Parts list and Tuning Procedures

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 10A Function of RF Semiconductors and Other Active Devices

Exhibit 10B List of Recommended Test Equipment for Servicing

Exhibit 10C Tuning Procedures

Function of RF Semiconductors & Other Active Devices

REF NUMBER	PART NUMBER	CIRCUIT APPLICATION	OPERATING FREQUENCY	INDUSTRY EQUIVALENT
CR1	48-80154K03	CLIPPER	444-474 MHz	MMBD353
CR2	48-80142L01	RF SWITCH	444-474 MHz	MMBV3401
CR3	48-80142L01	RF PIN SWITCH	444-474 MHz	MMBV3401
CR4	48-80142L01	RF PIN SWITCH	444-474 MHz	MMBV3401
CR5	48-80142L01	RF PIN SWITCH	444-474 MHz	MMBV3401
CR6	48-80142L01	RF PIN SWITCH	444-474 MHz	MMBV3401
CR7	48-80142L01	RF PIN SWITCH	444-474 MHz	MMBV3401
CR8	48-80939T01	DC SWITCH	DC	1N15711
CR51	48-80154K03	CLIPPER	44.85 MHz	MMBD353
CR151	48-62824C03	RX VCO FREQ CONTROL	399.15-429.15 MHz	1SV232
CR152	48-62824C03	RX VCO FREQ CONTROL	399.15-429.15 MHz	1SV232
CR153	48-80154K02	RX VCO AGC	399.15-429.15 MHz	BAS7004TA
CR201	48-13833C07	VOLTAGE MULTIPLIER	1.05 MHz	MMBD7000
CR202	48-13833C07	VOLTAGE MULTIPLIER	1.05 MHz	MMBD7000
CR203	48-13833C07	VOLTAGE MULTIPLIER	16.8 MHz	MMBD7000
CR206	48-80154K02	TX VCO AGC	444-474 MHz	BAS7004TA
CR251	48-62824C03	TX VCO FREQ CONTROL	444-474 MHz	1SV232
CR252	48-62824C03	TX VCO FREQ CONTROL	444-474 MHz	1SV232
CR253	48-62824C01	TX VCO MODULATOR	444-474 MHz	1SV229
CR401	48-05129M76	SHORT CIRCUIT PROTECTION	DC	MMBD914
CR402	48-83654H02	TEMPERATURE COMPENSATION	DC	
CR403	48-05129M76	DC SWITCH	DC	MMBD914
CR405	48-05129M76	DC SWITCH	DC	MMBD914
CR451	48-05129M76	DC SWITCH	DC	MMBD914
CR452	48-05129M76	TEMPERATURE COMPENSATION	DC	MMBD914
CR651	48-13833C07	ESD PROTECTION	AUDIO	MMBD7000
CR652	48-13833C07	ESD PROTECTION	AUDIO	MMBD7000
CR653	48-13833C07	ESD PROTECTION	AUDIO	MMBD7000
CR801	48-80939T01	SWITCH	5 kHz	1N15711
CR901	48-13833C07	ESD PROTECTION	DC	MMBD7000
CR902	48-05129M76	DC SWITCH	DC	MMBD914
CR903	48-13833C07	ESD PROTECTION	5 kHz	MMBD7000
CR2680	48-80236E07	TRANSIENT SUPPRESSOR	DC	MR2535L
Q1	48-13827A24	RF AMPLIFIER	444-474 MHz	MRF5812
Q2	48-13824A17	RF AMP BIAS CONTROL	DC	MMBT3906

REF NUMBER	PART NUMBER	CIRCUIT APPLICATION	OPERATING FREQUENCY	INDUSTRY EQUIVALENT
Q51	48-13827A07	I-F AMPLIFIER	44.85 MHz	MMBR941
Q52	48-13827A07	SECOND LOCAL OSCILLATOR	44.395 MHz	MMBR941
Q53	48-80947V01	DC SWITCH	DC	DTC144W
Q54	48-80947V01	DC SWITCH	DC	DTC144W
Q101	48-13824A17	CHARGE PUMP	6.25 kHz	MMBT3906
Q102	48-80214G02	CHARGE PUMP	6.25 kHz	MMBT3904
Q103	48-13824A17	LOCK DETECTOR	DC	MMBT3906
Q104	48-80947V01	DC SWITCH	DC	DTC144W
Q105	48-80214G02	LEVEL SHIFTER	6.25 kHz	MMBT3904
Q151	48-05128M66	RX VCO	399.15-429.15 MHz	MMBFU310
Q152	48-13827A07	RX VCO FIRST BUFFER	399.15-429.15 MHz	MMBR941
Q153	48-13827A07	RX VCO SECOND BUFFER	399.15-429.15 MHz	MMBR941
Q154	48-13827A07	RX VCO FEEDBACK BUFFER	399.15-429.15 MHz	MMBR941
Q201	48-13824A17	VOLTAGE MULTIPLIER	16.8 MHz	MMBT3906
Q202	48-80214G02	VOLTAGE MULTIPLIER	16.8 MHz	MMBT3904
Q203	48-80494U01	LOCK DETECTOR	5 kHz	DTA144W
Q204	48-80947V01	DC SWITCH	DC	DTC144W
Q251	48-05128M66	TX VCO	444-474 MHz	MMBFU310
Q252	48-13827A07	TX VCO FIRST BUFFER	444-474 MHz	MMBR941
Q253	48-13827A07	TX VCO SECOND BUFFER	444-474 MHz	MMBR941
Q254	48-13827A07	TX VCO FEEDBACK BUFFER	444-474 MHz	MMBR941
Q276	48-80214G02	DC FILTER	DC	MMBT3904
Q401	48-00869619	REGULATOR PASS DEVICE	DC	MJE371
Q402	48-80214G02	DC AMPLIFIER	DC	MMBT3904
Q403	48-80214L03	DC SWITCH	DC	BCW68G
Q404	48-80214G02	DC SWITCH	DC	MMBT3904
Q451	48-00869619	POWER CONTROL PASS DEVICE	DC	MJE371
Q452	48-80214G02	POWER CONTROL DRIVER	DC	MMBT3904
Q453	48-80214G02	CURRENT AMPLIFIER	DC	MMBT3904
Q501	48-80947V01	DC SWITCH	DC	DTC144W
Q901	48-80947V01	DC SWITCH	DC	DTC144W
Q902	48-80214L03	DC SWITCH	DC	BCW68G
Q903	48-80947V01	DC SWITCH	DC	DTC144W
Q904	48-80947V01	DC SWITCH	DC	DTC144W
Q905	48-80947V01	DC SWITCH	DC	DTC144W
Q906	48-80947V01	DC SWITCH	DC	DTC144W
Q907	48-80947V01	DC SWITCH	DC	DTC144W
Q908	48-80947V01	DC SWITCH	DC	DTC144W
Q909	48-80947V01	DC SWITCH	DC	DTC144W
Q910	48-80947V01	DC SWITCH	DC	DTC144W
Q911	48-80947V01	DC SWITCH	DC	DTC144W
Q912	48-80947V01	DC SWITCH	DC	DTC144W
REF NUMBER	PART NUMBER	CIRCUIT APPLICATION	OPERATING FREQUENCY	INDUSTRY EQUIVALENT

Q913	48-80494U01	DC SWITCH	DC	DTA144W
Q918	48-80947V01	DC SWITCH	DC	DTC144W
Q919	48-80947V01	DC SWITCH	DC	DTC144W
Q2610	48-02245J24	RF BUFFER STAGE	444-474 MHz	BFG35
Q2620	48-80225C09	GAIN CONTROLLED DRIVER	444-474 MHz	MRF630
Q2630	48-80225C19	RF PA FINAL AMPLIFIER	444-474 MHz	MRF654
U1	51-80470U01	DOUBLE BALANCED MIXER	44.85-474 MHz	LRFMS-1A-17
U2	48-09939C04	DC SWITCH	DC	UMC3TL
U3	48-09939C04	DC SWITCH	DC	UMC3TL
U4	48-09939C04	DC SWITCH	DC	UMC3TL
U51	51-80605E02	RECEIVER SYSTEM	44.85 MHz/455 kHz	CUSTOM
U52	51-05663U35	RF SWITCH	455 kHz	4066B
U53	51-05663U35	RF SWITCH	455 kHz	4066B
U101	51-80154R02	RX SYNTHESIZER	16.8-429.15 MHz	MB15A02PF
U201	51-05457W72	TX SYNTHESIZER	1.05-474 MHz	CUSTOM
U202	51-80404C05	REFERENCE OSCILLATOR	16.8 MHz	CUSTOM
U251	48-09939C04	DC SWITCH	DC	UMC3TL
U252	48-09939C04	DC SWITCH	DC	UMC3TL
U301	51-05469E65	5V REGULATOR	DC	LP2951C
U302	51-13806A35	SHIFT REGISTER	5 kHz	MC14094B
U401	51-02198J22	ERROR/DC AMPLIFIER	DC	4558
U402	51-80942T01	5V REGULATOR W/RESET	DC	LV387
U451	51-02198J22	ERROR/DC AMPLIFIER	DC	4558
U452	05-05226P38	D/A CONVERTER	5 kHz	CUSTOM
U501	51-09699X01	AUDIO POWER AMPLIFIER	AUDIO	TDA1519C
U551	51-80604E01	RX AUDIO FILTER	2.1 MHz	CUSTOM
U552	51-62852A09	AUDIO LIMITER	AUDIO	LMC7101
U553	51-80932W01	AUDIO AMP/FILTER	AUDIO	LM2904
U554	51-80932W01	AUDIO AMP/INVERTER	AUDIO	LM2904
U555	51-02198J22	AUDIO AMPLIFIER	AUDIO	4558
U556	51-80932W01	AUDIO AMPLIFIER	AUDIO	LM2904
U557	51-05663U35	AUDIO SWITCH	AUDIO	4066B
U558	51-05663U35	AUDIO SWITCH	AUDIO	4066B
U559	51-84704M60	AUDIO SWITCH	AUDIO	4053B
U560	51-84704M60	AUDIO SWITCH	AUDIO	4053B
U561	51-80932W01	AUDIO AMPLIFIER	AUDIO	LM2904
U562	51-13811A35	AUDIO COMPANDER	AUDIO	MC33111

REF NUMBER	PART NUMBER	CIRCUIT APPLICATION	OPERATING FREQUENCY	INDUSTRY EQUIVALENT
U601	51-80516U01	DATA CENTER SLICER	AUDIO	TA75S393F
U651	51-80604E01	AUDIO FILTER	2.1 MHz	CUSTOM
U652	51-80932W01	AUDIO AMP/SUMMER	AUDIO	LM2904
U653	51-84704M60	AUDIO SWITCH	AUDIO	4053B
U654	51-05663U35	AUDIO SWITCH	AUDIO	4066B
U655	51-05416G61	NOR GATE	DC	TC7S00F
U656	48-09939C04	DC SWITCH	DC	UMC3TL
U801	51-80489U01	MICROCOMPUTER	8.4 MHz	MC68HC11KA4
VR401	48-83461E40	VOLTAGE REFERENCE	DC	1N5231
VR402	48-80140L06	VOLTAGE REGULATOR	DC	MMBZ5231
VR551	48-80140L15	ESD PROTECTION	DC	MMBZ5240
VR553	48-80140L15	ESD PROTECTION	DC	MMBZ5240
VR901	48-80948V01	ESD PROTECTION	DC	MMBZ5254
VR902	48-80948V01	ESD PROTECTION	DC	MMBZ5254
VR903	48-80948V01	ESD PROTECTION	DC	MMBZ5254
VR904	48-80948V01	ESD PROTECTION	DC	MMBZ5254
VR905	48-80948V01	ESD PROTECTION	DC	MMBZ5254
VR906	48-80948V01	ESD PROTECTION	DC	MMBZ5254
VR907	48-80948V01	ESD PROTECTION	DC	MMBZ5254
VR908	48-80948V01	ESD PROTECTION	DC	MMBZ5254
VR909	48-80948V01	ESD PROTECTION	DC	MMBZ5254
VR910	48-80948V01	ESD PROTECTION	DC	MMBZ5254

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)	HLN9214	Computer to Radio Interface
Cable	HKN9215 or HKN9216	RIB to Computer
Cable	HKN9217	RIB to Radio
Software	HVN9054	Radio Alignment

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

TUNING PROCEDURE

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
U801	Microcomputer	Monitors Output of Power Limiting Circuit and Supplies data to Attenuators, Temperature Compensated Crystal Oscillator, and Digital to Analog Converter for Transmitter Modulation, Frequency and Power Adjustment
U201	Programmable Attenuator	VCO Modulation Sensitivity
U201	Programmable Attenuator	Reference Modulation Sensitivity
U651	Programmable Attenuator	Deviation Adjustment
U202	Temperature Compensated Crystal Oscillator	Transmitter Frequency Adjustment
U452	Digital to Analog Converter	Transmitter Power Adjustment

The value of a particular tuning element is determined by data sent to that tuning element by microcomputer U801. This data is generated by the microcomputer based on tuning information that is stored in the microcomputer's Electrically Erasable Programmable Read Only Memory (EEPROM).

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.).

Adjustments versus Calibration

The term "Adjustment" is the ability, through the RSS, to adjust the coarse output power, the maximum deviation and the frequency of the reference oscillator of the transmitter. Adjustments are performed at a single frequency that is normally at the center of the operating range.

The term "Calibration" is the ability, through the RSS, to adjust the RF output power and the maximum system deviation of the transmitter on eight 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 must be 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 adjustment.

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

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. Set the radio to the lowest customer frequency via the front panel “Up/Down” channel pushbuttons of the radio.
6. Start the Radio Service Software (RSS) for the radio.
7. Select **Service** from the menu bar.
8. Click on “Read Radio for Service”.
9. After the radio is read, again select **Service** from the menu bar. The adjustments and calibrations for the radio are shown in Figure 7.1.

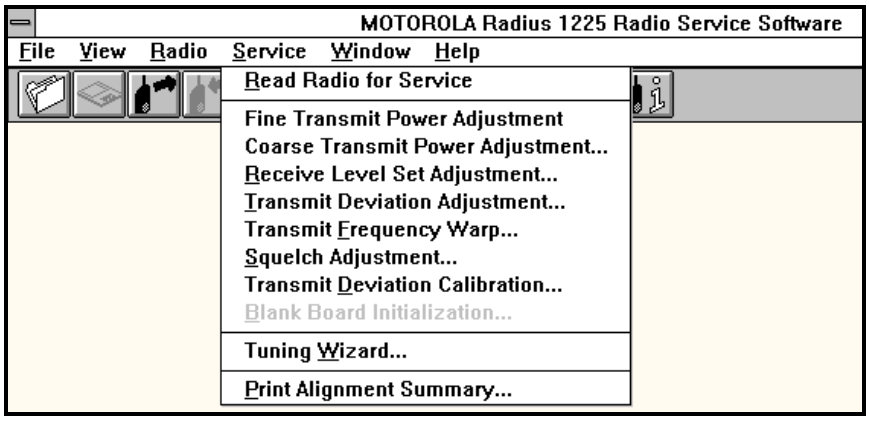

Figure 7.1 – Adjustments and Calibrations

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. Select “Transmit Deviation Adjustment” from the Service dropdown menu. The service adjustment window is shown in Figure 7.2.

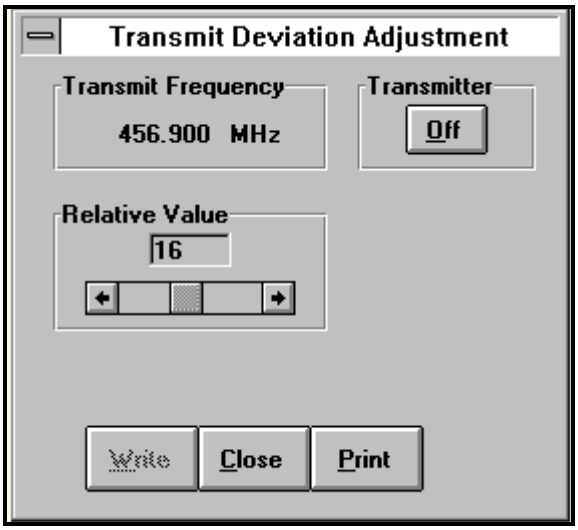

Figure 7.2 – Transmit Deviation Adjustment

2. Adjust the output level of the “Mod Out” of the CSA to 800 mV rms.
3. Key the transmitter by clicking the “Transmitter” button; the button will change to display “On” when the transmitter turns on.
4. Measure the maximum deviation of the transmitter with the CSA.
5. Unkey the transmitter by clicking the Transmitter button; the button will change to display “Off” when the transmitter turns off.
6. Use the right Relative Value arrow button to increase the maximum deviation. Use the left Relative Value arrow button to decrease the maximum deviation.
7. Perform steps 3 to 6 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.
8. Click the Write button to save the new value to the radio.
9. Click the Close button to exit the Transmitter Deviation Adjustment.

C. Transmit Deviation Calibration

The Transmit Deviation calibration window allows adjustment of the maximum deviation at eight (8) frequency points across the operating bandwidth of the radio. The window displays the frequency to which the transmitter has been programmed by the RSS and a relative scale for the value of the maximum deviation at each frequency.

1. Select “Transmit Deviation Calibration” from the Service dropdown menu. The service adjustment window is shown in Figure 7.3.

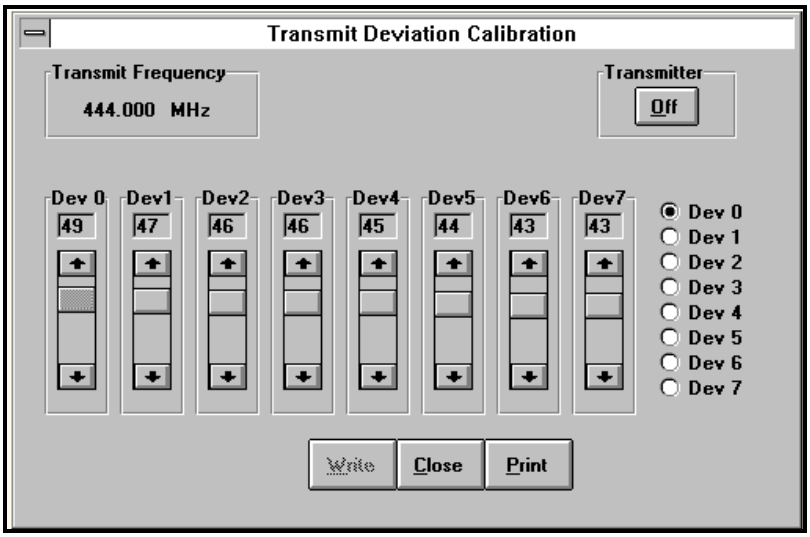

Figure 7.3 – Transmit Deviation Calibration

2. For full calibration, start with “Dev 0”.
3. Adjust the output level of the “Mod Out” of the CSA to 800 mV rms.
4. Key the transmitter by clicking the Transmitter button; the button will change to display “On” when the transmitter turns on.
5. Measure the maximum deviation of the transmitter with the CSA.
6. Unkey the transmitter by clicking the Transmitter button; the button will change to display “Off” when the transmitter turns off.
7. Use the up arrow button to increase the maximum deviation. Use the down arrow button to decrease the maximum deviation.
8. Perform steps 4 to 7 until the correct deviation is obtained. If the radio cannot be adjusted for rated deviation and the value displayed in the “Dev” window is at the maximum or the minimum, refer to the service manual for the radio for repair procedures.
9. After the correct maximum deviation is attained for the first tuning point, “Dev 0”, click on the “Dev 1” selector.
10. Perform steps 4 to 8 for each tuning point (“Dev 0” through “Dev 7).
11. Click the Write button to save the new values to the radio.
12. Click the Close button to exit the Transmit Deviation Calibration.

D. Transmit Frequency Adjustment (Warp)

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

1. Select “Transmit Frequency Warp” from the Service dropdown menu. The service adjustment window is shown in Figure 7.4.

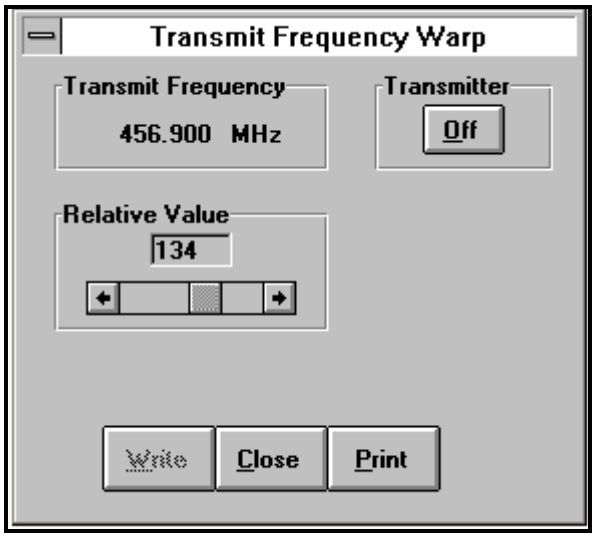

Figure 7.4 – Transmit Frequency Warp

2. Key the transmitter by clicking the "Transmitter" button; the button will change to display "On" when the transmitter turns on.
3. Measure the frequency of the transmitter with the CSA.
4. Unkey the transmitter by clicking the Transmitter button; the button will change to display "Off" when the transmitter turns off.
5. Use the right Relative Value arrow button to increase the frequency. Use the left Relative Value arrow button to decrease the frequency.
6. Perform steps 3 to 6 until the frequency is obtained. If the radio cannot be adjusted to the correct frequency and the Relative Value is at a maximum or a minimum value, refer to the service manual for the radio for repair procedures.
7. Click the Write button to save the new value to the radio.
8. Click the Close button to exit the Transmitter Deviation Adjustment.

E. Coarse Transmit Power Adjustment

The Coarse Transmitter Power Adjustment window allows electronic adjustment of the RF output power of the transmitter. The window displays a relative scale of the range available and the current position of the alignment within that range. The RF output power can be adjusted to two different values, Low Power and High Power. Each channel of operation may be assigned either the Low or the High value. Use the following procedure to adjust the coarse power settings.

1. Select "Coarse Transmit Power Adjustment" from the Service dropdown menu. The service adjustment window is shown in Figure 7.5.

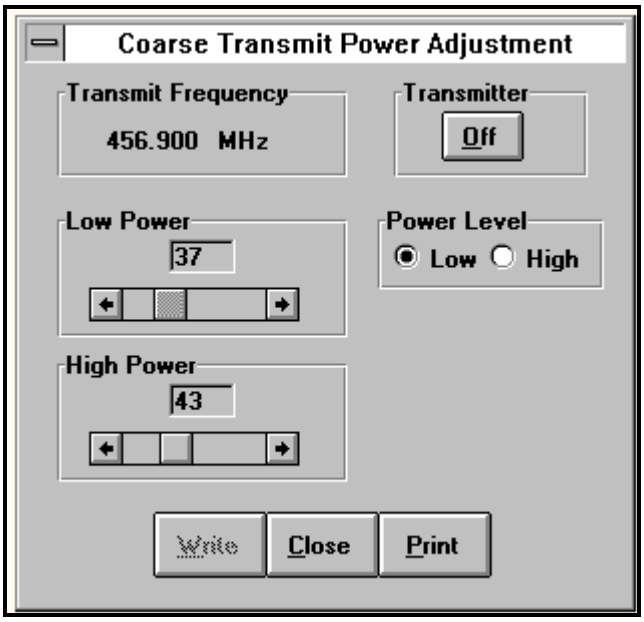

Figure 7.5 – Coarse Transmit Power Adjustment

2. Key the transmitter by clicking the "Transmitter" button; the button will change to display "On" when the transmitter turns on.
3. Measure the RF output power of the transmitter with the CSA.
4. Unkey the transmitter by clicking the Transmitter button; the button will change to display "Off" when the transmitter turns off.
5. Use the right Relative Value arrow button to increase the RF output power. Use the left Relative Value arrow button to decrease the RF output power.
6. Perform steps 3 to 6 until the desired RF output power is obtained for the Low Power setting. If the radio cannot be adjusted to the desired RF output power and the relative value is at a maximum or a minimum, refer to the service manual for the radio for repair procedures.
7. When the desired Low Power setting is obtained, click on the High selector button under Power Level.
8. Repeat steps 2 to 6 until the desired RF output power is obtained.
9. Click the Write button to save the new values to the radio.
10. Click the Close button to exit the Coarse Transmitter Power Adjustment.

F. Fine Transmit Power Calibration

The Fine Transmitter Power Calibration window allows adjusting the RF output power of the transmitter across the operating bandwidth of the radio. The window displays the relative value within the allowable range for each of eight tuning points. Calibration is done for both the Low Power and the High Power settings. Use the following procedure to calibrate the fine power settings.

1. Select "Fine Transmit Power Adjustment" from the Service dropdown menu. The service adjustment window is shown in Figure 7.6.

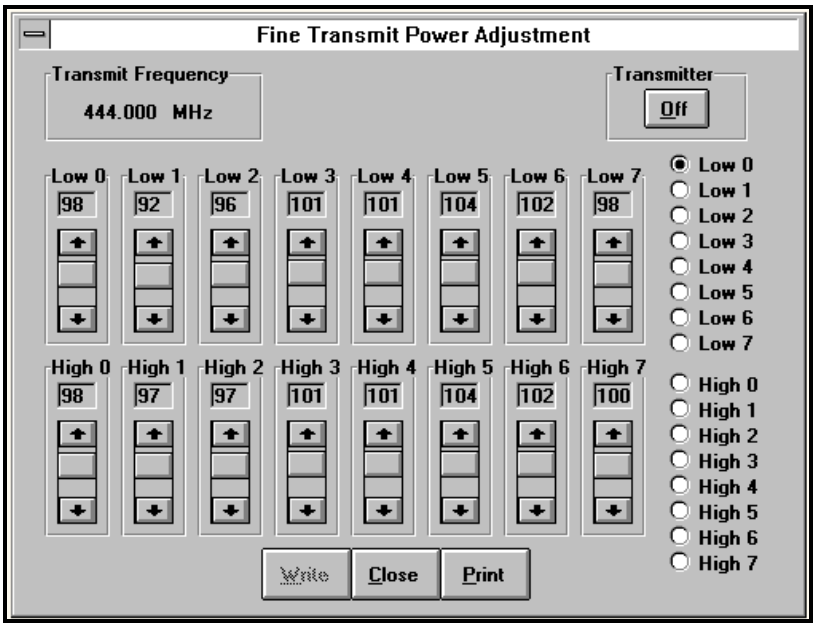

Figure 7.6 – Fine Transmitter Power Calibration

2. For full calibration, start with “Low 0”.
3. Key the transmitter by clicking the Transmitter button; the button will change to display “On” when the transmitter turns on.
4. Measure the RF output power of the transmitter with the CSA.
5. Unkey the transmitter by clicking the Transmitter button; the button will change to display “Off” when the transmitter turns off.
6. Use the up arrow button to increase the RF output power. Use the down arrow button to decrease the RF output power.
7. Perform steps 4 to 7 until the desired RF output power is obtained. If the radio cannot be adjusted for the desired RF output power and the value displayed in the “Low” window is at the maximum or the minimum, refer to the service manual for the radio for repair procedures.
8. After the correct RF output power is attained for the first tuning point, “Low 0”, click on the “Low 1” selector.
9. Perform steps 3 to 7 for each tuning point (“Low 0” through “Low 7).
10. After the Low Power calibration has been completed, click on the “High 0” selector button.
11. Repeat steps 3 to 9 for each of the High Power tuning points (“High 0” through “High 7).
12. Click the Write button to save the new values to the radio.
13. Click the Close button to exit the Fine Transmit Power Calibration.