UAT SWG07/WP-05

INTERNATIONAL CIVIL AVIATION ORGANIZATION (ICAO)
AERONAUTICAL COMMUNICATIONS PANEL (ACP)
WORKING GROUP C

Seventh Meeting of the UAT Subgroup
Montreal Canada,
16-18 November 2004

Draft of Appendix D of the UAT Implementation Manual v0.1

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This paper addresses an Action Item that was assigned during the sixth meeting of the UAT Subgroup of ACP Working Group C in Madrid Spain. It provides an initial draft of the Appendix D of the Implementation Manual to describe measurement data that were collected on UAT equipment, including production-level equipment, to characterize UAT receiver performance in various interference environments, including JTIDS/MIDS, DME/TACAN and self-interference, as described in Appendix C.

Draft V0.1
Appendix D

1 Introduction

Tests were conducted during the early standards work of UAT to insure that the UAT system provides acceptable performance in the intended future worst case environments. Results of testing with the Standard Interference Environment described in Appendix C are summarized in Appendix B. Extensive testing was conducted on prototype UAT receivers and additional testing was conducted on production-level equipment to characterize UAT receiver performance and validate acceptable performance of equipment that is designed to the developed standards. As described in Appendix C, sources of interference to the UAT receiver include on-channel self-interference from other UAT transmitters, DME on-channel or adjacent channel and JTIDS/MIDS signals that periodically occupy the frequency band at or near the 978 MHz UAT center frequency. The following test results contain data that was collected to assess UAT receiver performance against each interference source individually and in combination.

2 Pre-Production Testing

Testing was conducted during the development of the RTCA UAT MOPS (RTCA/DO-282A) to characterize UAT receiver performance when subjected to signals from systems that could impact UAT receiver performance. Testing also served to insure that receiver requirements specified resulted in expected performance. Prototype units were produced and used as victim receivers subjected to various interference scenarios to characterize and validate performance. Prototype receivers tested included both the Basic receiver and the High performance receiver. For the purposes of the data presented herein, the Basic receiver results is referred to as the 1.2 MHz receiver and the High Performance receiver is the 0.8 MHz receiver denoting the effective bandwidth of each receiver type.

2.1 TACAN/DME Testing

Testing was conducted subjecting the prototype receivers to various DME and TACAN signal powers and rates to assess impact. DME frequencies were selected to assess impact of on-channel DME interference, 1 MHz adjacent channel and 2 MHz off channel DME signals. In each of the series of test runs, a desired UAT signal was subjected to the TACAN or DME interference where the desired signal level was varied, typically in 1 dB steps, from below receiver MTL to above a power level where receiver performance was no longer impacted by the interference source. The following data presents results from subjecting the UAT receiver with DME pulse pairs at various rates and amplitudes. The results of receiver performance with DME at 2700 pulse pairs per second 2 MHz from the UAT frequency are contained in Figure 1. Power levels of the DME interference injected were -15, -21, -27 and -34 dBm. The results indicate that the Basic receiver provides slightly better performance to DME signals 2 MHz above the UAT frequency. Figures 2 and 3 contain results from subjecting the Basic receiver and the High Performance receiver, respectively, to DME at 2700 pulse pairs per second 1 MHz above the UAT frequency at various amplitudes. Figures 4 and 5 contain results from subjecting the Basic receiver and the High Performance receiver, respectively, to DME at 2700 pulse pairs per second on the UAT frequency at various amplitudes. Figures 6 through 12 contain similar results except the DME pulse pairs were injected at the higher 3600 pulse pairs per second rate. Figure 13 shows a comparison between TACAN and DME interference to both the Basic and High Performance UAT receivers. DME at 3600 pulse pairs per second is compared to TACAN at 2700. The power level of -60 dBm was applied to the UAT receiver at a frequency offset of 1 MHz from the UAT operating frequency. Figure 13 shows comparable performance between TACAN and DME interference at the same amplitude. Comparison of UAT Basic and High Performance receivers indicates improved performance with the High Performance receiver when subjected to DME/TACAN pulse pairs that are 1 MHz offset from UAT.

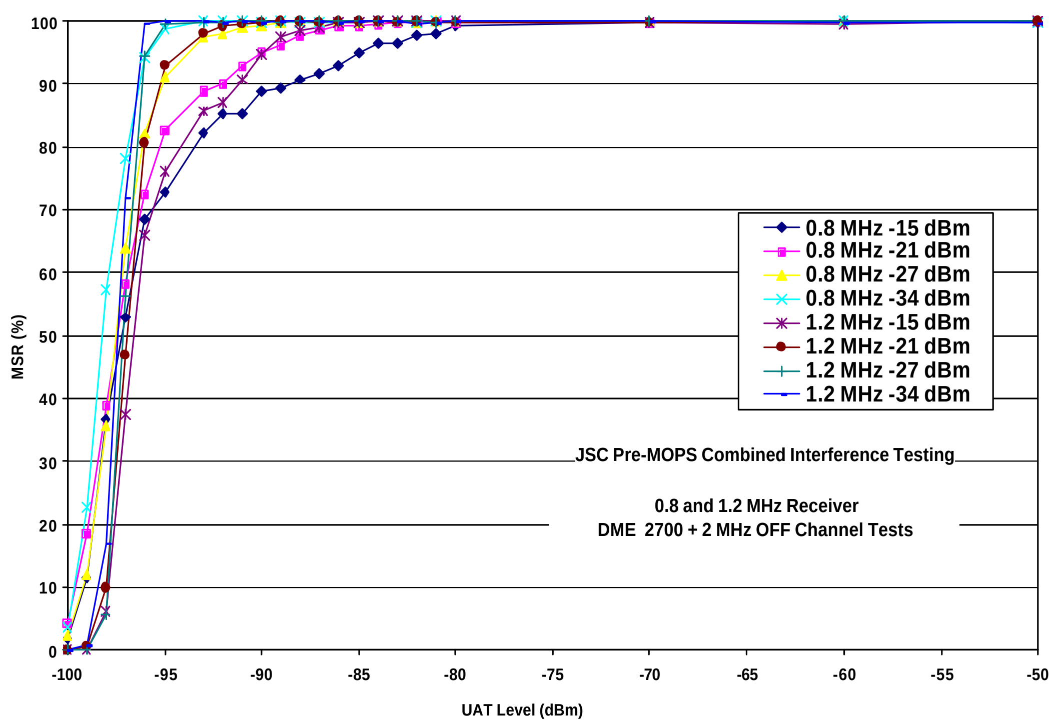

Figure 1 – UAT Receiver Performance DME 2700 Pulse Pairs at +2 MHz

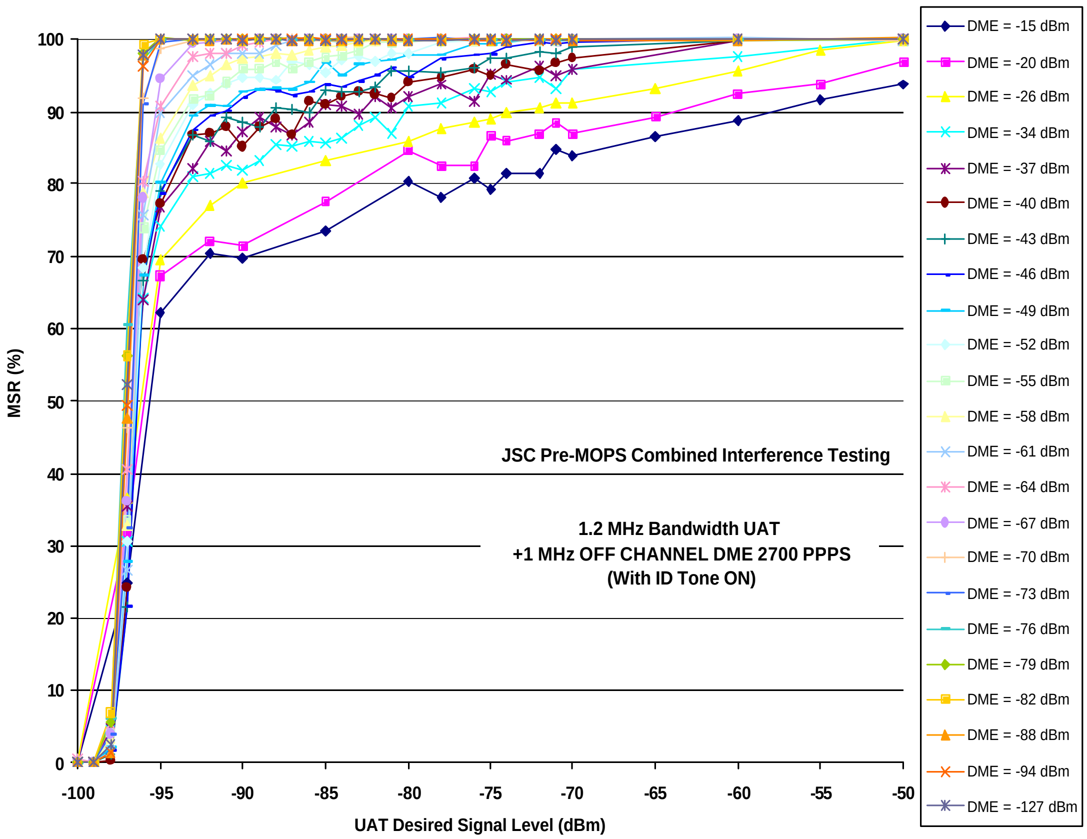

Figure 2 – UAT Basic Receiver Performance DME 2700 Pulse Pairs at +1 MHz

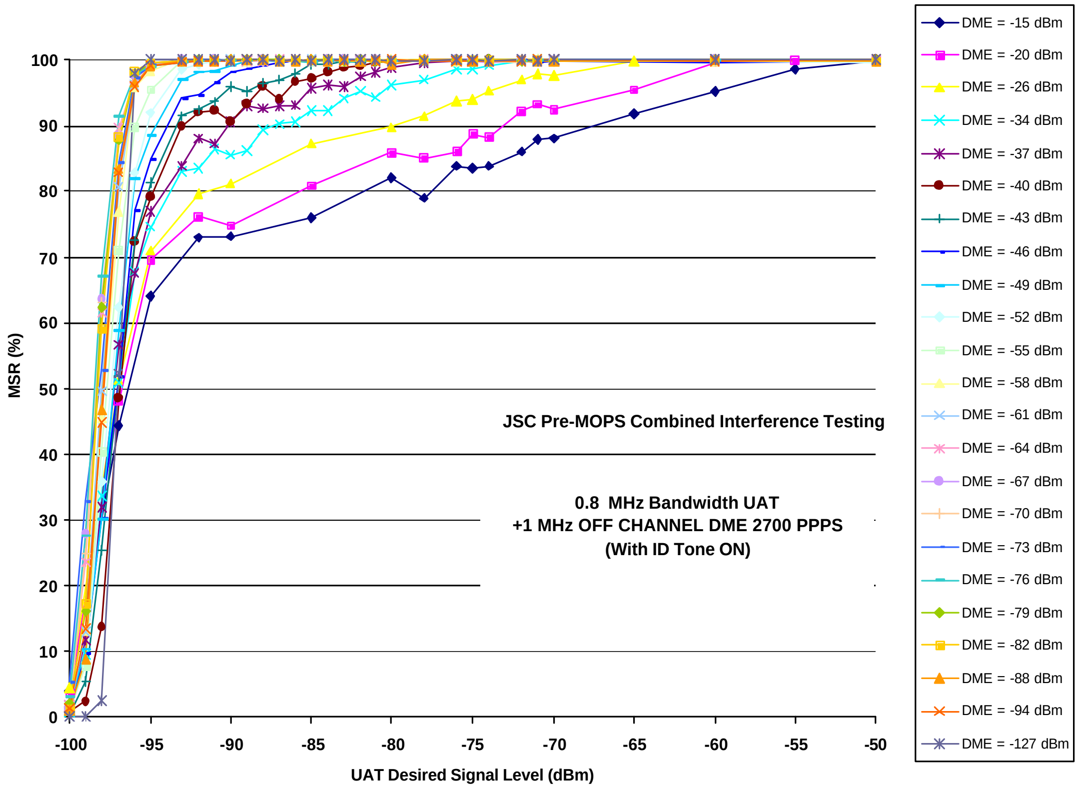

Figure 3 – UAT High Performance Receiver with DME 2700 Pulse Pairs at +1 MHz

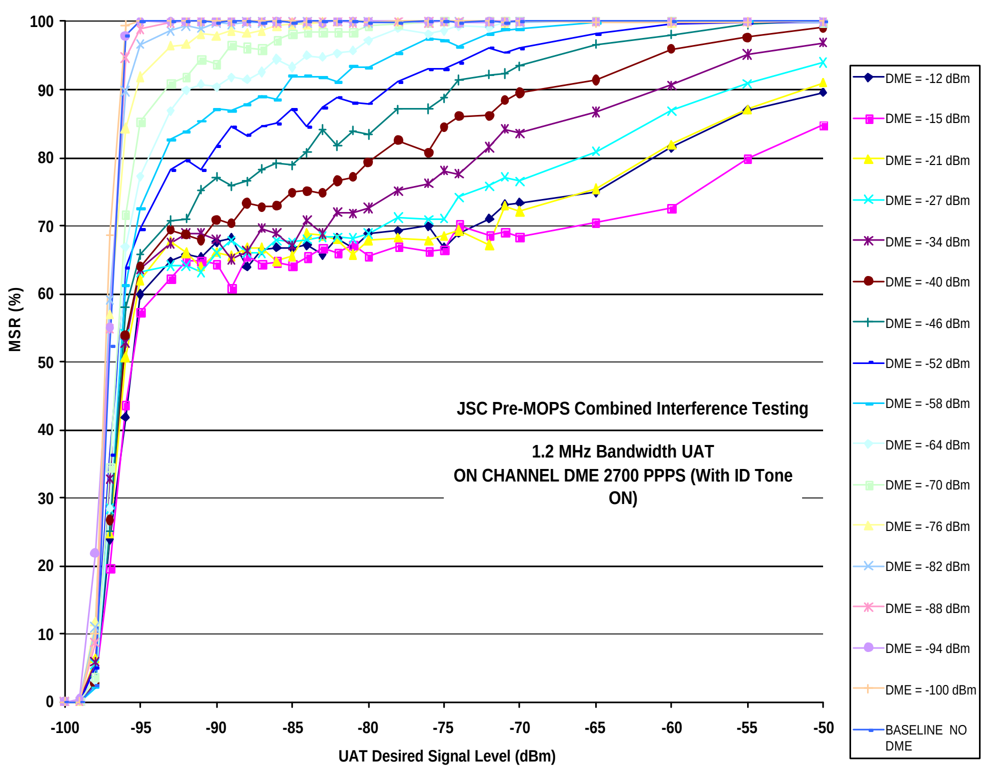

Figure 4 – UAT Basic Receiver Performance DME 2700 Pulse Pairs On Frequency

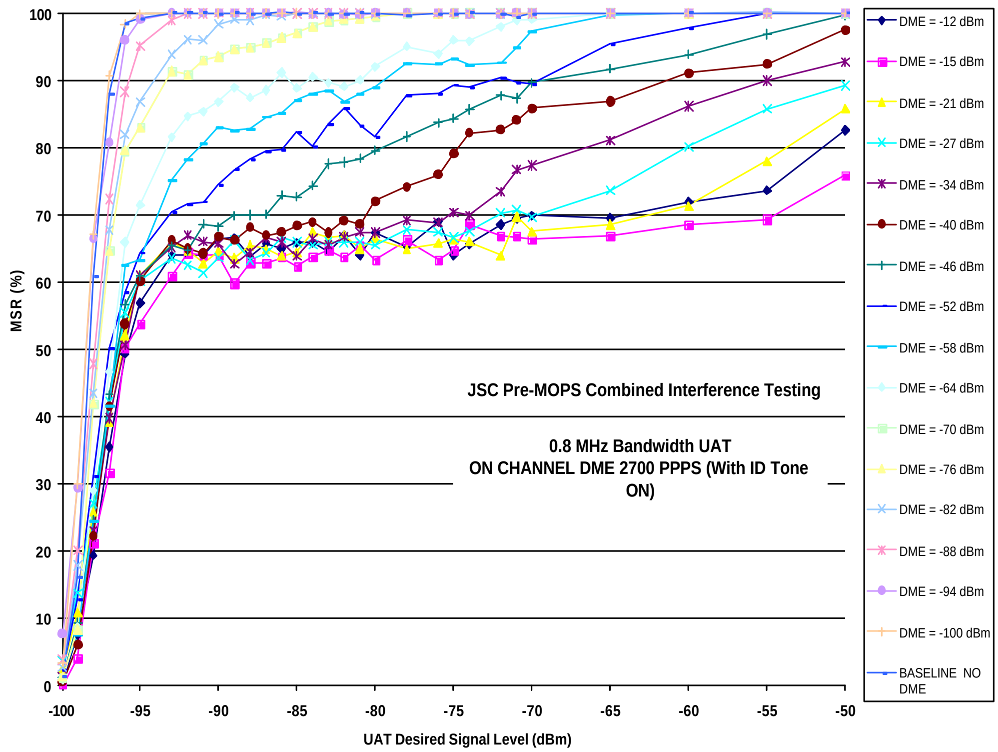

Figure 5 – UAT High Performance Receiver DME 2700 Pulse Pairs on Frequency

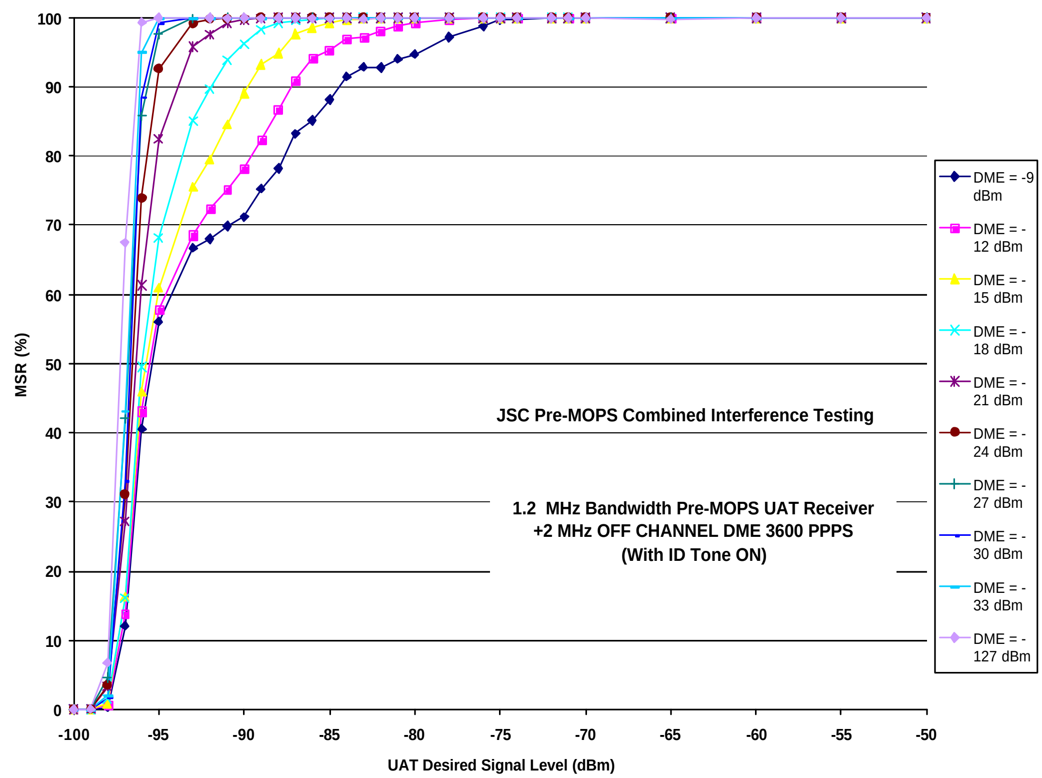

Figure 6 – UAT Basic Receiver Performance DME 3600 Pulse Pairs at +2 MHz

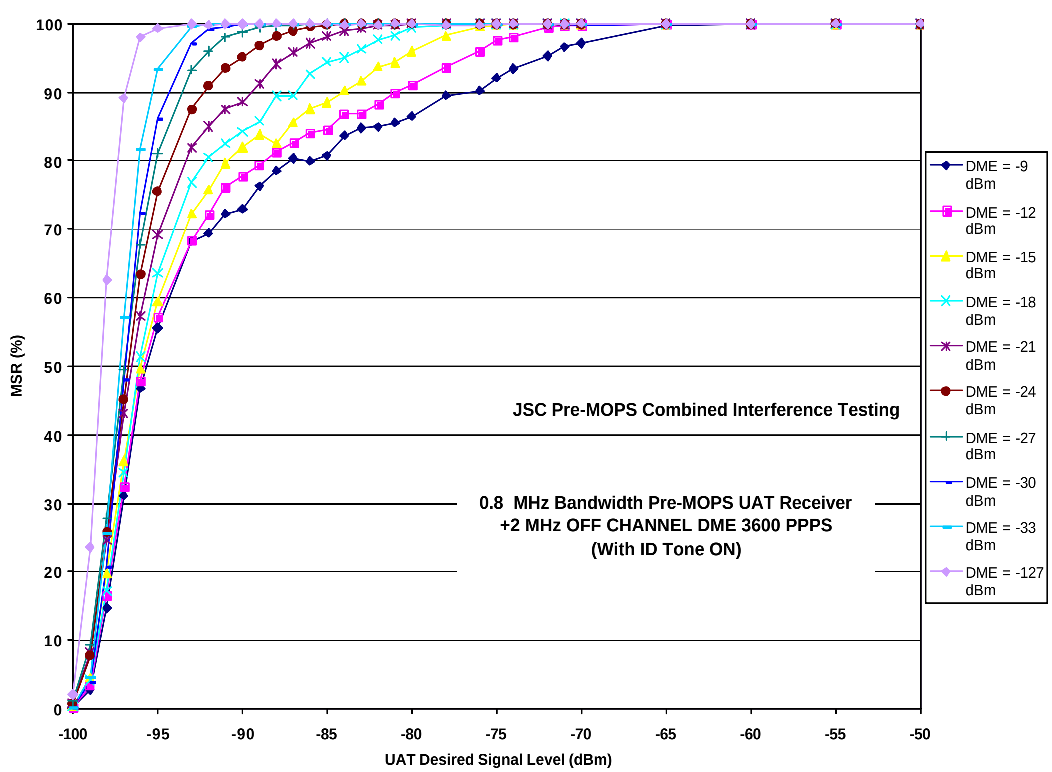

Figure 7 – UAT High Performance Receiver DME 3600 Pulse Pairs at +2 MHz

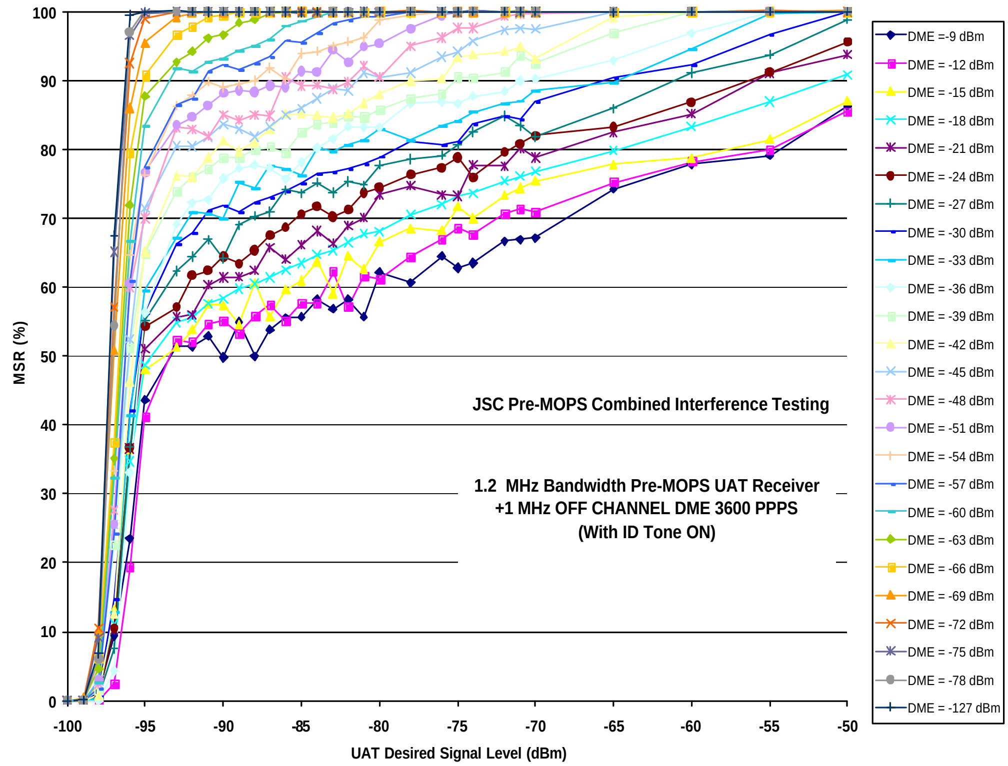

Figure 8 – UAT Basic Receiver Performance DME 3600 Pulse Pairs at +1 MHz

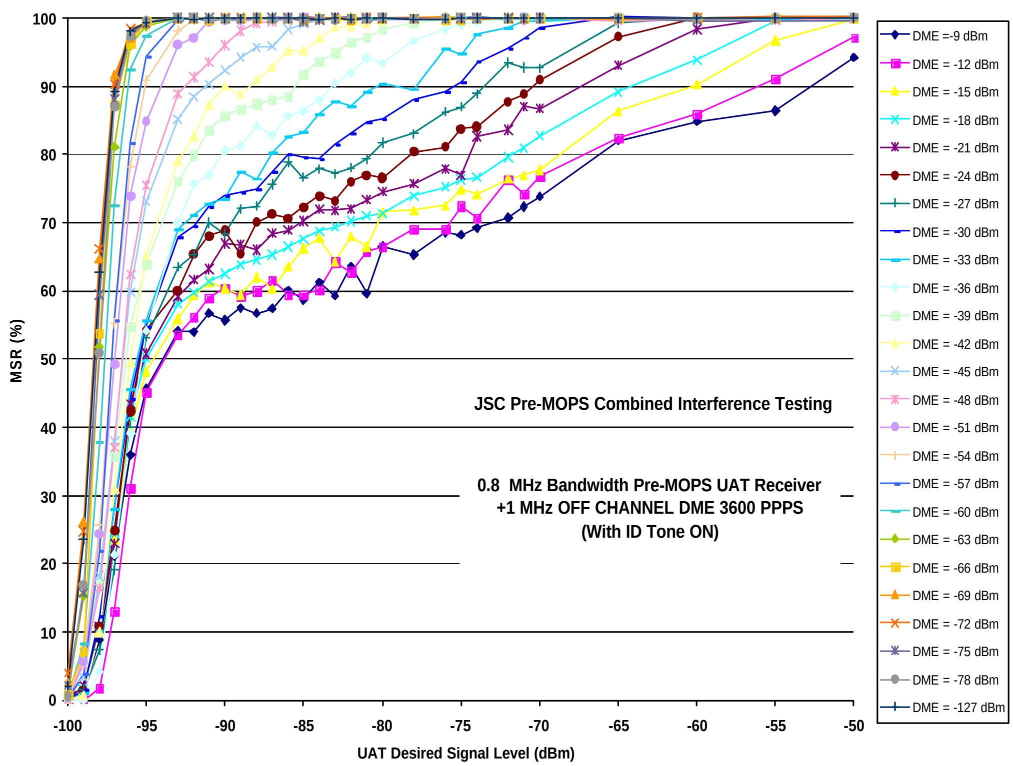

Figure 9 – UAT High Performance Receiver DME 3600 Pulse Pairs at +1 MHz

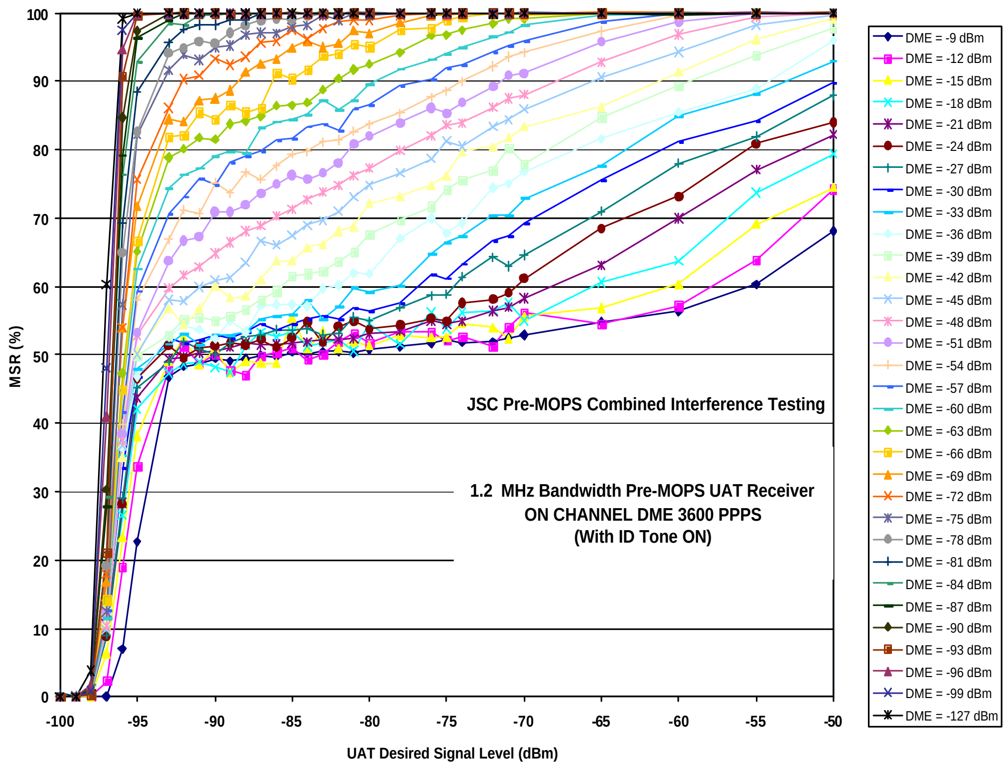

Figure 10 – UAT Basic Receiver Performance DME 3600 Pulse Pairs On Frequency

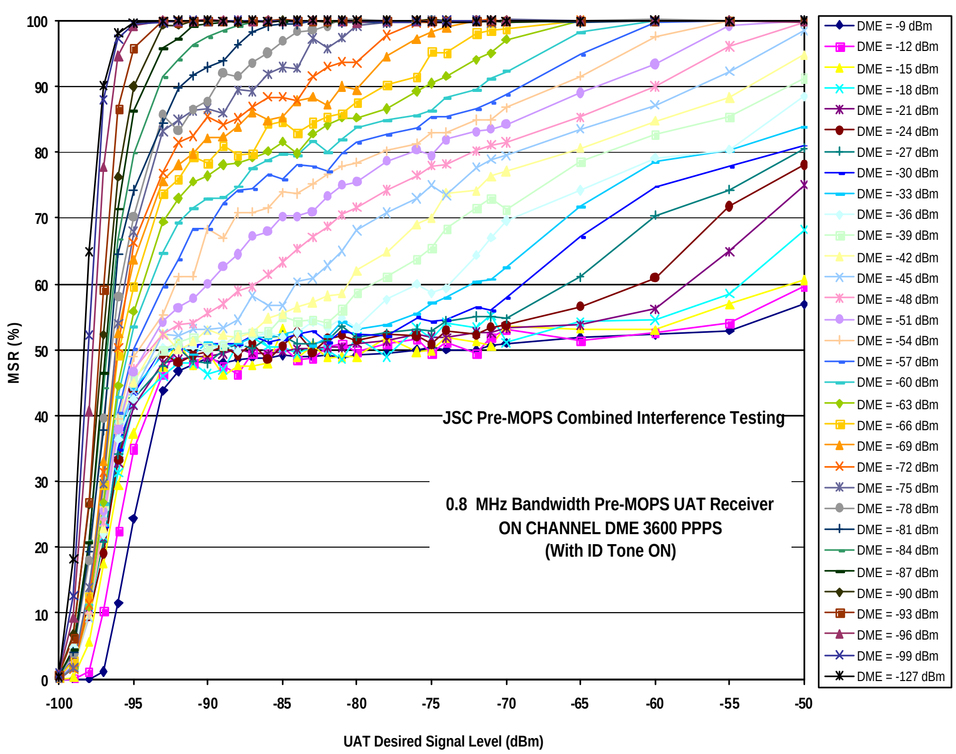

Figure 11 – UAT High Performance Receiver DME 3600 Pulse Pairs on Frequency

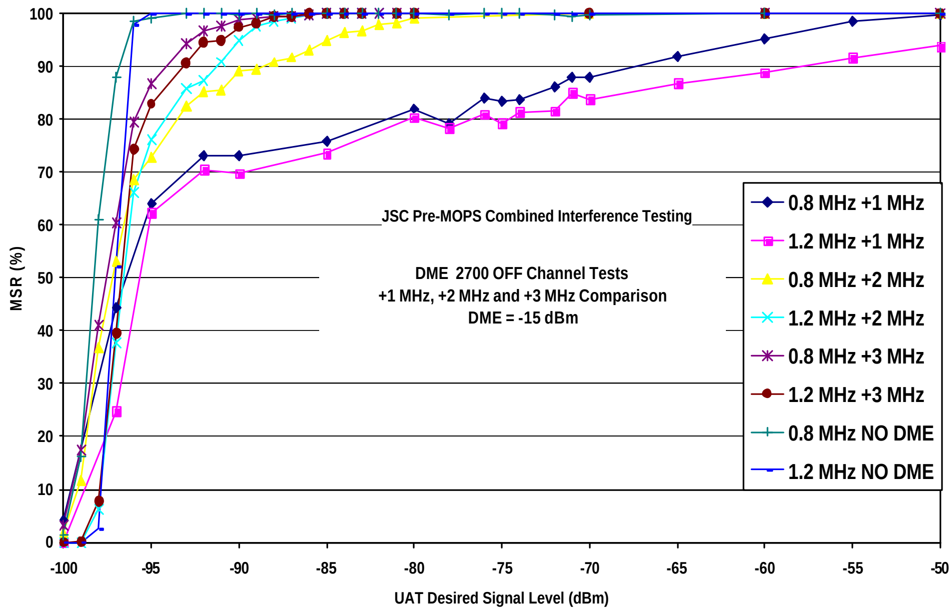

Figure 12 – UAT Receiver Performance DME 2700 Pulse Pairs Offset in Frequency

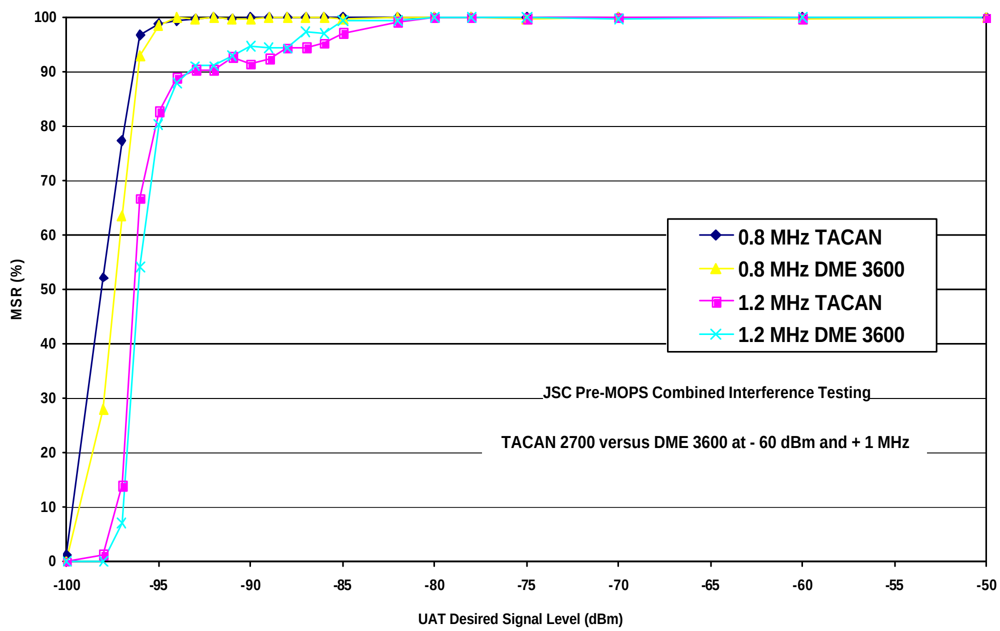

Figure 13 – UAT Receiver Performance TACAN 2700 and DME 3600 Pulse Pairs at +1 MHz

2.2 JTIDS/MIDS Testing

Testing was conducted subjecting the prototype receivers to various JTIDS/MIDS scenarios. These scenarios were derived and utilized in development of the Standard Interference Environment as described in Appendix C. Two scenarios were developed and used to test UAT performance against JTIDS/MIDS. One scenario, JTIDS Snapshot UAT001, is a scenario that was utilized in all prior JTIDS and DME compatibility testing. The second scenario, JTIDS Snapshot 700, consisted of a denser JTIDS environment. Both scenarios represented multiple JTIDS signal levels with one or more users and allocated JTIDS pulses into groups each with an assigned duty factor and amplitude level. JTIDS transmissions occur in time slots that are assigned randomly by the transmitter so the scenarios were defined by the percentage occupation of legal time slots. The strongest amplitudes are the foreground transmissions followed by up to 4 rings, each with decreasing power level. Each ring is assigned a time slot duty factor (TSDF). The JTIDS Snapshot UAT001 scenario consisted of a 300% JTIDS background density. Figure 14 shows the performance of the UAT receiver as a function of desired signal level when subjected to the JTIDS/MIDS UAT001 scenario. Both the Basic receiver and the High Performance receiver results are depicted. In general, the entire set of JTIDS/MIDS scenario runs yielded similar results as to impact to UAT receiver performance.

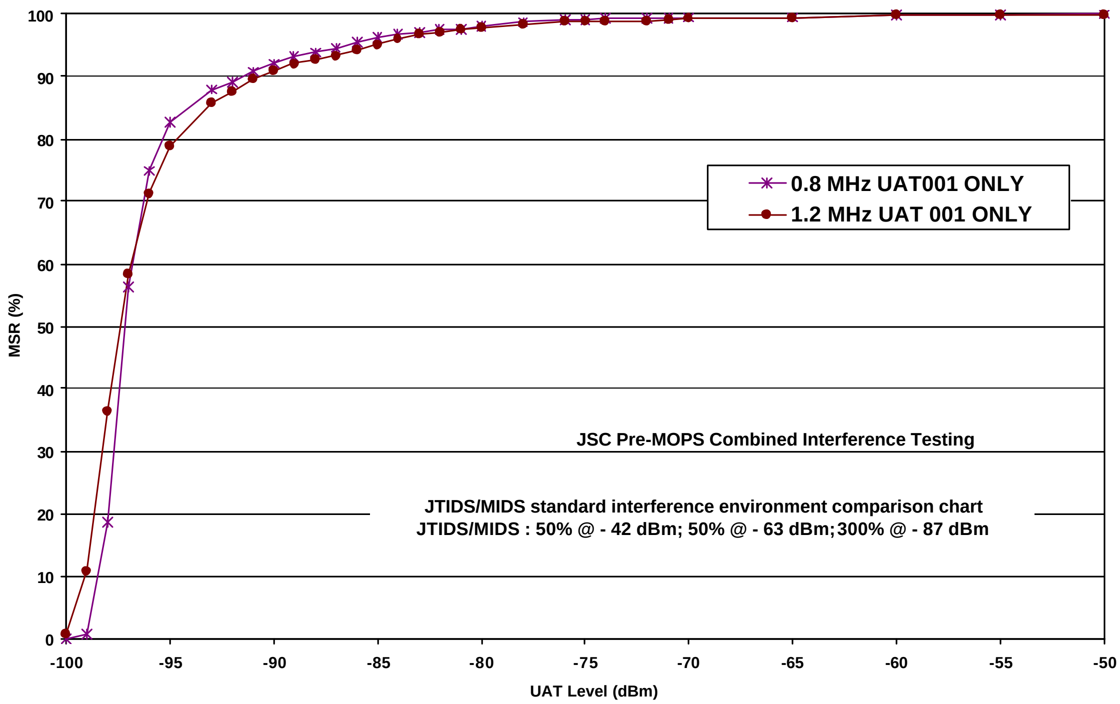

Figure 14 – UAT Receiver Performance with JTIDS/MIDS UAT001 Scenario

2.3 UAT Self Interference Testing

UAT self interference testing was conducted under the future high density Core Europe 2015 and LA 2020 scenarios described in Appendix C. Results of self interference testing with the pre-production units are shown in Figures xx and xx.

2.4 Combined Interference Testing

TBD

3 Production Testing

3.1 TACAN/DME Testing

TBD

3.2 UAT Self Interference Testing

TBD

3.3 Combined Interference Testing

TBD

4 Summary