Inflight Peripherals Limited

Audio Jacks:
Draft Test Procedure

Document reference: 02/T/JACKS/004

Date: Dec 2002

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Summary

The test plan includes the following:

Insertion/Extraction Force
Insertion/Extraction cycles - with no offset loading
Sideways pull-out
Torsion testing
Debris Clearance

Introduction

3.5mm diameter ‘mini jack’ style connectors are commonly used throughout the airline industry to provide the headset audio interface with the aircraft entertainment system.

In many IFE systems, most 3.5mm jacks are of a 'commercial' grade. These jacks are very cheap, and as a result, have low quality contacts and weak circuit board attachments.

The audio jacks installed in aircraft seats experience conditions in-service which are very different from their land based commercial counterparts. Standard tests exist which allow the ‘normal’ service life of an audio jack to be determined, such as a standard insertion/extraction life test. These standard tests measure the wear characteristics of the jack and its terminals when the plug is inserted and extracted along the axis of the bore of the jack. For an aircraft seat application this would also apply for the use of headsets under ‘normal’ circumstances, but the worst case scenario is when the passenger stands up with his/her headset still on. this situation transmits considerable torsion loads into the jack and its attachment points. In land-based applications, this scenario will occur fairly infrequently, but in aircraft applications it is a very common occurrence.

It is therefore desirable to have some form of 'breakaway' feature that allows the connection to separated without damage under such circumstances. Therefore, whilst it may initially be considered desirable to have very high plug retention force, this in itself may lead to premature failure.

The aircraft seat environment is also prone to dirt and dust, due to their use being almost constant throughout the day. Inevitably dirt, dust and debris will find its way inside the audio jack, and this can lead to mechanical damage and electrical breakdown. Jack designs that include a debris clearance feature are therefore desirable.

Tests are therefore required which will simulate these worst case conditions and allow the robustness of various audio jack designs to be determined.

Related Documents

International Specifications
IEC 60603 part 11 Detail specification for concentric connectors. Dimensions for Free connectors and fixed connectors

Inflight Peripherals Insertion test Specification 99/T/JACKS/001 REV B

Requirements

Insertion/Extraction force

Min 2.2N
Max 22N

As specified in IEC 60603 pt 11

Insertion/Extraction Cycles

Min 5,000 cycles per IEC 60603 pt 11

This figure is considered inadequate for IFE applications due to the high usage that jacks will encounter in service.

A figure of 20,000 cycles is considered to be a minimum for IFE applications, based on the following assumptions:

10 cycles per flight
2 flights per day
360 operational days per year

7200 cycles per year

20,000 cycles equates to approximately 3 years service life.

Sideways Pull out

No standard exists. The test used here is per Inflight Peripherals internal test specification.

Torsion Test

No standard exists. Test is per Inflight Peripherals internal test specification.

Modes of failure

Contact terminal fatigue.
IFPL undertook a review of many broken jacks, and found that a great number failed due to mechanical fatigue of the terminals.

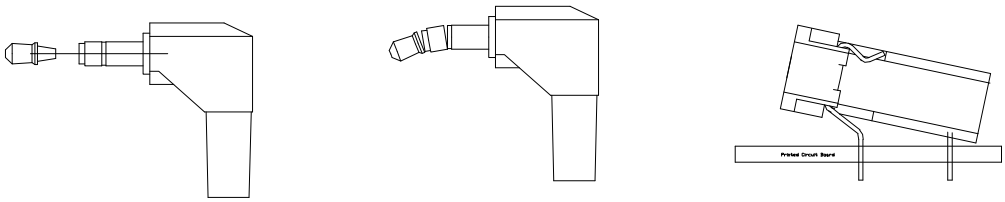
Headset plug tip breakage
Whilst not a particular issue in itself, the worst scenario is where a broken off headset plug tip remains inside the bore of the jack, and then the passenger forces another plug into the jack causing serious damage to the terminals inside.

Headset cable tear-out.
Headset cables necessarily use fine gauge wire, and these are prone to tearing out from the plug under sideways pull.

Snagging
Snagging has been identified as a major cause of failure of any of the parts. This happens under sideways pull-out conditions when the passenger gets up from his seat with his headset still on, or when the passenger sits on the cable, when returning to his seat.
If there are sharp edges at the entry to the jack, any recesses in the profile of the headset plug will snag on the sharp edge, preventing the plug from breaking away.

Snagging leads to –

Tip breaking off inside jack; Bending of plug; Jack breaking away from mountings due to torsion loads on the plug; Boss of jack breaking off or damage to the housing.



Of these, the least desirable are failure modes which cause the jack to become unusable. Damage to the headset cable and/or plug, whilst still a major cost issue, can be easily fixed in flight by simple replacement of the headset.

Test Descriptions

The tests undertaken aim to provide an assessment of likely audio jack robustness in-service.

1. Insertion/Extraction Force Test

Using a standard mandrel per Appendix A, the maximum insertion and extraction forces are tested for each jack. The force requirements given in IEC 60603-11 ensure that the plug is neither too hard to insert/extract, or too loose within the jack.

2. Insertion Extraction Cycle Test

Purpose: Gives a general comparison between different jack designs and provides an indication of the quality of the terminals, in particular. Commercial jacks are required to operate in excess of 5,000 insertion cycles. Whilst this may be suitable for consumer electronic products, this figure is inadequate for inflight applications, because the jacks will be used many times a day, every day of the year, for several years. A figure of 20,000 cycles is considered to be the minimum acceptable level.

For this test to be representative, then the plugs must be in 'as new' condition. If a plug is used more than 5,000 insertions, the plating will be worn through, and a flat spot will have developed.
The photographs show a plug that has undergone 5,000 insertions.

Continued use of a plug in this condition is totally useless, as the terminals within the jack under test will not be deflected fully.

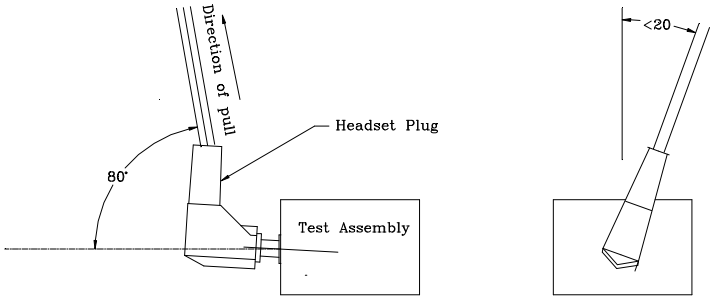
Because most jack terminals fail due to mechanical fatigue, it is essential that the test plug conforms fully to its 'as new' profile to ensure that the terminals are deflected fully each time the plug is inserted.

In addition to the fatigue of the terminals, the test should be representative of the fact that new, or nearly new headsets are used on a regular basis. These will have a sharp edge at the tip of the plug, and will cause more wear of the jack terminals than an old plug with a dulled edge.

The ideal test uses a hardened steel mandrel conforming to the dimensions given in IEC 60603-11. (see Appendix A)
The contact resistance must be measured at regular intervals, and also a 'crackle' check should be conducted. The 'crackle' check is done by playing audio through the jack and rotating and wiggling the headset plug whilst listening for crackling. This test is essential, because a jack might pass an electrical continuity test, but the audio quality may well be severely degraded.

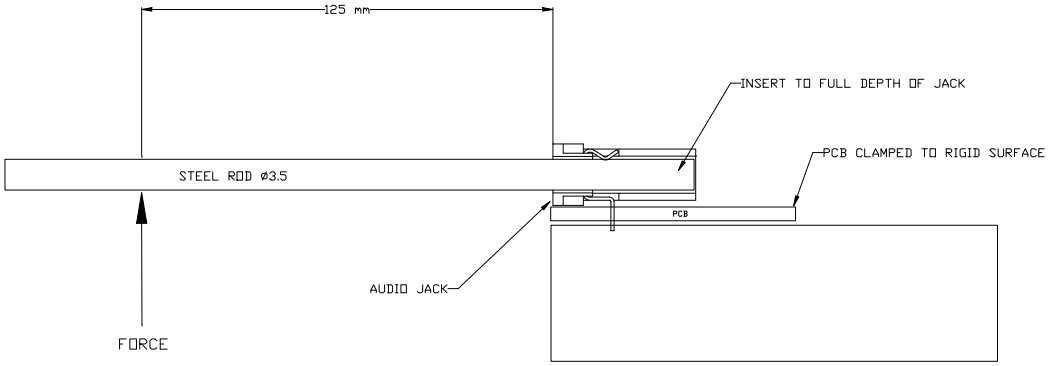
3. **Sideways Pull test**

Purpose: Intended to mimic a passenger getting up with his/her headset still on. Places a heavy torsion load onto the jack and gives an indication to how easily a headset plug might breakaway.



4. Torsion Test

Purpose: To test the mechanical strength of the jack, and its attachment to the circuit board. A 3.5mm diameter steel rod is inserted the full depth of the jack, and an increasing load is applied at the opposite end at a point 125mm from the jack entry hole, until the jack breaks from the circuit board. The maximum load is recorded. The test is repeated in 3 directions.



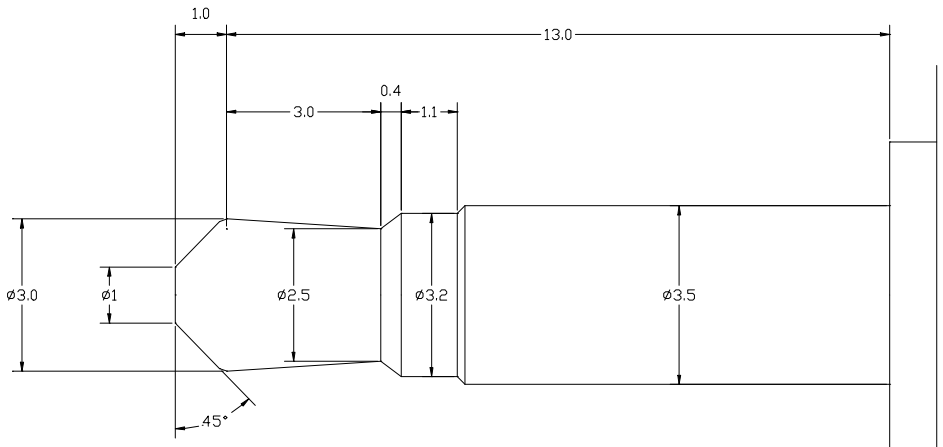
TORSION TEST ARRANGEMENT

5. Debris Clearance Test

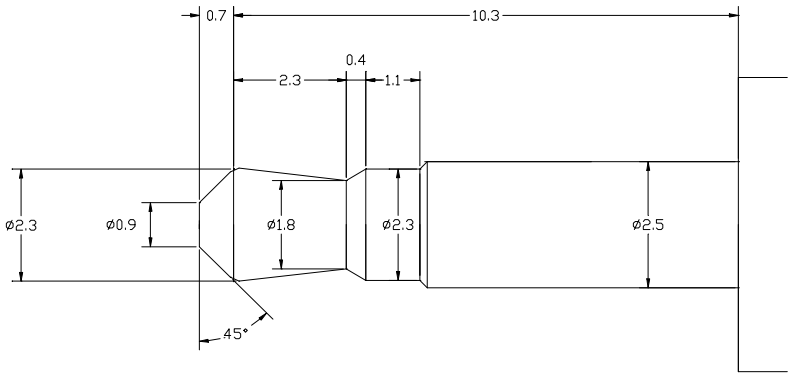
This test is intended to check the jacks tolerance to debris, such as broken headset plug tips. A plug tip is placed into the jack, and then a new headset plug forced into the jack. An assessment of any damage to the jack is then made. If the jack has a self-clearing design, then any debris will be ejected from the rear of the jack without damage to the jack body, or its terminals.

Appendix A

Test Mandrel Dimensions



3.5mm Plug Mandrel Dimensions
Reference IEC 60603-11



2.5mm Mandrel
Reference IEC 60603-11