PARTS LIST AND TUNE UP PROCEDURES

(CONFIDENTIALITY REQUESTED)

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	Tune Up Procedure

Exhibit 10A – Function of RF Semiconductors and Other Active Devices

Pursuant to 47 CFR 2.1033(c)(10)

Reference #	Part #	Circuit Application	Operating Freq.	Industry Equivalent
D100	4813833C02	DC Switch	DC	MMBD6100
D101	4813833C02	DC Switch	DC	MMBD6100
D102	4813833C02	DC Switch	DC	MMBD6100
D103	4802482J02	Antenna Switch	146-174MHz	MA4P959
D104	4802482J02	Antenna Switch	146-174MHz	MA4P959
D105	4805218N57	Reverse Volt. Peak Detector	DC	RB715F
D106	4805218N57	Reverse Volt. Peak Detector	DC	RB715F
D107	4805218N57	Forward Volt. Peak Detector	DC	RB715F
D108	4805218N57	Forward Volt. Peak Detector	DC	RB715F
D200	4802233J09	Voltage Multiplier	1.05MHz	IMN10
D201	4802233J09	Voltage Multiplier	1.05MHz	IMN10
D202	4862824C03	Crystal Warp	DC	1SV232
D203	4805649Q13	RX VCO Frequency Control	190-220MHz	1SV228
D204	4805649Q13	TX VCO Frequency Control	146-174MHz	1SV228
D205	4862824C01	TX VCO Modulator	Audio-174MHz	1SV229
D400	4813833C07	Steering Diode	DC	MMBD7000
D401	4813833C02	Steering Diode	DC	MMBD6100
Q100	4886163B01	TX RF Power Amplifier	146-174MHz	MRF1550
Q101	4813824A10	DC Switch	DC	MMBT3904
Q102	4813824A10	DC Switch	DC	MMBT3904
Q103	4813824A10	DC Switch	DC	MMBT3904
Q105	4886212B01	TX Driver Stage	146-174MHz	MRF1518
Q106	4805128M27	Current Source	DC	BSR33
Q200	4802245J95	RX Injection Amplifier	190-220MHz	BFS540
Q400	4809940E02	DC Switch	DC	DTC114YE
Q403	4809940E02	DC Switch	DC	DTC114YE
Q404	4809940E02	DC Switch	DC	DTC114YE
Q405	4809940E02	DC Switch	DC	DTC114YE
Q406	4809940E02	DC Switch	DC	DTC114YE
Q407	4809940E02	DC Switch	DC	DTC114YE
Q408	4880048M01	DC Switch	DC	DTC144EKA
Q409	4880048M01	DC Switch	DC	DTC144EKA
Q410	4880048M01	DC Switch	DC	DTC144EKA
Q411	4880048M01	DC Switch	DC	DTC144EKA
Q412	4880048M01	DC Switch	DC	DTC144EKA
Q413	4813824A10	DC Switch	DC	MMBT3904
Q414	4813824A10	DC Switch	DC	MMBT3904
Q415	4813824A10	DC Switch	DC	MMBT3904
Q500	4809940E02	DC Switch	DC	DTC114YE
Q502	4809940E02	DC Switch	DC	DTC114YE
Q503	4809940E02	DC Switch	DC	DTC114YE
Q504	4880048M01	DC Switch	DC	DTC144EKA
Q505	4813824A10	DC Switch	DC	MMBT3904
Q506	4813824A10	DC Switch	DC	MMBT3904
U100	5180932W01	Power Control	DC	LM2904
U101	5185130C65	TX Pre-Driver Stage	146-174MHz	30C65
U102	5180932W01	Power Control	DC	LM2904

U103	5113819A04	Power Control	DC	MC3303
U200	5185963A27	Frequency Synthesizer	1-220MHz	FRACN_63A27
U201	5105750U54	VCO Buffer IC	146-220MHz	50U54
U400	5102463J64	EEPROM	1MHz	X25128-2.7
U402	5102463J36	SRAM	3.78MHz	SRM2B256
U403	5102226J56	Microprocessor	7.56MHz	MC68HC11FL0
U404	5189233U02	FLASH	3.78MHz	AT49LV002N_70VI
U405	5113805B58	Shift Register	DC	MC74VHC1GT66
U500	4813833C02	Wired OR	DC	MMBD6100
U501	5102190C33	Voltage Regulator	DC	LM2941T
U503	5105469E65	Voltage Regulator	DC	LP2951C
U504	5185130C53	Audio and Signaling IC	DC	30C53
U508	5113816A30	Voltage Regulator	DC	MC33269D
U510	5104187K94	Voltage Regulator	DC	LP2986ILDX
U511	4813833C02	Wired OR	DC	MMBD6100
U512	4813833C02	Wired OR	DC	MMBD6100
U513	4813833C02	Reverse Protection	DC	MMBD6100
U514	4802393L66	DC Switch	DC	SI3455ADV
VR101	4813830A15	Power Control Loop Protection	DC	MMBZ5232B
VR102	4813830A15	Current Source	DC	MMBZ5232B
VR400	4813830A18	DC Switch	DC	MMBZ5235B
VR401	4813830G12	Overvoltage Protection	DC	MMSZ4687T1
VR402	4813830A09	DC Switch	DC	MMBZ5226B
VR500	4813832C77	Reverse Protection	DC	MR2835S
VR501	4813830A14	Reverse Protection	DC	MMBZ5231B
VR502	4813830G11	Reverse Protection	DC	MMSZ4686T1
VR503	4813830G09	Reverse Protection	DC	MMSZ4684
VR504	4813830G09	Reverse Protection	DC	MMSZ4684
VR692	4813830A75	ESD Protection	DC	MMBZ20VAL
VR693	4813830A77	ESD Protection	DC	MMBZ33VAL
VR694	4813830A75	ESD Protection	DC	MMBZ20VAL
VR695	4813830A75	ESD Protection	DC	MMBZ20VAL
VR696	4813830A75	ESD Protection	DC	MMBZ20VAL
VR697	4813830A75	ESD Protection	DC	MMBZ20VAL
VR698	4813830A75	ESD Protection	DC	MMBZ20VAL
VR699	4813830A75	ESD Protection	DC	MMBZ20VAL
Y201	4880114R06	16.8MHz Crystal	16.8MHz	114R06

Exhibit 10B – 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 Measurements
Power Sensor	HP 8428A or equivalent	Transmitter Output Power
DC Power Supply	0-20 volts at 15 amps	
Attenuator Pad	75 Watts, 30 dB	Transmitter Measurements
DC Ammeter	30mA to 20 A	Current Drain Measurements
Computer	IBM PC, PC/XT, or PC/AT	Radio Alignment
Radio Interface Box	RLN4008E	Computer Interface to Radio
Cable	3080369B72	From RIB to Computer
Cable	AAPMKN4004	From RIB to Radio
Software	RVN4191	Radio Alignment

Exhibit 10C – Tune Up Information

Pursuant to 47 CFR 2.1033(c)(9)

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
U403	Microprocessor	Supplies data to Audio Filter IC, Fractional-N Synthesizer, Temperature Compensated Crystal Oscillator, and Power Control For Transmitter Modulation, Frequency and Power Adjustment
U200	Programmable Attenuator	Reference Modulation Balance
U504	Programmable Attenuator	Deviation Adjustment
U200	Digital to Analog Converter	Transmitter Frequency Adjustment
U200	Temperature Compensated Crystal Oscillator	Transmitter Frequency Adjustment
U504	Digital to Analog Converter	Transmitter Power Adjustment

The value of a particular tuning element is determined by data sent to that tuning element by microprocessor U403. This data is generated by the microprocessor based on tuning information that is stored in the microprocessor’s EEPROM (Electrically Erasable Programmable Read Only Memory).

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

Tuning Parameters

Supply Voltage

13.8+/-0.1Vdc @ DC Connector under operating condition
5.5A Current limit

Temperature

25+/-2°C

Table 1 Test Frequencies

Test Frequency	VHF R2	
	Mobile	
	TX (MHz)	RX (MHz)
F1	146.000	146.025
F2	150.675	150.700
F3	155.325	155.350
F4	160.000	160.025
F5	164.675	164.700
F6	169.325	169.350
F7	174.000	173.975

1. PA Bias Tuning

This procedure must be done before the transmitter is keyed the first time. To avoid FET device damage care must be taken not to exceed the drain current and dissipation limits of the devices by setting a too high bias voltage during tuning. The use of a power supply with an appropriate current limitation setting is recommended. The tune procedure should be done as fast as possible to keep the device temperature low and to achieve the required quiescent current accuracy.

General Tuning Procedure

Set the power supply to the voltage and current specified above and power up the radio.

Define: PA_BIAS = 0xD9, PA_BIAS_MAX = 0xE9, PA_BIAS_MIN = 0xC9

Key the radio with the following values:

ASFIC BYTE 04 (DAC U) = 0x00

ASFIC BYTE 06 (DAC G) = 0xFF

Set the TX freq to 200 MHz to eliminate the VCO influence.

Measure the power supply current and put it in I_REF.

Set the ASFIC BYTE 04 (DAC U) to PA_BIAS.

Measure the power supply current and put it in I_BIAS.

Calculate: Delta = I_BIAS – I_REF.

```
IF 100 [mA] < Delta < 130 [mA]   *** PA bias current ok ***
      Program CP with ASFIC BYTE 04 (DAC U) = PA_BIAS and go to END
   ELSE
        IF Delta > 130 [mA]    *** PA bias current too high ***
           IF PA_BIAS < PA_BIAS_MIN
              Terminate the procedure and report FAIL – Hardware failure
           ELSE
           PA_BIAS = PA_BIAS – 1
           Go to stage (7)
        ELSE                  *** PA bias current too low ***
           IF PA_BIAS > PA_BIAS_MAX
              Terminate the procedure and report FAIL – Hardware failure
           ELSE
              PA_BIAS = PA_BIAS + 1
              Go to stage (7)

   END: PA_BIAS tune completed
```

2. Reference Oscillator Warping

Adjustment of the reference oscillator is critical for proper radio operation. Improper adjustment will not only result in poor operation, but also a misaligned radio that will interfere with other users operating on adjacent channels. For this reason, the reference oscillator should be checked every time the radio is serviced. The frequency counter used for this procedure must have a stability of 0.1 PPM (or better).

General Tuning Procedure

Set the power supply to the voltage specified above and power up the radio.
Remove any audio input signals to minimize frequency inaccuracy
Set the radio to the Carrier Squelch Environment, to 25kHz Channel Spacing and to the lowest transmit power level to reduce current drain during tuning.
Disable modulation (Environment Override) to minimize frequency inaccuracy.
Set the radio to the transmit frequency indicated in table 2.
Key up the radio.
Disable the digital modulation in the FRAC-N to minimize frequency inaccuracy.
Measure the transmit frequency and compare it with the specification limits +/-30Hz.
If the measured frequency is within the specification limits.
Dekey the radio.
Reference Oscillator Tuning done.
If the measured frequency is outside the specification limits.
Read the codeplug value for the Oscillator Warp.
While the transmit frequency is outside the specification limits.
Update the IC value of the Oscillator Warp without codeplug update.
Re-measure the transmit frequency and compare it with the specification limits.
Repeat steps (I) (ii) until the transmit frequency is within the specification limits.
Write the value of the tuned Oscillator Warp to the codeplug.
Dekey the radio.
Reference Oscillator Tuning done.

Table 2 Tuning Profile

These tables list for each band at which softpot frequency each parameter must be tuned or calculated.

	VHF (1-28W)							
	None	F1	F2	F3	F4	F5	F6	F7
XTAL Temperature Comp.	•	•	•	•	•	•	•	Tune
Ref Osc Warp	•	•	•	•	•	•	•	Tune
Supply Voltage Threshold	Tune	•	•	•	•	•	•	•
PA Bias Voltage	Tune	•	•	•	•	•	•	•
TX Power	•	Tune	Calc.	Calc.	Tune	Calc.	Calc.	Tune
PA Control Voltage Limit	•	Tune	Tune	Tune	Tune	Tune	Tune	Tune
Modulation Balance	•	Tune	Tune	Tune	Tune	Tune	Tune	Tune
Deviation Limit (Voice)	•	Tune	Calc.	Calc.	Tune	Calc.	Calc.	Tune
Signaling Deviation	•	•	•	•	Tune	•	•	•
Front End Tuning	•	OF4	OF4	OF4	Tune	OF4	OF4	OF4
Rated Audio	•	•	•	•	Tune	•	•	•
RX Squelch	•	Tune	Calc.	Calc.	Tune	Calc.	Calc.	Tune
RSSI (MPT)	•	•	•	•	Tune	•	•	•

NOTES:
• = No tuning required
Calc. = Linear interpolation using adjacent tune values
CFx = Use value obtained for Fx
OFx = Use offset calculated for Fx
25kHz = Use the values obtained for 25kHz channel spacing
Fixed = Use a fixed value (see appropriate table)

3. Transmitter Power Tuning

Overview: The softpots used for PA power setting do not contain the DAC values directly like they do in the portable radio. Instead they store the parameters (Mcp, Kcp) for approximation of the dependency between power and DAC setting. This procedure allows to set any power within the range of the PA without re-tuning. The PA output power (Pcp) levels are stored in the softpots for HIGH and LOW POWER. The following equations are used to calculate the DAC value for the desired power.

$$DAC\ PWR\ SET = 100 * \frac{4 * Kcp - Pcp}{Mcp}$$ Equ. 1

$$Pcp = 25 * \sqrt{desired\ power}$$ Equ. 2

The power is not stored directly in the softpots to avoid square root calculation by the radio software.

General Tuning Procedure

Set the power supply to the voltage specified above and power up the radio.
Read the tuning parameters from the radio and determine the values for DAC1 and DAC2.
Set the radio to the Carrier Squelch Environment and highest Transmit Power Level.
Disable modulation (Environment Override) and remove any audio input signals to minimize frequency inaccuracy.

This procedure is to be performed for all Power Tuning Channels indicated in table 1.

Set the radio to the appropriate transmit frequency.
Key up the radio.
Set the IC value of the Transmit Power to the value DAC1.
Measure the transmit power and note the value as P1.
Set the IC value of the Transmit Power to the value DAC2.
Measure the transmit power and note the value as P2.
Dekey the radio.
Calculate Mcp and Kcp with the following equations:

$$M = -\frac{\sqrt{P2} - \sqrt{P1}}{DAC2 - DAC1}$$ Equ. 3

$$Mcp = 2500 * M$$ Equ. 4

$$Kcp = 6.25 * \left(\sqrt{P1} + M * DAC1\right)$$ Equ. 5

Write the values Kcp and Mcp the codeplug.
Repeat steps (A) to (J) for all the channels that require actual tuning. Values for the untuned channels are to be interpolated by the test controller and programmed into the codeplug.

Transmit Power Tuning done.

4. Modulation Balance Tuning

Modulation balance balances the modulation sensitivity of the VCO and reference modulation (synthesizer low frequency port) lines. Balance algorithm is critical to the operation of signaling schemes that have very low frequency components (e.g. PL) and could result in distorted waveforms if improperly adjusted. The radio stores only one set of tuning data for all supported channel spacings (12.5, 20 and 25 kHz). Therefore, tuning should only be performed for 12.5 kHz channel spacing.

In the radio the deviation for 12.5 kHz is set by reducing the modulation sensitivity within the synthesizer IC. The reduction of the low audio frequency components is done by a division by 2 in the digital modulator and very accurate. The high audio frequency components are attenuated by a resistive network that has typically 6.3 dB. This inaccuracy will bring the modulation out of balance in the not tuned channel spacing. Tuning at 12.5 kHz will reduce the low frequency components at 25 kHz channel spacing, while tuning at 25 kHz will increase the low frequency components at 12.5 kHz channel spacing. Due to the fact that the upper spec limit is only 1dB, but the lower spec limit is -3 dB, tuning at 12.5 kHz improves the margin.

General Tuning Procedure

Set the power supply to the voltage specified above and power up the radio.
Set the radio to the External Signal Modulation Balance Environment, to 12.5kHz Channel Spacing and to the lowest transmit power level to reduce current drain during tuning.
This procedure is to be performed for all Modulation Balance Attenuator Tuning Channels indicated in table 2.

Set the radio to the appropriate Modulation Balance Attenuator Tuning Channel.
Remove any audio signals applied to any audio inputs to avoid a transmit frequency offset.
Key up the radio.
Update the IC value of the VCO Attenuator to its maximum setting ($255) without codeplug update.
Apply an 80Hz tone @ 100mV RMS to the Auxiliary Transmit Audio Path.
Measure the transmit deviation, note the value as D1.
Apply a 3kHz tone @ 100mV RMS to the Auxiliary Transmit Audio Path.
Measure the transmit deviation, note the value as D2.
Find the ratio of the measured transmit deviation values in dB using equation 20*log(D1/D2).
If the ratio of the measured transmit deviations is within ±0.15 dB

Dekey the radio.
Modulation Balance Tuning for the set Tuning Channel done. Continue with step (A) for the next Modulation Balance Attenuator Tuning Channel

If the ratio of the measured transmit deviations is NOT within ±0.15 dB

Read the codeplug value for the Modulation Balance Attenuator.
While the ratio of the measured transmit deviations is outside the specification limits.
Disable modulation (Environment Override) to minimize frequency offset.
Update the IC value of the Modulation Balance Attenuator without codeplug update.
Enable modulation (Environment Override).
Repeat steps (E) to (I).
Repeat steps (a) to (d) until the ratio of the measured transmit deviations is inside the specification limits

NOTE 1: Modulation must be removed from the Fractional –N Synthesizer while it is being programmed.
Dekey the radio.
Write the value of the tuned Modulation Balance Attenuator to the codeplug.
Modulation Balance Tuning done

5. Modulation Limit Tuning

Modulation limit tuning sets the maximum deviation of the carrier. The radio stores only one set (7 values across the frequency band) of tuning data for 25kHz channel spacing. Therefore, tuning across the frequency band must only be performed for 25 kHz channel spacing. For 12.5 channel spacings an offset value in the codeplug is used to reduce the deviation. The offset value should be tuned at one frequency only.
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General Tuning Procedure

The Modulation Balance Tuning must already be done for this procedure to be valid.
Set the power supply to the voltage specified above and power up the radio.
Set the radio to the Carrier Squelch Environment, to 25kHz Channel Spacing and to the lowest transmit power level to reduce current drain during tuning.
Enable the microphone path (Environment Override).
This procedure is to be performed for all Modulation Limit Tuning Channels indicated in table 2

Set the radio to the appropriate Modulation Limit Tuning Channel.
Remove any audio signals applied to any audio inputs to avoid a transmit frequency offset.
Key up the radio.
Apply a 1kHz tone @ 800mV RMS to the External Microphone Audio Path.
Measure the transmit deviation and compare it with the specification limits in the table 3.

Table 3 Reference Voice Deviation Tuning Limits

This table lists the tuning window for the reference voice deviation. All signaling deviations are based on this voice deviation. For 25/30 kHz channel spacing the deviation is tuned at multiple softpot frequencies. For all other channel spacings only an offset value is determined at one softpot frequency

Channel Spacing	Rated System Deviation	Deviation Tuning Window
25/30 kHz	5 kHz	4.40 - 4.60 kHz
12.5 kHz	2.5 kHz	2.20 - 2.30 kHz

If the measured transmit deviation is within the specification limits
Dekey the radio.
Modulation Limit Tuning for the set Tuning Channel done. Continue with step (A) for the next Modulation Limit Tuning Channel

If the measured transmit deviation is outside the specification limits

Read the codeplug value for the VCO Attenuator.
While the measured transmit deviation is outside the specification limits.
Update the IC value of the VCO Attenuator without codeplug update.
Re-measure the transmit deviation and compare it with the specification limits.
Repeat steps (a) (b) until the measured transmit deviation is inside the specification limits
Dekey the radio.
Write the value of the tuned VCO Attenuator to the codeplug.
VCO Attenuator Tuning for the set Tuning Channel done. Continue with step (A) for the next Modulation Limit Tuning Channel
This procedure is to be performed for all remaining Modulation Limit Tuning Channel Spacings (12.5 kHz) and the Modulation Limit Tuning Channel indicated in table 2

Enable the microphone path (Environment Override) and set the appropriate Modulation Limit Tuning Channel Spacing.

Set the radio to the appropriate VCO Attenuator Tuning Channel for the set channel spacing.

Remove any audio signals applied to any audio inputs to avoid a transmit frequency offset.

Key up the radio.

Apply a 1kHz tone @ 800mV RMS to the External Microphone Audio Path.

Measure the transmit deviation and compare it with the specification limits in Table 3.

If the measured transmit deviation is within the specification limits

Dekey the radio.
VCO Attenuator Tuning for the set Channel Spacing done. Continue with step (A) for the next Modulation Limit Tuning Channel Spacing

If the measured transmit deviation is outside the specification limits

Read the codeplug value for the VCO Attenuator.
While the measured transmit deviation is outside the specification limits.
Update the IC value of the VCO Attenuator without codeplug update.
Re-measure the transmit deviation and compare it with the specification limits.
Repeat steps (a) (b) until the measured transmit deviation is inside the specification limits
Dekey the radio.
Write the value of the tuned VCO Attenuator to the codeplug.
Modulation Limit Tuning for the set Tuning Channel done. Continue with step (A) for the next Modulation Limit Tuning Channel