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Diagnostic Procedures for Trend Monitoring System (TMS) Communications

J. S. Brown
M. D. Lenker

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THE
MITRE
CORPORATION
HOUSTON, TEXAS

Department Approval: _Eileen S Hemelin_

MITRE Project Approval: _Eileen S Hemelin_

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ABSTRACT

MITRE has designed and installed a prototype coaxial cable bus communications system at NASA's Johnson Space Center to support the Trend Monitoring System (TMS). The communications facility will be maintained by contractors under NASA's supervision. This document describes troubleshooting procedures at the system level; the procedures can be used by repair personnel to isolate a fault in the TMS and to restore the system to operation by swapping out failed components.

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DIAGNOSTIC PROCEDURES
FOR
TREND MONITORING SYSTEM (TMS) COMMUNICATIONS

SECTION I
INTRODUCTION

1.0   BACKGROUND

At NASA's Johnson Space Center (JSC) in Houston, Texas, the
Institutional Data Systems Division (IDSD) provides data reduction support
to manned spaceflight missions. The process of data reduction is accomplished
principally by the Orbiter Data Reduction Complex (ODRC) at present.
In response to requests from engineers both at NASA installations and at
principal contractor locations, data are extracted from raw data tapes,
converted to engineering units, and displayed in any one of a number of
different output forms. Ordinarily, the data reduction support offered by
the ODRC occurs at times ranging from hours to days after data arrives at
JSC.

In 1977, however, as data processing requirements for the test
program of the Space Shuttle were analyzed, it became clear that because
of the inability to test all thermal responses of the Shuttle before the
missions, there exists a need to monitor certain thermal measurements in
near real time. An interactive system in which thermal data are to be made
available as soon as possible after data tapes arrive was therefore planned.

To meet this requirement, NASA personnel in IDSD's Engineering
and Special Development Branch (FD7) designed and implemented the Trend
Monitoring System (TMS). The TMS employs MEGATEK 5000 intelligent
graphics terminals and a MODCOMP IV/35 host minicomputer. Because
high data rates are required in the system (a typical plot request may
generate 25,000 bytes of response which must be displayed in under
5 seconds) and because the separation between the host and the terminals

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is great, conventional communications systems are costly and difficult to apply. MITRE had developed a coaxial-cable-based bus communications system which supports high data rates over separations of several miles [1], and NASA elected to install a prototype bus system both to support the TMS and to provide a test bed for analysis of the bus concept.

In the installation of the bus system, MITRE performed system engineering of the cable plant and developed custom interfaces between the TMS computers and the bus. This work is documented in a series of reports ([2], [3], [4], [5], [6], [7], [8]).

1.1   Overview of Report

An important aspect of the operation of the bus communications system to support the TMS is timely diagnosis and repair of failures in the system. This document gives guidelines for isolation of faults and describes how to remedy problems by substituting spare components for failed units. The report is intended to be used as a manual during correction of operating problems. Section II contains a series of procedures which should enable a problem to be isolated and corrected usually in less than an hour. Section III contains limited material describing fault isolation within a malfunctioning Bus Interface Unit (BIU); this type of maintenance should be done after the system has been restored to full operation by substitution of a spare unit. The material in Sections II and III applies to remedial maintenance, but Appendix I contains information on how to use statistics from bus operation to detect incipient problems. Appendix II contains a listing and Nassi-Shneiderman chart of the VOLLEY program used in isolating cable plant faults.

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SECTION II
SYSTEM FAULT ISOLATION

2.0   INTRODUCTION

In the fault isolation discussed in the following paragraphs, it is assumed that software failures occur rarely enough that they can be cured by rebooting with new copies of the same software. This diagnostic procedure does not attempt to identify problems that may arise because of software design or implementation errors, but rather concerns itself solely with hardware failures and software failures which arise from contamination of the program by an unintended modification of the code.

Failures which can cause interruptions in TMS communications can occur at nine possible sites in the system. These sites are listed in Figure 2.0-1, together with identifying numbers which are used in the diagnostic procedures in paragraph 2.1.

Site Number	Site
1	MODCOMP software
2	MODCOMP hardware
3	MODCOMP 4805 board bus interface hardware
4	MODCOMP BIU
5	Radio Frequency (RF) cable plant
6	MEGATEK BIU
7	NOVA 4040 board bus interface hardware
8	NOVA software
9	NOVA hardware

Figure 2.0-1 Communications Failure Sites in the TMS

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There are a number of diagnostic approaches and tools which can
be used to localize faults in the TMS communications system. Among these
are the basic method of substituting known good (spare) components for
suspected bad components, after observation of system behavior or use of
special purpose tools has isolated the probable failure area. Among the
special purpose tools which are mentioned in the following paragraphs are a
backboard test BIU, which reflects back to the sender any message sent to
it, a MODCOMP program (VOLLEY), which sends out periodic messages to the
backboard BIU and examines the replies, and a dummy cable system (test jig),
which can be substituted for the real cable plant during certain tests.

2.1   Fault Diagnosis Procedures

Procedures for diagnosis of TMS communications problems are
shown in Figures 2.2-1 through 2.1-7 and Figure 2.1-9. Figure 2.1-8
describes a cable system test jig, and Figure 2.1-10 is a schematic diagram
of the TMS cable. Diagnostic work should begin by following the steps of
Procedure A (Figure 2.1-1).

The procedures in this section are intended to be used step-by-step
for isolating problems and for correcting them by substituting components.
Detailed instructions on the repair of failed components is beyond the scope
of this manual, though a limited suggestion of an approach to the repair
of BIUs is found in Section III.

The TMS Operator's Guide [9] and the TMS User's Guide [10]
should be available for reference during use of these procedures. These
two documents give details of such procedures as booting the MODCOMP
and booting the terminals.

Begin – problem reported by terminal user → Perform procedure A as a quick check of MODCOMP and Terminal → Problem Solved? — Yes → Stop

No ↓

Is MODCOMP running? — No or not sure → Failure may be at sites 1, 2, or 3 / Reboot MODCOMP → Problem Solved? — Yes → Stop

Yes ↓   No ↓

Are all terminals affected? — Yes → Failure is at Site 1, 2, 3, 4, or 5 / Perform procedure A

No ↓

Failure is not at sites 1, 2, 3, or 4 / Reset terminal user's BIU

↓

Did "Which System" appear? — Yes → Enter TMS and carriage return at terminal → Did "Link Accepted" appear? — No → Reboot the affected terminal – watch red and green lights on affected BIU

No ↓   Yes ↓

Failure is probably at site 6, 7, 8, or 9 / Perform procedure C

Problem Solved? — Yes → Stop

No ↓

Failure is probably at site 5 or 6 / Perform procedure D — No ← Did the red and green lights flash during reboot?

Yes ↓

Failure is probably at site 6, 7, 8, or 9 / Perform procedure C

Figure 2.1-1   Top Level Diagnosis Procedure

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1. **Quick check of the affected terminal:**

   a. Verify that power is on to the NOVA, to the display (note pilot light), to the hard copier, and to the BIU.

   b. Depress the black reset button on the terminal's hard copier.

   c. If the problem is in booting the terminal, verify that the BIU reset button is not depressed after the reset and pr load switches have been raised on the MEGATEK.

2. **Quick check of whether the MODCOMP appears to be ready and running:**

   a. Verify that all essential components have power. If trouble is found, correct the problem and reboot the MODCOMP. At least the following components should be checked:

      (1) MODCOMP BIU
      (2) MODCOMP Peripheral Controller Interface (PCI) cabinets
      (3) Cable system power supply
      (4) System console (must be on line as well as powered on)
      (5) MODCOMP disks (must be ready as well as powered on)

   b. Check that the MODCOMP run light on the CPU is lighted and that the console responds to a control-A input. If either or both of these conditions is not true, reboot the MODCOMP.

Figure 2.1-2 Diagnostic Procedure A – Quick Check
of User Terminal and of MODCOMP

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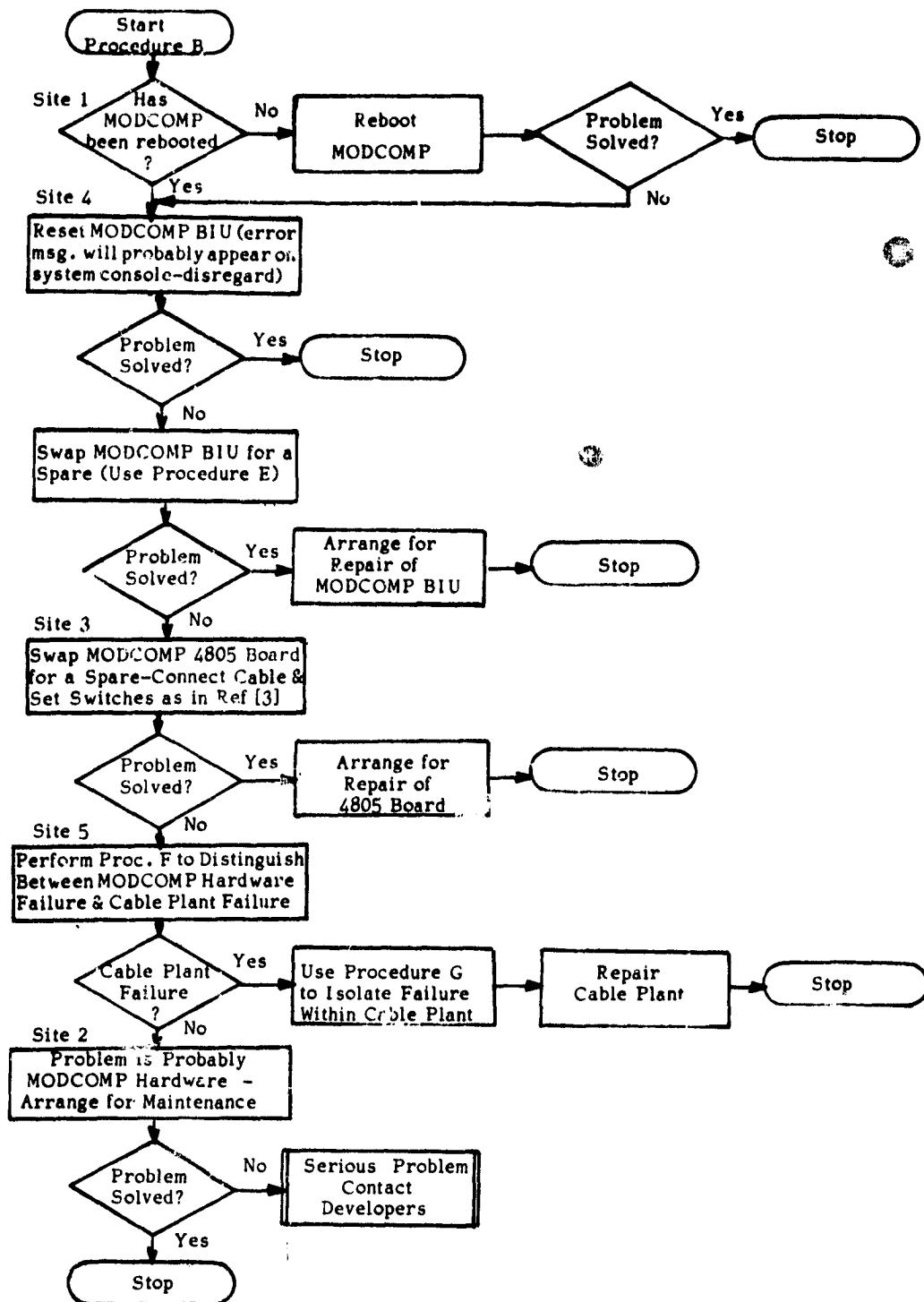
Figure 2.1-3 Diagnostic Procedure B – Eliminates Sites 1, 2, 3, 4, and 5
(MODCOMP Software and Hardware, 4805 Board, MODCOMP
BIU, and Cable Plant)

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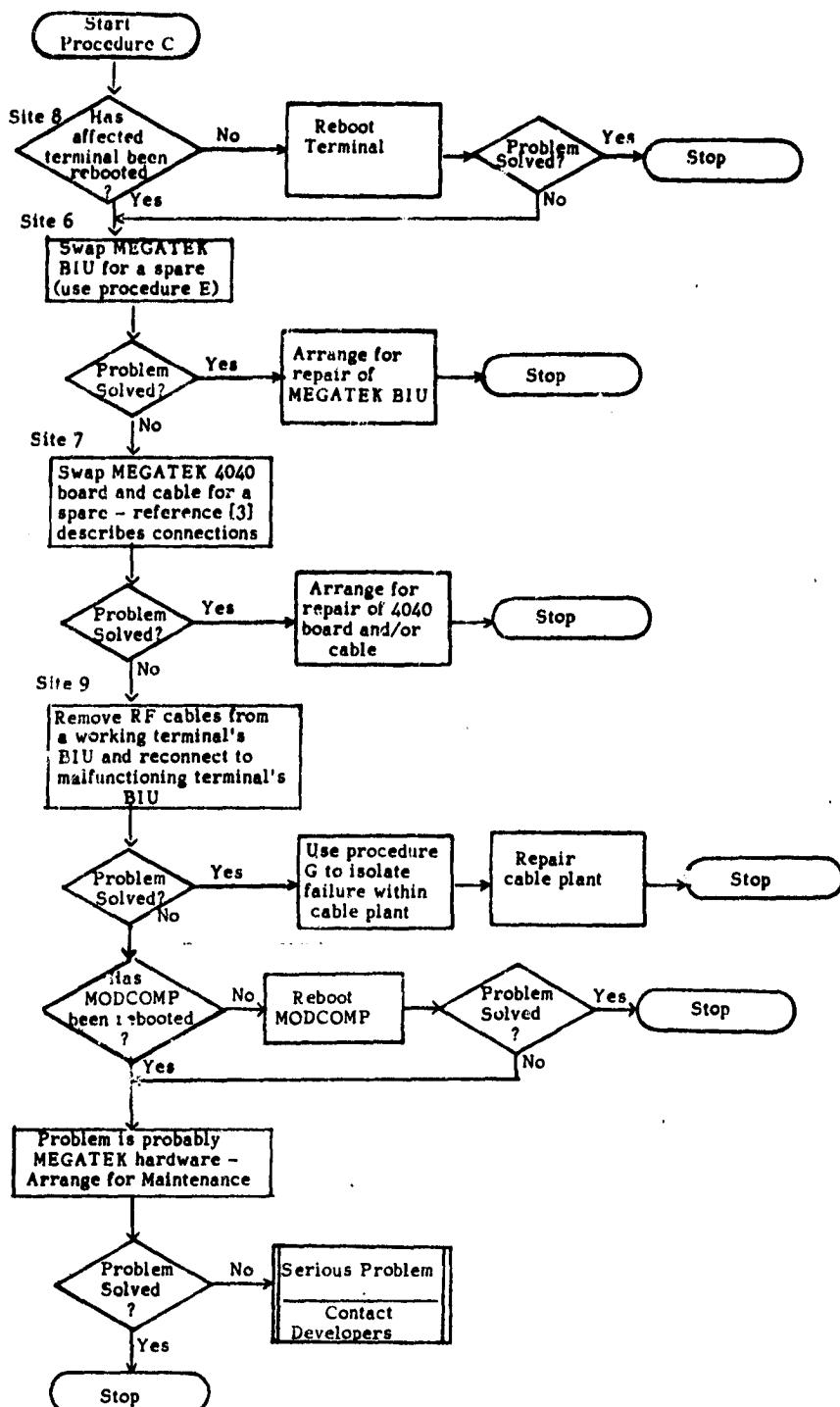
Figure 2.1.4 Diagnostic Procedure C – Eliminates Sites 6, 7, 8, and 9
(MEGATEK BIU, 4040 Board, NOVA Software and Hardware)
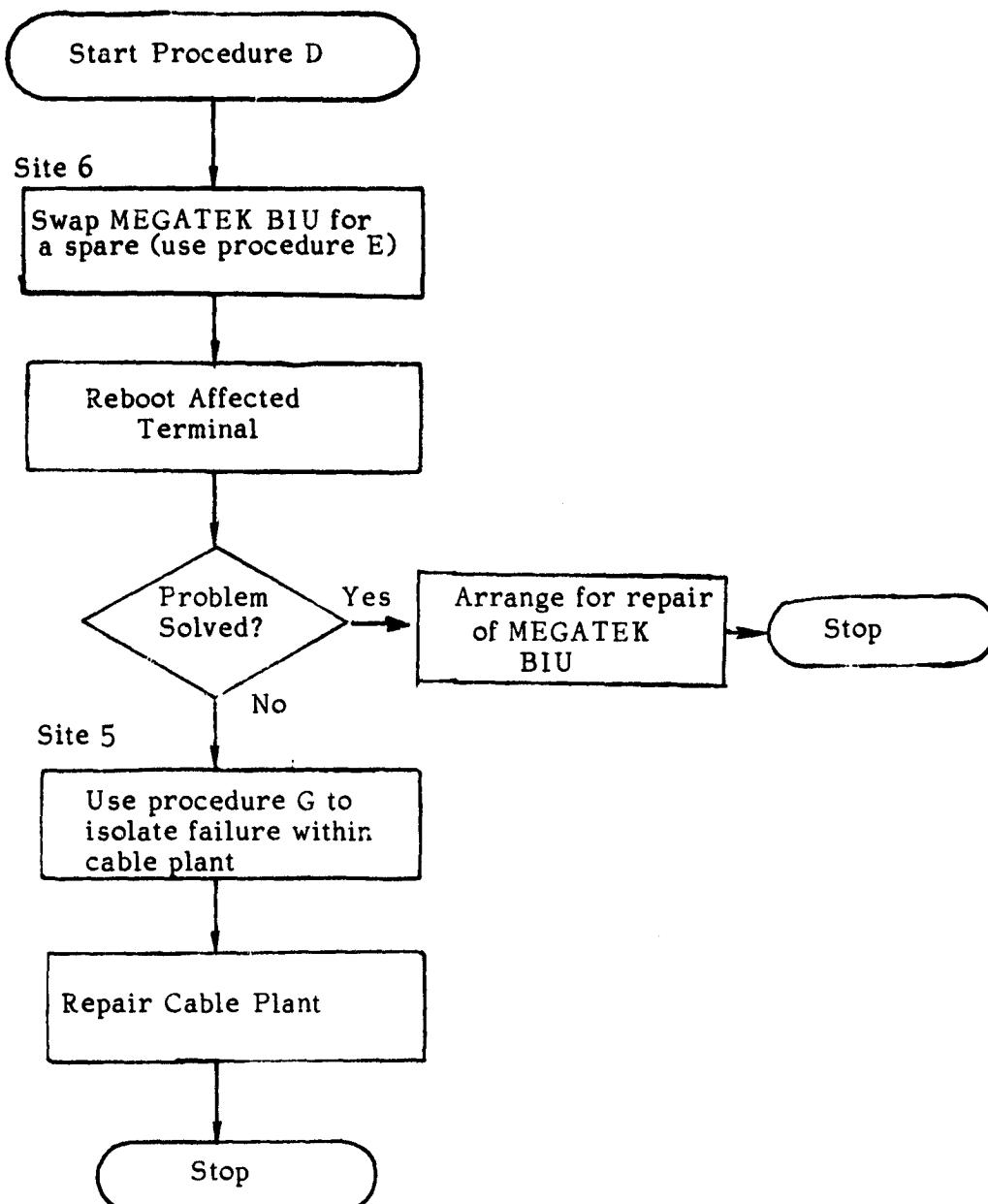
Figure 2.1-5 Diagnostic Procedure D – Eliminate Sites 5 and 6
(Cable Plant and MEGATEK BIU)

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1. Turn off power to the BIU.

2. Unplug power cord from the BIU and disconnect computer cable at the BIU.

3. Move Programmable Read-Only Memory (PROM) chips from old BIU to new BIU, if necessary. NOTE: When substituting BIUs at MEGATEKs, this step is normally not necessary.

   a. Remove top cover of BIU by taking out four attaching screws on botton of unit.

   b. The PROMs are located at board coordinates U22 and R14 (these are the locations of pin 1 of the chips). Carefully use a chip extraction tool to engage the chip and lift straight up, taking care not to bend the pins.

   c. Carefully replace each chip in its corresponding location in the new BIU. Take care not to bend the pins during insertion. The PROM labeled F800 should go at coordinate U22 and the one marked FC00 at R14. The cutout on the top of the PROM should be toward the edge connector on the digital board. When the PROMs are properly inserted, there will be one unfilled pin socket at each end of each PROM.

4. Move RF cables from old BIU to new BIU. The orange or red cable should be connected to the transmit modem (marked with a T on the back of the BIU), while the green or blue cable should be connected to the receive modem (marked with an R).

5. Connect computer cable to the new BIU and connect the power cord to the new BIU.

6. Turn on power to the new BIU.

Figure 2.1-6 Diagnostic Procedure E - Method of
Swapping BIUs

NOTE: This procedure cannot be performed during normal TMS operation.

1. Build or locate the bus test jig, which is constructed as follows:

   Two four-way multitaps (with 20 db attenuation to the tap -- Jerrold FFT-4-20 or equivalent) are connected back-to-back using a connector such as Jerrold VHH. The pass-through outputs on each tap (see Figure 2.1-8) should be terminated with 75-ohm resistive terminators (such as the combination of Jerrold VSF-59A adapter and TR-75F terminator). The arrows embossed into the tap cases should point away from each other. Designate one of the taps as the transmit tap.

2. Connect the MODCOMP BIU and the backboard diagnostic BIU to the test jig by cabling the transmit modem of each BIU to the transmit tap and the receive modem to the other tap. (Note that any TMS BIU may be used as a backboard BIU if Procedure E (Figure 2.1-6) is followed to place the backboard PROMs into the BIU.)

3. At the MODCOMP console, initiate the bus test program VOLLEY by the following steps:

   a. Get the MODCOMP's attention by typing control-A

   b. Enter /VOLLEY/E (carriage return)

4. VOLLEY will then begin to write messages to the line printer. If the message BACKBOARD IS OKAY; hh:mm:ss.ttt mm/dd/yyyy appears, the TMS problem is in the cable plant (site 5). If other messages appear, the problem is in MODCOMP hardware (site 2) which affects writing to the bus.

5. Remove the VOLLEY program by getting the MODCOMP's attention and then entering /VOLLEY/K (carriage return).

Figure 2.1-7   Diagnostic Procedure F – Distinguishes between Sites 2 and 5 (MODCOMP Hardware and Cable Plant)

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TR–75F

VSF–59A

To MODCOMP BIU
Receive Modem [1]

To Backboard BIU
Receive Modem [1]

Tap Directional Arrow

20

VHH
Connector

Multitap (FFT–4–20)

To MODCOMP BIU
Transmit Modem [1]

To Backboard BIU
Transmit Modem [1]
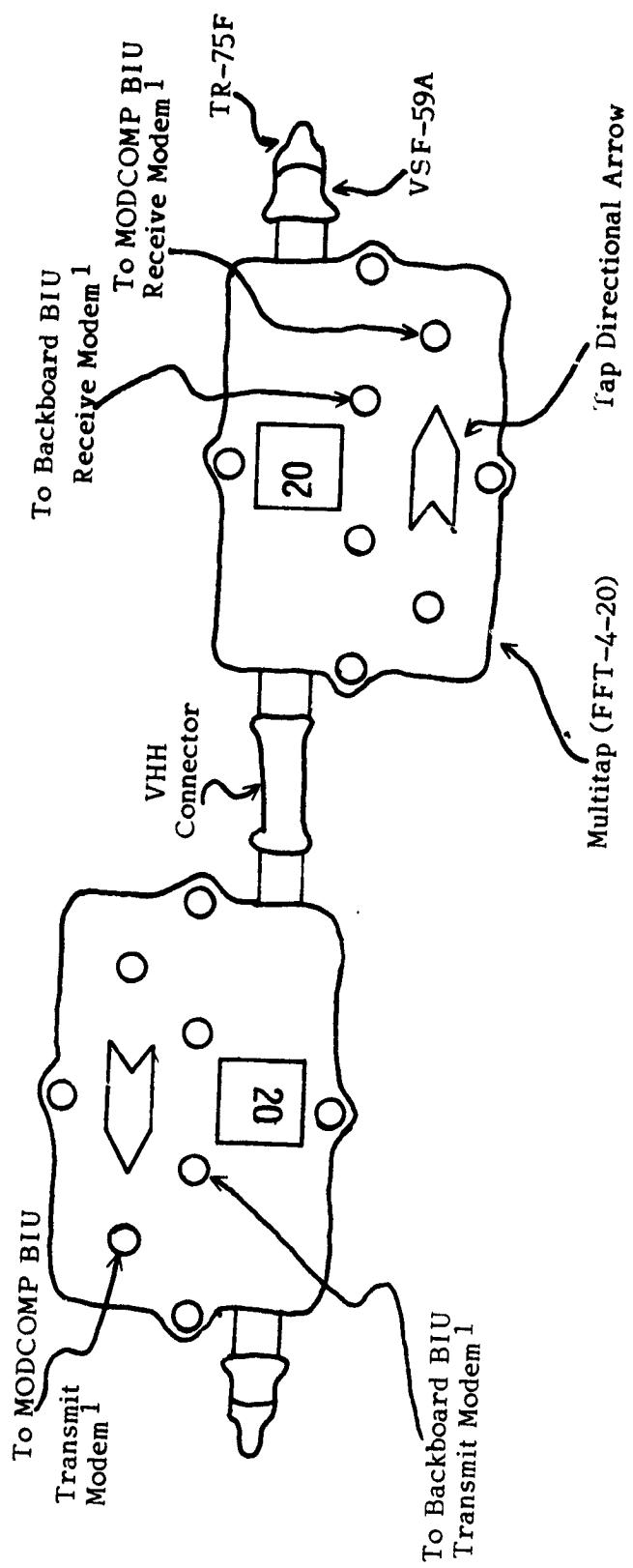
Note 1: Any of the 4 RG–59 Connections on this tap may be used.

Figure 2.1-8   Structure of Bus Test Jig

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NOTE: Steps 1 and 2 of this procedure can be performed concurrently with regular TMS work if a portion of the cable system is still operational.

1. Perform a quick check of the bus system power supply at the headend (located in one of the MODCOMP cabinets).

   a. Check that the power supply is receiving 115 VAC where it is plugged into the MODCOMP rack.

   b. Check the current in the secondary of the power supply, if the power supply in use is equipped with a meter. The current should read about 1.7 Amperes when the supply is powering the 6 line extender amplifiers used in the TMS system. If no meter is available, check the indicator light on the bottom of the supply. If the current is substantially different or if the indicator light is out, check the two fuses in the power combiner at the back of the cable system headend. Any fuse value greater than 3 A and less than 15 A may be used in the TMS, though the 3 A fuse should be used if possible.

2. Use the MODCOMP test program VOLLEY to isolate the location of cable bus failure by following the steps given below. The locations referenced in the steps are keyed to the schematic diagram of the cable system shown in Figure 2.1-10 (more information about the cable system is found in [2]).

   In each of the steps below, first connect the backboard BIU (any BIU with the diagnostic backboard PROMs in it) to the cable system at the indicated test point; the transmit cable from the backboard should go to the odd-numbered point (orange-banded cable) and the receive cable to the even-numbered point (green-banded cable). The VOLLEY program should then be run as described in steps 3, 4, and 5 of Diagnostic Procedure F (Figure 2.1-7). If the VOLLEY program

Figure 2.1-9 Diagnostic Procedure G - Isolates and Eliminates Failures within Site 5 (Cable Plant)

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is successful, the cable plant is operational between the headend and the test point being checked.

For ease in checking, conduct the tests in the following manner:

(1) Points 1 and 2 (the only taps in Building 30)

(2) If points 1 and 2 were operational, test points 11 and 12

(3) If points 11 and 12 were operational, test all points within Room 306B of Building 45

(4) If points 1 and 2 were operational, but points 11 and 12 were not operational, test all points within the utility tunnels

3. When the failed portion of the system has been isolated, bus communications should be restored by the following means.

[The portion containing the failure may include multitaps, line amplifiers, and/or directional couplers, as well as cable and connectors. Repairs of these components are discussed in the following steps.]

   NOTE: POWER TO THE CABLE SYSTEM MUST BE OFF
          BEFORE ANY OF THE FOLLOWING STEPS ARE
          TAKEN.

a. Check connections to the cable at suspected problem points. Make certain that the center conductor is firmly grasped by the set screw in all box-type components and that the braid or shield of the cable is firmly grasped by the connector.

b. If the failed component is a multitap, replace it with a spare of the same value; tap values are shown in Figure 2.1-10. Note that the shell of the tap can remain in place and only the internal portion substituted. If a tap has failed such that it affects only terminals connected to it, the tap may be left

Figure 2.1-9 (Continued)

in place and the terminals connected to another convenient set of taps. The transmit and receive cables of a terminal should normally be connected to taps in the same pair (as shown in Figure 2.1-10).

c. If the failed component is a line extender amplifier, replace the internal amplifier unit (leave the shell in place) and realign the amplifier using the procedure given in [2]. Make certain that the amplifier power tap is on the 45-60V range.

d. If the failed component is a directional coupler, replace the interior part of the directional coupler (leave the shell in place) with a coupler of the same isolation (as shown in Figure 2.1-10).

e. In the unlikely event that the failure is found to be an actual open or short in the cable itself, either the entire cable piece which has failed can be replaced, or the damaged area can be cut out and a new piece spliced in. Location of the exact point of a cable break is beyond the scope of this report, but such failures are expected to occur only at points of physical damage (cutting, etc.) to the cable. If the cable must be spliced, a box splice (such as Jerrold PBA series) should be used to facilitate later testing of the splice. In installing any new cable, make certain that connections are performed as in step a. above so that both the braid and the center conductor are electrically continuous.

Figure 2.1-9   (Concluded)

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Outbound Cable (Orange)
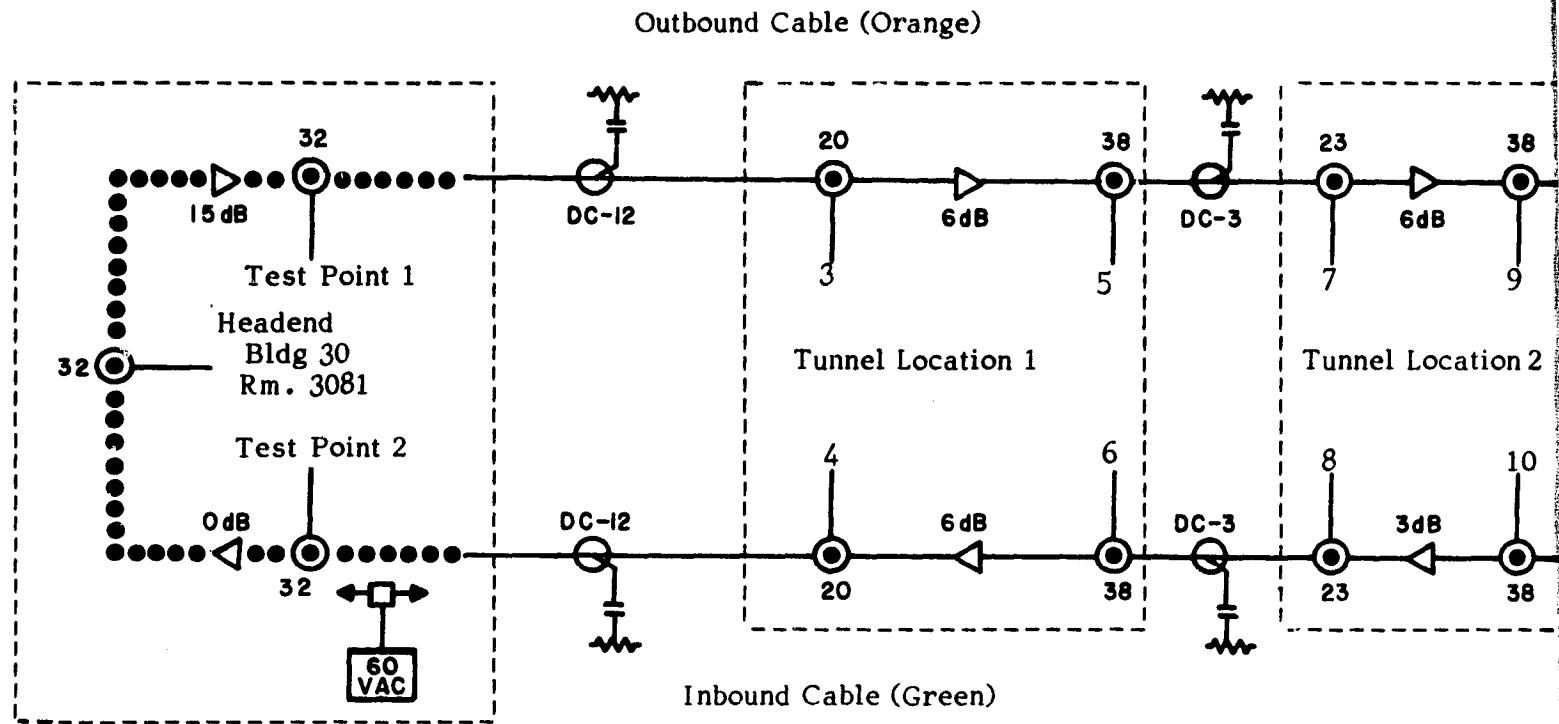
Key: Directional Coupler ─⊕─
        Amplifier ────▷─
        Multitap ◉
        Flexible Cable . . . . .

Notes:

1. Numbers beside directional
    couplers denote isolation from
    input to tap

2. Numbers beside amplifiers are
    attenuation pad values

Figure 2.1-10 TMS Cable Network Schem

6 db Attenuation Pad

23 23 23 20 20 17 17 14 7

13   15   17   19   21   23   25   27   29

Test Points

DC-3   23   6dB   38
7   9

Tunnel Location 2

Bldg
45
Rm.
321

Bldg 45 Rm. 306B

8   10

DC-3   3dB
23   38

Test Points

14   16   18   20   22   24   26   28   30

23   23   23   20   20   17   17   14   7

6 db Attenuation Pad
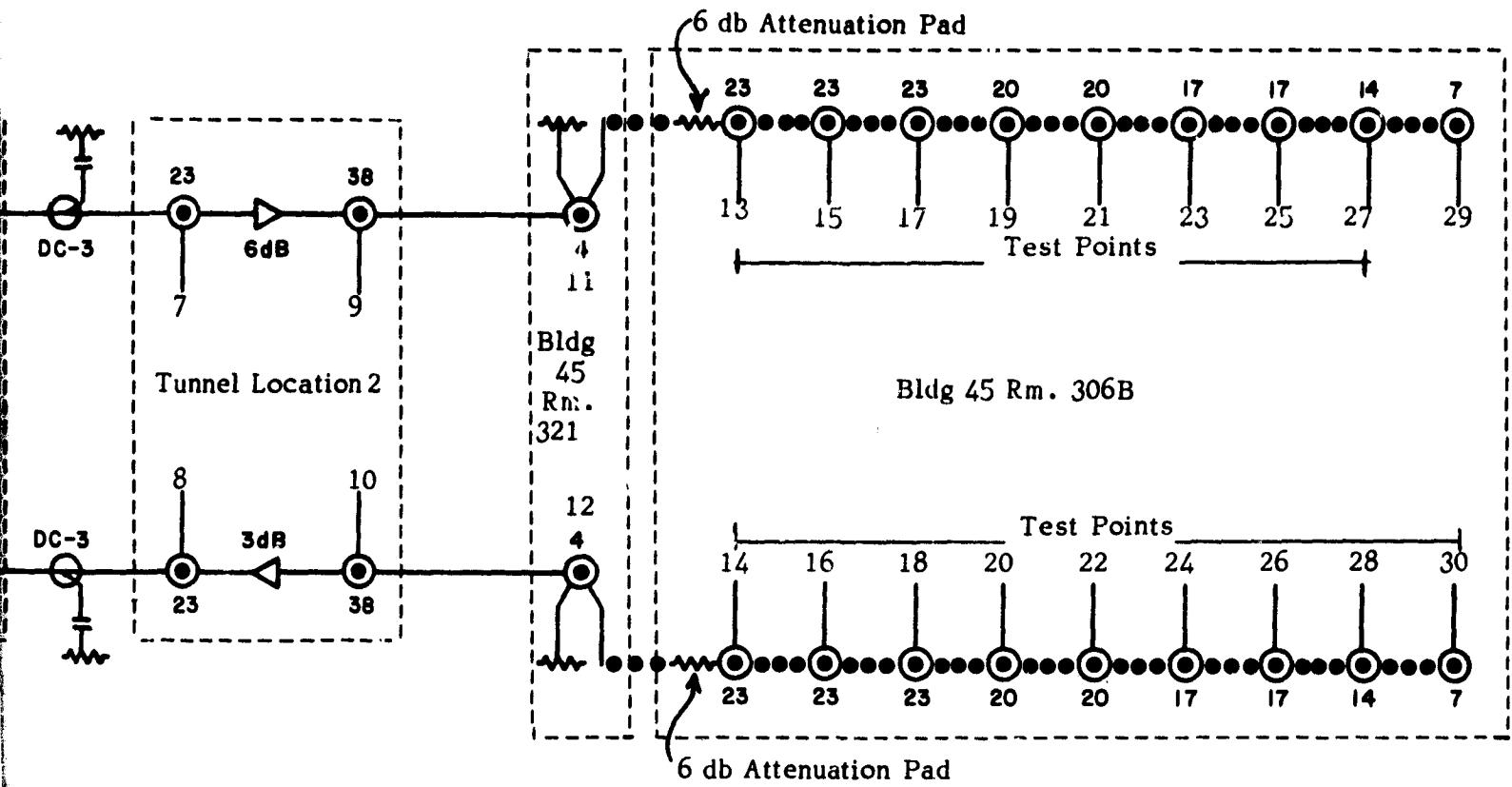
rs beside amplifiers are
ation pad values

3. Numbers beside multitaps indicate
the tap values; numbers beside
multitap drop connections are
test point numbers

0 TMS Cable Network Schematic

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SECTION III
FAULT ISOLATION WITHIN BIUs

3.0   INTRODUCTION

Repair of Bus Interface Units should ordinarily be undertaken by
qualified engineers or technicians who work from the schematic diagrams
and explanations in [4] and [11] to troubleshoot the digital logic of the BIU.
The BIU naturally falls into a modular division, however, and in many cases
simple replacement of modules provides an easy way to isolate a problem.
Operating experience has shown that the most likely components to fail in a
BIU are logic chips on the digital board, the modular power supply, and
circuitry (usually a chip) in either the modulator or the demodulator. The
remainder of this section defines several steps that may be fruitful in dealing
with BIU problems in these areas.

3.1   Diagnosis of BIU Trouble

As discussed in [4], the digital board of every TMS BIU is capable
of supporting either a parallel interface or a serial interface, but the BIU case
contains a connector for only one interface type. A BIU is termed a parallel
or a serial BIU, consequently, according to the connector on the case.
The BIU's operation is, of course, defined by the Programmable Read-Only
Memory (PROM) chips which are inserted into the digital board. Operationally,
the circuitry of the BIU falls into a portion to support the parallel interface,
a portion to support the serial interface, and a portion to support the BIU
interface to the bus network. Some types of failures affect all three operational
portions of the BIU, while others affect only one of the portions.

The testing of the network and serial portions of a BIU can be done on
the operational bus system without interfering with normal users, provided that
an additional BIU (which must be a serial BIU with PROMs to support an
asynchronous terminal) and a "dumb" terminal with RS-232 interface are
available. The second BIU should be connected to the bus system (the transmit

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modem [marked with a "T"] should be connected to the orange-labeled cable and the receive modem to the green-labeled cable), and the "dumb" terminal should be connected to the BIU's RS-232 plug. The red dual-inline-package (DIP) switch on the BIU digital board (see [4]) should be set to agree with the speed of the asynchronous serial terminal. The switch package is marked on one side with switch numbers, and on the other side with the word "open." Exactly one of the positions on the DIP switch should be depressed on the side with switch numbers; all the others should be depressed on the side marked "open." Table 3.1-I shows the correspondence between switch positions and terminal speed.

Table 3.1-I

DIP Switch Settings for Asynchronous Serial Terminals

Switch Position	Speed (Baud)
8	75
7	150
6	300
5	600
4	1200
3	2400
2	4800
1	9600

The test arrangement of the serial BIU and "dumb" terminal can be left connected to the network indefinitely (either powered on or not), if desired.

Figure 3.1-1 shows a diagnostic procedure that can be used to isolate failed portions of a BIU. It should be noted that this procedure will not identify all possible problems, but has been designed to pinpoint quickly the most probable failures.

1. Perform a quick check for power in the BIU by first checking the fuse (next to the line cord plug) and power supply output voltages.

   If the power supply connector pins are numbered from right to left when viewed from the top front of the BIU, then the following voltages should be present:

Pins	1,2	115 VAC
	3	-5 VDC
	4	-12 VDC
	5	+12 VDC
	6-8	return
	9-10	+5 VDC

2. To isolate the failed portion of the malfunctioning BIU, perform the following tests:

   a. Install the backboard PROMs in the bad BIU and connect the BIU to the bus system. Connection of the BIU and insertion of the PROMs should be done as described in Diagnostic Procedure D (Figure 2.1-5).

   b. Press the reset button on the "dumb" terminal BIU, and answer the WHICH SYSTEM? query with BAC (followed by a carriage return).

   c. If LINK ACCEPTED appears at the "dumb" terminal, type a string of 20 or so arbitrary characters (followed by a carriage return) and verify that the same string is echoed back from the backboard. If LINK ACCEPTED does not appear or this test fails, go to step e.

Figure 3.1-1

Diagnostic Procedure for a Failed BIU

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d. If this test is passed, then the most probable failure is a chip on the BIU digital board:

     (1) If the BIU is a serial BIU, the 1488, 1489, and 6850 chips are suspect.

     (2) If the BIU is a parallel BIU, the two 6522 chips are suspect.

In either case, the suspected chips should be replaced with known good chips. If the bad BIU is a parallel BIU, it should be retested with a MEGATEK (or with the MODCOMP); if it still does not work, repair attempts should be continued first by replacing other chips on the board, and then by digital logic checkout using the information in [4].

If the bad BIU is a serial BIU, it may be tested by swapping the backboard and "dumb" terminal BIUs in the test arrangement (using the procedure in Figure 2.1-6, and remember to swap the PROMs). If the bad BIU does not work then, continue to replace chips until all have been checked before beginning detailed logic checkout using [4].

e. If the bad BIU fails the backboard test of step c. above, turn off power to the BIU and substitute a known good digital board (move the backboard PROMs to the new board). Then retry the test of step c. If the test succeeds, the problem is probably a bad chip on the first digital board; chips should be replaced systematically before detailed logic checkout is begun (using information found in [4]).

f. If substituting digital boards, as in step e., does not correct the problem, substitute known good modems in the bad BIU.

Figure 3.1-1 (Continued)

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In performing this substitution, substitute modems in pairs only and make certain that the transmit modem (marked with a "T") goes into the BIU slot marked with a "T" and that the receive modem (marked with and "R") goes into the slot marked with an "R". REVERSING THE MODEM POSITIONS WILL DAMAGE THE MODEMS.

After substituting the modems, retry the test of step c. If the test succeeds, the problem lies in one of the modem boxes. Reference 10 may be used to assist in determining the exact failure.

g. If the test of step f. fails, the problem most likely lies in the BIU power supply, though possibly there could be a connection failure in the BIU chassis.

Figure 3.1-1 (Concluded)

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APPENDIX I
USING BUS STATISTICS TO DETECT INCIPIENT PROBLEMS

1.0   INTRODUCTION

Each Bus Interface Unit in the TMS emits periodic status messages onto the network; these status messages give information about successful and failed transmissions, number of received packets, and internal status information about the BIU. These messages are gathered from the network by the MODCOMP's BIU and accumulated by a part of the MODCOMP bus symbiont program described in [5].

Figure I-1 shows a typical bus statistics printout; this type of listing can be obtained by following procedure M-2 of [8]. At the top right of the printout is the time when the statistics counts were last reset; if the counts have not been reset since the last time the MODCOMP was booted, this field will show all zeros. The method of resetting the fields is also documented in procedure M-2 of [8]. Resetting the counts occasionally is desirable because when they reach 65535, they are not further incremented.

At the top right of the report are shown the time and date of the status summary. Below the date and time is a count of errors detected by the MODCOMP bus symbiont; these errors are usually generated when the MODCOMP BIU is reset or powered off and on.

Two lines appear in the status report for each BIU which has been active on the network since the last reset of the statistics accumulators. The first line shows the contents of the last status message emitted by a BIU, while the second line gives a running total of the count fields. The first column of the report shows the network address (2 bytes) of a BIU; on the TMS system the addresses 0200 (TMS MODCOMP), 0100 (STCS MODCOMP), BB00 (backboard diagnostic BIU), and 3x00 (terminals, where x is the terminal number) appear.

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MITRENET STATUS SUMMARY
16:52:35, 4/19/1979

ACCUMULATORS LAST RESET AT 16:45:48, 4/19/1979

SYMBIONT BUS ERROR COUNT = 0

DEVICE ADDRESS	GOOD XMITS	MISSING ACKS	COLLISIONS	LOST PKTS	GOOD RCVS	NOISY RCVS	CHOKED RCVS	LINE BUSY	QUEUES STATUS	UARTS STATUS	OTHER STATUS	TIME OF LAST UPDATE	
3100	1	0	0	0	0	0	0	0	0	600	1002	16:51:44.19	MEO 04/12/79
3100	189	3	1	0	7133	3	0	525	0	600	1002	(CUMULATIVE)	
200	0	0	0	0	1	0	0	0	0	600	1031	16:51:43.42	MOD 03/07/79
200	14113	340	2	0	1112	2	630	19	0	600	1031	(CUMULATIVE)	

**** END OF REPORT ****
$$

Figure I-1 Typical Bus Statistics Printout

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The "GOOD XMITS" column shows the number of successful trans-missions by a BIU, while "MISSING ACKS" indicates the number of times that the BIU transmitted a message but did not receive a correct acknowledgement. "COLLISIONS" counts the number of times that the BIU began transmitting at the same time that another BIU began to transmit.

"LOST PKTS" shows how many network packets were discarded by the BIU because the recipient failed to acknowledge the packet k times, where k is the maximum number of retries. "GOOD RCVS" indicates how many packets have been successfully received, while "NOISY RCVS" shows how many packets have been received with a bad longitudinal parity. "CHOKED RCVS" counts the number of time that a packet arrived for the BIU, but the BIU's buffers were all full and the BIU responded with an "I'm Full" acknowledgement. "LINE BUSY" tells the number of times that the BIU found the network in use when the BIU wanted to transmit a packet.

The "QUEUES STATUS," "UARTS STATUS," and "OTHER STATUS" gives status words for various internal aspects of the BIU. The "TIME OF LAST UPDATE" shows the time stamp (added by the MODCOMP) when the last status message was received; BIUs in the TMS system emit status messages once each minute. At the right of the time of update is a 12-character field identifying the PROM being used in the BIU.

I.1   Warning Indicators in the Status Report

In the vast majority of the time, the communications system will operate properly and the counts of missing acknowledgements, collisions, lost packets, noisy receives, choked receives, and line busy will be small. Certain conditions, however, can cause one or more of these counts to increase, and may indicate an imminent failure. Table I.1-I shows several of the status report fields, together with screening criteria and an indication of what may possibly be wrong. It should be remembered, of course, that certain "normal" causes can produce the same types of indications; for example, powering off one BIU in a conversation will cause the other BIU

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to report many missing acknowledgements and lost packets. The table should thus be used to help explain abnormal figures only when no obvious explanations are knows.

Table I.1-I

INDICATIONS FROM ABNORMAL STATISTICS REPORT FIELDS

Indication	Possible Problem
Missing acknowledgements are more than 5% of good transmissions or lost packets are more than about 0.01% of good transmissions	May indicate failing modem in the BIU or in another BIU, or powered-off or unavailable recipient BIU
Excessive line busy for one terminal (highest figure is more than twice next lowest figure)	May indicate malfunctioning receive modem
Choked receives more than about than about 1% of good receives	May indicate a problem between the BIU and its subscriber computer or terminal
Noisy receives greater than about 1% of good receives	May indicate unexplained noise on the network, possibly from improper or loose shielding on the RF drop cables
Status message older than about 3 minutes before time of status report	May indicate malfunctioning BIU

APPENDIX II
LOGIC DIAGRAM AND LISTING OF VOLLEY TEST PROGRAM
USED IN DIAGNOSTIC PROCEDURE F

The following diagram shows the logic flow of the program VOLLEY. Conventions used in this type of chart are described in [12].

```
┌──────────────────────────────────────────────────────────────────────────┐
│  INITIALIZE AND WRITE START-UP MESSAGE                                     │
├──────────────────────────────────────────────────────────────────────────┤
│  DO FOREVER                                                                │
│   ┌────────────────────────────────────────────────────────────────────┐  │
│   │  CLEAR USER FILE TABLE STATUS                                       │  │
│   ├────────────────────────────────────────────────────────────────────┤  │
│   │  SELECT OUTPUT MESSAGE                                              │  │
│   ├────────────────────────────────────────────────────────────────────┤  │
│   │  ISSUE QUICK-RETURN READ                                           │  │
│   ├────────────────────────────────────────────────────────────────────┤  │
│   │  ISSUE QUICK RETURN WRITE OF MESSAGE                               │  │
│   ├────────────────────────────────────────────────────────────────────┤  │
│   │  DELAY 400 TICKS  (2 OR 4 SECONDS, DEPENDING ON MODCOMP            │  │
│   │                         SYSGEN)                                     │  │
│   ├────────────────────────────────────────────────────────────────────┤  │
│   │  Y \   WRITE COMPLETED?                                       / N   │  │
│   ├───────────────────────────────────────────────┬────────────────────┤  │
│   │  Y \  READ COMPLETED?                 / N      │  TERMINATE         │  │
│   │                                                │  READ AND WRITE    │  │
│   ├──────────────────────────────┬────────────────┤                    │  │
│   │  Y \ WAS CORRECT ECHO /  N    │  TERMINATE     │                    │  │
│   │        RECEIVED               │  READ          │  OUTPUT ERROR      │  │
│   │                               │                │  MESSAGE           │  │
│   ├─────────────┬────────────────┼────────────────┤                    │  │
│   │  OUTPUT     │  OUTPUT         │  OUTPUT        │                    │  │
│   │  SUCCESS    │  ERROR          │  ERROR         │                    │  │
│   │  MESSAGE    │  MESSAGE        │  MESSAGE       │                    │  │
│   └─────────────┴────────────────┴────────────────┴────────────────────┘  │
└──────────────────────────────────────────────────────────────────────────┘
```
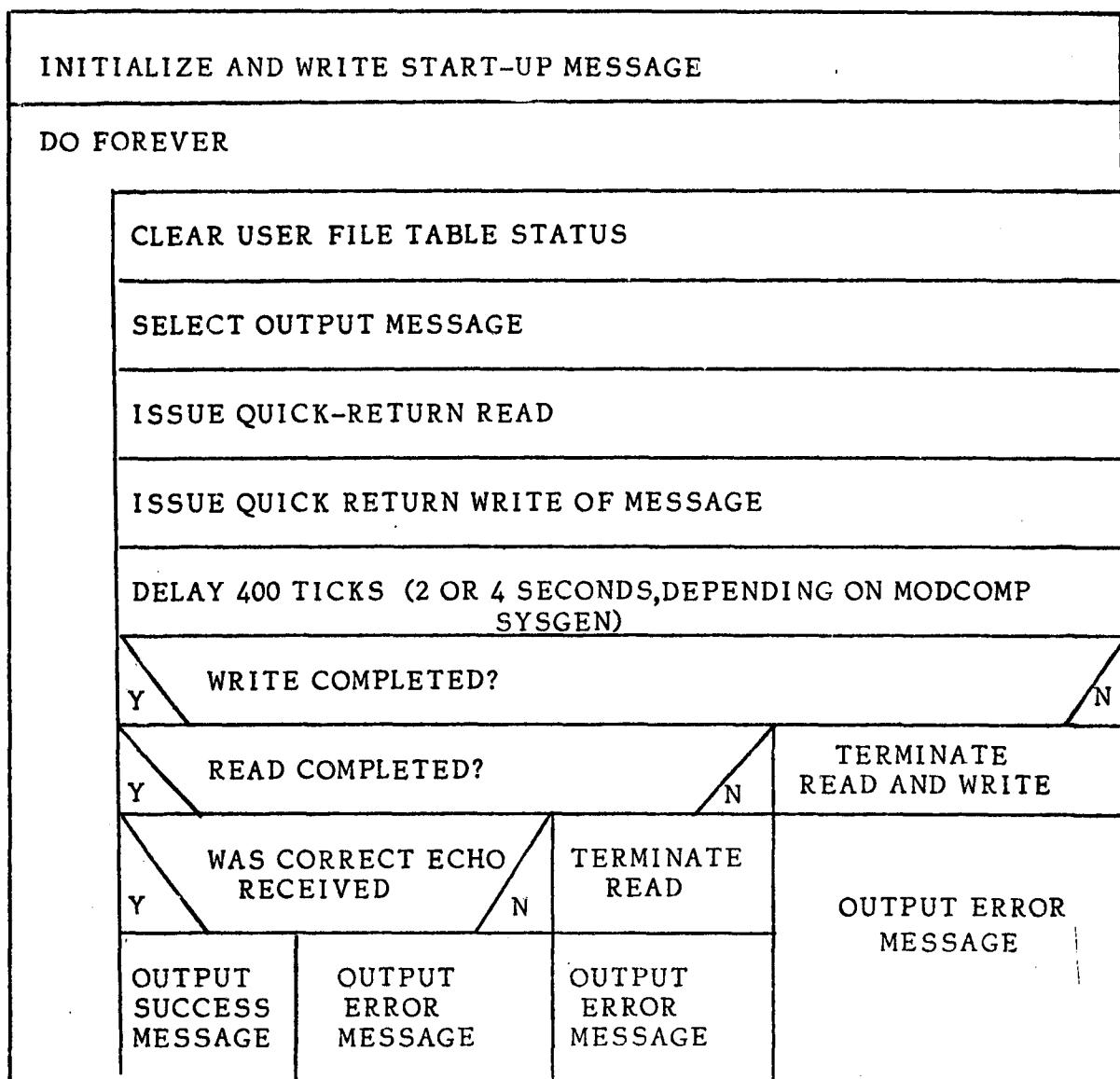
```
  1  C THIS IS THE 'VOLLEY' TEST PROGRAM.
  2  C
  3  C ITS PURPOSE IS TO TEST REGULARLY TO SEE WHETHER THE BACKBOARD
  4  C BIU CAN BE DETECTED ON THE BUS.
  5  C IT IS INTENDED TO AID IN FINDING FAULTS IN THE CABLE NETWORK.
  6  C IF ANY OTHER PROGRAM IS ACCESSING THE BACKBOARD FROM THE
  7  C MODCOMP CONCURRENTLY WITH THIS ONE, RESULTS ARE UNPREDICTABLE.
  8  C
  9  C THIS PROGRAM IS INTENDED TO BE CATALOGED AS A STAND-ALONE TASK,
 10  C AS DISTINCT FROM A BATCH OVERLAY. THIS IS BECAUSE THIS PROGRAM
 11  C NEVER TERMINATES VOLUNTARILY, AND MUST ALWAYS BE ABORTED BY THE
 12  C SYSTEM OPERATOR. MODCOMP PROVIDES NO FACILITY TO CANCEL RUNAWAY
 13  C BATCH TASKS FROM THE BATCH INPUT FILE.
 14  C
 15  C HERE IS HOW TO INVOKE THE PROGRAM:
 16  C          GO TO THE OPERATOR'S CONSOLE AND STRIKE CONTROL-'A',
 17  C          TYPE IN :  /VOLLEY/E,,TM
 18  C          THEN STRIKE CARRIAGE RETURN.
 19  C THEREAFTER, THIS PROGRAM WILL AT REGULAR INTERVALS EMIT A MESSAGE
 20  C (TWO BYTES LONG) TO THE BACKBOARD (FILE 'NOB') AND WAIT FOR A REPLY.
 21  C IF THE REPLY TAKES LONGER THAN 400 TICKS (EITHER TWO OR FOUR
 22  C SECONDS, DEPENDING ON SYSGEN OPTIONS), THE PROGRAM STOPS WAITING.
 23  C WHETHER THERE IS ANY REPLY OR NOT, THE PROGRAM REPORTS ON THE
 24  C 'DO' FILE EVERY 400 TICKS IF THERE WAS A REPLY TO THE LAST
 25  C MESSAGE, AND TRIES AGAIN TO TALK TO THE BACKBOARD.
 26  C THE COMMAND TO KILL THIS PROGRAM IS:   /VOLLEY/K
 27  C
 28  C
 29  C THE CODE FOLLOWS:
 30  C
 31              INTEGER*2 OUFT(8),IUFT(8),OUTBUF,INBUF,TIME(8)
 32  C                     OUFT IS THE OUTPUT UFT
 33  C                     IUFT IS THE INPUT UFT
 34  C                     OUTBUF IS THE MESSAGE EMITTED TO THE BACKBOARD
 35  C                     INBUF IS THE LAST THING GOTTEN FROM THE BACKBOARD
 36  C                     TIME IS AN ARRAY USED TO GET T.O.D. FOR LOGGING
 37              DATA IUFT/0,4Z59DA,4Z9000,3*0,4ZC000,0/
 38  C                     THE INPUT UFT SPECIFIES:
 39  C                     USE FILE 'NOB'
 40  C                     MAKE THE SYSTEM RECOVER FROM ERROS
 41  C                        (WHICH REALLY MEANS KILL THIS TASK IF ERRORS)
 42  C                     USE BINARY-MODE OPERATIONS
 43  C                     DO A QUICK RETURN FROM THE READ CALL
 44  C                     FIND THE BUFFER SIZE AND ADDRESS IN THE READ CALL
 45              DATA OUFT/0,4Z59DA,4Z9000,3*0,4ZC000,0/
 46  C                     THE OUTPUT UFT SPECIFIES:
 47  C                     USE FILE 'NOB'
 48  C                     SYSTEM RECOVERY FROM ERRORS
 49  C                     BINARY-MODE
 50  C                     QUICK-RETURN
 51  C                     THE BUFFER ADDRESS AND SIZE IS IN THE WRITE CALL
 52  C
 53              CALL INTLEN(.FALSE.)
 54  C                     (USE INTEGER*2 ARGUMENTS IN UTILITY CALLS)
 55              CALL TIMDT4(TIME,IC,0)
 56  C                     (GET THE PRESENT TIME AND DATE)
 57              WRITE(3,10)(TIME(I),I=1,7)
 58  10          FORMAT('1VOLLEY IS ACTIVE, ',I2,':',I2,':',I2,'.',I3,
 59        -     X,I2,'/',I2,'/',I4)
 60              OUTBUF=0
```

```
   61  C                      (PICK A MESSAGE TO SEND TO THE BACKBOARD)
   62  20          IUFT(1)=0
   63  C                      TOP OF THE MAIN LOOP
   64  C                      (CLEAN UP AFTER ANY ERRORS)
   65              OUFT(1)=0
   66  C                      (DITTO)
   67              OUTBUF=OUTBUF+1
   68  C                      (CHANGE OUTPUT MESSAGE FOR VARIETY)
   69              CALL READ4(IUFT(1),INBUF,2,.FALSE.)
   70  C                      (QUICK-RETURN READ)
   71              CALL WRITE4(OUFT(1),OUTBUF,2,.FALSE.)
   72  C                      (QUICK-RETURN WRITE)
   73              CALL TIMDT4(TIME,IC,0)
   74  C                      (REMEMBER WHEN THE WRITE HAPPENED)
   75              CALL DELAY(0,400,.FALSE.,.FALSE.,IC)
   76  C                      (WAIT A DECENT INTERVAL FOR RESPONSE)
   77              IF(OUFT(1).NE.2*(OUFT(1)/2))GO TO 400
   78  C                      (JUMP IF WRITE NOT YET COMPLETED (]) )
   79              IF(IUFT(1).NE.2*(IUFT(1)/2))GO TO 300
   80  C                      (JUMP IF UFT BUSY BIT STILL SET, I.E.,
   81  C                       IF READ NOT YET SATISFIED)
   82  C                      (IF WE FALL THROUGH, THE READ IS DONE)
   83              IF(OUTBUF.NE.INBUF)GO TO 200
   84  C                      (IF WRONG STUFF RECEIVED, JUMP)
   85  C                      (IF WE FALL THROUGH HERE, EVERYTHING IS COOL)
   86              WRITE(3,110)(TIME(I),I=1,7)
   87  110         FORMAT(' BACKBOARD IS OKAY;  ',I2,':',I2,':',I2,'.',I3,
   88     -        X,I2,'/',I2,'/',I4)
   89              GO TO 20
   90  C                      (ITERATE)
   91  200         WRITE(3,210)(TIME(I),I=1,7)
   92  210         FORMAT(' REPLY IS GARBLED;  ',I2,':',I2,':',I2,'.',I3,
   93     -        X,I2,'/',I2,'/',I4)
   94              GO TO 20
   95  C                      (ITERATE)
   96  300         CALL TERMIN8(IUFT)
   97  C                      (BLOT OUT THE OUTSTANDING READ)
   98              WRITE(3,310)(TIME(I),I=1,7)
   99  310         FORMAT(' BACKBOARD DOES NOT REPLY;  ',I2,':',I2,':',I2,'.',I3,
  100     -        X,I2,'/',I2,'/',I4)
  101              GO TO 20
  102  C                      (ITERATE)
  103  400         CALL TERMIN8(OUFT)
  104  C                      (CLEAN UP FAILED WRITE)
  105              CALL TERMIN8(IUFT)
  106  C                      (CLEAN UP AFTER READ, REGARDLESS OF RESULT)
  107              WRITE(3,410)(TIME(I),I=1,7)
  108  410         FORMAT(' WRITE FAILED - BACKBOARD STATE UNKNOWN;  ',
  109     -        I2,':',I2,':',I2,'.',I3,X,I2,'/',I2,'/',I4)
  110  C                      IF WE EVER GET HERE, THE PROBLEMS ARE ON THE
  111  C                      MODCOMP SIDE OF THE CABLE PLANT, IN THE BIU, THE
  112  C                      SYMBIONT, OR THE MODCOMP HARDWARE.
  113              GO TO 20
  114  C                      (ITERATE)
  115              END
```

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