


ATTACHMENT 2

**DRAFT T-PED Susceptibility Testing Frequency Plan
Prepared by Armstrong Aerospace
JC241-90282-02 Rev PB (January 3, 2012)**



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**Test Procedure, Ground EMC Test
Transmitting Portable Electronic Devices (T-PEDs)
Boeing 747-400 Series Aircraft**

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TEST PROCEDURE, GROUND EMC TEST

Transmitting Portable Electronic Devices (T-PEDs)
Boeing 747-400 Series Aircraft

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REVISION	DATE	REASON FOR REVISION	ISSUED BY	APPROVED BY
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DRAFT

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1. PURPOSE

The purpose of this document is to present a means of compliance with Federal Aviation Regulations 14 CFR 25.1309(a). This Electromagnetic Compatibility (EMC) test procedure is provided to establish that passenger and crew Transmitting Portable Electronic Devices (T-PEDs), as identified herein, do not adversely affect the operation and integrity of aircraft systems installed in Boeing 747-400 series aircraft.

2. SCOPE

This test procedure demonstrates that only those specific T-PED technologies, as identified herein, do not adversely affect the operation and integrity of other systems on the aircraft.

3. REFERENCE DOCUMENTS

- Armstrong Aerospace document JC241-8092-01, Setup/Calibration Procedure, Ground EMC Test, Transmitting Portable Electronic Devices (T-PEDs)
- Armstrong Aerospace drawing JC241-8092-03, Setup/Calibration Diagram, Ground EMC Test, Transmitting Portable Electronic Devices (T-PEDs)
- Armstrong Aerospace drawing JC241-9082-04, Test Procedure Diagram, Ground EMC Test, Transmitting Portable Electronic Devices (T-PEDs), Boeing 747-400 Series Aircraft
- Armstrong Aerospace document JC241-9082-05, Aircraft Equipment Record, Ground EMC Test, Transmitting Portable Electronic Devices (T-PEDs), Boeing 747-400 Series Aircraft
- Armstrong Aerospace document PL44-8092-10, Test Equipment Parts List, Ground EMC Test, Transmitting Portable Electronic Devices (T-PEDs)
- RTCA/DO-294C – Guidance on Allowing Transmitting Portable Electronic Devices (T-PEDs) on Aircraft

4. PREREQUISITE ACTIVITIES

4.1 Test Equipment Calibration

Calibration of the test equipment must be performed prior to execution of this test procedure as described in JC241-8092-01 and JC241-8092-03.

Calibration data will be recorded electronically in Appendix A – RF Frequency Chart/Calibration Record.

Columns A-J of Appendix A – RF Frequency Chart/Calibration Record identify the wireless standards, the uplink band of the standard, the test frequency in the uplink band that will be used to assess the aircraft systems for compatibility, the modulation of the test frequency that will be used, the test waveform that will be used, and the maximum effective isotropic radiated power (EIRP) allowed by regulation for the standard in both Watts EIRP (column I) and dBm EIRP (column J).

Column K defines the multiple equipment factor (MEF) that will be used to account for multiple device usage within the aircraft. The MEF was determined based on the 747-400 maximum seating of 624 passengers. Expected usage is less than half of all seats with spacing between users estimated at 1 meter. RTCA/DO-294C, Table 6.G-1 for a distance of 1m and 312 sources yields an MEF of 12. An MEF of 12 is used for all wireless standards except for the 802.11 standard which has been determined to have no MEF due to the transmission method that is used, however, DO-294C describes a minimum 10 dB be used to account for additional factors, therefore, an MEF of 10 is used for the 802.11 technologies.

Columns L-N provide the target EIRP in dBm, target EIRP in Watts and effective radiated power (ERP) in Watts.

Columns P-S provide typical dB gain and loss numbers for the antennas, amplifiers, cables and calculate the input to the amplifier.

Column T provides the calculated SigGen setting that should be used during calibration. The calculated SigGen setting is an estimate and may be adjusted during calibration.

Column U should be used to record the calibrated SigGen setting that was determined during calibration.

Columns W-AC provide the field strength of the signal in V/m, dBuV/m, antenna calibration factors, etc, used during calibration.

Columns AE and EF define the exposure limits for both controlled and uncontrolled environments. Section 6 summarizes the exposure limits for test personnel.

NOTE: The power levels and test frequencies in Appendix A – RF Frequency Chart/Calibration Record should be coordinated with applicable local regulatory authorities for approval prior to testing.

NOTE: Uplink band - From handset device to base station.

4.2 Aircraft Equipment Record

Record the airplane system (major component) part numbers and manufacturer information for all airplane systems being evaluated in JC241-9082-05. This establishes the airplane configuration at the time of test, which may be applicable for similarity considerations for follow-on installations on other airplanes.

NOTE: If it is determined that there are aircraft systems regarded as “Critical”, “Essential”, and “Non-Essential but Required for Dispatch” that have not been identified in this test plan, these equipment should also be evaluated for interference and results recorded at the end of the applicable section under “Additional Equipment”.

5. SCHEDULE / EFFECTIVITY LIST

5.1 Aircraft Effectivity List

This plan is applicable to the following six aircraft:

Customer Effectivity Code	Registration Number	Manufacturing Serial Number
003	VP-BVR	26637
004	VP-BKJ	26638
005	VP-BKL	28468
006	EI-XLZ	29119
007	VQ-BHW	28959
008	ZS-SBS	28959
038	EI-XLK	29950
039	EI-XLL	28031
040	EI-XLM	28028
041	EI-XLN	28029
042	EI-XLO	28025
913	N913UN	26359
914	EI-XLD	26360
916	EI-XLE	26362
917	EI-XLG	29899
918	EI-XLH	27650
919	EI-XLC	27100
920	EI-XLI	27648



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Customer Effectivity Code	Registration Number	Manufacturing Serial Number
921	EI-XLF	27645
922	EI-XLJ	27646

NOTE: Aircraft not listed in the Aircraft Effectivity List, including future new deliveries, will require an analysis of the aircraft data (AMM, WDM, IPB) in order to determine applicability of this plan to those aircraft.

5.2 Aircraft Configurations

Analysis of the data for the aircraft listed in the Aircraft Effectivity List has determined the following configuration differences within the effective aircraft.

747-400 Aircraft Configurations		
Equipment Location	Effectivity	Equipment Differences
E1-1	913	B08238- LOCATED ONLY ON LISTED EFF.
E1-2	003, 004, 005, 913	M07877- LOCATED ONLY ON LISTED EFF.
E1-5	003, 004, 005, 007, 008	B08385- LOCATED ONLY ON LISTED EFF.
E1-5	003, 004, 005, 007, 008	B07019- LOCATED ONLY ON LISTED EFF.
E2-1	913	M00118- LOCATED ONLY ON LISTED EFF.
E2-3	003, 004, 005	B07743- LOCATED ONLY ON LISTED EFF.
E8	913	M06769- LOCATED ONLY ON LISTED EFF.
E8	003, 004, 005, 913	M06770- LOCATED ONLY ON LISTED EFF.
E8	003, 004, 005, 007, 008	M00526- LOCATED ONLY ON LISTED EFF.
E8	913	B07454- LOCATED ONLY ON LISTED EFF.
E8	913	B08459- LOCATED ONLY ON LISTED EFF.
E8	913	B07455- LOCATED ONLY ON LISTED EFF.
E29	003, 004, 005	B08237- LOCATED ONLY ON LISTED EFF.
E29	003, 004, 005	B08228- LOCATED ONLY ON LISTED EFF.
E31	003, 004, 005	M00698- LOCATED ONLY ON LISTED EFF.
E31	003, 004, 005, 007, 008	B07454- LOCATED ONLY ON LISTED EFF.
E31	003, 004, 005, 007, 008	B07455- LOCATED ONLY ON LISTED EFF.

5.3 Susceptibility Assessment Schedule

As detailed within this test plan, testing will be performed at 20 locations (flight deck, 12 electronic equipment bay/rack locations, and seven cabin locations). A common test profile is used at each test location. The estimated average time for completion of each

back-door assessment (assuming no susceptibility is detected and no test equipment failures) is as follows:

Given:

Equipment configuration and antenna positioning time = 20 min.

Length of time required for FAA Representative/Designee to assess aircraft systems = 20 min.

Number of antenna polarizations = 2.

Therefore:

20 min + (20 min x 2 polarizations) = 60 min

The estimated average time for completion of each front-door assessment (assuming no susceptibility is detected and no test equipment failures) is as follows:

Given:

Equipment configuration and antenna positioning time = 10 min.

Length of time required for FAA Representative/Designee to assess aircraft systems = 10 min.

Number of antenna polarizations = 2.

Therefore:

10 min + (10 min x 2 polarizations) = 30 min.

6. SITE REQUIREMENTS / RESOURCES REQUIRED

6.1 Site Requirements

The testing will be accomplished at a suitable facility that can provide the personnel and support equipment as described within this plan.

- Since communication and navigation systems are being evaluated, it is preferable for the airplane to be outside of the hangar and 500 or more feet from large metallic structures. (**NOTE:** Due to potential local license restrictions, testing may be required to be performed inside of a hangar in order to comply with the local restrictions).
- Electrical and hydraulic power must be available throughout the test. Airplane power can be from any source (engine, APU, or external) during the test. In addition, APU and main engines will be run for evaluation of engine controls and electrical generation (IDG, GCU).
- Minimum of three 115/220VAC 50/60 Hz 20A sources of power are required to operate the test equipment (power requirements will vary depending on the number of amplifier/antenna assemblies used).
- The tests described herein may be performed in any order.
- Since the RF radiated field can be hazardous to personnel, the admittance of people in the vicinity of the tests should be minimized. Observers and visitors shall only be allowed onboard the aircraft in company of the test personnel. In addition,

a flashing red light will be located close to the aircraft entrance to inform personnel of the transmitting state.

6.2 Resources Required

- Test Sets and electrical power for ATC, TCAS, VOR/ILS, Marker Beacon, DME, and SELCAL. Note: Where possible, local off-the-air signals will be used when testing these systems. The test sets will be used only in the absence of valid local signals.
- Flashing red light
- Personal communication devices (i.e. hand-held radios) for communication between test personnel, FAA Representative/Designee, mechanics including headsets for Service Intercom communication.
- Tape measure (16' or longer)
- Test equipment specified in Test Equipment Parts List PL44-8092-10.
- Aircraft maintenance personnel with the authority and knowledge to assist in the performing of the aircraft system checks from the cockpit and Cabin Crew Control Stations.
- Aircraft maintenance personnel with the knowledge to operate the In-Flight Entertainment Equipment (IFE) including knowledge of crew passwords and login information.
- Exterior observers to monitor control surfaces for uncommanded movements (requires enough personnel to monitor flight control surfaces simultaneously such as rudder, elevator, ailerons and spoilers).
- Armstrong Aerospace personnel to set up and operate the test equipment, and coordinate the test effort.
- Digital camera to document test antenna positions and test equipment setup.

7. AIRCRAFT CONFIGURATION

As much as practically possible while allowing for personnel access and test cable routing, doors and hatches should be closed. All systems that can be safely operated on the ground should be switched on and set to valid modes. Select all navigation and communication systems on and receiving valid but minimal signals when test sets are available. Operate the navigation and communications equipment on at least one low, high and mid-band frequency. Record all frequencies used. Check that engine instruments, radio altimeter, stall warning, and flap indications are powered. Tune all radio receivers to the test set frequency or to a distant active channel. Check the magnetic compass is not displaying any erroneous heading at least four times throughout the test.

8. TEST WITNESSING & PERFORMANCE OF TESTS

Individuals witnessing the tests (FAA representative or designee) shall verify antenna position placement prior to performance of tests. The test witness shall be positioned such that observation of normal operation of the system/equipment under test is evident.

Testing personnel shall communicate any observations, such as fault displays, to the attention of the test witness.

9. EQUIPMENT UNDER TEST (EUT)

These test procedures should not be executed until all logbook discrepancies for any of the targeted aircraft systems have been resolved.

All aircraft systems regarded as “Critical”, “Essential”, and “Non-Essential but Required for Dispatch” will be evaluated for interference in the presence of the EMC test signal. Any observed effects should be assessed as failing the test but the interference threshold should be determined to allow for possible post-test evaluation and mitigation.

In the “Non-Essential” category, aircraft equipment that is not required for dispatch, but that might have a susceptibility to transmissions at the test frequencies will be tested. Equipment in this category includes primarily the IFE (in-flight entertainment) system head-end, distribution, and display units (if equipped). Any effect on devices in this category will be recorded and reported to the airline for additional action. Devices falling within this category will be clearly labeled “Non-Essential” on the aircraft-specific results report form.

10. OPERATION OF TEST AMPLIFIERS

Operator control of the low-band and high-band amplifiers is identical, and simple. The only control on the Amplifier Enclosure is a lighted ON-OFF switch. The amplifiers contain an integral fan within the enclosure that blows across the power supply and the cooling fins of the power amplifier. If the fan does not run when the power cord of the enclosure is plugged in, unplug the power cord and check the fuse in the holder mounted adjacent to the lighted ON-OFF switch. Replace if necessary, after determining cause of failure. Do not operate the power amplifiers if the enclosure fan is inoperative.

CAUTION: If any amplifier is operated without cooling airflow, POWER AMPLIFIER FAILURE WILL RESULT.

If an amplifier has been running for several minutes or longer, allow at least 2 minutes for the fan to run (to cool the amplifier) after the ON-OFF switch has been turned OFF, before disconnecting the Amplifier Enclosure power cord from the 115/220 VAC source. Avoid plugging in or disconnecting the power cord with the enclosure switch in the ON position.

When ready to commence testing, check that RF output of the SigGen is turned OFF, then turn the Amplifier Enclosure switch ON. The switch should light, indicating that power is being supplied to the amplifier. Allow several minutes for the amplifier to reach a normal operating temperature. Remove personnel from the vicinity of all test antenna(s) before turning the SigGen RF output ON again. When the particular test is finished, turn the SigGen RF output OFF. Depending on the wait time before starting the next test, the Amplifier Enclosure ON-OFF switch may be either turned OFF, or left ON. As long as the SigGen RF output is turned OFF, there will be no RF emission from the antenna(s), even with DC power being supplied to the amplifier.

11. RF PLANNING CHART/CALIBRATION RECORD

Provides the test frequencies, modulation and power levels to be used during on-aircraft testing. In addition, signal generator amplitude settings required to generate the required power level are determined during the calibration process and recorded there.

11.1 Test Signal Waveforms

DO-294C, table 6.F-1 provides an evaluation of wireless technologies and provides two basic signal waveforms for back-door EMI effects testing and limited front-door testing. The first basic signal waveform has been found to be applicable to all TDMA-like standards and the second to all CDMA/FDMA based access schemes. These two basic waveforms will be used for on-aircraft susceptibility testing.

11.1.1 Test Waveform 1 (TDMA and CSMA/FHSS Standards)

Test signal 1 is a pulse-modulated signal with a pulse-repetition-frequency (PRF) in the range of 200 Hz and a pulse duration in the range of 625 us as shown in Figure 1 – Test Waveform 1.

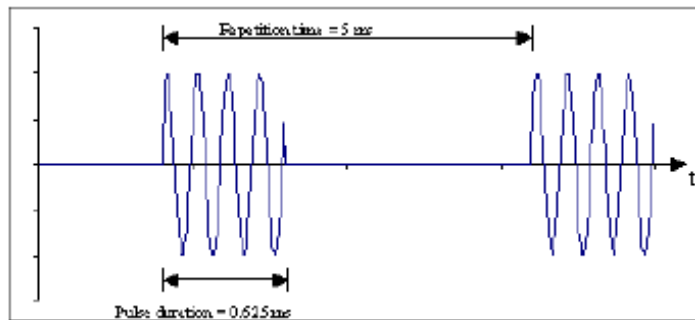


Figure 1 – Test Waveform 1

11.1.2 Test Waveform 2 (CDMA/FDMA Standards)

Test signal 2 is a continuous waveform with no pulse-modulation as shown in Figure 2 – Test Waveform 2.

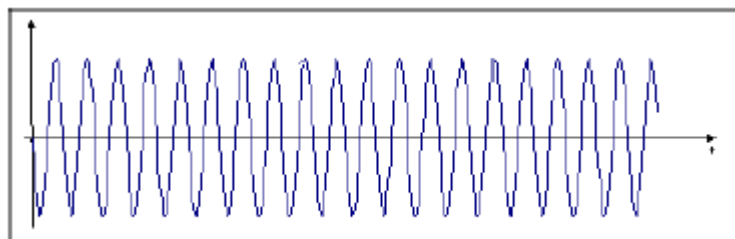


Figure 2 – Test Waveform 2

12. FCC EXPOSURE LIMITS

FCC Part 1 (Sec. 1.1310 Radio Frequency Radiation Exposure Limits) offers guidelines for human exposure to electromagnetic fields. Two limits are defined, one for Occupational Exposure and another for the general public (Incidental or Uncontrolled Exposure). Because our test occurs within a controlled environment, we must only comply with the Occupational Exposure limit, and not the more restrictive Incidental Exposure limit. However, we will calculate for both limits to allow personnel the knowledge to limit their exposure as much as possible.

Below 1500 MHz, FCC limits vary with the frequency in use.

Below 1500 MHz, FCC Exposure Limits	
Limit Type	Exposure Limit
Occupational/Controlled Exposure:	$f/300$ mW/cm ² ($f/30$ W/m ²), where f is frequency, averaged over 6 minutes
General Public/Uncontrolled Exposure:	$f/1500$ mW/cm ² ($f/150$ W/m ²), where f is frequency, averaged over 30 minutes

FCC limits are the same for all frequencies between 1500 and 100,000 MHz.

Below 1500 MHz, FCC Exposure Limits	
Limit Type	Exposure Limit
Occupational/Controlled Exposure:	5 mW/cm ² (50 W/m ²), averaged over 6 minutes
General Public/Uncontrolled Exposure:	1 mW/cm ² (10 W/m ²), averaged over 30 minutes

Note that the allowable values for exposure represent a power density averaged over a certain amount of time. A power density at or below that exposure limit may be tolerated for an indefinite period of time. A power density above that limit must be averaged over the specified time period. For example, an occupational exposure to a power density of 50 W/m² for an entire work shift is allowable. If the power density is increased to 150 W/m², for every 2 minutes of exposure to the field, a person must then be completely removed from the field for 4 minutes.

The electric field strengths (E_f) to be used are provided in Appendix A. Knowing the power density of our test signal and the distance from the antenna at which it is to be generated, we may use a ratio to calculate the distance from the transmitting antenna to the power density representing the FCC limit (reference column AG). This distance may then be employed as "closest point of approach" to a radiating antenna during conduct of the tests.

Caution: Exposure to Radio Frequency Radiation!

All personnel must remain at least 16" from any radiating test antenna.

13. BACK-DOOR EVALUATION

Back-door evaluation tests are performed to determine if the aircraft electronics are susceptible to interference from passenger T-PEDs through coupling of power or signal wires, or through apertures in the device enclosures. Reference JC241-9082-04 for back-door evaluation test antenna positions. At these positions, the equipment will be exercised and monitored by the FAA Representative/Designee.

In addition to all systems and equipment listed in this section, the following cabin components are to be evaluated. At the discretion of the FAA Representative/Designee, the equipment will be exercised and monitored per applicable maintenance instructions.

Cabin Components / Equipment	
System	Test Record
Cabin Components / Equipment	B.21

1. Ensure calibration of test equipment setup has been accomplished in accordance with JC241-8092-01. Accuracy of this calibration will be relied on to generate the desired field strength level of the test signals.
2. Identify and become familiar with the location of the aircraft equipment racks/locations as shown in JC241-9082-04.
3. Locate the test antenna at the first back-door evaluation location (order of testing is at the discretion of the Test Director and FAA Representative/Designee).
4. Set up the test equipment per JC241-8092-03.
5. Allow sufficient cable/wiring lengths to keep personnel separated from the test antennas during the test.
6. Orient the antenna in the horizontal polarization as shown in JC241-9082-03.
7. Record the test antenna location and test equipment setup using a digital camera.
8. Ensure that the SigGen RF outputs are both OFF.
9. Turn the amplifier enclosure switches ON. The power switches should light, indicating power is being supplied to the amplifiers.
10. Remove personnel from the vicinity of the antenna(s).
11. Set up the SigGen(s) (Vector Signal Generators) to transmit at the frequency and modulation for Test Frequency #1 as shown in Appendix A. Set the SigGen(s) amplitude to the specified RF level(s) established during calibration as recorded in column W of Appendix A. This will produce the field strength(s) identified during calibration.

NOTE: The SigGens are capable of being remotely controlled and may be pre-programmed during the calibration process to automatically sweep through the required test frequencies at the required power levels. Automated operation is at the discretion of the test personnel and is not described within this document.



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12. Turn the SigGen RF output(s) ON. The aircraft equipment is now being exposed to the test signal(s). Exercise the applicable aircraft equipment and verify that no abnormal equipment function occurs.
13. If abnormal function of an EUT does occur, coordinate with the FAA Representative/Designee a series of steps to confirm the effect. First, turn the SigGen RF Output(s) OFF and verify the abnormal function clears. After confirmation of the effect, turn the SigGen RF output(s) back on and reduce the output(s) of the SigGen(s) by .5 dB steps, pausing 10 seconds between steps while exercising the aircraft equipment, and note the level at which the abnormal function does not occur. Evaluate the position of the antenna, the polarization and the distance from the effected unit to determine if local beam strength is at or above desired test signal level. If necessary, reposition the test antenna and repeat the test.
14. Turn the SigGen RF Output(s) OFF. In Appendix B, record the test results as either 'Pass' or 'Fail' and if there was an 'Effect', provide a description of the effect (identify equipment, describe abnormal behavior, etc.). Record the test frequency(s) causing the effect, the transmit identifier (modulation and antenna polarization) and the susceptibility threshold (SigGen RF Output Level(s) at the lowest level observed to cause the effect), even if the local threshold level is ultimately determined to be above the required test signal level.
15. Repeat steps 11 through 14 for the remainder of the test frequencies listed in Appendix A.
16. Rotate the test antenna(s) to the vertical polarization.
17. Repeat steps 11-15 for the vertical antenna polarization.
18. Repeat steps 7-17 for the remaining back-door test antenna locations.

13.1 Antenna Position #1 – Flight Deck

Position test antenna(s) 40" from main instrument panel (reference JC241-9082-04 Test Procedure Diagram). Exercise and monitor the following systems. Reference the aircraft maintenance manual (AMM), if necessary, for guidance on operational test procedures.

Note: It may not be possible to expose all flight deck instruments with a single antenna position. Re-aim the antenna as required during the procedure. Exercise and monitor the following systems per the airplane maintenance manual operational test procedures:

Antenna Position #1, Flight Deck Systems / Equipment	
System	Test Record
Flight Deck Systems / Equipment	B.1

13.2 Antenna Position #2 – E1 Equipment Rack (Requires Engine Run)

Position test antenna(s) a maximum of 40" FWD of rack face (reference JC241-9082-04 Test Procedure Diagram). Exercise and monitor the following systems. Reference the aircraft maintenance manual (AMM), if necessary, for guidance on operational test procedures.

Antenna Position #2, E1 Equipment Rack Systems / Equipment	
System	Test Record
E1 Equipment Rack Systems / Equipment	B.2

13.3 Antenna Position #3 – E2 Equipment Rack (Requires Engine Run)

Position test antenna(s) a maximum of 40" FWD of rack face (reference JC241-9082-04 Test Procedure Diagram). Exercise and monitor the following systems. Reference the aircraft maintenance manual (AMM), if necessary, for guidance on operational test procedures.

Antenna Position #3, E2 Equipment Rack Systems / Equipment	
System	Test Record
E2 Equipment Rack Systems / Equipment	B.3

13.4 Antenna Position #4 – E31 Equipment Rack (Requires Engine Run)

Position test antenna(s) 40" AFT of rack face (reference JC241-9082-04 Test Procedure Diagram). Exercise and monitor the following systems. Reference the aircraft maintenance manual (AMM), if necessary, for guidance on operational test procedures.

Antenna Position #4, E31 Equipment Rack Systems / Equipment	
System	Test Record
E31 Equipment Rack Systems / Equipment	B.4

13.5 Antenna Position #5 – E30 Equipment Rack

Position test antenna(s) 40" AFT of rack face (reference JC241-9082-04 Test Procedure Diagram). Exercise and monitor the following systems. Reference the aircraft maintenance manual (AMM), if necessary, for guidance on operational test procedures.

Antenna Position #5, E30 Equipment Rack Systems / Equipment	
System	Test Record
E30 Equipment Rack Systems / Equipment	B.5

13.6 Antenna Position #6 – E6 and E9 Equipment Rack

Position test antenna(s) centered between racks, maximum of 40” from rack faces (reference JC241-9082-04 Test Procedure Diagram). Exercise and monitor the following systems. Reference the aircraft maintenance manual (AMM), if necessary, for guidance on operational test procedures.

Antenna Position #6, E6 and E9 Equipment Rack Systems / Equipment	
System	Test Record
E6 and E9 Equipment Rack Systems / Equipment	B.6

13.7 Antenna Position #7 – E29 Equipment Rack

Position test antenna(s) 40” from rack face (reference JC241-9082-04 Test Procedure Diagram). Exercise and monitor the following systems. Reference the aircraft maintenance manual (AMM), if necessary, for guidance on operational test procedures.

Antenna Position #7, E29 Equipment Rack Systems / Equipment	
System	Test Record
E29 Equipment Rack Systems / Equipment	B.7

13.8 Antenna Position #8 – E8 Equipment Rack

Position test antenna(s) 40” from rack face (reference JC241-9082-04 Test Procedure Diagram). Exercise and monitor the following systems. Reference the aircraft maintenance manual (AMM), if necessary, for guidance on operational test procedures.

Antenna Position #8, E8 Equipment Rack Systems / Equipment	
System	Test Record
E8 Equipment Rack Systems / Equipment	B.8

13.9 Antenna Position #9 – E42 Equipment Rack

Position test antenna(s) 40” from rack face (reference JC241-9082-04 Test Procedure Diagram). Exercise and monitor the following systems. Reference the aircraft maintenance manual (AMM), if necessary, for guidance on operational test procedures.

Antenna Position #9, E42 Equipment Rack Systems / Equipment	
System	Test Record
E42 Equipment Rack Systems / Equipment	B.9

13.10 Antenna Position #10 – E33 Equipment Rack

Position test antenna(s) 40” from rack face (reference JC241-9082-04 Test Procedure Diagram). Exercise and monitor the following systems. Reference the aircraft maintenance manual (AMM), if necessary, for guidance on operational test procedures.

Antenna Position #10, E33 Equipment Rack Systems / Equipment	
System	Test Record
E33 Equipment Rack Systems / Equipment	B.10



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13.11 Antenna Position #11 – M7603 Card File (Requires Engine Run)

Position test antenna(s) 40" from rack face (reference JC241-9082-04 Test Procedure Diagram). Exercise and monitor the following systems. Reference the aircraft maintenance manual (AMM), if necessary, for guidance on operational test procedures.

Antenna Position #11, M7603 Card File Systems / Equipment	
System	Test Record
M7603 Card File Systems / Equipment	B.11

13.12 Antenna Position #12 – M0826 and M7852 Card Files

Position test antenna(s) 40" from rack face (reference JC241-9082-04 Test Procedure Diagram). Exercise and monitor the following systems. Reference the aircraft maintenance manual (AMM), if necessary, for guidance on operational test procedures.

Antenna Position #12, M0826 and M7852 Card Files Systems / Equipment	
System	Test Record
M0826 and M7852 Card Files Systems / Equipment	B.12

13.13 Antenna Position #13 – M7952 Card File (MAWEA)

Position test antenna(s) 40" from rack face (reference JC241-9082-04 Test Procedure Diagram). Exercise and monitor the following systems. Reference the aircraft maintenance manual (AMM), if necessary, for guidance on operational test procedures.

Antenna Position #13, M7952 Card File Systems / Equipment	
System	Test Record
M7952 Card File Systems / Equipment	B.13

14. FRONT-DOOR EVALUATION

The purpose of front-door evaluation is to determine if the onboard receiver systems are susceptible to interference from passenger T-PEDs through coupling of the aircraft antenna system. At these positions, the specific onboard receiver system being evaluated will be exercised and monitored by the designated FAA Representative/Designee.

1. Ensure calibration of test equipment setup has been accomplished in accordance with JC241-8092-01 Setup/Calibration, Ground EMC Test, T-PEDs. Accuracy of this calibration will be relied on to generate the desired field strength level of the test signal.
2. Identify and become familiar with the location of the aircraft antennas as shown in drawing JC241-9082-04.
3. Locate the test antenna at the first front-door evaluation location horizontally polarized. Refer to JC241-8092-01 for guidance on Antenna Aiming (NOTE: Location of the test antennas during front-door evaluation focuses on areas where it is expected to be minimal path loss to each aircraft antenna system. Table 5.B-1 of RTCA/DO-294C provides guidance on test locations where path loss is minimal for the 747-400 aircraft).



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4. Allow sufficient cable/ wiring lengths to keep personnel separated from the test antennas during the test.
5. Record the test antenna location and test equipment setup using a digital camera.
6. Set up the SigGen (Vector Signal Generator) to transmit at the frequency and modulation for Test Freq # 1 as shown in Appendix A. Set the SigGen amplitude to the specified RF level established during calibration. This will produce the field strength identified during calibration Turn the SigGen RF Output OFF.
7. Turn the amplifier enclosure switch ON. The power switch should light, indicating power is being supplied to the amplifier.
8. Remove personnel from the vicinity of the antenna.
9. Turn the SigGen RF output ON. The aircraft equipment is now being exposed to the test signal. Exercise the identified aircraft equipment and verify that no abnormal equipment function occurs.
10. If abnormal function of EUT does occur, turn the SigGen RF Output OFF and verify abnormal function clears. After confirmation of effect, reduce the output of the SigGen by .5 dB steps, pausing 10 seconds between steps while exercising the aircraft equipment, and note the level at which the abnormal function does not occur. Evaluate position of antenna and distance from effected unit to determine if local beam strength is at or above desired test signal level. If necessary, reposition the test antenna and repeat test.
11. Turn the SigGen RF Output OFF. Record the test results as either 'Effect' or 'No Effect'. For all effects, describe the symptom or aircraft indicator, and whether or not the test signal was the source of interference. Record the test frequency being transmitted and the SigGen 'RF Output Level' at the susceptibility threshold (lowest level observed to cause the effect), even if the local threshold level is ultimately determined to be above our required test signal level.
12. Rotate the test antenna(s) to the vertical polarization.
13. Repeat steps 9-11 for the vertical antenna polarization.
14. Repeat steps 6 through 13 for all of the test frequencies listed in Appendix A.
15. Repeat steps 1 through 14 for the remaining front-door test antenna locations.

14.1 Antenna Position #14 – ~ STA 510

Position test antenna 40" from ~STA 510. Exercise and monitor the following systems. Reference the aircraft maintenance manual (AMM), if necessary, for guidance on operational test procedures.

Antenna Position #14, ~STA 510, Receiver Systems	
System	Test Record
~STA 510, Receiver Systems	B.14



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14.2 Antenna Position #15 – ~ STA 670

Position test antenna 40" from ~STA 670. Exercise and monitor the following systems. Reference the aircraft maintenance manual (AMM), if necessary, for guidance on operational test procedures.

Antenna Position #15, ~STA 670, Receiver Systems	
System	Test Record
~STA 670, Receiver Systems	B.15

14.3 Antenna Position #16 – ~ STA 840

Position test antenna 40" from ~STA 840. Exercise and monitor the following systems. Reference the aircraft maintenance manual (AMM), if necessary, for guidance on operational test procedures.

Antenna Position #16, ~STA 840, Receiver Systems	
System	Test Record
~STA 840, Receiver Systems	B.16

14.4 Antenna Position #17 – ~ STA 980

Position test antenna 40" from ~STA 980. Exercise and monitor the following systems. Reference the aircraft maintenance manual (AMM), if necessary, for guidance on operational test procedures.

Antenna Position #17, ~STA 980, Receiver Systems	
System	Test Record
~STA 980, Receiver Systems	B.17

14.5 Antenna Position #18 – ~ STA 1320

Position test antenna 40" from ~STA 1320. Exercise and monitor the following systems. Reference the aircraft maintenance manual (AMM), if necessary, for guidance on operational test procedures.

Antenna Position #18, ~STA 1320, Receiver Systems	
System	Test Record
~STA 1320, Receiver Systems	B.18

14.6 Antenna Position #19 – ~ STA 1710

Position test antenna 40" from ~STA 1710. Exercise and monitor the following systems. Reference the aircraft maintenance manual (AMM), if necessary, for guidance on operational test procedures.

Antenna Position #19, ~STA 1710, Receiver Systems	
System	Test Record
~STA 1710, Receiver Systems	B.19



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14.7 Antenna Position #20 – Aft-Most Cabin

Position test antenna 40” from most aft location in the cabin. Exercise and monitor the following systems. Reference the aircraft maintenance manual (AMM), if necessary, for guidance on operational test procedures.

Antenna Position #21, Aft-Most Cabin, Receiver Systems	
System	Test Record
Aft-Most Cabin, Receiver Systems	B.20

14.8 CONCLUSION

If no anomalous system responses are noted while performing these tests, then the T-PEDs identified within this document will be considered electromagnetically compatible with the Boeing 747-400 aircraft and in compliance with 14 CFR 25.1309(a).

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Test #	Wireless Standard	Uplink Frequency (T-PED Transmit) Start of Band (MHz)	Uplink Frequency (T-PED Transmit) End of Band (MHz)	Test Frequency (MHz)	Modulation		Emission Code	T-PED Intentional EIRP (W) From DO-294C Table 6.F-4	T-PED Intentional EIRP (dBm)	Target MEF (dB added)	Target EIRP (dBm, highest value of group)	Target EIRP (W)	Target ERP (W)	Biconical Antenna Gain	Amplifier Gain (dB)	Amplifier Input	50' LMR-500 Cable Loss (- dBm)	SigGen Output (Estimated)	SigGen Output (Actual)	SpecA Indicated Signal (dBm)	RF Exposure Hazard Minimum Distance From Antenna (inches)			
					Pulse	CW															Controlled Environment	Uncontrolled Environment		
1	CDMA2000	410	420	415		CW	NON	1	30.0	12	42.0	15.8	13.7	0.4	44	-2.4	1.0	-1.4	-6.80	15.4	12	27		
2	GSM400	450.4	457.6	454	Pulse		PON	2	33.0	12	45.0	31.7	29.5	0.6	46	-1.6	1.1	-0.5	-4.80	18.4	16	36		
3	CDMA2000	450	460	454		CW	NON	1	30.0	12	42.0	15.8	13.7	0.6	46	-4.6	1.1	-3.5	-7.80	15.4	11	25		
4	CDMA2000	479	484	482		CW	NON	1	30.0	12	42.0	15.8	13.7	0.1	46	-4.1	1.1	-3.0	-7.80	15.9	11	25		
5	CDMA2000	776	794	785		CW	NON	1	30.0	12	42.0	15.8	13.7	0.6	53	-11.6	1.5	-10.1	-8.40	12.2	9	19		
6	CDMA2000	806	849	828		CW	NON	1	30.0	12	42.0	15.8	13.7	0.0	53	-11.0	1.5	-9.5	-6.50	11.5	12	27		
	CDMAone	824	849				NON	1	30.0	12			13.7	0.0	53	-53.0	1.5							
	UMTS FDD		NON				0.25	24.0	12	13.7			0.0	53	-53.0	1.5								
7	GSM850	824	849		Pulse		PON	2	33.0	12	45.0	31.7	29.5	0.0	53	-8.0	1.5	-6.5	-3.20	14.5				
	IS-136							0.6	27.8	12			29.5	0.0	53	-53.0	1.5							
	UMTS TDD							0.25	24.0	12			29.5	0.0	53	-53.0	1.5							
8	CDMA2000	870	925	898		CW	NON	1	30.0	12	42.0	15.8	13.7	-0.9	53	-10.1	1.6	-8.5	-4.00	11.0	8	18		
9	GSM900	876	915	913	Pulse		PON	2	33.0	12	45.0	31.7	29.5	-1.1	53	-6.9	1.6	-5.3	0.00	13.8	11	25		
10	MOBILE SAT	1613.8	1626.5	1626	Pulse		PON	1	30.0	12	42.0	15.8	13.7	1.1	53	-12.1	2.2	-9.9	-9.00	4.7	6	14		
11	CDMA2000	1710	1785	1748		CW	NON	1	30.0	12	42.0	15.8	13.7	1.1	53	-12.1	2.2	-9.9	-11.00	3.5	6	14		
12	DCS1800				Pulse	PON	1	30.0	12	42.0	15.8	13.7	1.1	53	-12.1	2.2	-9.9	-11.00	3.5	6	14			
13	CDMA2000	1850	1910	1884		CW	NON	1	30.0	12	42.0	15.8	13.7	1.1	53	-12.1	2.3	-9.8	-12.00	2.8	6	14		
	UMTS FDD						NON	0.25	24.0	12			13.7	1.1	53	-54.1	2.3							
	CDMAone						NON	1	30.0	12			13.7	1.1	53	-54.1	2.3							
14	UMTS TDD				Pulse		PON	0.25	24.0	12	42.0	15.8	13.7	1.1	53	-12.1	2.3	-9.8	-12.00	2.8			6	14
	PCS1900							1	30.0	12			13.7	1.1	53	-12.1	2.3							
	IS-136							0.6	27.8	12			13.7	1.1	53	-54.1	2.3							
15	UMTS TDD	1900	1920	1910	Pulse		PON	0.25	24.0	12	36.0	4.0	1.8	1.1	53	-18.1	2.4	-15.7	-18.00	-3.5	3	7		
16	CDMA2000	1920	1980	1949		CW	NON	1	30.0	12	42.0	15.8	13.7	1.1	53	-12.1	2.4	-9.7	-10.50	2.4	6	14		
	UMTS FDD						NON	0.25	24.0	12			13.7	1.1	53	-54.1	2.4							
17	UMTS TDD	2010	2025	2018	Pulse		PON	0.25	24.0	12	36.0	4.0	1.8	1.1	53	-18.1	2.4	-15.7	-17.00	-3.9	3	7		
18	UMTS/3G/PCN	2110	2170	2140		CW	NON	0.25	24.0	12	36.0	4.0	1.8	1.1	53	-18.1	2.5	-15.6	-12.00	-4.8	3	7		
19	802.11b/g/n	2.4 GHz	2.497 GHz	2412	Pulse		PON	0.5	27.0	10	37.0	5.0	2.9	1.1	53	-17.1	2.7	-14.4	-7.00	-4.7	4	8		
20				2437	Pulse		PON	0.5	27.0	10	37.0	5.0	2.9	1.1	53	-17.1	2.7	-14.4	-8.50	-5.0	4	8		
21				2462	Pulse		PON	0.5	27.0	10	37.0	5.0	2.9	1.1	53	-17.1	2.7	-14.4	-9.50	-5.1	4	8		
22	FDD LTE (Band TBD)	2500	2685	2595	Pulse	CW	PON/NON	1	30.0	12	42.0	15.8	13.7	1.9	53	-12.9	3.3	-9.6	-4.40	-0.6	6	14		
23	Wi-Max	3400	3600	3450	Pulse	CW	PON/NON	1	30.0	12	42.0	15.8	13.7	1.9	53	-12.9	3.3	-9.6	-8.90	-4.2	6	14		
24	802.11a/n	5150	5250	5170	Pulse		PON	0.5	27.0	10	37.0	5.0	2.9	1.7	53	-17.7	4.2	-13.5	-5.20	-14.1	4	8		
25		5250	5350	5300	Pulse		PON	0.5	27.0	10	37.0	5.0	2.9	1.7	53	-17.7	4.2	-13.5	-13.90	-14.8	4	8		
26		5470	5725	5580	Pulse		PON	0.5	27.0	10	37.0	5.0	2.9	1.7	53	-17.7	4.4	-13.3	-13.30	-15.3	4	8		
27		5725	5825	5825	Pulse		PON	0.5	27.0	10	37.0	5.0	2.9	1.7	53	-17.7	4.4	-13.3	-13.90	-16.5	4	8		

Antenna Position	Paragraph	System	Effectivity	AMM Reference(s)	Frequency Range / Transmit Identifier												Description of Effect	Test Frequency(s) Causing Effect	Transmit Identifier	Susceptibility Threshold
					400 MHz to 1.0 GHz				1.0 GHz to 2.5 GHz				2.5 GHz to 6.0 GHz							
					H-PS	H-CW	V-PS	V-CW	H-PS	H-CW	V-PS	V-CW	H-PS	H-CW	V-PS	V-CW				
		Cockpit Voice Recorder	All	23-73																
		SPD Card File	All	27-28																
	R.8.3	Fuel Control																		
		Fuel Quality Indicating System	All	28-21																
	R.8.4	Additional Equipment																		
9 - E42 Rack	R.9.1	Communications																		
		Radio Frequency Unit (RFU)	All	23-25																
		Satcom Data Unit (DDU)	All	23-25																
	R.9.2	Additional Equipment																		
10 - E33 Rack	R.10.1	A/C Power Generation																		
		Charger APU Battery	All	24-31																
		Battery APU	All	24-31																
		DOCS- APU Battery	All	24-31																
	R.10.2	Additional Equipment																		
11 - M7603 Card File	R.11.1	Electrical System Card File	All																	
12 - M826 / M7852 Card Files	R.12.1	Fire Detection Card File	All																	
	R.12.2	Fuel System Card File	All																	
13 - M7953 Card File	R.13.1	MAWSA Card File	All																	
FRONT DOOR EMERGENCY																				
14 - Upper Deck, STA 510	R.14.1	Air Traffic Control (ATC)																		
		ATC (ATC Antenna Bottom)	All	34-53																
	R.14.2	Navigation																		
		TCAS (TCAS Antenna Top and Bottom)	All	34-45																
	R.14.3	Communications																		
		Airborne Telephone	All	23-12																
15 - Lower Deck, STA 670	R.15.1	Air Traffic Control (ATC)																		
		ATC (ATC Antenna Top)	All	34-53																
	R.15.2	Navigation																		
		DMC-L	All	34-55																
	R.15.3	Communications																		
		LGA	005-006	23-25																
		VHF-L	005-006	23-12																
		VHF-C	101-105	23-12																
		VHF-R	005-006	23-12																
16 - Lower Deck, STA 840	R.16.1	Navigation																		
		RA TX-L	All	34-33																
		RA TX-R	All	34-33																
		RA TX-C	All	34-33																
		GPS-L	006, 101-105	34-58																
		GPS-R	006, 101-105	34-58																
		DMC-R	All	34-55																
	R.16.2	Communications																		
		Airborne Telephone	All	23-19																
17 - Lower Deck, STA 980	R.17.1	Navigation																		
		RA RX-L	All	34-33																
		RA RX-R	All	34-33																
		RA RX-C	All	34-33																
		MS	All	34-32																
18 - Lower Deck, STA 1320	R.18.1	Navigation																		
		ADF-L	All	34-57																
		ADF-R	All	34-57																
	R.18.2	Communications																		
		Airborne Telephone	All	23-19																
19 - Lower Deck, STA 1710	R.19.1	Communications																		
		HGA Top	All	23-25																
		VHF-L	101-105	23-12																
		VHF-C	005-006	23-12																
		VHF-R	101-105	23-12																
		Airborne Telephone	All	23-19																
20 - Lower Deck, Air Most Cabin	R.20.1	Navigation																		
		VOR	All	34-51																
	R.20.2	Communications																		
		HF	All	23-11																
Cabin Components	R.21.1	Lavatory Smoke Detectors	All																	
	R.21.2	AED (Automated External Defibrillator)	All																	
	R.21.3	DEU (Decoder Encoder Unit)	All																	
	R.21.4	AMP (Attendant Indication Panel)	All																	
	R.21.5	Area Call Panel / Interphones	All																	
	R.21.6	FAP (Flight Attendant Panel)	All																	
	R.21.7	PSU (Passenger Service Unit)	All																	
	R.21.8	In-SeatIFE Equipment	All																	
	R.21.9	Rotating Navigation Beacon - Exterior Upper Fuselage, FR	All																	

LEGEND
 HF Horizontal Antenna, Pulse Wave
 HC Horizontal Antenna, Continuous Wave
 VP Vertical Antenna, Pulse Wave
 VC Vertical Antenna, Continuous Wave

Antenna Position	Paragraph	System	Efficiency	AIMM Reference(s)	Frequency Range / Emission Identifier												Description of Effect	Test Frequency(s) Guiding Effect	Transmit Identifier	Susceptibility Threshold
					400 MHz to 1.0 GHz				1.0 GHz to 2.5 GHz				2.5 GHz to 6.0 GHz							
					WPS	W-CW	W-PS	W-CW	WPS	W-CW	W-PS	W-CW	WPS	W-CW						

NOTE
1
2
3

RA is per table