RA-4000e RADAR ALTIMETER

FINAL TEST PROCEDURE

Prepared: _____ _____
DATE

Quality: _____ _____
DATE

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DATE

REVISION HISTORY

DATE	REV	DESCRIPTION	AUTHOR
	A	Initial Release	Russ Randant
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1. Introduction

This document is the Final test Procedure for the RA-4000e Radar Altimeter. It is to be used for new production units as well as repair.

2. Equipment Required

The following test equipment is required:

1. EUT FFS P/N 84560-01
2. Altitude simulator P/N 84740-00
   Attenuators:
   - Qty 2, fixed 20 dB
   - Qty 2, fixed 10 dB
   - Qty 1, fixed 6 dB
   - Qty 1, fixed 3 dB
   - MBG1152 500ft delay
3. Qty 2 – 150" antenna cables
4. RS-485/422 to RS-232 adapter
5. PC with at least one 9-pin serial port, with the following software applications:
   - RAMS.exe RA-4000 Test Software v. 01.02c or later
   - Flash Magic 1.65 or later
6. Test Set P/N 84648-00
7. Spectrum Analyzer (with a frequency range from 0 – 5Ghz or greater)
8. Power meter (with a frequency range of 0 – 5Ghz and power range of 0 – 100mw or higher)
9. Volt meter
10. Oscilloscope
11. 28vdc power supply
12. Frequency counter
13. Final test harness P/N 84649-00
14. Temperature chamber: Russell's #RB2-03-03, or equivalent

3. RA-4000e Alignment And Programming Procedure

Perform each step as directed then enter data or initial the test data sheet to indicate the step is successful.

NOTE – RAMS software provides an indication of System Status. If an error condition is reported, refer to Appendix D for an explanation and trouble-shooting guide.

3.1. Setup

Step	Action	Pass Criteria
1	Execute RAMS and verify the following line appears: *F1=0ft F2=50ft F3=100ft F4=2000ft F5=Clear* If these values are not present, refer to Appendix C to set them.	Values display as indicated.
2	Connect the EUT as indicated in Figure 1. Connect the 28vdc power supply to Test Fixture P/N 84648-00. Turn power supply ON. Verify the following:	
2.a	• Supply current	Current < 700 mA.
2.b	• Pin 15	15 VDC +/- 0.3 VDC
2.c	• Pin 10	10 VDC +/- 0.2 VDC
2.d	• Pin 14	5 VDC +/- 0.1 VDC

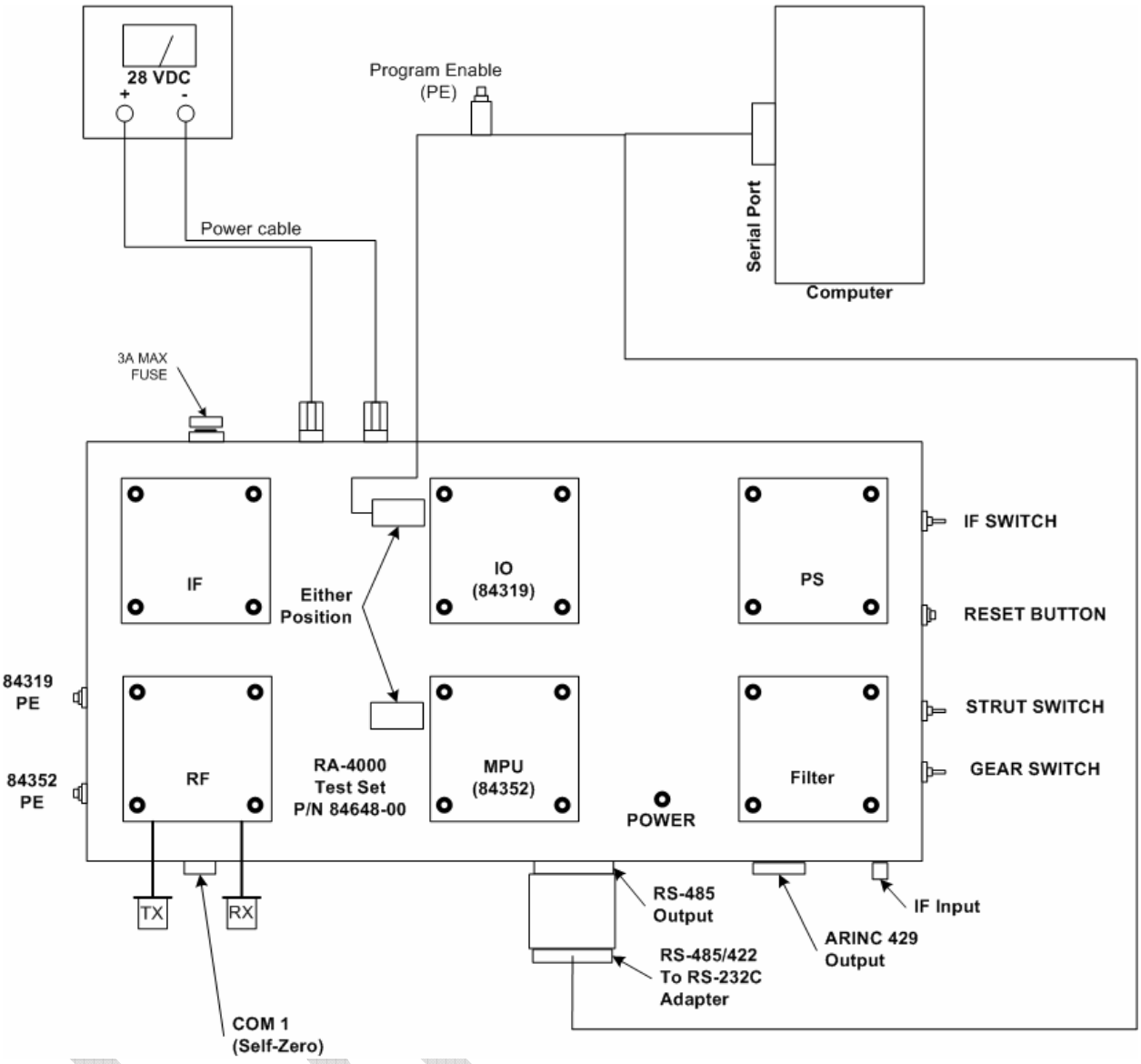

Figure 1 – Test Fixture 84648-00

3.2. Programming

Step	Action	Pass Criteria
3	Launch FlashMagic.exe on PC. Verify the following setting of FlashMagic.exe main window: *Section 1* Com port: com 1 (or port that you are connected to) Baud rate: 19200 Device: XA-G49 Osc. Freq.: 25.000000 *Section 2* Erase Blocks 0-4 Erase all flash + Security "is checked" *Section 4* Nothing checked.	
4	**To program the MPU:** Power off EUT. Connect programming harness between EUT and PC. Power on EUT. Press and hold the PE button located in the programming harness. While holding PE button, press and release the reset button. Release the PE button. In **FlashMagic** *Section 3,* select the file "RAPU-OC-2003". Click start on **FlashMagic** *Section 5* to begin programming. (Programming will take about 1 minute.) When programming is complete, press reset to exit programming mode. If **FlashMagic** reports "Unable to read security bits…", repeat the reset sequence using the PE button, then click "Retry". If the error message persists, verify 5 VDC is present at 84352-XX J402, pin 14. If 5 VDC is not present, troubleshoot problem in power supply. If 5VDC is present, replace the processor located at U402 on 84352-XX.	**FlashMagic** reports "Finished".

Step	Action	Pass Criteria
5	**To program the IO:** Connect the programming harness to the IO card. Repeat Step 4 above with the file “RAIO-OC-2003”. If an error message persists, verify 5 VDC is present at 84319-XX J302, pin 5. If 5 VDC is not present, troubleshoot problem in power supply. If 5VDC is present, replace the processor located at U402 on 84352-XX.	**FlashMagic** reports “Finished”.
6	**To verify programming:** Connect PC serial port cable to RS-485 adapter. Connect adapter to Test Fixture (P/N 84648-00, ref Figure 1) and launch RAMS.exe (Radar Altimeter Monitoring Systems) on PC.	
6.a	Verify MPU checksum	MPU Checksum = 8F00
6.b	Verify IO checksum	IO Checksum = AA32
7.a	On the RAMS display, verify A/D 0 (10 volt) If an out of tolerance condition is seen, use a voltmeter to directly measure 10 volts. Replace the 10V regulator at U202 on 42249-XX, if necessary.	A/D 0 = [C4 to F0]
7.b	On the RAMS display, verify A/D 2 (15 volt) If an out of tolerance condition is seen, use a voltmeter to directly measure 15 volts. Replace the 15V DC/DC converter at M201 on 42249-XX, if necessary.	A/D 2 = [E2 to EF]

3.3. RF Sweep Tuning

Step	Action	Pass Criteria
8	Attach the frequency counter to TP406 on 84352-XX board. Adjust R446 to 100 Hz (± 2 Hz). Record the frequency on the Data Sheet.	Freq. = 100 +/- 2 Hz
9.a	Couple a spectrum analyzer to the unit's "TX" output port found on the RF assembly. On the 84352-XX board, adjust R467 to set the high frequency limit to 4.35 GHz. Adjust R466 to set the low frequency limit to 4.25 GHz. Verify the low and high sweep frequency limits are set to 4.25 GHz and 4.35 GHz respectively. Verify the sweep frequency has a 100 MHz bandwidth. Connect channel 1 of the oscilloscope to TP406 and set the oscilloscope to trigger from the reference frequency at channel 1. Connect channel 2 of the oscilloscope to TP401. Observe both the reference square wave on channel 1 and the sweep voltage triangle wave on channel 2 (see Fig. 2). Proper lock of the PLL occurs when the triangular sweep voltage reverses as the reference square wave switches.	Steps accomplished and sweep is locked.
9.b	Adjust R467 to change the sweep width ± 15MHz. The sweep loop should remain properly locked (see Fig. 2). Reset R467 to 4.35 GHz. Adjust R466 to change the sweep width ± 15MHz. The sweep loop should remain properly locked (see Fig. 2.) Reset R466 to 4.25 GHz. Verify that the sweep frequency has a 100 MHz bandwidth.	Steps accomplished and sweep remains locked.

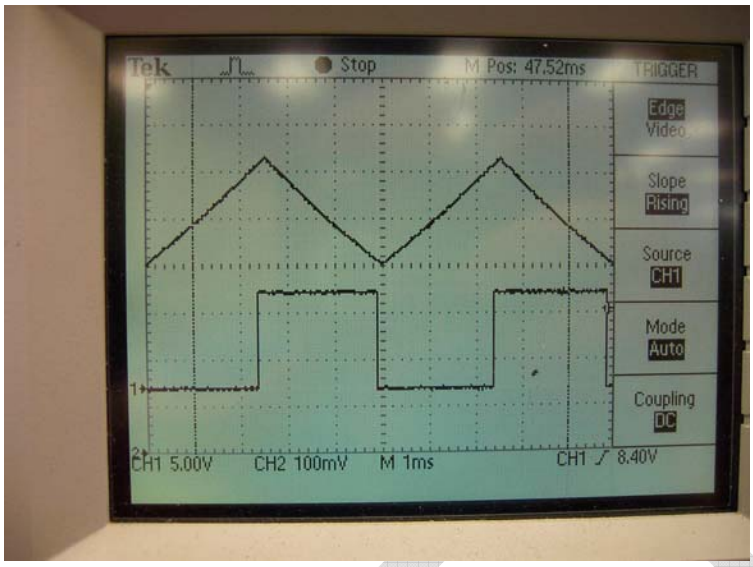

Figure 2 – Proper Phase Lock Loop (PLL)

3.4. Power Output

Step	Action	Pass Criteria
10	On the 84352-XX, check voltage at the emitter (pin 2) of Q404. The voltage at the emitter should fall between 3.0 VDC & 5.0 VDC. If it does not, replace R456 as required to bring voltage to specs. Record the voltage at Q404 on the Data Sheet.	Emitter voltage between 3.0 VDC and 5.0 VDC.
11	Couple a power meter to the unit's "TX" output port found on the RF assembly. Verify the power output is 90 mW +/-10%. If not, refer to Appendix C for tuning instructions. The power output should now be 90 mW +/-10mW (between 80 and 100 mw). Record the power output on the Data Sheet.	Power = 90 mW +/- 10mW.

3.5. Harmonic Maximums

Step	Action	Pass Criteria
12	Connect the RF-TX output from the EUT, through a 3 dB attenuator, to the Spectrum Analyzer. (Refer to Fig. 3. for the following setup.) Set the Spectrum Analyzer for: • Center Frequency to 8.5 GHz. • Span = 10 GHz. • Amplitude = -11 dB. • Press “Display”, then “Dspl lin on”. • Use Step-Knob to adjust reference line to -13 dB. Locate the 2nd harmonic located at 8.6 GHz and verify its amplitude is below -13 dB (indicated by the reference line). Adjust the Center Frequency to 17.2 GHz. Locate the 3rd harmonic located at 17.2 GHz and verify its amplitude is below -13 dB. If the -13 dB threshold is exceeded for either harmonic: 1. Verify that no tuning strips have been installed. 2. Reduce total power output via Step 9.	1st and 2nd harmonics below -13 dB

3.6. IF DC Balance

Step	Action	Pass Criteria
13	Set the IF output DC balance by first shorting TP301 on 84442-XX board to ground. On 84442-XX board, adjust R521 to measure a 30 mVDC (± 2 mVDC) at TP402 on 84352-XX board. Record the DC balance voltage on the Data Sheet.	TP402 = 30 mV +/- 2mV.
14	Disconnect delay lines (or simulator) from both the RX and TX connectors on the RF board. Adjust the IF gain potentiometer, R522 on 84442-XX board, for a 0.135VDC maximum reading at TP402 on 84352-XX.	TP402 maximum = 0.135 VDC.

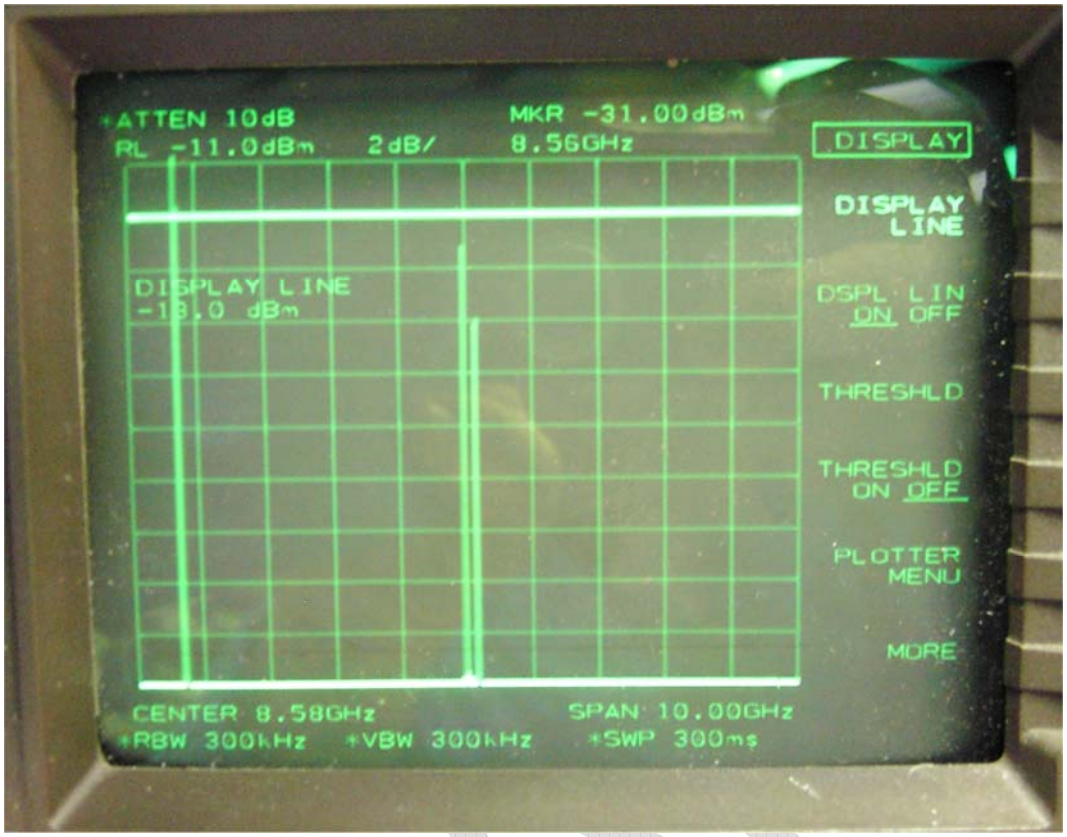

Figure 3 – Harmonics Measurement

3.7. Lock Threshold

Step	Action	Pass Criteria
15	Execute RAMS on the PC. Connect 2 150” antenna cables from unit to a 500ft bulk-acoustic-wave delay and variable attenuator. Turn attenuator to its OFF position (0) with the 500ft delay. Observe the ‘Altitude’ and status line on the RAMS software window. Verify that altitude is displayed and unit is locked. Slowly increase attenuation until screen shows an unlock condition by displaying a red “Invalid” message at the “Signal” line under “Status Bits”. Set the attenuator to 106 dB then adjust R436 on 84352-XX board until unit locks.	Steps accomplished.

3.8. Calibration

Step	Action	Pass Criteria
16.a	Set Altitude Simulator to 0ft and rotate variable attenuator from 0 to 20db. If a range of altitudes is displayed, return the attenuator dial to a point that produces the middle of the range. (If using bulk delay devices connect 27' cable and 50db of attenuation.) Calibrate 0ft by pressing "F1" on the PC keyboard. Altitude will momentarily turn red and then back to green. Verify that the altitude is now displaying 0ft (+/- 3').	Altitude = 0 ft. (+/- 3')
16.b	Set Altitude Simulator to 50ft and rotate variable attenuator from 0 to 20db. If a range of altitudes is displayed, return the attenuator dial to a point that produces the middle of the range. (If using bulk delay devices connect 50' delay and 65db of attenuation.) Calibrate 50ft by pressing "F2" on the PC keyboard. Altitude will momentarily turn red and then back to green. Verify that the altitude is now displaying 50ft (+/- 3').	Altitude = 50 ft. (+/- 3')
16.c	Set Altitude Simulator to 100ft and rotate variable attenuator from 0 to 20db. If a range of altitudes is displayed, return the attenuator dial to a point that produces the middle of the range. (If using bulk delay devices connect 100' delay and 75db of attenuation.) Calibrate 100ft by pressing "F3" on the PC keyboard. Altitude will momentarily turn red and then back to green. Verify that the altitude is now displaying 100ft (+/- 3').	Altitude = 100 ft. (+/- 3')
16.d	Set Altitude Simulator to 2000ft and rotate variable attenuator from 0 to 20db.	Altitude = 2000 ft. (+/- 100')

Step	Action	Pass Criteria
	If a range of altitudes is displayed, return the attenuator dial to a point that produces the middle of the range. (If using bulk delay devices connect 2000' delay and 100db of attenuation.) Calibrate 2000ft by pressing "F4" on the PC keyboard. Altitude will momentarily turn red and then back to green. Verify that the altitude is now displaying 2000ft (+/- 100').	
17	Move Altitude Simulator dial back to each altitude while observing the PC Screen, or connect separate delay devices at 50, 100 and 2000ft. Verify altitudes display within the ranges: 0', 50', 100' (+/- 3') 2000' (+/- 100') If not, repeat step 13 for each incorrect altitude.	All altitudes indicate within tolerance.

3.9. Strut/Unlock

Step	Action	Pass Criteria
18	On the Test Fixture toggle the 'Strut' switch to the down position. Verify that RAMS displays the change in 'Strut Status' line to "Active" and 'Altitude' line to "0 ft". Place switch back to center and verify the 'Strut Status' line is "Inactive".	Strut indicates.
19	Select "Unlock" on the Altitude Simulator. (Disconnect TX or RX line from EUT if not using an Altitude Simulator.) Verify that RAMS displays invalid signal and altitude 0ft.	Unlock indicates.

3.10. Verify Calibration & Clock

Step	Action	Pass Criteria
20	Assemble the unit. Connect test Harness 84649-00 and execute RAMS on the PC. Reset the EUT. Verify that the “CLK” field indicates one of FF, 00, or 01. If not, adjust R466 “100HZ clock” until one of these values is displayed.	Clock reads FF-01.
21	Verify altitudes display within tolerances indicated in Step 14. Repeat Calibration steps, as required.	All altitudes indicate within tolerance.

3.11. Temperature Calibration

Step	Action	Pass Criteria
22	Place unit in Temp Chamber with power off and unit connected to altitude simulator. Reduce chamber temperature to -55^{o}C. Wait for 1 hour after chamber has reached -55^{o}C. Turn unit on and wait 30 minuets for unit temperature to stabilize. Repeat the calibration procedures for each altitude 0, 50, 100, and 2000’. Verify altitudes display within tolerances given in Step 14.	All altitudes indicate within tolerance.
23	With EUT powered, raise chamber temperature to +70C. Wait for 1 hour after chamber has reached +70^{o}C. Repeat the calibration procedures for each altitude 0, 50, 100, and 2000’. Verify altitudes display within tolerances given in Step 14.	All altitudes indicate within tolerance.

3.12. Final Steps

Step	Action	Pass Criteria
24	Place locking compound on variable potentiometers R521 and R522 of 84442-XX board as well as R436, R451, R466, R467 AND R446 of 84352-XX board. Replace cover with 6 screws on unit.	Step completed.
25	**SUMMARY:** Indicate Pass/Fail for EUT and initial the data sheet.	All Steps successful.

END OF TEST PROCEDURE

Appendix A - Final Test Data Sheet

Work Order		Serial Number	
Date		Technician	

Step	Pass Criteria	Entry Type	Data Record
1	Values display as indicated.	Initial	
2.a	Current < 700 mA.	Current	
2.b	15 VDC +/- 0.3 VDC	VDC	
2.c	10 VDC +/- 0.2 VDC	VDC	
2.d	5 VDC +/- 0.1 VDC	VDC	
3	N/A	None	
4	FlashMagic reports “Finished”.	Initial	
5	FlashMagic reports “Finished”.	Initial	
6.a	MPU Checksum = 8F00	Checksum	
6.b	IO Checksum = AA32	Checksum	
7.a	A/D 0 = [C4 to F0]	Value	
7.b	A/D 2 = [E2 to EF]	Value	
8	Freq. = 100 +/- 2 Hz	Value	
9	Steps accomplished and sweep is locked.	Initial	
10	Steps accomplished and sweep remains locked.	Initial	
11	Power = 90 mW +/- 10mW.	Value	
12	1st and 2nd harmonics below -13 dB	Initial	
13	TP402 = 30 mV +/- 2mV.	VDC	
14	TP402 maximum = 0.135 VDC.	VDC	
15	Steps accomplished.	Initial	
16.a	Altitude = 0 ft. (+/- 3’)	Altitude	
16.b	Altitude = 50 ft. (+/- 3’)	Altitude	
16.c	Altitude = 100 ft. (+/- 3’)	Altitude	
16.d	Altitude = 2000 ft. (+/- 100’)	Altitude	
17	All altitudes indicate within tolerance.	Initial	
18	Strut indicates.	Initial	
19	Unlock indicates.	Initial	
20	Clock reads FF-01.	Clock	
21	All altitudes indicate within tolerance.	Initial	
22	All altitudes indicate within tolerance.	Initial	
23	All altitudes indicate within tolerance.	Initial	
24	Step completed.	Initial	
25	SUMMARY - All Steps successful.	Initial	

Appendix B - RAMS Calibration Setup

1. Locate the current calibration values displayed on the Altitude Simulator.
2. Verify the RAMS calibration values (located at the bottom of the screen) match the Altitude Simulator.
3. To modify the RAMS values, perform the following:
    a) Execute Windows Notepad (or similar editor)
    b) Open the file “RAMS.cal” located in the same directory as “RAMS.exe”.
    c) Modify the values in the file to match those of the Altitude Simulator.
    d) Save the edited file.
    e) Execute RAMS.exe again and verify the correct values are displayed.

Appendix C - Power Output Setup

If TX power output is not within specifications then use the following procedure to correct power output.

1. Turn unit power off. Remove R202 on bias board P/N 84768-XX and connect a variable resistor test fixture.

2. Set fixture to 500ohms and turn unit power on.

3. Connect power meter to TX of unit and observe power output. If power is not within specifications change resistance until power is as close as possible. NOTE: do not reduce resistance lower than 100 ohms.

4. Once correct resistance is found, obtain a resistor from the stock room with approximately the same resistance that you found (or as close as possible) and the exact wattage as the one removed and replace R202 with it. Re-test power output to verify that it is within 10%.

5. End of Power Output Setup.

Appendix D - System Status And Troubleshooting

The RA-4000e outputs a serial packet at a 10 Hz rate. In the packet is a one-byte indicator of System Status. This section provides interpretation and possible repair actions. Refer to RAPU-ICD-0200 for details on the serial protocol. The Status byte table is provided below in Table D-1. Refer to table D-2 for guidance on error codes and possible remedial actions.

Status Byte - Bit Definitions			
Bit	**Name**	**High (1) Indication**	**Low (0) Indication**
7-5	Error	If Status = 1 the error condition is given here, else these bits are undefined. 000 MPU - Voltage invalid 001 MPU - Lock test failure 010 MPU - Altitude test failure 011 MPU - VCO Monitor fail 100 IO - Flash Read/Write failure 101 IO - MPU Com fail 110 IO - MPU fail 111 IO - Invalid MPU SW	
4	Strut	On ground	In air
3	Signal	No Signal Lock	Signal Lock Acquired
2	Status	Unit Failure	Normal operation
1	Self test	Test in progress	Normal operation
0	Altitude	Ascending	Descending

Table D-1: Status Byte Definition

Error Code	Explanation / Troubleshooting Guidance
000	The MPU self-test has detected an out-of-tolerance condition in either of the A/D channel 0 (10 VDC) or 2 (15 VDC). Either one of the voltages is out of tolerance or the A/D is malfunctioning.
001	The MPU self-test has detected a failure in the Lock circuit. This test asserts "lock_unlock", waits 500 ms, and verifies that the circuit indicates an unlocked condition. Check for a stuck "Lock" output.
010	The MPU self-test has detected a failure in the Altitude self-test. This error is asserted when the self-test indicates a value other than 37 – 43.
011	The MPU self-test has detected a failure in either of the VCO Monitor test or the System Temperature self-test. The VCO Monitor is tested by forcing a "Too Hot" condition followed by a "Too Cold" condition, then verifying the conditions are correctly reported. Check for a failure in the VCO Temperature Sensor (RT202 on 9-1100-1176-03), or the Monitor circuit itself on 84352-XX. The System Temperature test indicates a failure if the temperature sensor indicates a temperature outside the range -70 to +115C. Check the temperature sensor (R407 and R402), or the A/D (U431) on 84352-XX.
100	The IO has detected an error in the Flash checksum. Replace the IO processor (U313 on 84319-XX).
101	The IO has lost communication with the MPU. Verify the MPU has been programmed with FlashMagic. If the MPU appears to be working, check the communications link between the processors.
110	The IO has detected a malfunctioning MPU. That is, the MPU is transmitting packets, but has sent an invalid self-test code. Replace the MPU processor (U402 on 84352-XX).
111	The IO has detected an invalid version of software running on the MPU. Reprogram the MPU per this document.

Table D-2: Error Code Description And Troubleshooting