

# **WINDOWS AT A TRACKING SITE**

**Ronald G. Streich and Charles R. Townsend**

Computer Sciences Corporation

P.O. Box 446

Edwards AFB, CA 93536

## **KEY WORDS**

Tracking Site Status, Tracking Site Control, Tracking Site Testing

## **ABSTRACT**

Rapid setup and verification of 4 automatic tracking antennas, 2 radio frequency switch matrixes, 32 telemetry receivers with 16 diversity combiners, an intermediate frequency switch matrix and the signal distribution equipment interface to the analog and digital fiber optic relay systems was required. This paper provides sample displays of the station status window, telemetry receiver and test parameter dialog boxes, mission event log window and test result windows for bit error rate, noise power ratio, solar calibration and antenna servo tests. Use of the software is apparent from sample displays so the text concentrates on lessons learned from site surveys, verification of configuration against mission files, accommodation of change of plug-in modules (e.g., IF filters in the telemetry receiver), tolerance of equipment removed from the system for maintenance, built-in test of serial and parallel communications and modular software design for replacement of equipment.

## **INTRODUCTION**

A typical flight test mission lasts about 1 1/2 hours with a tracker assigned to each aircraft. During the short winter days the flight schedule may slow to only 7 to 10 missions per day while long summer days may have 20 to 30 missions. Turnaround time between missions is usually dependent only on the tracking site, data center and mission control center reconfiguration time since the aircraft flight line facilities have their own telemetry preflight test systems. Computer assisted setup and verification was the only way to support the flight schedule.

Site visits were made to White Sands Missile Range (WSMR), Pacific Missile Test Center(PMTC) and the Western Space and Missile Center (WSMC) to review the

similar systems in use at other test ranges. Ideas were adopted from each of the ranges. Recent papers on those test range systems are listed in the references. The willingness of the engineers at each location to share the lessons they had learned saved us much effort.

One primary stimulus for computer assisted control was the single line, abbreviated character displays and key pads on the switching matrixes and other microprocessor based equipment. Operating procedures, checklists and mission logs containing preoperation verification test results had grown inordinately large. Operations personnel attended the site surveys with Air Force engineers, Systems Applications International Corporation (SAIC) systems advisory and technical assistance contract engineers and us (the technical services contractor engineers) to define the requirements in terms of replacing existing procedures and forms. After the site surveys the Air Force directed preparation of a system specification and prototype screens by the SAIC engineers. Operations personnel have been active as project team members in every phase from prototype screen development through the many stepwise refinements made to develop the final program. With the system specification completed the implementation was then assigned to us.

Since our engineers had experience building this type of system at previous work locations, we knew that testing is more complex than setup and status monitoring of the operational in-line equipment. Therefore, the project was scheduled in two phases - (1) computer assisted setup and status monitoring of the operational equipment as the primary goal and (2) computer assisted testing and logging. The difference in complexity between the two phases is apparent from the sample displays. Acceptance testing of the Phase One program was completed eight months after start of the project. Phase Two required an additional sixteen months including minor expansion of the requirements. Implementation was accomplished by two software engineers dedicated to this project. The WSMR servo test result displays in color graphics are outstanding and we have followed their example.

## **THE OPERATOR INTERFACE**

The graphical user interface as shown in the sample displays is a strong departure from the old text based screens that required some operator proficiency in typing and memorization of commands. The entire tracking station can be set up using only a mouse. This is accomplished using the Common User Access definitions (menu bars, popup windows, dialog boxes, check boxes, option buttons, edit boxes, list boxes, scrollbars, etc.). This type of display is in use in many different systems such as engineering work stations, nearly all modem PCM decommutator systems, voice

switching systems, etc. They appear similar to an operator whether the operating system is Windows, Presentation Manager, Open Look, Motif or other trade name.

The main program runs on a 486 based Pc compatible computer with a VGA display. An eight port RS-232 card in the computer is connected by eight serial data cables to IEEE-488 bus controllers mounted in the telemetry receiver equipment bays and the switch matrix bays. A typical bay contains four telemetry receivers and two diversity combiners plus one bus controller. In this way, the slow devices on the IEEE-488 bus do not slow each other by contention for the bus. The RS-232 serial ports in the computer each have individual transmit and receive buffers for simultaneous operation but they have not been required due to the slow IEEE-488 communications. For example, a telemetry receiver requires about 250 milliseconds to change configuration or send a complete status message. All the test equipment is in two adjacent bays and is connected to a single IEEE-488 controller card in the computer. This computer is designated as the Telemetry Analyst computer because it is located in a triple low bay console containing monitor oscilloscopes and a spectrum analyzer as well as communications panels to the antenna consoles and mission control.

Each of the four antenna consoles also contains a 486 based computer with a VGA display. This allows each of the antenna operators to make mission logs in real-time or to test between operations. The five computers will soon be connected by a Local Area Network (LAN) but no plans have been made to use the LAN other than to allow all the computers to share the laser printer attached to the analyst computer.

## **STATION SETUP AND STATUS MONITORING**

Figure 1 shows the main status and control window. The same display is used for status monitoring, editing mission files, setup of equipment and selection of equipment for test. The display is site specific to display which receiver groups (two telemetry receivers and a diversity combiner) are connected to which of the four autotrack antennas. Any or all receiver groups may be connected to any antenna output in any combination because non-blocking radio frequency (RF) switch matrixes are used. Non-blocking means any input can be connected to any or all outputs. The antennas are listed in the top four rows with the receiver groups listed in the columns. Clicking on one of the boxes, as in a spread sheet layout, causes the antenna output to connect to the corresponding receiver input when setup is selected from the Edit menu.

The radio frequency, the intermediate frequency (IF) bandwidth and the video bandwidth of each connected or selected receiver group are displayed in its spread sheet box. The background color of the box matches the color of the frequency band.

Light green represents 1435 to 1535 MHz; dark green represents 1750 to 1850 MHz; light blue represents 2200 to 2300; and dark blue represents 2300 to 2400 MHz. The colors are not necessary but they make differentiation between groups of equipment easier. In particular, the combined 10 MHz output of each diversity combiner is connected to a baseband transmission system through an IF switch matrix displayed on the lower half of the screen.

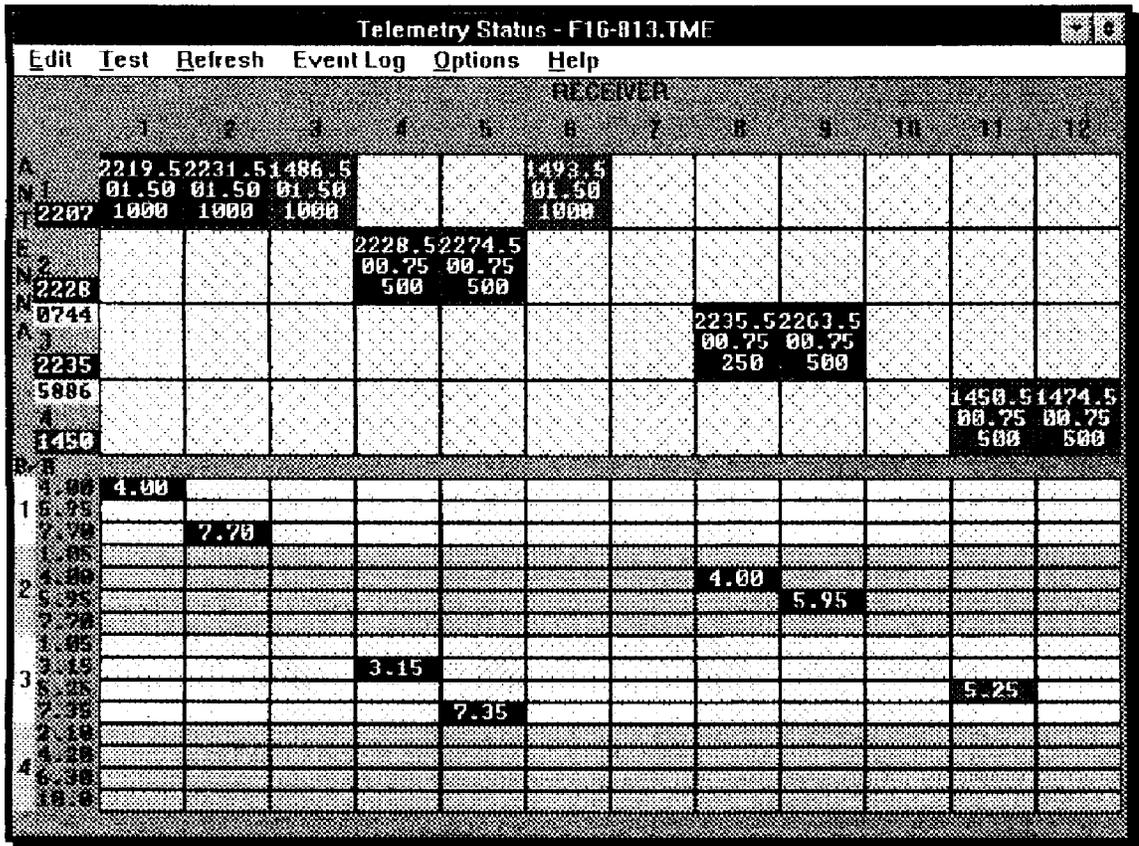


Figure 1 - Status Window

Clicking on a receiver group box opens the corresponding receiver dialog box and associated test parameter dialog box as shown in Figure 2. If the box was clicked while in the status mode then the status of the equipment is shown. If the Edit mode was selected from the menu, stored files may be displayed and edited or the operator can develop a new configuration then store it on disk or setup the equipment. The preoperation test configuration and test parameters are usually selected at the same time but they can be added at any time.

The TEST mode is entered from the status display window. Again, the main display has not changed. However, the area outside the spread sheets has turned red to notify the operator that he can now radiate test signals on the mission frequencies. The selection of menu items has changed to allow the operator to select Bit error rate

(BER), noise power ratio (NPR), preoperation or solar calibration testing. Selection of the equipment to be tested is made by clicking on the receiver group box(es). The BER, NPR, Preop or Solar menu item is then selected to initiate the test. Sample windows with data are shown in Figures 3 through 6 for each of these tests.

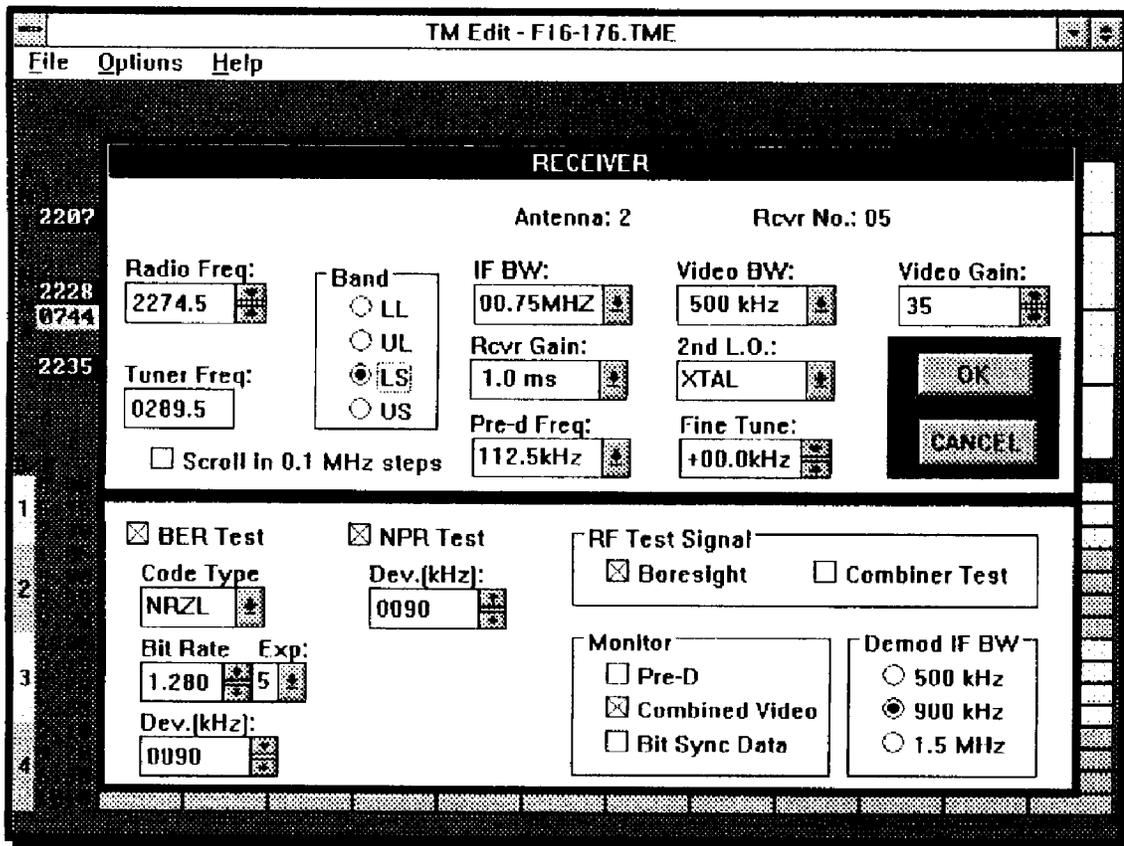


Figure 2 - Edit Window with Receiver Dialog Box Open

The Event Log window is selected from the status display menu ( see Figure 7). It is normally used on one of the antenna computers. The antenna servo test program is run only on the antenna computers that are connected directly to the antenna control unit via an IEEE-488 interface. Nine sets of tests as listed in Figure 8 can be performed. The results of the Tracking Error Gradient and Antenna Patterns are plotted on the screen or on the laser printer. The remaining results are in test or tabular form.

## CONCLUSIONS

The computer assisted control, status monitoring and testing of the tracking site equipment has been readily accepted by the operators. The main advantages of the software have been in reducing setup and test times while providing hard copy configuration sheets and test results. The visual displays were quickly learned and

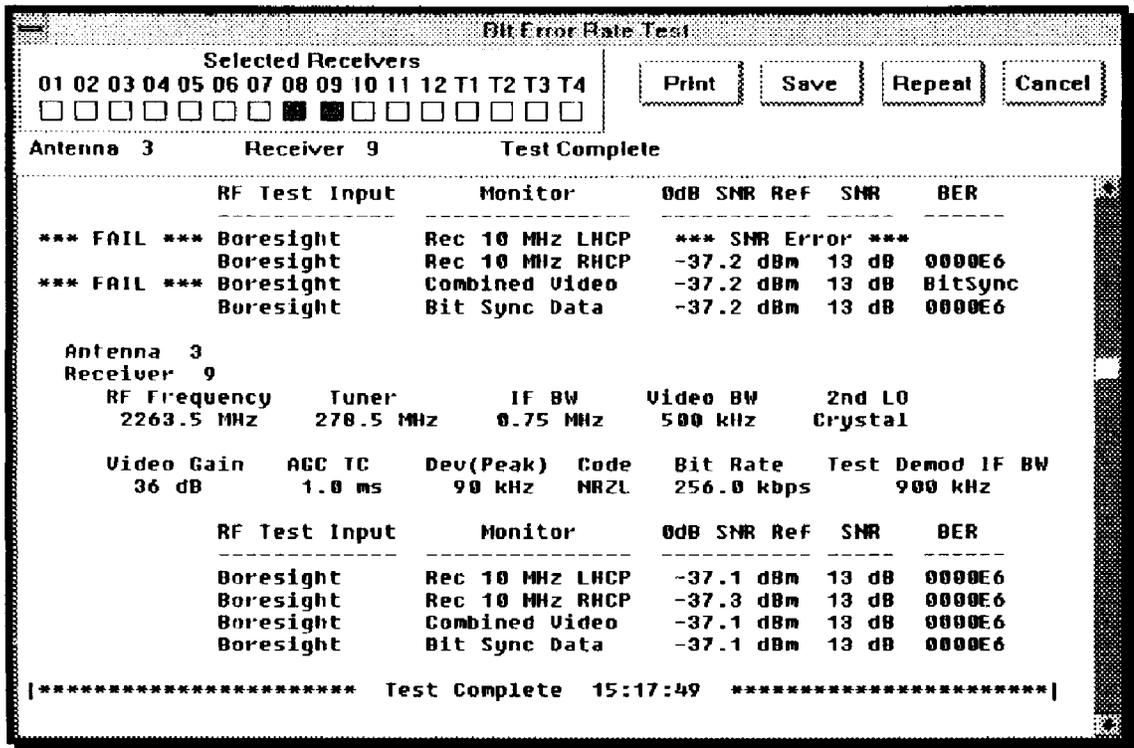


Figure 3 - Bit Error Rate Test

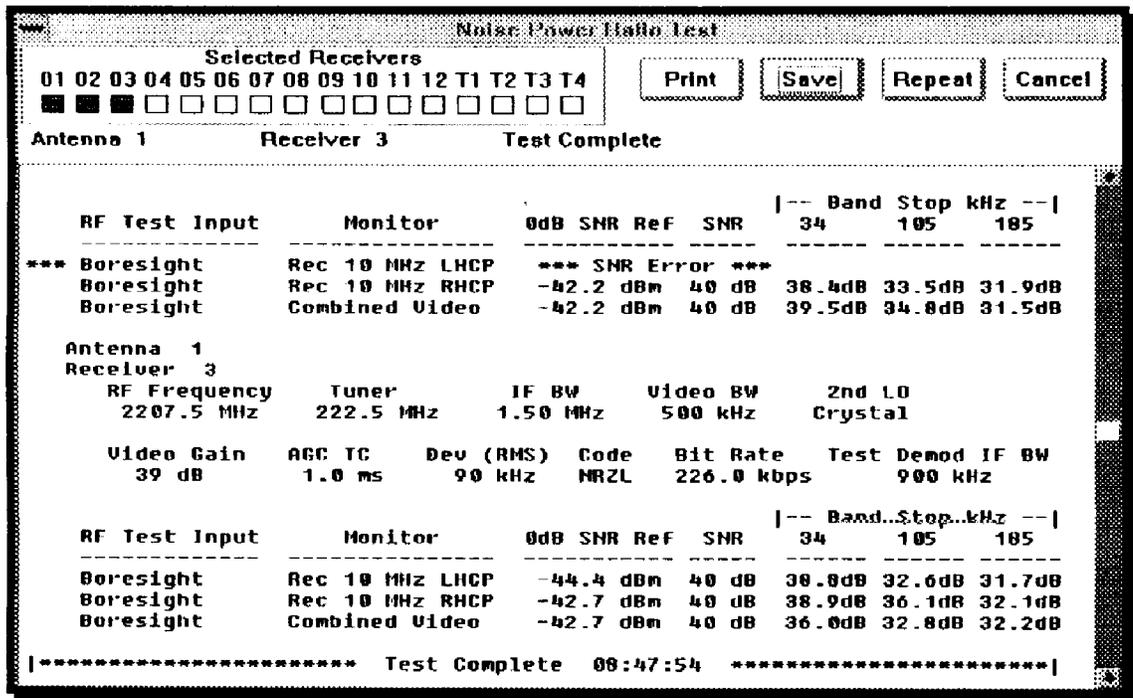


Figure 4 - Noise Power Ratio Test

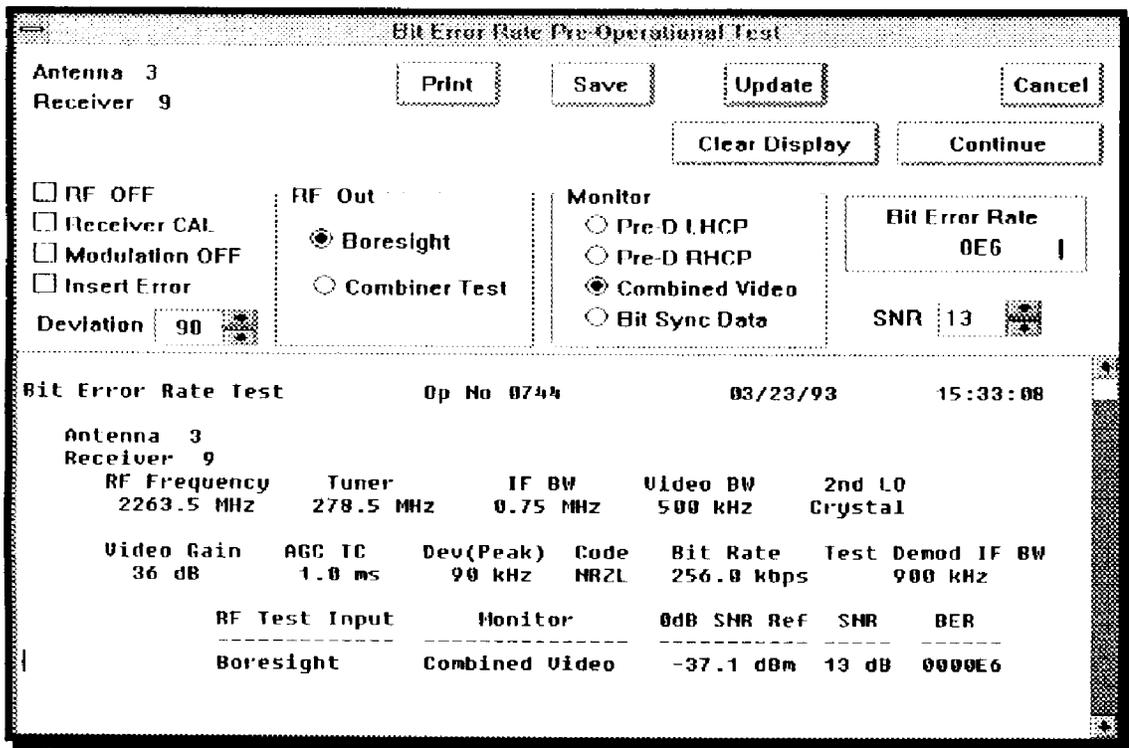


Figure 5 - Preop Bit Error Rate Test

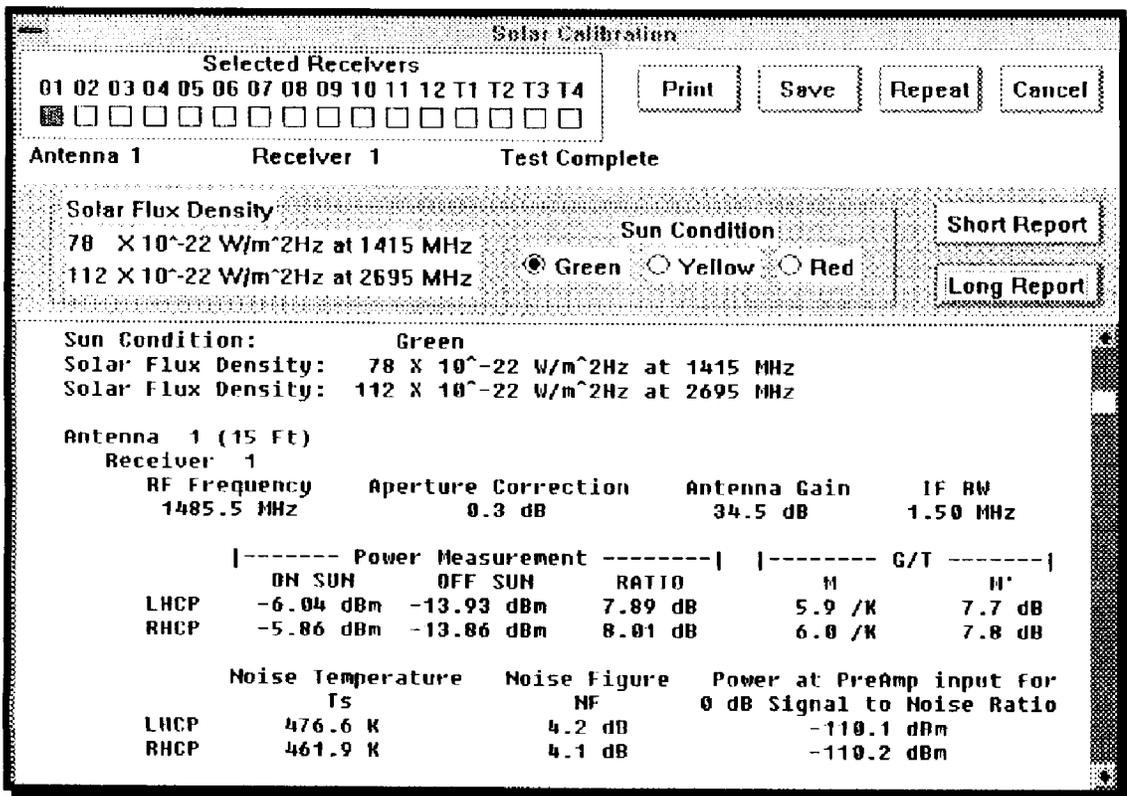


Figure 6 - Solar Calibration

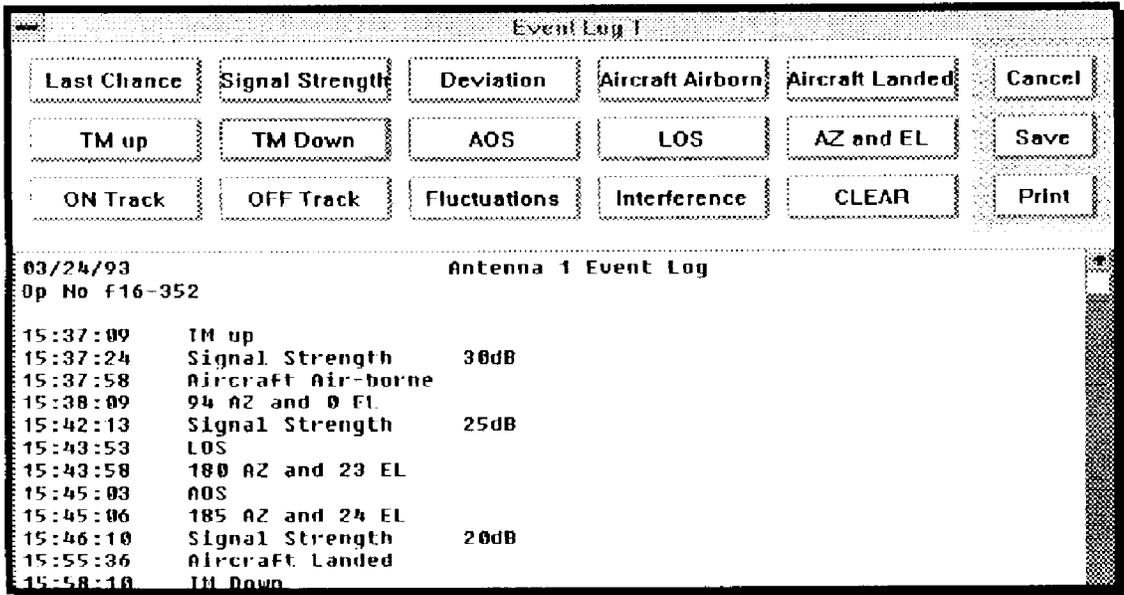


Figure 7 - Event Log

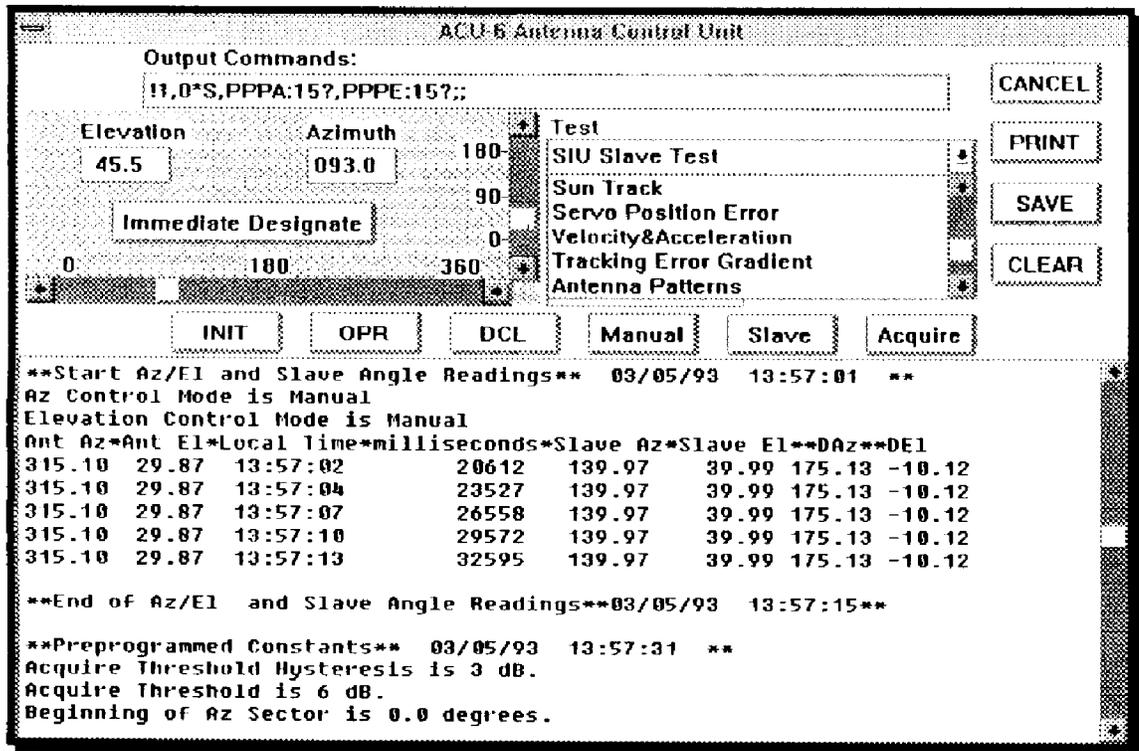


Figure 8 - Antenna Servo Test

offer a single point for quick look capability of entire station status. Checking function and driver return calls and the validity of all input and output is required for reliability. Displaying the corresponding probable error source when checks are not confirmed provides excellent diagnostics. These diagnostics pinpoint even the most minor

problems such as equipment not turned on or change of front panel controls. Displaying intermediate test measurements, such as power meter readings during signal to noise ratio measurements or solar calibrations, as a selectable option provides an excellent maintenance tool.

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