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Landsat 7 Ground Station (LGS)

System Users Guide

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Systems Users Guide

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Preface

This Systems Users Guide outlines the software structure and capabilities to effectively sustain operations on the Landsat 7 Ground Station (LGS).

This Systems Users Guide is controlled by the Landsat 7 (L7) Project Configuration Control Board (CCB) and may be updated by document change notice (DCN) and/or revision procedures in effect on the LGS Project. Comments and questions regarding this plan should be directed to:

Change History

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Chapter 1. Introduction

1.1 Purpose

The Landsat 7 Ground Station (LGS) Systems Users Guide (SUG) provides the information necessary for the Operations, Maintenance, and Engineering team located at EROS Data Center (EDC) to operate and maintain the Landsat 7 Ground Station equipment.

This document provides instructions for operating the Landsat 7 Ground Station (LGS). It covers the following topics:

- An Overview and theory of operation of the LGS Hardware/Software
- Startup, Login and Shutdown of various LGS Hardware/Software
- Navigating the LGS Monitor and Control Subsystem GUI (MCS)
- Navigating the Tracking Data Formatter (TDF)
- Navigating the Post Telemetry Processor (PTP)
- Monitoring the LGS
- Contingency Operations
- LGS Utilities

1.2 Organization

This document contains the following chapters and appendixes:

- Chapter 1, *Introduction*, provides an introduction to this document and an overview and theory of operation of the LGS
- Chapter 2, *Getting Started*, provides instructions for logging onto the various LGS subsystems (MCS, PTP, TDF, GSC), starting and stopping the MCS software, starting and stopping the PTP software, starting and stopping the TDF software, and starting and stopping the GSC software.
- Chapter 3, *Monitoring Operations*, provides instructions for monitoring operations and possible operator involvement during idle periods, during prepass activities, pass activities, and post pass activities. This chapter also provides a high level overview of the automation software to enable the user to have insight into the activities which occur during a pass.
- Chapter 4, *Contingency Operations*, provides instructions for setting up the system if specific components within the LGS have failed.

- Chapter 5, *Report Generation*, provides instructions for generating LGS reports.
- Chapter 6, *LGS Maintenance*, provides instructions for using the tools and status available to help diagnose problems when and if problems do occur.
- Chapter 7, *LGS GUI Reference*, describes the various Graphical User Interfaces and capabilities for the LGS. A screen heirarchy is provided with window names and screen names outlined.
- Appendix A, *LGS Alarm Conditions*, provides an overview of the LGS Alarm Conditions.

1.3 LGS Overview

This section summarizes the LGS mission, system automation capabilities, operator duties and periodic maintenance required to support the Landsat 7 mission.

1.3.1 LGS Mission

The Landsat 7 Ground Station (LGS) located at the EROS Data Center (EDC) in Sioux Falls, SD. provides a means for the capture and recovery of Landsat 7 spacecraft Enhanced Thematic Mapper-Plus (ETM+) image data, for processing through the Landsat 7 Processing System (LPS), also located at the EDC facility. The LGS captures up to three simultaneous X-Band (wideband) downlinks to support Landsat 7 image data recovery, and supports record and playback of the data in addition to real time output of the data to LPS. Wideband data processing includes the playback of ETM+ data, recorded at other ground stations, using the LGS wideband recorders to play the data back into the LPS.

In addition to the X-Band downlinks, LGS supports spacecraft command and telemetry processing by the capture and recovery of narrowband real-time telemetry and spacecraft recorder dump data. The narrowband link is captured at S-Band, and the recovered data streams sent to users at the Mission Operations Center (MOC) located at GSFC. In the event of data loss between LGS and the MOC, the LGS provides a recording of the recovered real-time and recorder dump data that is available for post pass playback. LGS also provides narrowband S-Band uplink support for commanding the Landsat 7 spacecraft remotely from the MOC. Lastly, the LGS measures the S-Band doppler track characteristics for each pass and sends the results to the MOC to support the refinement of Landsat 7 orbital ephemeris.

1.3.2 LGS Automation Capabilities

The LGS hardware and software implementation includes extensive automation capabilities designed to support automated system configuration and processing of the spacecraft data. This capability supports the operator and the LGS mission by minimizing operator errors that would otherwise occur in a non-automated station.

Automated processing begins with contact schedules received from the MOC, consisting of a schedule of future spacecraft passes and associated X-Band and S-Band track support requests. The MOC also sends up-to-date Landsat 7 ephemeris for modeling the orbit of the spacecraft for programmed antenna tracks.

The LGS interprets the schedule and ephemeris data from the MOC and follows timetables for automatically configuring the equipment to ensure that it is ready for mission support when required. The LGS is prepared to automatically track the spacecraft and to provide its data products to end users with minimal operator intervention.

During a spacecraft pass, the LGS supports automated wideband data connections to the LPS. S-Band data connections to and from the MOC are automatically established to support spacecraft command and telemetry requirements. S-Band Telemetry data is recorded at LGS for post pass playback. The recorded telemetry data may be sent to the MOC when requested, however, the post pass playback of data is a manual operation. During the pass, S-Band tracking data is collected automatically and at the end of the pass is sent to the MOC.

The LGS logs wideband link demod lock samples every second and formats the results into a contact status report. At the end of the pass, the contact status report is automatically sent to the MOC. Equipment health is monitored continuously and a report is generated and sent to the MOC whenever a change in equipment status would affect mission support. The equipment status report is always sent at the beginning of the pass in addition to those times when the report is generated due to a change of equipment health.

1.3.3 LGS Operator Duties

The LGS Operator oversees the functioning of LGS by monitoring status indications and performing intervention whenever the system fails to perform its intended function. The LGS automatically sets up the ground station for spacecraft support and tracks the spacecraft while providing status indications as the equipment is being configured and during the spacecraft track. The automation timetable for the display of status events is aligned to the scheduled pass Acquisition of Signal (AOS) and Loss of Signal (LOS) times.

The Monitor and Control System (MCS) workstation provides the primary Operator interface to the LGS. In the time prior to and during a scheduled pass, the MCS reports on key automation actions being performed, and will indicate when actions have failed through alarms. The MCS provides visual and audible alarming for alerting the Operator to a problem. The Operator must acknowledge the alarm and must have a remedy to the problem to ensure that no mission data is lost.

The status displayed at the MCS may warrant further investigation at a particular piece of equipment indicating an alarm condition. Knowledge of the status indications and the workings of each piece of equipment help the Operator to isolate faults and remedy the problem. Once the problem has been identified, an annotation to the equipment status

report should be made to communicate the condition of the LGS equipment to MOC personnel.

Some tasks that LGS supports are not automated and the operator must perform those tasks manually. The processing of ETM+ data from other ground stations is one example. For this instance the Operator plays pre-recorded tapes into the LPS by using the wideband recorders in playback mode. Other manual Operator tasks include the recording of wideband data and the post-pass playback of automatically recorded S-Band telemetry data.

The primary end product of the LGS is the data it produces. To ensure the quality of the data, LGS Operators are expected to perform routine checkouts of their systems, to certify that they are working properly. The LGS includes testing and simulation capabilities that allow the Operator to manually configure the system and exercise almost every component of the system.

1.3.4 LGS Maintenance

LGS maintenance procedures should be performed periodically to verify operational readiness of the LGS. Verification of the X-Band system and the S-Band system are performed independently. To support the verification of the LGS, both the X-Band and the S-Band systems include downlink simulation capability, effectively exercising all parts of the system.

System verification for either X-Band or S-Band is performed during pre-pass test procedures that specify the flow of simulated telemetry or BER PN data through the LGS. Observations of how the system processes the data during these tests tell the LGS Operator how the system performs at the time of measurement. A history of measurements collected over a long period establish a baseline for comparing the data collected during subsequent pre-pass test procedures and for forming a determination of system performance degradation.

LGS Maintenance procedures must include periodic calibrations to be performed on the various hardware components of the LGS. Each hardware component has a corresponding vendor supplied manual that provides details of the units' maintenance, in addition to the units' maintenance schedule.

1.4 LGS Theory of Operation

This section describes how the LGS hardware and software components function as a system to provide the required automated spacecraft tracking functions, data capture and processing functions that are expected of the LGS. Refer to the LGS Block Diagram for details of the LGS system connections, in support of the descriptions that follow.

1.4.1 LGS X-Band (Wideband) Data Reception Signal Flow

The LGS receives up to two X-Band downlink channels at the 10-m antenna feed located at the cassegrain-focus. Right and left hand circularly polarized signals are separated by the antennas X-Band hybrid polarizer. Right and left hand polarizations leave the

polarizer and enter into a waveguide switch providing polarization selection. The waveguide switch allows swapping of right and left hand polarizations at its two output ports. Each switch output is routed through a test inject coupler and into an LNA. One LNA serves a primary support role, the second LNA serves as a backup to the first. The two LNA outputs route to a switch for selection of the primary/backup LNA. The selected LNA output passes through a divider to supply the Antennas X-Band TRACK Receiver signal and to supply a DATA signal for the X-Band Downconverters.

The TRACK signal to the Track Downconverter and Tracking Receiver is used within the antenna subsystem to develop antenna control signals during autotrack. The DEU accepts AM and AGC signals from the Track Receiver and develops control signals to drive the antennas AZ, EL and Third Axis Servo Amplifiers and point the antenna at the spacecraft during a pass.

The X-Band RF, DATA signal is amplified by a line driver prior to the 4 way power divider and X-Band Downconverters. The Antenna subsystem ends at the line driver output feeding into the 4 way power divider. For additional information on the antenna subsystem refer to the Datron/Transco Inc. Antenna Manual.

Each wideband data channel of the X-Band RF consists of Asynchronous Quadrature Phase Shift Keyed (AQPSK) modulated carrier, with signal content occupying a 130MHz bandwidth. Any one of the three Downconverters translate a selected wideband channels' RF signal spectrum to a 375 MHz Intermediate Frequency (IF). The channel selection is controlled by generation of an appropriate Local Oscillator (LO) frequency back at the LGS Operations area. The Downconverter function is to translate to a lower frequency, the selected channel RF by a frequency difference equal to a multiple of the LO frequency that is input to the Downconverter. After downconversion, the IF signals are amplified and sent through a 900 foot cable run to the LGS Operations area.

LO generation at the LGS Operations area begins in Downconverter Reference Generators 1 through 3 (Marconi Signal Generators). Each LO signal passes through the Converter Status Unit (SCU) before it leaves the Operations area on its way to the Antenna pedestal. The Converter Status Unit senses a DC signal level added to the LO signal (AC component) by the Downconverter, as a means for relaying Downconverter health status. If the LO cable run suffers a disconnection between the SCU and Downconverter, the SCU will sense this as an error also.

IF signals are received at the IF Distribution Unit where the signals are processed to equalize the frequency dependant loss characteristics of the 900 foot cable run. The IF Distribution Unit also provides a patch panel (not shown on the drawing) for routing to the Demodulators and for test points. After equalization, the IF signals are distributed to the wideband demodulators for recovery of AQPSK baseband I and Q data. The Demodulator outputs are composed of separate I and Q baseband data streams, each stream containing data at 74.914 MBit/s.

Two Bit Synchronizer / Signal Conditioners (BSSC) process the I and Q baseband streams from the Demodulator producing two synchronized data and clock streams each

at 74.914MBit/s. The Matrix Switch connects any of the six clock/data streams from the Bit Synchronizers to any of five LPS inputs, or to either of the two Wideband Recorders.

Lock status of the Demodulators and of the Bit Synchronizers is logged by the MCS once per second during a pass. The Lock status is formatted into a Contact Status Report and the contents of this report indicate where data dropouts may have occurred during the pass. At the end of the pass, the Contact Status Report is closed and sent to the MOC.

For additional information on the X-Band RF/Telemetry Recovery Hardware, refer to the Scientific Atlanta System Reference and the chassis-level manuals. The Scientific Atlanta Equipment begins at the X-Band Downconverters located at the Antenna pedestal and ends at the Matrix Switch input in the Operations area.

1.4.2 LGS X-Band BER Test Signal Flow

The LGS provides signal simulation capability to verify the data recovery performance of the X-Band RF hardware. Signal simulation begins in the Operations area with the Anritsu PN Data Generator that feeds into the Test Modulator. The Data Generator produces psedorandom bit sequences suitable for measurement of system BER using the companion Anritsu PN Data Receiver. A Marconi Signal Generator supplies the 150MHz clock to the Data Generator.

The Test Modulator outputs a AQPSK modulated carrier with signal content occupying a bandwidth of 150MHz, centered at the 375MHz IF (bandwidth between 1st nulls). The output of the Test Modulator is adjustable over a 45dB range in 1 dB steps for investigating link performance as a function of power level. The signal path from the Test Modulator to the Distribution Unit includes a bandpass filter to simulate the spacecrafts Triplexer AQPSK channel width. Note that the simulated wideband channel width is less than the bandwidth from the Test Modulator. LGS link margins have anticipated the implementation loss introduced as a result of the channel filtering by the spacecraft.

The 375MHz Test channel IF is pre-compensated within the IF Distribution Unit, prior to its 900 foot trip to the Antenna pedestal. The pre-compensation equalizes the frequency dependent cable loss over that distance.

Within the Converter Unit located at the Antenna pedestal, the 375MHz Test IF is upconverted to any one of the three X-Band channel frequencies. The Upconverter function is to translate to a higher frequency, the 375 MHz Test IF by a frequency difference equal to a multiple of the LO frequency that is input to the Upconverter.

Generation of the LO frequency and its related X-Band channel frequency begins at the LGS Operations area in the Test Inject Reference Generator (Marconi Signal Generator). The Upconverter LO signal passes through the Converter Status Unit (SCU) before it leaves the Operations area on its way to the Antenna pedestal. The Converter Status Unit senses a DC signal level added to the LO signal (AC component) by the Upconverter, as a means for relaying Upconverter health status. If the LO cable run suffers a disconnection between the SCU and Downconverter, the SCU will sense this as an error also.

To complete the X-Band test path, the X-Band Test signal from the Upconverter is input to the Test Inject Port of the Antenna Subsystem. The Test signal level is boosted through an amplifier, and a controllable noise source is coupled to the Test inject path. The Test signal is split in a power divider, and then coupled into the two LNA inputs. Hereafter, the X-Band system processes the injected signals in the same manner as it would a spacecraft downlink.

The noise source may be enabled or disabled during measurements and when enabled, provides a more stable noise level as opposed to that obtained from antenna background noise. This feature may be used to remove some of the variability in antenna test measurements that would otherwise occur without use of the noise source.

After the Test signal is processed through the X-Band system, the recovered I or Q data stream and clock out of the Bit Synchronizer is routed to the Anritsu Data Receiver, via the Matrix Switch. The Data Receiver compares the received PN sequence against what was originally transmitted by its companion instrument (Anritsu Data Generator). The Data Receiver displays BER statistics for the link.

1.4.3 LGS S-Band Data Reception Signal Flow

The LGS receives the spacecraft's 2287.5MHz S-Band downlink signal at the 10-m antenna feed located at the prime-focus. The antenna S-Band hybrid polarizer separates Left and right hand circularly polarized signals. Each polarization is routed through its own diplexer for isolation of the command uplink signal from the downlink. Each isolated downlink routes through a test inject coupler and some waveguide switches that select prime or backup LNAs. Each selected LNA output passes through dividers to supply the Antennas Tracking Receiver signal and to supply a signal for the telemetry receivers located in the LGS operations area. The S-Band RF paths to the Tracking Receivers is used within the antenna subsystem to develop antenna control signals during autotrack. The antenna subsystem ends at a line driver input that boosts the signal level at the antenna pedestal prior to the cable run that ends in the LGS operations area where the telemetry receivers are located. For additional information on the antenna subsystem refer to the Datron/Transco Inc. Antenna Manual.

The S-Band Telemetry Receiver subsystem includes a Diversity Combiner providing a combined 20 MHz IF signal. The combined IF is the sum of the right and left hand IF signals from the 700-MR Receivers, added in proportion to the relative AGC levels from each Receiver. The combined 20 MHz IF is PM demodulated and the recovered signal, composed of baseband playback telemetry and realtime modulated subcarrier, is sent to the Programmable Telemetry Processor (PTP) for data recovery.

The PTP recovers the two telemetry data streams from the PM demodulated, composite Baseband/subcarrier signal from the Telemetry Receiver subsystem. The recovered spacecraft recorder dump data stream (playback) and the realtime telemetry data stream are formed into IPDU packets and sent to the MOC over an IP network interface.

1.4.4 LGS S-Band Carrier Doppler Measurement Signal Flow

During a spacecraft track, the downlink carrier frequency will have a doppler component added to it as a result of the motion of the spacecraft relative to LGS. The LGS S-Band Telemetry Receivers lock onto and track the carrier, using PM Demodulators built into each Receiver. As the doppler component causes the downlink carrier frequency to change, the Telemetry Receivers track the change by development of an internal LO frequency that acts to center the downconverted S-Band carrier in the center of the Receivers' IF passband. A translated version of this internal LO frequency is output by the Receivers for doppler extraction.

The Telemetry Receiver Subsystem outputs 180 MHz LO signals from each 700-MR Receiver including a frequency offset identical to the S-Band frequency offset added as a result of doppler. The doppler component may be one way (Landsat 7 to LGS) or it may be two way (LGS to Landsat 7 to LGS) as indicated by non-coherent or coherent S-Band Tracking modes, respectively. The 180 MHz LO signals are sent to the Carrier Doppler Measurement System (CDMS) for doppler signal extraction. The measured doppler component is sampled and recorded into Universal Tracking Data File (UTDF) format and sent to the MOC via ftp over the IP network.

1.4.5 LGS S-Band Data Transmission Signal Flow

The LGS transmits spacecraft commands on a modulated S-Band carrier at 2106.4063MHz. Command data arrives at the PTP over the IP network interface from the MOC. The PTP BPSK modulates the command data onto a 1.024 MHz subcarrier and echoes the command data back to the MOC for transmit verification. The TSS-2000 exciter/modulator PM modulates the 2106.4063MHz S-Band carrier with the modulated subcarrier from the PTP.

The S-Band output from the TSS-2000 leaves the operations area and routes through a cable run to the antenna pedestal. A RF switch located at the pedestal provides the option of routing the S-Band RF through the S-Band test inject port of the antenna to support loop back test capability. For normal operations, the switch is configured so the S-Band RF routes through a line driver, to boost the power to levels appropriate for HPA excitation, and into the antennas RF transmit port. The antennas S-Band Test Inject port and the RF Transmit port represent the dividing line between the Antenna Subsystem and the rest of LGS.

Within the Antenna Subsystem, the S-Band RF is amplified by the 200-Watt HPA, routed through a dummy load coax switch, converted from coax to waveguide, and carried through waveguide to a switch feeding the left and right hand diplexers. The switch feeding the diplexers selects the command uplink right or left hand polarization. The dummy load switch allows the amplified RF to be directed into a high wattage load to prevent antenna radiation if so desired.

Each diplexer isolates the uplink RF path from the downlink RF. The composite of uplink and downlink RF flows through the hybrid polarizer, and the uplink component is transmitted to the spacecraft. For additional information on the transmission signal flow at the antenna, refer to the Datron antenna and chassis manuals.

1.4.6 LGS S-Band Downlink Simulation and BER Test Signal Flow

The LGS provides signal simulation capability to verify the data recovery performance of the S-Band RF hardware. The S-Band system supports two methods for generating downlink test data streams including downlink telemetry data simulation or BER data generation. Downlink telemetry data simulation uses recorded Landsat 7 spacecraft data as a data source for constructing an S-Band Test signal. The other option is to exercise the S-Band system with framed PN data for collection of system BER performance data. In either case, signal simulation begins in the Operations area at the PTP.

The PTP generates two simulation streams; the first simulates the 256KBit/s baseband spacecraft recorder dump channel and the second simulates the 1.024MHz, BPSK modulated subcarrier containing spacecraft realtime telemetry. The two simulation streams are scaled and summed in the Modulation Amplifier, and the result is input to the S-Band Exciter to PM modulate an S-Band carrier.

Whenever the downlink is exercised for these tests, the Exciter must be used to support the test configuration and provide the S-Band RF for the downlink. For this reason, the command uplink through the Exciter and PA is not active for either of these tests. The PTP does support command uplink testing, however, none of the command data leaves the PTP subsystem during testing.

The Modulation Amplifier and Exciter are adjusted so that the modulation indices of the simulated downlink match those of the Landsat 7 spacecraft. In addition the Exciter's S-Band carrier frequency is set to 2287.5MHz to match Landsat 7. The modulated S-Band signal leaves the Operations area for the Antenna pedestal and runs through the coax switch that gates the uplink path to the Antenna S-Band Test Inject Port.

Within the Antenna Subsystem, the S-Band Test signal level is boosted through an amplifier, and a controllable noise source is coupled to the Test inject path. The Test signal is split in a power divider, and then coupled into the two LNA inputs. Hereafter, the S-Band system processes the injected signals in the same manner as it would a spacecraft downlink.

The noise source may be enabled or disabled during measurements and when enabled, provides a more stable noise level as opposed to that obtained from antenna background noise. This feature may be used to remove some of the variability in antenna test measurements that would otherwise occur without use of the noise source.

After the Test signal is processed through the S-Band system, the recovered baseband 256KBit/s and Realtime data streams are processed within the PTP. If the PTP is configured for a simulated spacecraft data test, the recovered data streams are encapsulated into IPDU packets and sent to the MOC. The MOC verifies that the data received matches that of the original data set used for the simulation as a criterion for proper S-Band system performance.

If the PTP is configured for BER testing, the recovered data streams will be encapsulated into IPDU packets and sent to another NT workstation on the IP network, where MOC simulation software resides for receiving and verifying the downlink. The MOC

simulator includes BER Receivers that compare the received PN data to what was originally transmitted, and displays BER statistics for the link.

1.5 LGS SubSystem Components

The following sections describe the functions of LGS subsystems not covered in the previous section, including hardware components that indirectly support the LGS mission. Added details are provided for other parts of the LGS already described.

1.5.1 Monitor and Control System

The LGS is centrally monitored and controlled from the Monitor and Control Subsystem (MCS) located at the EDC operations room. The MCS is a windows NT workstation that hosts the MCS Automation software consisting of a configured COTS software package with custom built driver interfaces. The software runs under the Factorylink Runtime Application (COTS software) provided by US Data Corporation.

The MCS automates the LGS by accepting contact schedules that are sent from the MOC, and by parsing the schedule contents into individual pass schedule work orders. The MCS also receives ephemeris data from the MOC and filters what it has received to find the most current orbital element for the upcoming pass.

The MCS automatically schedules and sends pass work orders and up to date ephemeris to the Antenna subsystem's Ground Station Controller (GSC) workstation pertaining to the upcoming pass. Timetables aligned to the scheduled pass AOS and LOS times drive the configuration of LGS equipment to ensure that it is ready for mission support when required. The MCS prepares the LGS to automatically track the spacecraft and to provide its data products to end users with minimal operator intervention.

The MCS provides RS-232 port interfaces for most of the LGS equipment except for the Antenna subsystem and the TDF and PTP which utilize the LAN. Two Digi Ports Plus Interface Units supply thirty two expansion ports for the MCS workstation (more than half are allocated). A few of the LGS hardware components communicate to the MCS by way of the IEEE-488 interface bus, requiring an RS-232 to IEEE-488 converter to interface the equipment by way of one MCS RS-232 port. The GSC, MOC and TDF communications to and from the MCS are supported by the IP network interface.

1.5.2 Antenna Subsystem

Datron/Transco, Inc. designed and installed the Antenna Subsystem in accordance with LGS requirements, to include a 10-meter antenna assembly and a remote controller, located at the LGS operations area. Datron's Ground Station Controller (GSC) serves as the remote control interface to Daytron's Antenna subsystem. The Antenna Subsystem includes a 10-meter reflector, a dichloric sub-reflector (prime focus for S-Band; cassegrain for X-Band), a AZ/EL/Tilt pedestal, a 200W transmitter, a boresight collimation source, redundant LNAs, and the GSC.

Using the above components, the antenna subsystem processes X-Band RF with a G/T of 34 dB/K and processes transmit and receive S-Band data with a G/T of 22 dB/K.

The GSC receives orders to schedule passes and receives tracking ephemeris from the remainder of LGS through the Monitor and Control System (MCS) IP network interface.

The antenna subsystem accepts either IIRV or NORAD 2-line elements and uses the data to propagate a model of the spacecrafts orbit. The MCS (not a part of the Antenna Subsystem) receives IIRV elements from the MOC, examines the elements and sends the most recent data to the GSC over the IP network interface. The MOC will send only IIRVs for Landsat 7 mission support.

The Antenna Subsystem, once requested to track a pass, will begin its antenna track in program track mode, following internally propagated orbital data for the spacecraft. Once the antennas track receivers acquire the X and/or S-Band downlink, the Antenna Controller transitions to autotrack mode. The Antenna Controller will favor X-Band autotrack over S-Band autotrack, unless no X-Band downlink is present. Tracking accuracy is enhanced by selection of X-Band autotrack vs. S-Band when the option is available.

1.5.3 X-Band RF&TLM Subsystem

The X-Band RF/TLM subsystem depicted in figure 1-1 was procured from Scientific Atlanta, Inc (SA). The X-Band subsystem provides the capability to receive 2 of 3 AQPSK modulated downlinks simulateously. X-Band RF/TLM subsystem capabilities include hardware support for Bit Error Rate (BER) tests.

The X-Band RF/TLM subsystem components consist of five reference generators (Marconi Signal Generators), a 4-way power divider, 3 downconverters, a driver amplifier, an IF distribution unit, 3 QPSK/AQPSK demodulators, 3 bit synchronizers, a BER tester, a modulator, and an upconverter.

The MCS interfaces to one Demod/Bit Sync over a common RS-232 port and uses the status obtained to indicate the lock condition for each wideband processing string. Lock status is sampled once per second during a pass and comprises the main content of the LGS Contact Status Report, sent to the MOC after the pass is completed.

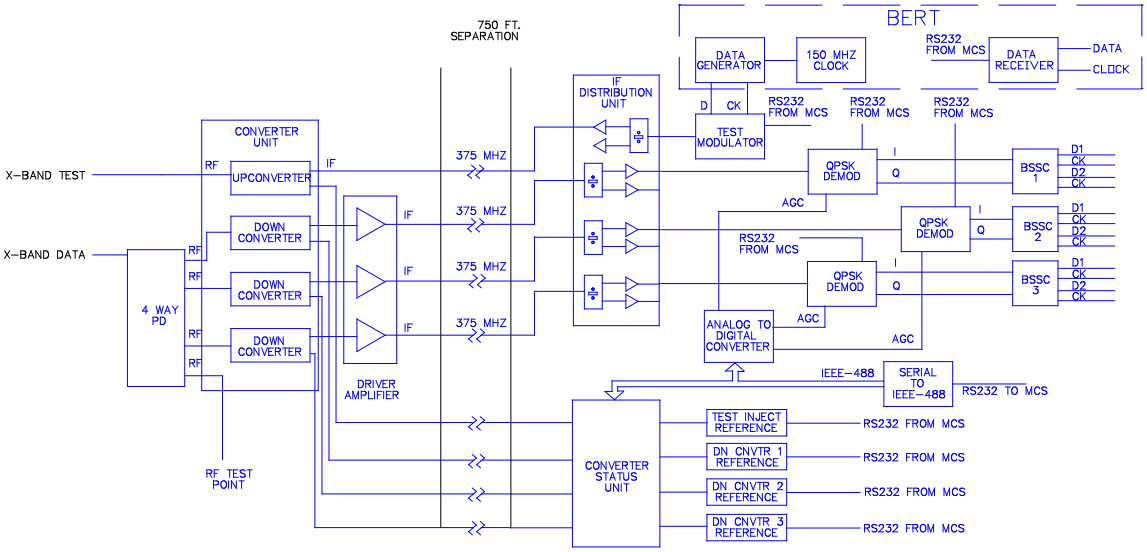


Figure 1-1 X-Band RF/TLM Subsystem Block Diagram

1.5.4 S-Band TLM & CMD and Tracking Subsystem

The LGS S-Band subsystem provides a means for the acquisition, capture, and recovery of S-Band data downlink from the Landsat 7 satellite and for providing a command uplink path originating from the MOC and ending at the Landsat 7 spacecraft. In addition, the S-Band system includes functions to log the doppler tracking characteristics for the pass.

To support the automated configuration of the system, the MCS retains automated control of all of the S-Band hardware components that are loacated in the LGS Operations area. Primary directives for the S-Band TLM&CMD subsystem are:

- Receive, record, and forward telemetry data to the MOC
- Receive and forward uplink commands to the satellite
- Provide one and two-way doppler tracking data to the MOC
- Provide for S-Band Test capability

The hardware components selected to meet these directives are:

1. Receiver (Microdyne 700-MR), 2 required for RH & LH polarizations
2. Diversity Combiner (Microdyne 1620-PC)
3. Exciter/Modulator (Microdyne TSS2000)
4. Programmable Telemetry Processor (Avtec PTP)
5. Carrier Doppler Measurement System (Apogee Labs CDMS)
6. Tracking Data Formatter (GSFC TDF)

7. Power Meter
8. Test Inject/HPA Coax Switch

1.5.4.1 Telemetry Receivers

Right-hand and Left-hand circularly polarized S-Band signals from the Antenna are processed through the Telemetry Receivers to generate 20 MHz IF for the Combiner and 2nd LO frequency of 180MHz +/- Fd. The Telemetry Receivers have internal PM Demodulators that track the S-Band signal and offset the 180MHz 2nd LO to compensate for the doppler offset present on the internally downconverted IF. The PM Demodulators, when locked, act to center the downconverted signal in the IF passband of the Receiver.

1.5.4.2 Diversity Combiner

The S-Band Diversity Combiner coherently mixes the RH and LH 20 MHz IF signals from the Telemetry Receivers in proportion to their relative signal strengths. The combined IF is PM demodulated, and two identical signals are output consisting of 1K or 4K realtime PSK modulated subcarrier plus baseband playback (spacecraft recorder dump data) at 256K. The two composite signals are sent to the PTP Primary System for recovering realtime and playback telemetry bit streams.

1.5.4.3 Exciter/Modulator

The S-Band Exciter PM modulates the 2106.4063 MHz S-Band carrier with PSK modulated command subcarrier from the PTP. Data content for the PSK command subcarrier originates from the MOC and is modulated onto the subcarrier by the PTP, before presentation to the Exciter's PM modulation input. The S-Band output from the Exciter is sent to the Antenna pedestal and amplified to restore power levels required for HPA excitation. The Test Inject/HPA Coax Switch in the Exciters' output path supports the capability to loop back S-Band RF into the Antennas Test Inject port for S-Band system tests.

1.5.4.4 PTP

The Programmable Telemetry Processor is an NT4.0 workstation that runs a telemetry processing application for configuring the PTP for processing the LGS downlink and uplink data. The PTP configuration is implemented as one or more "desktops" that configure the PTP's server software for operationa;l support.

The PTP Primary System configuration desktop is depicted in figure 1-2. This desktop supports realtime and playback telemetry recovery, command uplink modulation and command echo, and supports all socket interfaces to the MOC for telemetry and command.

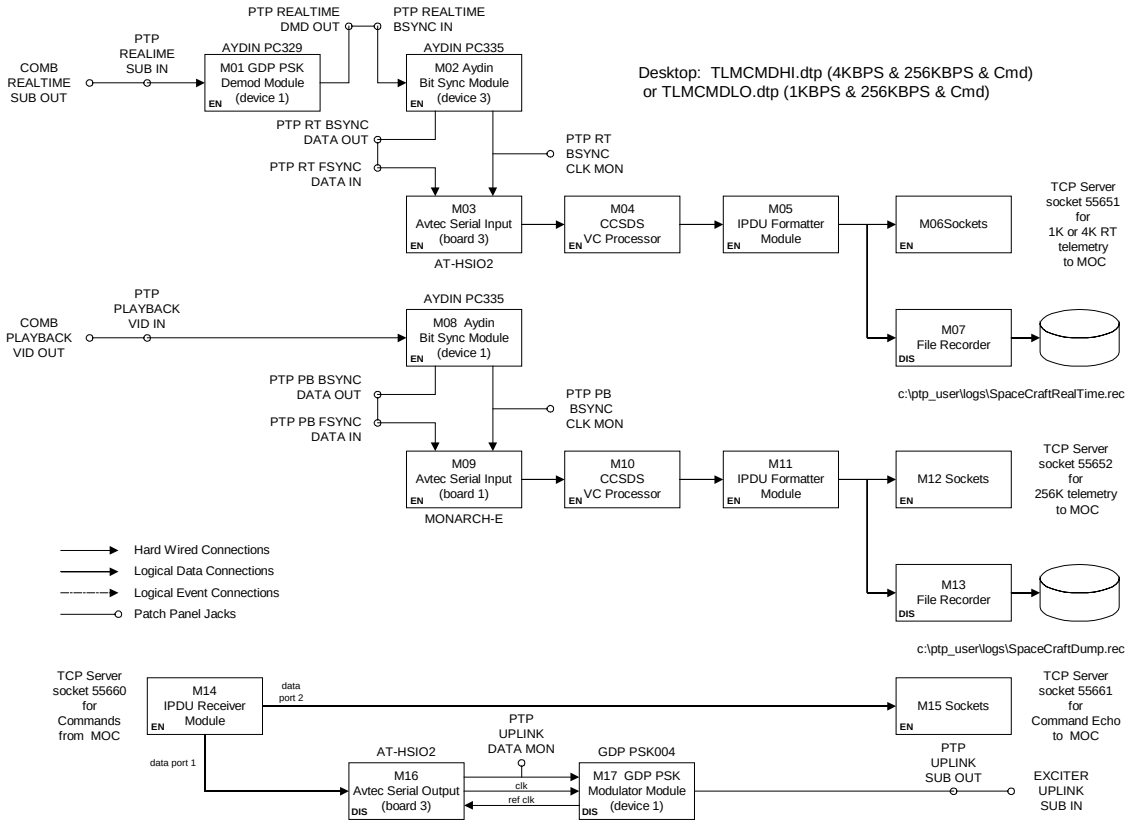


Figure 1-2 S-Band PTP Desktop for Mission Support

1.5.4.4.1 PTP 1K or 4K Telemetry Processing

The GDP PSK Demodulator (M01) accepts the composite PM demod signal from the Combiner and recovers the realtime PCM signal (modulated Bi0-S). The demodulated bit stream is input to the realtime Bit Synchronizer (M02) for data and clock recovery and for code conversion to NRZ-L.

The bit stream and clock from the Bit Sync are input to Avtec Serial Input (M03) for CCSDS frame synchronization. CCSDS frames pass through the CCSDS VC Processor (M04) on their way to the IPDU Formatter Module. The CCSDS VC Processor is included for implementing Software Reed Soloman error correction and for status indications. The LGS Operator monitors the realtime telemetry data at this point to observe VC Sequence errors should they occur.

The IPDU Formatter (M05) encapsulates the CCSDS Frames (CADUs) with IPDU headers suitable for network transmission to the MOC. LGS Source and L7M destination codes are annotated to the data as part of the IPDU header. The encapsulated telemetry data is sent to the MOC over a TCP server socket. File Recorder (M07) makes a backup copy of the realtime telemetry data to support the post-pass playback capability.

1.5.4.4.2 PTP 256K Telemetry Processing

The Aydin Bit Sync Module (M08) accepts the composite PM demod signal from the Combiner and recovers the 256K data and clock. The Bit synchronizer also converts the Bi0-S encoded input data to NRZ-L before sending the data and clock to Avtec Serial Input (M09) for CCSDS frame synchronization.

CCSDS frames are synchronized in Avtec Serial Input (M09) and pass through the CCSDS VC Processor (M10) on their way to the IPDU Formatter Module. The CCSDS VC Processor is included for telemetry status only; the LGS Operator monitors the 256K telemetry data at this point to observe VC Sequence errors should they occur.

The IPDU Formatter (M11) encapsulates the CCSDS Frames (CADUs) with IPDU headers suitable for network transmission to the MOC. LGS Source and L7M destination codes are annotated to the data as part of the IPDU header. The encapsulated telemetry data is sent to the MOC over a TCP server socket. File Recorder (M13) makes a backup copy of the 256K telemetry data to support the post-pass playback capability.

1.5.4.4.3 PTP Command Processing

Command processing begins when the MOC sends commands over a TCP server socket in the IPDU Receiver Module (M14). The IPDU Receiver examines the IPDU header and accepts only those commands intended for LGS. Data port 1 carries command data to Avtec Serial Output (M16) for generation of a TTL level uplink bit stream comprised of alternating 1/0 filler between command frames.

The uplink bit stream at 2 KBPS NRZ-M is PSK modulated on a 16 KHz coherent subcarrier in GDP PSK Modulator (M17). The uplink subcarrier is output from the PTP for PM modulation at the Exciter.

IPDU Receiver Module Data port 2 connects back to the MOC through socket module M15 to support the command echo capability of the LGS. Whenever the MOC requires an echo, the IPDU Receiver Module responds with one over this data path.

1.5.4.5 CDMS

The Carrier Doppler Measurement System (CDMS) extracts the doppler frequency (Fd) component from the Telemetry Receiver's 180 MHz 2nd LO output, by mixing the LO down to a frequency of 1 MHz +/- Fd, and then by PLL multiplying the signal to increase frequency resolution. The CDMS outputs to the Tracking Data Formatter (TDF) a biased count value of the PLL output containing the doppler offset.

1.5.4.6 TDF

The TDF receives the bias doppler samples from the CDMS, filters and logs the samples into a Universal Tracking Data Format (UTDF) file. After a file has been completed the TDF sends it to the MOC. The tracking data is used at GSFC for refinement of spacecraft ephemeris data, to support future spacecraft tracking missions' orbital determination.

1.5.6 Timing Subsystem

The Timing Subsystem provides a stable timing reference for all elements of the LGS and locks onto signals from Global Positioning System (GPS) satellites as the ultimate timing reference for the station. The MCS provides monitor only capabilities of the Timing Subsystem from its RS-232 port.

1.5.6.1 Timing Subsystem

The Timing subsystem provides various timing signals for synchronization of LGS hardware components to a common timing reference. The Timing Subsystem provides IRIG-B, 10-PPS, 1-PPS, 5MHz, and 10MHz signals. An IRIG-B time display is also provided at the LGS for Operator reference. An online redundant system is available to backup the primary timing system should component failure occur.

The primary and redundant segments of the Timing subsystem are comprised of one Hewlett-Packard (HP) GPS receiver (model HP 59551A), one Trak Model 8424 Timing Buffer Unit, one ATSC Model 8126 Distribution Unit, one ATSC Model 8128 Distribution Unit and one Trak Model 8404 Time Code Reader, .

The MCS receives only the health and status of the Timing Subsystem GPS receiver through its RS-232 port.

1.5.6.2 HP 59551A GPS Receiver

Based on the advanced Global Positioning System (GPS) receiver technology, the HP 59551A delivers accurate timing data, varying less than 1 microsecond from the satellite signal when locked to the GPS. The GPS receiver provides the 1PPS, IRIG B and the 10MHz timing signals used by the Timing Subsystem for signals distributed to the LGS system. Refer to the HP 59551A Operations and Maintenance manual for additional information.

1.5.6.3 Trak Model 8424 Timing Buffer Unit

The Trak 8424 Timing Buffer Unit distributes the IRIG-B and the 1-PPS from the GPS receiver and the 10-PPS from the ATSC Model 8128 at the input jacks J1, J2, and J8, respectively. The Model 8424 outputs 8 lines of buffered IRIG-B, 4 lines of 1-PPS time, and 4 lines of 10-PPS time.

In slots 15 and 16, two 4 Channel Linear Driver boards are inserted which receive the IRIG-B from the GPS receiver at input jack J8 and provide 8 lines of IRIG-B output signals at jacks J15A-D and J16A-D. In slot 1, a 4 Channel TTL Rate Driver board is inserted which receives the 1PPS from the GPS receiver at input jack J1 and provides 4 lines of 1PPS output signals at jacks 1A-D. In slot 3, another 4 Channel TTL Rate Driver board is inserted which receives the 10PPS from the Trak Model 8128 at input jack J2 and provides 4 lines of 10PPS output signals at jacks 3A-D. Refer to the Trak Model 8424 Timing Buffer Unit Technical Manual for additional information.

1.5.6.4 ATSC Model 8126 Distribution Unit

The ATSC Model 8126 Distribution Amplifier is a wideband, low noise, high isolation unity gain buffer. A single input can supply a fan-out of 16 channels. The 8126 Distribution Unit will receive a single 10MHz sine wave signal at the input jack J17 from the GPS receiver and generate 16 10MHz output signals at J1 through J16. Refer to the Model 8126 Distribution Amplifier Technical Manual.

1.5.6.5 ATSC Model 8128 Distribution Unit

The ATSC Model 8128 Distribution Unit receives the 10MHz signal on input jack J17 from the ATSC Model 8126 output jack J16 and generates eight 5 MHz signals on output jacks J1 - J8. The Model 8128 also generates a 10-PPS signal on output jack J10 by synchronizing itself to the 1 PPS signal from the GPS receiver. The 1PPS signal is required for a period of 3 seconds only.

1.5.6.6 Trak Model 8408 Time Code Reader

The Model 8408 Time Code Reader decodes and automatically recognizes the serial IRIG-B time code input at the BNC jack located on the rear of the display unit. This is displayed on a 1.0 inch LED display. A CPU code reader decodes and analyzes the incoming serial code, controls the display, and provides a display self-test on each power on. Refer to the Trak Model 8408 Technical Manual for additional information.

1.5.7 Matrix Switch Subsystem

A mechanism to distribute the LGS data to various external destinations was required for the LGS. For example, the ability to route the ETM+ data from one string of the RF&TLM Subsystem to one of the five Landsat 7 Processing System (LPS) strings is required. The Matrix Switch Subsystem was developed to perform this function.

The Matrix Switch Subsystem consists of a Matrix Systems, Inc. Model 12620 Matrix Switch. The Model 12620 is a 16x16 differential pair matrix switch with remote and local control capabilities. Remote monitor and control of the Matrix Switch Subsystem is provided through the Model 12620 RS-232 port. Refer to the Matrix Systems, Inc. Model 12620 Operations and Maintenance Manual for additional information.

The Matrix Switch Subsystem incorporates a patch panel with patch jacks to provide the capability to bypass the Matrix Switch in the event of a Matrix Switch malfunction. The patch panel is configured with a normal-through signal path which passes the data through the patch jacks when no patch cords are used. Inserting a patch cord into the patch jack, from the front panel, breaks the normal-through signal path and flows the data through the patch cord. To route the data to the destination, the opposite end of the patch cord must be inserted into the front panel side of the desired patch jack. In this manner, the use of patch cords can be used to bypass the Matrix Switch or for testing purposes.

1.5.8 Recorder Subsystem

The Recorder Subsystem provides a mechanism to playback ETM+ data from the supplemental Landsat 7 stations. The recorders (2) are Ampex 1600 Dsi systems utilizing

a Serial Interface Module (SIM) to convert the Ampex HOT LINK data interface to ECL format. The recorders interface to the Matrix Switch which allow record and playback configurations on the LGS. The MCS provides monitor and control of the subsystem through its RS-232 port utilizing the Hyperlink interface at the MCS.

1.5.9 Software Components

The subsystem components described below are only the components which required custom software be created to implement LGS requirements. The subsystems and components are:

- The Monitor and Control Subsystem (MCS)
- The Tracking Data Formatter (TDF)
- The Programmable Telemetry Processor

1.5.9.1 Monitor and Control Subsystem

The MCS provides the capability to remotely monitor and control the distributed LGS subsystems. A user friendly interface was created using commercially available products.

The MCS was developed from COTS items and consists of a Pentium based (166 MHz) PC, 17" SVGA monitor, a 16 port Digiboard Serial Communication Card with 2 (16) port Digi expansion chassis, 128Mbytes RAM, a minimum of 2Gbyte hard drive, a tape backup system, an IRIG-B time code reader, an ethernet card, and a mouse. The MCS GUI was developed using FactoryLink Enterprise Control System (ECS) Version 6.0.4, a commercially available development package from USData Corp. and resides on the Windows NT Version 4.0 platform. The MCS is a table top version and resides in the operations room at the EDC.

Operators have access to the control and monitor capabilities of the MCS from the keyboard. The MCS will prompt the operator for input when necessary but will initiate autonomous controls at predefined times. For example, the MCS will prompt the operator for confirmation to configure the equipment per the scheduled configuration parameters received from the MOC. If no action is received from the operator within 30 minutes prior to the Acquisition Of Signal (AOS) time, the MCS will automatically configure the equipment and initiate track activities.

Incorporated into the MCS hardware architecture is the DigiBoard PC/Xem system which is equipped with thirty two RS-232 asynchronous serial ports and expandable to sixty-four. The PC/Xem is an intelligent board that plugs into and connects the RS-232 channels to the MCS. The DigiBoard PC/Xem connects the MCS to the majority of the LGS subsystem equipment.

The 3COMM PLUS Ethernet card plugs into the MCS motherboard. The 3COMM PLUS 10base2 interface provides the connection to the closed segment of the EDC LAN. The MCS utilizes the LAN lines for control and monitor of the Antenna Subsystem GSC, the TDF, and the PTP, and communications to the MOC.

To synchronize the MCS time with the remainder of the LGS and to enable time synchronized interrupts, a Datum, Inc. PC03XT Time Code Reader Module is plugged into the MCS motherboard. The PC03XT is designed to decode the IRIG B time code signal received from the Timing Subsystem. The IRIG B and the 10PPS signal from the Timing Subsystem is received on the PC03XT input BNC connectors located at the rear of the MCS.

1.5.9.2 Tracking Data Formatter (TDF)

The S-Band subsystem provides the capability to receive a tracking data string from the receivers which is sent to the Carrier Doppler Measurement System (CDMS) where the data is extracted. The extracted data is then forwarded to the Tracking Data Formatter (TDF) where the data is packetized for transmission to the MOC. The data is transmitted to the MOC after the pass is complete and is in the format as defined in reference 1.0 (*The Landsat 7 Mission Operations Center (MOC) to Landsat 7 Ground Station (LGS) Interface Control Document, 511-44ICD/0296*). and transmit a single command data string to the satellite.

The TDF runs on an Industrial Computer Pentium Based System running Windows NT 4.0 for Workstations. It consists of 64MB of RAM, a 1.0 Gbyte Hard Drive, an ethernet card for communicating with the MCS and Mission Operations Center (MOC), and (1) PCDIO120-P multiple channel digital I/O board. There are 3 processes running on the TDF which were created for the LGS. A driver provides the capability to extract the data from the digital I/O board which reflects the doppler value sent from the CDMS. This value is then sent to another program which performs the packetization and formatting. The third process takes this packetized data and auto transfers it (FTP) to the MOC upon completion of the pass.

1.5.9.3 Programmable Telemetry Processor (PTP)

The S-Band subsystem provides the capability to receive a single telemetry string and transmit a single command data string to the satellite. The telemetry data will flow from the receivers/combiner to the Programmable Telemetry Processor (PTP), then becomes formatted for transmission to the MOC. Command data is received at the PTP from the MOC. Command data is routed through the TSS-2000 where it is modulated to the uplink carrier and transmitted to the satellite. The PTP is required to receive the IF signal from the receiver and extract the telemetry data for transmission to the MOC in real-time. In addition, command data from the MOC will be forwarded to the PTP and modulated onto the carrier.

The PTP is a system procured from Avtek Systems. It is a PC based, multi channel telemetry and command processing system. It acts as a gateway that accepts multiple telemetry streams and outputs timetagged frame or packet data over a network. The PTP also includes a command gateway that accepts input from the network and outputs serial commands to the uplink.

The PTP runs under Windows NT 4.0 operating system. It contains PCI and ISA I/O busses for the following interfaces:

- Ethernet interface
- SCSI and IDE hard disks
- CD ROM Drive
- AT-HSI02 Frame Synchronizer/Telemetry Simulator
- Monarch-E PCI Frame Synchronizer/Telemetry Simulator with Reed-Solomon Encoder/Decoder
- Bit Synchronizer (Aydin PC 335) with Viterbi decoder
- Command BPSK Modulator
- Tunable BPSK Modulator
- Tunable Subcarrier BPSK Demodulator
- IRIG-B and NASA-36 Time Code Processor

The PTP software consists of a server application (PTP_NT.EXE), a graphical user interface (CONSOLE.EXE), and the module dynamic link libraries (DLL). The PTP_NT server controls the PTP hardware and performs all of the real-time data processing. The CONSOLE application provides an easy-to-use interface for controlling the configuration for the PTP system. The CONSOLE communicates with the PTP_NT through TCP/IP sockets. The CONSOLE can run locally on the PTP system or on a remote PC that is connected to the PTP system via a TCP/IP network. The PTP_NT application can also be remotely controlled by a user application through the AV_PTP Remote Interface Library.

1.6 Operator Role

The LGS requires minimal operator intervention. It was designed to automatically schedule Landsat 7 passes, configure equipment appropriately, generate post pass products, and transfer these products to the MOC automatically. There are, however, certain functions required to ensure the LGS supports Landsat 7 operations. This includes normal monitoring of system health, contingency operations, and file management functions.

1.6.1 System Monitoring

The LGS was designed to provide a quick look status of the health of the components that comprise the system. Naturally, due to certain equipment constraints, this status is not all inclusive. The MCS, however, provides a quick look status of the health of the components. This is accomplished by the following color scheme implemented around the various components on the LGS Main Screen:

- yellow - indicates the component is healthy and is not functioning in a pass
- green - indicates the component is healthy and is functioning in a pass
- red - indicates the component is not healthy.

If a component is red, it still may be used in a pass. The automation software allows a conditional use of the component, however, it will require operator involvement. This is true for any component within the LGS. This holds true during an X-Band pass, also, when the automation software automatically assigns the X-Band downlinks to healthy "available" strings. If a string is not healthy, therefore unavailable, i.e. one or more components are indicating a red status, the automation software will not assign the string to a downlink. There are two scenarios that could occur.

- The operator sees the string(s) are red and sets up the system to "conditionally use" the string. This may require the operator to manually configure the component(s) which is indicating red status. The operator involvement must occur prior to the pre-pass since the automation software checks for equipment/string availability and/or conditional use status. This capability is accessed through the I/F Utility screen which is password accessed from the LGS Main Screen.
- One or more component(s) and/or string(s) are indicating "unavailable" red status. If conditional use is not desired, the automation software will prompt the operator for a redefinition of X-Band downlink requirements. For example, if two X-Band downlinks were required and only 1 string was available, the system would prompt the operator to delete one of the requested downlinks. This is accomplished by a pop up window during prepass setup.

1.6.2 Contingency Operations

The LGS was designed with some redundancy. The X-Band subsystem is required to support a maximum of 2 downlinks, however, the subsystem is configured with the capability of supporting 3 (1 spare). The S-Band subsystem has some redundant components such as the receivers and PTP (to an extent). Normally the MCS will automatically configure the components, however, at any time, the system components can be reconfigured at the actual hardware component. An understanding of the system and hardware is necessary to accomplish this manually. The operators role is as follows:

- Determine pass requirements and component/equipment requirements. Assess configuration to determine workaround if required.
- Configure necessary components as required. Maintenance personnel may be required in the case of possibly any recabling/patching of equipment.
- Communicate with the MOC on workarounds.
- Contact maintenance for resolution of problem.

There are certain single point failures within the system that will prohibit a track of a pass or be limited to providing certain capabilities such as generation of a Universal Tracking Data File (UTDF) which is accomplished by the Tracking Data Formatter (TDF). An operators role when an assessment is made with these limitations would be:

- Contact the MOC to communicate status/workarounds

- Configure the equipment to best meet requirements.

It should be noted that the MCS normally provides the necessary controls to configure all of the LGS equipment for the upcoming pass including the GSC. In a case where the MCS is inactive, the pass can manually be configured:

- at the GSC by ensuring the proper ephemeris is loaded and by "adding" the appropriate pass from the candidate pass list.
- at the TDF by entering the appropriate AOS/LOS
- at the PTP by loading and enabling the required desktops based on requirements in the contact schedule
- at each component

The above scenarios would require operations personnel to manually obtain the contact schedule and appropriate ephemeris data from the MOC. Normally, this data is FTPed into the MCS from the MOC and the MCS automatically handles the processing of the data/pass events. If the MCS was inactive, the MOC would also not be capable of receiving an Equipment Status Report or Contact Status Report since these reports are automatically generated/FTPed to the MOC.

Chapter 4, *Contingency Operations*, will further outline equipment parameter requirements and setup requirements for supporting contingency operations.

1.6.3 File Management

The operator's role in LGS file management is to periodically assess the system resources and determine appropriate time frames for archiving necessary files. What is archived and how often is dependent on the operations procedures, however, the following is a list of directories in the MCS and TDF which are used to "store" files/products as they are created by the system.

The LGS is initially configured to receive contact schedules and ephemeris data from the MOC. These files are FTPed "PUT" in the MCS directories as follows:

- Contact Schedules - C:\public\Lgs7cs\
- Ephemeris Data - C:\public\Lgs7sad\

The MCS also automatically creates Contact Status Reports and Equipment Status Reports which are FTPed to the MOC. The reports are also put in the following MCS directory:

- Contact Status Reports - C:\cs\
- Contact Status Reports – C:\csr\
- Equipment Status Reports – C:\es\
- Equipment Status Reports – C:\esr\

At the TDF, upon completion of a pass, a tracking file is created and FTPed to the MOC. The file is also put in the following TDF directory:

- Universal Tracking Data File - C:\tdf\tdfdoppler\

Chapter 2. Getting Started

2.1 Introduction

This chapter describes the fundamentals of operating the LGS. It explains the steps required to:

- Log on and start up the MCS/MCS Software
- Log on and start up the TDF/TDF Software
- Log on and start up the PTP/PTP Software
- Shutting down the Software
- Navigate the MCS GUI
- Navigate the TDF
- Navigate the PTP

2.1.1 Logging On and Starting Up the MCS

Once you have a user name and password, you can log on to the MCS. To log on to the MCS:

1. Press Cont/Alt/Del
2. Type in your user name and password

To start up the MCS, click on the Start Factory Link icon. This starts bringing up the MCS application. The system is designed to bring up the LGS in a known configuration. This is automatically accomplished within the task by executing a program called *lgsinit.prg* which is located in C:\FLLGS7\shared\procs\. No operator involvement is necessary. The initialization program methodically performs certain tasks in order to bring the LGS up in a known/stable state. It provides:

- an initialization window indicating the progress of the initialization
- enabling of interfaces
- setting of prepass, pass, and post pass variables to known values
- checking for equipment in local mode/control
- configuring equipment to default parameters
- initializing the Matrix Switch
- enabling the 30 second status poll

There are two windows that may pop up during initialization. One is a window appearing whenever the Modulator is in local mode. This can either be cleared or the window will

clear by itself, at the end of a short period of time. It is simply a prompt to indicate the Modulator is in local mode. The second window appears as a result of a detected IEEE488 bus interface problem. If the initialization fails to establish communication with the IEEE488 bus interface, the window will pop up requiring operator attention. Since the IEEE488 device controls the Synthesizer Control Unit it would be imperative to resolve the communication problem.

Once the initialization window has closed, the LGS Main Screen window will appear (Figure 2-3). The system is still initializing so several devices may indicate a "red" status. This is because the first status poll is in process and a subsequent process will occur after each poll to check the status conditions of each device within the LGS. It should be approximately 30 to 50 seconds before the system is stable.

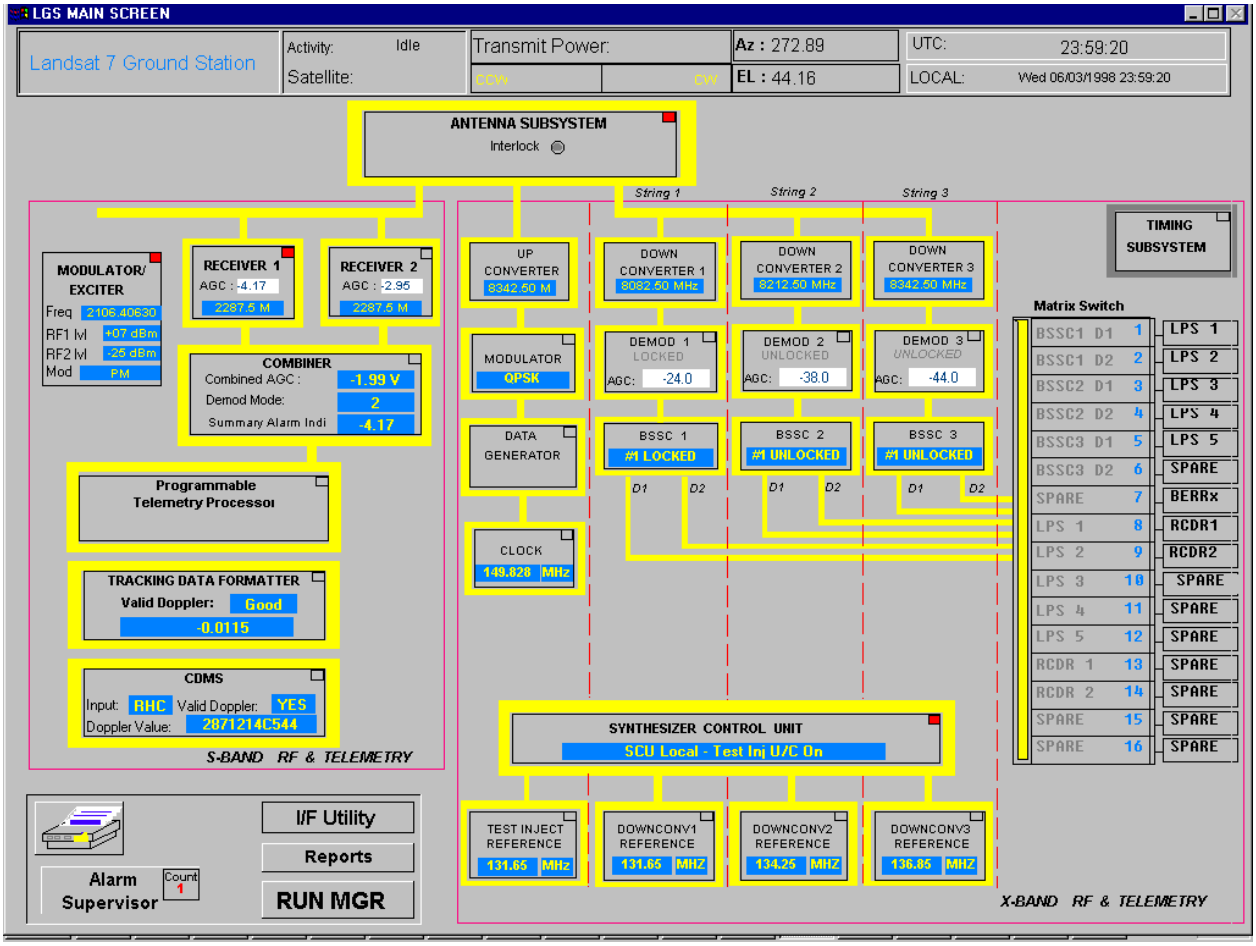


Figure 2-3 LGS MCS Main Screen

2.1.2 Logging On and Starting Up the TDF

Once you have a user name and password, you can log on to the TDF. To log on to the TDF:

1. Press Cont/Alt/Del
2. Type in your user name and password

To start up the TDF, click on the TDF icon. This starts bringing up the TDF application. No operator involvement is necessary. The status and local control is then provided via the TDF GUI which is displayed in Figure 2-4.

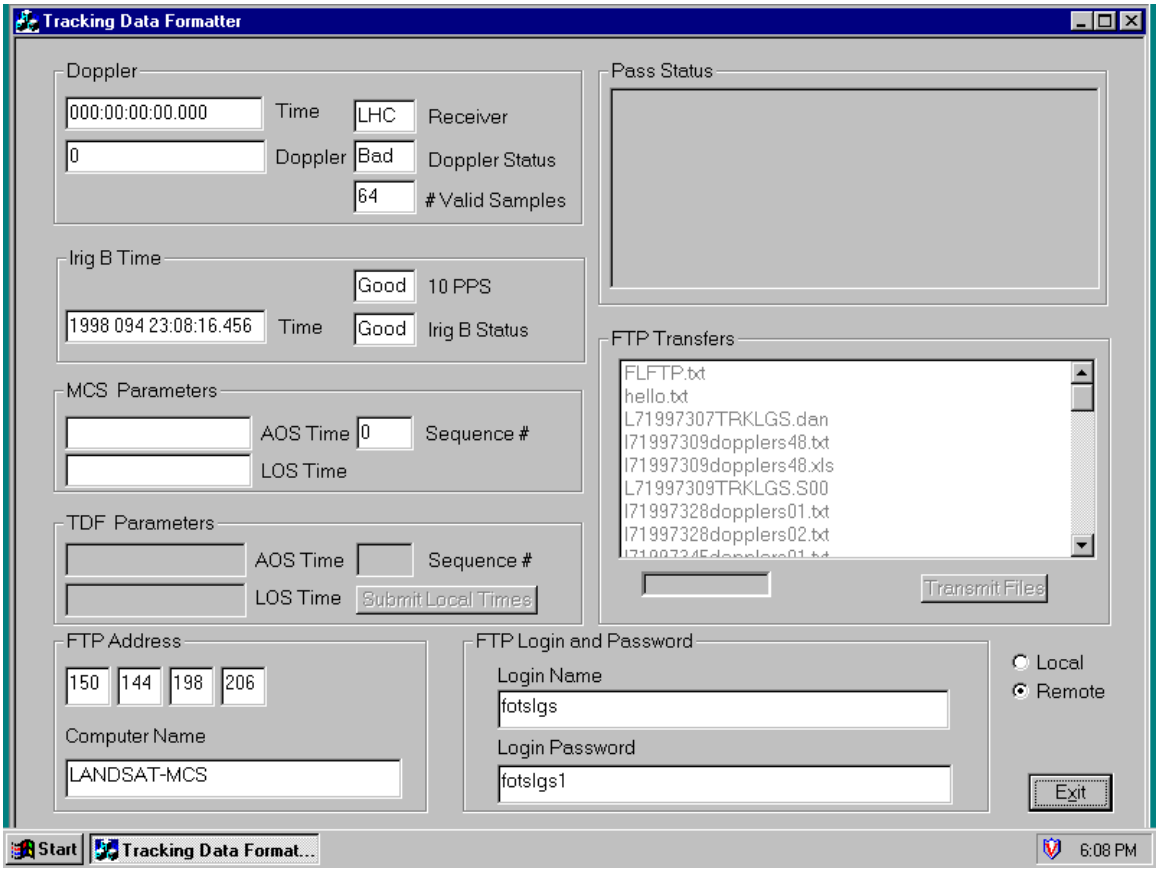


Figure 2-4 LGS TDF Main Screen

2.1.3 Logging On and Starting Up the PTP

Logging on the PTP is different from the TDF and MCS. There is no user name/password logon necessary. The PTP, upon restart or powerup, will automatically come up and load the PTP_Server 1. Once this is accomplished the system waits until either the remote host (MCS) initiates a connection or a local connection is initiated with the Console.exe program. For further details on PTP functionality, refer to the *PTP_NT User's Manual, Version 1.0.*

The PTP server application comes up with an empty configuration upon completion of a system boot-up procedure. During an LGS pre-pass automation procedure (under control of the MCS), the PTP Server will automatically be configured with a remote connection from the MCS that in turn, will be used to configure the PTP Server for spacecraft support. The MCS pre-pass automation configures the PTP Server with the TLMCMDLO.DTP or TLMCMDHI.DTP desktop configuration as dictated by the anticipated realtime telemetry data rate on the downlink. The determination of downlink telemetry data rate is extracted from the Contact Schedule by the MCS.

Whenever manual control of the PTP is desired, the Operator must establish a user interface connection to the PTP Server application. The Operator does this by launching the CONSOLE.EXE application, then establishing a connection to the PTP Server using the Console's "File/Connect Server" menu option. Once the connection has been made, the Operator selects the desired PTP configuration and thereby prepares the PTP Server with the desired software.

Table 2-1 summarizes the PTP Server configurations that are used for Primary and Backup Landsat 7 mission support, and for supporting PTP Test capabilities.

PTP Desktop Filename	Description	Support Mode	Desktop Name For Backup Support
TLMCMDLO.DTP	Demodulates Realtime 1.024 MHz Subcarrier and recovers realtime demodulated baseband telemetry at 1.216 Kbps and Playback Telemetry at 256KBPS. Supports CMD uplink at 2KBPS and CMD echo to MOC	Primary Mission Support	TLMCMDLB.DTP
TLMCMDHI.DTP	Demodulates Realtime 1.024 MHz Subcarrier and recovers realtime demodulated baseband telemetry at 4.864 Kbps and Playback Telemetry at 256KBPS. Supports CMD uplink at 2KBPS and CMD echo to MOC	Primary Mission Support	TLMCMDHB.DTP
TLMSIMLO.DTP	Generates 1.024MHz subcarrier with 1.216KBPS recorded spacecraft data for realtime simulation stream and 256KBPS baseband simulation stream from recorded spacecraft data. The test streams are used to verify TLMCMDLO.DTP	Primary System, Simulated Spacecraft data Test with MOC	TLMSIMLB.DTP
TLMSIMHI.DTP	Generates 1.024MHz subcarrier with 4.864KBPS recorded spacecraft data for realtime simulation stream and 256KBPS baseband simulation stream from recorded spacecraft data. The test streams are used to verify TLMCMDHI.DTP	Primary System, Simulated Spacecraft data Test with MOC	TLMSIMHB.DTP
BERGENLO.DTP	Generates 1.024MHz subcarrier with 1.216KBPS CCSDS BER data for realtime simulation stream and 256KBPS baseband simulation stream from CCSDS BER data. Also supports CMD Subcar Demod and CMD BER Rx. The test streams are used to verify TLMCMDLO.DTP	Primary System, CCSDS BER data Test with MOCSIM Desktop on separate NT4.0 workstation on IP network.	BERGENLB.DTP
BERGENHI.DTP	Generates 1.024MHz subcarrier with 4.864KBPS CCSDS BER data for realtime simulation stream and 256KBPS baseband simulation stream from CCSDS BER data. Also supports CMD Subcar Demod and CMD BER Rx. The test streams are used to verify TLMCMDHI.DTP	Primary System, CCSDS BER data Test with MOCSIM Desktop on separate NT4.0 workstation on IP network.	BERGENHB.DTP
MOCSIM.DTP	Receives 1.216KBPS (or 4.864KBPS) realtime TLM IPDU packets, and 256 K IPDU playback TLM packets over IP Netwk. The data goes to BER Rx for each TLM stream. Also generates CMD BER CCSDS packets and receives the CMD echo for BER Rx on the echo.	BER data testing. Runs on separate IP networked NT4.0 workstation.	MOCSIM.DTP

Table 2-1 LGS PTP Configurations

2.1.4 Shutting Down the Software

Shutting down the software on the systems require no special precautions. Perform the following functions on the appropriate subsystems:

- On the MCS, click the *RUN MGR* button on the LGS Main Screen. This will close this window and the Run Manager (LANDSAT 7 – MCS) window will be displayed. Click on the *Stop Application* button at the bottom left of the window. This will stop the MCS and return the system to the NT desktop display.

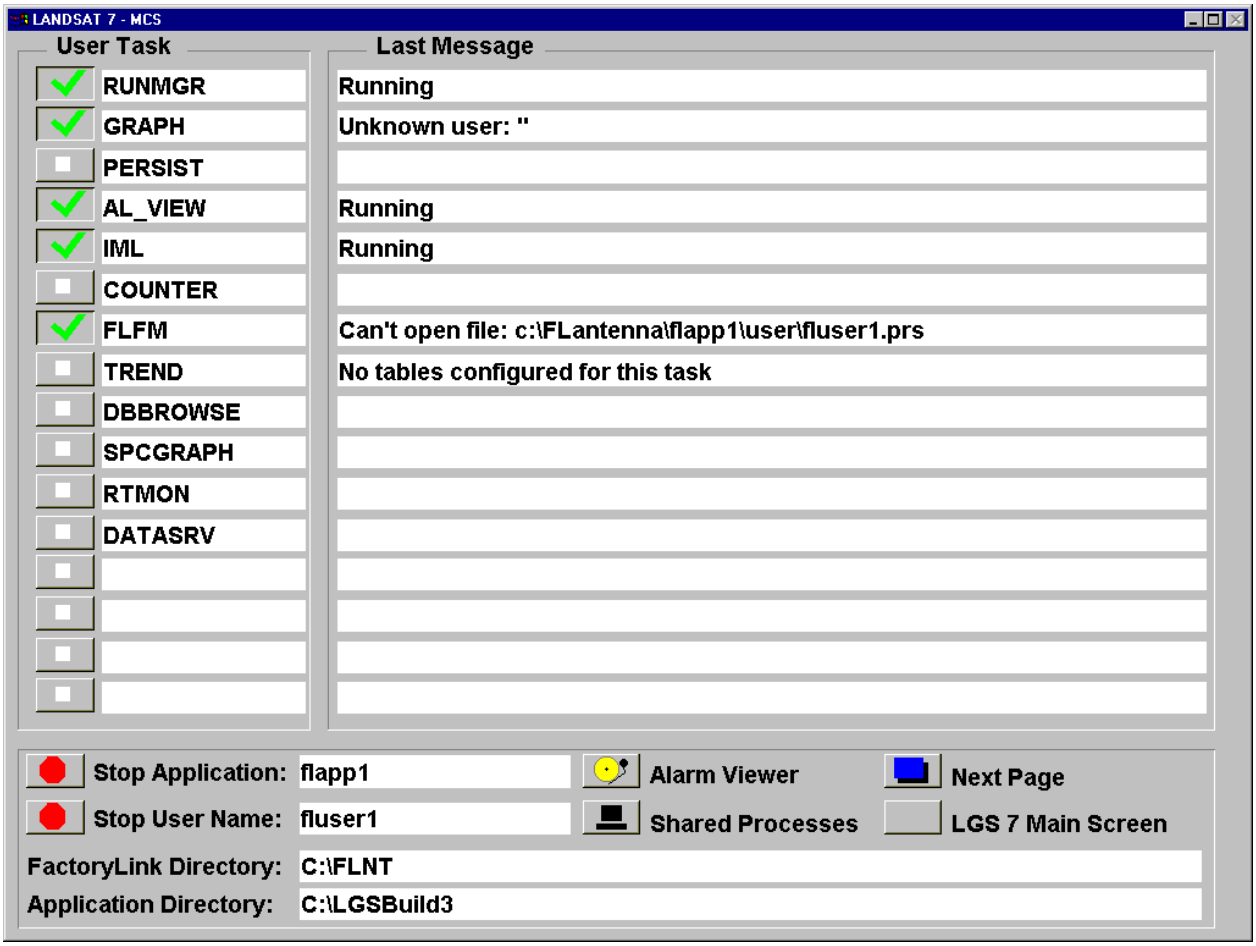


Figure 2-5 LGS MCS Run Manager Window

- On the TDF, click the *Exit* box at the bottom right of the TDF GUI. This will stop the TDF application and return the system to the NT desktop display.

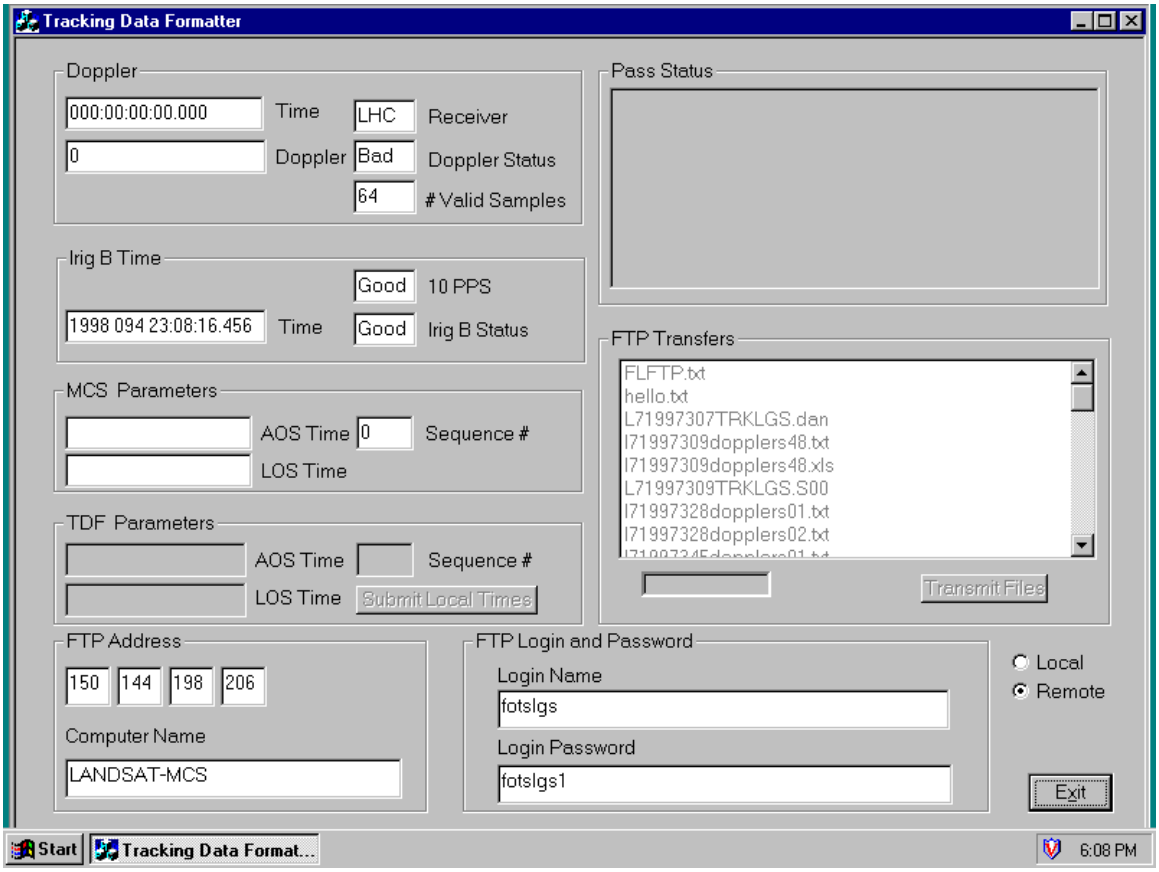
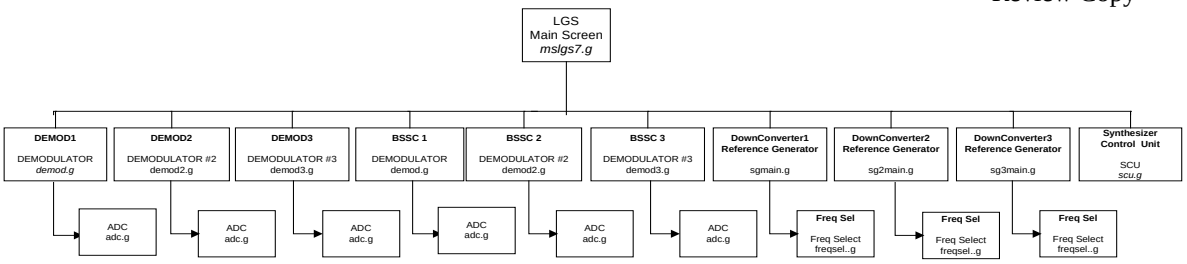


Figure 2-6 LGS TDF Main Screen

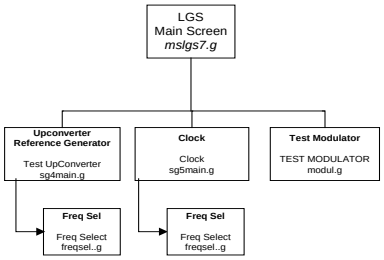
- On the PTP, in the PTP_NT application (the black screen area) type **quit** <CR>. This will stop the PTP_NT application and return the system to the NT desktop display.

2.1.5 Navigating the MCS

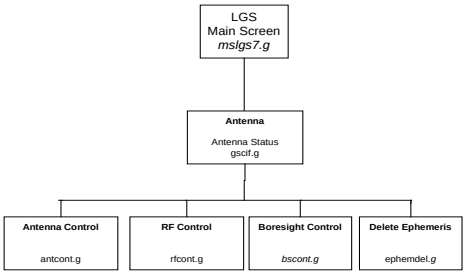
The MCS was developed utilizing USDATA product Enterprise Control System (ECS) Version 6.04. A high level GUI was developed to depict a functional diagram of the LGS with an X-Band Subsystem and an S-Band Subsystem. The GUI employs a simple point and click windows environment and provides access to lower level equipment. Every window has a way back to the previous window utilizing the *Previous Screen* buttons on each screen. Each screen also provides a print screen capability and access to the alarm logging screen. A screen heirarchy is shown in Figure 2-7



X-Band Subsystem



X-Band Test String



Antenna Subsystem

Figure 2-7 LGS MCS Screen Hierarchies