# Network Telemetry System Performance Tests in Support of the MVM'73 Project

R. D. Rey and E. T. Lobdell
Network Operations Office

*This article presents a description of Network Telemetry System Performance Tests that were executed throughout the DSN in support of the MVM'73 project.*

## I. Introduction

System Performance Tests (SPTs) are executed throughout the DSN whenever a modification is made to the Network Telemetry System that affects its performance. This is the case when new software or hardware is added, as was required for the support of Mariner 10. The purpose of this article is to describe the effort that was undertaken in executing telemetry SPTs throughout the DSN and to present the test results. The philosophy and the objectives of the SPTs will be discussed so as to demonstrate the benefits gained by performing these tests. A description of the telemetry SPTs will be presented, along with a description of the test procedure and test software. A summary of the results and the status of the Network Telemetry System will be presented.

## II. Objectives of System Performance Testing

The development of test procedures, test software, and the execution of the telemetry SPTs are performed to accomplish certain objectives. The overall objective is to guarantee that the Network Telemetry System can meet specified operational capabilities. These capabilities are defined in various documents; those of particular importance are given in Refs. 1 through 3. The SPT must verify that the telemetry system configurations and interface requirements are satisfied. They must also evaluate the ability of the Telemetry System to meet performance requirements.

The telemetry SPT is designed so that it can be used to locate or diagnose system problems. The problems may occur during the installation of new equipment or software, or they may be the results of system failures uncovered during DSN real time tracking operations. Some of the latter type problems have been discovered when portions of the SPT are used during countdown tests.

Use of SPTs for prepass readiness tests is another objective that requires that the SPT procedure be modular. Thus, the various classes and levels of prepass readiness tests can be accomplished by executing the appropriate sections of the procedure.

The modularity feature of the procedure enhances the capability to test modifications that may affect the capabilities of the Telemetry System. Portions of the test procedures are used to perform onsite (DSN Facility) acceptance testing of both hardware and software.

An additional objective of SPTs is to aid in the training of station personnel. The SPTs are prepared so that the configurations used are as near as possible to configurations used for real time tracking of the spacecraft. By using the test procedures, station personnel can gain experience in operating the Telemetry System and Telemetry and Command Data (TCD) software. This experience is particularly valuable when new equipment, configurations, or software have been introduced.

## III. Test Configuration

Shown in Fig. 1 is the general telemetry test configuration. Simulated data are generated in the Simulation Conversion Assembly (SCA). The simulated data called for in the tests are a 2047-bit psuedo-noise (PN) sequence; yet fixed pattern data, such as square wave data, may be used if special tests require that the data be recognized and validated by visual inspection. The SCA generates either a single channel or two channels of data, depending on the telemetry mode being tested. In the case of the single channel of data, the SCA modulates these data with a square wave subcarrier. For the two channels, the data channels are modulated with two subcarriers using the interplex scheme. The modulation indices of the subcarriers are set by using the wave analyzer at the receiver. The data on the subcarriers phase modulate a carrier generated in the test transmitter, which is interfaced to the DSN Block III receiver through ambient load and the 20-dB coupler. The test transmitter signal level is adjusted to obtain the required signal-to-noise ratio which is accurately measured at the Y-factor detector.

The Telemetry and Command Data handling software (DSN Program Library Software No. DOI-5050-OP) resides in the Telemetry and Command Processor (TCP) and in the Data Decoder Assembly (DDA), both of which are small general purpose computers. The TCD software can be configured to process data using any one of three telemetry channels. For Mariner 10 support the channels are as follows:

(1) Channel 1 (CH1). Low-rate uncoded (LR UNC) with data rates of 8⅓ and 33⅓ bits/s. This channel interfaces the Subcarrier Demodulator Assembly (SDA) directly to the software internal bit sync loop residing in the TCP. The TCP formats these data, records them as a digital Original Data Record (ODR), and transmits them via high-speed data (HSD).

(2) Channel 2 (CH2). Medium-rate coded (MR C) at 490 and 2450 bits/s; LR UNC at 8⅓ and 33⅓ bits/s. The data from the SDA are synchronized and detected by the Symbol Synchronizer Assembly (SSA). The medium rate coded data are block-decoded using DDA software. These data are formatted and transmitted to the TCP where they are recorded as an ODR and transmitted via HSD. Low-rate data are accepted by the DDA from the SSA. These data are formatted and transmitted to the TCP where they are handled the same as Channel 1 data.

(3) Channel 3 (CH3). High-rate coded (HR C) at 22.05 and 7350 kilobits/s; medium rate coded at 490 and 2450 bits/s; high-rate uncoded (HR UNC) at 117.6 kilobits/s. The high rate coded and medium rate coded data are decoded by the Block Decoder Assembly (BDA). The DDA accepts the high- or medium-rate decoded data from the BDA or high-rate uncoded data from the SSA. These data are formatted and transmitted via wide band data (WBD) lines if they are high-rate coded or via HSD lines if they are medium-rate coded. The formatted data are also recorded on the DDA 9-track high-density recorder (HDR), creating an ODR.

The transmitted data blocks (the output of the TCD) are described in detail in Ref. 4. The specifications placed on the telemetry system by these requirements are very important and must be tested.

The TCP has a 24-bit direct transfer interface with the Digital Instrumentation System (DIS). The operational telemetry software uses this interface to transfer initialization, status and calculation messages to the monitor system (Ref. 5). This interface is tested, but without the DIS monitor operational software.

The DIS is used to process the data for the test using the Telemetry and Command System Test Program (DOI-5409-SP). The data transmitted by the TCP or DDA go to the station communication center and are normally transmitted to the Mission Control and Computing Center (MCCC). To use the DIS as the processing computer, the DDA or TCP HSD/WBD lines must be patched at the station communication center to the DIS HSD/WBD lines.

## IV. Telemetry System Test Software

The Telemetry and Command System Test Program, DOI-5409-SP, resides in the DIS computer. It contains two subprograms: a telemetry subprogram and a command subprogram, both under the control of an Executive Program. The program interfaces with the TCD string to be tested through the HSD/WBD on-site GCF equipment (station communications center), and the 24-bit monitor interface. By virtue of these interfaces, the TCD and its operational software are tested in an operational environment. That is, the telemetry system test validates data as they are transmitted externally from the TCD system.

The software receives the monitor data, and formats and prints the results selectively on the DIS I/O typewriter or line printer. Due to the greater print speed of the line printer, it is normally used during the tests. The monitor data displayed are initialization messages, status messages, and the calculation messages. These messages are validated by visual inspection for correctness and completeness in compliance with Ref. 5.

The telemetry data HSD/WBD blocks may be displayed on the line printer for visual inspection, although normal operation consists of permitting the software to output the following:

(1) Standard block header information consisting of source, destination, data-dependent type (DDT), user-dependent type (UDT), spacecraft identification, and day of the year and the time of the block formation.

(2) Formatted configuration and lock status with receiver AGC or signal level in dBm, and the TCD software channel in use.

(3) The bit error rate (BER) or word error rate (WER) measured over a given period; the bit rate and data format.

In the bit error rate test, the data may be either PN or a fixed pattern. The test software synchronizes to the data and does a bit-by-bit comparison. The WER/BER accumulation may be over any chosen interval resulting in a grand total, while statistics can be displayed as interim summaries at intervals as required.

As the test is being executed, the test software will detect errors and display error messages as follows:

(1) The $\Delta t$ between telemetry HSD/WBD blocks are not within specified tolerances.

(2) Excessive bit error or incorrect data type, as evidenced by the inability to achieve synchronization.

(3) Binary time and multisecond clock differences.

(4) GCF errors.

The telemetry system software is an invaluable tool, which has done much to facilitate and ease the execution of the Telemetry System Performance Tests.

## V. Test Procedure Format

The Network Telemetry System Performance Tests for Mariner 10 were executed using Ref. 6. In this section, the format of the procedure will be presented to provide a description of the tests that are performed at the Deep Space Stations.

The overall test is divided into three main tests. Each test contains a number of subtests that are modular so that any test can be run independently. This allows the procedures to be used for prepass readiness tests, troubleshooting, and new equipment or software tests. It also allows for reduced testing when resources so demand.

The three tests are the Configuration and Interface Tests, the Telemetry Performance Tests and the Non-Real Time Capability Tests. These tests all call out a Test Preparation Section as needed. The complete test, two TCD strings, can be accomplished in 40 hours.

### A. Configuration and Interface Tests

The Configuration and Interface Tests are performed on the three telemetry channels (CH1, CH2, and CH3). They test the telemetry operational software and hardware interfaces using all the operational configurations planned for Mariner 10 support. This test contains HSD and WBD interface tests that verify the HSD/WBD blocks. The blocks are verified by inspection of the formatted block headers, configuration and lock indicators that are formatted for ease of interpretation, and by the absence of error messages. This section contains a set of TCP-DIS monitor message verification tests that verify that the initialization, status, and calculation messages are correct as specified.

Although the AGC/dBm conversion test and the signal-to-noise ratio (SNR) calculation test are separate sections of the test procedure, they are normally run with the configuration and interface tests. The AGC/dBm conversion test verifies that software can perform a correct conversion from AGC volts to signal level in dBm. The conversion parameters are entered in the program, and accuracy of the conversion is checked to see that it is

within ±0.05 dBm. The SNR calculation test verifies the accuracy of the software SNR estimator routine. SNRs of 15, 10, and 5 dB are set up using the Y-Factor machine. The calculation is verified to be accurate within ±0.3 dB.

The important aspect of the configuration and interface tests is that they insure that the functional capabilities of the Telemetry System exist. (The configurations tested can be found in Fig. 3.)

### B. Telemetry Performance Test

The Telemetry Performance Tests determine the capability of the Telemetry System to meet the DSN support performance requirements. These tests are designed to evaluate telemetry performance at threshold SNRs with CH1, CH2, and CH3 configured in the Mariner support modes.

The test measures the output data Word Error Rate (WER) for coded data and the Bit Error Rate (BER) for uncoded data given an input data signal-to-noise ratio. The results are compared against predicted BER/WER, and if they are within given tolerances, the performance is considered to be acceptable. The predictions are based on available mathematical models of the Telemetry System (Refs. 7 through 10). These models are evaluated using a computer program. This program is called the Telemetry Efficiency Program, and is used primarily to generate performance parameters for the telemetry SPTs.

A strong signal test is always executed prior to a weak signal test. The strong signal test is run to detect gross errors in the HSD/WBD blocks that would invalidate the weak signal tests, which take much longer to perform. The strong signal test also confirms the set up configuration and interfaces.

The weak signal performance tests are run for all operational configurations and data rates. An accurate SNR is set using the Y-Factor machine, and the WER/BER is measured and recorded. The SNR calculation is also checked for accuracy. (The telemetry modes and performance tolerances can be obtained from Fig. 5.)

During the execution of the telemetry performance tests, Original Data Records (ODRs) are created to be played back and validated in the Non-Real Time Capability Tests, with the exception of the ODR for the 117.6 kilobits/s uncoded data mode. Since the WBD lines are limited to a data rate of 28 kilobits/s, it is not possible to perform a telemetry performance test in real time. Therefore, the data are recorded, then played back at the wideband rate, with an effective data rate of 22 kilobits/s. (This is also normal operational procedure for supporting the 117.6 kilobits/s mode.) Performance data can then be obtained as they were for the other data modes.

### C. Non-Real Time Capability Tests

The ODRs generated in the performance tests are validated in the third set of SPTs. These are the Non-Real Time Capability Tests. In the first part of these tests, the ODR playback demonstration, the digital ODRs are played back using the appropriate playback program, the 7-track playback program (DOI-5041-OP) or the 9-track playback program (P9 module of DOI-5050-OP). This demonstrates the ability to play back tapes, using both the TCD and the playback software. The HSD/WBD blocks are checked in a manner similar to the configuration and interface tests, to insure that the tapes were properly recorded.

In the second part of the Non-Real Time Capability Tests, analog tape playback demonstration, analog tapes are generated at a specific SNR and then played back. The tape output SNR is obtained and compared against the set SNR. The tape output SNR must be no greater than 1 dB, less than the set SNR.

Data reporting is accomplished by using four data sheets. These are presented in Figs. 2 through 5. The data sheets are:

(1) Data Sheet 1: Test Report Log. This data sheet is used to keep a record on what tests have been performed throughout the Network (Fig. 2).

(2) Data Sheet 2: Configuration/Interface Tests. This sheet gives a checklist of the tests performed for the Configuration and Interface Tests (Fig. 3).

(3) Data Sheet 3: dBm Conversion and SNR Calculation Tests. Tabulates results of these tests (Fig. 4).

(4) Data Sheet 4: Performance Tests. Tabulates results of the Performance Tests, plus results of the ODR playback (Fig. 5).

Test results are analyzed and recorded by the Telemetry System Cognizant Operations Engineer (SCOE).

## VI. MVM'73 Network Telemetry Test Status and Results

Execution of network telemetry SPTs for MVM'73 was scheduled to begin in May of this year, with a completion date of 10 August 1973. Unfortunately, these dates were not met due to the late delivery of operational software

and hardware. The tests were still being executed after the Mariner 10 launch; however, all of the Configuration and Interface Tests plus those capabilities that were required for launch had been completed prior to launch. The tests were required to be performed at the following stations:

(1) Goldstone, California: DSS 12 and DSS 14.

(2) Tidbinbilla, Australia: DSS 42 and DSS 43; conjoint stations.

(3) Madrid and Ceberos, Spain: DSS 62 and DSS 63.

The tests were conducted by station personnel. In a number of cases the SPTs uncovered station problems, which, when corrected by the station personnel, required a rerun of system tests. The station personnel also made recommendations on modifications or corrections of the procedures.

Data taken during the tests were transmitted to the telemetry SCOE. The data were analyzed and saved. To evaluate the status of the Telemetry System, a Telemetry Test Status Board was created. The most recent data from each station are recorded on this Board, and are presented in Fig. 6.

The Telemetry Test Status Board presents the date that the Configuration and Interface Tests, including AGC/dBm and SNR tests, were completed. It also presents the results of the performance tests (1-1 through 7) and the date that these tests were completed. For the performance tests, the data rate, input SNR, allowable WER/SER, and allowable SNR with tolerances are presented. The Board shows which tests are not completed and due, are out of tolerance, and are not required from a particular station.

All of the Configuration and Interface Tests (including the AGC/dBm and SNR tests) were successfully completed prior to Mariner 10 launch. The Telemetry Performance Tests were not completed. Some of the tests were run, but the results were not within tolerance. These results were accepted since they were nearly within specification, and it was deemed that the station resources not be loaded by further testing except on a best efforts basis.

In some cases, data from the tests were not available. These tests were not completed due to hardware problems that were uncovered prior to or during the tests. Since the tests were run late, many problems were discovered just prior to Mariner 10 launch. The problems could not be corrected due to the Mariner configuration freeze, and then the Pioneer 10 configuration. The problems are now being corrected and the tests will be run after the termination of the Pioneer configuration freeze.

The Non-Real Time Tests were executed prior to Mariner launch with the following results:

(1) All TCP ODRs were validated.

(2) DDA ODRs at DSSs 14 and 63 have been validated.

(3) Hardware problems with the DSS 43 DDA ODRs have been uncovered.

(4) All 26-meter-antenna DSS analog tape ODRs have been validated.

(5) Problems with the recorder track assignments of the 64-meter-antenna DSS Analog Tape ODRs have been uncovered.

Overall, the performance as demonstrated by the Telemetry SPTs, has been acceptable.

# References


1. *Deep Space Network System Requirements–Detailed Interface Design*, Document No. 820–13. Jet Propulsion Laboratory, Pasadena, Calif., Feb. 1, 1971. (JPL internal document.)

2. *Deep Space Network Support Requirements for MVM'73 Project*, Document No. 615–15–Rev. A. Jet Propulsion Laboratory, Pasadena, Calif., Jan. 15, 1973. (JPL internal document.)

3. *GCF-NASCOM MVM'73 Project Support Communications Capabilities, Configurations, and Operational Support Procedures–Network Operations Plan for MVM'73 Project*, Document No. 615–93–01. Jet Propulsion Laboratory, Pasadena, Calif., Sept. 20, 1973. (JPL internal document.)

4. *Telemetry System Wideband and High Speed Data Interfaces*, Document No. TLM–3–5, listed in *Deep Space Network System Requirements–Detailed Interface Design*, Document No. 820–13. Jet Propulsion Laboratory, Pasadena, Calif., May 1, 1973. (JPL internal document.)

5. *DSS Monitor System Interfaces with DSS Monitor Program DOI–5046–OP*, Document No. 820–13, MON 5–4, listed in *Deep Space Network System Requirements–Detailed Interface Design*, Document No. 820–13. Jet Propulsion Laboratory, Pasadena, Calif., Feb. 28, 1973. (JPL internal document.)

6. *DSIF Standard Test Procedure Telemetry System Performance Test MVM'73 Version*, Document No. 853–61; 2A–07. Jet Propulsion Laboratory, Pasadena, Calif., Dec. 28, 1973.

7. Brockman, M. H., "MMT Subcarrier Demodulator," in *The Deep Space Network*, Space Programs Summary 37-46, Vol. III, pp. 189–204. Jet Propulsion Laboratory, Pasadena, Calif., July 31, 1967.

8. Burt, R. W., "DSIF System Verification Tests," in *The Deep Space Network*, Space Programs Summary 37-51, Vol. II, pp. 132–136. Jet Propulsion Laboratory, Pasadena, Calif., May 31, 1968.

9. Edelson, R. E., *Telecommunications Systems Design Techniques Handbook*, Technical Memorandum 33-571. Jet Propulsion Laboratory, Pasadena, Calif., July 15, 1972.

10. Tausworthe, R. C., "Communications Systems Development: Efficiency of Noisy Reference Detection," in *The Deep Space Network*, Space Programs Summary 37-54, Vol. III, pp. 195–201. Jet Propulsion Laboratory, Pasadena, Calif., Dec. 31, 1968.

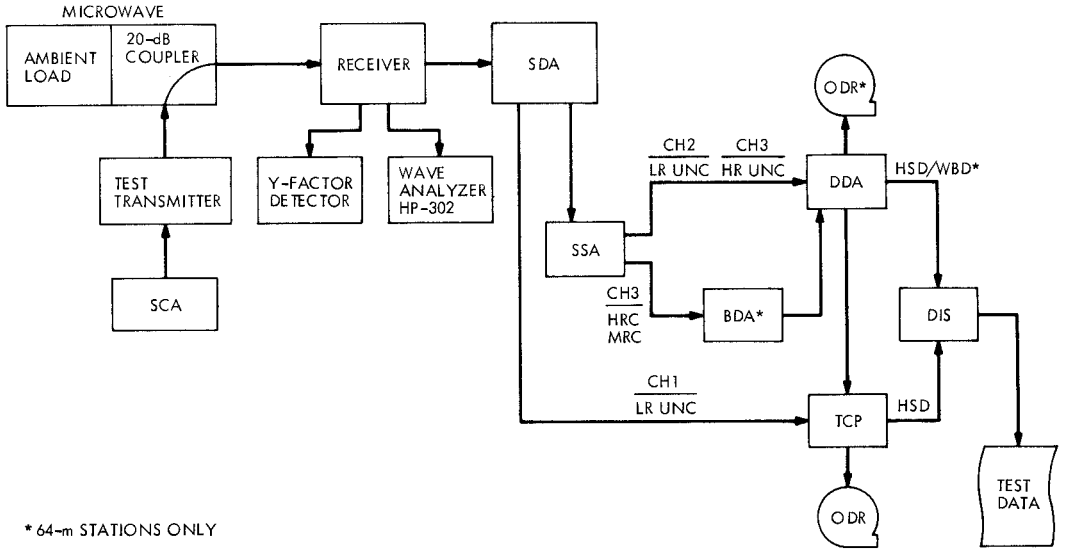


**Fig. 1. Telemetry test configuration, general**

DSS _____ TCD String _____

Test Conductor _____

| Test and Paragraph No. | Date Conducted | Passed | Failed | Comments |
|---|---|---|---|---|
| Configuration/Interface — | | | | |
| - Test 1 (C.2.a.) | | | | |
| - Test 2 (C.2.a.) | | | | |
| - Test 3 (C.2.b.) | | | | |
| - Test 4 (C.2.b.) | | | | |
| - Test 5 (C.2.c.) | | | | |
| - Test 6 (C.2.c.) | | | | |
| - Test 7 (C.2.d.) | | | | |
| - Test 8 (C.2.d.) | | | | |
| AGC/DBM Conversion TEST (C.3) | | | | |
| SNR Calculation Test (C.4) | | | | |
| Performance Test - 1 (C.5.b.) | | | | |
| Performance Test - 2 (C.5.c.) | | | | |
| Performance Test - 3 (C.4.d.) | | | | |
| Performance Test - 4 (C.5.e.) | | | | |
| Performance Test - 5 (C.5.f.) | | | | |
| Performance Test - 6 (C.5.g.) | | | | |
| Performance Test - 7 (C.5.a.) | | | | |
| ODR Playback Demonstration (C.6.) | | | | |
| Analog Tape Record/Playback (C.7) | | | | |

**Fig. 2. Data Sheet 1. Test report log, MVM'73 TLM system test**

DSS _____ Test Conductor _____ Date _____

| Test No. | TCD String No. | Bit Rate bps | Configuration | | | | | Verification, Check if OK: Config and Lock Status | | Verification, Check if OK: Monitor Messages | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | RCV | SDA | SSA | BDA | DDA | HSD | WBD | Init | Calc | Status |
| **26-Meter Station (Standard)** | | | | | | | | | | | | |
| 1-A | 1 | 33.333 | 1 | 1 | | | | | NA | | | |
| 2-A | 1 | 33.333 | 2 | 2 | | | | | NA | | | |
| 3-A | 1 | 2450.0 | 1 | 1 | 1 | | 1 | | NA | | | |
| 4-A | 1 | 2450.0 | 2 | 2 | 1 | | 1 | | NA | | | |
| 1-B | 2 | 33.333 | 1 | 1 | | | | | NA | | | |
| 2-B | 2 | 33.333 | 2 | 2 | | | | | NA | | | |
| 3-B | 2 | 2450.0 | 1 | 1 | 1 | | 1 | | NA | | | |
| 4-B | 2 | 2450.0 | 2 | 2 | 1 | | 1 | | NA | | | |
| **64-Meter Stations (Conjoint), *DSS 14 and CTA 21** | | | | | | | | | | | | |
| 1-A | 1 | 33.333 | 1 | 1 | | | | | NA | | | |
| 2-A | 1 | 33.333 | 2 | 2 | | | | | NA | | | |
| 3-A | 1 | 2450.0 | 1 | 1 | 1 | | 1 | | NA | | | |
| 4-A | 1 | 2450.0 | 2 | 2 | 1 | | 1 | | NA | | | |
| 5-A | 1 | 22.05K | 1 | 1 | 1 | 1 | 1 | NA | | | | |
| 6-A | 1 | 22.050K | 2 | 2 | 1 | 1 | 1 | NA | | | | |
| 7-A | 1 | 117.6K | 1 | 1 | 1 | 1 | 1 | NA | ** | | | |
| 8-A | 1 | 117.6K | 2 | 2 | 1 | 1 | 1 | NA | ** | | | |
| 1-B | 2 | 33.333 | 1 | (4)2 | | | | | NA | | | |
| 2-B | 2 | 33.333 | 2 | 3 | | | | | NA | | | |
| 3-B | 2 | 2450.0 | 1 | (4)2 | 1 | | 1 | | NA | | | |
| 4-B | 2 | 2450.0 | 2 | 3 | 1 | | 1 | | NA | | | |
| 5-B | 2 | 22.05K | 1 | (4)2 | 1 | 1 | 1 | NA | | | | |
| 6-B | 2 | 22.05K | 2 | 3 | 1 | 1 | 1 | NA | | | | |
| 7-B | 2 | 117.6K | 1 | (4)2 | 1 | 1 | 1 | NA | ** | | | |
| 8-B | 2 | 117.6K | 2 | 3 | 1 | 1 | 1 | NA | ** | | | |
| **26-Meter Stations (Conjoint)** | | | | | | | | | | | | |
| 1-B | 2 | 33.333 | 4 | 5 | | | | | NA | | | |
| 2-B | 2 | 33.333 | 3 | 5 | | | | | NA | | | |
| 3-B | 2 | 2450.0 | 4 | 5 | 1 | | 1 | | NA | | | |
| 4-B | 2 | 2450.0 | 3 | 5 | 1 | | 1 | | NA | | | |
| 1-C | 3 | 33.333 | 3 | 4 | | | | | NA | | | |
| 2-C | 3 | 33.333 | 4 | 5 | | | | | NA | | | |
| 3-C | 3 | 2450.0 | 3 | 4 | 1 | | 1 | | NA | | | |
| 4-C | 3 | 2450.0 | 4 | 5 | 1 | | 1 | | NA | | | |

**Record only (DDA ODR)

**Fig. 3. Data Sheet 2. Configuration/interface tests**

dBM Conversion Test:

| | TCP 1 | TCP 2 | TCP 3 |
|---|---|---|---|
| AGC | | | |
| dBM | | | |

Results should be 130 dBM ±0.5 dB

SNR Calculation Test:

| Input $ST_b/N_o$ | SNR Allowable | TCP 1 | TCP 2 | TCP 3 |
|---|---|---|---|---|
| 15.0 dB | 15.0 dB ±0.3 dB | | | |
| 10.0 dB | 9.3 dB ±0.3 dB | | | |
| 5.0 dB | 4.3 dB ±0.4 dB | | | |

DSS _____

Test Conductor _____

Date _____

**Fig. 4. Data Sheet 3. dBm conversion and SNR calculation tests**

| Test No. | Bit Rate and Data Type | Run Time | Input $ST_b/N_o$ dB | WER/BER Allowable | SNR Allowable dB | WER/ BER Results | SNR Results dB | Start Time | Stop Time | ODR Playback Check if OK |
|---|---|---|---|---|---|---|---|---|---|---|
| 1-1 | 117.6 kbps UNC | 5 min | 2.5 | 0.040 to 0.050 | | | | | | |
| 1-2 | 2450.0 bps B.C. | 30 min | *10.17 | <0.00001 | | | | | | |
| 2-1 | 22.05 kbps B.C. | 5 min | 2.0 | 0.050 to 0.070 | 1.4 ±0.5 | | | | | |
| 2-2 | 2450.0 bps B.C. | 30 min | *7.7 | <0.00002 | 7.5 ±0.8 | | | | | |
| 3-1 | 7350.0 bps B.C. | 30 min | 5.0 | 0.0006 to 0.002 | 4.8 ±0.5 | | | | | |
| 3-2 | 490.0 bps B.C. | 30 min | *12.9 | <0.00001 | 12.8 ±0.9 | | | | | |
| 4 | 2450.0 bps B.C. | 30 min | 3.0 | 0.017 to 0.035 | 2.0 ±0.5 | | | | | |
| 5 | 490.0 bps B.C. | 30 min | 4.0 | 0.013 to 0.030 | 2.7 ±0.5 | | | | | |
| 6 | 33.333 bps UNC | 30 min | 5.0 | 0.014 to 0.025 | 3.9 ±0.5 | | | | | |
| 7 | 8.333 bps UNC | 2.5 h | 6.0 | 0.020 to 0.040 | 3.6 ±0.5 | | | | | |

*Resultant $ST_b/N_o$ dual subcarrier interplex calculation

NOTE: Reproduce this table for use as a data sheet.

DSS _____ TCD _____ (Primary)

Date _____ Test Conductor _____

**Fig. 5. Data Sheet 4. Performance tests**

MVM 73 NETWORK TELEMETRY TEST STATUS

| SYSTEM PERFORMANCE TESTS; 853-61; 2A-07 | | | | | CTA 21 | | | | | | DSS 71 | | | DSS 12 | | | | | | DSS 14 | | | | | | DSS 42 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | TCP 1 | | | TCP 2 | | | TCP 1 | | | TCP 1 | | | TCP 2 | | | TCP 1 | | | TCP 2 | | | TCP 2 | | | TCP 3 | | |
| TEST | BIT RATE (BPS) DATA TYPE | INPUT $ST_b/N_o$ (DB) | WER/BER ALLOWABLE | SNR (DB) ALLOWABLE | WER/BER | SNR | DATE | WER/BER | SNR | DATE | WER/BER | SNR | DATE | WER/BER | SNR | DATE | WER/BER | SNR | DATE | WER/BER | SNR | DATE | WER/BER | SNR | DATE | WER/BER | SNR | DATE | WER/BER | SNR | DATE |
| CONFIG INTERFACE | -- | -- | -- | -- | -- | -- | 7-23 | -- | -- | 7-23 | -- | -- | 7-23 | -- | -- | 10-1 | -- | -- | 10-4 | -- | -- | 9-28 | -- | -- | 9-28 | -- | -- | 10-31 | -- | -- | 10-31 |
| AGC/DBM | -- | -- | -- | -- | -- | -- | 7-23 | -- | -- | 7-23 | -- | -- | 7-23 | -- | -- | 10-2 | -- | -- | 10-4 | -- | -- | 9-28 | -- | -- | 9-28 | -- | -- | 10-31 | -- | -- | 10-31 |
| SNR | -- | -- | -- | -- | -- | -- | 7-23 | -- | -- | 7-23 | -- | -- | 7-23 | -- | -- | 10-21 | -- | -- | 7-26 | -- | -- | 9-28 | -- | -- | 9-28 | -- | -- | 9-23 | -- | -- | 10-3 |
| 1 - 1 | 117.6 K UNC | 2.5 | 0.040-0.050 | 2.0 ± 0.3 | -- | -- | -- | 0.047 | 2.1 | 7-23 | NR | NR | NR | -- | -- | -- | -- | -- | -- | 0.05 | 2.0 | 9-24 | X | X | X | -- | -- | -- | -- | -- | -- |
| 1 - 2 | 2450.0 BC | 10.17 | <0.00001 | 10.0 ± 1.0 | 0.0 | 9.7 | 7-23 | NR | NR | NR | 0.0 | 10.5 | 10-17 | 0.0 | 10.43 | 10-15 | $1.2 \times 10^{-6}$ | 10.34 | 10-2 | 0.0 | 10.5 | 9-24 | 0.0 | 10.5 | 9-24 | 0.0 | 11.98 | 10-31 | 0.0 | 11.3 | 10-3 |
| 2 - 1 | 22.05 BC | 2.0 | 0.050-0.070 | 0.8 ± 0.3 | -- | -- | -- | 0.068 | 0.5 | 7-23 | NR | NR | NR | -- | -- | -- | -- | -- | -- | 0.05 | 1.0 | 9-24 | 0.058 | 1.0 | 9-24 | -- | -- | -- | -- | -- | -- |
| 2 - 2 | 2450.0 BC | 7.7 | <0.00002 | 7.4 ± 0.8 | 0.0 | 7.3 | 7-23 | NR | NR | NR | 0.0 | 7.0 | 10-17 | 0.0 | 8.25 | 10-21 | 0.0 | 7.12 | 10-2 | 0.0 | 7.0 | 9-24 | 0.0 | 7.0 | 9-24 | $1 \times 10^{-5}$ | 6.94 | 10-31 | 0.0 | 8.3 | 10-3 |
| 3 - 1 | 7350.0 BC | 5.0 | 0.0006-0.002 | 4.1 ± 0.4 | -- | -- | -- | 0.0012 | 4.0 | 7-23 | NR | NR | NR | -- | -- | -- | -- | -- | -- | 0.0008 | 4.0 | 9-24 | 0.0007 | 4.3 | 9-24 | -- | -- | -- | -- | -- | -- |
| 3 - 2 | 490.0 BC | 12.9 | <0.00001 | 12.6 ± 0.9 | 0.0 | 12.2 | 7-23 | NR | NR | NR | 0.0 | 13.0 | 10-17 | 0.0 | 13.71 | 10-21 | 0.0 | 12.06 | 10-2 | 0.0 | 12.0 | 9-24 | 0.0 | 12.0 | 9-24 | 0.0 | 13.6 | 10-31 | 2.0 | 12.49 | 10-31 |
| 4 | 2450.0 BC | 3.0 | 0.017-0.035 | 2.0 ± 0.4 | NR | NR | NR | 0.022 | 2.4 | 7-23 | 0.024 | 2.0 | 7-23 | 0.0319 | 1.85 | 10-21 | 0.0319 | 2.5 | 7-26 | 0.024 | 2.0 | 7-23 | 0.02 | 2.0 | 9-11 | 0.0136 | 2.61 | 10-31 | 0.0148 | 2.48 | 10-31 |
| 5 | 490.0 BC | 4.0 | 0.013-0.030 | 2.7 ± 0.4 | 0.022 | 2.5 | 11-30 | 0.018 | 2.65 | 7-23 | 0.019 | 2.62 | 7-23 | 0.0133 | 2.93 | 10-21 | 0.017 | 2.87 | 7-26 | 0.015 | 3.0 | 7-23 | 0.014 | 3.0 | 9-11 | 0.014 | 3.2 | 10-31 | 0.016 | 2.80 | 10-31 |
| 6 | 33.333 UNC | 5.0 | 0.014-0.025 | 3.9 ± 0.5 | NR | NR | NR | 0.0176 | 3.71 | 7-23 | 0.02 | 3.71 | 7-23 | 0.0136 | 4.18 | 10-21 | 0.02 | 3.78 | 10-2 | 0.012 | 4.32 | 9-24 | 0.013 | 4.1 | 9-24 | 0.013 | 4.11 | 10-31 | 0.013 | 4.06 | 10-31 |
| 7 | 8.333 UNC | 6.0 | 0.020-0.040 | 3.6 ± 0.5 | NR | NR | NR | 0.03 | 3.62 | 7-23 | 0.03 | 3.37 | 7-23 | 0.027 | 3.5 | 10-21 | 0.027 | 3.75 | 10-2 | 0.02 | 3.9 | 9-28 | 0.02 | 3.6 | 9-24 | 0.0127 | 3.77 | 10-31 | 0.024 | 3.23 | 10-31 |

| SYSTEM PERFORMANCE TESTS; 853-61; 2A-07 | | | | | DSS 43 | | | | | | DSS 62 | | | | | | DSS 63 | | | | | | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | TCP 1 | | | TCP 2 | | | TCP 1 | | | TCP 2 | | | TCP 1 | | | TCP 2 | | | |
| TEST | BIT RATE (BPS) DATA TYPE | INPUT $ST_b/N_o$ (DB) | WER/BER ALLOWABLE | SNR (DB) ALLOWABLE | WER/BER | SNR | DATE | WER/BER | SNR | DATE | WER/BER | SNR | DATE | WER/BER | SNR | DATE | WER/BER | SNR | DATE | WER/BER | SNR | DATE | |
| CONFIG INTERFACE | -- | -- | -- | -- | -- | -- | 8-3 | -- | -- | 8-3 | -- | -- | 7-23 | -- | -- | 7-23 | -- | -- | 9-7 | -- | -- | 8-10 | X = NOT COMPLETED AND DUE |
| AGC/DBM | -- | -- | -- | -- | -- | -- | 8-3 | -- | -- | 8-3 | -- | -- | 7-23 | -- | -- | 7-23 | -- | -- | 9-7 | -- | -- | 8-10 | ☐ = OUT OF TOLERANCE |
| SNR | -- | -- | -- | -- | -- | -- | 8-3 | -- | -- | 8-3 | -- | -- | 7-23 | -- | -- | 7-23 | -- | -- | 9-7 | -- | -- | 8-10 | NR = NOT REQUIRED |
| 1 - 1 | 117.6 K UNC | 2.5 | 0.040-0.050 | 2.0 ± 0.3 | X | X | X | X | X | X | -- | -- | -- | -- | -- | -- | 0.04 | 2.0 | 10-4 | 0.0425 | 2.0 | 10-4 | |
| 1 - 2 | 2450.0 BC | 10.17 | 0.00001 | 10.0 ± 1.0 | X | X | X | X | X | X | $0.4 \times 10^{-5}$ | 9.79 | 9-27 | 0.000017 | 10.37 | 9-27 | $1 \times 10^{-6}$ | 8.9 | 9-7 | $4 \times 10^{-6}$ | 8.93 | 9-7 | |
| 2 - 1 | 22.05 K BC | 2.0 | 0.050-0.070 | 0.8 ± 0.3 | X | X | X | 0.048 | 2.33 | 10-31 | -- | -- | -- | -- | -- | -- | 0.0709 | 0.795 | 9-7 | 0.0667 | 0.744 | 9-7 | |
| 2 - 2 | 2450.0 BC | 7.7 | 0.00002 | 7.4 ± 0.8 | X | X | X | X | X | X | $0.2 \times 10^{-5}$ | 7.87 | 9-27 | 0.0 | 7.9 | 9-27 | $9 \times 10^{-6}$ | 6.59 | 9-7 | $1.4 \times 10^{-5}$ | 6.59 | 9-7 | |
| 3 - 1 | 7350.0 BC | 5.0 | 0.0006-0.002 | 4.1 ± 0.4 | X | X | X | 0.0006 | 5.71 | 10-31 | -- | -- | -- | -- | -- | -- | 0.0015 | 4.05 | 9-7 | 0.00087 | 4.36 | 9-7 | |
| 3 - 2 | 490.0 BC | 12.9 | 0.00001 | 12.6 ± 0.9 | X | X | X | X | X | X | 0.0 | 13.2 | 9-27 | 0.0 | 13.27 | 9-27 | 0.0 | 12.65 | 9-7 | 0.0 | 12.0 | 9-7 | |
| 4 | 2450.0 BC | 3.0 | 0.017-0.035 | 2.0 ± 0.4 | X | X | X | X | X | X | 0.0315 | 1.77 | 9-27 | 0.031 | 1.71 | 9-27 | 0.024 | 2.04 | 9-7 | 0.022 | 2.15 | 9-7 | |
| 5 | 490.0 BC | 4.0 | 0.013-0.030 | 2.7 ± 0.4 | X | X | X | 0.02 | 2.32 | 7-20 | 0.019 | 2.75 | 8-2 | 0.018 | 2.75 | 8-2 | 0.021 | 2.66 | 9-7 | 0.013 | 2.92 | 9-7 | |
| 6 | 33.333 UNC | 5.0 | 0.014-0.025 | 3.9 ± 0.5 | 0.0133 | 3.85 | 7-20 | 0.013 | 4.01 | 7-20 | 0.0193 | 3.62 | 9-27 | 0.0169 | 3.83 | 9-27 | 0.0118 | 4.36 | 10-4 | 0.0119 | 4.2 | 10-4 | |
| 7 | 8.333 UNC | 6.0 | 0.020-0.040 | 3.6 ± 0.5 | X | X | X | 0.020 | 3.6 | 7-20 | 0.024 | 3.65 | 9-27 | 0.0217 | 3.66 | 9-27 | 0.0206 | 3.98 | 10-4 | 0.0186 | 4.09 | 10-4 | |

**Fig. 6. MVM'73 network telemetry status**