0100 Scope

Introduction

The purpose of this document is to provide a method of manually tuning, programming and testing an AIRPLAY Receiver and Controller pair. The development of this protocol was necessary so that Automatic would have a method of producing the first 1000, and possibly 20 000, units before an automated testing protocol was in place.

0110 Test Setup Note

All tests are designed to work independently of each other. This means that the methods used to power up and place the Receivers and Controllers into test mode is given for all tests.

This independent setup allows for parallel testing for multiple test stations. For example, 5 people do tuning, 5 people do Receiver testing, 5 do Controller testing. By providing independent tests, tuning and testing can be done separately, and the tests do not have to be done in a strict order.

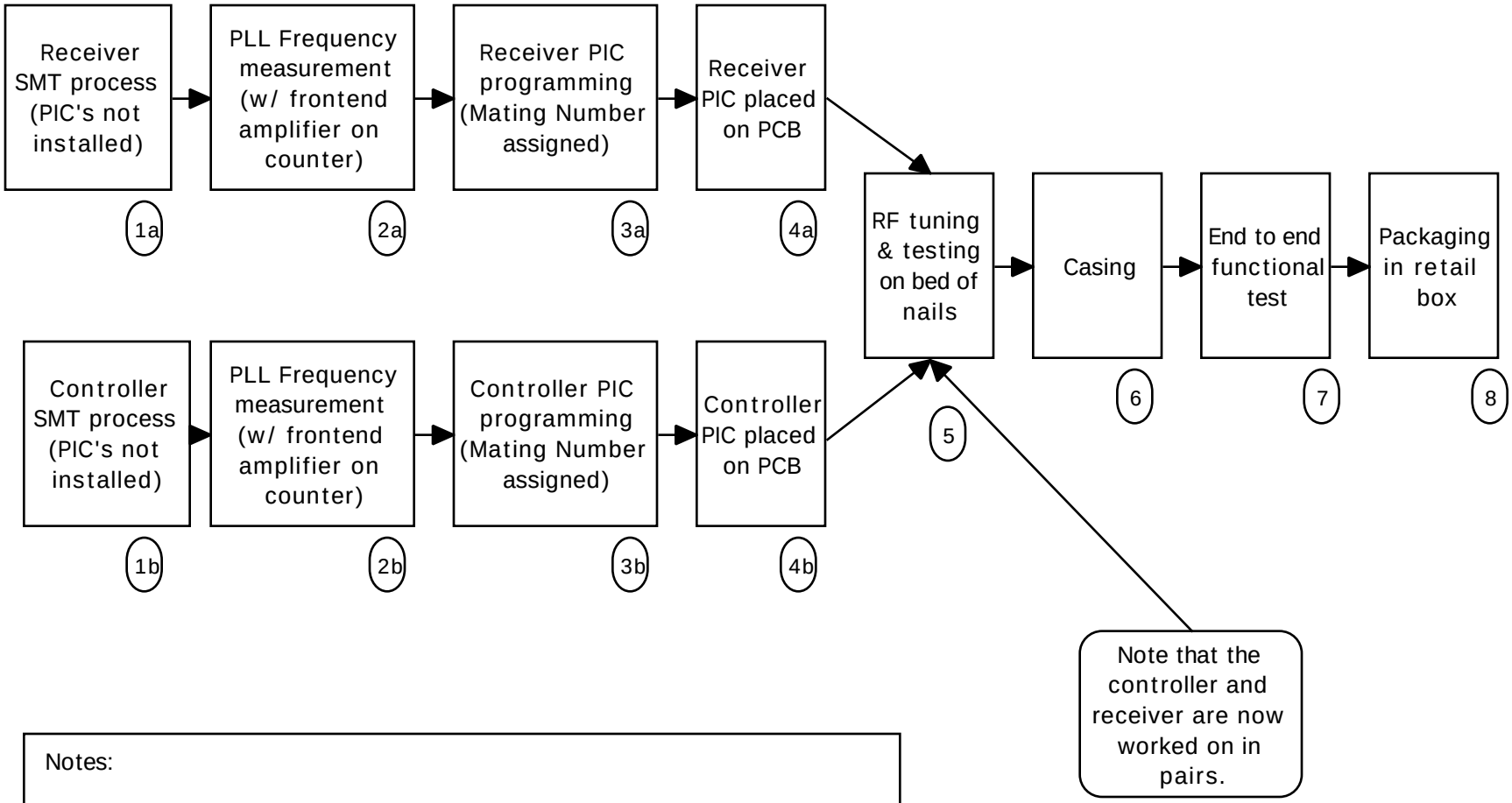
0120 Testing Methods

Louis Garner from Eleven will be responsible for deciding which tests are performed, in what sequence, and at what sampling rates. He is expected to use information from experience, hands-on observation of the production process and the consistency of the product being produced in his decisions.

0130 Document Organization

This document is divided into 9 sections:

Section 1	Introduction.
Section 2	AIRPLAY manufacturing procedure.
Section 3	Minimum equipment requirements and specifications.
Section 4	PLL frequency measurement. (Flowchart 2a,b)
Section 5	PIC programming. (Flowchart 3a,b)
Section 6	RF tuning and testing. (Flowchart 5)
Section 7	End to end functional test. (Flowchart 7)
Section 8	Appendices.
Section 9	Revision History



Notes:

1. In steps 3a and 3b Mating Numbers are assigned to the programmed PIC's. Extra labels will be provided by Eleven so that board carriers and/or PIC's can have their Mating Number attached to them.

2. Step 5 only requires one bed-of-nails test fixture. The controller and receiver with matching Mating Numbers must be tuned and tested together.

0300 Minimum Equipment Specifications

Voltmeter	Measurement range: 0 to 5.0 V Accuracy: +/- 5.0 mV
Carrier Signal Generator	Carrier frequency Range: 300 MHz to 350 MHz Modulation depth Range: 10 kHz to 20 kHz Amplitude output range: -110 dBm TO 0.0 dBm Capabilities: External input for modulation signal, FM modulation Accuracy: 10 ppm
Signal Generator	Signal frequency range: 5 kHz to 20 kHz Amplitude output range: 1 Vpp Capabilities: Low distortion Accuracy: TBA
Audio Analyzer	Input sensitivity: 50 mV Capabilities: Must perform SINAD measurements. Accuracy: TBA
Spectrum Analyzer	Capabilities: -120 dBm sensitivity Resolution BW: <1.0 kHz Frequency range: 200 kHz to 350 MHz
Frequency Counter	Input sensitivity: 50 mV (see appendix for method of raising this value) Accuracy: <0.1 ppm error
Oscilloscope	Capabilities: Must be able to accuratly measure a 10 kHz sine wave.
PIC Programmer	Microchip Promate II #DV007003
PIC Programmer Socket	SOIC-28 socket module for Promate II #AC164017

0400 Crystal Frequency Measurement Conditions

Important Note It may be necessary to measure the crystal frequencies and tune the AIRPLAY Controllers and Receivers under controlled temperature conditions. It is expected that the required temperature will be 25^{0}C. Louis will evaluate the effect of temperature on the crystals when in China.

0410 Receiver Crystal Frequency Measurement

Equipment Use a frequency counter with AC coupling on.

Step 1 Power Receiver by applying 3.3 VDC at test point #8, and connecting test point #16 to ground.

Step 2 Measure frequency at test point #11 to 1 Hz accuracy. For example,10.244642 MHz.

Step 3 Record result for use in the PIC programming stage.

0420 Controller Crystal Frequency Measurement

Equipment Use a frequency counter with AC coupling on.

Step 1 Power Controller by applying 1.5 VDC at test point #6, and connecting test point #3 to ground.

Step 2 Measure frequency at test point #2 to 1 Hz accuracy. For example,10.244642 MHz.

Step 3 Record result for use in the PIC programming stage.

0500 Introduction

The Microchip Promate II will be used for stand-alone PIC programming. Included on the provided CD is the latest software and firmware for the Promate II in the \picpgm\mplab\setup directory.

Note 1 Firmware revision V4.22.00 or above must be installed in order for the semi-automated programming software to work correctly. The current firmware version is displayed when the Promate is powered up. If it is necessary to upgrade the firmware, read the files README.CMD and README.PRO that will be installed by running \picpgm\mplab\setup\setup.exe.

If it is necessary to upgrade the Promate firmware in the future, ensure that the firmware and PC software are upgraded at the same time to avoid conflicts between firmware and software. Should another programming system be used other than MPLAB and Promate, this precaution should also be taken into consideration. It is not expected that a firmware update will be necessary.

The software that Eleven provided on the CD should be more than adequate for this application.

Note 2 It may be possible at this time to use any PIC programmer that will program from a DOS command line prompt. The Promate II was chosen so that the same equipment would be used here and in China for the first run of AIRPLAY. A lower cost replacement for the Promate II that is being considered is the Advanced-Transdata PGM16N which is $320.00 US with socket.

Note 3 A MSDOS manual is included in .PDF format in case modifications are needed to the batch files that run the semi-automated PIC programming.

Note 4 The socket that the PIC's are placed in for programming is expected to wear and cause repeated and frequent programming errors. The part number for this socket is AC164017 and is stocked by Digikey for $159.00 US.

0510 Installation of Automated Programming Software and Support Files

Step 1 Copy the entire contents of the provided CD into a new directory called: c:\picpgm

Using the c:\picpgm directory name will ensure that the software on the CD will run correctly when copied to the PC's hard drive without reconfiguration.

Step 2 Run the file c:\picpgm\mplab\setup\setup.exe. This will install MPLAB. Install MPLAB to c:\picpgm\mplab\.

Step 3 Copy the file PROCMD.EXE and MPLAB.DVS to c:\picpgm\config\. This will ensure that the correct versions are used.

Step 4 Connect the Promate II programmer to the PC that will be used to program the PIC's.

0520 Programming Procedure

Introduction The following procedure should be used when it is time to program the Receiver and Controller PIC's.

Step 1 Open a dos prompt.

Step 2 Change to the \picpgm directory.

Step 3 Run PROGRAM.BAT.

Step 4 When the PIC programming software is run for the first time it will ask for a starting Mating Number. The user will be given the choice of continuing with the last Mating Number recorded by the programming software, or will be able to enter a new starting Mating Number.

Press Y to use the last number recorded, or N to enter a new starting Mating Number.

Note Mating Numbers are entered in hexadecimal, with valid Mating Numbers ranging from 0000 to 7FFF inclusive.

Step 5 A visual representation of the Mating Number will be displayed to the user. Press Y to use the Mating Number, press N to choose another starting Mating Number.

Step 6 The software will then ask for the last four digits of the Receiver crystal frequency. For example, if the crystal frequency was 10.244567, you would enter 4567.

Step 7 Next, a prompt will appear for the Controller crystal frequency. Enter the last four digits of the Controller crystal frequency as done in step 5.

Note The valid range for the last four digits of the crystal frequencies for the Receiver and Controller are from 4488 to 5512 inclusive. Frequencies outside of this range will not be accepted.

Step 8 Place a blank PIC into the Promate II socket.

Step 9 Press any key to start the Receiver PIC programming.

Note If a programming error occurs the user will be prompted to insert a new PIC. The software will not continue until a PIC is programmed for the Receiver.

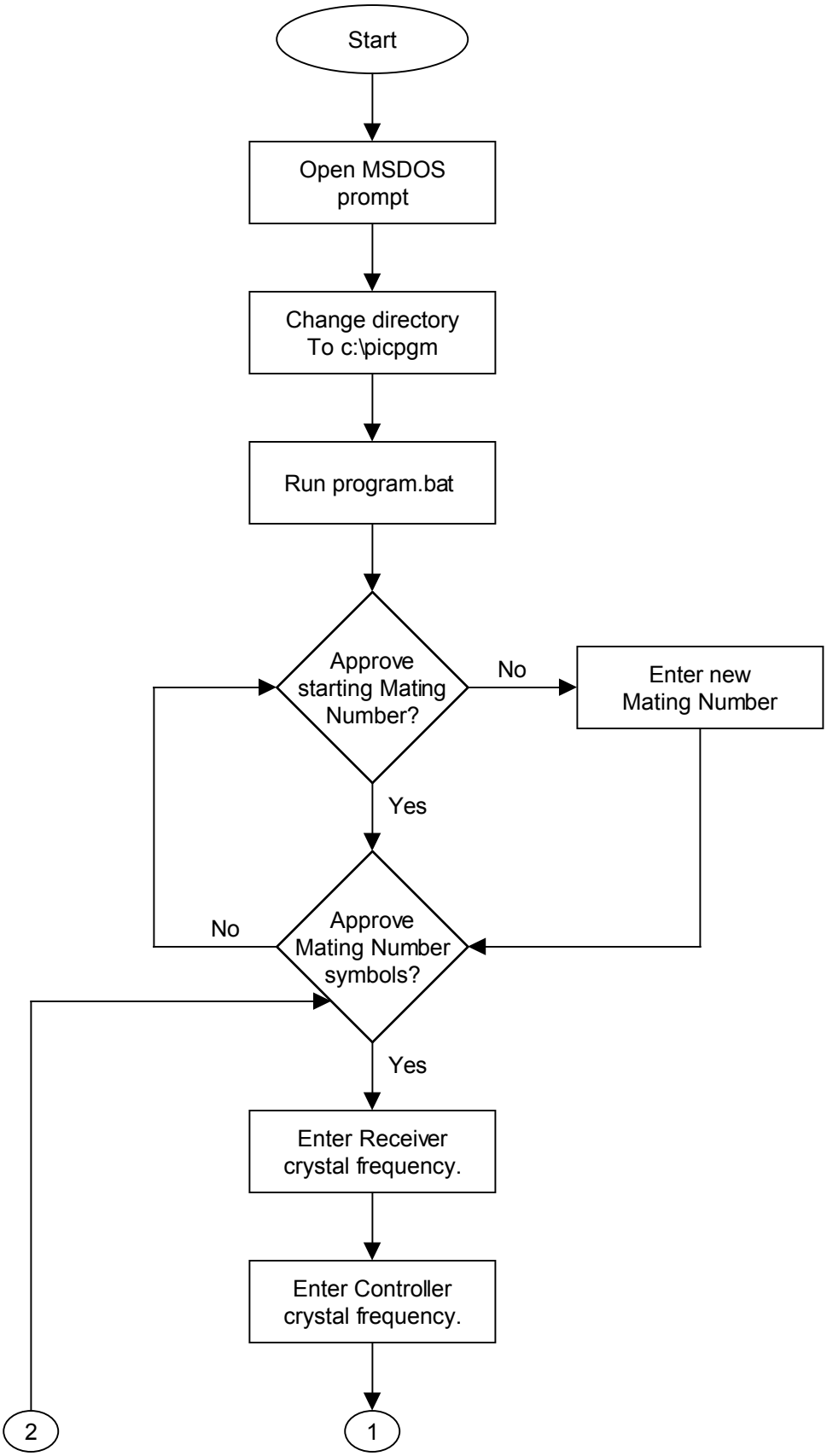
Step 10 Remove the programmed Receiver PIC from the Promate II socket. Place another blank PIC into the Promate II socket.

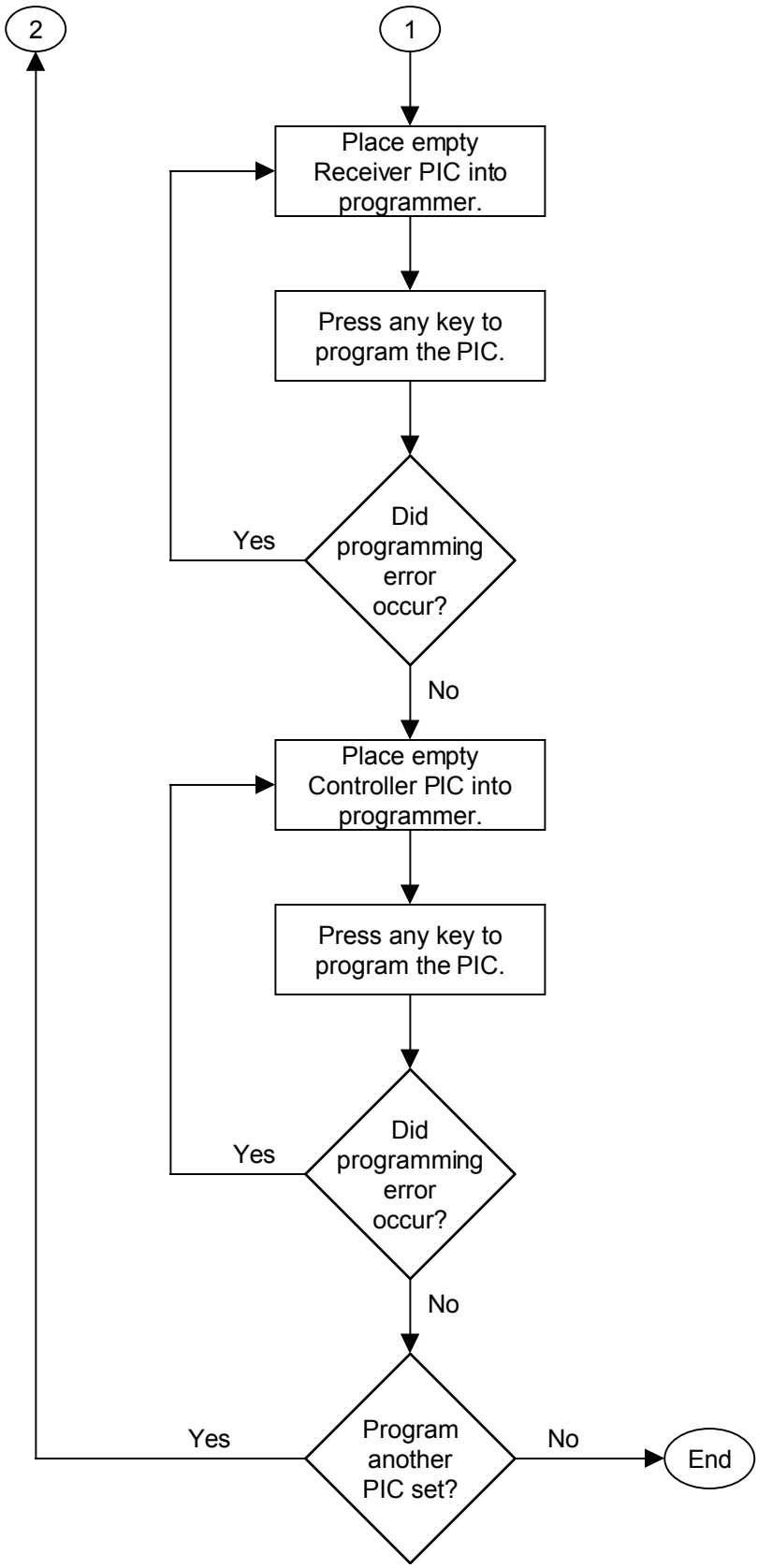
Note If a programming error occurs the user will be prompted to insert a new PIC. The software will not continue until a PIC is programmed for the Controller.

Step 11 Press any key to program the Controller PIC.

Step 12 The software will prompt if another set of Controller and Receiver PIC's are to be programmed. Press Y to program another set, press N to exit.

Important Note If repeated programming failures occurs in steps 8 and 10 above, the Promate II socket should be replaced. See equipment list for replacement part number.


Start
Open MSDOS prompt
Change directory To c:\picpgm
Run program.bat
Approve starting Mating Number?
No
Enter new Mating Number
Yes
Approve Mating Number symbols?
No
Yes
Enter Receiver crystal frequency.
Enter Controller crystal frequency.
2
1


2
1
Place empty Receiver PIC into programmer.
Press any key to program the PIC.
Did programming error occur?
Yes
No
Place empty Controller PIC into programmer.
Press any key to program the PIC.
Did programming error occur?
Yes
No
Program another PIC set?
Yes
No
End

0610 Receiver Tuning

Important Note Non-metallic tools must be used to make all adjustments to the components on the PCB's.

Step 1 Ground Receiver test point #2. (This places the PIC into test mode when power is applied, starting in channel 7.)

Step 2 Power Receiver, test point #16 is ground, test point #8 is 3.3 VDC. (PlayStation pin #4 is ground, pin #5 is 3.3 VDC.)

Step 3 Measure DC voltage at test point #12. (The voltage at test point #12 will be a DC voltage only with no AC component.)

Adjust VCO inductor coil (designator LA1) so that the voltage measured at test point #12 reaches 1.30 VDC (1.25 to 1.35 VDC is acceptable) with respect to system ground.

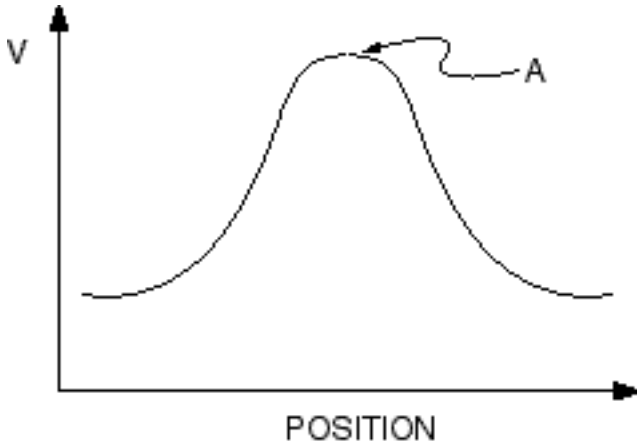
If voltage at test point #12 never reaches the valid range of 1.25 to 1.35 VDC (typically staying at 0 or 3.3 VDC) there is a problem with the Receiver PCB, or the Receiver is not in test mode. Remove power from the PCB once, and start at step 1 again. This repeat step will help ensure that the Receiver was in test mode.

Step 4
Important Note Louis will be providing the specification for the antenna needed in this test when he arrives in China.

Set the carrier signal generator to 317.113 MHz (Receiver channel 7), with **no modulation**, and high output signal strength (exact strength will be investagated by Louis).

The voltage at test point #9 will need to be monitored for this test. The voltage at this test point will range from 0 to 3.3 V, and will have an AC and a DC component. Measuring the voltage at test point #9 will require a meter which performs RMS measurements. (This is mentioned for the benefit of the design of the automated test system. The automated system will require the ability to measure the average value of the voltage at test point #9)

Adjust capacitor, designator CV1, until the voltage at test point #9 reaches a maximum value. The expected voltage characteristic of test point #9 is:

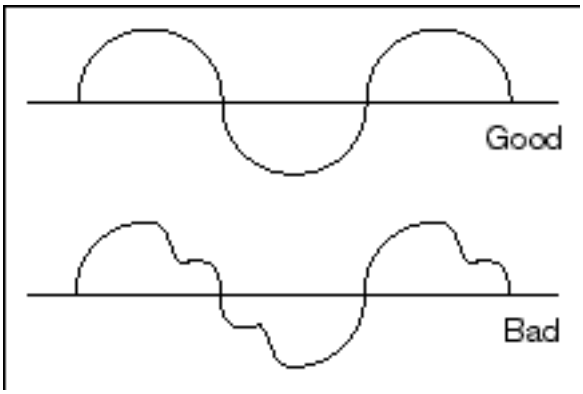


The voltage at the maximum will depend on signal strength and will be specified later.

Step 5 This Receiver tuning step requires an oscilloscope, and the carrier signal generator to be modulated with a 13 kHz modulation depth with a 10 kHz signal.

Connect the oscilloscope to test point #10. A sine wave should be observed.

Adjust the intermediate frequency coil LA2 to maximize the amplitude and minimize the distortion of the observed signal. An example of good and bad signal observations is shown below.



At this point the Receiver is completely tuned.

0620 Receiver Quality Control Testing

There are two methods which can be used to test the Receiver. The first and preferred method, provides a real number which can be read from an instrument. The second method is graphical and requires the use of human observations.

0630 Receiver Quality Control Testing Method #1

For this test it is necessary to modulate a 317.113 MHz carrier with a 10.5 kHz signal. An audio analyzer is also required to do the SINAD measurement.

Note Remove power to the receiver before starting this test.

Step 1 Ground Receiver test point #2. (This places the PIC into test mode when power is applied, starting in channel 7.)

Step 2 Power Receiver, test point #16 is ground, test point #8 is 3.3 VDC. (PlayStation pin #4 is ground, pin #5 is 3.3 VDC.)

Step 3 Modulate the 317.113 MHz carrier at a modulation depth of 13.0 kHz with a 10.5 kHz signal.

Step 4 Connect the output of test point #10 to the audio analyzer.

Step 5 Read and record the SINAD value from the audio analyzer. (Expected values for all SINAD measurements range from 18 to 21.)

Step 6 Changing receiver channels. It necessary to take this measurement from channels 7, 15 and 0. To change from channel 7 to 15, pulse (L to H followed by a H to L transition) at test point #2 for a duration no less than 100 ms.

Note 1 In steps 6 and 8 the H edge of the pulse can be replaced by high impedance.

Note 2 It is important that test point #2 is debounced so that the channel of the Receiver is not unintentionally changed.

Step 7 Change carrier signal frequency to 319.4874 MHz.

Step 8 Read and record the SINAD value from the audio analyzer.

Step 9 Change the receiver channel from 15 to 0 by pulsing test point #2 again.

Step 10 Change carrier signal frequency to 315.0146 MHz.

Step 11 Read and record the SINAD value from the audio analyzer.

At this point, this Receiver quality control test is complete.

0640 Receiver Quality Control Testing Method #2

This test uses the carrier signal of 317.113 MHz with no signal source (no modulation).

Step 1 Ground Receiver test point #2. (This places the PIC into test mode when power is applied, starting in channel 7.)

Step 2 Power Receiver, test point #16 is ground, test point #8 is 3.3 VDC. (PlayStation pin #4 is ground, pin #5 is 3.3 VDC.)

Step 3 Connect the spectrum analyzer to test point #9 (Should see carrier at 455 kHz).

Step 4 Adjust the spectrum analyzer settings to:
100 kHz span (10 kHz/div)
300 Hz resolution bandwidth (1 kHz acceptable)

Note The sweep time may have to be increased in order for the spectrum analyzer to accommodate the 300 Hz resolution bandwidth.

Step 5 Observe waveform from spectrum analyzer with carrier at 455 kHz.

Step 6 Record the number of divisions for measurement A. (Shown below)

Step 7 Change Receiver channel from 7 to 15 by pulsing test point #2 as in testing method #1.

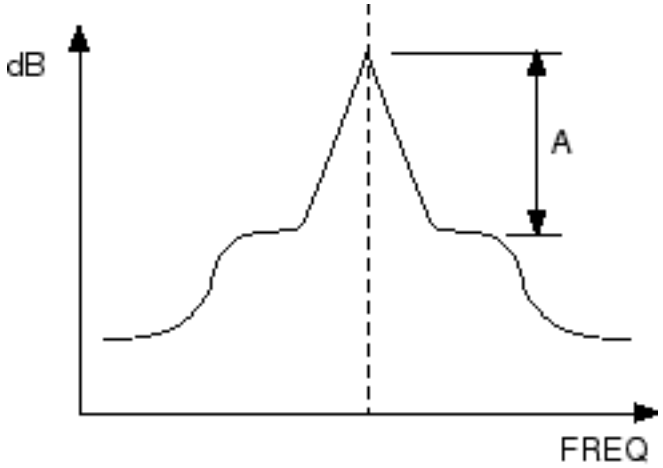
Step 8 Change carrier frequency to 319.4874 MHz.

Step 9 Record the number of divisions for measurement A. (Shown below)

Step 10 Change Receiver channel from 15 to 0 by pulsing test point #2.

Step 11 Change carrier frequency to 315.0146 MHz.

Step 12 Record the number of divisions for measurement A. (Shown below)



At this point, this Receiver quality control test is complete.

0650 Controller Tuning

Important Note Non-metallic tools must be used to make all adjustments to the components on the PCB's.

Step 1 Apply power to Controller by connecting test point #6 to 1.5 V and test point #3 to ground.

Step 2 Ground test point #1.

Step 3 Pulse test point #7 for 50 ms to turn on the power regulator. **Test point #7 must float at the end of the 50 ms pulse.**

Step 4 **Float test point #1.** The controller will now be in test mode.

Step 5 Measuring the voltage at test point #10, adjust the VCO inductor coil LA1 until the voltage is between 1.45 and 1.55 VDC.

If voltage at test point #10 never reaches the valid range of 1.45 to 1.55 VDC (typically staying at 0 or 3.3 VDC) there is a problem with the Controller PCB, or the Controller is not in test mode. Remove power from the PCB once, and start at step 1 again. This repeat step will help ensure that the Controller was in test mode.

The Controller is now tuned.

0660 Controller Quality Control Testing

The controller also has two possible quality control tests. The first, and preferred method, produces a SINAD ratio for the whole Controller and Receiver RF link, and the second method requires human observation.

0670 Receiver & Controller Quality Control Testing Method #1

This test is designed to test the quality of the RF link between the Controller and the Receiver.

Note A 10 m separation between test stations is required for this test. Louis will advise if sheilded test stations or RF isolated rooms will be adequate.

Step 1 Power Controller into test mode by doing the following. (This is the same method that was used to power the Controller into test mode in the Controller tuning section.)

Step 1a Apply power to Controller by connecting test point #6 to 1.5V and test point #3 to ground.

Step 1b Ground test point #1.

Step 1c Pulse test point #7 for 50 ms to turn on the power regulator. Test point #7 must float at the end of the 50 ms pulse.

Step 1d Float test point #1. The Controller will now be in test mode.

Step 2 Pulse test point #16 for a duration no less than 100 ms. Test point #16 is normally high and will require a H to L and a L to H transition to turn on the 10 kHz modulation test mode. In other words, ground test point #16 for 100 ms. The test point can float after the pulse.

Step 3 Power Receiver into test mode. (This is the same method that was used to power the Receiver into test mode in the Receiver tuning section.)

Step 3a Ground Receiver test point #2. (This places the PIC into test mode when power is applied, starting in channel 7.)

Step 3b Power Receiver, test point #16 is ground, test point #8 is 3.3 VDC.

Step 4 Connect the output of test point #10 **ON THE RECEIVER** to the audio analyzer.

Step 5 Read and record the SINAD value from the audio analyzer. (Expected values for all SINAD measurements range from 18 to 21.)

Step 6 The SINAD measurement needs to be taken when both the Receiver and Controller are on channels number 7, 15 and 0. The Receiver and Controller must be on the same channel at the same time.

Changing Controller channels. To change from channel 7 to 15, pulse (L to H followed by a H to L transition at end of pulse) at test point #12 for a duration of no less that 100 ms.

Changing Receiver channels. To change from channel 7 to 15, pulse (as above), at test point #2 for a duration of no less than 100 ms.

Step 7 Read and record the SINAD value from the audio analyzer.

Step 8 Change the Controller and Receiver channels from 15 to 0 by following step #6 above.

Step 9 Read and record the SINAD value from the audio analyzer.

At this point, this Controller and Receiver quality control test is complete.

0680 Controller Quality Control Testing Method #2

This test uses the carrier signal of 317.113 MHz with no signal source.

Important Note Ensure that no modulation is used in this test.

Step 1 Apply power to Controller by connecting test point #6 to 1.5 V and test point #3 to ground.

Step 2 Ground test point #1.

Step 3 Pulse test point #7 for 50 ms to turn on the power regulator. **Test point #7 must float at the end of the 50 ms pulse.**

Step 4 **Float test point #1.** The controller will now be in test mode.

Step 5 Connect the spectrum analyzer to test point #11 (should see carrier at 317.113).

Step 6 Adjust the spectrum analyzer settings to:
100 kHz span (10 kHz/div)
1 kHz resolution bandwidth

Step 7 Observe waveform from spectrum analyzer with carrier at 317.113 MHz. (Louis will provide picture when equipment is available)

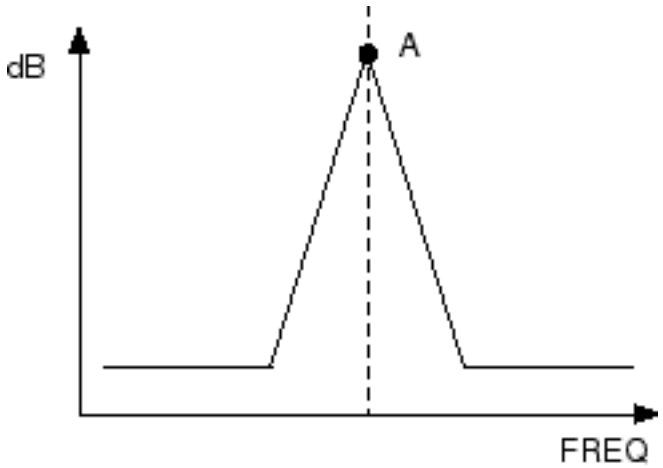
Step 8 Record the number of divisions for measurement A. (Shown below)

Step 9 Change the Controller channel from 7 to 15 by pulsing test point #12.

Step 10 Record the amplitude for measurement A. (Shown below)

Step 11 Change Controller channel from 15 to 0 by pulsing test point #12.

Step 12 Record the amplitude for measurement A. (Shown below)



At this point, the Controller quality control test is complete.

0700 Introduction

The end to end test station will be composed of an interface box that an AIRPLAY receiver plugs into. The interface box will also be connected to the computer for recording of results and control of tests.

0710 Procedure

Step 1 Take a Receiver/Controller pair and connect the Receiver to the connection provided on the interface box.

Step 2 Insert a battery into the reLOAD battery bay and power up the Controller by using the POWER/CHANNEL button.

Step 3 Enter the test mode key sequence. This sequence is used to ensure that all of the buttons on the controller are operating correctly.

The buttons must be entered in the following order to put the Controller into test mode:

hold CHANNEL
click SELECT
click CROSS
click CROSS
release CHANNEL

At which time the LED will flash 5 times to acknowledge test request. Then in order, the following key sequence must be entered:

DPAD-LEFT
DPAD-DOWN
DPAD-RIGHT
DPAD-UP
START
PROGRAM
CHANNEL
SELECT
SQUARE
CROSS
CIRCLE
TRIANGLE
R1
L1
R2
L2

The LED will flash 5 times to acknowledge test succeeded, or the LED will remain on if a failure occurs. If the test fails, remove and reinsert the battery in the AIRPLAY controller then repeat step (3) once to ensure an error was not made in the order which buttons were pressed.

At this time the operator will have to indicate to the GUI that the test has passed or failed. The possibility of automating this notification of pass or fail is being investigated.

Step 4 The next test is the RF channel test. For this the user is required to enter the key sequence:

hold CHANNEL
click SELECT
click SQUARE
click TRIANGLE
release CHANNEL

If the key sequence was entered properly the LED will flash 11 times to acknowledge the test request. The test will take from 40 to 45 seconds to complete. The Controller will continually run the RF test, blinking the LED 11 times at the start of each test, until the battery is removed.

Step 5 Watch the computer monitor for notification that the RF test is complete. The computer will indicate to the user if the unit under test (UUT) passed or failed the tests, and if failed, will identify which test failed.

Step 6 Remove and reinsert the battery.

Step 7 Power off test. This test is used to ensure that the Controller will power down when the proper key sequence is given. Perform the following operations to exercise the UUT:

hold PROGRAM
click CHANNEL
release PROGRAM
click CHANNEL
LED will flash 3 times to acknowledge power up

hold PROGRAM
click CHANNEL
release PROGRAM
click CHANNEL
LED will flash 3 times to acknowledge power up

If the unit powered down correctly, indicate this to the GUI by pressing PASSED/CONTINUE. If the unit did not power down correctly press FAILED/CONTINUE.

Step 8 If the computer passes the Controller, check the Mating Number on the AIRPLAY units to the one printed on the screen. If the Mating Numbers are the same, this AIRPLAY is ready for packaging. If the computer fails the AIRPLAY unit, make note of the errors on the screen and send the units to a rework station.

Notes

1. The key test sequence uses all of the buttons on the Controller. If any buttons do not work, the test sequence will not be accepted. Each button must be pressed exactly once, in the described order. If these two conditions are not met then the test request will not be accepted, and the LED will not flash 5 times. If the LED does not flash 5 times to indicate a passed test, remove the battery and start again at step (3).

2. Please be sure that there is a minimum distance of 10 m between adjacent test stations, or that the test stations are within shielded rooms.

3. Be advised that the PlayStation connecter on the secondary TF interface box will wear and require replacement.

4. The computer collects data on the AIRPLAY units passing through it. At various times the data files need to be transferred to Eleven.

0810 Receiver Test Station Requirements

It is expected that an antenna will have to be placed in proximity to the receiver to do the receiver tests. The method of using the signal cable itself is not acceptable due the fact that the signal strength at the receiver antenna will change from test to test.

What is required is that the signal at a specific location in the test fixture be known in strength and must remain constant between tests.

Louis will provide an antenna design once in China.

0810-30 Changed from Ed being consulted to Louis will provide a solution in China.

0820 Mating Numbers

Introduction Each pair of Receivers and Controllers is mated via a 15 bit code. (Valid Mating Numbers range from 0000 to 7FFF hex inclusive). Both products are tagged with a Mating Number on a sticker underneath the product. The 15 bit code is represented by 8 characters. An example of a Mating code is: ○×□△-△□×○.

Key

Hex: 0 Binary: 0000 AIRPLAY: ○○
Hex: 1 Binary: 0001 AIRPLAY: ○×
Hex: 2 Binary: 0010 AIRPLAY: ○□
Hex: 3 Binary: 0011 AIRPLAY: ○△
Hex: 4 Binary: 0100 AIRPLAY: ×○
Hex: 5 Binary: 0101 AIRPLAY: ××
Hex: 6 Binary: 0110 AIRPLAY: ×□
Hex: 7 Binary: 0111 AIRPLAY: ×△
Hex: 8 Binary: 1000 AIRPLAY: □○
Hex: 9 Binary: 1001 AIRPLAY: □×
Hex: A Binary: 1010 AIRPLAY: □□
Hex: B Binary: 1011 AIRPLAY: □△
Hex: C Binary: 1100 AIRPLAY: △○
Hex: D Binary: 1101 AIRPLAY: △×
Hex: E Binary: 1110 AIRPLAY: △□
Hex: F Binary: 1111 AIRPLAY: △△

0830 Front-end Amplifier For Crystal Frequency Measurements

Introduction To reduce the 50 mV sensitivity requirement on the frequency counter, the following front-end amplifier can be used to amplify the crystal signal.

CIRCUIT TBA

0840 Used Test Point List

Receiver

2

8

9

10

11

12

16

Controller

1

2

3

6

7

10

11

12

16

0900 Revision History

Version 1.1 to 1.2	
0100	Paragraph 2-Decision of which tests are run and at what sample rates was added.
0650	Corrected error, changing test point #2 to test point #1
0670	Entire procedure has changed as there is now a new way to get into test mode and to generate a 10 kHz signal. (A external signal generator is no longer required for this test.) Also added instructions to change the channel on both the receiver and transmitter at the same time.
0110	Changed to 0130
0120	Section Added. Moved comment about responsibility to its own section, originally from 0100
0110	Section Added. Explained why power up is done at the start of each of the tests when in some cases this step would not be necessary in some situations.
0630, 0640, 0680	Added methods to power the Controller and Receivers into test mode at the start of each test.
Version 1.2 to 1.3	
0400-20	Step 2 - changed test point #1 to test point #11.
0410-20,30	Removed step 1 and note as per Louis.
0500-25	Added note to ensure firmware and software are the same version.
0500-40	Referenced note 0500-25.
0510-15	Added note for valid Mating Numbers 0000 to 7FFF inclusive.
0510-30, 50	Step 2, 5 - added word crystal.
0510-70	Added note on repeated programming failures.
0610-30	Changed test point #1 to test point #12 as per Louis.
0610-40	Changed voltage range from 1.50V (1.45 -> 1.55) to 1.30V (1.25 -> 1.35)
0610-50	Same changed as 610-30 and 610-40 above.
0630-15	Added note to remove power before test.
0630-60	Changed SINAD range from 16 -> 20 to 18 -> 21.
0630-75	Added note that case use high Z not just H for steps 6 and 8.
0630-76	Added note about debouncing.
0630-80	Added steps 6A and 8A (after old numbers 6 and 8) to change carrier frequency changes.
0640-90+	Added steps 7A and 9A (after old numbers 7 and 9) to change carrier frequencies.

0670-130	Changed SINAD measurement from 16 -> 20, to 18 -> 21.
0680-10	Deleted modulation note.
0680-15	Added modulation note.
0680-110,130	Changed “number of divisions” to “amplitude”.
0820-10	Added note for valid Mating Numbers 0000 to 7FFF inclusive.
Version 1.3 to 1.4	
0500, 0510, 0520	Completely re-did programming section. Lots of important changes were made.
Version 1.4 to 1.5	
0400,0410	Changed section 0400 to 0410 and section 0410 to 0420.
0400	Added warning that it may be necessary to measure crystal frequencies and tune the AIRPLAY controllers and receivers under controlled temperature conditions.
0520-75	Added new step 5 and moved old step 5+ to step 6+. Note about visual representation of mating number being displayed was added in the new step 5.
0520-80	New step 6, changed frequency from 10.240123 to 10.244567 so that the example would give a number (4567) within the valid range.
0610-40	Changed test point #1 to test point #12.
0610-55	Note added about Louis taking care of antenna design when in China.
0900	Moved revision history from section 0840 to 0900.
0840	Added section on used test points for Receiver and Controller.
0610-60+	MAJOR CHANGE: Method used to tune the receiver was changed to ensure that the discriminator was also being tested, not just the filter stages. New equipment (oscilloscope added).
0380-65	Added oscilloscope to the required equipment list.
0670-20	Changed note to include sheilded boxes and isolated rooms.