ABSTRACT

This ATM provides rationale for acceptance of EMI test results from Engineering or Prototype test hardware as a valid basis for determining adequate margins of compatibility in conducted and radiated EMI characteristics on Array E subsystem interfaces.

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Verification of a 6 dB margin of compatibility for EMI characteristics in of each of the Array E subsystems is required to assure proper system operation. This verification is based upon analysis of EMI test results from independent EMI tests for the Central Station and each experiment. This analysis has been completed and shows sufficient margin to satisfy the requirement. Engineering and prototype model hardware was tested to provide the basic EMI data for this analysis.

The changes made in each of the experiments, since the DVM/Proto EMI tests, have been examined to determine if the results of these tests remain valid for the Qual and Flight models. In most cases further experiment EMI tests have been run or are planned since the DVM/Proto EMI tests so that the effects of experiment changes on EMI are documented. The HFE has flown on earlier arrays and no changes have been made during the Array E program. Changes to the ESP C/S electronics were tested as part of the Qual C/S EMI tests. An EMI test was run on the Qual model LSG which incorporated all but one of the changes made since the DVT EMI test and this single change was subsequently tested. Further EMI tests are planned for the LMS prototype as part of the qualification testing of changes made to this experiment. These changes will be incorporated in the Proto LMS and the pertinent parts of the EMI test rerun. Only LEAM has not had further EMI tests run since the DVM/Proto EMI tests. However the effect of LEAM changes which affect EMI were measured during experiment acceptance testing

In addition to these tests on individual experiments, the radiated interference and radiated susceptibility aspects of EMI testing are performed for each experiment during Qual system EMI tests. Although it is not possible to establish the margin of compatibility for conducted interference and conducted susceptibility from these tests, successful system integration implies that a positive margin exists.

In the following paragraphs changes to each experiment and their effect on experiment EMI are discussed. Only those changes which have not been verified by subsequent experiment EMI tests are included.

LSP

The LSP C/S electronics have been considered a part of the ALSEP C/S for the purpose of EMI tests. That is, all C/S EMI tests have included measurements with LSP C/S electronics operating and not operating. Therefore changes to the LSP C/S electronics since the DVM EMI tests have been tested as part of the Qual C/S EMI tests.

LMS

EMI testing of the new circuit for the Analyzer Control Electronics and a change in the Housekeeping Multiplexer are planned as a part of the qualification testing for this new circuit. The EMI test will be run on the LMS prototype, modified with these circuit changes per ALSEP Array E Proto (Multimode) LMS EMI Test Procedure TP 2368982. Other changes to the LMS will in no way effect experiment EMI. The LMS changes and their effect on EMI are:

1. An integrated circuit monostable multivibrator has been added to the Decoder and Signal Conditioning circuit. The monostable multivibrator circuit produces a 3.5V, 40 msec pulse at the time of experiment power turn on for use within the Decoder and Signal Conditioning circuits. Because this circuit operates only at experiment turn on its operation cannot effect experiment EMI.

2. Three 390 pF capacitors have been added to the Counter and Data Compressor board to filter noise at the input to the 21st bit counter. These capacitors could only act to reduce experiment EMI.

3. The Voltage Multiplier and output filter sections of the Electron Multiplier High Voltage Power Supply have resistors of higher value than were used in the prototype model. These resistors increased the filtering at the output of the Electron Multiplier High Voltage Power Supply and thus decrease susceptibility and conducted and radiated EMI of this circuit.

4. A diode has been added to HK channel 3 in the Housekeeping Multiplexer. This diode limits the ion pump current to less than 1 volt. This change will not effect experiment EMI. However the prototype HK board will be modified prior to rerunning the experiment EMI test.

5. The Analyzer Control Electronics have been modified from a single ionization mode unit to a four ionization mode unit. This modification will be made to the prototype and further EMI tests run as part of the qualification of this change.

It is concluded that the minor changes to the LMS described above in no way will effect experiment EMI compatibility.

LEAM

No EMI tests have been run on LEAM subsequent to the DVM/Proto EMI tests. It is significant that circuit changes, which effect EMI, were directed toward reduction of power line conducted and radiated EMI. These changes were:

1. Additional filtering, an inductor and diode, was added at the power supply front end. This additional filtering reduced a large turn-on transient that had existed due to input filter capacitor charging and reduced the 29 Volt line ripple. The effect of this change was not measured as part of an EMI test, but rather as part of LEAM acceptance tests. Turn on transient was measured at 1/2 specification value and 29 volt ripple was measured at 1/3 specification value as part of the LEAM Preassembly Acceptance Test - TP 2365348.

2. The squib lines have been shielded and squib monitor channels were modified to read a ratio of filtered 5V DC instead of the 3 VAC squib supply. Both of these changes were made to reduce radiated EMI from the squib lines. Proof that this would reduce radiated EMI was established during the experiment EMI test when measurements were made with the squib line shielded and without the squib load.

Several other changes were made that reduce EMI within LEAM itself and should act to reduce external EMI. They are:

1. A capacitor was added to the heater status monitor circuit to slow up the rise time for this circuit and thus reduce the transient at LEAM heater turn on.

2. Prelocation and twisting of shielding for critical wire pairs in the central electronics wire harness to reduce crosstalk.

3. Added shielding on the dual sensor microphone board to correct a flight calibration noise problem.

4. Added capacitors to microphone board between 24V line and return to correct a low temperature noise problem.

5. Added a copper shield on the dual sensor microphone board to eliminate regeneration.

LEAM changes that will in no way affect EMI were:

1. Replaced transistor Q_1 on power supply surge limiter because of a NASA alert on the previously used transistor.

2. Added a diode across Q_2 on the power supply surge limiter circuit to protect against possible reverse breakdown.

3. Added a selected resistor to the noise microphone circuit to make the noise microphone threshold detector rise time identical to that of the main microphone.

4. Added a JK FF to the noise microphone accumulator board to eliminate noise microphone accumulator double counts.

5. Boosted 3 V AC Squib Power Supply output with additional windings to bring it within specification value for maximum load.

Thus LEAM changes that directly effect experiment EMI act to improve performance and were effectively tested during the prototype EMI test or in subsequent acceptance testing. The remaining aspects of the DVM/Proto EMI test results remain valid for the Qual and Flight models.

LSG

All changes, to the LSG since the DVM/Proto EMI tests, with one exception, were tested during LSG Qual Model EMI tests (TP 2365536, LSG EMI Test Procedure Heater Box/Electronics). The initial DVM/Proto EMI test on the LSG disclosed out of tolerance radiated EMI at 48 MHz. The source of this EMI was attributed to the output stage of the Heater Box Heater Control circuit. This out of tolerance radiated EMI was again measured during the Qual model EMI test. This led to a design change incorporated per CR/N FC 70398 (Flt) and FC 70399 (Qual). The effectiveness of this design change was proven in a modified EMI test performed as part of the LSG Integrated Functional test, TP 2365545. Thus EMI testing has been performed with all changes to LSG incorporated.