800-mV rms.
9. Measure the deviation of the 1 kHz modulating tone of the transmitter with the CSA.
10. Use the Up/Down arrow keys to adjust the deviation of the 1 kHz tone until the correct deviation is obtained. If the radio cannot be adjusted for rated deviation and the Relative Value is at a maximum or a minimum value, refer to the service manual for the radio for repair procedures.
11. Press F6, “Toggle PTT”, to unkey the transmitter.
12. Press F8, “Program Value”, to store the new data in the codeplug of the radio.

C. Transmit Frequency Adjustment (Warp)

The Transmit Frequency Warp window allows adjustment of the frequency of the 16.8 MHz reference oscillator (TXCO). The screen displays a relative scale of the alignment range available and the current position of the alignment inside that range.

1. Select “REFERENCE OSCILLATOR WARP” from the alignment menu. The reference oscillator warp screen is shown in Figure 11.3.

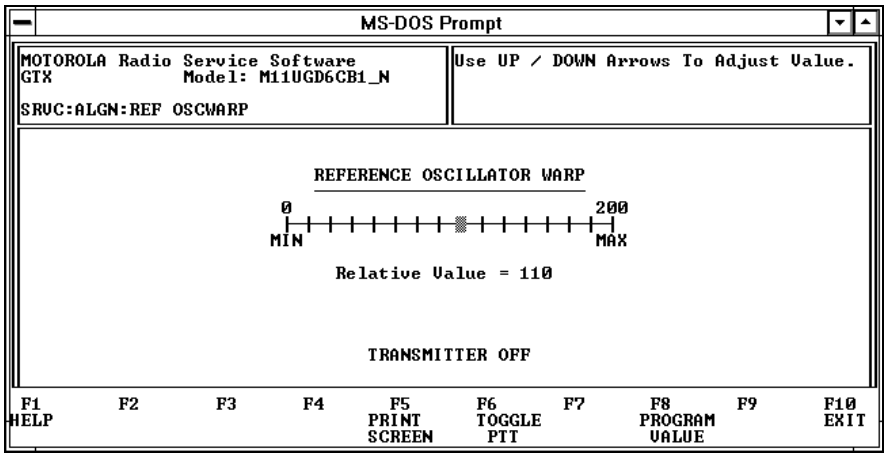

Figure 11.3 – Reference Oscillator Warp

2. Press F6, “Toggle PTT”, to key the transmitter.
3. Measure the frequency of the transmitter with the CSA.
4. Use the Up/Down arrow keys to adjust the frequency of the transmitter. If the radio cannot be adjusted for the correct test frequency and the Relative Value is at a maximum or a minimum value, refer to the service manual for the radio for repair procedures.
5. Press F6, “Toggle PTT”, to unkey the transmitter.
6. Press F8, “Program Value”, to store the new data in the codeplug of the radio.

D. Transmit Power Adjustment

The Transmitter Power Adjustment screen allows electronic adjustment of the RF output power of the transmitter. The screen displays a relative scale of the range available and the current position of the alignment within that range.

1. Press F7, “TRANSMITTER POWER Adjustment” from the alignment menu. The transmitter power adjustment screen is shown in Figure 11.4.

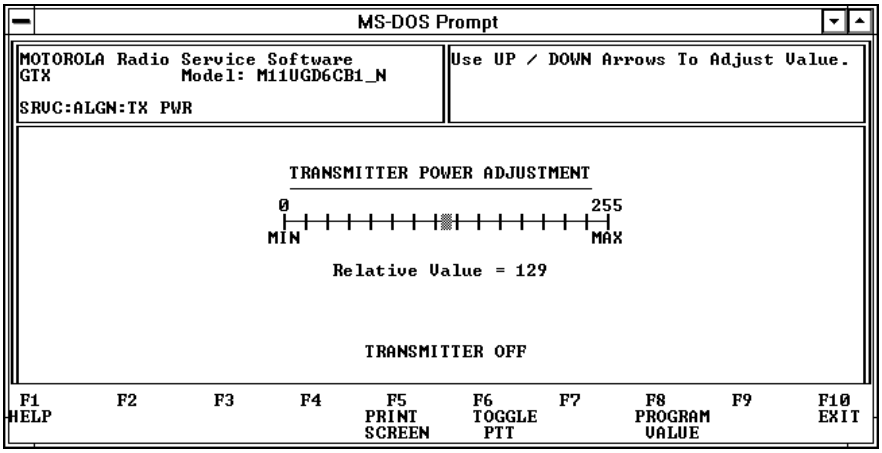

Figure 11.4 –Transmit Power Adjustment

2. Press F6, “Toggle PTT”, to key the transmitter.
3. Measure the RF output power of the transmitter with the CSA.

4. Use the Up/Down arrow keys to adjust the output power of the transmitter. If the radio cannot be adjusted for the correct output power and the Relative Value is at a maximum or a minimum value, refer to the service manual for the radio for repair procedures.
5. Press F6, “Toggle PTT”, to unkey the transmitter.
6. Press F8, “Program Value”, to store the new data in the codeplug of the radio.

Calibration

A. Test Setup and Initial Reading of Radio Data

1. Connect the radio to an IBM® PC or compatible computer using the Radio Interface Box (RIB) and the appropriate cables.
2. Connect the “RF In/Out” of the CSA to the antenna connector of the radio.
3. Connect the CSA “Mod Out” port to the audio input connector of the breakout box in the cable from the RIB to the radio
4. Turn on power to all equipment.
5. Start the Radio Service Software (RSS) for the radio.
6. From the “Main Menu”, press F6, “ BOARD REPLACEMENT Procedures”.
7. Press F2, “LOGIC OR RF BOARD”, from the Board Replacement Menu. The “Logic or RF Board Replacement Procedure” screen is shown in Figure 11.6.

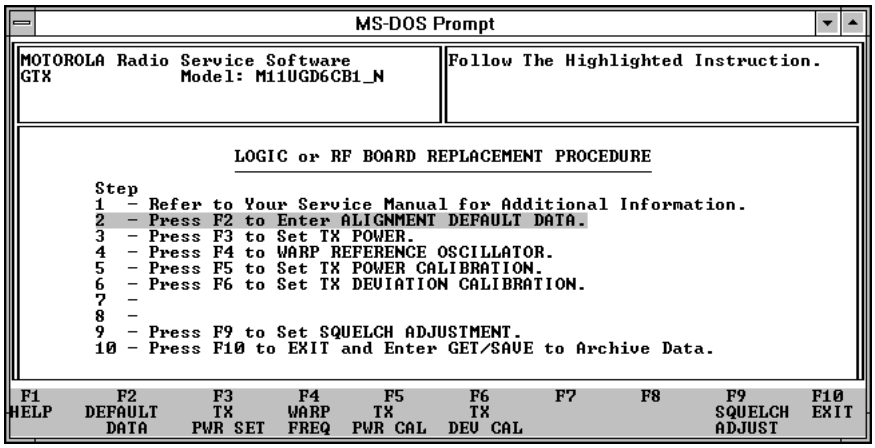

Figure 11.6 – Logic or RF Board Replacement Procedure

8. Press F2, “Enter Alignment Default data” from the board replacement menu.
9. Press F8, “Program Value”, if the default tuning data is required or, press F10, “Exit”, if the present values are sufficient.

B. Set Transmit Power

The Transmitter Power Adjustment screen allows electronic adjustment of the RF output power of the transmitter. The screen displays a relative scale of the range available and the current position of the alignment within that range.

1. Press F3, “Set TX POWER” from the board replacement menu. The transmitter power adjustment screen is shown in Figure 11.7.

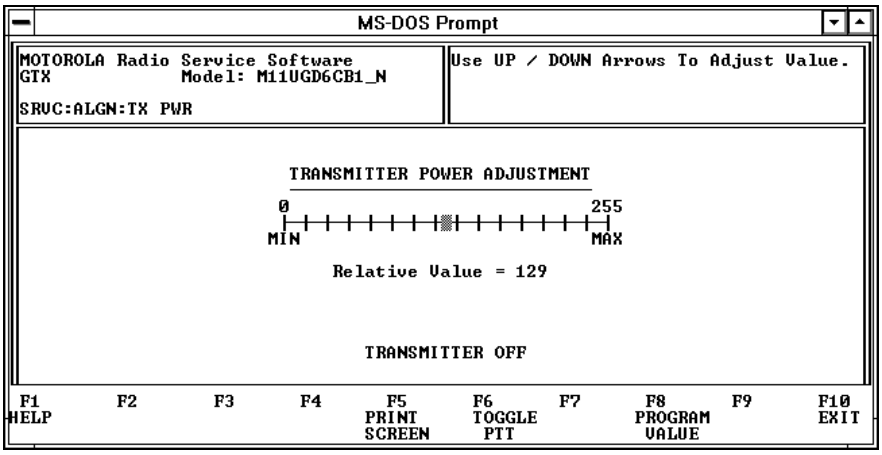

Figure 11.7 –Transmit Power Adjustment

2. Press F6, “Toggle PTT”, to key the transmitter.
3. Measure the RF output power of the transmitter with the CSA.
4. Use the Up/Down arrow keys to adjust the output power of the transmitter. If the radio cannot be adjusted for the correct output power and the Relative Value is at a maximum or a minimum value, refer to the service manual for the radio for repair procedures.
5. Press F6, “Toggle PTT”, to unkey the transmitter.
6. Press F8, “Program Value”, to store the new data in the codeplug of the radio.

C. Warp Transmit Frequency

The Warp Reference Oscillator screen allows adjustment of the frequency of the 16.8 MHz reference oscillator (TXCO). The screen displays a relative scale of the alignment range available and the current position of the alignment inside that range.

1. Press F4, “WARP REFERENCE OSCILLATOR” from the replacement menu. The reference oscillator warp screen is shown in Figure 11.8.

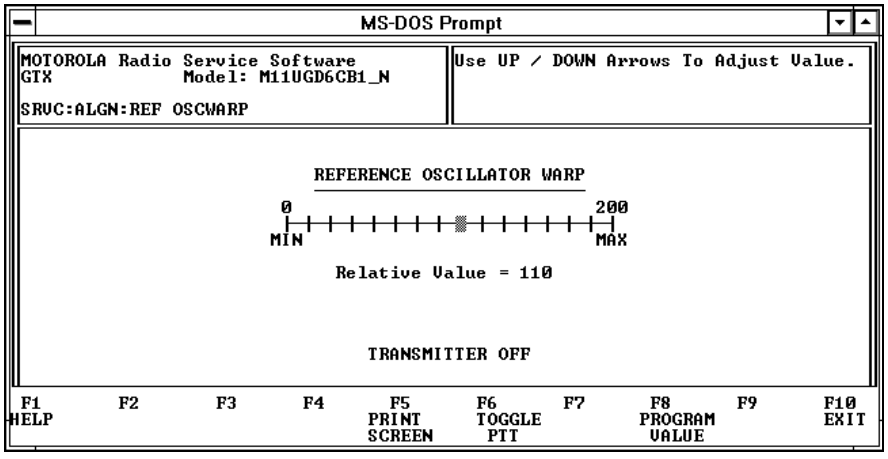

Figure 11.8 – Reference Oscillator Warp

2. Press F6, “Toggle PTT”, to key the transmitter.
3. Measure the frequency of the transmitter with the CSA.

4. Use the Up/Down arrow keys to adjust the frequency of the transmitter. If the radio cannot be adjusted for the correct test frequency and the Relative Value is at a maximum or a minimum value, refer to the service manual for the radio for repair procedures.
5. Press F6, “Toggle PTT”, to unkey the transmitter.
6. Press F8, “Program Value”, to store the new data in the codeplug of the radio.

D. Transmit Power Calibration

The Transmitter Power Calibration window allows adjusting the RF output power of the transmitter across the operating bandwidth of the radio. The screen displays the relative value within the allowable range for each of sixteen (16) tuning points. Use the following procedure to calibrate the output power settings.

1. Press F5, “Set TX POWER CALIBRATION” from the board replacement menu. The transmitter power calibration procedure is shown in Figure 11.9.

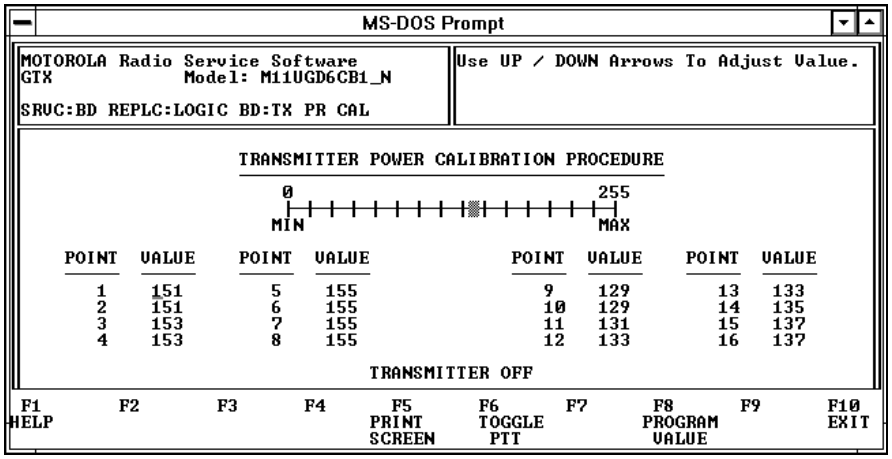

Figure 11.9 –Transmitter Power Calibration

2. Press F6, “Toggle PTT”, to key the transmitter.
3. Measure the RF output power of the transmitter with the CSA.
4. Use the Up/Down arrow keys to adjust the output power of the transmitter. If the radio cannot be adjusted for the correct output power and the Relative Value is at a maximum or a minimum value, refer to the service manual for the radio for repair procedures.
5. Note the current drain of the radio for the proper output power level.
6. Press F6, “Toggle PTT”, to unkey the transmitter.
7. Press “Tab” to advance to the next tuning point.
8. Repeat steps 2 to 6 to adjust the output power for all sixteen (16) tuning points.
9. Press F8, “Program Value”, to store the new data in the codeplug of the radio.

E. Transmit Current Limit Adjustment

The Transmitter Power Calibration window allows adjusting the RF output power of the transmitter across the operating bandwidth of the radio. The screen displays the relative value within the allowable range for each of eight (8) tuning points. Use the following procedure to calibrate the output power settings.

1. Press F10, “Exit”. The transmitter current limit adjust screen is shown in Figure 11.10.

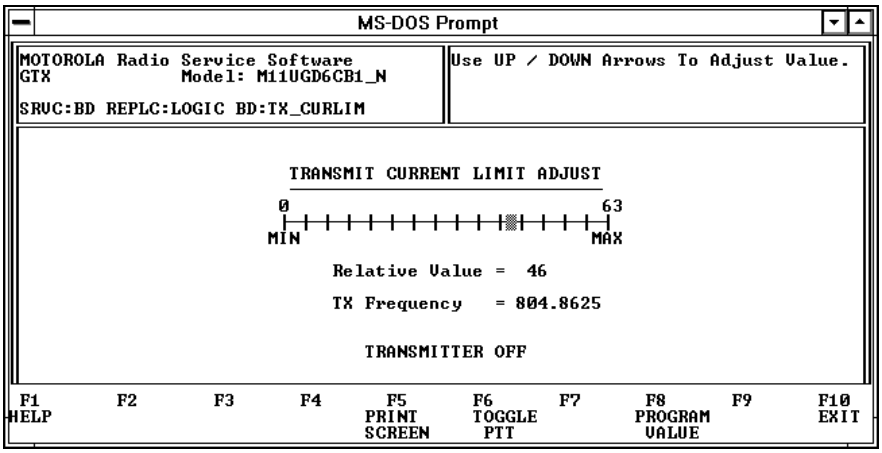

Figure 11.10 –Transmit Current Limit Adjust

2. Press F6, “Toggle PTT”, to key the transmitter.
3. Measure the current of the transmitter.
4. Press F6, “Toggle PTT”, to unkey the transmitter.
5. Press “Tab” to advance to the “TX Frequency” highlight. Use the Up/Down arrow keys to select the next test frequency.
6. Repeat steps 2 to 5 to determine which frequency produces the highest current drain.
7. Use the Up/Down arrow keys to select the test frequency corresponding to the highest current drain.
8. Press “Tab” to return to “Relative Value” highlight.
9. Press F6, “Toggle PTT”, to key the transmitter.
10. Use the Up/Down arrow keys to adjust the current limit point to the maximum current as specified in the service manual. For the transmitter covered by FCC ID ABZ99FT3003, the maximum current is 12 Amperes.
11. Press F6, “Toggle PTT”, to unkey the transmitter.
12. Press F8, “Program Value”, to store the new data in the codeplug of the radio.

F. Transmit Deviation Calibration

The Transmit Deviation Calibration screens allow adjustment of the modulation balance and the maximum deviation at sixteen (16) frequency points across the operating bandwidth of the radio. The screens display the frequency to which the transmitter has been programmed by the RSS and a relative scale for the value of the balance and the maximum deviation at each frequency.

Modulation Balance

1. Press F6, “Set TX DEVIATION CALIBRATION”, from the board replacement menu. The balance calibration screen is shown in Figure 11.11.

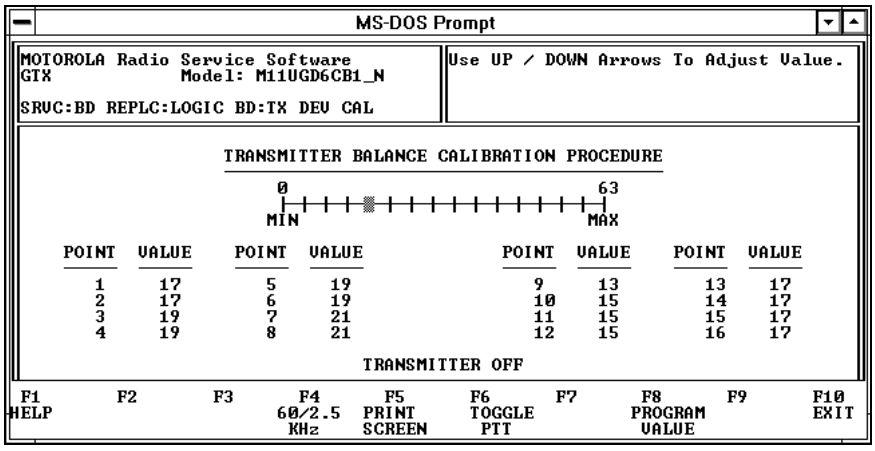

Figure 11.11 – Transmit Deviation Calibration

2. Key the transmitter by pressing F6, “Toggle PTT”.
3. Measure the deviation of the 60 Hz modulating tone of the transmitter with the CSA.
4. Press F4, “60/2.5 kHz”, to change to the 2.5 kHz modulating tone.
5. Measure the deviation of the 2.5 kHz modulating tone of the transmitter with the CSA.
6. Use the Up/Down arrow keys to equalize the deviation for the 60 Hz and 2.5 kHz tones.
7. Press F6, “Toggle PTT”, to unkey the transmitter.
8. Press “Tab” to advance to the next tuning point.
9. Repeat steps 2 to 8 to adjust the modulation balance at each of the sixteen (16) tuning points.

Deviation Calibration

1. Adjust the output level of the “Mod Out” of the CSA to 800-mV rms.
2. Press F10, “Exit”, to terminate the balancing adjustments and enter the deviation calibration procedure. The deviation calibration screen is shown in Figure 11.12.

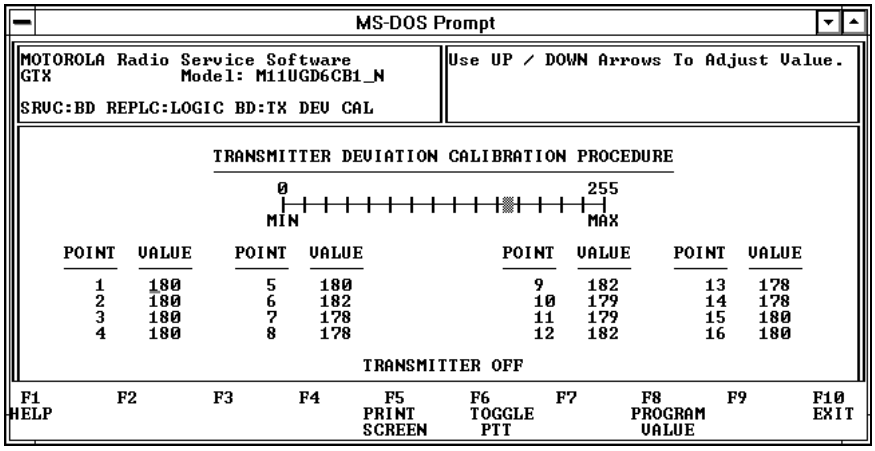

Figure 11.12 – Transmit Deviation Calibration

3. Press F6, “Toggle PTT”, to key the transmitter.
4. Measure the deviation of the 1 kHz modulating tone of the transmitter with the CSA.
5. Use the Up/Down arrow keys to adjust the deviation of the 1 kHz tone until the correct deviation is obtained. If the radio cannot be adjusted for rated deviation and the Relative

Value is at a maximum or a minimum value, refer to the service manual for the radio for repair procedures.

6. Press F6, “Toggle PTT”, to unkey the transmitter.
7. Press “Tab” to advance to the next tuning point.
8. Repeat steps 3 to 7 to adjust the transmitter deviation at each of the sixteen (16) tuning points.
9. Press F8, “Program Value”, to store the new data in the codeplug of the radio.