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OPERATION AND MAINTENANCE MANUAL

FOR

MODEL 7200 CONTROL SYSTEM
WITH
7150 DRIVE CABINET
VERSION 3 SOFTWARE

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CAUTIONARY NOTICE

Although the manufacturer has attempted to detail in this manual all areas of possible danger to personnel in connection with the use of this equipment, personnel should use caution when installing, checking out, operating, and servicing this equipment. Care should be taken to avoid electrical shock, whether the hazard is caused by design or malfunction.

The manufacturer is specifically not liable for any damage or injury arising from the failure to follow the instructions contained in this manual or failure to exercise due care and caution in the installation, operation, checkout, and service of this equipment.

WARNING

THE CURRENTS AND VOLTAGES IN THIS EQUIPMENT ARE DANGEROUS. PERSONNEL MUST AT ALL TIMES OBSERVE SAFETY REGULATIONS.

PLEASE READ THE FOLLOWING PRECAUTIONS

This manual is intended as a general guide for trained and qualified personnel who are aware of the dangers of handling potentially hazardous electrical and electronic circuits. This manual is not intended to contain a complete statement of all safety precautions that should be observed by personnel in using this or other electronic equipment.

The installation, operation, maintenance, and service of this equipment involves risks both to personnel and equipment and must be performed only by qualified personnel exercising due care. Vertex Communications Corporation shall not be responsible for injury or damage resulting from improper procedures or from the use of improperly trained or inexperienced personnel performing such tasks.

During installation and operation of this equipment, local building codes and fire protection standards must be observed.

WARNING

ALWAYS DISCONNECT POWER BEFORE OPENING COVERS, DOORS, ENCLOSURES, GATES, PANELS, OR SHIELDS. ALWAYS USE GROUNDING STICKS AND SHORT OUT HIGH VOLTAGE POINTS BEFORE SERVICING. NEVER MAKE INTERNAL ADJUSTMENTS OR PERFORM MAINTENANCE OR SERVICE WHEN ALONE OR FATIGUED.

Do not remove, short-circuit, or tamper with interlock switches on access covers, doors, enclosures, gates, panels, or shields. Keep away from live circuits.

WARNING

IN CASE OF EMERGENCY BE SURE THAT POWER IS DISCONNECTED.

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1.0 INTRODUCTION

1.1 Purpose

This manual provides the user with the information necessary to install and operate the Vertex Model 7200 Antenna Control System (ACS). Failure to follow the instructions and all cautions and warnings provided in this manual may result in improper installation and/or operation of the 7200 ACS.

1.2 Scope

This manual primarily contains the information related to the 7200 ACS, and includes limited information about the antenna structure, the equipment used to develop an analog tracking signal, and other equipment peripheral to the 7200 ACS.

1.3 Organization

This manual is divided into the following sections:

Section 1.0, Introduction, gives the purpose, scope, and organization of this manual. Information for obtaining technical support is also included in this section.

Section 2.0, Overview of the 7200 ACS, provides a general overview of the system, including specifications, the functions of the system, and a description of the controls and indicators.

Section 3.0, Theory of Operation, explains the theory of operation of the 7200 ACS.

Section 4.0, Installation, provides instructions for installing the 7200 ACS, showing the connections of system cabling and explaining the setup and initial power-up of the system.

Section 5.0, Operation, provides detailed information for configuring and operating the 7200 ACS.

Section 6.0, Site Acceptance Test Procedure, contains the instructions for testing the mechanical operation and software functions of the 7200 ACS.

Section 7.0, Maintenance, provides information necessary for maintaining the 7200.

Section 8.0, Engineering Drawings, contains the engineering drawings for the 7200 ACU and the drive cabinet.

Appendix A, Acronyms and Abbreviations, lists the definitions of all acronyms and abbreviations used in this manual.

Appendix B, 7200 ACU Password Protection, provides information to set, change, and clear user passwords from the 7200 ACS. It also provides information to disable password protection on the system.

Appendix C, 7200 Remote Monitor and Control, provides information useful for setting up remote communications with the 7200 ACS.

Appendix D, A/D Card Calibration Procedure, contains instructions for calibrating the Analog-to-Digital (A/D) card of the 7200 ACU. A field calibration may be necessary if operational problems are incurred, or if nonstandard tracking sources are used in the Automatic Gain Control (AGC) mode.

Appendix E, Two-Speed Resolver Calibration, provides instructions for calibrating the two-speed resolvers in the 7200 ACS.

Appendix F, Tracking Tutorial for Operators, provides instructions for quickly setting up tracking with the 7200 ACS, eliminating the need to read the step-by-step instructions in Section 5.0 of the manual.

Appendix G, 7200 Troubleshooting Guide, contains probable causes and corrective action for troubleshooting the 7200 ACS.

Appendix H, Vendor Data, contains detailed information related to the Sumitomo electronic motor controller modules (inverters) used in the drive cabinet. The vendor Operations and Maintenance (O&M) manual is also included.

Appendix I, 7200 ACU Menu Tree Software, contains the flow charts for the 7200 menu tree software version 2.10.11.

Appendix J, Technical Support, contains information on how to get technical support and includes a Technical Inquiry Fax Form.

1.4 Technical Support

The 7200 Antenna Control Unit (ACU) contains context-sensitive, on-line help that is easily accessible from any menu or submenu in the system by simply pressing the [HELP] key on the 7200 ACU's front panel. For operational problems, a troubleshooting guide is provided in Appendix G of this manual.

If assistance is needed that cannot be provided by accessing the on-line help or referencing this manual, please refer to Appendix J for instructions on how to obtain additional technical support.

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2.0 OVERVIEW OF THE 7200 ACS

2.1 General Information About the 7200 ACS

The 7200 ACS is an antenna pointing system, controlled manually or automatically, that positions the antenna to receive the peak signal from one or more communications satellites. The 7200 ACS uses microprocessor technology to provide accurate antenna positioning, high reliability, and maximum system flexibility. The system has the capabilities for rapid multiple satellite access, highly sophisticated predictive tracking with inclined orbit satellites, and RS-232C, RS-422, or IEEE-488 (Optional) remote control communications.

In two-axis applications, azimuth (AZ) and elevation (EL) controls are used to position the antenna. The three-axis applications uses AZ, EL, and polarization (POL) controls to position the antenna and feed assembly. The four-axes uses AZ, EL, and two polarization s (POL & 4TH AXIS) to control the position of the antenna and feed assembly. Variable speed inverters provide two-speed operation for AZ and EL with continuously variable drive rates over a range of approximately 50 to 1. The 7150 Drive Cabinet houses the drive controls and interfacing equipment to the 7200 ACS. The 7150 Drive Cabinet is normally mounted on the antenna foundation.

A large 8-inch by 4-inch electrouminescent display and a sensible, uncluttered keypad form a user interface which is fully menu-driven and includes context-sensitive help messages. With much detail paid to the man-machine interface, the 7200 ACU provides straightforward access to an extremely versatile ACS.

The 7200 offers a number of operational modes including manual jog control, several programmed positioning modes, "conventional" steptrack, and the revolutionary Orbit Prediction Track (OPT) mode. OPT provides tracking performance approaching that of monopulse control systems by combining efficient steptrack operation with advanced orbital propagation algorithms to produce a state-of-the-art, predictive tracking method. With OPT, the 7200 provides highly accurate tracking with minimal initial data approximately 1.25 hours for initial model development).

Two-speed motor control is provided as standard equipment, not through the use of expensive clutched arrangements or dual-wound drive motors, but with standard three-phase induction motors, controlled by solid state variable frequency inverters. This approach not only provides a reliable and cost-effective means of two-speed operation (with ratios of up to 50 to 1), but also allows for more precise positioning than conventional Alternating Current (AC) motor control systems which simply use contactors to switch motor power on and off. This is a result of the ability of the inverter to "ramp" the motor speed up or down in a controlled manner rather than simply removing motor power while at full speed. This can result in uncontrollable coasting and inevitable "overshoot" of the target.

An optional cable allows the user to remotely control the antenna axes, using the Portable Maintenance Control Unit (PMCU) located in the 7150 MCU.

2.2 System Specifications

As shown in Table 2-1, the 7200 ACS has specifications that reflect performance sufficient for virtually any communications system antenna, as well as Tracking, Telemetry, and Control (TT&C) applications. Tracking accuracy within 5 percent of the receive antenna beamwidth are achievable due to the advantages provided in the sophisticated OPT modeling. The overall tracking accuracy is related to the resolution of the angular position display system, which is configured according to individual system requirements.

TABLE 2-1 7200 ACS SPECIFICATIONS

FEATURE	DESCRIPTION
Tracking Accuracy	Nominally more than 10% of receive 3 dB beamwidth, RMS, in Steptrack mode. Nominally 5% of receive 3 dB beamwidth, RMS, with valid model in OPT mode (independent of orbit inclination).
Position Encoding	1)(Standard) Absolute, single-speed, brushless resolvers (size 11) and 16-bit monolithic LSI tracking resolver-to-digital conversion Integrated Circuits (IC's) with 0.02 RMS accuracy. 2)(Optional) Absolute, electrical two-speed, brushless resolvers (size 20) and paired LSI tracking resolver-to-digital conversion IC's with 0.01 peak accuracy. 3)(Optional) Absolute optical encoders w/accuracies to 0.001 per special order.
Front Panel Position Display Resolution	0.01 Standard 0.001 Optional (Available only with high accuracy encoding system options.)
Position Encoding Repeatability	Typically 1 LSB of resolver-to-digital conversion resolution
Input Power Requirements	Drive cabinet: 208 VAC, three-phase, 60 Hz, 5-wire WYE. Current requirements determined by motor horsepower. ACU: 120 VAC, 60 Hz; 200 VA (Nominal) *Other line voltage interfaces available per specification
Horsepower Range	1/2 to 20 HP; Others available per special order
ACU Tracking Receiver Interface	Analog(standard): Dual 0 to 10 VDC analog inputs, slope *0.2 V/dB; Contact closure outputs for selection of up to four tracking signals Serial (TRL Series Receivers): Via M&C port or optional additional serial port
Remote Communications Interface	RS-232C or RS-422 serial communications for remote monitor and control. IEEE-488 (GPIB) is available as an option.
Summary Alarm Output	Normally closed dry contacts, rated 24 VDC at 1 amp
System Interconnect Cabling	*ACU/drive cabinet interface (1) 25/C, #22 AWG *Resolver/ACU (2) three-shielded pair, #22 AWG (two-axis systems) *(3) three-shielded pair, #22 AWG (three-axis systems) *100 feet of interconnect cabling *Additional cabling is available up to a maximum length of 1500 feet *Two-speed and optical encoding systems cabling requirements specified for each requirement
Environmental	**Rack-mounted equipment:** Temperature - 0 C to + 50 C; Humidity - 90% non-condensing **Outside equipment:** Temperature - -40 C to +50 C (Low temperature package necessary below -10 C) Humidity - 100% condensing.

Specifications subject to change without notice.

2.3 System Configuration

Refer to Figure 2-1 for a typical overall block diagram of the integrated control system. Items shown with solid interconnection lines represent fundamental system components which provide automatic positioning for a two-axis system. Items connected with a dashed line represent typical system options such as a tracking receiver and/or POL motorization components or Customer-Furnished Equipment (CFE) remote Monitor and Control (M&C) equipment.

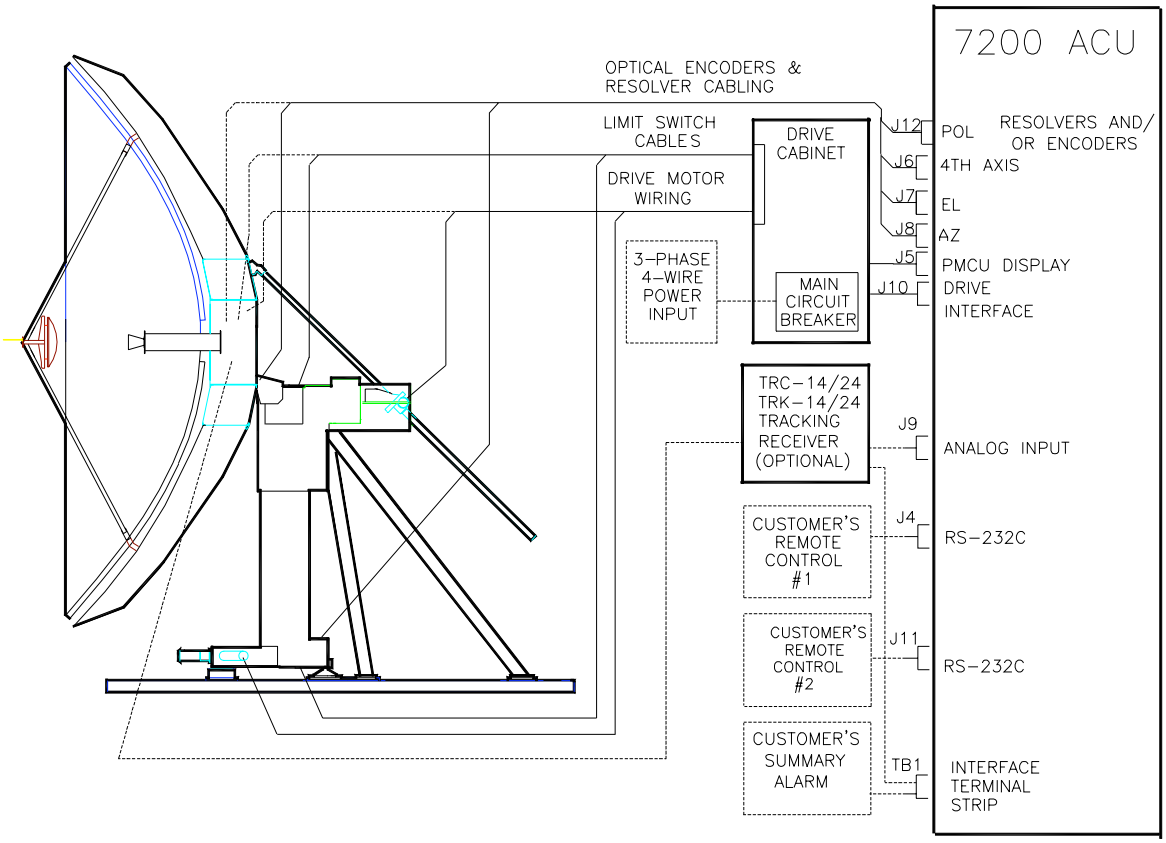

Figure 2-1 7200 ACS Block Diagram

The standard main input voltage for the drive cabinet is 208/120 Volts (V) AC three-phase WYE, or 380 - 415 VAC three-phase WYE; requiring a four-wire circuit, plus a ground conductor. The actual current/power requirements for a given system are essentially established by the drive motor characteristics with only a small portion being used for control logic power. Other input voltages and frequencies are available as options, as is single-phase input power (the drive motors remain three-phase in this case as the inverter modules perform the required conversion). The input power wiring connects to pressure-type lug terminals on the main circuit breaker housing inside the drive cabinet.

NOTE: In all cases, power wiring to the drive cabinet must be sized for the rated currents and voltage drop and installed by qualified personnel in accordance with local codes.

Power for each of the drive motors is supplied from the drive cabinet through double insulated cables which are run through conduit and other enclosures serving as cable plenums and pull boxes. The motor power conductors connect to pressure-type lugs on terminals in the drive cabinet and in the motor junction boxes. Motor power wiring is sized for rated currents and voltage drops and is protected by overcurrent devices as defined by the regulations of the National Electrical Code (NEC), International Electrotechnical Commission (IEC), and Institute of Electrical and Electronic Engineers (IEEE).

Overtravel limit switches for each axis are interfaced with the drive cabinet via double insulated control cabling. In the drive cabinet, drive interlock logic is provided for each direction of travel and a summary limit alarm is developed and provided to the ACU for display. The limit switch cables connect to pressure-type terminals at each limit switch and in the drive cabinet.

Axis drive commands and drive cabinet status signals are passed between the ACU and drive cabinet through a 25 conductor, #22 AWG cable with a maximum length of 1500 feet. The cable connects to a pressure-type terminal strip in the drive cabinet and terminates into a 25-pin female D-connector at the rear of the ACU.

The AZ, EL, and POL (three-axis systems) and AZ, EL, POL and 4TH AXIS (four-axis systems) transducers interface directly with the ACU via a shielded multiconductor cable for each device. The standard configuration includes single-speed, brushless resolvers that require six-conductor cables. The cables terminate to flying leads at the resolver via solder or positive crimp connections and terminate into male D-connectors at the ACU end (25-pin for AZ and EL; 9-pin for POL). Other types of position transducers, including high accuracy two-speed resolvers and absolute optical encoders, are available as options to accommodate critical accuracy requirements.

In applications requiring closed-signal-loop tracking (Steptrack and OPT), a Direct Current (DC) tracking signal is accepted through the ACU rear panel via a 9-pin D-connector. The nominal tracking voltage input is in the range of 0 to 10 VDC, with a slope of 0.2 V/decibels (dB) to 1.0 V/dB. Two A/D inputs are provided and the second may be used either as a backup for the primary channel or as an input for an alternate tracking source. Beacon select outputs are provided on a 7200 ACU rear panel terminal strip, allowing remote manual or automatic beacon selection with Vertex tracking receivers. If one of the optional Vertex TRL series of tracking receivers is used, signal strength and beacon selection functions may be provided via a serial link.

Full function remote control of the tracking system is facilitated through one or more serial links configured at the factory for either RS-232C or RS-422 operation. An IEEE-488, or GPIB, interface is also available. A form C summary alarm contact is provided on the ACU rear panel user interface terminal strip TB1.

2.4 System Hardware

The 7200 ACS consists of the following subsystems:

Model 7200 ACU
7150 Drive cabinet
Position Feedback Devices

The system interfaces with three-phase induction motors for AZ and EL positioning and a single-phase AC synchronous stepping motors for POL rotation. Limit interfaces are for normally closed switches that open upon engagement.

2.4.1 7200 ACU Hardware

The Model 7200 ACU is a technically advanced, specially designed, multitasking embedded control computer that includes input and output circuitry sufficient for interfacing with all other related tracking system components. The ACU hardware is based upon the industrial Versa Module Europe (VME) bus architecture, providing extreme versatility and reliability far above many other hardware platforms. Several printed circuit cards and peripheral subassemblies, described in subsequent paragraphs, are integrated in a custom chassis to comprise the ACU. The primary components of the 7200 ACU are:

Front Panel Display Assembly
Analog Daughter PCB
Dual Channel RDC - PCB
Optical Encoder I/O PCB
Optical Encoder PCB
Input/Output (I/O) PCB
Back Panel PCB
Two Power Supplies
Computer Printed-Circuit Board (PCB)
Single/Dual-Speed PCB
Keyboard PCB

The 7200 ACU front panel is shown in Figure 2-2. The 7200 ACU functional block diagram is shown in Figure 2-3. Figures 2-4 and 2-5 show the top and side view of the ACU respectively. (Refer to the engineering drawings in Section 8.0)

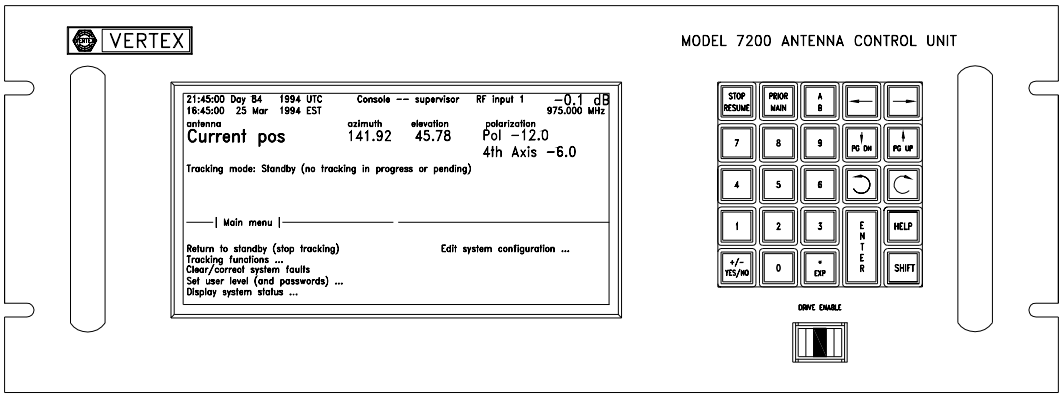

Figure 2-2 7200 Antenna Control Unit Front Panel

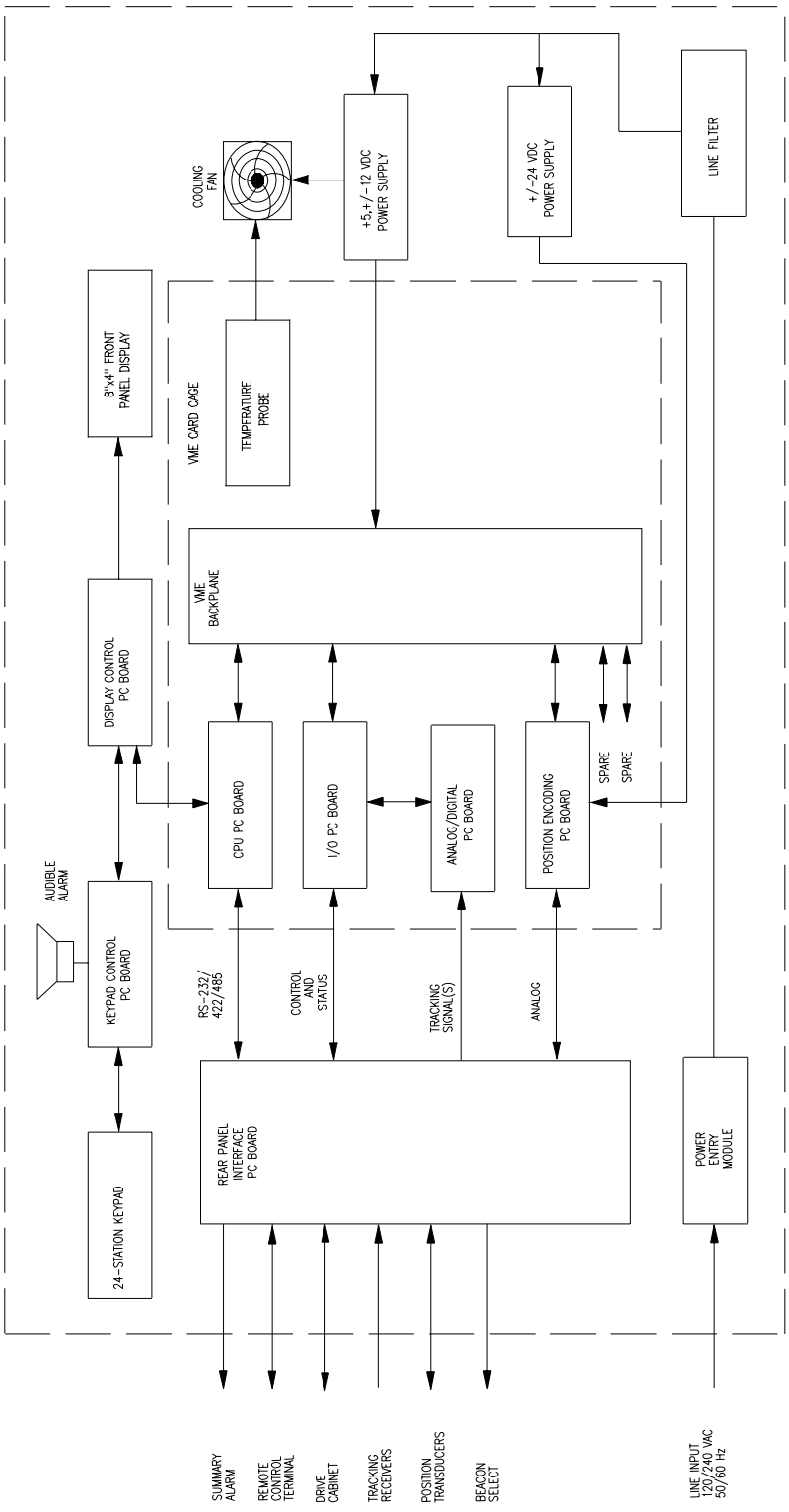

Figure 2-3 7200 ACU Functional Block Diagram

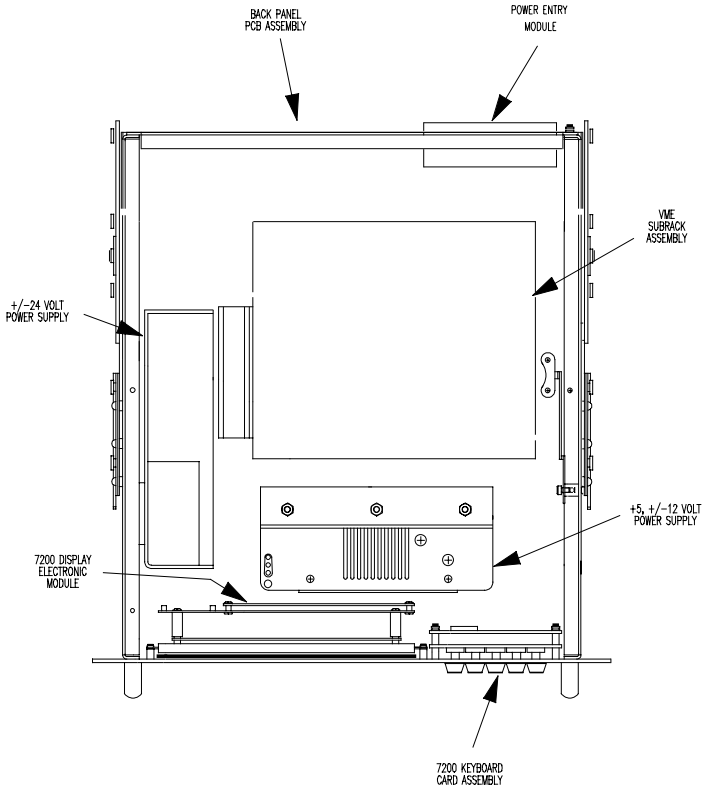

Figure 2-4 7200 Antenna Control Unit Top View

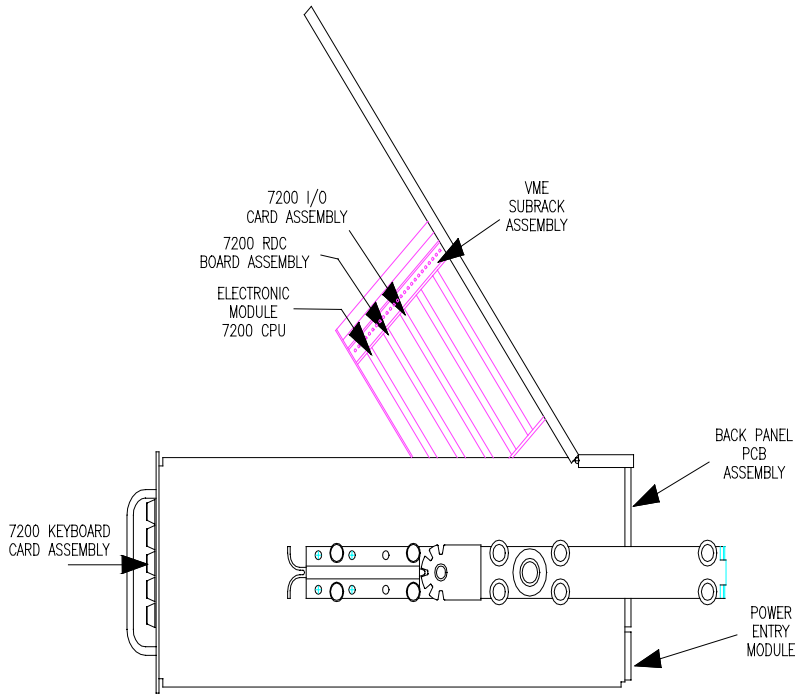

Figure 2-5 7200 Antenna Control Unit Side View

2.4.1.1 Central Processing Unit Circuit Card Assembly

The 7200 ACU uses the Motorola 68030 32-bit microprocessor as the Central Processing Unit (CPU), providing sufficient computing power for the sophisticated control and tracking algorithms used by the ACU. A dedicated VME CPU circuit card is provided, which includes the CPU, Read-Only Memory (ROM), Random Access Memory (RAM), bus control circuitry, and nonvolatile memory control circuitry, providing efficient and reliable system operation.

2.4.1.2 User Interface

One of the most striking and advanced features of the 7200 ACU is the user interface, which combines an 8-inch by 4-inch electroluminescent display with a custom 24-station keypad to provide the most straightforward, powerful, and user-friendly operating platform in the industry. As shown in Figure 2-2, the 7200 ACU front panel layout is uncluttered and offers a logical format for the display of information.

2.4.1.3 Input/Output Printed-Circuit Board Assembly

The I/O PCB provides the electrical interface between the ACU and the drive cabinet. In addition, the I/O card serves as the interface between the CPU and the ACU rear panel status inputs and control outputs, and also incorporates an A/D daughterboard with interfaces for the DC tracking voltage inputs. VME bus interface circuitry is also provided to accommodate the regulation of data transfer between the I/O circuit card and the CPU circuit card.

2.4.1.4 Resolver-to-Digital Converter Printed-Circuit Board Assembly

The Resolver-to-Digital Converter (RDC) PCB accepts analog inputs from the antenna-mounted resolvers (via the rear panel termination circuit card) and provides a binary digital encoded representation of the pointing angles for each axis to the CPU. VME bus interface circuitry is included, based upon CPU and RDC timing requirements. The standard configuration is for single-speed resolvers and 16-bit encoding; however, the RDC PCB can be configured to accept dual-speed resolver inputs and provide higher resolution as required. In addition, alternate means of position encoding are available, including high accuracy absolute optical encoders, in which case an alternate position interface circuit card is provided.

2.4.1.5 Optical Encoder Daughter Board (AZ and EL)

The OE daughter card is mounted on a standard I/O card. This card takes the EIA-422A serial encoder data and converts it to 24 bits for use by the CPU. Two CPLD's are employed to convert the buffered serial data to parallel data for use by the CPU. The card reads each encoder about 4000 times per second.

2.4.1.6 Dual Channel Resolver-to-Digital Converter Printed-Circuit Board Assembly (POL and 4TH AXIS)

The Resolver-to-Digital Converter (RDC) PCB accepts analog inputs from the antenna-mounted resolvers (via the rear panel termination circuit card) and provides a binary digital encoded representation of the pointing angles for the POL and 4TH AXIS to the CPU. VME bus interface circuitry is included, based upon CPU and RDC timing requirements. The standard configuration is for single-speed resolvers and 16-bit encoding; however, the RDC PCB can be configured to accept dual-speed resolver inputs and provide higher resolution as required.

2.4.1.7 ACU Chassis Assembly

The ACU is housed in a custom chassis assembly which mounts in a standard 19-inch Electronics Industry Association (EIA) rack, requiring 7-inches of vertical rack space. The nominal overall dimensions of the ACU chassis are: 7-inches tall by 19-inches wide by 20-inches deep. A five-slot VME card cage, which interfaces the CPU, I/O, and RDC PCB's, is mounted to the inside of the chassis top plate. The top plate is hinged at the rear of the chassis and includes a locking support arm to facilitate convenient front-side access to the card cage. The front panel display and keyboard and their respective control circuit cards are supported by studs connected to the front panel.

A VME backpanel PCB serves as the bus interface and DC power supply distribution system for the CPU, I/O, and RDC PCB's. Two of the five slots are available for future expansion and/or customized features.

A PCB mounted to the ACU rear panel accepts all external wiring and connectors (with the exception of the line cord) and serves as a "break-out" device with connections to each of the circuit boards in the card cage.

Two thermally controlled cooling fans are provided to ensure operation of the ACU internal components well within device ratings. The fans are powered from the +12 V supply and have sensors which monitor temperature in the card cage and adjust fan speeds accordingly.

Power for all ACU components is provided by two power supply assemblies which are mounted to the bottom plate of the chassis. The primary power supply is of the multiple output, switched mode type, providing output voltages of +5 and −12 VDC for all logic and control circuits, with the exception of some of the position encoding PCB circuitry. A secondary, linear power supply operating at −24 VDC is used to power sections of the RDC circuitry. Nominal power requirements for the ACU are 200 VA at 120 or 240 VAC, 50 or 60 Hertz (Hz).

Both power supplies used in the 7200 ACU have an automatic shutdown feature in case over-current or over-temperature conditions occur. The system also has a line fuse on the rear power entry module in case of catastrophic failure. Radio Frequency Interference (RFI) suppression is provided by an input line conditioning filter.

2.4.2 Antenna Drive Cabinet Hardware

The standard motor drive cabinet is a freestanding, foot-mounted aluminum NEMA-4X enclosure with overall dimensions of approximately 36-inches tall by 30-inches wide by 10-inches deep. The aluminum cabinet provides outstanding corrosion protection even in the harshest of environments.

A functional block diagram of the drive cabinet is shown in Figure 2-6.

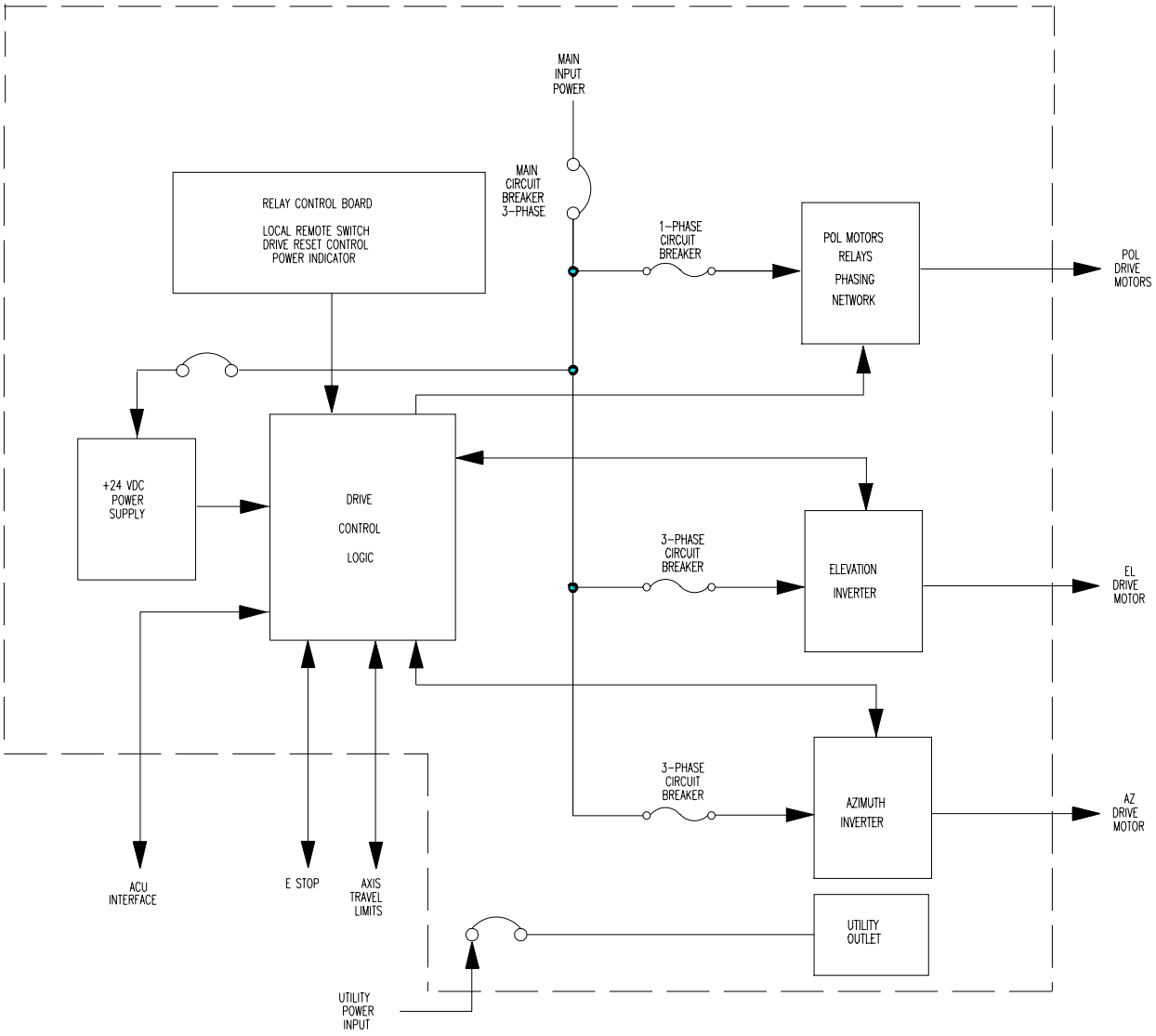

Figure 2-6 Drive Cabinet Block Diagram

The drive cabinet consists of the following major components:

Portable Maintenance Control Unit
Main and Inverter Drive Circuit Breakers
EMERGENCY STOP SWITCH
AZ Variable Speed AC Drive Unit (Inverter)
EL Variable Speed AC Drive Unit (Inverter)
24 VDC Power Supply
Control Circuitry for the POL Motors (In Three-Axis and Four-Axis Systems)

Figure 2-7 shows the major components of the drive cabinet. Refer to the engineering drawings in Section 8.0.

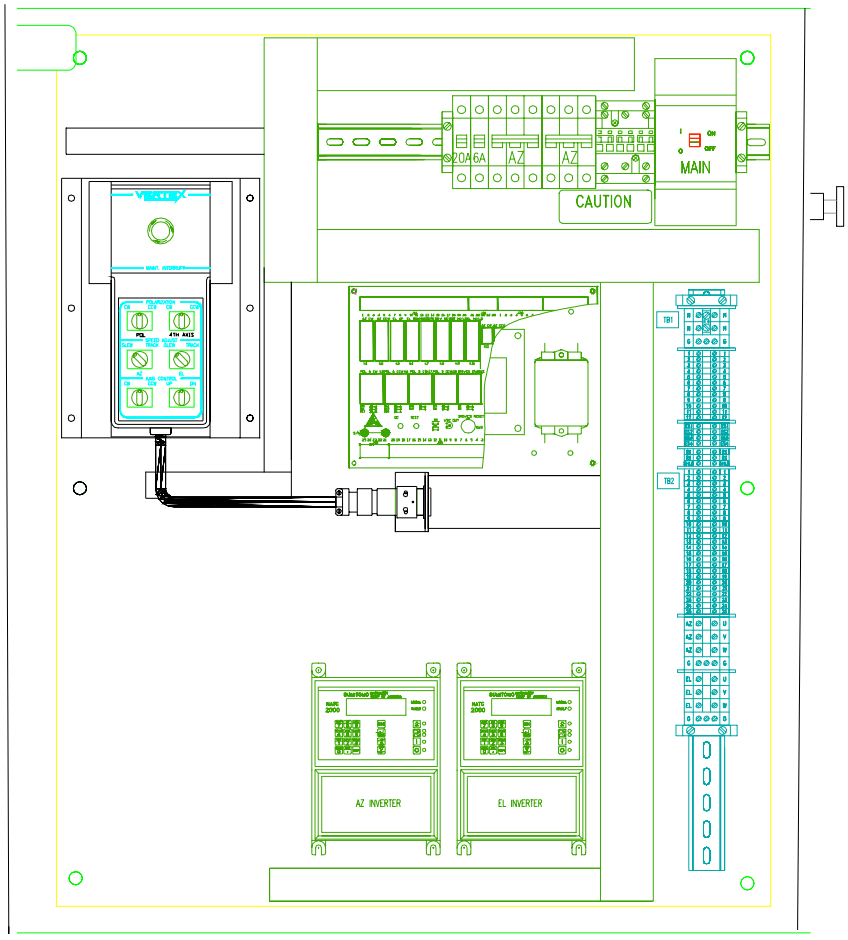

Figure 2-7 Drive Cabinet Assembly

The Portable Maintenance Control Unit (PMCU) located inside the 7150 Drive Cabinet allows the operator to control antenna movement from the proximity of the antenna.

The MAIN CIRCUIT BREAKER controls the main power to the drive motors, the limit switches, and the drive cabinet, but does not provide power to the 7200 ACU. Each inverter has an individual circuit breaker for protection.

The EMERGENCY STOP switch (on the outside of the drive cabinet), when pressed, removes power from the drive motors by opening the drive enable contactor.

The AZ and EL inverters provide pulse-width-modulated motor current, allowing continuously variable drive rates over a range of up to 50 to 1.

The 24 VDC power supply provides operating voltage to the drive cabinet relay circuit board.

Relay PCB accepts all limit switch status inputs and controls the commands to the inverter drives and the POL motors.

2.4.2.1 AZ and EL Drive Inverters

One of the critical advantages of the 7200 ACS over many other systems is the use of variable frequency drive inverters to control the speed of standard three-phase induction motors for AZ and EL antenna motion. This approach has several distinct advantages over the commonly used and simplistic on/off contactor control of motor power. First, inverters allow Vertex to offer two-speed control in a standard configuration without the problems associated with special dual-wound motors or clumsy clutching arrangements. Secondly, the inverters offer precision motor control by ramping motor speeds up and down in a controlled manner rather than simply switching full motor power on and off and having to contend with inertial coasting of the motor rotor and the related axis overshoot. In addition to these two distinct advantages, the inverter drives offer superior motor protection through sophisticated electronic motor overcurrent protection. Motor current is continuously monitored and compared against allowable levels for different conditions. Should the actual measured current exceed the allowable levels, the inverter trips and the drive is disabled. The inverter then has the capability to automatically reset and continue operation, provided the current remains within allowable limits.

2.4.2.2 Polarization Motor Control (POL and 4th Axis)

A three-axis system uses a Single-speed POL AC synchronous stepping motor for feed assembly rotation (**POL**). In the four-axis system a pair of Single-speed POL AC synchronous stepping motors are used for feed assembly rotation. Both POL motors are controlled and powered from the 7150 MCU. Drive power to the POL motor(s) is switched, according to the required direction of rotation, by relays located on the Relay PCB. A resistance-capacitance (RC) network in the drive cabinet provides the proper phase relationship to each motor.

2.4.2.3 Drive Cabinet Control Logic

Motor drive commands and interlock functions in the drive cabinet are performed with relay logic operating at +24 VDC, which is derived from a regulated power supply. Commands can be received from the ACU, or PMCU, for motor speed and direction. The **Drive Reset** is controlled from the Relay PC board and the **Emergency Stop** is located on the right side of the enclosure. The drive cabinet relay logic then commands the axis drives accordingly. Likewise, limit switches mounted on the structure activate relays in the drive cabinet upon engagement to form axis interlocks and provide the appropriate fault reporting to the ACU.

2.4.2.4 Local Control

Local (Maintenance) control of the antenna drives is facilitated through a set of switches on the PMCU in the drive cabinet. A MAINT/REMOTE switch located on the Relay PCB allows the operator to select between ACU control and local drive cabinet control. With the select switch set to the MAINT position, ACU control is disabled; however, all status reporting remains fully operational at the ACU.

2.4.2.5 Drive Cabinet Overcurrent Protection

As described in paragraph 2.4.2.1, "intelligent" electronic overcurrent protection is provided for AZ and EL drive motors by the variable frequency inverters. In addition, there are several other protection devices integral to the drive cabinet. The inverter inputs are individually protected by circuit breakers essentially to offer short-circuit protection in the event of a drive inverter catastrophic failure. The +24 VDC logic power supply line input a back panel mounted circuit breaker. In three-axis and four-axis systems, the POL motor circuit(s) are individually protected by a circuit breaker. A main input power circuit breaker is also provided, which serves as an internal disconnect for the entire cabinet.

2.4.2.6 AZ and EL Drive Motors

Three-phase induction gearmotor assemblies are utilized for actuation of the AZ and EL axes. The motors are sized based upon deadweight, frictional, and wind-loading requirements, as well as the required axis velocities. The standard motors can be connected for either 208 or 380 - 415 VAC three-phase input, based upon the line voltage available to the drive cabinet. The motors have sealed, permanent, synthetic grease lubricated bearings and the gearboxes are lubricated with synthetic gear oil, minimizing maintenance requirements.

2.4.2.7 Absolute Position Transducers

Angular position feedback is provided by absolute position transducers (resolvers) for each axis. The standard configuration includes size 11 single-speed, brushless resolvers which, combined with the position encoding circuitry in the ACU, yield an accuracy of 0.02 degrees, root mean square (RMS). The resolver reference voltage for the standard devices is 4.6 V RMS, at 2500 Hz.

Encoding system options include electrically wound two-speed resolvers or absolute optical encoders to provide increased resolution and accuracy. With the two-speed option, an overall control system accuracy of 0.01 degree peak error is achieved. In this configuration, dual monolithic resolver-to-digital conversion IC's are used in the ACU with bit rotation techniques incorporated to significantly increase binary resolution. Various optical encoder configurations allow for resolution and accuracy levels commensurate with the most demanding system applications.

2.4.2.8 Axis Overtravel Limit Switches

Overtravel is prevented in each direction for each axis of rotation by electrical limit switches with normally closed (open upon limit engagement) contacts. The switches are designed with double break contacts such that movement of the switch actuator in either direction opens a corresponding set of discrete contacts. In this manner, only one limit switch assembly is required for each axis. Each switch is mounted with bracketry which includes adjustable strikers for each direction of travel.

2.4.2.9 Drive Cabinet Low-Temperature Option

The standard 7200 ACS drive cabinet is rated to operate in an outside ambient temperature range of 14 F (-10 C) to 122 F (+50 C). For systems where the ambient temperature will fall below 14 F (-10 C), an optional low-temperature package is available for the drive cabinet.

For the low-temperature option package, a 200 watt forced air convection heater with integrated fan and wall insulation are installed inside the drive cabinet. Over current protection is provided by a individual circuit breaker sized to the wattage and input voltage of the heater. When the thermostat inside the drive cabinet registers a temperature below 41 F (5 C), the heater is activated and heats the air inside the drive cabinet. An external thermostat shuts the heater off when outside air exceeds 41 F (5 C). The heated air maintains the internal temperature of the drive cabinet to within the standard operating temperature range.

2.5 Controls and Indicators

The controls and indicators for the 7200 ACS are located on the ACU and inside the drive cabinet. The EMERGENCY STOP button is located on the outside of the drive cabinet and additional optional emergency stop switches may be provided at other locations.

2.5.1 7200 ACU Controls and Indicators

The controls and indicators for the ACU are located on the front panel and on the rear panel. The following paragraphs describe the functions of the ACU controls and indicators.

2.5.1.1 The Power On/Off Switch

The power on/off switch is located on the rear of the 7200 ACU in the power entry module. When the switch is set to the on position, power is applied to the two power supplies in the ACU.

2.5.1.2 The Alphanumeric Display

The 7200 ACU user interface combines an 8-inch by 4-inch electroluminescent display with a custom 24-station keypad to provide the most straightforward, powerful, and user-friendly operating platform in the industry. Figure 2-8 shows each section of the 7200 ACU display, and each section is described in detail in the following paragraphs.

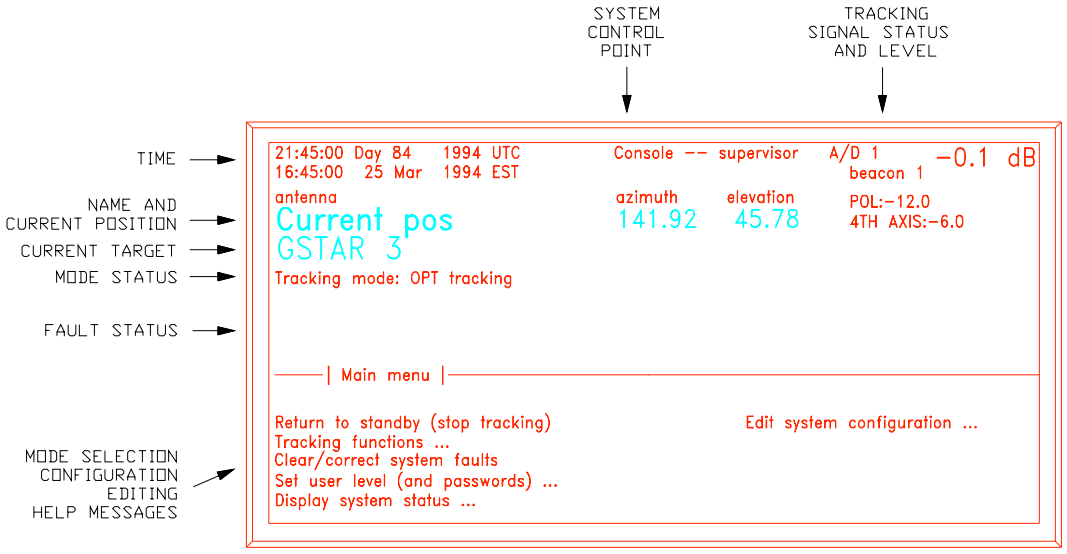

Figure 2-8 7200 Antenna Control Unit Display

The display is divided into upper and lower sections: the upper section (approximately 60 percent) is dedicated to real-time information display, and the lower section is used for interactive mode selection, configuration, editing, and help messages. In the real-time display section, "current pos" AZ and EL angles are displayed in single-high, single-wide characters. A user-configurable alphanumeric field to the left of the current position angles allows for labeling (naming) the display, primarily to aid identification in multiple-antenna stations. The line of information directly below the current position information (also double-high characters) identifies the target currently being accessed by the system. If the system is in the process of moving from one target to another, or in a program tracking mode of operation, the target (or next position) angles are also displayed directly below the current position angles.

Immediately below the target name field is a line of information that displays the current mode of operation and pending modes. The current target shown in Figure 2-8 is GSTAR III and the mode status line shows that the current tracking mode is **OPT**.

Shown in the field above the current position angles are current time [local and/or Coordinated Universal Time (UTC)], user level (**Monitor**, **Operator**, or **Supervisor**) and tracking signal status and level. Each of these items may be blanked out by the user if not required in a particular application (refer to paragraph 5.8.6.11, for information on user interface options).

System fault status is reported in inverse, double-high, double-wide characters in the field below the **Tracking mode** status line. In the event of multiple fault conditions, the fault messages are scrolled continuously at approximately one-second intervals. An audible alarm (if the alarm option is turned on) accompanies any major fault and may be silenced from the front panel keypad (refer to paragraph 5.8.6.11, for information on user interface options).

The lower portion of the display allows fully menu-driven selection of control modes, parameter editing, etc. A logical tree structure provides for easy and efficient system operation with minimal reliance upon system operation manuals. One item in each menu is always highlighted by an inverse-video cursor which is controlled by keypad direction keys. The [ENTER] key then selects the highlighted item either for mode selection or edit functions. A dedicated [HELP] key and context-sensitive help messages serve to remind the operator of operational procedures.

The display control PCB receives commands from the CPU through a serial link and provides appropriate decoding and driver functions for illumination of the display.

2.5.1.3 The Keypad

Commands from the keypad are decoded and serialized through a dedicated keypad control PCB and sent to the CPU through a serial link shared with the display control serial link. A speaker located on the keypad control circuit board provides an audible alarm for fault conditions. Refer to Table 2-2 for explanations of the function of each key.

TABLE 2-2 7200 ACU KEYPAD CONTROLS	
CONTROL	**FUNCTION**
	Moves the selection cursor up. The up arrow moves the cursor from the bottom item in the right column to the top of the left column, but does not wrap from the top of the left column to the bottom of the right column. Also used to toggle between preprogrammed choices for tracking modes, naming targets, etc. (refer to Section 5.0 of this manual).
	Moves the selection cursor down. The down arrow moves the cursor from the top item in the left column of a menu to the bottom of the right column, but does not wrap from the bottom of the right column to the top of the left column. Also used to toggle between preprogrammed choices for tracking modes, naming targets, etc. (refer to Section 5.0 of this manual).
	Moves the selection cursor to the right. In a multicolumn menu, the right arrow moves the selection cursor from the left column to the right column, but does not wrap the selection cursor from the right column to the left column.
	Moves the selection cursor to the left. In a multicolumn menu, the left arrow moves the selection cursor from the right column to the left column, but does not wrap the selection cursor from the left column to the right column.
PG DN	When pressed simultaneously with [SHIFT] key, changes display to the next page for multiscreen menus. Has no effect on single-screen menus.
PG UP	When pressed simultaneously with [SHIFT] key, changes display to the previous page for multiscreen menus. Has no effect on single-screen menus.
ENTER	Selects the currently highlighted item.
PRIOR	Returns to the last screen viewed before the user pressed [ENTER] or [HELP]. During in-line editing, restores data to the value it had before [ENTER] was last pressed.
MAIN	When pressed simultaneously with the [SHIFT] key, returns to the **Main menu**. **NOTE: If the [MAIN] key is pressed while editing data, all changes that have been made are lost.**
STOP	Stops movement of the antenna when pressed. KEYBOARD STOP flashes on the screen in double-high letters. If the audible alarm is turned on, the alarm sounds until the [SHIFT] and [RESUME] keys are simultaneously pressed.
RESUME	When pressed simultaneously with the [SHIFT] key, resumes tracking when a tracking mode is interrupted by keyboard stop.
HELP	Provides access to the context sensitive help screens from anywhere in the menu system.
SHIFT	Allows the use of the shift functions shown in white letters on the keyboard.
+/-	Used when entering numerical parameters if that range includes negative numbers. Also used to toggle between **Momentary** and **Sticky** keypad mode for the ACU keypad.
YES/NO	Toggles between YES and NO when setting parameters or when changing operating modes for the system.
A/B	Toggles the display between POL only, 4TH AXIS only, and POL and 4TH AXIS (Active on Four-axis system only)
	The period is used to choose between POL and 4TH AXIS in a four-axis system.
EXP	Used for entering exponents into numeric data fields.
	In **Manual antenna control** mode, moves POL clockwise (CW). Has no other use.
	In **Manual antenna control** mode, moves POL counterclockwise (CCW). Has no other use.
0 - 9	The numeric keys are used for entering numerical data. Hexadecimal digits A - F may be entered by pressing the [SHIFT] key and 0 - 5, respectively.

2.5.1.4 Drive Enable Switch

When the DRIVE ENABLE switch is in the out position, it is illuminated, and the drive motors are enabled through the drive enable contactor. When the DRIVE ENABLE switch is in the in position, and not illuminated, the drive motors are disabled, and a message is displayed on the screen of the 7200 ACU.

2.5.2 Drive Cabinet Controls and Indicators

The drive cabinet contains the following controls and indicators located on the PMCU and the Relay PCB. The functions of each control is described in Table 2-3.

TABLE 2-3 DRIVE CABINET PMCU AND RELAY PCB CONTROLS

CONTROL	FUNCTION
MAINT/REMOTE	The MAINT/REMOTE switch is located on the Relay PCB. When set to the REMOTE position, transfers control to the 7200 ACU. When set to MAINT > the PMCU has control of the system. The remote mode is selected when the switch is in the UP position. Maintenance mode is selected when the switch is in the DOWN position.
DRIVE S RESET	The DRIVE S RESET pushbutton is located on the Relay PCB. If the AZ or EL inverter trips, the RESET button restores operation.
AZIMUTH SPEED ADJUST	Located on the PMCU. SLEW SPEED/TRACKING SPEED select switch - Selects the AZ drive speed (functional in MAINT mode only). SLEW SPEED - This speed is programmed in to the AZ drive and sets the AZ high speed drive rate. TRACKING SPEED - This speed is programmed in to the AZ drive and sets the AZ low speed drive rate.
AZIMUTH CW & CCW SWITCH	Located on the PMCU, when this switch is turned to CW and held it rotates the Azimuth in the CW direction at the speed determined by the AZIMUTH SPEED ADJUST Switch until the switch is released. When the switch is released it returns to center and the motion ceases. This switch when turned to CCW and held rotates the Azimuth in the CCW direction at the speed determined by the AZIMUTH SPEED ADJUST Switch until the switch is released. When released the switch returns to center and the motion ceases.
ELEVATION SPEED ADJUST	Located on the PMCU. SLEW SPEED/TRACKING SPEED select switch - Selects the EL drive speed (functional in MAINT mode only). SLEW SPEED - This speed is programmed in to the EL drive and sets the EL high speed drive rate. TRACKING SPEED - This speed is programmed in to the EL drive and sets the EL low speed drive rate.
ELEVATION UP & DN SWITCH	Located on the PMCU. This switch when turned to UP and held rotates the Elevation in the UP direction at the speed determined by the AZIMUTH SPEED ADJUST Switch until the switch is released. When the switch is released it returns to center and the motion ceases. This switch when turned to DN and held rotates the Elevation in the DN direction at the speed determined by the AZIMUTH SPEED ADJUST Switch until the switch is released. When released the switch returns to center and the motion ceases.
CONTROL POWER CIRCUIT BREAKER	Provides circuit protection for the DC power supply that provides 24 VDC for control circuits.
CONTROL POWER LED	The Light-Emitting Diode (LED) is located on the Relay PCB and illuminates green when power is ON.
MAIN CIRCUIT BREAKER	Provides circuit protection for Entire drive cabinet power circuits.
DRIVE(S) CIRCUIT BREAKER	Provides individual circuit protection for each drive.
RECEPTACLE CIRCUIT BREAKER (if installed)	Provides circuit protection for the duplex utility outlet on the leg of the drive cabinet.

2.5.2.1 Inverter Controls and Indicators

Figure 2-9 describes the controls and indicators on the inverters inside the drive cabinet.

NTAC-2000 AC drives are supplied with a Digital Operator Interface (DOI) located on the front of the drive. The DOI can be used to operate the drive, change program parameters and to display drive operating conditions. See Figure 2-9 below for DOI layout and component identification. See the NTAC 2000 Drive instruction manual for detailed descriptions of these operators.

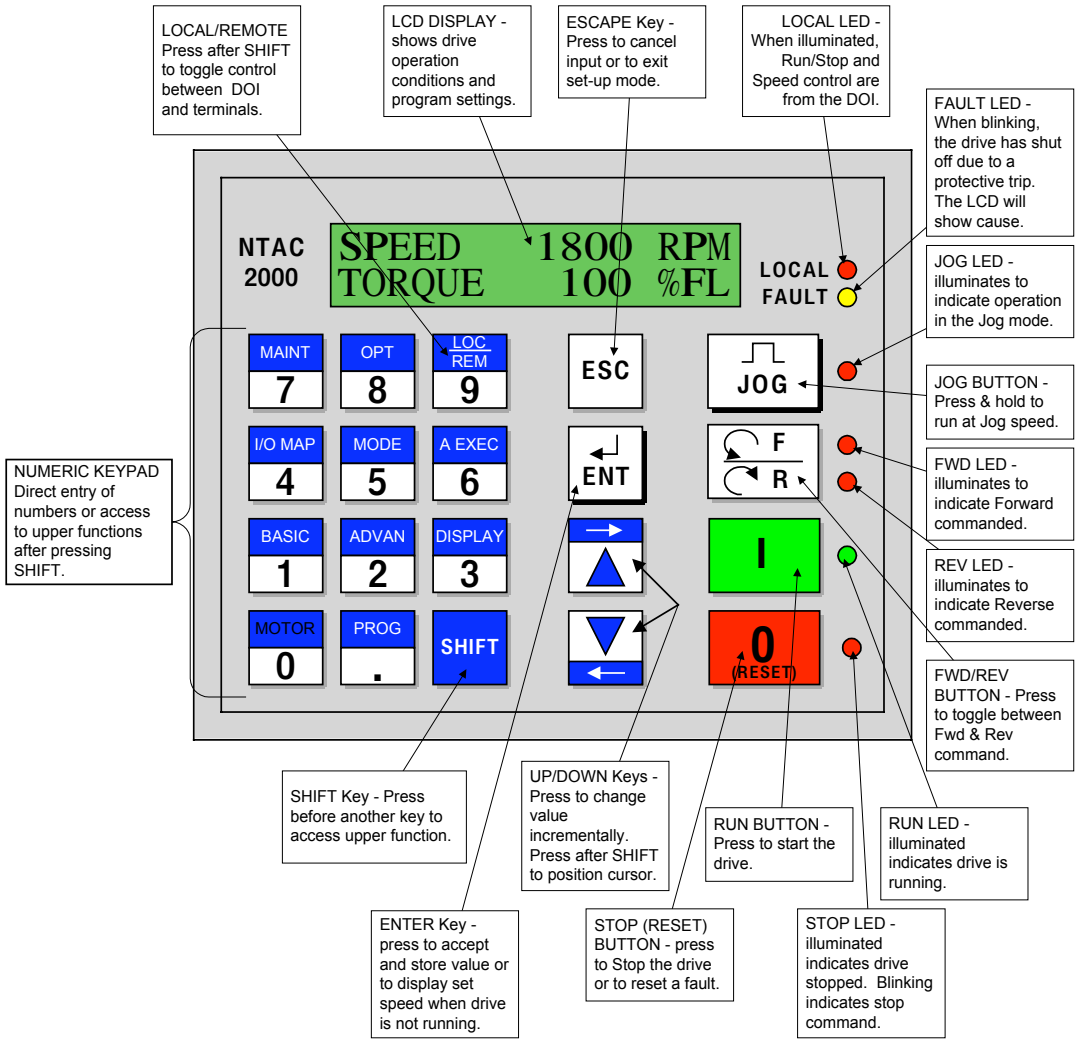

Figure 2-9 DOI Layout and Component Identification

WARNING

DO NOT USE THE FORWARD, REVERSE OR JOG BUTTONS ON THE INVERTER DRIVES TO MOVE THE ANTENNA. THE LIMIT SWITCHES WILL NOT STOP THE ANTENNA MOVEMENT AND POSSIBLE STRUCTURAL DAMAGE TO THE ANTENNA CAN OCCUR

2.5.2.2 Drive Cabinet Inverter (Motor Controller) Fault Status Reporting

The inverters in the drive cabinet monitor both internal and motor status and provide fault detection by displaying fault messages on the display on the inverter control panel and a contact closure on the line to the 7200 ACU. The fault messages are detailed in the NTAC 2000 instruction manual.

2.6 System Functions

The 7200 ACS offers a full complement of standard antenna position control modes as well as a number of advanced tracking modes. For automatic tracking, the 7200 ACS incorporates a new approach to control system operation with a unique target-oriented environment, which provides for the establishment of unique system characteristics for multiple targets (satellites). In this manner, each target to be accessed is user-configured with tracking mode, tracking signal frequency and slope, etc., and a target-specific data base is established for any predictive or programmed tracking data relative to the target. Once configured, tracking for a target is initiated and maintained in a fully automatic manner simply by invoking the "name" of the target. This greatly enhances normal operation of the system by reducing the level of required operator expertise and intervention.

Configuring a target includes the establishment of an operational mode to be used for accessing that target. The following paragraphs describe the available control modes for the system in some detail. It should be noted that configuration of a new target or editing of an existing target configuration is a relatively simple matter, with the ACU user interface prompting the user for any required information in logical order. As a result, the system essentially allows for direct mode entry with the target configuration being accomplished in real time. For more information on configuring targets, refer to paragraph 5.8.2.6.

2.7 Standby

In **Standby** mode, the antenna is not being commanded to move in any axis from the ACU. The AZ and EL inverters are powered-up but are not enabled, and brakes are set on systems equipped with brakes. Real-time status, time, signal level, and position information is being displayed on the ACU front panel along with any current fault information. In **Standby** mode, the ACU is in an active wait state for instructions from the front panel or computer interface.

2.8 Manual Control Via Portable Maintenance Control Unit (PMCU)

Manual control of antenna position is provided from the drive cabinet PMCU (Figure 2-10) or the ACU user interface.

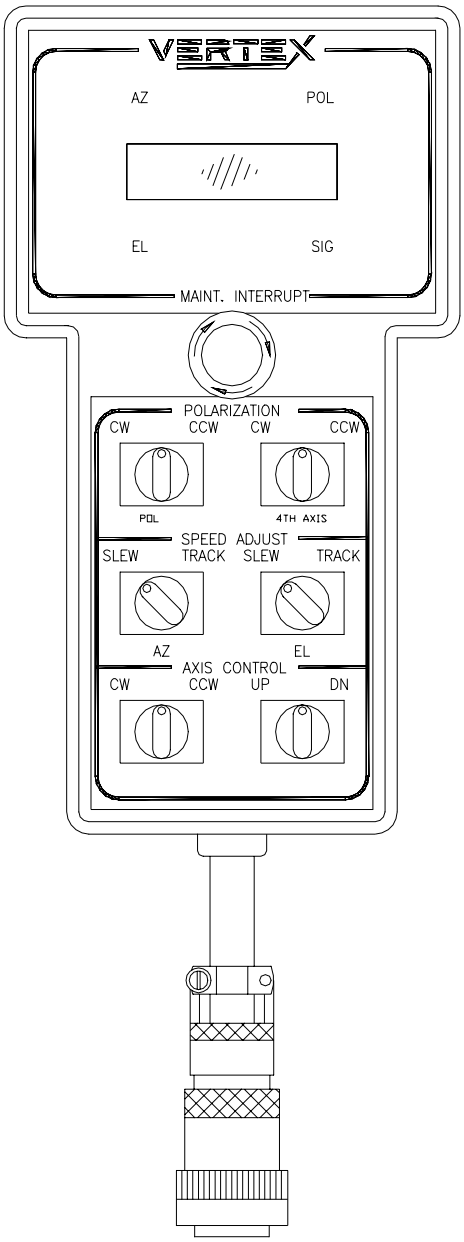

Figure 2-10 Portable Maintenance Control Unit

2.8.1 Manual Antenna Control from the Drive Cabinet

Manual control of each axis is provided at the drive cabinet using the PMCU, primarily to facilitate antenna maintenance. Setting the MAINT/REMOTE switch located on the Relay PCB panel to MAINT mode transfers control of the system to the PMCU, allowing maintenance to be performed on the system.

Therefore, with this switch in the MAINT position, the ACU cannot assume control. With the switch in the REMOTE position, the ACU has control of the system and the PMCU is inoperative.

2.8.2 Manual Antenna Control from the Antenna Control Unit

Real-time manual jog control is provided at the ACU by dedicated keys on the keypad (one key for each direction of travel) which are activated by selecting **Manual antenna control** from the ACU **Main menu** (refer to paragraph 5.8.2.5). For the AZ and EL axes, pressing the jog keys results in corresponding low speed motion of the antenna. Pressing the jog keys while pressing the [SHIFT] key results in high speed antenna motion. POL jog control (3-axis systems) is single-speed only. 4TH AXIS jog control (4-axis systems) is also single-speed.

2.9 Immediate Tracking

The 7200 ACU provides four immediate tracking modes as described in the following paragraphs. These tracking modes are accessed from the **Main menu** by selecting **Tracking functions...**. For more information on these tracking modes, refer to paragraph 5.8.2.4.

2.9.1 Move to Look Angles

In this mode of operation, the system moves the antenna to a preprogrammed set of AZ, EL, and POL(s) coordinates (look angles), and then actively maintains the antenna at that position. During the operation, the antenna is moved at slew (fast) speed until relatively close to the target, and then automatically switches to track (slow) speed for final positioning. Positioning is complete when the axis position feedback reflects antenna positioning to within a user-definable deadband around the target angles. (Refer to paragraph 5.8.2.4.1.)

2.9.2 Move to Longitude

This mode is identical to **Move to look angles**, except that the user enters a longitude on the geostationary arc instead of AZ and EL coordinates. The ACU computes the AZ and EL coordinates from the given longitude. (Refer to paragraph 5.8.2.4.2.)

2.9.3 Steptrack

Steptrack mode provides automatic periodic positioning of the antenna for maximum receive signal strength as measured at the ACU tracking signal input. The 7200 ACU utilizes the Vertex Adaptive Steptrack (AST) algorithm to perform the function of conventional steptrack peak signal optimization, eliminating the random "guessing" errors associated with predetermined fixed scan patterns. AST employs alternate AZ and EL peaking operations based upon a mathematical relationship between the change in receive signal level and a given change in angular antenna position. For each axis, an initial fixed-size step is taken, and signal strength levels before and after the step are used to determine the magnitude and direction of the corrective (peaking) step required. Once the peak position is determined, flags are set, indicating the direction of travel of the satellite so that the initial step for the next peaking operation will tend to move the antenna along the satellite ephemeris. This feature greatly reduces the errors introduced by the "wrong" guess made during significant portions of the daily satellite drift by algorithms which consistently make initial steps in a given direction.

Steptrack peaking operations are performed at user-definable time intervals, or when the receive signal level falls below a user-settable threshold. Steptracking parameters, including tracking signal frequency, cycle time, track threshold, etc., are established for each target, allowing maximum versatility for the system. (Refer to paragraph 5.8.2.4.3.)

2.9.4 Star Tracking

Automatic **Star tracking** is provided as an aid in performing antenna gain calculations by the radio star method. Such measurements require consistent, accurate positioning along the path of a star with relatively high velocity. This can be done by manual positioning, but automatic pointing allows for more accurate tests, performed in less time. Automatic pointing for stars including Cassiopeia A, Taurus, and Orion is supported, based upon site location coordinates.

2.10 Tracking Functions

The 7200 ACU allows a user to configure up to 50 targets for establishment of target-specific data bases (refer to paragraph 5.8.2.6). The following tracking modes are available:

Move to look angles (refer to paragraph 2.9.1)
Move to longitude (refer to paragraph 2.9.2)
Intelsat 11-element
Orbit Prediction Tracking (OPT)
Star tracking (refer to paragraph 2.9.4)

2.10.1 Intelsat 11-element Track

In this mode, the antenna is moved according to pointing data generated using the Intelsat Eleven Parameter Model. The ACU accepts element sets as distributed by Intelsat, as well as local site data, and calculates the corresponding predicted AZ and EL positions along the ephemeris. The antenna is then moved to the predicted positions with sufficient frequency to maintain pointing within a user-selectable deadband around the theoretical values. Again, the data for a given target is maintained in a dedicated data base for that target and is continually updated to provide appropriate positioning anytime the target is accessed (within time of validity constraints).

2.10.2 Orbit Prediction Tracking

The OPT system provides exceptional short-term and long-term pointing capabilities by combining orbital mechanics with modern modeling and error analysis techniques. Orbital mechanics are used to provide a model of the satellite's and earth's surface motion. The modeling and error analysis takes pointing data collected in **Steptrack** operations and finds the satellite orbital parameters and systematic errors caused by the mechanical structure which provide the best least squares solution. The orbital parameters and systematic errors are then fed back through the orbital mechanics models to determine antenna look angles at any future point in time. The models accurately match the "real world" and provide excellent real world results. (Refer to paragraph 3.1).

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3.0 THEORY

This section provides in-depth information on **OPT** and **Orbit scan**, two of the more advanced features of the 7200 ACS.

3.1 OPT

3.1.1 Orbit Prediction

OPT is the algorithm used by the 7200 ACS to predict the position of a spacecraft based upon its previous motion. The basic principle proposes that if the spacecraft's position, velocity, and all of the forces acting upon it are known, its position can be predicted at any time in the future.

An "OPT model" is what is referred to in orbital mechanics as an orbital element set. An orbital element set describes the position and velocity of an orbiting body at some particular time (the epoch time, or simply, the epoch). **OPT**'s position predictions are made by taking the orbital element set and using the data it provides, along with the computed forces acting on the spacecraft, to predict the position of the spacecraft at the desired time.

The prediction is performed using an algorithm called a propagator. A propagator takes an orbital element set at some epoch, and produces an orbital element set at a later epoch. **OPT** uses two different propagators in its operations:

Two-body propagator: Where only the earth's force on the spacecraft is considered and earth is modeled as a sphere with uniform mass.
Multibody propagator: Where the following effects on the spacecraft are considered:

- Earth's gravity, including a geopotential model (accounting for the nonuniformity of the earth's gravitational field).
- Sun's gravity.
- Moon's gravity.
- Solar radiation pressure on the spacecraft.

The two-body propagator is the simplest and fastest, and provides quick solutions while accounting for the most significant factor affecting the spacecraft's motion. The multibody propagator, although more complex, provides a more accurate model of the spacecraft's actual motion.

3.1.2 Orbit Determination

An orbital element set is composed by making an initial guess of the orbit and then generating positions from this guess, using the propagators described previously. These positions are compared with the positions gathered by AST. The differences between AST data and propagator-generated data are used to determine a correction to the orbit. The process is repeated until the RMS error between the AST data and the propagator-generated data is minimized. The algorithm used to perform this is referred to as the solver.

The orbit must be periodically re-solved in order to remain accurate. Theoretically, if all of the forces acting upon the spacecraft are known at any time, the orbital element set can be predicted forward to any desired time. However, all of the forces are not known at all times. The largest unknown force comes from the station-keeping maneuvers performed in order to keep the spacecraft in the desired orbit. Station-keeping is only performed periodically (typically once every few days). If the orbit is determined from data after a maneuver has taken place, then station-keeping has no effect on the validity of the orbit solution until a new station-keeping maneuver is performed.

The two-body propagator does not take into account any forces except those generated by the Earth's gravity, and even then, only a simplified model is used. A position prediction from a two-body propagator has an error that grows with time due to the omission of these forces in the orbit determination.

Neither propagator can account for varying effects on the ground. The primary ground errors affecting the system are:

Wind loading of the antenna.
Thermal distortion of the antenna, caused by non-uniform solar heating.

Both of these factors affect the data collected by AST. However, **OPT** is able to separate ground errors from the orbital solution by taking advantage of the fact that the spacecraft's motion must follow Newton's laws. This information is retained as two error terms, one per axis. These error terms are used to correct future position predictions.

3.1.2.1 Short-term and Long-term OPT Solutions

OPT generates three distinct types of orbital solutions:

Short-term solution using two-body propagator (ST)
Long-term solution using two-body propagator (LT2b)
Long-term solution using multibody propagator (LTmb)

All of these solutions are generated using the method described previously. The differences in the solutions are due to the time span of AST data used, and the propagator used. The ST will use up to the last 10 hours of data available, while the LT (2b and mb) will use up to the last 73 hours of data available.

Assuming that tracking is started on a target with no stored AST data, the first ST solution will be available for use approximately 90 minutes after tracking begins. The first LT2b solution will be available 18 hours after tracking begins. The first LTmb solution will be available 35 hours after tracking begins.

The choice of which solution is used for tracking is made by comparing, after each steptrack cycle, the peak position with the predicted positions from all available models. The solution which produces a position closest to the steptrack peak is used.

3.2 Orbit Scan

The 7200 ACU has a satellite locating algorithm referred to as **Orbit scan**. The purpose of **Orbit scan** is to locate satellites in inclined operation. This method is superior to other scanning methods such as Box Scan, Spiral Scan, or Raster Scan. Orbit scan will only search the most probable path of the satellite and not waste time in empty sky.

The **Orbit scan** mode is a user-selectable option on the **OPT** tracking. When correctly set up, **Orbit scan** will be used when no **OPT** solutions exist, and no signal is available at current pointing or at box center for the designated target.

3.2.1 Orbit Scan Theory

This scan method will only be effective for geosynchronous satellites in inclined operation. It is assumed that the satellite owners are attempting to hold nominal longitude and a near circular orbit.

The 7200 ACS creates a set of orbital parameters to place the ascending node at nominal longitude and provide the estimated inclination. The resulting trajectory will follow the most likely path for a satellite in this type of operation. From the site point of view, this produces a figure 8 (approximately) which is followed from box center. The system always starts by traveling north from box center, all the way around the figure 8 and back to box center (refer to Figure 3-1). This will work correctly regardless of site to satellite orientation. (Note: Figure 3-1 shows the scan in terms of latitude/longitude. The trajectory will look different in terms of AZ/EL based on site position and satellite position.)

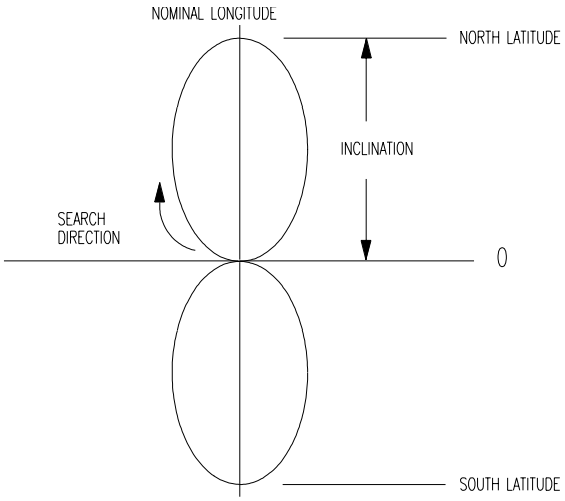

Figure 3-1 Orbit Scan Theory

3.2.2 Orbit Scan Operation

To use **Orbit scan** it is necessary to have correct site information loaded in the site parameters. When an **OPT** target is built, the user must provide the nominal longitude (degrees east) and an estimated inclination. Then the **Orbit scan** parameter must be enabled. (Note: The longitude range is NOT used by **Orbit scan** but is used to set up **Box limits** for the target's operation.)

When the target is selected for tracking, if no solutions are available, the system will follow this sequence. If **Box limits** are enabled, then **OPT** will check to see if the system is currently inside the box. If not, the system will go to box center. Then it will check for a signal. If no signal is received, and **Orbit scan** is enabled, **OPT** will calculate a satellite trajectory which places the ascending node at the nominal longitude and provides an inclination equal to the estimated inclination provided.

The trajectory is assumed to be a circular orbit with a sidereal period. This trajectory is then followed in steps equal to a 5 dB signal change based on the 3 dB beamwidth of the antenna. The signal level is monitored throughout the operation. If the level rises 0.5 dB above the **Low signal level** set for the target, the satellite is assumed to be acquired. If no satellite acquisition occurs after one pass, the system will stop at box center and issue an **OPT cannot track** alarm.

It should be noted that the **Orbit scan** is only used when no **OPT** solutions exist for a given target. Once a solution exists, the scan will NOT be used, no matter how old the solution may be or if there is no signal at the solution's position.

At acquisition, the system enters steptrack to peak the antenna and then begins standard **OPT** operation.

4.0 INSTALLATION AND INITIAL SETUP OF 7200/7150

WARNING

Always disconnect power before opening covers, doors, enclosures, gates, panels, or shields. Never make internal adjustments or perform maintenance or service when alone or fatigued. Main power connections and grounding should be performed by qualified personnel. Keep away from live circuits; be familiar with the equipment and don't take chances. In case of emergency, be sure to disconnect power before touching equipment or personnel in contact with the equipment.

4.1 Overview

This section of the manual provides the information necessary for the installation and initial setup of the 7200/7150 ACS for all modes of operation, including connection details for the remote serial interface. Appendix C of this manual contains the remote interface protocol.

The system installation and setup instructions are presented in the following general order.

Mechanical Installation
System Cabling
Power-Up and Setup

4.2 Mechanical Installation

4.2.1 Antenna-Mounted Components

Mechanical interfaces for the antenna and motors vary with the specific equipment provided and are detailed in the drawing package supplied with each antenna. Proper and complete installation of the motors, resolvers, and limit switches is imperative for safe and accurate system operation. Refer to the mechanical drawings supplied in the appropriate drawing package separate from this manual for mechanical interface details and complete this phase of installation first.

4.2.2 Installing the Drive Cabinet

Refer to Vertex foundation and conduit layout drawings for recommended locations of the drive cabinet. Use the following procedures to install the drive cabinet.

1. Locate the drive cabinet as close as possible to the antenna without obstructing the full range of antenna movements.

2. Center the drive cabinet over any conduit stub-ups to facilitate conduit termination and wire pulling.

3. Attach the drive cabinet to the foundation using at least two 1/2-inch concrete anchors on each leg.

4. Using a set of knock-out punches, punch conduit holes in the bottom of the drive cabinet to facilitate conduit entry. Install conduits.

4.2.3 Installing the 7200 ACU

Determine the location of the 7200 ACU in the rack. Refer to Figure 4-1 for details of rack mounting.

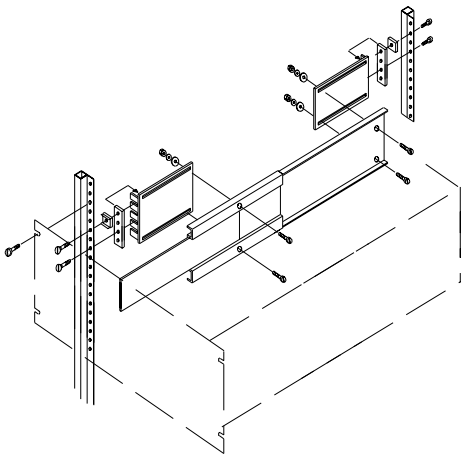

Figure 4-1 Mounting the 7200 ACU

1. In the rack rail, countersink the mounting holes for the threaded strip.

2. Install the threaded strips but do not tighten the bolts.

3. Insert mounting brackets between the rack and the threaded strips.

4. Install telescopic slides onto the mounting brackets but do not tighten.

5. Slide the 7200 ACU into the rack-mounted telescopic slides.

6. Adjust the rack-mounted telescopic slides until the ACU is level and slides smoothly in and out of the rack.

7. Tighten the threaded strips and the mounting brackets after the telescopic slides are adjusted.

8. Using four No. 10 screws, secure the 7200 ACU to the rack.

4.3 System Cabling

The following paragraphs describe the cabling and list the connections for the 7200 ACS. Cables must be connected from the antenna to the drive cabinet, from the drive cabinet to the 7200 ACU, and from the antenna to the 7200 ACU. Power must also be provided from CFE power distribution points to the drive cabinet and ACU. Be sure the cables are connected correctly and securely because proper functioning of the system during power-up is important for the protection of the equipment and for timely completion of the installation. Refer to Figure 4-2.

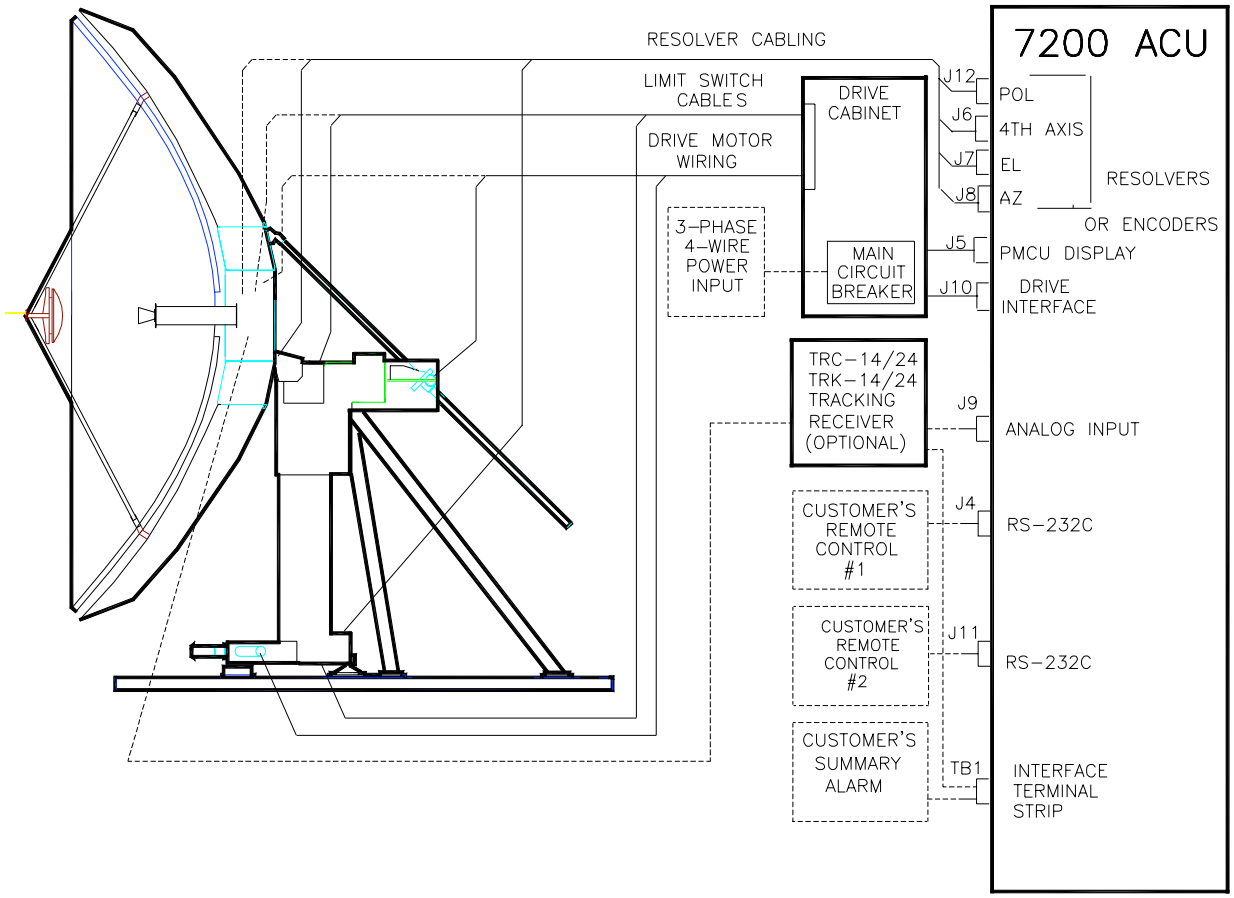

Figure 4-2 7200 Antenna Control System Cabling Diagram

4.3.1 Drive Cabinet Main Power Connection

Always follow applicable local electrical safety codes when installing wire and cables.

1. If conduit is not installed, use chase nipples with bushings or other suitable means to protect the wire and cables.

2. Check the main breaker size in the drive cabinet to determine required power conductor size for this installation.

3. If the wire from the distribution panel to the drive cabinet is long, increase wire size to keep the voltage drop to less than 5 percent of nominal.

> ***NOTE:*** ***The prime power required for the standard drive system is 3 phase WYE, 5-wire with ground. Other prime power configurations are available by special order. The neutral wire of the power system must be installed for proper operation.***

4. Connect the three-phase line leads to the line side (top) of the main circuit breaker in the upper right corner of the drive cabinet. Refer to Figure 4-3 for a drawing of the drive cabinet.

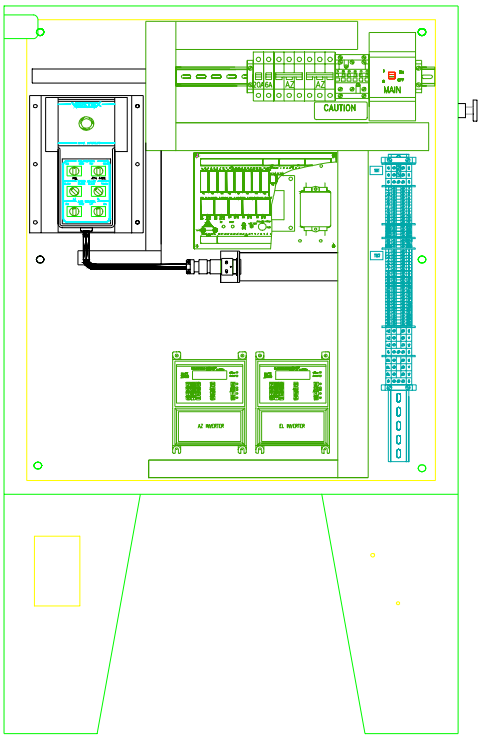

Figure 4-3 Drive Cabinet Assembly

5. Tag the neutral wire with white electrical tape and connect the wire to one of the large terminals marked N on TB1 in the lower right corner of the drive cabinet.

6. Tag the ground wire with green and yellow electrical tape and connect the wire to one of the large green terminal blocks labeled with a G or a ground symbol on TB1.

4.3.2 Connecting the Drive Motors to the Drive Cabinet

To connect the drive motors to the drive cabinet, refer to Table 4-1 and use the following procedures.

NOTE: The AZ and EL motors require 3-phase conductors and a ground conductor.

TABLE 4-1 MOTOR CONNECTIONS TO THE DRIVE CABINET

DRIVE CABINET TB1	DEVICE	FUNCTION
Az-U	Az Motor	Phase 1
Az-V	Az Motor	Phase 2
Az-W	Az Motor	Phase 3
EL-U	EL Motor	Phase 1
EL-V	EL Motor	Phase 2
EL-W	EL Motor	Phase 3
POL CW	POL Motor	POL Motor CW
POL CCW	POL Motor	POL Motor CCW
N	POL Motor	POL Motor Common
4TH AXIS CW	POL Motor	4TH AXIS Motor CW
4TH AXIS CCW	POL Motor	4TH AXIS Motor CCW
N	POL Motor	4TH AXIS Motor Common

1. Wire the AZ and EL motors for the appropriate system voltage by following the motor wiring diagrams inside the motor terminal box or on the motor nameplate.

2. Connect the AZ motor leads to TB1 terminals labeled Az-U, Az-V, and Az-W.

3. Connect the motor ground wire to the ground terminal.

4. Connect the EL motor leads to TB1 terminals labeled EL-U, EL-V, and EL-W.

5. Connect the motor ground wire to the ground terminal.

If 2-axis system perform steps 1-5.
If 3-axis system perform steps 1-9.
If 4-axis system perform steps 1-13.

6. Connect the wire from terminal 1 of the POL motor to the TB1 terminal labeled POL CW in the drive cabinet.

7. Connect the wire from terminal 3 of the POL motor to the TB1 terminal labeled POL CCW in the drive cabinet.

8. Connect the wire from terminal 2 of POL motor to TB1 terminal labeled N.

9. Connect the 4TH AXIS motor case ground to the ground terminal on TB1 in the drive cabinet.

10. Connect the wire from terminal 1 of the 4TH AXIS motor to the TB1 terminal labeled POL CW in the drive cabinet.

11. Connect the wire from terminal 3 of the 4TH AXIS motor to the TB1 terminal labeled POL CCW in the drive cabinet.

12. Connect the wire from terminal 2 of 4TH AXIS motor to TB1 terminal labeled N.

13. Connect the 4TH AXIS motor case ground to the ground terminal on TB1 in the drive cabinet.

4.3.3 Limit Switch Connections

Connect the limit switches to TB1-1 through TB1-9 on the drive cabinet as shown in Table 4-2. Note that normally closed (open upon limit) contacts are required.

TABLE 4-2 LIMIT SWITCH CONNECTIONS TO THE DRIVE CABINET

DRIVE CABINET TB1	DEVICE	FUNCTION
1	Az Limit Switch	Az CW Limit
2	Az Limit Switch	Az Limit Common
3	Az Limit Switch	Az CCW Limit
4	EL Limit Switch	EL Up Limit
5	EL Limit Switch	EL Limit Common
6	EL Limit Switch	EL Down Limit
7	POL Limit Switch	POL CW Limit
8	POL Limit Switch	POL Limit Common
9	POL Limit Switch	POL CCW Limit
10	4TH AXIS Limit Switch	4TH AXIS CW Limit
11	4TH AXIS Limit Switch	4TH AXIS Limit Common
12	4TH AXIS Limit Switch	4TH AXIS CCW Limit

4.3.4 Installing the 7200 ACU Control Cable

The procedures for installing the 7200 ACU control cable are different for the standard product and a system with the optional low-temperature package. For standard system installation, refer to paragraph 4.3.4.1, and for systems with the optional low-temperature package, refer to paragraph 4.3.4.2 for control cable installation procedures.

4.3.4.1 Standard System 7200 ACU Control Cable Installation

1. Connect one end of the 25-conductor control cable (Belden 8459 or equivalent) to the 25-pin connector labeled DRIVE INTERFACE (J10) on the back of the 7200 ACU (refer to Figure 4-4). Refer to Table 4-4A for a pin-out and the function of each conductor.

2. Connect the other end of the 25-conductor cable to the 25-point terminal strip TB2 inside the drive cabinet (refer to Table 4-4A).

TABLE 4-3 REAR PANEL CONNECTORS

REF DESIG	TYPE	GENDER
J4	DB-25	SOCKET
J5	DB-25	PLUG
J6	DB-9	SOCKET
J7	DB-25	SOCKET
J8	DB-25	SOCKET
J9	DB-9	PLUG
J10	DB-25	PLUG
J11	DB-25	SOCKET
J12	DB-9	SOCKET
TB1	20 PIN COMPRESSION	CARD EDGE

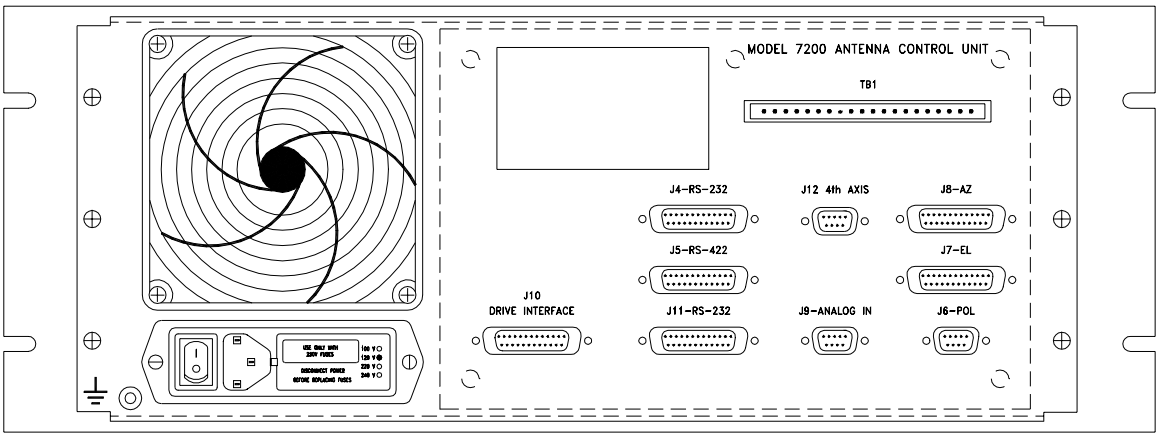

Figure 4-4 7200 Antenna Control Unit Rear Panel

TABLE 4-4A CONTROL CABLE CONNECTIONS		
DRIVE CABINET TB2	7200 ACU J10	FUNCTION
1	1	AZ CW Command
2	2	AZ Common
3	3	AZ CCW Command
4	4	EL Up Command
5	5	EL Common
6	6	EL Down Command
7	7	POL CW Command
8	8	POL Drives Enable Command
9	9	POL CCW Command
10	10	Summary Limit
11	11	4TH AXIS CW Command
12	12	4TH AXIS Drives Enable Command
13	13	4TH AXIS CCW Command
14	14	AZ Fault
15	15	EL Fault
16	16	E Stop Return
17	17	Sum Limit, Az Fault, EL Fault Common
18	18	Sum Limit, Az Fault, EL Fault Common
19	19	E Stop Command
20	20	No Connection
21	21	AZ High Speed Command
22	22	EL High Speed Command
23	23	Drives Enable
24	24	Local Maint Status
25	25	Local Maint Status Return

TABLE 4-4B CONTROL CABLE CONNECTIONS		
DRV CAB TB1	**7200 ACU J5**	**FUNCTION**
Rx(+)	19	RS-422 Receive
Rx(-)	6	RS-422 Receive Not
SHLD	20	Shield

4.3.4.2 Standard System 7200 ACU RS-422 Cable Installation

1. Connect one pair of the two twisted pair control cable (Belden 8162 or equivalent) to the 25-Pin connector labeled (J5) RS422/485 on the back of the 7200 ACU (refer to Figure 4-4). Refer to Table 4-4B for a pin-out and function of each conductor.

2. Connect the other end of the two-twisted pair cable to terminal strip TB1 inside the drive cabinet (Refer to Table 4-4B)Cabinet (refer to Table 4-3).

4.3.4.3 Portable Maintenance Control Unit (PMCU) With Position Display Option Installation

The PMCU with Position Display (Optional) is provided for local control at the antenna. It is located inside the 7150 MCU.

4.3.4.3.1 PMCU Connections

The following table gives the terminal numbers and a description of the terminals of the PMCU terminal strip (J5) on the relay Printed Circuit Board (PCB) and the MS connector located on the back plate of the 7150 drive cabinet. The connections on TB1 are for the RS-422 that is used on the optional PMCU display. This information is for reference only.

TABLE 4-5 PMCU CONNECTIONS

RELAY PCB "J" CONNECTORS	DESCRIPTION	MS CONNECTOR PIN OUT
J5-1	INTERRUPT RTN	B
J5-2	MAINT. INTERRUPT	A
J5-3	AZ CW	N
J5-4	AZ/EL COMMON	E
J5-5	AZ CCW	P
J5-6	AZ SLEW	J
J5-7	EL UP	L
J5-8	EL DN	M
J5-9	EL SLEW	K
J5-10	POL CW	G
J5-11	POL COMMON	F
J5-12	POL CCW	H
J5-13	4TH AXIS CW	C
J5-14	4TH AXIS CCW	D
J5-15	NC	
J5-16	NC	
J4-13	+24 VDC	W
J4-11	VDC COMMON	X
TB1 TERMINAL STRIP		
RS-422 Rx	RS-422 RECEIVE	R
RS-422 $\overline{\text{Rx}}$	RS-422 RECEIVE NOT	S
SHLD	SHLD	T
	NC	U
	NC	V
	NC	Y
	NC	Z

4.3.4.3.2 PMCU Display Setup

In order for the PMCU display to operate, the serial link connections must be in place between the ACU and drive cabinet, and the RS422 (J5 or Port 2) serial port must be setup properly in the ACU. Failure to perform the following steps will result in a **LINK LOSS** fault on the PMCU display. The PMCU will still be able to control the antenna locally.

1. Complete the serial link connections between J5 (RS422) on the ACU and TB1 in the drive cabinet. Refer to Table 4-4B for connection description. Refer to Table 4-12 for a complete RS422 pin-out of port J5.

2. From the 7200 ACU Main Menu, select **Edit System Configuration Remote Port Configuration**. Setup the following parameters. Please be aware that you must save the changes to the port configuration before the new settings become valid.

   Port = 2
   Baud (bps) = 9600
   Parity = None
   Data bits = 8
   Stop bits = 1
   Shell = PMCU
   Handshake = None

4.3.5 Resolver Connections (4th Axis System Only)

Connect each end of the respective cables to the POL resolver and J6, and the 4th Axis resolver and J12. Use the following correlation shown in Table 4-6A. J6 & J12 are 9-pin D connectors. Refer to Figure 4-4 for location of the connectors on the ACU.

NOTE: Connect shield leads at the ACU connector end only. Do not allow the shield leads to come into contact with one another or with the resolver case. At the antenna end, tape each lead separately. Connecting shields at both ends creates a current path (ground loop) which may cause erratic position readings.

TABLE 4-6A RESOLVER CONNECTIONS

7200 ACU J6, & J12	FUNCTION	RESOLVER LEAD COLOR
2	R1	Red/White
8	R2	Yellow/White
9	S1	Red
5	S2	Yellow
4	S3	Black
3	S4	Blue
1,6,7	Shield	Not Connected at Resolver

* Shielding pairs: R1-R2, S1-S3, S2-S4.

The connections for two-speed, size 20 resolvers are provided in Table 4-6B. Connect each end of the respective cables to the AZ resolver and J8, and the EL resolver and J7, following the correlation shown below. J7 and J8 are 25-pin D connectors. Refer to Figure 4-4 for location of the connectors on the ACU.

TABLE 4-6B
RESOLVER CONNECTIONS (SIZE 20) TWO-SPEED

7200 ACU J7, J8	FUNCTION	RESOLVER PIGTAIL LEAD COLOR AND CIRCULAR CONNECTOR PIN NUMBER	
2	R1	Red/White	6
8	R2	Black/White	7
9	S1	Red	1
5	S2	Yellow	4
4	S3	Black	2
3	S4	Blue	5
10	S11	red/green	8
13	S12	yellow/green	11
11	S13	black/green	9
14	S14	blue/green	12
1,6,7,12,15	Shield	Not Connected at Resolver	
No Connection	Reserved	3	
No Connection	Reserved	10	

* Shielding pairs: R1-R2, S1-S3, S2-S4, S11-S13, S12-S14.

If position readouts bobble or do not track to antenna motion, refer to Section 5.0 in Appendix G, Troubleshooting Guide, of this manual.

4.3.5.1 Optical Encoder Connections (Optional)

This section applies only if optical encoders are used for the azimuth and elevation transducers.

TABLE 4-7
OPTICAL ENCODER CONNECTIONS

7200 J7, J8	FUNCTION	800499-02 800695-J4	800499-01 800481-P1
15	CLK	1	1
16	CLKN	2	2
17	SHLD (CLK)	N.C.	N.C.
18	CLK2	7	N.C.
19	CLK2N	8	N.C.
20	SHLD (CLK2)	10	NC
21	DAT	3	3
22	DATN	4	4
23	SHLD (DAT)	9	NC
24	+24V	5	5
25	+24V RTN	6	6

TABLE 4-8 OPTICAL ENCODER CONNECTIONS TABLE			
OPTICAL ENCODER COLOR	**FUNCTION**	**800499-02 800695-J1**	**800499-01 800481-P2**
PUR	CLK	1	1
YEL	CLKN	2	2
GRY	DAT	3	3
PNK	DATN	4	4
BRN/GRN	+5V	7	7
WHT/GRN	GND	8	8
BRN	UA1	9	5
GRN	UA1R	10	6
RED	UA2	11	9
BLK	UA2R	12	10

NOTE: The table below applies **only** with the optional Position Display Unit.

TABLE 4-9 POSITION DISPLAY UNIT TABLE		
POSITION DISPLAY UNIT J1, J2	**FUNCTION**	**AZIMUTH & ELEVATION OPTICAL ENCODER J-BOXES J3**
15	CLK	1
16	CLKN	2
17	SHLD (CLK)	NC
18	CLK2	7
19	CLK2N	8
20	SHLD (CLK2)	10
21	DAT	3
22	DATN	4
23	SHLD (DAT)	9
24	+24V	5
25	24V RTN	6

4.3.6 Analog Input Connections

Two analog input ports are provided on the 7200 ACU via J9 on the rear panel (Refer to Figure 4-4). Internally, the analog inputs connect to A/D converter circuits that condition tracking signal inputs for use by the main processor. Dual analog inputs and A/D circuitry provide a spare channel in case of primary channel failure or for signal input from an auxiliary source.

Each analog input has (+), (-), and GND terminals to facilitate devices with isolated or differential outputs. In most cases, the (+) output of the tracking receiver connects to the (+) analog input, and the common or (-) output of the tracking receiver connects to the (-) analog input with no further connections required. The analog input voltage range is 0 to 10 VDC. The voltage per dB slope range is 0.1 to 1.0 V/dB.

Refer to Table 4-10 and connect the analog inputs to J9 (9-pin D-connector) on the rear panel of the 7200 ACU.

TABLE 4-10
ANALOG INPUT CONNECTIONS

J9	DESIGNATION	FUNCTION
1	GND	Sig Ground
2	AD1 +	Channel 1(+) *
3	AD1 GND	Channel 1 (GND)
4	AD2-	Channel 2(-) *
5	SPARE	No Connection
6	GND	Sig Ground
7	AD1-	Channel 1(-) *
8	AD2 +	Channel 2(+) *
9	AD2 GND	Channel 2 (GND)

* Standard connection procedure.

4.3.6.1 A/D Card Calibration

A calibration procedure is normally performed at the factory as part of the product configuration, therefore a field calibration is only performed if operational problems due to drift are encountered at a later date, or if different video receivers are used in the AGC mode. Should field calibration be necessary, refer to Appendix D for the calibration procedure.

The A/D converter daughter card is used to convert analog DC voltage levels representing tracking signal levels into a digital format suitable for the 7200 ACU processing routines. It has two independent converter channels, each of which has the capability of converting linear tracking receiver voltage levels or video AGC voltage levels into a digital format. Refer to engineering drawings Section 8 for a schematic and pictorial view of the following discussion.

Site designators in parentheses indicate the channel 2 signal path. The input signal is coupled into the board through J9R. From here the signals are routed to JP1 (JP2) which either couples the signal into U4 (U5) for AGC mode operation or bypasses the operational amplifier chain. The signal then goes into the A/D converter U1 (U2) where it is digitized using a dual slope integrating converter.

TP1 (TP2) are test points which when used in conjunction with TP3, (analog ground), enable the user to monitor the actual voltage being presented to the card.

TP4 (TP5) are test points which when used in conjunction with TP3, (analog ground), enable the user to monitor the voltage being presented to the A/D converter. This can vary from the input at TP1 (TP2) if the AGC mode is selected.

JP1 (JP2) select either the linear or the AGC mode of operation. Position 'A' routes the input through the operational amplifier chain for AGC mode. Position 'B' couples the signal directly into the A/D converter.

R2 (R16) form a resistive divider network which adjusts the integrating converter's U1 (U2) reference voltage.

R14 (R26) is an offset adjustment potentiometer that sets the nominal AGC input voltage to linearized tracking output voltage operating point.

4.3.7 Remote Communications Connections

Tables 4-10 and 4-11 provide the connections for the remote communication ports to the 7200 ACU. Refer to Appendix C for information on the remote communications protocol. The standard 7200 ACU is configured for RS-232C communications via J4 and J11.

TABLE 4-11
STANDARD COMMUNICATION PORT CONNECTIONS (RS-232C)

J4,J11	DESIGNATION	FUNCTION
1	PROT GND	Protective Gnd
2	RS-232 XDATA	Transmit
3	RS-232 RDATA	Receive
7	SIG GND	Sig Gnd

TABLE 4-12
COMMUNICATION PORT CONNECTIONS (RS-422)

J5	DESIG	FUNCTION
1	GND	Ground
2		
6	XDATA-	Transmit (-) *
9	RDATA-	Receive (-) *
15		
16		
19	XDATA +	Transmit (+) *
20	XDATA SHLD	Transmit Shld *
22	RDATA +	Receive (+) *
23	RDATA SHLD	Receive Shld *

* Standard connection scheme for RS-422 port.

NOTE: When using PMCU with Display COMM Port J5 is not available for use with an M&C system.

4.3.8 Remote Beacon Select and Summary Fault Connections

TB1 on the 7200 ACU rear panel provides a summary fault output (normally closed dry contacts) and four contact closures for remote beacon selection. The fault contacts have continuity between them under normal conditions but provide an open circuit under fault conditions. The terminals for remote beacon select are open circuits for the respective beacon 1 through 4 unless that beacon is selected through the 7200 ACU front panel. Thus, the customer interface beacon contacts for any selected beacon provide a closed circuit, allowing the flexibility of switching beacon channels and/or sources on compatible equipment. The remaining IN and OUT terminals are reserved for future use.

Refer to Table 4-13 and make the appropriate connections to TB1 on the 7200 ACU rear panel.

TABLE 4-13
REMOTE BEACON SELECT AND SUMMARY FAULT TERMINAL STRIP

TERMINAL (TB1)	FUNCTION
1	Summary Alarm Out
2	Summary Alarm Return
3	Beacon 1 Out
4	Beacon Common
5	Beacon 2 Out
6	Beacon Common
7	Beacon 3 Out
8	Beacon Common
9	Beacon 4 Out
10	Beacon Common

Pins 4, 6, 8, and 10 are jumpered together and tie into the COM terminal on the Vertex tracking receivers. Pins 3, 5, 7, and 9 connect to the appropriate Bn terminal on the tracking receiver. Pin 1 is on the left end of TB1 with the user facing the rear of the 7200 ACU.

4.4 Initial Power-Up and System Setup

Before proceeding with system power-up, check all system cabling and termination for correctness and integrity. Then proceed, in the order presented, with the following items. Because the antenna may be moved from the control panel of the drive cabinet, independent of the ACU, system start-up will be initiated at the drive cabinet.

4.4.1 Drive Cabinet Power-Up and Initialization

The inverters have no internal adjustments; therefore, before power-up the covers of the inverters should be in place.

4.4.1.1 Initial Power-Up

1. Verify that the following conditions exist at the respective drive cabinet controls:

    a. CONTROL switch set to the LOCAL position
    b. CONTROL POWER switch set to ON
    d. EMERGENCY STOP button pulled out

2. Apply power to the drive cabinet by setting the MAIN CIRCUIT BREAKER to ON. Turn on all other breakers. The green indicator LED in the center of the CONTROL POWER circuit breaker should illuminate at this time. Also, the displays on the inverters should become active.

4.4.1.2 Pulse-Width Modulation Inverter Drive Setup (AZ/EL Drv Modules)

The intelligent, variable speed motor control modules incorporated in the drive cabinet for AZ and EL require correct setting for a number of operational parameters. All parameters should be set correctly from the factory, but the procedures in paragraph 4.4.1.2.1 should be followed to ensure that the correct settings have been retained. Additionally, some codes may have to be altered during system installation to fine-tune system performance.

4.4.1.2.1 Function Parameters

NTAC-2000 AC drives are supplied with a Digital Operator Interface (DOI) attached to the front of the drive. The DOI can be used to operate the drive, change program parameters and to display drive operating conditions. Figure 4-5 below for DOI layout and component identification. See the NTAC 2000 Drive instruction manual for detailed descriptions of these operators.

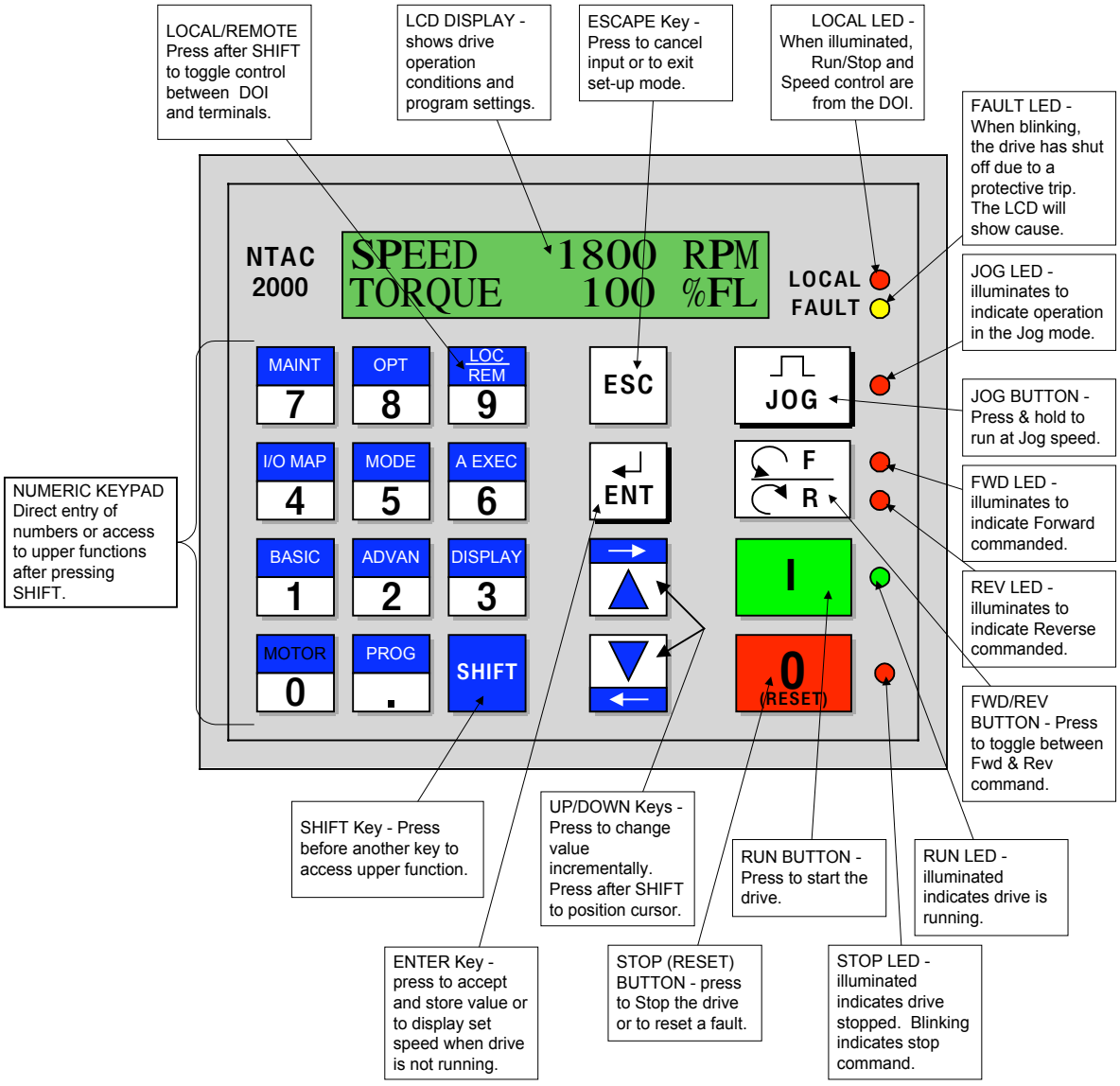

Figure 4-5 DOI Layout and Component Identification

WARNING

DO NOT USE THE FORWARD, REVERSE OR JOG BUTTONS ON THE INVERTER DRIVES TO MOVE THE ANTENNA. THE LIMIT SWITCHES WILL NOT STOP THE ANTENNA MOVEMENT AND POSSIBLE STRUCTURAL DAMAGE TO THE ANTENNA CAN OCCUR.

4.4.1.2.2 NTAC 2000 Inverter Drive Setup (Function Parameters)

All parameters are set at the factory. VCSD has modified some of these parameters.

TABLE 4-14 NTAC 2000 DRIVE PARAMETERS			
FUNCTION NUMBER	**AZ INVERTER**	**EL INVERTER**	**FACTORY & VCSD SETTINGS**
11			**Motor Voltage;** **Set to Nameplate rating on motor**
12			**Motor Full Load Amps** **Set to nameplate rating on motor**
13			**Motor HP** **Set to nameplate rating on motor**
14			**Motor rated Frequency** **Set to nameplate rating on motor**
15			**Motor rated Speed** **Set to nameplate rating on motor** See Note 3
16	USE ONLY THE STANDARD AUTOTUNE FUNCTION IT DOES NOT ROTATE THE MOTOR. ****WHEN ANY PARAMETER IS CHANGED, THE AUTOTUNE MUST BE REDONE****		
18			**80 RPM**
101			**0.8S**
102			**0.8S**
111			**Set to 10% of motor nameplate RPM.** **See Note 2**
112			**Set to motor nameplace RPM.** **See Note 1**
201			**3**
202			**0.5**
204			**TRUE**
205			**FALSE**
225			**10**
303			**I OUT (A)**
402			**RUN FWD**
403			**RUN REV**
404			**RESET**
414			**0.0V**
421			**FAULT**
422			**RUN**
423			**AT SPD**
502			**REMOTE**
503			**REMOTE**

NOTE: 1. Use motor name plate speed. Example 1720 RPM (Slew Speed)
2. Use 10% of motor name plate speed. Example 170 RPM (Track Speed)
*3. Minimum rated speed for 60 Hz motor is 1630 RPM. Minimun rated speed for 50 Hz motor is 1370 RPM. Failure to set these minimum values may result in **a MOTOR PARAMETERS FAULT** during autotune.*

)

NOTE: Do not make changes to the program function codes before contacting Vertex Control Systems. Changing these parameters could cause Drive malfunctions, incorrect tracking of the antenna, and or physical damage to the system.

All other parameters are set at factory default.

4.4.1.3 Drive Motor Phasing

Because all axis drives are bi-directional, the actual direction of antenna axis rotation should correspond to the direction commanded by the control system. The following procedures should be followed to ensure this correspondence (make all control commands at the PMCU).

NOTE: Prior to performing these procedures, ensure that the antenna is clear of electrical and mechanical stop limits in all axes, preferably with each axis near the center of travel.

WARNING

IF ANY AXIS DRIVE MOTOR IS PHASED INCORRECTLY, THE CORRESPONDING ELECTRICAL LIMIT SWITCH WILL NOT PREVENT OVERTRAVEL OF THE ANTENNA.

4.4.1.3.1 AZ Motor Phasing

1. Using the PMCU set the AZIMUTH SPEED ADJUST switch to the TRACK position.

2. Hold the AZ AXIS switch to CW for a few seconds and then to CCW for a few seconds, while observing the direction of rotation of the antenna.

3. If the direction of antenna rotation agrees with the control commands, proceed to paragraph 4.4.1.3.2.

4. If the direction of antenna rotation is reversed from the commanded direction, remove power from the drive cabinet, and switch the AZ motor leads connected to terminals Az-U and Az-W.

5. Restore power to the drive cabinet and recheck for proper AZ rotation.

4.4.1.3.2 EL Motor Phasing

1. Using the PMCU set the ELEVATION SPEED ADJUST switch to the TRACK position.

2. Hold the EL AXIS switch to UP for a few seconds and then DOWN for a few seconds, while observing the direction of rotation of the antenna.

3. If the antenna movement correlates with the commanded direction, proceed to paragraph 4.4.1.3.3.

4. If the direction of antenna rotation is reversed from the commanded direction, remove power to the drive cabinet, and switch the EL motor leads connected to terminals EL-U and EL-V.

5. Restore power to the drive cabinet and recheck for proper EL rotation.

4.4.1.3.3 POL Motor and 4th Axis Motor Phasing

1. Hold the POL switch to CW for a few seconds and then to CCW for a few seconds. The CW drive command should result in clockwise rotation of the feed assembly as viewed from the rear of the antenna structure; the CCW drive command should result in counterclockwise rotation of the feed assembly as viewed from the **rear** of the antenna structure.

2. If the drive command and axis rotation are correct, proceed to paragraph 4.4.1.4.

3. If the drive command and axis rotation are reversed, remove power from the drive cabinet and switch the POL motor leads connected to terminals POL CW and POL CCW located on TB1.

4. Restore power to the drive cabinet and recheck for proper POL rotation.

5. The 4-axis Systems has an 4th Axis that is part of the Feed Assembly. There are many different versions for the feed arrangement so a separate Appendix will explain the 4th Axis when needed.

4.4.1.3.4 Setting Position Parameters

See figure 5-1 Menu for the location of applicable parameters.

1. From the 7200 ACU command the antenna CW, UP, and POL CW.

2. Observe each position display for increasing angles. If not, set the corresponding angular transducer parameter to "REV".

3. Enter the station location parameters.

3. Steer the antenna to a satellite with known current position data. Accurately position the antenna for maximum signal and set the Position Parameters to agree with the known satellite look angles.

4.4.1.4 Electrical Limit Switch Tests and Preliminary Settings

> ***CAUTION***
> ***In the following steps, jog the antenna slowly as it nears each limit to prevent possible damage to the antenna structure because of a malfunctioning or improperly adjusted limit switch. This caution is necessary only during installation in order to verify that the limit switches are functioning correctly.***

1. Using the PMCU hold the AZ AXIS CONTROL switch to the CW position and drive the antenna into the AZ CW limit. Verify that the CW movement of the antenna stops and that CCW motion is allowed. If CW and CCW limits are operating backward, switch wires on TB1-1 and TB1-3.

2. Using the PMCU hold the AZ AXIS CONTROL switch in the CCW position and drive the antenna into the AZ CCW limit. Verify that the CCW movement of the antenna stops and that CW motion is allowed.

3. Using the PMCU hold the EL AXIS CONTROL switch in the UP position and drive the antenna into the EL UP limit. Verify that the upward movement of the antenna stops and that downward motion is allowed.

4. Using the PMCU hold the EL AXIS CONTROL switch in the DOWN position and drive the antenna into the EL DOWN limit. Verify that the downward movement of the antenna stops and that upward motion is allowed. If UP and DOWN limits are operating backward, switch wires on TB1-4 and TB1-6.

5. Using the PMCU hold the POL switch in the CW position and drive the feed tube into the CW limit. Verify that the CW movement of the feed tube stops and that CCW motion is allowed. If CW and CCW limits are operating backward, switch wires on TB1-7 and TB1-9.

6. Using the PMCU hold the POL switch in the CCW position and drive the feed tube into the CCW limit. Verify that the CCW movement of the feed tube stops and that CW motion is allowed.

7. The 4-axis Systems has a 4th Axis that is part of the Feed Assembly. There are many different versions for the feed arrangement so a separate Appendix will explain the 4th Axis when needed.

If any of the limit switches do not operate in the manner described above in steps 1 through 4, discontinue operation of the system until the problem is cleared. Limit circuit problems can usually be traced to a wiring error between the switch and drive cabinet.

After ensuring proper operation of all limits, set the limit stops for each axis to ensure clearance of all obstructions while allowing only the necessary total antenna travel in each axis.

4.4.1.5 AZ and EL Speed Adjustments

Low and high-speed drive rates for the AZ and EL axes are preset parameters inside each drive.

Set the drive cabinet MAINT/REMOTE switch to REMOTE to transfer control to the 7200 ACU.

Refer to Section 5.0 of this manual for operation of the 7200 ACS.

4.4.1.6 Setting Beacon Signal Level and Slope

See Table 5-6 Calibrate Tracking Signal for additional details.

1. Adjust the antenna for maximum beacon signal level.

2. Select menu item Calibrate Tracking Signal

3. Set the 0 dB point.

4. Move the antenna off the target 3 dB and set the -3 dB point.

The system should now be ready for site acceptance tests.

5.0 OPERATION

5.1 Introduction

This section of the manual provides the procedures for operation of the 7200 ACS. The 7200 ACS contains on-line help that is accessible by simply pressing the [HELP] key on the front panel keypad (refer to paragraph 5.3 for information on the 7200 help system).

This section begins by giving the user an introduction to the 7200 ACS menu and help systems. For clarity, all menu items (and system messages and prompts) that appear in text will be in boldface type and shown in text exactly as they appear on the display. All key names are presented in square brackets ([]).

The 7200 ACU has a Simulation mode that can be used for training purposes or for becoming familiar with the system before beginning system operation. For more information on the ACU simulator, refer to paragraph 5.8.6.6.

Manual antenna control, instructions on how to use the tracking functions of the system, and procedures for editing the tracking data and system configuration are included in this section.

5.2 The 7200 ACS Menu System

The menu system provides access to all of the capabilities of the 7200 ACS and is structured according to system functions. The menu system is displayed in the lower portion of the display on the front panel of the ACU and each "screen" is titled for convenience. Items displayed that are followed by "..." are menus. The arrow keys on the 7200 keypad may be used to place the cursor on any menu item. If [ENTER] is then pressed, the relevant screen for the item chosen will be displayed and depending on the item chosen, the new screen may contain one, or a combination, of the following items:

a function [e.g., "**Return to standby (stop tracking)**"]
a parameter (e.g., "**Target name**")
a menu (e.g., "**Edit schedule...**")

On-line help is available for all menus, functions, and parameters. The help system for the 7200 ACS is described in detail in paragraph 5.3, but pressing the [HELP] key at any time will display either help for the entire system, or help related to the item that is highlighted.

Figure 5-1 shows a representation of the (Main Menu) screen as it appears on the 7200 ACU display. See Appendix "I" for 7200 Menu Tree software flow charts.

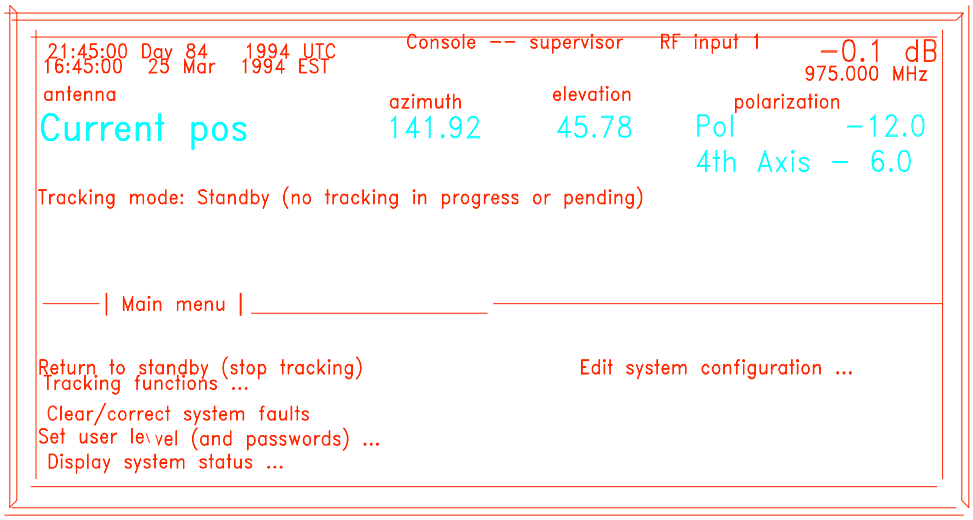

Figure 5-1 7200 ACS Basic Menu System

5.2.1 Multiscreen Menus

Each screen can display up to 5 lines of text or 10 menu items (5 per column). If more information than can fit on one screen needs to be displayed, there will be a message in the screen title as shown in Figure 5-2. To view the next screen of a multiscreen menu, simultaneously press [SHIFT] and [F6 DN]. To view the previous screen of a multiscreen menu, simultaneously press [SHIFT] and [F6 UP]. Note that pressing [PRIOR] will return the system to the previous menu, or moves you up the menu tree. It will **not** return you to the previous screen.

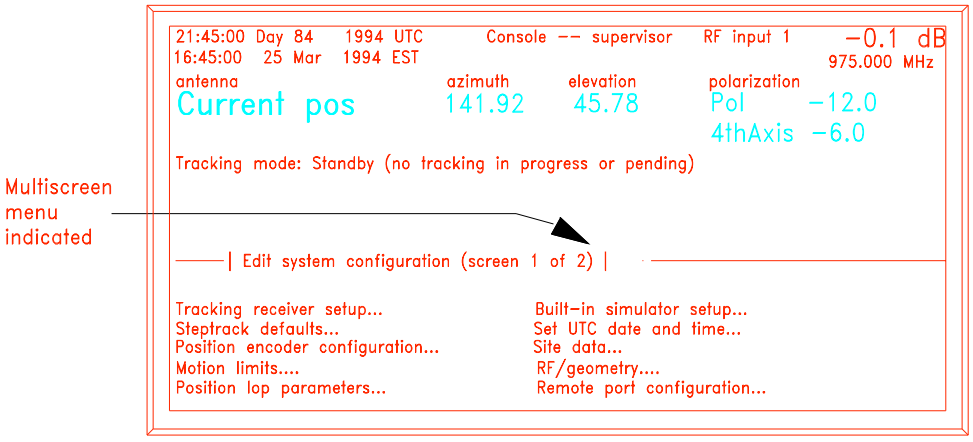

Figure 5-2 Multiscreen Menu

5.2.2 Menu Items

Some of the menus (e.g., "**Edit target parameters...**") will have parameters appear on the screen which only appear under certain conditions. As an example, when the tracking mode for a certain target is set to **Move to look angles...**, **Edit target parameters...** will have only the following two items displayed:

Look angles [deg]
Bias angles [deg]

However, when the tracking mode for a target is set to **Intelsat 11-element**, 22 different parameters will be displayed.

Figure 5-3 shows an example of the menu that appears when **Tracking functions...** is selected from the **Main menu**. If **Immediate tracking...** is chosen from that menu, the **Immediate tracking** screen appears with additional items displayed. If the user then chooses **Move to longitude...**, the **Immediate move to longitude** screen appears with the relevant functions/parameters displayed.

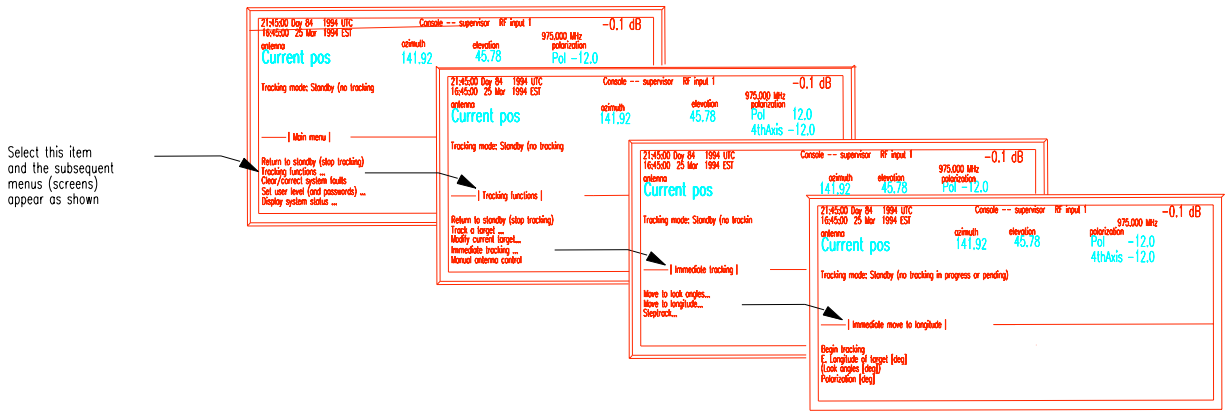

Figure 5-3 Tracking Functions Menu System

5.3 The Help System

The 7200 ACU provides easy-to-use, on-line help. By simply pressing the [HELP] key on the 7200 front panel, help for the entire system or help pertaining to the item on which the cursor is resting is displayed on the front panel. Press the [PRIOR] key to exit the help screen.

Figure 5-4 shows a representation of a help screen containing information on the overall system help (Introductory help).

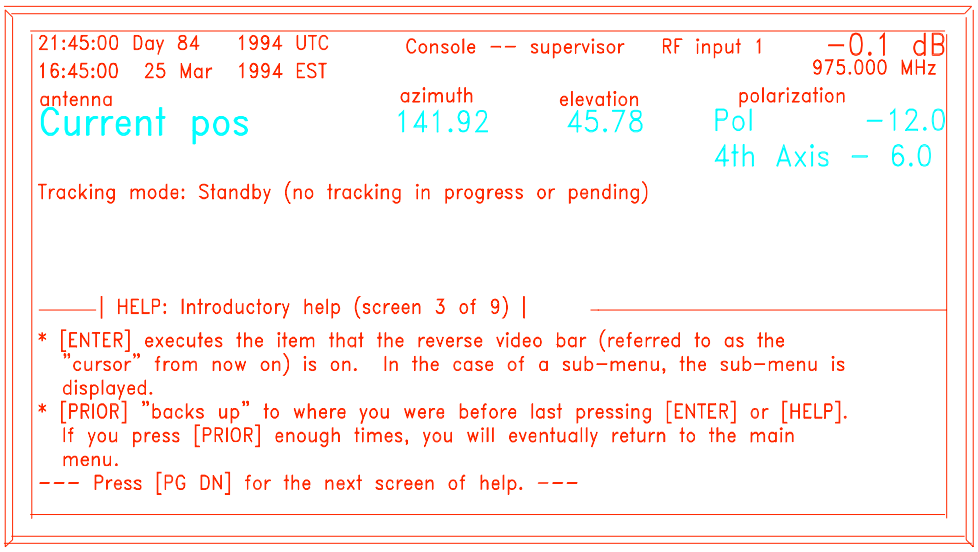

Figure 5-4 7200 ACS Help Screen (Introductory Help)

In addition to the Introductory (overall system) help, the 7200 help system includes information on all system functions, parameters, and menus. Help screens may contain explanations of a parameter or a function and any requirements for executing that function (e.g., the user level necessary to execute the function). Figure 5-5 is an example of a help screen that describes the parameter **E. Longitude of site [deg]** which is in the **Edit System Configuration Menu** in the **Site data...** menu.

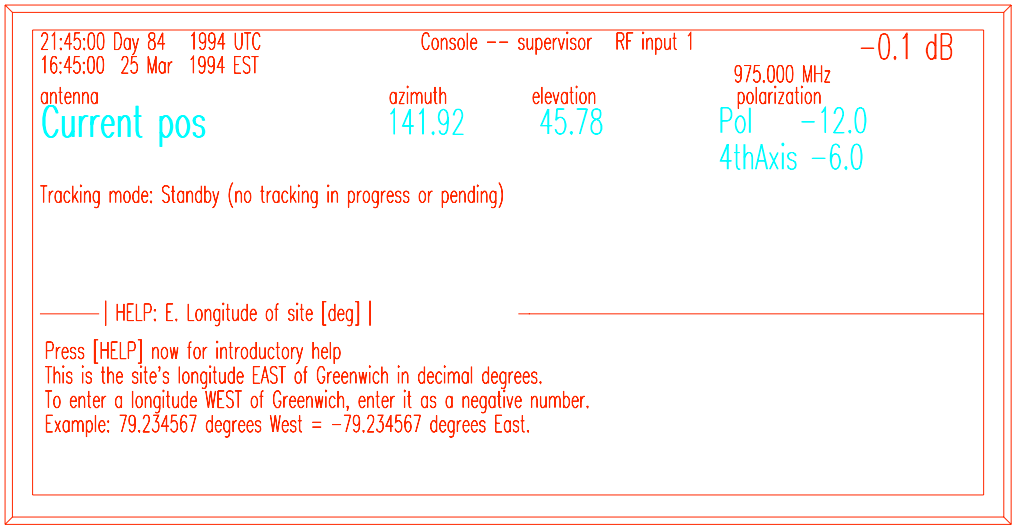

Figure 5-5 7200 ACS Help Screen (Parameter Help Screen)

5.4 System Prompts

Executing functions and changing parameters on the 7200 ACS are made simple with the use of system prompts. For example, if a user wishes to change the parameter **E. Longitude of site [deg]** shown in Figure 5-5 above, the system will prompt the user with the allowable range of values when this parameter is selected to be edited. Figure 5-6 shows the screen that will appear when the cursor is placed over the parameter and the [ENTER] key is pressed.

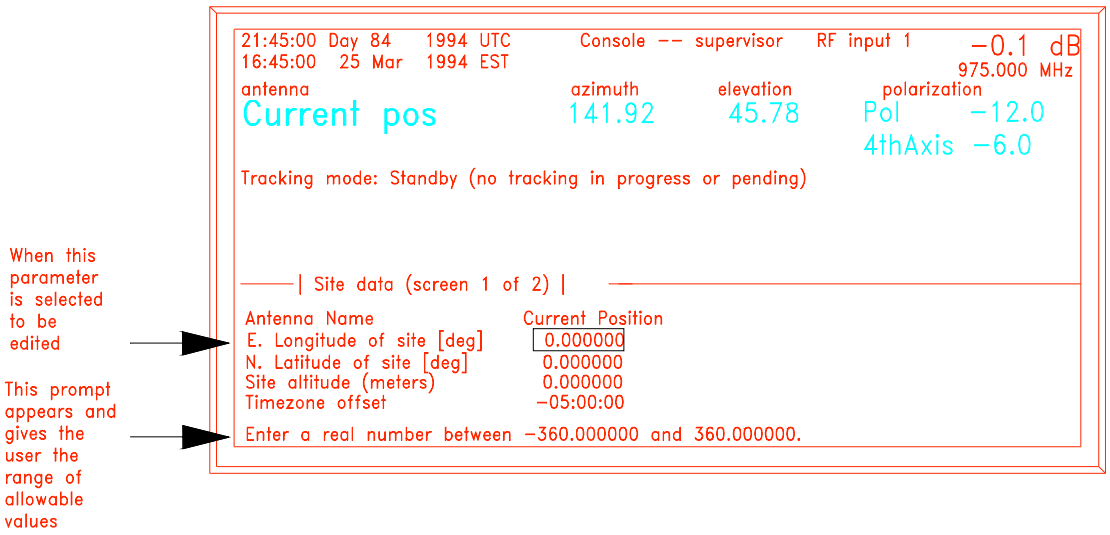

Figure 5-6 Parameter Edit Screen

5.4.1 Error Messages for Incorrect Entries

The 7200 ACS not only provides value ranges in system prompts when the user is editing parameters, but it also provides error messages when an out-of-range value is entered. For example, if the user is editing the parameter shown in Figure 5-6 above, and enters a value of 365.000000, the following system prompt will appear:

Your entry 365.000000 is too high.
Enter a real number between -360.000000 and 360.000000.

Press [ENTER] to continue.

5.4.2 Confirmation Messages

Depending on the setting of the user interface options parameters (refer to paragraph 5.8.6.11), the system will display tracking and editing confirmation messages, and a warning bell may be operational to alert the user that a confirmation message awaits a response. The bell will also sound when an invalid key is pressed.

> ***NOTE:*** ***The defaults for the confirmation messages are set so that the messages appear. For all operating procedures in this manual, it is assumed that the defaults are unchanged and all confirmation messages will appear.***

The following is an example of a tracking confirmation message:

Stop tracking and return to standby?(yes/no) YES
[YES/NO] changes YES/NO response. [ENTER] accepts displayed YES/NO response.

5.5 Parameter and Data Storage

All parameters (target-specific and system) are stored in battery-backed nonvolatile RAM on the CPU board. This includes all accumulated steptrack data.

In addition, when the ACU is powered up, it automatically resumes tracking the target that it was tracking at the time the system was powered down. If the ACU was in Standby at that time, it remains in Standby. There is a five-second delay from the time the ACU completes power-up and is ready to be commanded and when tracking resumes on the target that was being tracked at power-down time. This gives the user the opportunity to return the unit to Standby before antenna movement starts.

5.6 Power-Up Procedures

Before proceeding with these power-up procedures, be sure that Section 4.0, Installation, of this manual has been used to install, set up, and configure the system.

To power up the 7200 ACS, use the following procedures.

1. On the 7150 Drive Cabinet, pull the EMERGENCY STOP switch to the out position.

2. On the 7150 Drive Cabinet, set the following controls as indicated:

   a. Set the Main Circuit Breaker to ON
   b. Set all remaining Circuit Breakers to ON
   c. Set MAINT/REMOTE switch to MAINT

3. On the 7200 ACU back panel, set the on/off switch to the on position.

5.7 Manual Movement of the Antenna

5.7.1 Manual Movement From the Drive Cabinet (PMCU)

Manual control of each axis is provided at the drive cabinet by using the PMCU, primarily to facilitate antenna maintenance. A MAINT/REMOTE switch (CONTROL) located on the Relay PCB. It is the only selection point for maintenance mode. Therefore, with this switch in the MAINT position, the ACU cannot assume control. With the switch in the REMOTE position, the ACU has control of the system and the drive cabinet switches are inoperative.

To operate the antenna from the drive cabinet, use the following procedures.

1. On the drive cabinet, set the CONTROL switch to MAINT to enable the controls on the PMCU.

2. Set the AZIMUTH SPEED ADJUST to TRACKING SPEED. The SLEW SPEED and TRACKING SPEED parameters are set in the drivers. (Slew Speed is a fast speed. Track Speed is a slow speed.)

3. Hold the momentary AZ AXIS CONTROL to the CW or CCW position. Holding the switch at CW results in clockwise motion of the antenna as observed from the **rear** of the antenna. Holding the switch at CCW results in counterclockwise motion of the antenna. When released, the switch automatically returns to the center (off) position.

4. Set the ELEVATION SPEED ADJUST to TRACKING SPEED. The SLEW SPEED and TRACKING SPEED parameters are set in the drives.

5. Hold the momentary EL AXIS CONTROL switch to the UP or DOWN position. Holding the switch at UP results in upward motion of the antenna and holding the switch at DOWN results in downward motion of the antenna. When released, the switch automatically returns to the center (off) position.

6. Hold the momentary POL switch to the CW or CCW position. Holding the switch at CW causes the feed assembly to rotate CW as observed from the **rear** of the antenna and holding the switch at CCW causes the feed assembly to rotate CCW. When released, the switch automatically returns to the center (off) position.

7. The 4-axis System has an 4TH AXIS that is part of the Feed Assembly. There are many different versions for the feed arrangement so a separate Appendix will explain the 4TH AXIS when needed.

8. Press the RESET Button located on the Relay PCB to clear any faults detected by the motor controllers (inverters).

9. Return MAINT/REMOTE switch to REMOTE.

5.7.2 Manual Movement From the ACU

Refer to paragraph 5.8.2.5 for instructions on manually controlling the antenna from the ACU.

5.8 The 7200 ACS Main Menu

All operation of the 7200 ACU is through the Main Menu. See Appendix "I" for 7200 menu tree flow charts. The Main Menu gives the operator a choice to select a function for the 7200 ACU to perform or to select another menu where more functions are available or where parameters can be changed.

For example, the **Main menu** has two functions: **Return to standby (stop tracking)** and **Clear/correct system faults**. It also has four menus:

Tracking functions...
Set user level (and passwords)...
Display system status...
Edit system configuration...

Figure 5-7 shows a representation of the **Main menu** screen as it appears on the 7200 ACU display.

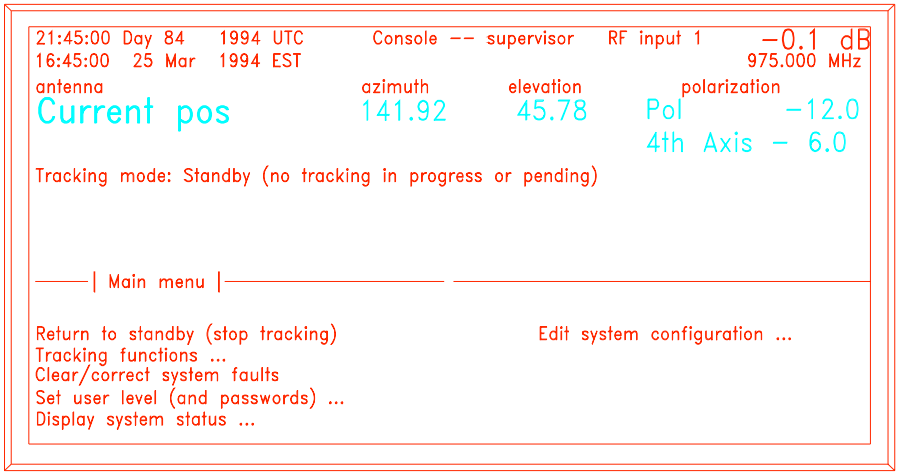

Figure 5-7 7200 ACU Main Menu Screen

NOTE: To return to the Main menu from any screen, press the [Shift] key and hold it while pressing the [PRIOR] key.

The following paragraphs describe each of these functions and menus.

5.8.1 Return to Standby (Stop Tracking) Function

Selecting **Return to standby (stop tracking)** places the system in Standby mode. In Standby mode the antenna is not being commanded to move by the ACU. Real-time status, signal level, and position information is being displayed on the ACU front panel. Any current fault information is also displayed.

The AZ and EL inverters are powered up but are not enabled, and on systems equipped with brakes, the brakes are set. In Standby mode, the ACU is in an active wait state for instructions from the front panel or computer interface.

During tracking, the ACU may be commanded to stop tracking and return to the **Standby** mode by selecting the **Return to standby (stop tracking)** function. For convenience, the function is included in two menus: **Main menu** and **Tracking functions menu**.

5.8.2 Tracking Functions Menu

All antenna control, including manual antenna control, is accessed from the **Main menu**. The **Tracking functions menu** includes the following functions and menus:

Return to standby (stop tracking)
Track a target...
Modify current target...
Immediate tracking...
Manual antenna control
Edit a new or existing target...
Target scheduler...

The following paragraphs will describe each of these functions and menus.

5.8.2.1 Return to Standby (Stop Tracking) Function

Return to Standby (Stop Tracking) is the function that appears under the **Main menu** and it is also available under the **Tracking functions...** menu for convenience.

When this function is selected, the system will prompt the user to ensure that the user wishes to stop tracking and return the ACU to Standby mode. In Standby mode, the status line of the ACU will indicate that the ACU is in Standby mode and no tracking is currently in progress.

5.8.2.2 Track a Target Menu

The Track a Target menu allows selection of a preconfigured target to track. When this menu is selected, if there are no previously configured targets, the screen will appear as shown in Figure 5-8. For instructions on entering targets into the target selection menu, refer to paragraph 5.8.2.6.

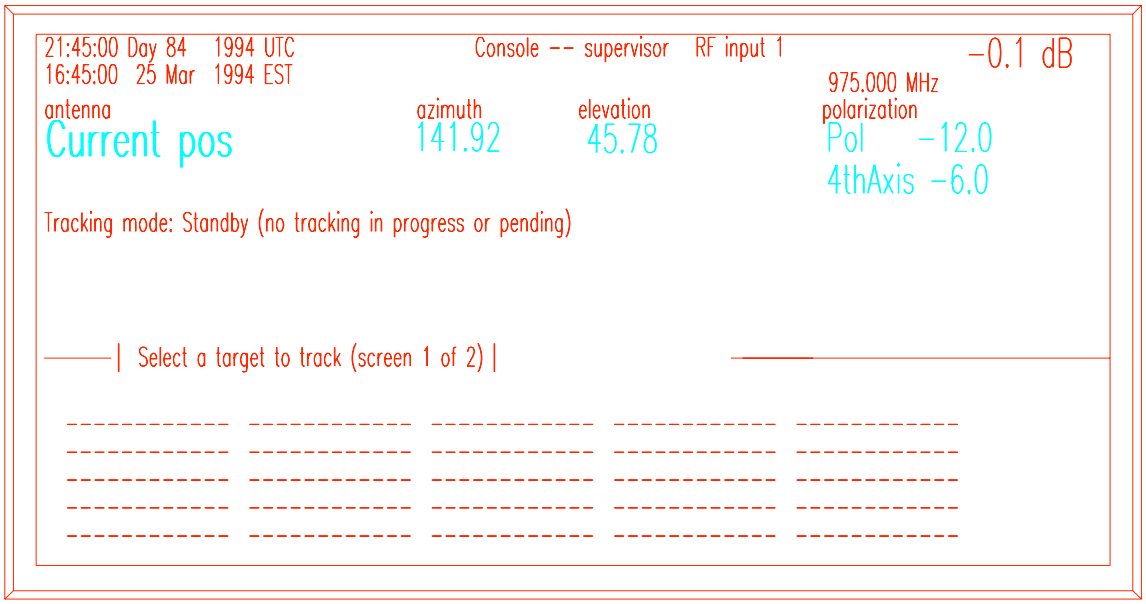

Figure 5-8 Track a Target Screen

Although individual tracking modes are directly accessible through the **Immediate tracking...** menu, primary 7200 ACS operation is through the **Track a target...** menu. This target-oriented environment consists of preconfigured targets that include the desired tracking mode. Multiple, unique data bases are simultaneously maintained for all targets. The user simply selects the name associated with the desired target and the ACU automatically invokes the mode, or series of modes, and any predictive tracking data base(s) established for that target.

To track a target in the target selection menu, use the following procedures:

1. From the **Main menu**, select **Tracking functions...**, and **Track a target...**.

2. Using the arrow keys on the 7200 ACU keypad, move the cursor to the desired target and press [ENTER].

3. A prompt will appear to confirm that tracking should begin at the preconfigured position. To begin tracking the target, toggle the [YES/NO] key to [YES]. To cancel the tracking function, answer [NO], and the ACU will return to the **Track a target...** screen.

When commanded to begin tracking the target, the system will move the antenna to the target's position and hold that position. The name of the target remains on the display under the antenna name.

5.8.2.3 Modify Current Target Menu

From this menu, the user can modify the target currently being tracked. The items under this menu vary according to the tracking mode of the current target.

Tracking receiver parameters... is available in all tracking modes and is the only item displayed when the system is in **Standby**.
Manually bias target is available in all tracking modes, but not in **Standby.**
Edit current target... is available for all tracking modes, allowing the user to edit the **Target name**, **Tracking mode**, and target parameters.
Reset OPT target is only available when a target's tracking mode is **OPT.**
Set star time bias... is only available for targets configured for the **Star tracking** mode.

5.8.2.3.1 Manually Bias Target Function

NOTE: The Manually bias target function is not available when the system is in Standby mode.

The **Manually bias target** function allows the user to create a bias for a target preconfigured with any tracking mode (except OPT); the functionality varies according to the selected tracking mode of the target. This function is used to peak polarization on targets with OPT tracking modes -- i.e., OPT's polarization predictions are "calibrated" by adjusting polarization as the target moves along its orbit. Figure 5-9 is an example of how the front panel display looks when manual biasing is being performed on a target preconfigured for the **OPT** mode.

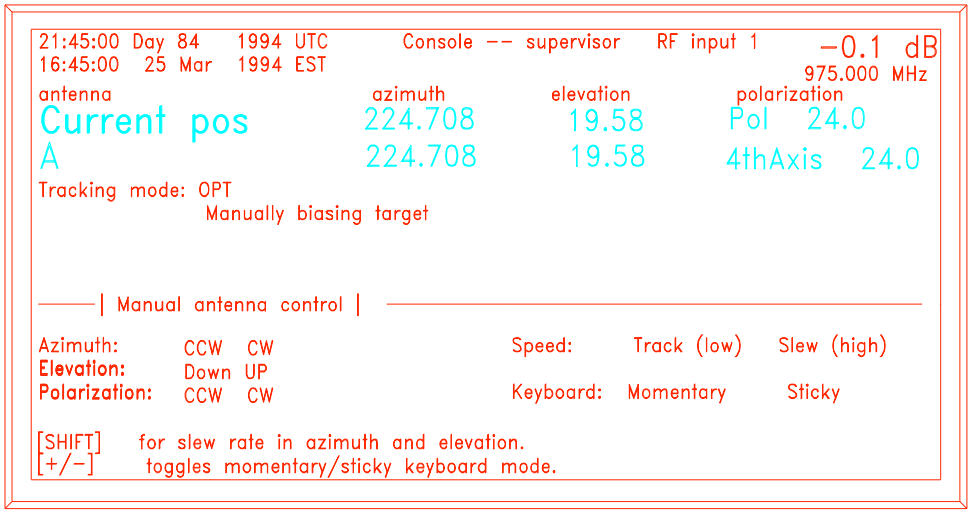

Figure 5-9 Manually Bias Target Screen

Although the screen in Figure 5-9 is titled **Manual antenna control**, only biasing can be performed from this screen. Paragraph 5.8.2.5 explains how to manually control the antenna from the ACU.

For a target with a tracking mode of **Move to look angles**, **Move to longitude**, **Intelsat-11 element,** and **Star tracking**, the bias can be thought of as a "target-specific offset". Targets with these tracking modes have a parameter, **Bias angles**, which has a value in degrees for each axis. When the ACU is tracking a target, the command position is computed using the appropriate technique for the tracking mode, and then the bias angles are added to create the final command position to which the ACU drives the antenna.

Use the following procedures to perform manual biasing:

1. From the **Main menu**, select **Tracking functions...**; then select **Modify current target...**, and **Manually bias target**. The following prompt appears:

   Enter manual antenna control to bias the current target? [yes/no]
   [YES/NO] changes YES/NO response. [ENTER] accepts displayed YES/NO response.

2. Answer YES. Peak the antenna using the appropriate arrow keys.

3. Press [PRIOR]. The following prompt appears:

   Set bias for the current target from current look angles? (yes/no)
   [YES/NO] changes YES/NO response. [ENTER] accepts displayed YES/NO response.

4. If the user answers yes, the command position is subtracted from the current position on each axis and stored as the target's bias. If the user responds no, the ACU will move the antenna to the position computed for the target, effectively "undoing" the manual antenna movement.

Because the **Immediate tracking...** modes are used for immediate tracking only (i.e., the antenna is commanded to move to a position and is held there), none of these modes have bias angles. For more information on **Immediate tracking...**, refer to paragraph 5.8.2.4.

5.8.2.3.2 Tracking Signal Parameters Menu

The parameters for the **Tracking signal parameters...** menu vary according to the setting of **Shell** under the **Remote port configuration...** menu (refer to paragraph 5.8.6.10).

If **Shell** is set to **TRL**, the parameters in Table 5-1 will appear; for all other settings for **Shell** (**Disabled**, **Printer**, **M&C**, and **Visual**), the parameters in Table 5-2 will appear.

TABLE 5-1 SERIAL TRACKING SIGNAL PARAMETERS	
PARAMETER	**DESCRIPTION**
Frequency [MHz]	Frequency for the tracking receiver.
RF input	Selects RF (polarization) input to the tracking receiver.
Attenuation [dB]	Attenuation setting for the tracking receiver.

TABLE 5-2 ANALOG TRACKING SIGNAL PARAMETERS	
PARAMETER	**DESCRIPTION**
A/D channel	One of two available A/D channels.
Beacon	One of four available beacon signals.

NOTE: This menu is also included in the Tracking receiver setup menu under the Edit system configuration menu and Edit a new or existing target menu under Tracking function. Procedures for changing the parameters under all menus are the same.

Tracking signal input is only used for signal-based tracking (i.e., **Steptrack** and **OPT**). If the system is performing other types of tracking, the operator may want to see what the tracking receiver "sees" for a particular beacon frequency.

For targets tracking in OPT, changes to these parameters remain in effect until the target is restarted (or power is cycled). To permanently change a tracking signal source, the system must be at **Supervisor** level and the changes must be made by accessing the **Edit a new or existing target...** menu (refer to paragraph 5.8.2.6).

To edit any of the parameters under this menu, use the following procedures:

1. From the **Main menu**, select **Tracking functions...**; then select **Modify current target...** and **Tracking signal parameters...**.

2. Using the arrow keys, move the cursor to the parameter to be edited and press [ENTER]. Using the numeric keys, enter a value within the range specified in the system prompt and press [ENTER].

3. Press the [PRIOR] key and the following prompt appears:
   Save changes to menu "Tracking signal parameters"? (yes/no)
   [YES/NO] changes YES/NO response. [ENTER] accepts displayed YES/NO response.

4. To save the changes, toggle the YES/NO key to YES and press [ENTER].

5.8.2.3.3 Reset OPT Target Function

The **Reset OPT target** function is only available when an **OPT** target is being tracked. If this function is selected, the user is prompted to verify that the user wants to erase all stored steptrack data and orbital modes for the current target. This is not required for normal operation. If the ACU is tracking poorly under OPT, it may be necessary to use this function to cause OPT to discard poor steptrack data and/or orbital solutions it has generated and stored.

Executing this function does not change any of the target's **Steptrack** or **OPT** configuration parameters.

5.8.2.3.4 Set Star Time Bias Function

The **Set star time bias...** function is only available when a star target is being tracked. The bias is a time value that is added to the current time to determine the point in the star's trajectory to which the ACU will point.

By default, the star time bias is 00:00:00, which means that the ACU is tracking the star in real time. If the bias is changed to a nonzero number, the ACU will "run ahead" of the star by that amount of time. For example, if the star time bias is 00:01:00, the ACU will run 1 minute ahead of the star.

To edit the **Set star time bias...**, select the function, select **Time bias**, and enter the desired numeric values (within the range of values specified in the system prompt).

5.8.2.3.5 Edit Current Target Menu

The function of this menu is identical to the function of the **Edit a new or existing target...** menu (refer to paragraph 5.8.2.6), and is placed under **Modify current target...** for convenience when modifying the current target.

5.8.2.4 Immediate Tracking Menu

Immediate tracking allows the user to begin tracking without first configuring a target. This method of tracking is useful for testing purposes and moving the antenna to odd locations. To track a satellite for operational use, a target should be configured for that satellite -- refer to paragraph 5.9.2.6 for details on configuring targets.

> ***NOTE: Each time the user enters one of the Immediate tracking mode menus, the data in the menu is reset to default values to prepare for immediate use. As a result, if the ACU is currently performing immediate tracking, the parameters used for tracking cannot be viewed once the menu is exited.***

For example, if the user enters **Immediate tracking..., Edit Immediate Target Parameters** and then selects **Move to look angles...,** the current position is copied into **Look angles [deg].** If the user enters the following values:

azimuth = 200.00 elevation = 30.00 polarization = 0.0

and then begins tracking, presses [PRIOR] to return to the **Immediate tracking...** menu, and then re-enters **Move to look angles...** under the **Immediate tracking...** menu, the **Look angles [deg]** will not show the values previously entered. Instead, the current position at the time the menu was entered will be displayed.

This menu contains the following menus:

Track Immediate Target...
Edit Immediate Target...

5.9.2.4.1 Steptrack Parameters

Table 5-3 describes the steptracking parameters and lists the default settings for each parameter.

NOTE: Before changing any of the steptrack parameters, read the information about that parameter in Table 5-3.

TABLE 5-3 STEPTRACK PARAMETERS

PARAMETER	DEFAULT	DESCRIPTION
Cycle time	00:02:00	Sets time between the end of one **Steptrack** cycle and the beginning of the next cycle when no OPT solution is available. For immediate Steptrack, this is the only cycle time used. In addition, this time is used when excessive discrepancies exist between the models and the steptrack pointing.
Receive -3 dB beamwidth [deg]	0.27	The receive -3 dB of the antenna. Used by Steptrack and OPT to determine deflection from beam center.
Step size [deg]	00.020	Sets the size of each step that the antenna makes as the step-track algorithm approximates a curve and samples points along that curve. This step is also used for steptrack operations in OPT tracking. The value should be set to approximately 8% of the -3 dB receive beamwidth of the given antenna, but no less than 0.02 with standard encoders.
Position deadband [deg]	00.03	Steptrack moves the antenna closer to the peak signal until the difference between the previous estimated peak position and the current peak position is less than the deadband. As in system configuration parameters, this deadband setting affects AZ and EL only. When the antenna moves to within this deadband of the peak signal, steptracking stops for that cycle. The value should be less than 10% of the -3 dB receive beamwidth, but greater than 0.01 for systems with standard encoders.
Maximum no. of cycles	5	Limits the number of AZ and EL attempts the steptrack algorithm makes in finding the peak signal. Nominal value is 5, but the value should be decreased for a very fast target as steptrack assumes

		target is fixed for duration of steptrack operations.

TABLE 5-3 STEPTRACK PARAMETERS (continued)

PARAMETER	DEFAULT	DESCRIPTION
Cycle to start rate estimates	3	Sets the cycle at which rate estimates will be made during step-track operations. The rate estimates are only made when no OPT solution exists for the target being tracked. If an OPT solution is available, the rates used by steptrack are obtained from OPT. The nominal value is 3, but should be decreased to 2 for a very fast target. For a stationary target, the value should be set to 5.
Peaking correction limit (%BW)	30	Sets the maximum beam radial distance steptrack will adjust the antenna pointing in one cycle. The value is given in percent of -3 dB beamwidth. Nominal value is 30% -- this can be lowered to 10% to limit the steptrack working area but will inhibit the ability of steptrack to peak on a highly inclined satellite.
Weight adjustment value	1.00	The steptrack algorithm combines data together by a weighting system which is determined automatically. This parameter can be used to magnify the internal weighting under special situations. The nominal value is 1.0 and should not be changed unless directed by Vertex personnel. Increasing this value decreases the responsiveness of steptrack.
Low tracking signal level [dB]	-7.00 dB	Defines the lowest signal level with which steptrack can work to perform its operations. If the signal falls below this level while steptracking, the ACU will display a Low tracking signal level message and wait until the signal rises above this level before attempting another steptrack cycle. ***NOTE: Setting this value too close to 0 dB will interfere with proper steptrack operation.***
Signal threshold [dB]	15.00 dB	While the ACU is waiting for the cycle time to expire (to begin a new steptrack cycle), if the signal falls by this many dB below the most recently acquired peak, it will do a steptrack cycle immediately. If the signal threshold is set below the Low tracking signal level [dB], it will only do steptrack cycles at intervals given by Cycle time.
Axis to peak first	Elevation	Allows selection of which axis is peaked first during steptrack cycle. Normally, the axis for which the satellite has the greatest apparent motion is peaked first. Select AZ if the required motion for following the satellite is more AZ than EL. Otherwise, set this parameter to EL.
# of samples	30	Sets the number of signal readings taken at each position during steptrack operations. The value should be between 10 and 150.
Sun outage protection	Enabled	Sun outage protection works by inhibiting steptrack whenever the current look angles are within a specific angle from the center of the sun. The angle used is the 3 Db beamwidth plus the radius of the sun's disk. A delay of up to 10 minutes may result. The ACU must contain the correct site and time information for this parameter to function.

5.9.2.4.2 Edit Steptrack Parameters... Menu

This menu contains the steptrack parameters. For a description of the parameters and the default settings, refer to paragraph 5.9.2.4.3.1.

The following parameters are included in this menu:

Cycle time
Receive -3 dB beamwidth [deg]
Step size [deg]
Position deadband [deg]
Maximum no. of cycles
Cycle to start rate estimates
Peaking correction limit (%BW)
Weight adjustment value
Low tracking signal level [dB]
Signal threshold [dB]
Axis to peak first
# of samples
Sun outage protection

To edit the steptrack parameters, use the following procedures:

1. From the Main menu, select **Tracking functions...**, then **Immediate tracking..., Steptrack...,** and **Edit steptrack parameters....**

2. Using the arrow keys, move the cursor to the parameter to be changed and press [ENTER].

3. A prompt will appear at the bottom of the screen. If the parameter is a numeric value, the prompt will give the acceptable range of values to be entered. Using the numeric keys, enter the desired value and press [ENTER]. If the parameter is a non-numeric value (e.g., **Axis to peak first),** the prompt will instruct the user to change the value using the up and down arrow keys. Pressing either the up or down arrow key will "toggle" through the choices for the parameter. When the desired choice appears next to the parameter, press [ENTER].

5.8.2.5 Manual Antenna Control Function

Figure 5-10 shows a representation of the **Manual antenna control** screen.

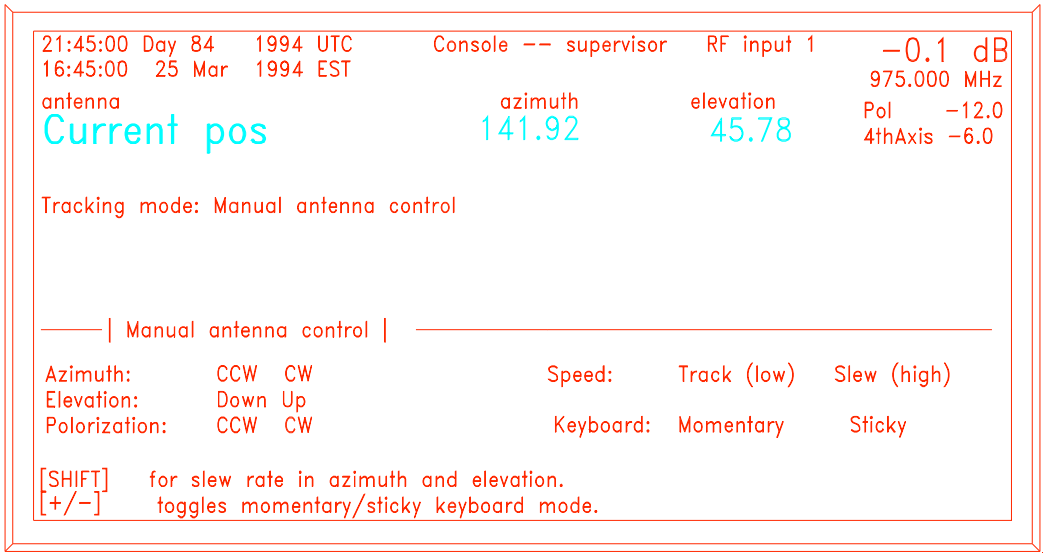

Figure 5-10 Manual Antenna Control Screen

5.8.2.5.1 7200 ACU Keypad Momentary and Sticky Modes

There are two modes for use of the keypad in the **Manual antenna control** function: **Momentary** mode and **Sticky** mode.

In **Momentary** mode, the axis is driven only as long as a direction key (arrow key) is pressed. Therefore, **Momentary** mode is the "normal" mode of operation for the keypad.

Sticky mode is used to drive the antenna for extended periods of time, such as doing test patterns. To move the antenna in Sticky Mode hold the [+/-] key with the desired directional key; release both keys and the antenna will continue to move in the selected direction until one of the following conditions exists.

the directional key is pressed again
the opposite directional key is pressed
the soft limit is reached (refer to paragraph 5.8.6.4.1)
the keypad is returned to **Momentary** mode (the [+/-] key is pressed again)

To use the **Sticky** mode at slew rate, hold the [+/-] key with the desired directional key; then release the keys and press [SHIFT]. Pressing [SHIFT] again will stop the slew rate, but the keypad remains in **Sticky** mode.

As an added safety feature, the ACU will return the keypad to the **Momentary** mode when the antenna is not being moved.

5.8.2.5.2 Antenna Speed Selection Control from the ACU

The [SHIFT] key toggles between track (low) speed and slew (high). POL is one speed and therefore the [SHIFT] key has no effect on its speed.

To operate the antenna manually, use the following procedures:

1. From the **Main menu**, select **Tracking functions...** and then **Manual antenna control**.

   NOTE: In the following steps, the respective field is highlighted to indicate commanded speed and direction.

2. To move the AZ axis at track speed, press the left arrow key to move the axis CCW and the right arrow key to move it CW. To move the axis at slew speed, hold down the [SHIFT] key and the left arrow key to move the antenna CCW, and to move the axis at slew speed in the CW direction, hold down the [SHIFT] key and the right arrow key.

3. To move the EL axis at track speed, press the up arrow key to move the axis upward and the down arrow key to move it downward. To move the axis at slew speed, hold down the [SHIFT] key and the up arrow key to move the antenna upward, and to move the axis downward at slew speed, hold down the [SHIFT] key and the down arrow key.

4. To rotate the Pol axis, press the CCW arrow key or the CW arrow key. To move the axis at slew speed, hold down the [SHIFT] key and the up arrow key to move the antenna upward, and to move the axis downward at slew speed, hold down the [SHIFT] key and the down arrow key.

5.8.2.6 Edit a New or Existing Target Menu

The **Edit a new or existing target menu** allows the user to configure up to 50 targets for the target-oriented environment to establish a target-specific data base for any predictive or programmed tracking data relative to the target.

This menu contains the target selection menu and the following parameters and menu:

Target name
Tracking mode
Edit target parameters...

The target selection menu appears as either 25 blank lines (to denote the capability to configure targets -- this menu contains two screens, each with 25 initialized or non-initialized targets), names of any preconfigured targets, or a combination of blank lines and named targets. Refer to the following paragraphs to name a target, change the tracking mode of a target, or to edit a target's parameters.

Once configured, tracking for a target is initiated by selecting the name of the target under the menu **Track a target...**. The target name will also be displayed when the target is being tracked. Refer to paragraph 5.8.2.2 for information on tracking a target in the target-oriented environment.

5.8.2.6.1 Target Name Parameter

As mentioned in paragraph 5.8.2.6, when the **Edit a new or existing target...** menu is accessed, the target selection menu will appear. The user can name a new target or edit an existing target's name. The target name may be up to 12 characters in length. Refer to paragraph 5.8.2.6.1.1 for procedures to name a target.

5.8.2.6.1.1 Creating a Target Name

To create a new target name, use the following procedures:

1. From the **Main menu**, select **Tracking functions...**; then select **Edit a new or existing target...**.

2. The "Select a Target to Edit" screen appears.

3. Select a non-initialized item (represented as "----------") on the target selection menu and press [ENTER].

4. The **Edit target data** screen will appear. This screen contains **Target name** and **Tracking mode** parameters, and the menu **Edit target parameters...**.

5. Select **Target name**. The following prompt appears: **Arrow keys move around, change letters; up to 12 characters are allowed.**

6. To create a target name, use the up and down arrow keys to scroll through the character set, consisting of the following:

   A blank space
   Uppercase alphabet letters
   Lowercase alphabet letters
   Digits 0 through 9
   Special characters:!"#$ % &'()* + ,-./:; < = > ?@[\]^_ ‘ {|} ~

7. When the desired character is highlighted, press the right arrow key to move to the next space to create a target name of more than one letter. Blank spaces may be included as part of the target's name. Once completed press [ENTER] and that will enter the target name as selected by the user

5.8.2.6.1.2 Editing a Target Name

To edit an existing target name, use the following procedures:

1. From the **Main menu**, select **Tracking functions...**; then select **Edit a new or existing target...**.

2. On the target selection menu, move the cursor to the target to be edited and press [ENTER]. The **Edit target data** screen will appear. This screen contains **Target name** and **Tracking mode** parameters, and the menu **Edit target parameters...**.

3. Select **Target name**. The following prompt appears: **Up and down arrows change character, left and right arrows change position**.

4. The cursor highlights the first character of the target name. Use the right arrow key to move to the character to be edited, and using the up and down arrow keys, scroll through the character set to the desired character. When all characters have been edited as desired, press [ENTER].

5.8.2.6.1.3 Deleting a Target Name

To delete an existing target name, use the following procedures:

1. From the **Main menu**, select **Tracking functions...**; then select **Edit a new or existing target...**.

2. Move the cursor to the target to be deleted and press [ENTER]. The **Edit target data** screen will appear. This screen contains **Target name** and **Tracking mode** parameters, and the menu **Edit target parameters...**.

3. Select **Tracking mode** and using the up and down arrow keys, toggle to the **Unused** mode and hit [ENTER].

4. Exit the menu, and save the changes to the menu.

5.8.2.6.2 Tracking Mode Parameter

NOTE: All noninitialized targets (shown as "----------") have a tracking mode of "Unused".

Use the following procedures to change the tracking mode of a target:

1. From the **Main menu**, select **Tracking functions...**; then select **Edit a new or existing target...**.

2. Move the cursor to the target to be edited (a noninitialized or named target) and press [ENTER]. The **Edit target data** screen will appear. This screen contains **Target name** and **Tracking mode** parameters, and the menu **Edit target parameters...**.

3. Select **Tracking mode**. Using the up and down arrow keys, the user can scroll through the following choices for the tracking mode:

   Unused
   Star tracking Track a star. This is commonly used as a point of reference during installation.)
   OPT (Calculates an OPT orbital element set and follows the calculated position.)
   Intelsat 11-element -IESS-412 (Calculates an orbit by using figures from Intelsat, and moves to the current calculated position.)
   Move to longitude (moves to longitude and holds position).
   Move to look angles (Moves to look angles.)

   NOTE: When the Tracking mode for a target is set to Star tracking, the system will automatically "blank" or erase any user-defined Target name. If one of the preprogrammed stars is chosen for the Star parameter under the Edit target parameters... menu, the name of the selected star becomes the Target name. If User-defined is selected, the Target name can be edited by following procedures listed in paragraph 5.8.2.6.1.1.

4. When the desired tracking mode is highlighted, press [ENTER].

5.8.2.6.3 Edit Target Parameters Menu

The items in the **Edit target parameters...** menu vary according to the tracking mode of the target (refer to paragraph 5.8.2.6.2 for the tracking modes). The following paragraphs describe the parameters for each available tracking mode.

To edit a target's parameters, use the following procedures:

1. From the **Main menu**, select **Tracking functions...**; then select **Edit a new or existing target...**.

2. Select **Edit target parameters...**.

3. Using the arrow keys, select the parameter to be edited and press [ENTER].

4. For parameters requiring numeric values, use the numeric keys on the keypad to enter the desired value (within the specified range), and press [ENTER]. If the parameter has a predefined list of choices, use the up and down arrow keys to toggle through the preset choices.

5.8.2.6.3.1 Star Tracking Mode Parameters

Table 5-4 describes the parameters for **Star tracking**.

TABLE 5-4 STAR TRACKING PARAMETERS

SELECTION	DESCRIPTION
Star	Five preset stars and one user-definable entry are programmed for this parameter. For the user-definable star, the user may enter any right ascension of the star in degrees, declination of the star in degrees, and the epoch set, which is the Julian date representing the epoch for the right ascension and declination values. Common values are: B1950 = 2433282.423; J2000 = 2451545.0. (The data for the predefined stars is from the U. S. Naval Observatory.)
Right ascension [deg]	The right ascension (in degrees) of the star
Declination [deg]	The declination (in degrees) of the star
Epoch [Julian date]	Epoch for the right ascension and declination. Common values are R1950 = 2433282.423; J2000 = 2451545.0.
Time bias	Used to cause star tracking to run ahead of where the star is in real time.
Bias angle [deg]	Bias angles for the star. Refer to section 5.8.2.3.1, Manually bias target, for a description of the function of bias angles.

5.8.2.6.3.2 OPT Tracking Mode Parameters

The **Edit target parameters...** screen for targets with tracking modes set to **OPT** contains three menus and one function:

Spacecraft parameters...
Steptrack parameters...
OPT parameters...
Reset OPT target

Table 5-3 describes the **Steptrack** parameters, and Tables 5-5, 5-7, 5-8, and 5-9 describe the **Spacecraft parameters...** and **OPT parameters...**. Refer to paragraph 5.8.2.3.3 for information on the **Reset OPT target** function.

TABLE 5-5 SPACECRAFT PARAMETERS	
PARAMETER	**DESCRIPTION**
Box center longitude [deg.East]	East longitude where the spacecraft is at its box center.
Longitude range [deg]	Used for the box limit and orbit scan. This sets the longitude range of motion from the box center longitude. Nominal value is 0.1 , which means the spacecraft is constrained to box center longitude – 0.1 .
Estimated inclination [deg]	Used to determine the box limit along with the longitude range. Also used for the orbit scan, if it is enabled.
Box limit	The ACU's box limit generates a latitude/longitude box using the box center longitude, longitude range, and estimated inclination. The box limit should usually be ENABLED, as it provides OPT with information about the spacecraft's range of motion, which helps prevent tracking the wrong spacecraft. When box limit is ENABLED and a new or erased OPT target is started, it first checks to see if the antenna is within the box limit. If not, OPT will move to the target's box center longitude before doing anything else, even if it is seeing a usable tracking signal (from the wrong spacecraft) at the starting point. If box limit is disabled, OPT cannot detect that it is on the wrong target. While OPT is tracking, if it ever moves the antenna outside of the box, a "Box limit" error occurs, and OPT will not track until the error is cleared.
Orbit scan	Used if OPT has no signal and no orbit model with which to work. A circular geosynchronous orbit is generated passing through the box center longitude with an inclination given by the **Estimated inclination** parameter. The scan then runs the antenna around this trajectory looking for a signal that is at least 0.5 dB above the **Low tracking signal level**. If it finds such a signal, OPT begins at that point. If one orbit is swept without finding a signal, OPT stops. If disabled, OPT stops without trying a scan first.

The **Spacecraft parameters...** menu contains two menus: **Tracking signal parameters...** (refer to paragraph 5.8.2.3.2) and **Calibrate tracking signal...**. The **Calibrate tracking signal...** menu contains the parameters listed in Table 5-6, and it also contains the **Manual antenna control** function described in paragraph 5.8.2.5.

TABLE 5-6 CALIBRATE TRACKING SIGNAL	
PARAMETER	**DESCRIPTION**
Set 0 dB point	Selecting this causes the 0 dB point to be set at the current A/D reading. The new value is displayed in **0 dB setting**. To set this value, peak up the antenna on all axes and adjust the incoming voltage between 6 V and 8 V. This value also affects the dB display on the front panel and the OPT/Steptrack tracking modes.
Set -3 dB point	Selecting this will set the -3 dB point at the current A/D reading. This will complete the calibration of the volts/dB slope for the tracking signal. To set the -3 dB point, first set the **0 dB point**, then run the antenna off the target by 3 dB and select this item. If the antenna cannot be run off of the target, a -3 dB attenuator may be used at the tracking receiver input.
0 dB setting	This value is generated by executing the **Set 0 dB point**.
A/D slope	This value is generated by executing the **Set -3 dB point**.

The parameters listed in Table 5-8 should only be modified by Vertex personnel or experienced technicians who thoroughly understand these parameters

TABLE 5-7 OPT PARAMETERS

PARAMETER	DEFAULT	DESCRIPTION
Cycle time with ST solution	00:10:00	Sets the cycle time between steptrack operations when a short-term solution is in use.
Cycle time with LT solution	00:20:00	Sets the cycle time between steptrack operations when a long-term solution is in use.
Signal fluctuation limit [dB]	0.20	This value sets the point at which steptrack, under OPT operation, will go to a fixed scan pattern. This will only happen when an OPT model is available and the Std. Dev. On the OPT Statistics screen is greater than this parameter. A fixed scan will minimize tracking errors in a noisy environment. The nominal value is set to 0.20 dB, but can be decreased to cause the OPT to use a fixed pattern more frequently.
Min. ST solution time span	1.25	Sets the minimum window of data used to create a short-term solution. The smallest allowable value is 1.25 hours. The value may be increased if performance of the early solutions is less than desirable.
Min. LT solution time span	18	Sets the minimum window of data used to create a long-term solution. The smallest allowable value is 18 hours. The value may be increased if performance of the early solutions is less than desirable.

CAUTION
Improper modification of the parameters listed in Table 5-8 will severely degrade OPT performance.

TABLE 5-8 ADVANCED OPT PARAMETERS		
PARAMETER	**DEFAULT**	**DESCRIPTION**
ST discard point	0.10	Represents the fraction of the -3 dB beamwidth at which OPT will start the process to invalidate the current short-term solution. Setting this value larger will allow more error growth, but setting it too small will cause excessive steptrack operations.
LT discard point	0.09	Represents the fraction of the -3 dB beamwidth at which OPT will start the process to invalidate the current long-term solution. Setting this value larger will allow more error growth, but setting it too small will cause excessive steptrack operations.
dB collect cycle time [ms]	500 ms (0.5 sec)	Controls the frequency at which new points are read from the current A/D. A window of 40 points is held to determine the mean dB and standard deviation of the signal inside OPT. The nominal value is 500 ms (0.5 sec) which will cover the last 20 seconds in time. Increasing this value will stretch the time the window covers but only 40 points are maintained.
Propagator cycle time [ms]	1000 ms (1 sec)	Controls the frequency at which new look angles are calculated from an existing OPT solution. The value can be increased to lower the workload on the CPU.
Max solution RMS	0.10 (10% bandwidth)	***WARNING: Setting this value too low will cause OPT to malfunction.*** Represents the fraction of the receive -3 dB beamwidth at which OPT will no longer consider an orbital element set valid. Setting this value too high could allow OPT to use a bad solution.
Max steptrack fit [db]	N/A	One of two values used to determine if a steptrack operation should be accepted by OPT. **SP_FIT** (seen in **Steptrack statistics**) is the comparison data. This parameter should only be changed on the advice of Vertex personnel.
Max steptrack std [db]	N/A	One of two values used to determine if a steptrack operation should be accepted by OPT. **SP_STD** (seen in **Steptrack statistics**) is the comparison data. This parameter should only be changed on the advice of Vertex personnel.
Use solutions	Enabled	In normal operation, OPT will follow its solutions between steptrack operations. This parameter must be enabled for this to happen. Disabling this parameter will stop OPT from using its solutions, but OPT will continue to collect data and generate solutions. OPT will always use its solutions to initially acquire the target.

The non-geosynchronous parameters listed in Table 5-9 provide OPT with the capability to support tracking a satellite in non-geosynchronous orbits under certain circumstances. Improper use of these parameters will severely degrade OPT performance. Vertex recommends that the user contact a Control Systems Group engineer before attempting to modify these parameters.

TABLE 5-9 NON-GEOSYNCHRONOUS SUPPORT PARAMETERS

PARAMETER	DEFAULT	DESCRIPTION
Non-geosynchronous tracking	Disabled	Allows the ACU to track satellites that are not in geosynchronous orbit. In this system, a geosynchronous orbit is defined to have a period very close to 1 sidereal day (86164 seconds) and an eccentricity near zero (circular orbit). Inclined orbits with these characteristics are still geosynchronous. For most applications, this parameter should be disabled. Unless an operator is *certain* that this parameter needs to be enabled, it should be Disabled. This is typically used for drift orbit support (repositioning a satellite to a new orbital assignment on the geostationary arc), limited transfer orbit tracking, and Molniya-type orbit tracking. If this parameter is enabled, *all* other items in this menu *must* be set properly to begin tracking. The values should be as accurate as possible. When OPT gathers sufficient steptrack data, it will compute its own values for these parameters, and the values in this menu will be dropped from use.
Orbital period [seconds]	86164 seconds	Used in conjunction with the steptrack data to build OPT solutions. The orbital period is the time in which the satellite makes one complete revolution around the Earth. Units are seconds.
Orbital eccentricity	0.00000	Used in conjunction with the steptrack data to build OPT solutions. The orbital eccentricity defines the shape of the orbit. The value is non-dimensional.
Orbit argument of perigee [deg]	0.000	Used in conjunction with the steptrack data to build OPT solutions if the eccentricity is set greater than zero. The argument of perigee is the angular measurement, in the plane of the satellite's orbit, between the ascending node and the periapsis point. Units are degrees. ***NOTE: If the orbital inclination is very near zero, this angle is measured from the mean vernal equinox vector to the periapsis point.***

5.8.2.6.3.3 Intelsat 11-Element (IESS-412) Tracking Mode Parameters

Table 5-10 describes the **Intelsat 11-element** parameters.

TABLE 5-10 INTELSAT 11-ELEMENT PARAMETERS

PARAMETER	DESCRIPTION
Year	Year portion of the epoch time on which the ephemeris is based; value must be a four-digit number (1990; 2001).
Month	Month portion of the epoch time on which the ephemeris is based; input is a two-digit integer value (01 - 12).
Day	Day portion of the epoch time on which the ephemeris is based; input is a two-digit integer value (01 - 31).
Hour	Hour portion of the epoch time on which the ephemeris is based; input is a two-digit integer value (00 -23).
Minute	Minute portion of the epoch time on which the ephemeris is based; input is a two-digit integer value (00 - 59).
Second	Second portion of the epoch time on which the ephemeris is based; input is a two-digit integer value (00 - 59).
LM0 [deg. E]	Mean longitude (degrees east of Greenwich). Labeled LM0 on the 11-parameter ephemeris from Intelsat.
LM1 [deg/day]	Mean longitude drift rate (degrees east per day).
LM2 [deg/day/day]	Mean longitude drift acceleration (degrees east per day).
LONC [deg. E]	Amplitude of the cosine component of the longitude oscillation (degrees east).
LONC1 [deg/day]	Rate of change in LONC (degrees east per day).
LONS [deg. E]	Amplitude of the sine component of the longitude oscillation (degrees east).
LONS1 [deg/day]	Rate of change in LONS (degrees east per day).
LATC [deg. N]	Amplitude of the cosine component of the latitude oscillation (degrees north).
LATC1 [deg/day]	Rate of change in LATC (degrees north per day).
LATS [deg. N]	Amplitude of the sine component of the latitude oscillation (degrees north).
LATS1 [deg/day]	Rate of change in LATS (degrees north per day).
Longitude at 170 hours [deg. E]	Satellite longitude at epoch plus 170 hours (degrees east).
Latitude at 170 hours [deg. N]	Satellite latitude at epoch plus 170 hours (degrees north).
Polarization angle [deg]	POL angle used with Intelsat tracking if POL is enabled. If the ACU does not control POL, this value is irrelevant.
Bias angles [deg]	Angles added to the look angles to determine the target position. These exist because the look angles can only be edited at Supervisor level, but the bias angles can be edited at Operator level, allowing periodic repeaking of the target without losing the base position.
Pointing update time [ms]	Controls the frequency at which new look angles are calculated from the Intelsat parameters. The nominal value is 1000 milliseconds (ms) (1 second). The value can be increased to lower the workload on the CPU.

5.8.2.6.3.4 Move to Longitude Tracking Mode Parameters

The **Move to longitude** parameters are described in Table 5-11.

TABLE 5-11 MOVE TO LONGITUDE PARAMETERS		
PARAMETER	**DEFAULT**	**DESCRIPTION**
E. Longitude of target [deg]	N/A	E. longitude of target to which antenna will move
(Look angles [deg])	N/A	Read-only item that shows look angles corresponding to the **E. Longitude of target [deg]**
Polarization [deg]	N/A	POL look angle for target
Bias angles [deg]	N/A	Added to **Look angles [deg])** to compute target position; these exist because look angles can be edited only at Supervisor level; Operator level can edit the **Bias angles [deg]**

5.8.2.6.3.5 Move to Look Angles Tracking Mode Parameters

Table 5-12 describes the **Move to look angles** parameters.

TABLE 5-12 MOVE TO LOOK ANGLES PARAMETERS		
PARAMETER	**DEFAULT**	**DESCRIPTION**
Look angles [deg]	N/A	Look angles to which the antenna will move when selected target is tracked.
Bias angles [deg]	N/A	These angles are added to the look angles to determine the target position. These exist because the look angles can only be edited at Supervisor level, but the bias angles can be edited at Operator level, allowing periodic repeaking of the target without losing the base position.

5.8.2.7 Target Scheduler Menu

The **Target scheduler...** menu allows the user to program up to 200 targets with corresponding dates and times at which tracking begins for each target. This allows fully automatic tracking of a number of targets, each with its own preconfigured mode of tracking.

When the target scheduler is running and a target is being tracked, the display will show the target name under the **Current pos**, **Moving to target** or **Awaiting next scheduled target time (no tracking in progress)** will be displayed at the **Tracking mode:** prompt, and **Next target** will show the name, date, and time of the next target to be tracked.

The **Target scheduler...** menu contains the **Track schedule** and **Edit schedule...** menu.

5.8.2.7.1 Track Schedule

When this function is selected, if there are entries in the schedule, a prompt appears asking the user if tracking is to begin at the first target in the schedule -- the target's name and parameters are displayed in the prompt. The following paragraphs provide procedures for viewing and editing the track schedule.

5.8.2.7.2 Edit Schedule Menu

Edit Schedule Menu allows viewing and editing of the **Track schedule**. Items under this menu include the following:

View/edit existing entries...
Add a new entry...
Delete one entry...
Delete ALL entries

The user must be at **Operator** or **Supervisor** level to make changes to the schedule; however, the schedule may be viewed at **Monitor** level. Also note that any changes made in this menu do not take effect until the user presses [PRIOR] to leave the menu and saves the changes.

NOTE: All entries displayed or entered are in UTC time, not local time.

5.8.2.7.2.1 View/Edit Existing Entries Menu

View/Edit Existing Entries Menu displays all entries in the schedule. There is one entry displayed per line, in the following format:

date: dd Mmm yyyy time: hh:mm:ss target: target_name

To view entries in the schedule, use the following procedures:

1. From the **Main menu**, select **Tracking functions...**, **Target scheduler...**, and **Edit schedule...**.

2. Select **View/edit existing entries...** and the entries will be displayed. To edit an entry, use the following procedures:

To edit entries in the schedule, use the following procedures:

1. From the **Main menu**, select **Tracking functions...**, **Target scheduler...**, and **Edit schedule...**.

2. Select **View/edit existing entries...** and place the cursor on the target to be edited and press [ENTER].

3. For parameters requiring numeric values, use the numeric keys on the keypad to enter the desired value and press [ENTER]. If the parameter has a predefined list of choices, (e.g., the date), use the up and down arrow keys to toggle through the preset choices. To edit (change) the target name selected, when the **Select a target** screen is displayed, use the arrow keys to highlight the desired target and press [ENTER].

5.8.2.7.2.2 Add a New Entry Menu

Add a New Entry Menu allows the user to enter the name (from the **Select a target** screen), date, and time of up to 50 targets to be added to the schedule. If a new entry has the same date and time as an existing entry, the existing entry will be replaced with the new entry. New entries are inserted into the schedule in chronological order, moving entries with a later date and time down in the schedule. When the schedule is full, the user must delete an entry before adding a new one (refer to paragraph 5.8.2.7.2.3 for procedures to delete an entry).

To add a new entry, use the following procedures:

1. From the **Main menu**, select **Tracking functions...**, **Target scheduler...**, and **Edit schedule...**.

2. Select **Add a new entry...** and press [ENTER].

3. For parameters requiring numeric values, use the numeric keys on the keypad to enter the desired value and press [ENTER]. If the parameter has a predefined list of choices, (e.g., the date), use the up and down arrow keys to toggle through the preset choices. To select a target to be added, when the **Select a target** screen is displayed, use the arrow keys to highlight the desired target and press [ENTER].

4. To enter (add) an entry, press [ENTER] when **Add the entry above to the schedule** is highlighted. Notice that the number of entries in the schedule is updated on the display.

5.8.2.7.2.3 Delete One Entry Menu

Delete One Entry Menu allows the user to delete one entry at a time. As mentioned in paragraph 5.8.2.7.2.2, when the schedule is full, the user must delete an entry before adding a new one.

To delete an entry, use the following procedures:

1. From the **Main menu**, select **Tracking functions...**, **Target scheduler...**, and **Edit schedule...**.

2. Select **Delete a new entry...** and press [ENTER].

3. Select the entry to be deleted and press [ENTER]. A confirmation message will appear before the deletion is processed.

5.8.2.7.2.4 Delete All Entries Function

Delete All Entries Function allows the user to delete all entries in the schedule. A confirmation message will appear to verify that the user intends to delete all entries from the schedule.

To delete all entries from the schedule, use the following procedures:

1. From the **Main menu**, select **Tracking functions...**, **Target scheduler...**, and **Edit schedule...**.

2. Select **Delete ALL entries** and press [ENTER].

3. A confirmation message will appear to verify that this will delete all entries in the schedule.

5.8.3 Clear/Correct System Faults Function

Clear/Correct System Faults Function clears all faults that can be cleared, and acknowledges faults that the ACU cannot correct. If there are unacknowledged faults:

All faults are displayed in reverse video (even if some faults had been previously acknowledged). If all faults displayed have been acknowledged, they are displayed in normal video.
If the audible alarms are on (refer to paragraph 5.8.6.11), the ACU will emit a steady tone -- acknowledging the faults will deactivate the alarms.
The summary alarm contact closure is opened. When all faults are cleared and/or acknowledged, this contact will close.

Some faults can only be acknowledged by the ACU; action external to the ACU is required to clear the fault (e.g., if the EMERGENCY STOP button on the drive cabinet is engaged, the button must be disengaged at the drive cabinet before the fault can be cleared.)

Some faults are "latching"; that is, even though the fault condition has been cleared, the user must acknowledge that the fault occurred before the fault message will disappear from the ACU display. An example of a latching fault is the "Tracking signal input saturated" fault message, indicating that the tracking signal input exceeded 10 VDC. The ACU cannot track properly with that voltage. This latches because this error often occurs intermittently. Intermittent tracking problems can be caused by this, and it is important to be aware of such a fault so that it can be corrected.

To clear system faults, return to the **Main menu** and select **Clear/correct system faults**.

Table 5-13 describes the faults that may be displayed on the ACU.

TABLE 5-13 CLEAR/CORRECT SYSTEM FAULTS	
FAULT	**DESCRIPTION**
Axis immobile	Indicates that the antenna has been commanded to move in a particular axis, but the antenna has not moved or the resolver has not moved.
Axis soft limits	Indicates that the antenna has moved beyond the limits set by the software in the ACU.
Axis reversed	Indicates that the antenna is moving in the direction opposite to the commanded direction. Can also be a result of the antenna "whipping".
Axis runaway	Indicates that the antenna has not been commanded to move, but the antenna is moving. Can also be a result of the antenna "whipping".
Azimuth drive fault	Indicates that the AZ speed controller is tripped or has lost power.
East box limit violation	Indicates that the antenna has jogged beyond the limit set by the east box limit in the steptracking configuration of a target.
Elevation drive fault	Indicates that the EL speed controller is tripped or has lost power.
Emergency stop at drive cabinet	Indicates that the EMERGENCY STOP switch at the drive cabinet is pushed in.
Keyboard stop	Indicates that tracking has been stopped from the ACU keyboard.
Low tracking signal level	Indicates if the signal is below the threshold necessary for steptracking functions.
Maintenance override at drive cabinet	Indicates that the CONTROL switch in the drive cabinet is set to MAINT. The 7150 drive cabinet switch has a remote position and maintenance position.
No power at drive cabinet	Indicates that the drive cabinet is without power.
Non-volatile RAM corrupted	Indicates that one or more parameter tables failed power-up test and was loaded with default values. All data in the RAM is lost and must be re-entered.
OPT cannot track	OPT has no valid orbital models and a low tracking signal level condition exists. OPT will maintain the antenna at the current position until the low tracking signal level condition is gone.
South box limit violation	Indicates that the antenna has jogged beyond the limit set by the south box limit in the steptracking configuration of a target.
Travel limit switch (summary)	Indicates that the antenna has tripped one of the mechanical limit switches.
West box limit violation	Indicates that the antenna has jogged beyond the limit set by the west box limit in the steptracking configuration of a target.
System error: unused fault	A firmware error has occurred; call Vertex upon the indication of this fault.

5.8.4 Set User Level (and Passwords) Menu

Set User Level (and Passwords) Menu contains the following functions:

Go to monitor level
Go to operator level
Go to supervisor level
Change operator password
Change supervisor password

5.8.4.1 7200 ACS User Levels

The 7200 ACS has three user levels:

Monitor level: At Monitor level, the user can examine all system parameters but cannot edit the parameters or command the antenna.

Operator level: At Operator level, the user can command the antenna to a new target or use manual mode, but cannot edit system parameters.

Supervisor level: At Supervisor level, there are no restrictions on the user -- the user may modify any system parameters or target configurations.

To change the user level of the system, use the following procedures:

1. From the **Main menu**, select **Set user level (and passwords)...**.

2. Select the desired level and press [ENTER].

5.8.4.2 7200 ACS Passwords

No password is required to change the user level of the system to Monitor, but passwords are required to change to either the Operator or Supervisor level.

Passwords are one to nine digits (0 through 9). Setting a password to 0 disables password protection for that level. Supervisor level is required to change passwords at Operator or Supervisor levels.

If password protection is not desired, disable passwords (set the password to 0), and set the user level to Supervisor. The user level is stored in battery-backed memory and will be retained by the ACU until it is changed.

For instructions on disabling or changing passwords through the system hardware, refer to Appendix B.

To change an Operator password, use the following procedures:

1. From the **Main menu**, select **Set user level (and passwords)...**.

2. Select **Change operator password** and press [ENTER]. If the system is not at Supervisor level, a prompt will appear to notify the user to go to Supervisor level (refer to paragraph 5.8.4.1).

3. The following prompt will appear:
   Enter new password to go to operator level: _____

4. Enter the desired password (one to nine digits, 0 to 9) and press [ENTER].

5. The following prompt will appear: **Re-enter password:**

6. Re-enter the password exactly as it was originally entered. If the password is incorrectly entered, the following prompt will appear: **Password entered differently; try again**

7. If the password is entered incorrectly again, the system will return to the **Change user level** screen.

To change a Supervisor password, select **Change supervisor password**, and follow steps 3 through 7 above.

5.8.5 Display System Status Menu

This menu contains the following parameters:

Input states
Output states
Optical Encoders
RDC states
A/D states
Position loop diagnostics
Steptrack statistics
OPT statistics
Orbit data
Box limits
Background tasks
Simulated target
Star viewing windows
View message buffer
Serial TRL diagnostics
Power-up test report
Firmware version information

These functions are not normally used in everyday operation, but are useful in debugging the 7200 ACS, especially during installation.

5.8.5.1 Input States

When **Input States** is selected from the menu, the input states of the I/O board are displayed. The logic is negative true; therefore a 0 indicates that an input is engaged and a 1 indicates that an input is disengaged. The only inputs supported by the drive cabinet are the first five (EM STOP, MAINT, SUM LIM, AZ DRIVE FLT, AND EL DRIVE FLT). If all five inputs are in the 1 state, the 7200 ACU interprets this condition as a no-power condition at the drive cabinet.

5.8.5.2 Output States

If **Output States** is selected from the menu, the screen shows the current output states from the I/O board. Outputs are negative true; therefore, 0 for one of the drive lines (AZ CW, EL UP) indicates movement in that direction. DRIVE ENABLE is 0 if the drive cabinet is enabled (powered). For beacons (B1 - B4), the one showing 0 is the beacon selected. SUM ALM is 0 for OK and 1 for fault.

5.8.5.3 Optical Encoders

Optical Encoders shows, in real time, the errors occurring on the serial link from the optical encoders and the CPU. This screen can only be accessed if **Encoder type** is set to an optical encoder type in the **Position configuration...** menu.

This information is most useful during the installation of the system. There are no "acceptable" limits, but for proper operation, the values must remain five percent or less.

5.8.5.4 RDC States

The information shown in Figure 5-11 shows the state of the RDC card. This data is primarily used for debugging systems with standard resolvers. On single-speed systems, AZ and EL fine data, states, and mode will show all bits as **F** (hexadecimal).

The information is displayed in hexadecimal by default, but can be changed to binary display by pressing [ENTER] to toggle between hexadecimal and binary.

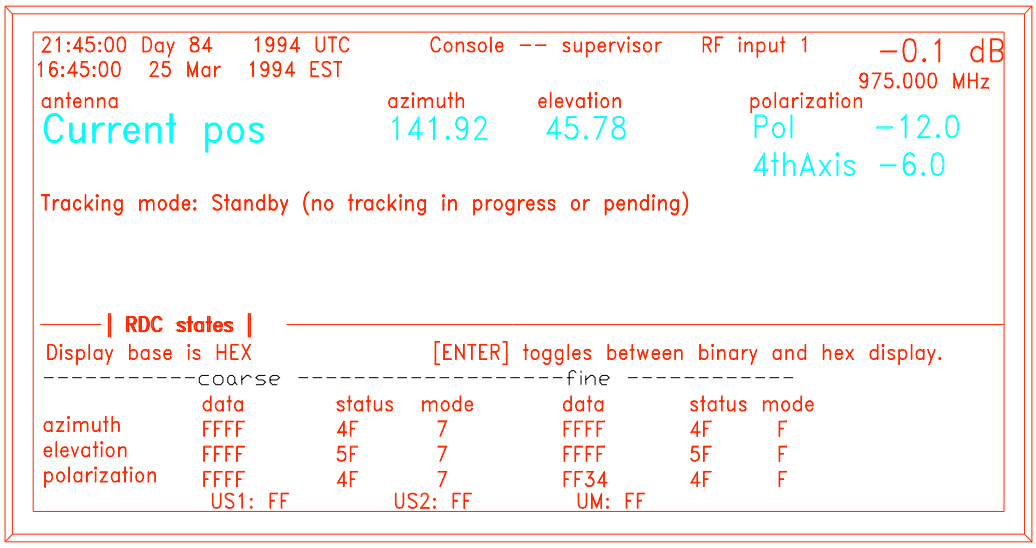

Figure 5-11 RDC States Display

On systems with two-speed resolvers, this information is also used to determine the internal alignment of the resolver (i.e., the fine resolver value when the coarse resolver value is 0). Even though it is unused on two-speed resolver systems, POL fine bits will always show all bits as **1**'s. On systems without two-speed resolvers, the fine data fields should show **FFFF** in hexadecimal (or **1111 1111 1111 1111** in binary).

US1 and **US2** are unused states 1 and 2, and **UM** is unused mode, but all should show **1**'s. The status and mode information are not useful to the user; they are provided for Vertex engineers' use only and are not documented here.

5.8.5.5 A/D states

A/D States provide the status of the A/D states for each channel. The display shows raw data, the 12-bit data from the A/D board (in hexadecimal and binary), and the status of three flags as follows:

If the flags are off, the display shows "**---**"
An **O** indicates that the A/D is overrange (saturated)
An **S** indicates sign, which is true if a positive voltage is present; negative voltage readings are unusable
An **N** indicates that a new value is ready (**N** will normally be flashing on and off)

5.8.5.6 Position Loop Diagnostics

Position Loop Diagnostics shows the states of the position loop task in real time. The status (awake or asleep) of the position loop is displayed. If the loop is awake, the antenna is being actively commanded to a position (or the system is actively holding the current position). If the system is in **Standby** or **Manual** mode, the loop is asleep and is not commanding the antenna.

The **FSM state** provides the current status of position loop Finite State Machine (FSM) for each axis. Table 5-14 describes the possible states of the FSM.

TABLE 5-14 FINITE STATE MACHINE STATES

STATE	DESCRIPTION
Slew drive	Indicates that the antenna is driving at slew (fast) speed toward the target.
Slew coast	Indicates that the antenna is now within the slew->track transition point, waiting for the antenna to coast to a stop before proceeding.
Track drive	Indicates that the antenna is driving at track (slow) speed toward the target.
Track coast	Indicates that the position loop has come within the deadband and is waiting for the antenna to come to a stop.
Inch coast	Indicates that the position loop either overshot the positioning deadband on the way to the target, or the antenna has drifted outside the positioning deadband and the antenna is inching back to the deadband.
On target	Indicates that the antenna is within positioning deadband of the target.
Unknown	Indicates that the FSM has not been used since power-up of the ACU.
Outputs	Shows (in the form rate, direction), the rate and direction in which the antenna is being driven. For example, slew CCW indicates that the antenna is moving CCW at slew rate. If the antenna is not being commanded, this line indicates **Track Stop**.
Distance to target	Shows how far the antenna has to move to get to the commanded position. Positive value means move up/CW to get to the target.

5.8.5.7 Steptrack Statistics

The **Steptrack statistics** provide real-time information when the **Steptrack active** field is true. When **Steptrack inactive** is true, the final values at completion of the last steptrack operation are displayed. Table 5-15 describes the steptrack statistics.

TABLE 5-15 STEPTRACK STATISTICS	
FIELD	**DESCRIPTION**
no. of cycles	Indicates the number of complete steptrack cycles (both AZ and EL peaking) performed to achieve peaking constraints.
SP_LOOP	Indicates the number of loops required by the fitting algorithm.
SOL-MAX DIFF	Indicates the calculated radial difference in percentage of beamwidth between the position where maximum signal was recorded and the adjusted peak position.
SP_FIT	Minimized least squared error between internal beam model and collected data.
SP_STD	Maximum standard deviation of original recorded during stepping operations.
SP_WT	Weight value used for filtering steptrack peak estimates.
CAL STEP	Estimated step to peak antenna (in percentage of beamwidth).

5.8.5.8 OPT Statistics

OPT statistics provides useful information only when OPT is in operation. The statistics are described in Table 5-16. Information on this screen is intended for use by Vertex personnel.

TABLE 5-16 OPT STATISTICS	
FIELD	**DESCRIPTION**
STvsAST delta	The short-term versus AST delta is the calculated radial error in percentage of beamwidth between the last steptrack solution and the short-term solution at that time.
LTvsAST delta	The long-term versus AST delta is the calculated radial error in percentage of beamwidth between the last steptrack solution and the long-term solution at that time.
LTvsST delta	The difference between the LT solution and the ST solution at the last steptrack operation.
Sol. in use	Displays, in real time, the OPT model being followed.
Mean	The mean signal level being used in OPT (real time).
Std. Dev.	The standard deviation of the signal used to determine when the signal is too noisy to steptrack (real time).
ST Sol	The RMS of the deviations for the last short-term solution created.
LT2b Sol	The RMS of the deviations for the last long-term solution created using the two-body propagator.
LTmb Sol	The RMS of the deviations for the last long-term solution created using the multibody propagator.
ST SOLVER	Indicates if the short-term solver task is awake or asleep.
LT SOLVER	Indicates if the long-term solver task is awake or asleep.

5.8.5.9 Orbit Data

Orbit data provides information from the current target OPT solutions. This information can be useful in setting up or checking **Box limit**s. Three solutions may exist for each OPT target: Short-term, Long-term (2b), and Long-term (mb). If data is not available for a given solution, **Not available** will be displayed.

Under each solution, the user will see the data listed in Table 5-17 calculated at the solution epoch.

TABLE 5-17 ORBIT DATA CALCULATIONS

FIELD	DESCRIPTION
Longitude (E)	Estimated east longitude of the satellite.
Inclination	Estimated orbital inclination, in degrees.
Axis 1 delta	Estimated delta, in degrees, applied to the first axis. For most systems, axis 1 is AZ.
Axis 2 delta	Estimated delta, in degrees, applied to the second axis. For most systems, axis 2 is EL.

5.8.5.10 Box Limits

The **Box limits** information provides the limits in use and the current pointing location inside the box. The limits are only active when the current target is an OPT target and Box limits are enabled. This information is provided to assist in troubleshooting Box limit errors. The longitude/latitude values displayed are estimates determined from the current look angles. The estimates are independent of the OPT solutions and will function with or without OPT solutions, and the estimates do not affect the solutions.

The north/south limits are determined by the **Estimated inclination** input for the target under OPT parameters. The east/west limits are determined by using three values: the **Longitude range**, a longitude spread calculated from the **Estimated inclination**, and the **Box center longitude**. These values are input for the target under OPT parameters.

When a north/south limit is intersected and no other problem exists, open the limits by increasing the **Estimated inclination** for that target. The **Orbit data** screen can assist in determining the target's inclination. The **Estimated inclination** must be set to a value greater than that displayed on the **Orbit data** screen.

When an east/west limit is intersected and no other problem exists, open limits by increasing the **Estimated inclination** and/or the **Longitude range** value. The box center longitude should be verified to be at the normal longitude for the satellite. This nominal longitude can be obtained from the satellite operator or may be estimated on the **Orbit data** screen if the axis are very small.

5.8.5.11 Background Tasks

Background tasks indicates whether the background tasks or awake or asleep. Table 5-18 describes each of the tasks.

TABLE 5-18 BACKGROUND TASKS

TASK	DESCRIPTION
POSITIONER	The task that drives the antenna to a target and holds it there. **PPSOTOPMER** will be asleep when in **Standby** and awake when tracking. **Steptrack** will momentarily put **POSITIONER** to sleep while it is gathering data and then wake it up again. **POSITIONER** will also be asleep during manual antenna control.
OUINTF	(Outside Unit Interface) Reads the position transducers (resolvers) and does fault monitoring. OUINTF should always be awake.
ST_SOLVER	Used by OPT to build orbit solutions. These tasks will be awake occasionally when a new solution is being built. Builds short-term solutions.
LT_SOLVER	Used by OPT to build orbit solutions. These tasks will be awake occasionally when a new solution is being built. Builds long-term solutions.
SIMULATOR	This task will be AWAKE when the ACU is in SIMULATION mode.
TARGETER	Drives the current target. For **Move to look angles** and **Move to longitude** targets, **TARGETER** will be awake only long enough to set **POSITIONER** to the correct look angles. Then it will go to sleep and remain asleep. For **OPT**, **Intelsat**, and **Star tracking**, **TARGETER** should be awake at all times.
SCHEDULER	This task drives the **Target scheduler**. This task should be awake when **Target scheduler** is operating, and asleep when the scheduler is not being used.

NOTE: When the ST_SOLVER and LT_SOLVER tasks are shown, the target name is also displayed because the task(s) may not necessarily be building solutions for the target currently being tracked.

5.8.5.12 Simulated Target

Simulated Target is useful only in SIMULATION mode. When in SIMULATION, this shows the simulated target's current position and error and basic orbit information.

5.8.5.13 Star Viewing Windows

The **Star Viewing Windows** screen shows the windows of visibility (when the star is within the software travel limits of the antenna) for a star. This is used primarily for G/T testing of antennas by radio stars. This screen shows at what times of the day the star will be visible for use by the tester.

Table 5-19 describes the parameters for **Star viewing windows**.

TABLE 5-19 STAR VIEWING WINDOWS	
PARAMETER	**DESCRIPTION**
Star	This is the star for which information is to be displayed. When selected, a screen similar to the target selection screen will appear, showing only the targets with **Tracking mode** set to **Star tracking**.
Date	Reference date for the viewing windows. The star's position at 0 hours UTC on this date is analyzed. If the star is in view at that time, the window in which the star is will be displayed. If the star is not in view, the next window in time will be displayed.

Selecting **Display viewing windows...** will display the viewing windows for the star selected corresponding to the date entered in the **Date** parameter. If **Soft limits** are enabled, then the Acquisition of Star (AOS) and Loss of Star (LOS) are bounded by the soft limits (i.e., the star is within the soft limits between AOS and LOS). If **Soft limits** are disabled, then AOS and LOS values are only bounded by the horizon (0 degrees elevation).

To use this utility, a target for the star must be established. To view a window for an existing target with a tracking mode set to **Star tracking**, use the following procedures:

1. From the **Main menu**, select **Display system status...** and then **Star viewing windows**.

2. Place the cursor on **Star** and press [ENTER]. A screen similar to the target selection screen will appear, listing only those stars with a tracking mode set to **Star tracking**.

3. Select the star to be viewed and press [ENTER]. The target name will be displayed in the **Star** parameter, and the star's reference date will be displayed in the **Date** parameter.

4. To display the "viewing windows" for the selected star, select **Display viewing windows...**. The dates and times (in UTC) at which the star will be visible to the antenna are listed. The up and down arrow keys may be used to scroll forward or backward through the visibility dates.

To set a target with a **Tracking mode** of **Star tracking**, use the following procedures.

1. From the **Main menu**, select **Tracking functions...**, and **Edit a new or existing target...** (refer to paragraph 5.8.2.6).

2. Select a noninitialized target, and set the **Tracking mode** to **Star tracking** (refer to paragraph 5.8.2.6.2). If the star is a user-defined star, "name" the target.

3. Select **Edit target parameters...**. To select one of the preprogrammed stars, select **Star**, and using the up and down arrow keys, scroll through the list of stars. To select one of the stars, when the name of the star is highlighted, simply press [ENTER] and the values for **Right ascension [deg]**, **Declination [deg]**, and **Epoch [Julian date]** will automatically be assigned to those parameters. To define another star, select the choice "User-defined" for **Star**, and assign the values for these parameters by selecting each parameter and entering values within the specified range.

5.8.5.14 View Message Buffer

View Message Buffer displays the contents of the message buffer. The message buffer holds up to 120 lines of text. The ACU prints messages into this buffer when certain events (selected by the user) occur. The events may be viewed as they occur; the user may also scroll through the buffer to see earlier events.

When this screen is first accessed, the most recent messages are displayed. Events that have scrolled off of the screen may be viewed by pressing the up arrow key to scroll back one line in the buffer. Pressing page up ([SHIFT] and the up arrow key) scrolls back through an entire screen. Note that once an arrow key is pressed, the display will no longer show new events as they occur. To view the most recent events, press [PRIOR] to return to the **Display system status...** menu and press [ENTER] to return to the **View most recent messages** screen.

5.8.5.15 Serial Tracking Receiver Diagnostics

The tracking receiver diagnostics screen shows the "raw" states values being transmitted by the tracking receiver to the ACU. This information is beneficial only to Vertex engineers troubleshooting the serial link. The message, **Serial receiver link not in use** indicates that no serial port has been set up as a tracking receiver interface.

5.8.5.16 Power-up Test Report

The **Power-up test report** option provides the time that the ACU was last powered up, and the status of peripherals on the VME bus. If any errors were detected on these cards at power-up, the errors will be displayed.

5.8.5.17 Firmware Version Information

The **Firmware version information** provides the type of software used in the ACU and the date of the version installed in the system.

5.8.6 Edit System Configuration Menu

> ***WARNING***
> ***Any of the system configuration parameters may be viewed at any time, but modifying these parameters after installation may cause the ACU to malfunction.***

The **Edit system configuration...** menu contains the following menus and function:

Tracking receiver setup...
Steptrack defaults...
Position encoder configuration...
Motion limits...
Position loop parameters...
Built-in simulator setup...
Set UTC date and time...
Site data...
RF/geometry
Remote port configuration...
User interface options...
Tracking restoration options...
Factory tests...
Message printer options...

5.8.6.1 Tracking Receiver Setup Menu

The **Tracking receiver setup...** menu is used at system installation time to configure the tracking receiver. This must be done before invoking Steptrack or OPT. Setting the volts/dB slope under this menu is necessary for proper Steptrack and OPT operation.

This menu contains the following parameters, sub-menu, and function.

Receiver controller
Set 0 dB point
Set -3 dB point
0 dB setting
A/D slope
Tracking signal parameters...
Manual antenna control

5.8.6.1.1 Receiver Controller Parameter

The setting of the Receiver Controller Parameter selects how the tracking receiver is controlled. This only affects the "serial" tracking receiver input (i.e., a receiver with serial link); if an analog signal input is used, this parameter has no effect.

The default, and normal, setting for this parameter is **7200**. This setting signals the system to assume the receiver to be in remote control, and receiver commands (frequency, attenuation, and RF input) are sent from the 7200 to the receiver. If the receiver is in local control, a **Tracking receiver in local control** alarm is issued. The 7200 will continue to track with the signal sent from the receiver even when this alarm is in effect.

Receiver is selected to allow control of the tracking receiver from the receiver's front panel, or to allow the receiver to be controlled by another computer (M&C). Tracking receiver commands will not be sent from the 7200 to the receiver, even if it is in remote control mode.

To set this parameter, use the following procedures.

1. From the **Main menu**, select **Edit system configuration...**. Then select **Tracking receiver setup...** and **Receiver controller**.

2. Use the up and down arrow keys to toggle between the preprogrammed choices of **7200** and **Receiver**. When the desired choice is highlighted, press [ENTER].

5.8.6.1.2 Calibrating the Tracking Signal

The parameters listed in Table 5-6 are used to set the volts/dB slope of the A/D channels.

5.8.6.1.3 Tracking Signal Parameters Menu

The parameters for the **Tracking signal parameters...** menu will vary according to the type of tracking being performed. If a tracking receiver with serial link is being used, the **Shell** parameter under **Remote port configuration...** will be set to **TRL**, and **Frequency [MHz]**, **RF input**, and **Attenuation [db]** parameters will be displayed under this menu. If an analog signal input is used, **A/D channel** and **Beacon** parameters will be displayed. Refer to paragraph 5.8.2.3.2 for a listing of the parameters and procedures for changing the parameters.

5.8.6.1.4 Manual Antenna Control Function

The **Manual antenna control** function is also accessible from this menu for convenience.

5.8.6.2 Steptrack Defaults Menu

This **Steptrack defaults...** menu has the same steptrack parameters that are found in the **Edit steptrack parameters...** menu under **Immediate tracking...**. Refer to Table 5-3 for a listing and description of the parameters.

Whenever a new OPT target is created, the initial parameter values for the target are obtained from Table 5-3. The values of these parameters only affect the creation of new OPT targets; once a target is created, it has its own set of steptrack parameters. Changes made to the defaults will not affect targets created before the defaults were changed. In addition, **Immediate steptrack** gets its default steptrack parameters from this table.

5.8.6.3 Position Encoder Configuration Menu

The **Position encoder configuration...** menu allows the user to set the position encoder offsets. The offset for an axis is the difference between the actual axis position and the angle returned by the encoder. When the encoder bracketry is properly aligned, this difference (the offset) is a constant throughout the range of motion of the antenna.

In addition, the 7200 ACU has the ability (in software) to reverse the direction in which the encoders count; that is, when the encoder indicates movement in the CW direction of its shaft but the ACU reports CCW direction, and vice versa.

Table 5-20 describes the **Position encoder configuration...** parameters.

TABLE 5-20 POSITION ENCODER CONFIGURATION PARAMETERS

PARAMETER	DESCRIPTION
Encoder direction	This sets the counting direction, or "sense" of the encoders (resolvers). If antenna movement in one direction causes the resolvers to indicate motion in the opposite direction, the direction may either be reversed by changing the phasing of the resolvers, or by changing the direction for that axis from Fwd (forward) to Rev (reversed). **NOTE: For absolute optical encoders, this is the only way to change the counting direction.**
Current position [deg]	For each axis, the current position is the "raw position" returned from the encoder plus the offsets.
Offsets [deg]	Value added to the raw position to determine the current position, or the difference between the actual axis position and the angle returned by the encoder.
Encoder type	This parameter is hardware-dependent and is set at the factory. This MUST NOT be changed by the user.
2-speed internal alignment	This option will appear on the menu only in systems with Encoder type set to 2-speed resolvers. These values are used to correct the internal alignment of the two-speed resolvers. The correction value is determined form the RDC diagnostics screen. To determine the value, rotate the resolver shaft until the coarse reading is 0000 (hex) and refer to Appendix E.

There are two ways to set the offsets:

1. Enter the current position of the antenna into the **Current position [deg]** field. At installation time the antenna is normally peaked on a target (satellite or boresight tower) with a known look angle. When the current position is entered, the offsets are automatically computed.

2. Enter the offsets directly by selecting **Offsets [deg]** and entering the desired value. This is normally done only when a firmware upgrade requires re-entry of parameters, or if the nonvolatile memory should fail.

For systems with two-speed resolver option, refer to Appendix E for procedures to calibrate the two-speed resolvers.

5.8.6.4 Motion Limits Menu

There are two types of motion limits:

Software travel limits ("soft limits"): The ACU will not drive the antenna beyond the soft limits if the option is enabled. The limits function as a "prelimit", stopping motion of the antenna before it reaches the electrical travel limit switches. The soft limits should be set such that when the antenna is moving at its fastest rate and hits the soft limit, it stops just short of tripping the limit switch.

Motion errors: The motion errors prevent motion of an axis in the event that antenna motion as reported by the position encoders does not correspond with predicted motion due to ACU motor commands.

Table 5-21 describes the **Motion limits...** parameters.

TABLE 5-21 MOTION LIMITS PARAMETERS

PARAMETER	DEFAULT	DESCRIPTION
Soft limits	Enabled	These are normally enabled. If the antenna needs to be moved to its limit switches (from the ACU) for maintenance purposes, the soft limits should be temporarily disabled.
Lower/CCW soft limits [deg]	AZ: 130.00 EL: 15.00 POL: 90.00	This position vector (along with Upper/CW soft limits [deg]) defines the range of motion that the ACU will allow. For each axis, if the antenna is at the lower/CCW limit, it may be moved up/CW to the upper/CW limit.
Upper/CW soft limits [deg]	AZ: 230.00 EL: 60.00 POL: 90.00 4thAxis: 90.00	This position vector (along with Lower/CCW soft limits [deg]) defines the range of motion that the ACU will allow. For each axis, if the antenna is at the lower/CCW limit, it may be moved up/CW to the upper/CW limit.
Motion errors	Enabled	Normally enabled, but may be disabled for testing purposes.
Immobile/reversed timeout [ms]	AZ: 2000 EL: 2000 POL: 2000 4thAxis 2000	Whenever the antenna is put into motion, the downcounter is loaded with this parameter and the current position is recorded. When that downcounter expires, the current position is compared against the previously recorded position. If, for each axis, encoders do not show a value of at least Immobile/reversed tolerance [deg] of motion, an "axis" immobile error is displayed (where "axis" is AZ, EL, or POL). The error may be cleared by selecting Clear/correct system faults from the Main menu. If the encoders show movement greater than the tolerance on an axis, but in the opposite direction in which the ACU commanded the antenna, an axis reversed error is displayed. If the test is passed for all three axes, the downcounter is reset with the Immobile/reversed timeout [ms] and the process is repeated continuously.
Immobile/reversed tolerance [deg]	AZ: 0.02 EL: 0.02 POL 0.20 4thAxis 0.20	If the encoders show movement greater than the tolerance on an axis, but in the opposite direction in which the ACU commanded the antenna, an axis reversed error is displayed. The error may be cleared by selecting Clear/correct system faults from the Main menu. If the test is passed for all three axes, the downcounter is reset with the Immobile/reversed timeout [ms] and the process is repeated continuously. When the antenna is commanded to stop, the ACU waits for it to come to rest, then records the position. If, any at point in the future, the current position is different from the recorded position more than the value of the Runaway angle on an axis when the ACU is not commanding the antenna to move, an axis runaway error is displayed and all drives are disabled. Selecting Clear/correct system faults from the Main menu... resets the drives and clears the error.
Runaway angle [deg]	AZ: 0.1 EL: 0.1 POL 0.2 4thAxis: 0.2	When the antenna is commanded to stop, the ACU waits for it to come to rest, then records the position. If, at any point in the future, the current position differs from the recorded position by more than the value of this parameter on an axis when the ACU is not commanding the antenna to move, an axis runaway error is displayed and all drives are disabled. Selecting Clear/correct system faults from the Main menu resets the drives and clears the error.

To edit any of the parameters under this menu, use the following procedures.

1. From the **Main menu**, select **Edit system configuration...** and then select **Motion limits...**.

2. To change **Soft limits** or **Motion errors**, use the arrow keys to move the cursor to the parameter to be edited and press [ENTER]. Using the up and down arrow keys, toggle through the preprogrammed choices. When the desired choice is highlighted, press the [ENTER] key.

3. To change any of the remaining parameters, use the arrow keys to move the cursor to the parameter to be edited and press [ENTER]. Using the numeric keys, enter a value within the range specified in the system prompt and press [ENTER].

4. Press the [PRIOR] key and the following prompt appears:

   Save changes to menu "Motion limits"? (yes/no)
   [YES/NO] changes YES/NO response. [ENTER] accepts displayed YES/NO response.

5. To save the changes, toggle the YES/NO key to YES and press [ENTER].

5.8.6.4.1 Soft Limits

Soft limits are normally enabled, but they are disabled during site acceptance testing to allow the antenna to reach the travel limit switches.

The **Lower/CCW soft limits [deg]** and **Upper/CW soft limits [deg]** define the range of motion of the antenna. These limits are normally set such that when the soft limit is reached while traveling at slew speed, the limit switches are not yet engaged.

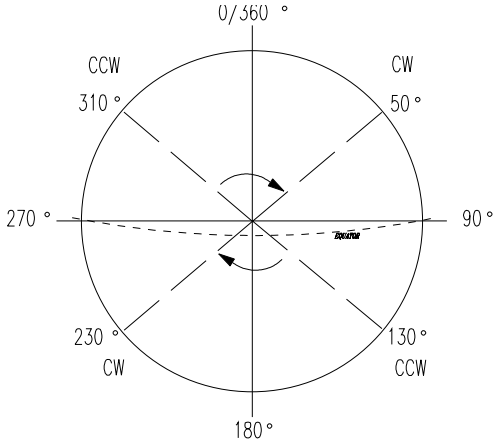

Figure 5-12 Soft Limits

Motion is allowed, moving up/CW, from the lower/CCW limit to the upper/CCW limit. For the defaults shown in Table 5-21, the antenna may move CW in AZ starting from 130.00 to 230.00 degrees. This is a typical setting in the Northern Hemisphere for an antenna with –50.00 degrees of motion in AZ from a centerline of due south (180.00 degrees). The corresponding values in the Southern Hemisphere would be a CCW limit of 310.00 degrees and a CW limit of 50.00 degrees (refer to Figure 5-12). This allows movement CW from 310.00 degrees through 0 degrees to 50.00 degrees. If the values were reversed (i.e., CCW = 50.00 degrees and CW = 310.00 degrees), the ACU would recognize that the antenna could not move through 0 degrees and the system would not function properly.

The POL values also illustrate this: the range of motion is from -90.00 degrees (270.00) to 90.00 degrees. Since the negative value is the CCW limit, the feed can move through 0 degrees.

5.8.6.4.2 Motion Errors

The parameter **Motion errors** must be enabled for the three types of motion errors listed in Table 5-22 to be detected.

TABLE 5-22 MOTION ERRORS

ERROR	DESCRIPTION
Immobile Error	ACU is commanded to move, but does not move.
Reversed Error	ACU moves in the direction opposite to the commanded direction.
Runaway Error	ACU moves even though no command for movement was given.

All motion errors must be cleared manually by the user by either executing **Clear/correct system faults** from the **Main menu** or via the M&C interface by issuing the C3 command.

5.8.6.4.3 Immobile and Reversed Errors

Both immobile and reversed errors are governed by the parameters **Immobile/reversed timeout [ms]** and **Immobile/reversed tolerance [deg]** (refer to Table 5-21 for a description of these parameters).

When the antenna is commanded to move on an axis, the current position is recorded and a timer is set to the value given by **Immobile/reversed timeout [ms]** for that axis. When the timer expires, the new current position is compared against the recorded position. If the antenna does not move in the correct direction at least the distance given by the **Immobile/reversed tolerance [deg]**, an error will occur. If no error is detected, the timer is reset and the process repeats for as long as the antenna is being commanded to move.

If the antenna has not moved the minimum distance, an axis immobile error is reported and displayed. If the antenna has moved a distance equal to or greater than the **Immobile/reversed tolerance [deg]** and in the direction opposite to the direction commanded by the ACU, an axis reversed error is reported and displayed.

The most common cause of an immobile error is that larger, slower antennas do not move fast enough to cover the required distance in 2000 ms (2 seconds). To prevent immobile errors in such systems, the value of the **Immobile/reversed timeout [ms]** should be increased, after verifying that the antenna is moving properly.

The **Immobile/reversed tolerance [deg]** parameter is not normally changed, except on small, mobile antennas, where the antenna may move 0.02 degrees due to wind motion, etc. The value of the parameter may be increased to provide better immobile and reversed protection to the system. Reversed errors rarely occur once proper encoder and motor direction have been established.

5.8.6.4.4 Runaway Errors

An axis runaway error is declared by the ACU whenever the antenna is not being commanded to move, but the encoders report a motion greater than that given by the **Runaway angle** parameter. If this error is detected, the drive enable line to the ACU is opened, which inhibits motion on **all** axes (the 7200 ACU does not have individual axis enable lines for each axis).

Executing **Clear/correct system faults** will clear the error and re-enable the drive cabinet.

5.8.6.5 Position Loop Parameters

The parameters listed in Table 5-23 control how the antenna is moved to the target position and the precision of the antenna's position.

TABLE 5-23 POSITION LOOP PARAMETERS

PARAMETER	DESCRIPTION
Slew rate	Under normal operation of the ACS, the slew rate (high speed) is enabled; however, for testing, it is sometimes disabled so that the antenna will use only its track speed to reach the target.
Slew -> track transition [deg]	These angles determine whether the antenna moves at slew (high) speed or track (slow) speed to reach the target position. For each axis, if the distance from the current position to the target position is greater than the slew -> track transition angle for that axis, the antenna moves at slew speed. If the distance is less than this value, the antenna moves at track speed. If these angles are set too low, the antenna will overshoot the target, and if they are set too high, the antenna will take longer than necessary to reach the target.
Slew -> stop coast time [ms]	This is the time, in milliseconds, that the ACU waits for the axes to come to a stop after the motors are stopped from slew speed.
Track -> stop coast time [ms]	This is the time, in milliseconds, that the ACU waits for the axes to come to a stop after the motors are stopped from track speed.
Positioning deadband [deg]	This parameter determines the accuracy of the position loop. The position loop will continue to move the antenna from the current position to the target until the antenna is within the positioning deadband for this axis.
Inching on time [ms]	Inching on time is used in the event of target overshoot. The motors are turned on for a period of time equal to the value of this parameter and then turned off for a period of time equal to the value of Track -> stop coast time [ms]. This "inching" is repeated until the antenna comes within the deadband set for the axis. Inching on time [ms] should be set just high enough to get the antenna to move -- oscillation can occur if the value of the parameter is set too high.

To edit any of the parameters under this menu, use the following procedures.

1. From the **Main menu**, select **Edit system configuration...** and then select **Position loop parameters...**.

2. To change Slew rate, use the arrow keys to move the cursor to the parameter to be edited and press [ENTER]. Using the up and down arrow keys, toggle through the preprogrammed choices. When the desired choice is highlighted, press the [ENTER] key.

3. To change any of the remaining parameters, use the arrow keys to move the cursor to the parameter to be edited and press [ENTER]. Using the numeric keys, enter a value within the range specified in the system prompt and press [ENTER].

4. Press the [PRIOR] key and the following prompt appears:

   Save changes to menu "Position loop parameters"? (yes/no)
   [YES/NO] changes YES/NO response. [ENTER] accepts displayed YES/NO response.

5. To save the changes, toggle the YES/NO key to YES and press [ENTER].

5.8.6.6 Built-in Simulator Setup

The ACU has a simulation program that can be used for training purposes or to become familiar with the system before beginning operation of the system. The simulation program can also be used for testing an M&C interface. For normal operational purposes, the **Operation mode** under this menu should be set to **Live**.

To edit the **Operation mode**, use the following procedures.

1. From the **Main menu**, select **Edit system configuration...** and then select **Built-in simulator setup...**.

2. To change **Operation mode** use the arrow keys to move the cursor to the parameter and press [ENTER]. Using the up and down arrow keys, toggle through the preprogrammed choices. When the desired choice is highlighted, press the [ENTER] key.

3. Press the [PRIOR] key and the following prompt appears:

   Save changes to menu "Built-in simulator setup" and reboot the ACU? (yes/no)
   [YES/NO] changes YES/NO response. [ENTER] accepts displayed YES/NO response.

5.8.6.6.1 Antenna Simulator Setup

When in **Simulation** mode, the ACU reads a simulated set of inputs and writes output to the simulator. The simulator provides change in resolver feedback based on the outputs, at a rate determined by the parameters listed in Table 5-24. Note that these rates are unrealistically high -- they are set high to verify that the commands are transmitted properly during testing of an M&C interface. The high rates allow the ACU to move to a new target rapidly. For training purposes, Vertex advises that the rates be set to more realistic values.

> ***NOTE: The resolver excitation signals are active in Simulation mode (i.e., the resolvers are powered).***

TABLE 5-24 ANTENNA SIMULATOR PARAMETERS		
PARAMETER	**DEFAULT**	**DESCRIPTION**
Antenna slew rate [deg/s]	AZ = 8.00 EL = 4.00 POL = 0.00	Determines how fast the simulator drives the simulated antenna in slew (high) speed.
Antenna track rate [deg/s]	AZ = 0.20 EL = 0.20 POL = 0.40	Determines how fast the simulator drives the simulated antenna in track (slow) speed.

To edit the parameters under this menu, use the following procedures.

1. From the **Main menu**, select **Edit system configuration...**, **Built-in simulator setup**, and then select **Antenna simulator setup...**.

2. Use the arrow keys to move the cursor to the parameter to be edited and press [ENTER]. Using the numeric keys, enter a value within the range specified in the system prompt and press [ENTER].

5.8.6.6.2 Spacecraft Simulator Setup

Spacecraft Simulation Setup menu allows the user to set up a simulated spacecraft (satellite). The user can set nominal longitude, orbital inclination, and other simulated characteristics of the desired target. The parameters under this menu are listed in Table 5-25.

TABLE 5-25 SPACECRAFT SIMULATOR PARAMETERS	
PARAMETER	**DESCRIPTION**
Box center date	Gives the date on which the simulated spacecraft is at its box center.
Box center time	Gives the time at which the simulated spacecraft is at its box center.
Box center longitude [deg. E]	Box center longitude, in degrees east, of the simulated spacecraft.
Inclination [deg]	Inclination of the simulated spacecraft.
Receive -3 dB beamwidth [deg]	Receive -3 dB beamwidth used to simulate a signal for the simulated spacecraft. This value should be set to represent a specific antenna size.
Signal noise [dB]	Represents the magnitude of simulated signal noise to be injected into the simulated signal.

To edit the parameters under this menu, use the following procedures.

1. From the **Main menu**, select **Edit system configuration...**, **Built-in simulator setup**, and then select **Spacecraft simulator setup...**.

2. Use the arrow keys to move the cursor to the parameter to be edited and press [ENTER]. To change the month portion of the **Box center date**, use the arrow keys to toggle through the preprogrammed choices. When the desired choice is highlighted, press [ENTER].

3. To change any of the remaining parameters, select the parameter, and using the numeric keys, enter a value within the range specified in the system prompt and press [ENTER].

5.8.6.7 Set UTC Date and Time

NOTE: The system clock MUST be set to UTC -- setting it to local time will cause time-dependent tracking modes (i.e., OPT, Intelsat, Star tracking) to malfunction.

This function contains the following parameters and menu:

Date
Time
Await mark...

The date and time are set on the ACU by using the following procedures.

1. From the **Main menu...**, select **Edit system configuration...** and **Set UTC date and time**.

2. Select **Date** and enter the correct day of the year. Press [ENTER] and the month is highlighted.

3. Using the up and down arrow keys, select the correct month. Press [ENTER] and the year is highlighted.

4. Enter a year within the range specified in the prompt and press [ENTER].

5. Set the time in the same manner as the date and press [ENTER].

6. To enter the date and time into the system, select **Await mark...** and the following message appears:

   System UTC date and time will be set to hh:mm:ss dd Mmmm yyyy (the date and time entered above will be displayed) **when [ENTER] is hit. Press [PRIOR] to cancel.**

7. Press [ENTER] to enter the date and time into the system.

5.8.6.8 Site Data

The parameters in the **Site data...** menu provide the following information to the ACU:

The antenna's name, which is displayed, along with the current position, on the ACU front panel
The position of the antenna: latitude, longitude, and altitude
The difference between the local time and UTC (**Timezone offset**)
Local timezone (displayed for the user's convenience only -- it is not used by the ACU for any functions)

NOTE: The E. Longitude of site [deg] and N. Latitude of site [deg] position inputs must be in decimal degrees.

To convert **E. Longitude of site [deg]** and **N. Latitude of site [deg]** to decimal degrees, use the following formula:

*Decimal Degrees = Whole Degrees + [(Minutes * 60) + seconds]/3600*

For example, to convert 67 degrees, 38 minutes, 15 seconds to decimal degrees using the formula above, the equation would be:

*67 + {[(38 * 60) + 15]/3600} = 67.6375 degrees*

Table 5-26 describes each of the parameters of the **Site data...** menu.

TABLE 5-26 SITE DATA PARAMETERS	
PARAMETER	**DESCRIPTION**
Antenna name	This is the name displayed in the Current pos field of the 7200 ACU display. The antenna name may be up to 12 characters in length and may be changed by the user. In a rack with multiple ACU's, antenna names are commonly used to distinguish between systems. Also, the M&C link can read the antenna name and determine to which ACU it is connected.
E. Longitude of site [deg]	Site longitude in decimal degrees East. West longitudes may be entered by including a "-" sign before the longitude value.
N. Latitude of site [deg]	Site latitude in decimal degrees East. Southern latitudes may be entered by including a "-" sign before the latitude value.
Site altitude [meters]	Altitude of the antenna, in meters, above the mean sea level.
Timezone offset	Time difference between local site time and UTC. A " + " sign in front of the local time indicates that the local time is ahead of UTC; a "-" sign indicates that local time is behind UTC. Eastern Standard Time is the default.
Timezone abbreviation	Abbreviation used to indicate local time zone.

To change the antenna name, use the following procedures:

1. From the **Main menu...**, select **Edit system configuration...**, **Site data...**, and **Antenna name**.

2. Using the arrow keys (up and down arrow keys toggle through the ASCII character set; left and right arrow keys move cursor left and right), change the antenna name as desired.

3. Press [ENTER] to enter the new antenna name into the system.

To change the **Timezone offset**, use the following procedures:

1. From the **Main menu...**, select **Edit system configuration...**, **Site data...**, and **Timezone offset**.

2. Use the up and down arrow keys to toggle between + and -, select the appropriate sign, enter the numeric value of the offset, and press [ENTER].

With the exception of **Timezone abbreviation**, the other parameters are all numeric entries and may be changed by selecting the parameter and entering a value within the range specified by the system prompt. To change the **Timezone abbreviation**, use the arrow keys to toggle through the ASCII character set as described above in the procedures for changing the **Antenna name**.

5.8.6.9 RF/Geometry...

The **RF/Geometry...** enables/disables POL control and contains the parameters described in Table 5-27. If POL is controlled by the ACU, set this parameter to enabled. If this parameter is disabled (for 2-axis systems), POL will not appear on the real-time display or in any menus.

TABLE 5-27 RF/GEOMETRY PARAMETERS

PARAMETER	DESCRIPTION
Polarization axis	Set this to Enabled if the POL axis is controlled by the ACU.
Antenna droop correction	Set this to Enabled if the POL axis is controlled by the ACU.
Amplitude droop corr. [deg]	The amplitude of the droop correction is used to adjust the EL look angle for mechanical droop. This value is determined from structural analysis of the dish.
Elevation alignment [deg]	The EL alignment angle is the EL angle at which the dish was balanced and focused. This value is used in the droop correction.

To edit any of the parameters under this menu, use the following procedures.

1. From the **Main menu**, select **Edit system configuration...** and then select **RF/geometry...**.

2. To change **Polarization axis** or **Antenna droop correction**, use the arrow keys to move the cursor to the parameter to be edited and press [ENTER]. Using the up and down arrow keys, toggle through the preprogrammed choices. When the desired choice is highlighted, press the [ENTER] key.

3. To change any of the remaining parameters, use the arrow keys to move the cursor to the parameter to be edited and press [ENTER]. Using the numeric keys, enter a value within the range specified in the system prompt and press [ENTER].

4. Press the [PRIOR] key and the following prompt appears:

   Save changes to menu "RF/geometry"? (yes/no)
   [YES/NO] changes YES/NO response. [ENTER] accepts displayed YES/NO response.

5. To save the changes, toggle the YES/NO key to YES and press [ENTER].

5.8.6.10 Remote Port Configuration

The parameters in the **Remote port configuration...** menu control remote communications with the 7200 ACU via its serial port(s). The standard ACU has three serial ports: two RS-232C ports; (J4 and J11) and an RS-422 port (J5).

The 7200 ACU supports several distinct "shells", or command interfaces:

RC M&C - The Request/Command M&C is a command-line monitor and control interface to the ACU, typically used for computer control applications.

MT M&C - The Menu Tree M&C is a command line monitor and control interface to the ACU, typically used for remote control applications. The MT M&C is more operator friendly than the RC M&C.

Visual - This is the menu-driven user interface as shown on the front panel of the ACU. This is only functional with an optional 7200 Remote Control Unit.

TRL - This is the port used for the tracking receiver interface. Only one port may support a TRL at any time.

PMCU - This is for the 7150 PMCU (optional) display. It is used on the RS-422 Interface.

Printer - This is used to connect a serial printer for system logging purposes.

Table 5-28 describes each of the **Remote port configuration...** parameters.

TABLE 5-28 REMOTE PORT CONFIGURATION PARAMETERS

PARAMETER	DEFAULT	DESCRIPTION
Port	1	Selects the port for which the configuration is being edited. The allowable values are 1 to the number of remote ports available. Port 0 is the console and may not be edited. Each port has its own remote port configuration. Changing the port number changes all other fields in this menu to reflect the settings for the selected port.
Bps (baud)	9600	This sets the data rate in bits per second for the specified port. Options are: 300, 1200, 2400, 4800, 9600, 19200, and 38400.
Parity	None	This sets the parity for the specified port. Options are: None, Even, or Odd.
Data bits	8	This sets the number of data bits for the specified port. Options are 7 or 8.
Stop bits	1	This sets the number of stop bits for the specified port. Options are 1 or 2.
M&C echo*	Disabled	This sets the echo mode for the specified port. If Enabled, the ACU echoes all input.
M&C checksums*	Disabled	If enabled, beginning of each line to and from the ACU has a two-character checksum that is the one's complement of the sum, module 256, of the characters on the line (this does not include first space after the checksum; nor does it include the CR at the end of the line).
M&C newline*	CR	This affects how the ACU terminates lines sent from the ACU to the remote computer. Input to the ACU is expected to be terminated by CR only. Options are: CR (carriage return) or CRLF (carriage return/line feed).
Shell	RC M&C	This specifies the user interface for the specified port. If a port is not being used, this parameter should be set to disabled. Options are: *M&C - command line interface *Visual - menu-driven user interface used by the console; requires a 7200 Remote Control Unit *Disabled - port is unused *TRL - port used for the tracking receiver interface. Only one port may be a TRL at any time. ***[NOTE: When Shell is set to TRL, the RF input number and polarization value (in MHz) will be displayed, instead of the A/D and beacon numbers, in the upper right-hand portion of the ACU display.]*** *PMCU - Uses the RS-422 port for connection to the 7150 PMCU (Optional) Display *Printer - optional setting; used for printing system messages.

Note: M&C echo, M&C checksums, and M&C newline are only effective if Shell is set to one of the M&C shells.

The following parameters may be changed by selecting the parameter, and using the up and down arrow keys to toggle between preprogrammed choices:

bps (baud)
Parity
M&C echo
M&C checksums
M&C newline
Shell

To change the other parameters, **Port**, **Data bits**, and **Stop bits**, select the parameter and enter the desired value within the range specified in the system prompt.

5.8.6.11 User Interface Options Menu

The user can configure the ACU's display, enable or disable audible alarms, and control some system security features by setting the user interface options described in Table 5-29.

TABLE 5-29 USER INTERFACE OPTIONS SETTINGS

OPTION	DEFAULT	DESCRIPTION
UTC display	On	Turning this off suppresses the UTC time and date display. If local time is left on with this off, the local time is shown in the upper left-hand corner of the display.
Local time display	On	Turning this off suppresses the local time display.
UTC date format	dd Mmm	This controls how the UTC date is played. Options are: dd Mmm example: 26 Mar DDY example: Day 85
Local date format	dd Mmm	This controls how the local date is displayed. Options are the same as UTC date format.
Tracking signal display	On	Turning this off suppresses the signal level display as well as the tracking receiver's frequency and polarization. This option is normally set to On.
Signal units	Db	This may be changed to volts; this is useful for debugging or calibrating the A/D's. In normal operation, the dB display is more useful.
User level display	On	Turning this off suppresses the port and user level display on the top line of the display. If there is no M&C connected to the system, nor a 7200 Remote Control Unit, it is recommended that this be turned off.
Confirm tracking	On	When changing the tracking mode of the system (including going to Standby or Manual antenna control), the ACU will ask for confirmation if this is On. In addition, the ACU will display the position to which it is about to drive the antenna when the user selects a new target to track. If this is off, the ACU proceeds without confirmation. Vertex recommends that this option be left on.

TABLE 5-29 USER INTERFACE OPTIONS SETTINGS		
OPTION	**DEFAULT**	**DESCRIPTION**
Confirm edits	On	When this is on, the ACU asks for confirmation before saving changes to a menu; if this is off, the ACU automatically saves changes upon exiting a menu. Vertex recommends that this value be left on. If it is turned off, and a mistake is made while editing, there is no obvious way to undo the changes. However, if MAIN is pressed while editing, all changes are lost -- this is true of all editing menus, regardless of the setting of this parameter.
Warning bell	On	The ACU sounds a "bell" tone whenever confirmation dialogs are brought up (for changing tracking mode, saving changes, error messages, etc.). It also sounds the bell whenever an invalid key is pressed. The bell may be turned off at the user's discretion.
Audible alarm	On	The audible alarm is a tone (different from the warning bell tone) which is continuously sounded whenever the ACU has a fault condition that has not been acknowledged. Normally, this is left on, as it will alert an operator that a fault condition is in effect, even if the operator cannot see the display. This is often turned Off during installation until all connections are in place. It may also be turned Off if the SUM ALM contact is wired to a station alarm which provides an alternative audible/visual alarm source. The SUM ALM will be open if and only if the audible alarm would be sounding if turned On; if an alternative alarm source is available, the audible alarm is redundant.
Monitor can [STOP]/[RESUME]	YES	If this is set to NO, then a user at Monitor user level cannot stop tracking by pressing the [STOP] key, nor can they resume tracking by pressing [RESUME]. This also affects the M&C command C1 (STOP/RESUME via M&C). This setting does not affect the DRIVE ENABLE button on the ACU front panel, which bypasses the CPU and is not under software control.
Monitor can clear defaults	YES	If this is set to NO, then a user at Monitor user level cannot successfully execute Clear/correct system faults from the ACU front panel. The user also cannot successfully execute the M&C C3 command.
YES/NO default answer	YES	If this is set to NO, then whenever a dialog requiring a YES/NO answer is displayed, the initial (default) answer is NO. The user must press the [YES/NO] key to change the answer to YES before pressing ENTER. Some critical commands, such as resetting an OPT target or resetting the system to ROM defaults, have a default answer of NO regardless of the setting of this parameter.
Always show target position	NO	When this is set to NO, the target (command) position is shown on the line underneath the current antenna position only when repositioning the antenna to a new target. Once the target is acquired, the target position is removed from the display. At this point, it doesn't convey any useful information in normal operation; also, the user can quickly glance at the ACU display and tell if it is on target. If the target position is no longer displayed, the ACU is on target. Turning this ON causes the ACU to always show the target position when tracking a target. This includes all Immediate tracking... modes. Regardless of this setting, the target position is never shown in Standby or Manual antenna control, as it is meaningless in these modes. It is, however, shown when manually biasing a target (see paragraph 5.8.2.3.1).

The parameters under this menu may be changed by selecting the desired parameter, and using the up and down arrow keys, toggling through the preprogrammed choices. When the desired setting is highlighted, press the [ENTER] key.

To save the changes, press [PRIOR] and answer yes when prompted to save the changes.

5.8.6.12 Tracking Restoration Options Menu

This menu controls how the ACU restores tracking after an interruption such as power loss or a fault (e.g., emergency stop). By default, the ACU attempts to return to tracking the last target it was tracking as soon as the fault condition(s) clears. For some reasons, some users may wish to inhibit this restoration action under certain fault conditions. This may be done by changing the parameters in this menu. Table 5-30 lists the parameters, their defaults, and a description of each of the parameters under this menu.

TABLE 5-30 TRACKING RESTORATION OPTIONS PARAMETERS		
PARAMETER	**DEFAULT**	**DESCRIPTION**
Standby after boot	NO	If this parameter is set to NO, when the ACU is powered up, it attempts to resume tracking the target it was tracking when power was lost. If the system was in Standby or manual, the ACU powers up in Standby mode, and if the Target scheduler was running, it will be restarted. If this parameter is set to YES, the ACU will return to Standby when powered up and automatic tracking will not resume.
Standby on emergency stop	NO	Regardless of the setting of this parameter, the ACU cannot command the antenna unless all emergency stops are disengaged. If this parameter is set to NO, when emergency stops are cleared, the ACU resumes tracking the target. If this is set to YES, the ACU returns to Standby mode immediately upon detection of an emergency stop.
Standby on motor controller fault	NO	If this parameter is set to NO, the ACU waits for the motor controller fault to clear and then resumes tracking the target. If this parameter is set to YES, the ACU returns to Standby immediately upon detection of the fault. **NOTE:** Clear/correct system faults resets the drive cabinet if a motor controller fault exists, which normally clears the fault. If one motor controller fails and the other continues to operate, the ACU continues tracking on the axis that is still operable.
Standby on maintenance override	NO	The setting of this parameter determines what the ACU does when the user flips the CONTROL switch at the drive cabinet from REMOTE to LOCAL to allow local control of the antenna at the drive cabinet. If this parameter is set to NO, the ACU waits for the drive cabinet to be switched from MAINT. to REMOTE, and then resumes tracking the target. If set to YES, the ACU returns to Standby immediately upon detection of the CONTROL switch being returned to the LOCAL position. **NOTE:** Regardless of the setting of this parameter, the ACU cannot command the antenna unless the switch is in the REMOTE position.
Standby on drive cabinet power loss	NO	If set to NO, when power is lost to the drive cabinet, the ACU waits for power to be restored and then resumes tracking. If set to YES, the ACU returns to Standby immediately upon detection of loss of power.
Tracking initiation delay [ms]	0	This parameter controls the delay between a tracking mode or target change. Whenever the tracking mode is changed (except for returning to Standby), or a new target is selected, the ACU waits for the amount of time of this parameter before initiating tracking. Also, output 1 on ACU terminal TB1 is closed and remains closed while tracking. This may be used to drive a warning beacon, horn, etc. In addition, when changing between targets or to or from manual mode, there is an additional one second delay. This delay is used to open output 1 on terminal TB1 and then close it again, which may be used to reset a horn with a fixed alarm time, so that it will sound again. Setting this parameter to a value other than 0 disables the delay and output 1 is not driven.

The parameters under this menu may be changed by selecting the desired parameter, and using the up and down arrow keys, toggling through the preprogrammed choices. When the desired setting is highlighted, press the [ENTER] key.

To save the changes, press [PRIOR] and answer yes when prompted to save the changes.

5.8.6.13 Factory Tests

The **Factory tests...** menu contains tests that are used at the factory during system testing. These tests are available to the user because some of these tests may be useful in the field during troubleshooting.

5.8.6.13.1 Video Tests

These tests are used to examine the display for malfunctioning pixels, data lines, etc.

The ACU must be in Standby, and the port performing the test must be at Operator or Supervisor level. During the test, the [STOP]/[RESUME] keys are still operational. To execute the **Video test**, use the following procedures.

1. From the **Main menu...**, select **Edit system configuration...**, **Factory tests...**, and **Video test**.

2. If the ACU is not in Standby mode, a message will appear alerting the operator to this fact and when the [ENTER] key is pressed, the ACU will return to the menu.

If the ACU is in Standby mode, a warning message will appear to alert the user that the display will be blanked for the test.

3. To begin the test, answer yes to the prompt and press [ENTER]. Note that the [PRIOR] key may be pressed at any time to terminate the test.

4. Pressing the [ENTER] key will step through the test, with the following conditions occurring in the order listed:

   All pixels on
   All pixels off (display blank)
   Odd-numbered horizontal lines illuminated
   Even-numbered horizontal lines illuminated
   Odd-numbered vertical lines illuminated
   Even-numbered vertical lines illuminated

5. After the last test sequence is run, press the [ENTER] key and the following prompt will appear:

   Press [PRIOR] to end the test.
   Press [ENTER] to rerun the test.

6. Press [PRIOR] to restart the real-time display and return to the **Factory tests...** menu.

5.8.6.13.2 Keyboard Test

The **Keyboard test** is used to verify that the keyboard is operating properly. This may be used either on the ACU front panel or on an optional 7200 Remote Control Unit.

The ACU must be in Standby, and the port that is to be tested (including the ACU front panel) must be at Operat**or** or Supervisor level. During this test, all keys (e.g., [STOP], [RESUME], and [MAIN]) are disabled.

To execute the **Keyboard test**, use the following procedures.

1. From the **Main menu...**, select **Edit system configuration...**, **Factory tests...**, and **Keyboard test**.

2. A prompt appears advising the user that the [STOP], [RESUME], and [MAIN] keys are disabled during the test. Answer yes to proceed with the test. Press [ENTER].

3. A representation of the 7200 ACU keypad is drawn in the lower section of the display. Press any key and notice that the label of the key's representation on the display is shown in reverse video; releasing the key causes the key's label on the display to return to normal video. If more than two keys are pressed simultaneously, **FAULT** appears in reverse video on the display. All keys must be released to clear the fault and allow continuation of the test.

4. To end the test, press the [PRIOR] key twice.

5.8.6.13.3 Reset ACU to ROM Defaults

Executing the **Reset ACU to ROM defaults** function is the final step in 7200 ACU production, after testing but before packaging.

> ***WARNING***
>
> ***Executing this function resets all parameters to their ROM defaults, erases all targets, and clears all stored steptrack data. The 7200 ACU will be unusable after executing this function until it has been reconfigured. It should not be necessary to execute this function in the field, and should only be used upon the advice of a Vertex Control Systems engineer.***

5.8.6.13.4 I/O Loopback Tests

The **I/O loopback tests** are used to verify operation of the 800252 I/O board during factory tests. The tests require the use of the 7200 Test Bed Unit (TBU), which is only available at the factory; therefore this test cannot be performed outside of the factory. The tests are left accessible in the ACU in order to test the I/O card along with the CPU and its firmware in place.

5.8.6.13.5 Force Faults Clear

The normal method used by the 7200 to clear faults is to execute **Clear/correct system faults** from the **Main menu**. **Force faults clear** forces all faults to clear if executing **Clear/correct system faults** fails to clear all faults (this may occur during a firmware upgrade).

5.8.6.14 Message Printer Options

An optional message printer may be attached to the system. When the printer is enabled (by setting the **Shell** parameter under the **Remote port configuration...** menu to **Printer**), messages are printed out as the status of the system changes. The parameters under **Message printer option...** allow the user to selectively include or exclude certain types of messages. The parameters are described in Table 5-31.

TABLE 5-31 MESSAGE PRINTER OPTIONS PARAMETERS	
PARAMETER	**DESCRIPTION**
Target change/standby	When Enabled, a message is printed on the message printer whenever the ACU begins tracking a new target or when the ACU is placed in Standby. The target name is printed, along with the target number [the position of the target in the Track a target menu (target 1 is the first target in the first column, target 6 is the first target in the second column)].
Faults	When Enabled, faults are printed on the message printer as they occur, and fault acknowledgments are also printed.
New steptrack peak	When Enabled, a message is printed whenever Steptrack completes a peaking cycle. The message includes the target name, target number, date, time, and the antenna's current look angles.
New OPT solution	When Enabled, a message is printed whenever OPT completes generating a new solution. The message includes the target name, target number, and type of solution that has become available.
Parameter changes	When Enabled, a message is printed whenever changes are made (and saved) to any system parameters or target configuration.
User level change	When Enabled, a message is printed whenever the user level is changed on any port in the system.
System clock set	When Enabled, a message is printed when the system date and/or time is changed by the user.
Tracking signal changed	When Enabled, a message is printed when tracking signal parameters (frequency or polarization) are changed. Note that this message is NOT printed when the signal source is changed by tracking a new target, even if it changes the signal source.
Target scheduler status	When Enabled, whenever the Target scheduler changes to a new target, the time and date for the next target are printed. A message is also printed if the schedule is exhausted (empty) or an invalid entry is discovered in the schedule.
Initialization messages	When Enabled, messages are printed as each phase of initialization is completed. This parameter is usually only enabled for debugging purposes.

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6.0 SITE ACCEPTANCE TEST PROCEDURE

6.1 Preliminary Information

This test procedure is intended to serve as the final proof of performance document for the 7200 ACS, subsequent to field installation and set-up. Prior to the performance of these tests, the system must have been installed and adjusted as described in Section 4.0 of this manual. All motor rotation directions should be normalized, all limit stops should be set, and the Radio Frequency (RF) equipment used to provide the analog tracking signal should be calibrated for proper system performance.

This procedure is provided for both two, three-axis and four-axis systems. Ignore all references to the POL axis drive components for two-axis systems. The 3-axis system has POL and the four-axis has POL & 4th Axis.

6.2 Drive Cabinet Line Voltage Measurements and Power-Up

1. Using an AC voltmeter with the main circuit breaker OFF, measure and record the voltages on the line (upper) side of the main breaker as indicated below (record data under the appropriate heading for the main power provided for this system):

3-PHASE SYSTEMS (4-WIRE + GROUND)	
A phase to B phase	VAC
B phase to C phase	VAC
C phase to A phase	VAC
A phase to Neutral	VAC
B phase to Neutral	VAC
C phase to Neutral	VAC

SINGLE-PHASE SYSTEMS (3-WIRE 2-WIRE + GROUND)	
L1 to L2	VAC
L1 to Neutral	VAC
L2 to Neutral	VAC

SINGLE-PHASE SYSTEMS (2-WIRE + GROUND)	
Line to Neutral	VAC

2 Inside the drive cabinet set the MAIN CIRCUIT BREAKER to ON. _____(Check)

3. Verify that the EMERGENCY STOP button is in the out position. _____(Check)

4. Turn all circuit breakers to the ON position and verify that the green LED in the on the Relay PCB is illuminated. _____ (Check)

5. Verify that the CONTROL switch is in the MAINT position. _____(Check)

6.3 Motor Phasing Tests

1. Set the AZIMUTH and ELEVATION switches (Located on the PMCU) to TRACKING SPEED. _____(Check)

2. Jog AZ briefly CW and then CCW, checking to see that the resulting motion corresponds to the respective switch commands. _____(Check)

3. Jog EL briefly up and then down, checking to see that the resulting motion corresponds to the respective switch commands. _____(Check)

4. Jog POL briefly CW and then CCW, checking to see that the resulting motion corresponds to the respective switch commands. (N/A if "POL" is unavailable) _____(Check)

5. Jog 4th Axis briefly CW and then CCW, checking to see that the resulting motion corresponds to the respective switch commands. (N/A if "4th Axis" is unavailable) _____(Check)

6. Set the AZIMUTH and ELEVATION switches (Located on the PMCU) to SLEW SPEED. _____(Check)

7. Jog AZ briefly CW and then CCW, checking to see that the resulting motion corresponds to the respective switch commands. _____(Check)

8. Jog EL briefly up and then down, checking to see that the resulting motion corresponds to the respective switch commands. _____(Check)

9. Jog POL briefly CW and then CCW, checking to see that the resulting motion corresponds to the respective switch commands. (N/A if "POL" is unavailable) _____(Check)

10. Jog 4th Axis briefly CW and then CCW, checking to see that the resulting motion corresponds to the respective switch commands. (N/A if "4th Axis" is unavailable) _____(Check)

6.4 Limit Switch Tests

NOTE: This test may be combined with 6.9, Software Limit Tests, on slow-moving antennas where running through both software travel limits and limit switches independently would be very time-consuming. To perform the tests in this fashion, first verify that the Soft limits parameter is Enabled, (refer to paragraph 5.8.6). Use Manual antenna control from the ACU (refer to paragraph 5.8) to drive the antenna into its soft limit, then at the drive cabinet, complete the test by driving the antenna into the travel limit switch.

In this paragraph, the function and setting of the electrical limit switches on the antenna structure will be checked. Drive the antenna from the drive cabinet, which allows high speed jogging while also providing viewing access for any possible obstructions.

Use the following procedures to test the limit switches.

1. a. Drive the antenna using the JOG AZ CW switch until the limit switch stops the movement of the antenna. _____(Check)
   b. Check the 7200 ACU display for a **SUM LIMIT** message. _____(Check)
   c. Record the AZ angle at which the limit occurred. _____ (Record)
   d. Verify that the antenna will drive in the CCW direction. _____(Check)

2. a. Drive the antenna using the JOG AZ CCW switch until the limit switch stops the movement of the antenna. _____(Check)
   b. Check the 7200 ACU display for a **SUM LIMIT** message. _____(Check)
   c. Record the AZ angle at which the limit occurred. _____(Record)
   d. Verify that the antenna will drive in the CW direction. _____(Check)

3. a. Drive the antenna using the JOG EL UP switch until the limit switch stops the movement of the antenna. _____(Check)
   b. Check the 7200 ACU display for a **SUM LIMIT** message. _____(Check)
   c. Record the EL angle at which the limit occurred. _____ (Record)
   d. Verify that the antenna will drive in the DOWN direction. _____(Check)

4. a. Drive the antenna using the JOG EL DOWN switch until the limit switch stops the movement of the antenna. _____(Check)
   b. Check the 7200 ACU display for a **SUM LIMIT** message. _____(Check)
   c. Record the EL angle at which the limit occurred. _____(Record)
   d. Verify that the antenna will drive in the UP direction. _____(Check)

THREE AXIS SYSTEM (IF APPLICABLE)

5. a. Drive the antenna using the JOG POL CW switch until the limit switch stops the movement of the antenna. _____(Check)
   b. Check the 7200 ACU display for a **SUM LIMIT** message. _____(Check)
   c. Record the POL angle at which the limit occurred. _____(Record)
   d. Check that the feed will drive in the CCW direction. _____(Check)

6. a. Drive the antenna using the JOG POL CCW switch until the limit switch stops the movement of the antenna. _____(Check)
   b. Check the 7200 ACU display for a **SUM LIMIT** message. _____(Check)
   c. Record the POL angle at which the limit occurred. _____(Record)
   d. Check that the feed will drive in the CW direction. _____(Check)

FOUR AXIS SYSTEM (IF APPLICABLE)

5. a. Drive the antenna using the JOG 4th Axis CW switch until the limit switch stops the movement of the antenna. _____(Check)
   b. Check the 7200 ACU display for a **SUM LIMIT** message. _____(Check)
   c. Record the 4th Axis angle at which the limit occurred. _____(Record)
   d. Check that the feed will drive in the CCW direction. _____(Check)

6. a. Drive the antenna using the JOG 4th Axis CCW switch until the limit switch stops the movement of the antenna. _____(Check)
   b. Check the 7200 ACU display for a **SUM LIMIT** message. _____(Check)
   c. Record the 4th Axis angle at which the limit occurred. _____(Record)
   d. Check that the feed will drive in the CW direction. _____(Check)

6.5 Drive Cabinet Inverter Parameters NTAC 2000

NTAC-2000 AC drives are supplied with a Digital Operator Interface (DOI) attached to the front of the drive. The DOI can be used to operate the drive, change program parameters and to display drive operating conditions. Figure 4-5 below for DOI layout and component identification. See the NTAC 2000 Drive instruction manual for detailed descriptions of these operators.

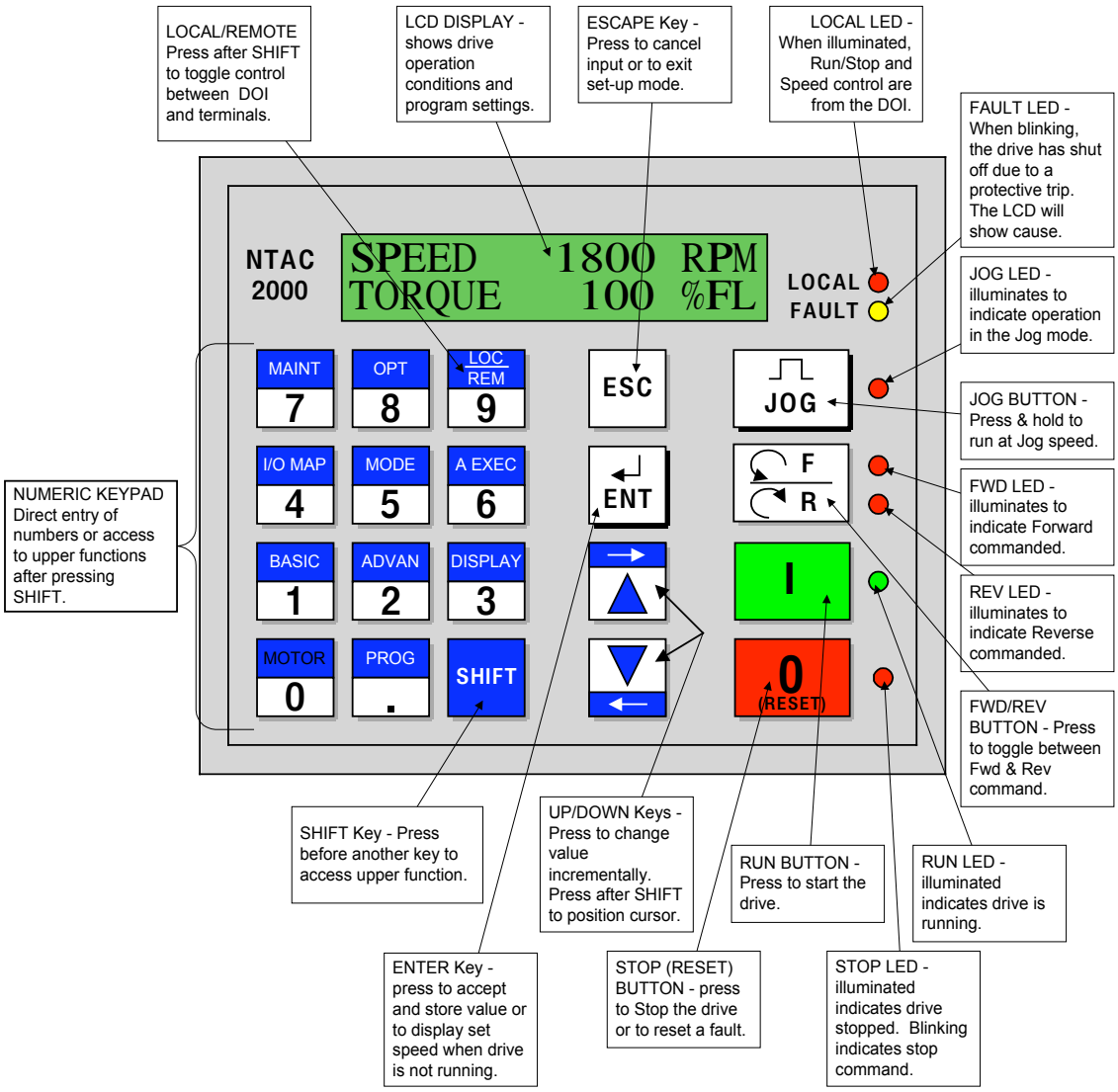

Figure--DOI Layout and Component Identification

WARNING

DO NOT USE THE FORWARD, REVERSE OR JOB BUTTONS ON THE INVERTER DRIVES TO MOVE THE ANTENNA. THE LIMIT SWITCHES WILL NOT STOP THE ANTENNA MOVEMENT AND POSSIBLE STRUCTURAL DAMAGE TO THE ANTENNA CAN OCCUR.

All parameters are set at the factory. VCSD has modified some of these parameters.

NTAC 2000 DRIVE PARAMETERS			
FUNCTION NUMBER	**AZ INVERTER**	**EL INVERTER**	**FACTORY & VCSD SETTINGS**
11			**Motor Voltage;** **Set to Nameplate rating on motor**
12			**Motor Full Load Amps** **Set to nameplate rating on motor**
13			**Motor HP** **Set to nameplate rating on motor**
14			**Motor rated Frequency** **Set to nameplate rating on motor**
15			**Motor rated Speed** **Set to nameplate rating on motor** See Note 3
16	USE ONLY THE STANDARD AUTOTUNE FUNCTION IT DOES NOT ROTATE THE MOTOR. ****WHEN ANY PARAMETER IS CHANGED, THE AUTOTUNE MUST BE REDONE****		
18			**80 RPM**
101			**0.8S**
102			**0.8S**
111			**Set to 10% of motor nameplate RPM.** **See Note 2**
112			**Set to motor nameplace RPM.** **See Note 1**
201			**3**
202			**0.5**
204			**TRUE**
205			**FALSE**
225			**10**
303			**I OUT (A)**
402			**RUN FWD**
403			**RUN REV**
404			**RESET**
414			**0.0V**
421			**FAULT**
422			**RUN**
423			**AT SPD**
502			**REMOTE**
503			**REMOTE**

NOTE: 1. Use motor name plate speed. Example 1720 RPM (Slew Speed)
2. Use 10% of motor name plate speed. Example 170 RPM (Track Speed)
*3. Minimum rated speed for 60 Hz motor is 1630 RPM. Minimun rated speed for 50 Hz motor is 1370 RPM. Failure to set these minimum values may result in **a MOTOR PARAMETERS FAULT** during autotune.*

6.6 Antenna Control System Configuration Parameters

The configuration parameters should be recorded during the ATP so that the user has a written record of the initial configuration parameters for future reference.

6.6.1 Position Encoder Configuration

1. From the **Main menu**, select **Edit system configuration...**. _____(Check)

2. Select **Position encoder configuration...**. _____(Check)

3. Record the encoder configuration in the following table.

PARAMETER	SETTING		3-Axis	4-Axis
	AZ	EL	POL	4th Axis
Encoder direction				
Current position [deg]				
Offsets [deg]				

6.6.2 Motion Limits

1. Press the [PRIOR] key, which returns the display to the **Edit system configuration...** menu. _____(Check)

2. Select **Motion limits**. _____(Check)

3. Record the motion limits in the following table.

PARAMETER	SETTING		3-Axis	4-Axis
Soft limits	AZ	EL	POL	4th Axis
Lower/CCW soft limits [deg]				
Upper/CW soft limits [deg]				
Immobile/reversed timeout [ms]				
Immobile/reversed tolerance [deg]				
Runaway angle [deg]				

6.6.3 Position Loop Parameters

1. Press the [PRIOR] key, which returns the display to the **Edit system configuration...** menu. _____(Check)

2. Select **Position loop parameters...**. _____(Check)

3. Record the parameters in the following table.

PARAMETER	SETTING
Slew rate	
Slew -> track transition [deg]	
Slew -> stop coast time [ms]	
Track -> stop coast time [ms]	
Positioning deadband [deg]	
Inching on time [ms]	

6.6.4 Site Data

1. Press the [PRIOR] key, which returns the display to the **Edit system configuration...** menu. _____(Check)

2. Select **Site data...**. _____(Check)

3. Record the parameters in the following table.

PARAMETER	SETTING
Antenna name	
E. Longitude of site [deg]	
N. Latitude of site [deg]	
Site altitude [meters]	
Timezone offset	
Timezone abbreviation	

6.6.5 RF/Geometry

1. Press the [PRIOR] key, which returns the display to the **Edit system configuration...** menu. _____(Check)

2. Select RF/Geometry. _____(Check)

3. Record the parameters in the following table.

PARAMETER	SETTING
Polarization axis	

6.7 Manual Antenna Control Tests

1. From the **Main menu**, select **Tracking functions...** and then **Manual antenna control**. _____(Check)

2. Jog AZ CCW and observe that **Azimuth: CCW** and **Speed: Track (low)** are highlighted and that the AZ angle decreases. _____(Check)

3. Jog AZ CW and observe that **Azimuth: CW** and **Speed: Track (low)** are highlighted and that the AZ angle increases. _____(Check)

4. Jog EL DOWN and observe that **Elevation: Down** and **Speed: Track (low)** are highlighted and that the EL angle decreases. _____(Check)

5. Jog EL UP and observe that **Elevation: Up** and **Speed: Track (low)** are highlighted and that the EL angle increases. _____(Check)

THREE AXIS SYSTEM

6. Jog POL and observe that **Polarization: CCW** is highlighted and that the POL angle decreases. _____(Check)

7. Jog POL CW and observe that **Polarization: CW** is highlighted and that the POL angle increases. _____(Check)

FOUR AXIS SYSTEM

8. Jog 4th Axis CCW and observe that **Polarization: CCW** is highlighted and that the POL angle decreases. _____(Check)

9. Jog 4th Axis CW and observe that **Polarization: CW** is highlighted and that the POL angle increases. _____(Check)

10. Hold the [SHIFT] key down and jog AZ CCW and observe that **Azimuth: CCW** and **Speed: Slew (high)** are highlighted and that the AZ angle decreases. _____(Check)

11. Hold the [SHIFT] key down and jog AZ CW and observe that **Azimuth: CW** and **Speed: Slew (high)** are highlighted and that the AZ angle increases. _____(Check)

12. Hold the [SHIFT] key down and jog EL DOWN and observe that **Elevation: Down** and **Speed: Slew (high)** are highlighted and that the EL angle decreases. _____(Check)

13. Hold the [SHIFT] key down and jog EL UP and observe that **Elevation: Up** and **Speed: Slew (high)** are highlighted and that the EL angle increases. _____(Check)

> ***NOTE: When moving the antenna in sticky mode, pressing the +/- key and the direction-activating key starts the antenna movement, and pressing the direction-activating key stops the antenna movement.***

14. Repeat steps 2 through 12 in **Sticky** mode. _____(Check)

6.8 Software Limit Tests

The software (soft) limits provide an added margin of safety when the location of the 7200 ACU or the remote link causes obstructed visibility of the antenna. Test the function and setting of each soft limit by driving the antenna from the 7200 ACU using **Manual antenna control**.

1. From the **Main menu**, select **Tracking functions...** and then select **Manual antenna control**. _____(Check)

2. Press the [+ /-] key and the direction key to drive the antenna CW in AZ until the soft limit stops the movement of the antenna. _____(Check)

3. Check the display for an **AZIMUTH CW SOFT LIMIT** message. _____(Check)

4. Record the AZ angle at which the limit occurred. _____(Record)

5. Drive the antenna CCW in AZ to check that the antenna will back out of the soft limit. _____(Check)

6. Drive the antenna CCW in AZ until the soft limit stops the movement of the antenna. _____(Check)

7. Check the display for a **SOFT LIMIT** message. _____(Check)

8. Record the AZ angle at which the limit occurred. _____(Record)

9. Drive the antenna CW in AZ to check that the antenna will back out of the soft limit. _____(Check)

10. Drive the antenna up in EL until the soft limit stops the movement of the antenna. _____(Check)

11. Check the display for a SOFT LIMIT message. _____(Check)

12. Record the EL angle at which the limit occurred. _____(Record)

13. Drive the antenna down in EL to check that the antenna will back out of the soft limit. _____(Check)

14. Drive the antenna down in EL until the soft limit stops the movement of the antenna. _____(Check)

15. Check the display for a SOFT LIMIT message. _____(Check)

16. Record the EL angle at which the limit occurred. _____(Record)

17. Drive the antenna up in EL to check that the antenna will back out of the soft limit. _____(Check)

THREE AXIS SYSTEM

18. Drive the feed tube CCW until the soft limit stops the movement of the feed tube. _____(Check)

19. Check the display for a SOFT LIMIT message. _____(Check)

20. Record the POL angle at which the limit occurred. _____(Record)

21. Drive the feed tube CW to check that the feed tube will back out of the soft limit. _____(Check)

22. Drive the feed tube CW until the soft limit stops the movement of the feed tube. _____(Check)

23. Check the display for a SOFT LIMIT message. _____(Check)

24. Record the POL angle at which the limit occurred. _____(Record)

25. Drive the feed tube CCW to check that the feed tube will back out of the soft limit. _____(Check)

FOUR AXIS SYSTEM

26. Drive the feed tube CCW until the soft limit stops the movement of the feed tube. _____(Check)

27. Check the display for a SOFT LIMIT message. _____(Check)

28. Record the 4th Axis angle at which the limit occurred. _____(Record)

29. Drive the feed tube CW to check that the feed tube will back out of the soft limit. _____(Check)

30. Drive the feed tube CW until the soft limit stops the movement of the feed tube. _____(Check)

31. Check the display for a SOFT LIMIT message. _____(Check)

32. Record the 4th Axis angle at which the limit occurred. _____(Record)

33. Drive the feed tube CCW to check that the feed tube will back out of the soft limit. _____(Check)

6.9 Steptrack Tests

6.9.1 Input Signal Variation

Accurate tracking is predicated on a stable reference tracking signal. Therefore, the stability of the tracking signal must be established before system tracking accuracy can be evaluated.

Observe the beacon level on the 7200 display with the antenna parked at beam center for at least one minute and record the signal variation in the following table.

Signal Variation (dB)	

If the observed variation is in excess of +/- 0.1 dB, evaluation of the system tracking accuracy will be uncertain, limited by the amount of fluctuation present.

6.9.2 Tracking Accuracy

1. In **Manual antenna control**, move the antenna off beam center in the direction listed in the following table until the signal level drops 2dB.

2. Activate **Steptrack** and allow the system to repeak the antenna and record the resulting signal level from the 7200 ACU display below in the TRACK LEVEL column.

3. Return to **Manual antenna control** and manually peak the antenna and record the resulting signal level in the MANUAL LEVEL column. Repeat steps 1-3 for each subsequent direction listed in the following table.

DIRECTION	TRACK LEVEL	MANUAL LEVEL	ERROR
AZ CCW			
AZ CW			
EL UP			
EL DOWN			

NOTE: If the level achieved in Steptrack is greater than that achieved in manual peaking, enter a zero for the error.

4. Calculate the RMS tracking accuracy as follows:

$$RMS\ TRACKING\ ERROR = \frac{[(AZCCW)^2 + (AZCW)^2 + (ELDOWN)^2 + (ELUP)^2]^{1/2}}{2}$$

5. Record the RMS TRACKING ERROR (< 0.1 dB, Nominal) _____dB(Record)

6.9.3 Miscellaneous Error and Fault Messages

1. In the drive cabinet, set the DRIVE CIRCUIT BREAKER to OFF. Verify that the 7200 ACU display shows **NO POWER AT DRIVE CABINET**. _____(Check)

2. In the drive cabinet, set the DRIVE CIRCUIT BREAKER to ON. _____(Check)

3. Press the EMERGENCY STOP button on the side of the drive cabinet. Verify that the 7200 ACU display shows **E STOP**. _____(Check)

4. Verify that the customer interface FLT contacts open. _____(Check)

5. Set the EMERGENCY STOP button to the out position. _____(Check)

6. Verify that the inverters reset and that there are no fault messages displayed. _____(Check)

7. Verify a closed circuit between the customer interface FLT terminals. _____(Check)

THIS CONCLUDES THE 7200 ACU ACCEPTANCE TESTS.

SIGNATURE OF WITNESSES		
SIGNATURE	**COMPANY**	**DATE**
	VERTEX COMMUNICATIONS CORPORATION	

7.0 MAINTENANCE

This section presents information on maintaining the 7200 ACS to ensure optimum system performance.

7.1 Air Filter

The air filter on the back of the 7200 ACU (refer to Figure 7-1) should be cleaned at least every six months. If the ACU is in an environment that is exposed to a large amount of dust and dirt frequently, the filter should be checked for excessive dust accumulation at least once a month.

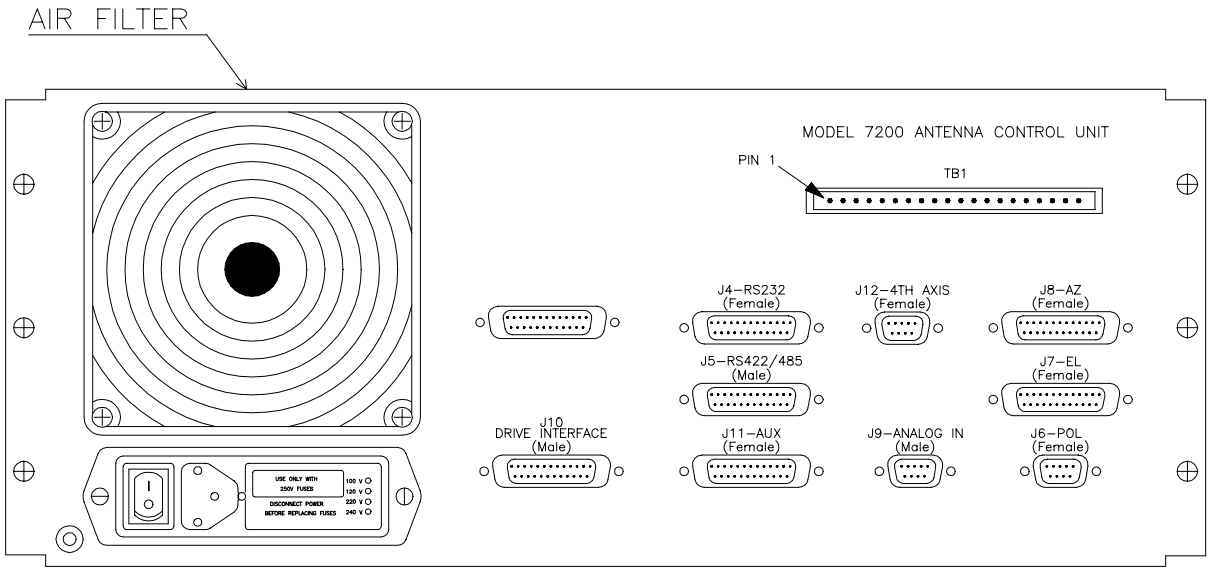

Figure 7-1 7200 ACU Rear Panel Fan

Before removing the filter, turn the power switch on the 7200 ACU to the off position. To remove the filter, lift up on the plastic housing of the exhaust fan, gradually working it off of the rear panel and remove the filter. Once removed, the filter can be cleaned with a high-pressured hose. If the filter needs to be replaced, replace it with Vertex part #BFN002. Replace the filter and secure the fan housing.

Battery should be tested once a year and replaced if less than 2.8VDC.

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8.0 Engineering Drawings

This section contains the following engineering drawings called out in this manual:

200602 Remote Interface PMCU Model 7150

200607 POL Motor, 50Hz (Optional)

200608 POL Motor, 60Hz (Optional)

200620 Antenna Control Unit Assembly and Wiring Model 7200 STD

200811 Baseline AZ/EL Assembly (208 VAC) Model 7150 Series II

200812 Baseline AZ/EL Assembly (380-415 VAC) Model 7150 Series II

800684 ACU Rear Panel PC Board Assembly Model 7200 w/Optical Encoders

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APPENDIX A - ACRONYMS AND ABBREVIATIONS

The following is a list of acronyms and abbreviations that are used by Vertex Control Systems and may appear in this manual.

A	Amperes
AC	Alternating Current
ACS	Antenna Control System
ACU	Antenna Control Unit
A/D	Analog-to-Digital
ADU	Antenna Drive Unit
AGC	Automatic Gain Control
AOS	Acquisition of Star
ASCII	American Standard Code for Information Interchange
ASSY	Assembly
AST	Adaptive Steptrack
AZ	Azimuth
BCD	Binary Coded Decimal
BDC	Block Downconverter
BIT	Built-In Test
BW	Bandwidth
CCW	Counterclockwise
CFE	Customer-Furnished Equipment
COM	Common
CPU	Central Processing Unit
CR	Carriage return
CRLF	Carriage return/line feed
CW	Clockwise
dB	Decibel
dBm	Decibel referred to 1 milliwatt
DC	Direct Current
deg	Degrees
DMM	Digital Multimeter
DOS	Disk Operating System
EIA	Electronic Industries Association
EIC	Encoder Input Circuit
EL	Elevation
EPROM	Erasable Programmable Read-Only Memory
E STOP	Emergency stop

FLT	Fault
FSM	Finite State Machine
FWD	Forward
GHz	Gigahertz
GND	ground
HB	High Byte
HP	horsepower
Hz	Hertz
I/O	Input/Output
IC	Integrated Circuit
IEC	International Electrotechnical Commission
IEE	Institute of Electrical Engineers
IEEE	Institute of Electrical and Electronic Engineers
IF	Intermediate Frequency
ISIO	Intelligent Serial Input/Output
km	Kilometer
LB	Low Byte
LED	Light-Emitting Diode
LNA	Low Noise Amplifier
LOS	Loss of Signal (Loss of Star)
LSB	Least Significant Bit
LSI	Large Scale Integration
LT	Long-term
M	Meter
M&C	Monitor and Control
mA	Milliamperes
mb	Multibody (propagator)
MHz	Megahertz
ms	Millisecond
N/A	Not applicable
NEC	National Electrical Code
NEMA	National Electrical Manufactures Association
NORAD	North American Air Defense Command
NVRAM	Nonvolatile Read-Only Memory
O&M	Operations and Maintenance
OPT	Orbit Prediction Tracking

PC	Printed circuit
PCB	Printed-Circuit Board
PH	Phase
PLL	Phase-Lock Loss
PMCU	Portable Maintenance Control Unit
POL	Polarization
p-p	Peak-to-peak
PROG	Program
PROM	Programmable Read-Only Memory
RAM	Random Access Memory
RC	Resistance-capacitance
RDC	Resolver-to-Digital Converter
REV	Reverse
RF	Radio Frequency
RFI	Radio Frequency Interference
RMS	Root mean square
ROM	Read-Only Memory
rpm	Revolutions per minute
sec	Second
SPST	Single-Pole Single-Throw
ST	Short-term
STD	Standard
2b	Two-body (propagator)
TBT	Tracking Band Translator
TBU	Test Bed Unit
TEE	True Equinox and Equator
TT&C	Telemetry, Tracking, and Control
UTC	Coordinated Universal Time
V	Volts
VAC	Volts AC
VDC	Volts DC

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APPENDIX B - 7200 ACU PASSWORD PROTECTION

This appendix details the usage of the password protection system on the 7200. Procedures are provided for setting and changing the password. Procedures are also provided for clearing the password, if the user has forgotten the password or the user does not want password protection to be enabled on the system at any time.

The 7200 ACU, as shipped, has password protection enabled with all passwords cleared. The user can then set the password by entering the **Set user level (and passwords)...** menu and following the procedures provided in paragraph 5.8.4 in the Operations Section of this manual.

If the passwords have already been set, the ACU will ask for the old password first before accepting a new password.

If a password has been lost or the user wants to disable password protection, use the following procedures to reset a password or disable password protection.

The following tools are required:

1 flathead screwdriver for #10-32 screws
1 Phillips screwdriver for #6-32 screws
1 trimming tool or small flathead screwdriver

1. On the front of the 7200 ACU, set the DRIVE ENABLE switch to disable the drives.

2. Using a large flathead screwdriver, remove the four screws holding the 7200 ACU in the rack.

3. On the rear of the 7200 ACU, set the power switch to the off position.

4. On the rear of the 7200 ACU, check that all cables have enough slack to allow the unit to be pulled forward about 20 inches (50 centimeters).

5. Carefully slide the 7200 ACU forward until the hinge at the rear of the top cover clears the front of the rack.

6. Using a Phillips screwdriver, remove the two screws holding the front of the cover.

7. Note the hinge on the right side of the 7200 ACU. Lift the cover of the 7200 ACU and lock it in place by pulling forward on the joint of the hinge. The slide mount can also be used to tilt the entire ACU in 45-degree increments for easier access.

8. Inside the 7200 ACU, disconnect the following cables:

   a. The 10-conductor cable from the daughtercard on the I/O card (800252) assembly.
   b. The 50-conductor cable from the I/O card (800252) assembly going into the middle of the card directly below the 10-conductor ribbon cable.
   c. The 26-conductor cable from the RDC card (800225) assembly going into the middle of the card directly below the previous cable.

9. Using a small flathead screwdriver or trimming tool, on the Force CPU card set the switch labeled 2 so that the arrow points to 0.

   NOTE: In the next step when the ACU is powered up, the display screen will indicate some alarm conditions because of the disconnected cables.

10. On the rear of the 7200 ACU, set the power switch to the on position. If desired, acknowledge any faults.

11. From the **Main menu**, select **Set user level (and passwords)...**. Verify that user levels can be changed without a password.

12. If password protection is not desired, go to step 17.

13. Using a small flathead screwdriver or tuning tool, set switch 2 so that the arrow points to position 4.

14. If password protection is desired, enter a password.

15. On the 7200 ACU rear panel, set the power switch to the off position for 5 seconds and then set the power switch to the on position.

16. Verify that the password protection has been enabled by changing the user level.

17. On the rear of the 7200 ACU, set the power switch to the off position.

18. Reconnect the ribbon cables to the cards.

19. On the rear of the 7200 ACU, set the power switch to the on position.

20. Verify that the only fault showing is DRIVE DISABLED (LOW SIGNAL may also be displayed).

21. Verify that the resolver readout is steady.

22. Press the DRIVE ENABLE switch so that the drives are enabled.

23. Verify that all faults are cleared, with the possible exception of a low signal level.

24. On the rear of the 7200 ACU, set the power switch to the off position.

25. Holding the top left corner of the cover with one hand, press the hinge in with the other hand and lower the cover until it seats on top of the unit. Reinsert and tighten the two #6-32 screws that secure the cover.

26. Slide the 7200 ACU back into position and secure the front panel to the rack with four #10-32 screws.

27. On the rear of the 7200 ACU set the power switch to the on position. Verify that password protection has been set correctly.

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APPENDIX C - 7200 REMOTE MONITOR AND CONTROL PROTOCOL

1.0 INTRODUCTION

This appendix contains the 7200 Remote M&C protocol. It is provided to assist in the setup of remote communications with the 7200 ACU. The command line-oriented protocol and command set for the 7200 ACU's remote M&C shell are both discussed.

The remote port's communication parameters (bps, parity, data bits, stop bits) may be configured at the front panel of the 7200 ACU. From the **Main menu**, select **Edit system configuration...**, and then **Remote port configuration....** For the purposes of this document, the **Shell** parameter should be set to **M&C**.

The command line interface is designed to be used in conjunction with an M&C computer, not by operators directly. Although the command set is all in printable ASCII, it is not designed to be user-friendly. In order to simplify the M&C programmer's job, the command set was written to be as consistent and uniform as possible.

1.1 Scope

This appendix is applicable to 7200 ACU firmware Version 3.22 or later.

Sections labeled as FACTORY OPTION do not apply to all systems. If you are unsure about your system configuration or cannot find the necessary information in this manual, consult your Vertex representative.

2.0 INPUT ECHO AND LINE EDITING

Communications are performed either with or without echo. This can also be set for each port in the **Remote port configuration**... menu.

Regardless of echo state, the following line-editing commands are supported:

1. Backspace (BS: ASCII 8) backspaces over one character. The 7200 ACU sounds the bell using the ASCII bell character (BEL: ASCII 7) if there is nothing to backspace over. If echo is off, the 7200 ACU will not return the BS character.

2. Escape (ESC: ASCII 27) kills the current line. The input already typed in is not backspaced over; however, the 7200 ACU prints '\', followed by a newline (Refer to Section 3.0.) and '000 > ', indicating the last command was processed without errors.

3.0 REQUEST/COMMAND PROTOCOL

Two types of communication with the 7200 are allowed: requests and commands. Any remote port may execute a request at any time. Section 5 lists all requests and commands, including the respective function, system response, and required security level.

The security level must be set to at least Operator level (level 2) before the M&C interface will accept commands. Some commands cannot be executed without Supervisor security level (level 3). Refer to Section 4.5 for details.

Requests/Commands are entered in the format [R or C]n [parameters](CR) where:

R and C are uppercase ASCII characters (R = ASCII 82, C = ASCII 67).
There is no space between R and C and the number n.
n is a number in ASCII; n is one to three decimal digits (0-999, inclusive).
Leading 0's are permitted (Example: R1, R01, and R001 are all valid).
[parameters] are zero or more space-separated ASCII strings that are specific to the Request/Command.
(CR) is a carriage-return (ASCII 13). No line feed is used. CR's input to the 7200 ACU will not be echoed regardless of whether echo is enabled or disabled.

The response from a request or command is always in the form:

[(newline)data]
[(newline)data]
(newline)nnn>

The [data] field is Request/Command-specific. Data may or may not be returned, depending on the Request/Command. The data is terminated by a newline, which consists of CR (ASCII 13) and an optional LF (ASCII 10). There may be more than one line of data, depending on the Request/Command.

The M&C response will always terminate with a newline, followed by three ASCII digits "nnn," followed by a ">" (ASCII 62). "nnn" is an error code, and "000" indicates that the Request/Command was acceptable (no syntax errors) and was processed without errors.

Example: R0 is a "noop" (no-operation). It returns only a "000" error code.

Send: R0 (CR)
Receive: (newline)000>

The M&C interface will always return responses as soon as possible, allowing the remote controller to issue another Request/Command. Some operations, such as resetting the drive cabinet, may take several seconds. Such operations will be executed in background mode and will not be completed by the time the response is sent back to the remote computer.

After sending a Request/Command, the remote computer must wait for the "nnn>" prompt before sending the next Request/Command, or it may be ignored by the M&C interface.

If the 7200 is reset or port configurations have changed, an interface clear (IFC) needs to be sent by the controller in charge (CIC).

4.0 GENERAL TRANSMIT/RECEIVE FORMATS

4.1 White Space

Spaces (ASCII 32 decimal) are used to separate fields. When the 7200 ACU sends data, fields are always separated by one space unless otherwise noted. If the 7200 ACU's response is several fields followed by a (CR), the last field will not have a space between it and the (CR).

Input may have more than one space separating fields. If checksumming is enabled, however, additional spaces will alter the checksum. Refer to Section 4.4.

4.2 Position Vectors

Position vectors are always transmitted by the 7200 ACU in the form of azimuth, elevation, and polarization, where the format of the look angle is the same as shown on the 7200 ACU front panel display. For signed angles, a "-" immediately precedes the angle if it is negative. Positive signed and unsigned angles are identical; there is no leading "+." The AZ output is unsigned. Its range is 0 angle < 360. The EL and POL outputs are signed: -180 angle < 180.

At least one digit will always be both to the left and to the right of the decimal point (Example: 0.0). POL will always return 0.0 degrees if disabled.

Example return: 125.35 53.81 -2.0

Position vectors, sent from the remote to the 7200 ACU, must have at least one digit to the right of the decimal point. If a sign is included, it must immediately precede the number with no space between the sign and the most significant digit.

4.3 Error Codes (at End of Request/Command Response)

000 No error: Request/Command completed successfully.

001 Last Request/Command received successfully; awaiting further input.

1nn Invalid data in field nn on this line. Field 0 is always the checksum field. If there is no checksum, the first field is field 1. In most cases, field 1 is the Request/Command. In the case of multiline input (001 > prompt), the checksum is field 0 (if enabled) and the next field is field 1, etc. Invalid data means either that the data makes no sense for the field in question (Example: non-numeric string where number is expected), the data is out of range, or the data is invalid.

100 Indicates checksum failure. If there are extra fields in the input, that field will be flagged as invalid data.

20n Security violation: Insufficient security level to complete command.
n indicates the required level: 2 = operator or 3 = supervisor.

300 Could not complete motion command because of ACU/drive fault(s).

301 Intelsat elements failed 170-hour verification.

302 Could not update pointing command because controller is not currently tracking the Immediate target AND in **Move to look angles...** mode.

303 Expired table: All records expired

304 Empty table: No records exist

4.4 Checksums

The 7200 ACU remote supports an optional input/output checksum feature that can be enabled/disabled either at the front panel or at a remote station using the C102 command. Refer to Section 5.0. If checksums are enabled, the 7200 ACU transmits a checksum before each line of output and expects a checksum before each line of input.

If checksums are enabled, the general I/O format becomes:

M/C sends: cc text(CR)
ACU sends: [(newline)cc text]

(newline)cc nnn >
where cc = checksum.

Checksums, both to and from the 7200 ACU, are transmitted as two ASCII encoded hexadecimal (uppercase) digits.

The checksum is the 1's complement of the sum, modulo 256, of all the characters in text (including all blanks). This does not include the first space after the checksum, nor does it include the CR that terminates the line.

The checksum output by the 7200 ACU also does not include the first space after the checksum.

Example 1: R0 (noop) request

M/C sends: 7D R0(CR)
ACU sends: (newline)31 000 >

Example 2: C2 (move to position): AZ outside of soft limits

M/C sends: BA C2 100.00 50.0 0.0(CR)
ACU sends: (newline)2E 102 >

4.5 Security Level Description

The 7200 ACU has a simple three-level security system to help prevent unauthorized use which may cause problems with operation such as running off the target, changing parameters to improper settings, etc. This system is not designed to hide details of the 7200 ACU's operation; in fact, any user at any time may view any status or parameter settings of the 7200 ACU.

4.5.1 Security Levels and Transitions

The 7200 ACU has three security levels; their rules apply to the remote ports as well as to the front panel with a few exceptions. The levels are:

Monitor: (level 1) All system status and parameter values may be examined; however, none may be modified at this level. The antenna may not be commanded from Monitor level.

Operator: (level 2) All privileges of Monitor level. Additionally, a user with Operator privileges may command the antenna to a new position. This includes the ability to manually command the antenna. A user with Operator privileges may not modify system parameters; however, an Operator may initiate a tracking mode that will modify the stored data, and/or orbit models for the target in question.

Supervisor: (level 3) Supervisor has complete access to the system, and may modify all system parameters.

The 7200 ACU can support several monitor ports simultaneously. Only one port, including the front panel, may be at a security level other than Monitor at a certain time.

One port ("A") may take control from another ("B"), provided that port A has the password for a higher security level then B.

The exceptions to the rules above that apply to the remote ports are:

1. At the 7200 ACU front panel, the [STOP] key is always available for use regardless of user level; however, the remote port must be at Operator or Supervisor level in order to stop the antenna.

2. The 7200 ACU front panel may assume control from a remote port, provided the user has an adequate security level. If both ports are at the same security level, the front panel assumes control. For example, if the antenna is currently being controlled by a remote port in Operator level, and a user logs into the front panel in Operator level, the remote port goes back to Monitor level and cannot assume any level other than Monitor. The front panel only permits it by either dropping down to Monitor level, or the remote asserts Supervisor level. If the front panel is in Supervisor level, no remote port can take control away from it.

When the 7200 ACU power is cycled, the security levels of all ports (including the front panel of the 7200 ACU) remain the same.

4.5.2 Passwords

Passwords are a one to nine digit number. Setting a password to 0 disables password protection for that security level. To completely disable passwords, set both Operator and Supervisor passwords to 0.

Even if both passwords are disabled, the same procedure must be used to change security levels and transfer control to/from the remote ports. The system will not prompt for a password.

5.0 X0nn - GENERAL REQUESTS AND COMMANDS

Note that for all requests, the security level is Monitor (level 1), unless otherwise specified.

All strings must be enclosed in quotation marks (").

C0
Function: No operation. This command may be used to test whether the remote port is communicating correctly with the 7200 ACU.
Response: < none >
Security: Operator (level 2)

R0
Function: No operation.
This command may be used to test whether the remote port is communicating with the 7200 ACU.
Response: < none >
Security: Monitor (level 1)

C1 n
Function: Stop/resume tracking.
n = 0: Stop antenna. Does not return to **Standby**. This is equivalent to pressing the STOP key on the 7200 ACU front panel.
n = 1: Resume tracking. This is equivalent to pressing the RESUME key on the 7200 ACU front panel.
n = 2: Stop tracking and return to **Standby** mode. This has no effect on the STOP/RESUME function.
Response: < none >
Security: Operator (level 2)

R1 n
Function: Request position loop information.
n = 0: Request current antenna position vector.
n = 1: Request current command position vector.
R10 Response: v
where v = position vector (azimuth elevation polarization)
R11 Response:
0 (if in Standby) or 1 v (if tracking)
v is a position vector as described above.
Security: Monitor (level 1)

C2 v

Function: Move antenna to new position and hold.
If the 7200 ACU is currently tracking a target, the antenna will leave that target to go to the new position given by the vector v.

Response: < none >

Note: The M&C will report an "out of range" error if an element of the position vector is outside of the soft limits; i.e.: 102 > for azimuth outside of soft limits, 103 > for elevation, 104 > for polarization.

Security: Operator (level 2)

R2 [n]

Function: Request basic fault status.
n = 0: (default) Return all faults present at this time.
n = 1: Return only faults that are new since last read by R2.

Response: h, where h is one ASCII encoded hexadecimal digit (0-F), bitmapped as listed in the following table.

BIT	INDICATION
0	Drive cabinet fault is in effect (no power, emergency stop, etc.)
1	Motion fault is in effect (soft limit, immobile, etc.)
2	Tracking fault is in effect.
3	System error condition is in effect (hardware failure, watchdog time out, etc.)

Example: 5 (drive cabinet fault and tracking fault)

Security: Monitor (level 1)

C3

Function: Acknowledge and attempt to clear all system faults.
The 7200 ACU will acknowledge all currently active faults, close the FLT relay, and attempt to clear the faults. Some faults (such as the emergency stop) cannot be cleared by the 7200 ACU; however, the FLT relay will still be closed.

Response: < none >

Note: If a drive fault is in effect, resetting the drives takes approximately three (3) seconds. Any faults that occur after this command will cause the FLT to reopen. These faults will then have to be acknowledged (using C3) to close the FLT relay again.

Security: Operator (level 2)

R3 h

Function: Detailed fault report.
Request fault status on fault bits h from R2 request; that is, a detailed fault status will be sent for each bit set in h in the request.

Response: h, where h is eight (8) ASCII encoded hexadecimal digits. Each digit represents four bits in the tables following this section. Response fields are sent in the order shown in the table below, space separated.

Example:
000 > R3 3
00000002 00100010
(Emergency stop, POL CW soft limit, POL runaway)
000 >

Note: "R3 0" will force all four fields to be sent. Fields will be sent in order: drive cabinet faults, motion faults, tracking faults, and system faults.

Security: Monitor (level 1)

DRIVE CABINET FAULTS	
BIT	**INDICATION**
0	No power at drive cabinet
1	Emergency stop at drive cabinet
2	Maintenance override at drive cabinet
3	Travel limit switch (summary)
4	Azimuth drive fault
5	Elevation drive fault
6	Azimuth CW limit switch[1]
7	Azimuth CCW limit switch[1]
8	Elevation upper limit switch[1]
9	Elevation lower limit switch[1]
10	Polarization[2] CW limit switch[1]
11	Polarization[2] CCW limit switch[1]
12	Resetting drive cabinet
13	Drives disabled at console
14	ACU Offline
15	Polarization #2 CW limit switch[3]
16	Polarization #2 CCW limit switch[3]

[1] Not implemented in the current version, and will return a zero. The M&C programmer may check these bits and report errors for them ("unspecified errors" for unused bits). It should not be assumed that unused bits are always zero.

[2] Polarization reads as Polarization #1 in 4 axis systems.

[3] Only applicable in 4 axis systems.

MOTION FAULTS	
BIT	**INDICATION**
0	Azimuth CW soft limit
1	Azimuth CCW soft limit
2	Elevation upper soft limit
3	Elevation lower soft limit
4	Polarization[2] CW soft limit
5	Polarization [2] CCW soft limit
6	West box limit violation
7	East box limit violation
8	North box limit violation
9	South box limit violation
10	Polarization [2] CW box limit violation[1]
11	Polarization [2] CCW box limit violation[1]
12	Azimuth immobile
13	Azimuth reversed
14	Azimuth runaway
15	Elevation immobile
16	Elevation reversed
17	Elevation runaway
18	Polarization[2] immobile
19	Polarization[2] reversed
20	Polarization[2] runaway
21	Keyboard stop
22	Polarization #2 CW soft limit[3]
23	Polarization #2 CCW soft limit[3]
24	Polarization #2 CW box limit violation[1&3]
25	Polarization #2 CCW box limit violation[1&3]
26	Polarization #2 immobile[3]
27	Polarization #2 reversed[3]
28	Polarization #2 runaway[3]

[1] Not implemented in the current version, and will return a zero. The M&C programmer may check these bits and report errors for them ("unspecified errors" for unused bits). It should not be assumed that unused bits are always zero.

[2] Polarization reads as Polarization #1 in 4 axis systems.

[3] Only applicable in 4 axis systems.

TRACKING FAULTS	
BIT	**INDICATION**
0	Target outside of soft limits
1	Low tracking signal level
2	Excessive tracking signal noise
3	Intelsat data expired
4	Intelsat pre-epoch prediction
5	Intelsat data invalid - cannot track
6	OPT cannot track
7	Tracking signal input saturated
8	Invalid target in target schedule
9	Sun outage; Steptrack inhibited
10	Tracking delay in effect
11	Reserved; unused
12	Reserved; unused
13	Reserved; unused
14	Standby (no tracking in progress)
15	Reserved; unused
16	Tracking receiver serial link failure
17	Tracking receiver in LOCAL control
18	Tracking receiver out of band
19	Tracking receiver fault
20	Table Track data expired
21	Orbital elements invalid - - cannot track

SYSTEM FAULTS	
BIT	**INDICATION**
0	LB PROM checksum failure
1	HB PROM checksum failure
2	Azimuth (coarse) LOS
3	Azimuth (coarse) BIT failure
4	Azimuth (fine) LOS
5	Azimuth (fine) BIT failure
6	Elevation (coarse) LOS
7	Elevation (coarse) BIT failure
8	Elevation (fine) LOS
9	Elevation (fine) BIT failure
10	Polarization[1] LOS
11	Polarization[1] BIT failure
12	A/D 1 failure
13	A/D 2 failure
14	Unexpected exception
15	Sanity check failed
16	Non-volatile RAM corrupted
17	Watchdog timeout
18	Simulation
19	Azimuth encoder error
20	Elevation encoder error
21	Polarization[1] encoder error
22	OUINTF task aborted
23	POSITIONER task aborted
24	TARGETER task aborted
25	SCHEDULER task aborted
26	Bus error on boot up
27	SYSFAIL line - timeout
28	SIMULATOR task aborted
29	Remote control panel link failure
30	System date/time invalid

[1]Polarization reads as Polarization #1 in 4 axis systems.
[2]Only applicable in 4 axis systems.

R4 n

Function: Request user level status.
Request the security level for a control port.
n = 0: Request security level for this port.
n = 1: Request port number and security level for the port (if any) in control of the 7200 ACU.

Response: n@m, where n is the port number (0 being the front panel), and m is the security level:
1 = Monitor, 2 = Operator, 3 = Supervisor.

Example: 0@3 (Front panel is at Supervisor level.)

Note: R4 1 implicitly returns the security level of all ports because only one port may be at a level higher than Monitor (1). If all ports are at Monitor level, "0@1" will be returned.

Security: Monitor (level 1)

R5 n [m]

Function: Change security level.
This command was written as a request because a user can only issue commands with Operator or higher security level. If it were a command, the port could never be changed from Monitor level.
n: Security level to change to:
1 = Monitor, 2 = Operator, 3 = Supervisor.
m: Password for the requested level.

Response: < none >

Note: A password is not required if the password option is disabled or if the command is to drop user level to a lower priority. It is not an error to supply a password in this case; it will be ignored. If a password is not supplied with this request and one is required, a "001>" error is returned. A password may then be entered. If the echo option is enabled, the password will be echoed with periods "..." as it is being typed.

Security: Monitor (level 1)

R7 [n]

Function: Is a general status request, which groups a number of pieces of data together.

Response: The following items are returned in the listed order:
Date/Time - same as R240
Target # - same as R300
Target Mode - same as R11
Target submode - new to RC M&C (see list below)
Summary fault - same as R2 (0 or 1) (see arguments for R2)
Signal level - same as R10
Current position - same as R1 0 ONLY (you can not request command position)

0	None
1	Manually Biasing Target
2	Acquiring Target
3	Holding Target Position
4	Holding Present Position; Cannot Track
5	Tracking Target using Model
6	Steptracking: Peaking Azimuth
7	Steptracking: Peaking Elevation
8	Steptracking: Peaking both Axes
9	Awaiting Next Steptrack Cycle
10	Performing Stow Operations
11	Orbit Scan
12	*Monopulse Calibration
13	*Monopulse Active
14	*Holding Position; Awaiting Target
15	*Tracking Remote Data
16	*Monopulse Active Without OPT
17	*Manual Rate Search
18	Acquiring Starting Position
19	Holding Starting Position; Awaiting Start Time
20	*Using Interpolated Data
21	*Table Expired; Awaiting New Data
22	Waiting for 3-Phase Power Loss to Clear
23	*Tracking Target Using SGP4
24	*Tracking Target using SDP4
25	Tracking hold initiated by M&C

*Denotes **FACTORY OPTION** tracking modes.

Note: Takes same argument as R2.
Example:
```
000>R7 0
09/03/1999 23:17:32 -1 0 0 140 -16.0 86.495 11.665 0.0
000>
```
Security: Monitor (level 1)

R10

Function: Request tracking signal level.
Response: n, where n is the tracking signal level in dB.
Security: Monitor (level 1)

R11 Function: Request current tracking mode.
Response: m, where m is one of the following tracking modes:

-1	Unused
0	Standby, No Tracking in Progress
1	Move to Look Angles
2	Move to Nominal Longitude
3	Intelsat IESS412 Element Tracking
4	Steptrack
5	Orbit Prediction Tracking (OPT)
6	*NORAD 2 Card Element Tracking
7	Star Tracking
8	*Monopulse/OPT
9	Antenna Stow
10	Antenna Unstow
11	*Moon Tracking
12	Manual Antenna Control
13	Awaiting Next Scheduled Target
14	Restoring Last Target
15	Restoring Target Scheduler
16	*Monopulse/Transfer Orbit Tracking
17	*Tracking Table in Memory
18	*Orbital Element Tracking
19	*Sun Tracking

*Denotes **FACTORY OPTION** tracking modes.

Security: Monitor (level 1)

R20 Function: Request last steptrack peak information.
Request the last steptrack peak information, time, and target number.
Response: n mm/dd/yyyy hh:mm:ss <vector>, where n is the target number.
If n = -1, no steptrack has been performed since power-up; the remaining fields (date, time, and vector) are not sent.
Security: Monitor (level 1)

5.1 X1nn - Port Configuration Requests and Commands

All requests and commands for port configuration take the port number (m) as an optional argument, defaulting to the port issuing the Request/Command. So, m should always read [m] (indicating that m is optional.) Note that each port can be configured independently. Those commands that can optionally specify a port, may omit the port number. If this is omitted, the command affects the port issuing the command. In the following commands, m specifies the port number.

C100 n [m] Function: Set newline mode for a port.
n = 0: newline becomes CR only.
n = 1: newline becomes CRLF.
Response: < none >
Note: This command only affects the newline sent by the 7200 ACU. A CR must terminate input to the 7200 only. ALF is not tolerated.
Security: Supervisor (level 3)

R100 m Function: Request newline mode for a port.
This is used to determine which newline mode the current port is in. n is optional and is used to specify a port number. If no port is specified, this request inspects the mode of the requesting port.
Response: n, where n = 0 if newline = CR, or n = 1 if newline = CRLF.
Security: Monitor (level 1)

C101 n [m] Function: Set echo mode for a port.
n = 0: Turns echo off.
n = 1: Turns echo on.
Response: < none >
Security: Supervisor (level 3)

R101 m Function: Request echo mode for a port. Returns the echo mode for the current port if n is omitted, otherwise returns the echo mode for the port specified.
Response: n, where n = 0 if echo = off, or n = 1 if echo = on.
Security: Monitor (level 1)

C102 n [m] Function: Set checksum mode for a port.
n = 0: Turns command line checksumming off for port specified.
n = 1: Turns command line checksumming on for port specified.
Response: < none >
Note: If no port is specified, this command operates on the commanding port.
Security: Supervisor (level 3)

R102 m Function: Request checksum mode for a port. Returns the checksum mode for the current port if n is omitted, otherwise returns the mode for the port specified.
Response: n, where n = 0 if check-summing = off, or n = 1 if check-summing = on.
Security: Monitor (level 1)

C103 n [m] Function: Set communications parameters for a port.
n = baud parity data bits stop bits
Response: < none >
Example: C 103 9600 2 7 2 1, where setting is 9600 bps, even parity, seven data bits, 2 stop bits, directed at port 1. The convention for parity is NONE = 0. ODD = 1, EVEN = 2.
Note: If this command is used to change settings on the port that executed the command, the settings will change before the prompt returns; therefore, the prompt will probably be garbled.
Security: Supervisor (level 3)

R103 [m] Function: Request communications parameters for a port.
Response: < baud rate > < parity > < data bits > < stop bits >
Security: Monitor (level 1)

5.2 X2nn Global ACU Configuration Requests and Commands

C200 c
Function: Enable/disable soft limits.
c = Y: Enables soft limits.
c = N: Disables soft limits.
Response: < none >
Security: Supervisor (level 3)

R200
Function: Request soft limit status.
Response: c, where c = "Y" if soft limits are enabled and c = "N" if soft limits are disabled.
Security: Monitor (level 1)

C201 v
Function: Set lower/CCW soft limits.
v = position vector.
Response: < none >
Security: Supervisor (level 3)

R201
Function: Request lower/CCW soft limits.
Response: < position vector >
Security: Monitor (level 1)

C202 v
Function: Set upper/CW soft limits.
v = position vector
Response: < none >
Note: On any axis, the antenna may travel CW from the CCW (lower) limit to the CW (upper) limit. If the CW soft limit for an axis is greater than the CCW soft limit, the antenna travels through 0 degrees going CW from the CCW limit to the CW limit.
Security: Supervisor (level 3)

R202
Function: Request upper/CW soft limits.
Response: < position vector >
Security: Monitor (level 1)

C203 v
Function: Set immobile/reversed timeout.
Set axis immobile/reversed timeout.
v = time vector, where the units are in seconds.
Response: < none >
Example: C203 2.0 2.0 2.0 sets all three axes to 2.0 second timeout.
Security: Supervisor (level 3)

R203 Function: Request immobile/reversed timeout.
Response: < time vector >
Security: Monitor (level 1)

C204 v Function: Set immobile/reversed tolerance.
v = position vector
Response: < none >
Security: Supervisor (level 3)

R204 Function: Request immobile/reverse tolerance.
Response: < position vector >
Security: Monitor (level 1)

C205 v Function: Set runaway error tolerance.
v = position vector
Response: < none >
Security: Supervisor (level 3)

R205 Function: Request runaway error tolerance.
Response: < position vector >
Security: Monitor (level 1)

C210 v Function: Set slew--> track transition angles.
v = position vector
Set slew--> track speed transition deltas. POL is single speed on standard 7200 ACU's; therefore, the POL value may not be applicable even though the field is required.
Response: < none >
Security: Supervisor (level 3)

R210 Function: Request slew--> track transition angles.
Response: < position vector >
Security: Monitor (level 1)

C211 v Function: Set position loop deadband.
v = position vector
Response: < none >
Security: Supervisor (level 1)

R211 Function: Request position loop deadband.
Response: < position vector >
Security: Monitor (level 1)

C212 v
Function: Set inching on times.
v = time vector
Response: < none >
Security: Supervisor (level 3)

R212
Function: Request inching on times.
Response: < time vector >
Security: Monitor (level 1)

C213
Function: No function. This originally was used to change the position loop velocity tolerance, but is now supported for backward compatibility purposes only.
Response: < none >
Security: Supervisor (level 3)

C220 v
Function: Set encoder-counting direction.
v = vector
Set encoder-counting direction. For each axis, Y = reversed, N = normal.
Response: < none >
Example: C220 Y N Y, AZ and POL are reversed. EL is not.
Security: Supervisor (level 3)

R220
Function: Request encoder counting direction.
Response: < vector >
Example: R220
Y N Y (shows AZ, EL, POL) 000 >
Security: Monitor (level 1)

C221 v
Function: Set encoder offsets directly.
v = position vector
Set offsets directly by supplying offset values.
Response: < none >
Security: Supervisor (level 3)

R221
Function: Request encoder offsets.
Response: < position vector >
Security: Monitor (level 1)

C222 v
Function: Set encoder offsets indirectly.
v = position vector Set offsets indirectly by supplying look angles.
Response: < none >
Note: There is no matching request for C222, use R221.
Security: Supervisor (level 3)

C223 c Function: Set POL enabled flag.
c = "Y" to enable, "N" to disable.
Response: < none >
Security: Supervisor (level 3)

R223 Function: Request POL enabled flag.
Response: c, where c = "Y" if POL flag is enabled, c = "N" if POL flag is disabled.
Security: Monitor (level 1)

C230 s Function: Set antenna name.
s = quoted string of 12 characters.
Response: < none >
Security: Supervisor (level 3)

R230 Function: Request antenna name.
Response: s, where s is a quoted string up to 12 characters long.
Security: Monitor (level 1)

C231 n Function: Set site longitude.
n = angle in degrees.
Response: < none >
Security: Supervisor (level 3)

R231 Function: Request site longitude.
Response: n, where n is an angle in degrees.
Security: Monitor (level 1)

C232 n Function: Set site latitude.
n = angle in degrees North.
Response: < none >
Security: Supervisor (level 3)

R232 Function: Request site latitude.
Response: n, where n is an angle in degrees North.
Security: Monitor (level 1)

C233 n Function: Set site altitude.
n = site altitude in meters.
Response: < none >
Security: Supervisor (level 3)

R233 Function: Request site altitude.
Response: n, where n is the site altitude in meters.
Security: Monitor (level 1)

C234 dt
Function: Set local time offset from UTC.
dt is the time offset, in the form " + hh:mm:ss;"
+ = '+' for time ahead of UTC;
'-' for time behind UTC.
Response: < none >
Example: -05:00:00 (set offset to -5 hours = Eastern Standard Time.)
Security: Supervisor (level 3)

R234
Function: Request local time offset from UTC.
Response: dt, where dt is the same format as described for the C234 command.
Security: Monitor (level 1)

C235 s
Function: Set local time zone abbreviation.
s = quoted string of three characters.
Response: < none >
Example: C235 "EST" for Eastern Standard Time.
Security: Supervisor (level 3)

R235
Function: Request local time zone abbreviation.
Response: s, where s is a quoted string of three characters.
Security: Monitor (level 1)

C240 d t
Function: Set current UTC date and time.
d = date in form: mm/dd/yyyy
t = time in form hh:mm:ss.
Response: < none >
Example: C240 mm/dd/yyyy hh:mm:ss
Security: Supervisor (level 3)

R240
Function: Request UTC date and time.
Response: d t, where d and t are the same date and time formats, respectively, that are used for the C240 command.
Security: Monitor (level 1)

5.3 X3nn Tracking and Target Requests and Commands

C300 n
Function: Track target by target number.
n = input target number, n = [1,50]
Response: < none >
Security: Operator (level 2)

R300
Function: Request target currently being tracked.
Response: n, where
n = -1 if 7200 ACU is in **Standby** mode,
n = 0 if in **Immediate** mode,
n = 1-50 if tracking a preprogrammed target .
Security: Monitor (level 1)

C301 s
Function: Track target by target name.
s = quoted string holding target name.
Response: < none >
Security: Operator (level 2)

R301
Function: Request name of target currently being tracked.
Response: s, where s is a quoted string containing the target name, or n is sent if in **Standby** mode (n = -1), or **Immediate** mode (n = 0).
Security: Monitor (level 1)

C302 n
Function: Clear target by number
n = input target number, n = [1,50]
Response: < none >
Security: Supervisor (level 3)

R302 n
Function: Request tracking mode and name of target by number
n = input target number, n = [1,50]
Response: m s, where m is the tracking mode (Refer to R11.), and s is a quoted string containing the target name.
If the target is unused a zero is returned as the mode with NO name (i.e., s is not returned).
Security: Monitor (level 1)

C303 s
Function: Clear target by name
s = quoted string holding target name.
Response: < none >
Security: Supervisor (level 3)

R303 s
Function: Request number and tracking mode of target by name.
s = quoted string holding target name.
Response: m n, where n is the target number, and m is the tracking mode of the target. Refer to R11. If the named target does not exist, an error code is returned.
Security: Monitor (level 1)

C305
Function: Begin immediate steptrack.
Response: < none >
Security: Operator (level 2)

R305
Function: Request steptrack status.
Response: c, where c = "Y" if the 7200 ACU is actively steptracking the current target, or c = "N" if the 7200 ACU is not currently in a steptrack cycle.
Note: This request functions while in **Immediate Steptrack** or **OPT** mode (while actively steptracking).
Security: Monitor (level 1)

C306 v
Function: Update command position of tracking started with C2 command with the vector v. This command is only used to update the commanded pointing position of the antenna after a C2 command has been used to start **Move to look angle...** tracking. This command should only be used to continue operations on a single satellite. It will not initiate tracking from **Standby** or any other tracking mode. When changing to a new satellite, the C2 command should be issued.
Response: < none >
Security: Operator (level 2)

C307 n
Function: This **FACTORY OPTION** command to set the radius distance the boresite should be away from the sun center.
n = real value in degrees range 0 to 1.0
Response: none
Security: Monitor (System must already be in **Sun track** mode)

R307
Function: This **FACTORY OPTION** command returns the radial distance in degrees and a true/false flag if within deadband from the commanded radius
Response: n.nnn f
Security: Monitor (System must already be in **Sun track** mode)

C308 a
Function: This **FACTORY OPTION** command is used to set the angular rotation off the CW AZ direction for the radius distance (in 307) away from the sun center.
a = real value in degrees range 0 to 360.0
Response: none
Security: Monitor (System must already be in **Sun track** mode)

R308
Function: This **FACTORY OPTION** command returns the angular rotation off the CW AZ direction and a true/false flag if within deadband from the commanded angle
Response: aaa.aaa f
Security: Monitor (System must already be in **Sun track** mode)

R309
Function: This **FACTORY OPTION** command returns the time stamped sun centriod position and the current look angles at the time of the request. The built in receiver voltage (A/D 1) is also returned
For possible future use, also note the millisecond output in the time format is for future expansion and currently set to zero.
Response: MM/DD/YYYY HH:MM:SS.sss
AAA.AAAA EEE.EEEE AAA.AAAA EEE.EEEVV.VVV
Example: 000 > R30901/14/2000 05:58:18.000 098.2358 007.5663
098.2362 007.5693 00.000
Security: Monitor (System must already be in **Sun track** mode)

C310 n
This **command is only available** when the system is NOT configured to use a TRL tracking receiver.
Function: Set current A/D source.
n = channel number, n = [1,2]
Response: < none >
Security: Operator (level 2)

R310
This **command is only available** when the system is NOT configured to use a TRL tracking receiver.
Function: Request current A/D source.
Response: n, where n = channel number.
Security: Monitor (level 1)

C311 n
This **command is only available** when the system is NOT configured to use a TRL tracking receiver.
Function: Set current beacon.
n = beacon number, n = [1,4]
Response: < none >
Security: Operator (level 2)

R311 This **command is only available** when the system is NOT configured to use a TRL tracking receiver.
Function: Request current beacon.
Response: n, where n = beacon number, n = [1,4]
Security: Monitor (level 1)

C312 n v Function: Set Bias angles in specified target.
n = input target number, n = [1,50]
v = < bias vector >
Response: < none >
Security: Operator (level 2)

R312 n Function: Request Bias angles of specified target.
n = input target number, n = [1,50]
Response: v, where v = < bias vector > .
Security: Monitor (level 1)

C313 n This **command is only available** when the system is configured to use a TRL tracking receiver.
Function: Set current Frequency [MHz]
n = frequency in MHz for the tracking receiver
range [900.000 to 12750.000]
Response: < none > .
Security: Operator (level 2)

R313 This **command is only available** when the system is configured to use a TRL tracking receiver.
Function: Request current Frequency [MHz]
Response: n, where n = frequency in MHz range [900.000 to 12750.000]
Security: Monitor (level 1)

C314 n This **command is only available** when the system is configured to use a TRL tracking receiver.
Function: Set RF input
n = RF (POL) input to the tracking receiver
n = [1,2]
Response: < none > .
Security: Operator (level 2)

R314 This **command is only available** when the system is configured to use a TRL tracking receiver.
Function: Request current RF input
Response: n, where n = RF (POL) input to tracking receiver
n = [1,2].
Security: Monitor (level 1)

C315 n This **command is only available** when the system is configured to use a TRL tracking receiver.
Function: Set Attenuation [dB]
n = attenuation in dB for the tracking receiver
n = range [0.0 to 50.0]
Response: < none >
Security: Operator (level 2)

R315 This **command is only available** when the system is configured to use a TRL tracking receiver.
Function: Request current Attenuation [dB]
Response: n, where
n = attenuation in dB for the tracking receiver.
n = range [0.0 to 50.0]
Security: Monitor (level 1)

C316 n This **command is only effective** with a CP/LP controller connected to a 7200 ACU and while the CP/LP controller is in **REMOTE Control** mode.
Function: Set feed polarization mode of CP/LP controller, which may be Circular or Linear.
n = polarization mode command
n = 0: polarization switches are commanded to Circular path
n = 1: polarization switches are commanded to Linear path
Response: < none >
Security: Operator (level 2)

R316 This **command is only effective** with a CP/LP controller connected to a 7200 ACU.
Function: Request current CP/LP controller status
Response: **m n**
m = CP/LP controller mode
m = 0: CP/LP controller in LOCAL Control mode
m = 1: CP/LP controller in REMOTE Control mode
n = current polarization mode
n = 0: polarization switches are set to Circular path
n = 1: polarization switches are set to Linear path
Security: Monitor (level 1)

C318 n "Reset OPT target" is used to clear the target's stored steptrack data and orbital elements. This is used in the event that OPT comes up with bad solutions and is unable to track properly. "Reset OPT target" does not affect any of the spacecraft, steptrack, or OPT parameters.

Function: Reset OPT target
n = target number of a valid OPT mode target
if n = 0 then reset the current OPT target under track.
This has the same effect as selecting the target number of the current target in track.
Response: < none >
Security: Operator (level 2)

C319 n Function: Stops and resumes tracking in OPT mode only.
Does not cause alarm condition and has no effect on other modes.

n = 0 Similar to action of [STOP] key but could have delay to allow completion of current steptrack cycle. The hold is not in effect until the "Tracking hold initiated by M&C" submode (25) is set. Check submode with R7 request.

n = 1 Clears "Tracking hold initiated by M&C" submode and allows system to continue operation. Hold can also be cleared by taking system to STANDBY or restarting the target.

Response: < none >
Security: Operator (level 2)

C320 n [s] Function: Upload IESS412 element set into target.
n = target number, s = quoted string holding name [optional] used to set name. If target is pre-existing Intelsat, then input data will over write existing data.

Response: An awaiting further input error code will be returned. This command initiates an edit session that must be continued in sequence till completion. Nineteen items are expected, one per line, in the following order:

```
001>  YYYY      (Year)
001>  MM        (Month)
001>  DD        (Day)
001>  HH        (Hour)
001>  MM        (Minute)
001>  SS        (Second)
001>  sxxx.xxxx (LM0)
001>  sx.xxxx   (LM1)
001>  sx.xxxxxx (LM2)
001>  sx.xxxx   (LONC)
001>  sx.xxxx   (LONC1)
001>  sx.xxxx   (LONS)
001>  sx.xxxx   (LONS1)
001>  sx.xxxx   (LATC)
001>  sx.xxxx   (LATC1)
001>  sx.xxxx   (LATS)
001>  sx.xxxx   (LATS1)
001>  sxxx.xxxx (Longitude predict at 170 hours)
001>  sx.xxxx   (Latitude predict at 170 hours)
```

Edit session ends and data is checked for 170-hour verification. Upon failure, a 301> error code is returned and the input data is NOT stored into the target area. If the parameters pass the 170- hour verification, they will be stored in the target database. If at any point within the edit session an out of range value or another Request/Command is received, the edit session will be aborted.

Security: Supervisor (level 3)

R320 n

Function: Download IESS412 element set from target.
n = target number.

Response: A multiple line output (19 lines of data) will be returned in the following format:

YYYY	(Year)
MM	(Month)
DD	(Day)
HH	(Hour)
MM	(Minute)
SS	(Second)
sxxx.xxxx	(LM0)
sx.xxxx	(LM1)
sx.xxxxxx	(LM2)
sx.xxxx	(LONC)
sx.xxxx	(LONC1)
sx.xxxx	(LONS)
sx.xxxx	(LONS1)
sx.xxxx	(LATC)
sx.xxxx	(LATC1)
sx.xxxx	(LATS)
sx.xxxx	(LATS1)
sxxx.xxxx	(Longitude predict at 170 hours)
sx.xxxx	(Latitude predict at 170 hours)

Note: 4 digits are required for year (e.g.: 1994, not 94); all others are identical to Intelsat format.
An [ESC] character sent at any time will terminate the output stream.

Security: Monitor (level 1)

C321 n a

Function: Set POL angle in specified Intelsat target.
n = input target number, n = [1,50]
a = POL angle

Response: < none >

Security: Supervisor (level 3)

R321 n

Function: Request POL angle of specified Intelsat target.
n = input target number, n = [1,50]

Response: a, where a = POL angle

Security: Monitor (level 1)

C322 n m
Function: Set Intelsat pointing update time in specified Intelsat target.
n = input target number, n = [1,50]
m = Update time in milliseconds
Response: < none >
Security: Supervisor (level 3)

R322 n
Function: Request pointing update time of specified Intelsat target.
n = input target number, n = [1,50]
Response: m, where m = update time in milliseconds.
Security: Monitor (level 1)

C330
Function: Execute antenna stow. No arguments.
Response: < none >
Security: Operator (level 2)

C331
Function: Execute antenna unstow. No arguments. > = operator required.
Response: < none >
Security: Operator (level 2)

5.3.1 Table Track Support (FACTORY OPTION)

The following requests and commands provide table track support. A table track record [TTRec] (each entry in the table) consists of date/UTC time tag and look angle set (AZ EL POL); therefore each record in the table is of the following form and format:

Form: [date time < azimuth elevation polarization >]

Format: **[mm/dd/yyyy hh:mm:ss < aaa.aaa eee.eee ppp.ppp >]**

C340 n f Function: Initiate table track upload into ACU NVRAM. **n**th record follows each time a 001 > prompt is returned by the ACU, until total **n** is reached. The time tagged (date/time) records must be ordered sequentially from earliest too latest.

n = integer value representing total # of records. The MAX value of n is 200.

n = 0 causes all records to be erased (count set to 0). No records are accepted when n = 0; replace/append flag still expected.

f = replace/append flag. This flag indicates whether the following records will **replace** the current table in memory or will be **appended** to the current table, starting at the date/time of the first record and replacing all the following records.

f = 0: **replace** current table

f = 1: **append** to current table

Response: 001 > prompt until **n** records are uploaded, then 000 > prompt when done.

Example:
000 > C340 6 0
001 > [TTRec]
001 > [TTRec]
001 > [TTRec]
001 > [TTRec]
001 > [TTRec]
001 > [TTRec]
000 >

Security: Supervisor (level 3)

R340 st end Function: Download records from **st** to **end** from table in ACU NVRAM.

st = integer value, from 1 to 200, representing the starting record to download

end = integer value from **st** + 1 to 200, representing the end record to download

Response: n Table Track records, separated by CR-LF, in the form:

TTRec = [mm/dd/yyyy hh:mm:ss < aaa.aaa eee.eee ppp.ppp >]

Example:

000 > R340 1 6
[TTRec]
[TTRec]
[TTRec]
[TTRec]
[TTRec]
[TTRec]
000 >

Note: If the **end** is greater than the last record in the table ONLY the existing records in the table will be downloaded, and in the case the table is empty the response is an error code 304 Empty table: No records exist.

Security: Monitor (level 1)

C341 Function: Initiate **Table Track** mode using table in ACU NVRAM.

Response: < none > or error code:
303 Expired table: All records expired
304 Empty table: No records exist

Security: Supervisor (level 3)

5.3.2 Orbital Element Tracking (FACTORY OPTION)

C350 n [s]

Function: Command uploads the Orbital element set into target.
n = Target number
s = Quoted string holding name [optional] used to set name. If target is pre-existing Orbital Element Tracking, then input data will over write existing data.

Response: An awaiting further input error code will be returned. This command initiates an edit session that must be continued in sequence till completion. Twelve items are expected, one per line, in the following order: (Note: Orbital Elements are Free Format)

001>	YYYY	(Year)
001>	MM	(Month)
001>	DD	(Day)
001>	HH	(Hour)
001>	MM	(Minute)
001>	SS.SSS	(Second)
001>	sxxxxx.xxxx	(ECI X Position km)
001>	sxxxxx.xxxx	(ECI Y Position km)
001>	sxxxxx.xxxx	(ECI Z Position km)
001>	sxxx.xxxx	(ECI X Position m/sec)
001>	sxxx.xxxx	(ECI Y Position m/sec)
001>	sxxx.xxxx	(ECI Z Position m/sec)

Edit session ends and data is validated. Validation includes checking that semi-major axis, Eccentricity and Inclination are within expected tolerances around a pre-defined mean. Upon failure, a 306> error code is returned and the input data is NOT stored into the target area. If the parameters pass the validation check, they will be stored in the target database. If at any point within the edit session an out of range value or another Request/Command is received, the edit session will be aborted.

Note:
1. 4 digits are required for year (e.g.: 2000, not 00).
2. The Orbital Elements are expected in a True Earth Mean Equinox (TEME) reference fixed at time of Epoch.

Security: Supervisor (level 3)

R350 n

Function: Command downloads the Orbital element set from target.
n = target number.

Response: A multiple line output (12 lines of data) will be returned in the following format:

YYYY	(Year)
MM	(Month)
DD	(Day)
HH	(Hour)
MM	(Minute)
SS.SSS	(Second)
sxxxxx.xxxx	(ECI X Position km)
sxxxxx.xxxx	(ECI Y Position km)
sxxxxx.xxxx	(ECI Z Position km)
sxxx.xxxx	(ECI X Position m/sec)
sxxx.xxxx	(ECI Y Position m/sec)
sxxx.xxxx	(ECI Z Position m/sec)

Note: An [ESC] character sent at any time will terminate the output stream.

Security: Monitor (level 1)

C351 n a

Function: Command sets the POL angle in specified Orbital Element Target.
n = input target number, n = [1,50]
a = POL angle

Response: < none >

Security: Supervisor (level 3)

R351 n

Function: Command requests POL angle of specified Orbital Element Target.
n = input target number, n = [1,50]

Response: a, where a = POL angle

Security: Monitor (level 1)

5.3.3 Norad Element Support (FACTORY OPTION)

C360 n [s] Function: Upload Norad element set into target.

n = Target number

s = Quoted string holding name [optional] used to set target name. If target is pre-existing Norad Element Tracking, then input data will over write existing data.

It is important to note that preprocessing of the Norad 2-line element set is necessary to use this input command.

Response: An awaiting further input error code will be returned. This command initiates an edit session that must be continues in sequence till completion. Nine items are expected, one per line, in the following order:

(Note: Elements are Free Format)

001 > YYYY	(EpochYear)
001 > DOY.DDD	(Day of year and fractional portion of the day)
001 > s.nnnnne-n	(BSTAR drag term)
001 > nnn.nnnn	(Inclination [Degrees])
001 > nnn.nnnn	(Right Ascension of the Ascending Node [Degrees])
001 > .nnnnnnn	(Eccentricity)
001 > nnn.nnnn	(Argument of Perigee [Degrees])
001 > nnn.nnnn	(Mean Anomaly [Degrees])
001 > nn.nnnnnnnn	(Mean Motion [Revs per day])

Note:

1. 4 digits are required for year (e.g.: 2000, not 00).
2. The ACU will select the propagator (SPP4 or SDP4) when tracking starts based on the orbital period. If less than 225 minutes SGP4 will be used. For greater or equal to 225 minutes DSP4 will be used.
3. Decimal points must be supplied for the elements that do not have them in the original sets. This includes BSTAR and Eccentricity.
4. The data is taken from the following locations:

	Line	Column
Epoch Year	1	19-20
Epoch DOY	1	21-32
BSTAR	1	54-61
Inclination	2	09-16
RAAN	2	18-25
Eccentricity	2	27-33
ARGP	2	35-42
Mean Anomaly	2	44-51
Mean Motion	2	53-63

Security: Supervisor (level 3)

R360 n

Function: Download Norad element set from target.
n = target number.

Response: A multiple line output (9 lines of data) will be returned in the following format:

YYYY	(Epoch Year)
DOY.DDD	(DOY and fraction of the day)
s.nnnnne-n	(BSTAR drag term)
nnn.nnnn	(Inclination [Degrees])
nnn.nnnn	(RAAN [Degrees])
.nnnnnnn	(Eccentricity)
nnn.nnnn	(Argument of Perigee [Degrees])
nnn.nnnn	(Mean Anomaly [Degrees])
nn.nnnnnnnn	(Mean Motion [Revs per day])

Note: An [ESC] character sent at any time will terminate the output stream.

Security: Monitor (level 1)

C361 n a

Function: Set POL angle in specified Norad Element Target.
n = input target number, n = [1,50]
a = POL angle

Response: < none >

Security: Supervisor (level 3)

R361 n

Function: Request POL angle of specified Norad Element Target.
n = input target number, n = [1,50]

Response: a, where a = POL angle

Security: Monitor (level 1)

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APPENDIX D - A/D CARD CALIBRATION PROCEDURE

1.0 Introduction

This appendix contains instructions for calibrating/recalibrating the A/D card of the 7200 ACU. A calibration procedure is normally performed at the factory as part of the product configuration. A field recalibration should only be necessary if operational problems (normally due to drift) are incurred, or if different video receivers are used in the AGC mode.

The following equipment is required:

1 Digital Multimeter (DMM), 3.5 digits
1 DC voltage source, adjustable, 0 VDC to +10 VDC
1 trimmer adjustment tool

For an AGC mode realignment (i.e., for a different or new receiver), proceed to paragraph 3.0.

If performing a full (linear and AGC) realignment, follow the steps in paragraphs 2.0 and 3.0.

Open the 7200 ACU by removing the four #6-32 screws holding the front of the top lid and swing the lid into a locked position. Locate the 800221 assembly, normally found on top of the I/O card (800252).

If one or both of the channels is configured for AGC mode (JP1/2 are in position "A) then power down the unit, note the channel configuration and place all jumpers into the "B" position.

Power up the unit and proceed with the calibration.

2.0 A/D Converter Linear Offset Adjustment

1. Connect the DC voltage source to the input terminals of the back of the 7200 ACU for both channel 1 and channel 2.

2. Connect the DMM across the DC voltage source and adjust the voltage source so that the DMM indicates 5.00 VDC.

3. On the 7200 ACU **Main menu**, select **Display system status...**, and **A/D states**.

4. Note the readings on channels 1 and 2; adjust R2 (channel 1) and R16 (channel 2) until the voltage indicated on the 7200 ACU matches that of the DMM.

5. Vary the power supply output voltage and take several readings at the low, middle, and high ends of the input voltage range to make sure there are no non-linearity (voltage should match to 10 mV).

3.0 AGC Mode Offset Adjustment

Because most AGC voltage outputs are not calibrated and have a wide video signal dynamic range, it is often necessary to 'tweak' the AGC mode offset on the assembly.

If proceeding from paragraph 2.0, power down the 7200 ACU and reconfigure the appropriate jumpers (JP1/2) into the 'A' position for AGC mode. Power up the 7200 ACU.

1. On the 7200 ACU **Main menu**, select **Display system status...** and **A/D states**.

2. To effectively align the AGC offset, acquire and peak the desired video signal AGC voltage from the video receiver and pipe it into the converter card. If this method is inconvenient, then the DC voltage power supply can be adjusted to the appropriate voltage to simulate the receiver.

3. Adjust R14 for channel 1 and/or R26 for channel 2 AGC offsets. Note that it may take several revolutions of the trimmer to scale the voltage properly due to the high gain of the rest of the circuit. This is because the typical volts/dB scale on an AGC circuit is on the order of several mV, so there is not enough resolution on the 12 bit ADC's to use in steptrack operation.

This completes the calibration/adjustment procedure for the 800221 assembly.

APPENDIX D - TWO-SPEED RESOLVER CALIBRATION

1.0 Introduction

This appendix contains instructions for calibrating the two-speed resolvers (two-speed resolver option only) in the 7200 ACS.

2.0 Setting Excitation Voltage

The two-speed system used on the 7200 ACU is stable to within +/-0.0005 degrees, hence bobble in the last one one-thousandth position may be present, but only by one count. An excessive bobble of more than 0.001 degree is usually caused by either poor or insufficient environmental shielding or low excitation voltage (providing there are no mechanical problems). The following procedures describe how to check the excitation voltage; shielding is discussed in Appendix G, Troubleshooting Guide, of this manual.

1. Turn off the power to the 7200 ACU and slide it forward from the rack. Remove the four #6-32 screws holding the front of the top lid and lift the lid, locking it in place with the hinge found on the right side of the sub-rack inside the unit.

2. Power up the unit and disable the drives using the front DRIVE ENABLE switch as a precautionary measure. Disconnect the 50-conductor ribbon cable going to the right side of the 800252 I/O card; exposing a small blue trimpot on the 800225-02 RDC card. This trimpot adjusts the resolver excitation voltage level which can be measured at the two-terminal connector at the bottom of the back panel.

3. Use an AC RMS voltmeter to set the voltage to at least 4 V RMS. If the bobble persists, raise the voltage up to a maximum of 9 V RMS. This should correct the problem on standard run lengths. If the bobble persists or does not diminish, a bad shield or signal wire connection may be the problem.

4. Reconnect the 800252 50-conductor ribbon cable assembly, re-enable the drives, and verify that no drive cabinet related errors are occurring. Resecure the top lid, slide unit back in rack, and resecure the unit using the #10-24 cup head screws.

3.0 Two-Speed Internal Alignment

The resolver system used in the standard 800225-02 option package for the 7200 ACU is an electrical two-speed resolver type. Due to finite manufacturing tolerances, cable length differences, and other variables, the coarse and fine resolver 0 points may not necessarily coincide.

In the case of the standard 32 to 1 ratio, this can result in 11.25 degree skips and jumps when the antenna moves through an unaligned 0 point. To correct this, perform the following procedure:

1. From the **Main menu**, select **Edit system configuration...**, then **Position encoder configuration...**. Set **Encoder type** to **Standard accuracy (2500 Hz)** and save changes.

   This effectively ignores the fine (32:1) resolver, and provides a stable display with which to work while performing the alignment procedure.

2. From the **Main menu**, select **Display system status...**, then select **RDC states**. The fields indicated by **--- data ---** display the actual resolver position as being read by the 7200 ACU. Note that the value is in hexadecimal notation.

3. By alternating between this screen and **Manual antenna control**, move the antenna until the AZ and EL resolvers are on a multiple of 0800h (0800 hexadecimal); i.e.: 0000h, 0800h, 1000h, 1800h, 2000h, etc. When this is accomplished, record the fine resolver values for AZ and EL.

4. Return to the **Position encoder configuration...** menu. Change **Encoder type** to **2-speed resolvers**. Press [PRIOR] and save changes.

5. Re-enter the **Position encoder configuration...** menu. The **2-speed internal alignment** field will be visible. Enter the fine resolver values for AZ and EL that were recorded in step 3 in these fields, then press [PRIOR] and save changes.

APPENDIX E - TRACKING TUTORIAL

This appendix contains information for quickly setting up tracking with the 7200 ACS. Even though this section has been written for an inexperienced operator, the user may still encounter difficulties. If while trying to use these procedures, the operator experiences problems, it is recommended that the user abort the operation and refer to Section 5.0, Operation, and become more familiar with the system before attempting to track a target.

The 7200 has an easy-to-use help system that may be referenced at any time during this procedure by simply pressing the [HELP] key.

To quickly begin tracking a target with the 7200 ACS, use the following procedures.

1. From the **Main menu...**, select **Edit system configuration...**, and **Site data...**.

2. Select **E. Longitude of site [deg]** and following the allowable range of values shown in the system prompt, use the numeric keys to enter the E. longitude of the site.

3. Following the procedure in step 2, select **N. Latitude of site [deg]** and **Site altitude [meters]** and enter the site specific values.

4. Press [PRIOR] and answer yes to the system prompt to save the changes.

5. Select **Set UTC date and time...**.

6. Select **Date** and enter the correct day of the month. Press [ENTER] and the month is highlighted.

7. Using the up and down arrow keys, select the correct month. Press [ENTER] and the year is highlighted.

8. Enter a year within the range specified in the prompt and press [ENTER].

9. Set the time in the same manner as the date and press [ENTER].

10. To enter the date and time into the system, select **Await mark...** and the following message appears:

System UTC date and time will be set to
hh:mm:ss dd Mmm yyyy (Note: the time and date just entered will be displayed.)
when [ENTER] is hit.
Press [PRIOR] to cancel.

11. Press [ENTER] to enter the date and time into the system. Press [PRIOR] twice to return to the **Main menu**.

The next step in the procedure is to calibrate the look angles. This requires pointing the antenna at a known position so that the encoder offsets can be set properly. Normally this known position will be a satellite that is well-station kept or one for which a calculate ephemeris can be obtained.

12. Locate a stable satellite with a known nominal longitude in the operational region and peak the antenna on the satellite (possibly using a spectrum analyzer). If the angles are off, use a mechanical inclinometer to estimate the elevation.

13. Set the elevation angle and sweep azimuth to find the satellite. Verify that proper satellite identification has been made.

14. The 7200 ACU will calculate the look angles for a given longitude if the site data has been set properly. From the **Main menu**, select **Tracking functions...**, **Immediate tracking...** and **Move to longitude...**.

15. Select **E. Longitude of target [deg]** and enter the target's longitude. The desired look angles will be displayed on the **(Look angles [deg])** line of the display. Record the values to be used as the current position. Press [PRIOR] three times to return to the **Main menu**.

16. Select **Edit system configuration...** and **Position encoder configuration...**. Select **Encoder direction** and using the up and down arrow keys, set the encoder direction for each axis.

17. Select **Current position [deg]** and enter values obtained in step 15. Press [PRIOR] and answer yes to save changes. Press [PRIOR] to return to the **Main menu.**

The steptrack defaults should now be set. It is best to configure the steptrack defaults prior to building any OPT targets. For most systems, no target-specific parameter adjustments will be necessary.

To set the -3 dB beamwidth, check the data sheet or approximate the value using the following equation:

freq = receive frequency (in GHz): C-Band = 3.95 GHz
X-Band = 7.50 GHz
Ku-Band = 11.95 GHz
size = antenna diameter in meters

$$\textbf{-3 dB beamwidth} = \frac{19}{\textbf{frequency} * \textbf{size}}$$

18. From the **Main menu...**, select **Edit system configuration...** and **Steptrack defaults...**.

19. Select **Receive -3 dB beamwidth [deg]** and enter the value obtained above.

20. Select **Step size [deg]**. This parameter should be set to approximately 8 percent of the **-3 dB beamwidth**, but no less than 0.02 on systems with standard resolvers. Enter the value and press [ENTER].

21. Select **Position deadband [deg]**. This parameter should be set to approximately 5 percent of the **-3 dB beamwidth**, but no less than 0.02 on systems with standard resolvers. Enter the value and press [ENTER]. Answer yes to the system prompt to save changes and press [PRIOR] to return to the **Main menu**.

In normal environments, no other steptrack defaults require modifications from the preset values. The OPT defaults should remain at factory settings also.

The next step in the tracking sequence is to build a target.

22. From the **Main menu...**, select **Tracking functions...**, and **Edit a new or existing target...**.

23. Select a noninitialized item (represented as "----------") on the target selection menu and press [ENTER].

24. The **Edit target data** screen will appear. This screen contains **Target name** and **Tracking mode** parameters, and the submenu **Edit target parameters...**.

25. Select **Target name**. The following prompt appears:
Arrow keys move around, change letters; up to 12 letters are allowed.

26. To create a target name, use the up and down arrow keys to scroll through the character set consisting of the following:

    A blank space
    Uppercase alphabet letters
    Lowercase alphabet letters
    Digits 0 through 9
    Special characters:!"#$ %&'()* + ,-./:; < = > ?@[\]^_‘{|} ~

27. When the desired character is highlighted, press the right arrow key to move to the next space (to create a target name of more than one letter). Pressing [ENTER] will enter the target name as selected by the user. (It is often helpful to use the satellite name as the target name.) Blank spaces may included as part of the target's name.

The target mode must now be set for the target named in the above steps. The target parameters must also be edited. The target parameters made available for editing will be determined by the tracking mode selected for the target. For most systems, OPT will be the desired tracking mode.

28. Select **Tracking mode**. Using the up and down arrow keys, scroll through the following choices for the tracking mode:

    Unused
    Star tracking
    OPT
    Intelsat 11-element
    Move to longitude
    Move to look angles

29. When the desired tracking mode is highlighted, press [ENTER].

30. To edit the target parameters, select **Edit target parameters...**.

31. If the **Tracking mode** is set to OPT, the steptrack parameters will be set to the default values, with the exception of **-3 dB beamwidth**, **Step size [deg]**, and **Position deadband [deg]**, which will retain the values set in the above steps. Select **OPT parameters...**.

    NOTE: If Tracking mode is other than OPT, refer to Section 5.0 of this manual for parameters that will be available for editing with other tracking modes.

32. Select **Spacecraft parameters...** and set the following parameters (the remaining parameters should only be changed upon the advice of Vertex personnel):

    Box center longitude [deg.East]
    Longitude range [deg]
    Estimated inclination [deg]

33. Press the [SHIFT] and [PG DN] keys to move to screen 2 of the **Spacecraft parameters...** menu, and select **Tracking signal parameters...**. The parameters displayed will depend upon the setting of the **Tracking receiver input** parameter under **Tracking receiver setup...** in the **Edit system configuration...** menu. Select and edit the parameters.

    NOTE: Box limit and Orbit scan require the setting of the parameters listed in steps 32 and 33 -- if these are not set, DO NOT enable Box limit or Orbit scan as the system will attempt to track a target at zero longitude.

34. Enable **Box limit** and **Orbit scan.**

35. Press [PRIOR] and answer yes to the prompt to save the changes. Press [PRIOR] twice to return to the **Main menu**.

The 7200 ACU must be properly calibrated to the slope of the tracking signal in order to provide optimum performance of the **Steptrack** feature.

36. Peak the antenna on the satellite to be tracked (use **Orbit scan** if necessary to locate an inclined satellite).

37. When the beacon or signal has been acquired, from the **Main menu**, select **Edit system configuration...**, and **Tracking receiver setup...**.

38. Adjust the input level at peak to approximately 8 V.

39. Select and set **Set 0 dB point**.

40. Insert a 3 dB attenuator in the RF path into the back of the beacon receiver.

41. Select and set **-3 dB point**.

42. Press [PRIOR] to back out of the menu and save the changes.

If a 3 dB attenuator is unavailable, there are two other methods that may be used to drop the signal to 3 dB:

Move the antenna in EL by half the 3 dB beamwidth.

On the Vertex TRC-14 or TRK-14, use the level adjust to drop output voltage 1.5 V (this is close to a 3 dB drop).

43. To begin tracking the target configured above, from the **Main menu**, select **Tracking functions...** and **Track a target...**.

44. Select the target to be tracked from the target selection screen. If the **Confirm tracking** option in the **User interface options...** is enabled, verify that the information displayed in the confirmation prompt is correct, and answer yes. The system will begin tracking the target.

APPENDIX F - 7200 GPIB (IEEE-488) REQUEST/COMMAND MONITOR AND CONTROL PROTOCOL

1.0 INTRODUCTION

This appendix contains the Remote M&C protocol for the 7200 GPIB (IEEE-488) interface. It is provided to assist in the setup of remote communications with the 7200 ACU. The command line-oriented protocol and command set for the 7200 ACU's remote M&C shell are both discussed.

There are no GPIB communication parameters that may be set by the user.

The command line interface is designed to be used in conjunction with an M&C computer, not by operators directly. Although the command set is all in printable ASCII, it is not designed to be user-friendly. In order to simplify the M&C programmer's job, the command set was written to be as consistent and uniform as possible.

1.1 Scope

This appendix is applicable to 7200 ACU firmware Version 3.22 or later.

Sections labeled as OPTIONAL do not apply to all systems. If you are unsure about your system configuration or cannot find the necessary information in this manual, consult your Vertex representative.

2.0 INPUT ECHO AND LINE EDITING

GPIB transactions are performed without echo. Backspace and escape are not supported on the GPIB interface.

3.0 REQUEST/COMMAND PROTOCOL

Two types of communication with the 7200 are allowed: requests and commands. . Any remote port may execute a request at any time. Section 5 lists all requests and commands, including the respective function, system response, and required security level.

The security level must be set to at least Operator level (level 2) before the M&C interface will accept commands. Some commands cannot be executed without Supervisor security level (level 3). Refer to Section 4.5 for details.

Requests/Commands are entered in the format [R or C]n [parameters] (EOI) where:

R and C are uppercase ASCII characters (R = ASCII 82, C = ASCII 67). There is no space between R or C and the number n.
n is a number in ASCII; n is one to three decimal digits (0-999, inclusive). Leading 0's are permitted (Example: R1, R01, and R001 are all valid).
[parameters] are zero or more space-separated ASCII strings that are specific to the Request/Command.
(EOI) is the GPIB EOI (End or Identify). No carriage return follows the command.

On the GPIB interface, (newline) is always CRLF (ASCII 13 plus ASCII 10).

The response from a request or command is always in the form:

[(newline)data]
[(newline)data]
(newline)nnn>

The [data] field is Request/Command-specific. Data may or may not be returned, depending on the Request/Command. The data is terminated by a newline, which consists of CR (ASCII 13) and an optional LF (ASCII 10). There may be more than one line of data, depending on the Request/Command.

The M&C response will always terminate with a newline, followed by three ASCII digits "nnn," followed by a ">" (ASCII 62). "nnn" is an error code, and "000" indicates that the Request/Command was acceptable (no syntax errors) and was processed without errors.

Example: R0 is a "noop" (no-operation). It returns only a "000" error code.

Send: R0(EOI)
Receive: (newline)000>

The M&C interface will always return responses as soon as possible, allowing the remote controller to issue another Request/Command. Some operations, such as resetting the drive cabinet, may take several seconds. Such operations will be executed in background mode and will not be completed by the time the response is sent back to the remote computer.

After sending a Request/Command, the remote computer must wait for the "nnn>" prompt before sending the next Request/Command, or it may be ignored by the M&C interface.

If the 7200 is reset, or port configurations have changed, an interface clear (IFC) needs to be sent by the controller in charge (CIC).

4.0 GENERAL TRANSMIT/RECEIVE FORMATS

4.1 White Space

Spaces (ASCII 32 decimal) are used to separate fields. When the 7200 ACU sends data, fields are always separated by one space unless otherwise noted. If the 7200 ACU's response is several fields followed by a (CR), the last field will not have a space between it and the (CR).

Input may have more than one space separating fields. Checksums are not supported on the GPIB interface.

4.2 Position Vectors

Position vectors are always transmitted by the 7200 ACU in the form azimuth, elevation, and polarization, where the format of the look angle is the same as shown on the 7200 ACU front panel display. For signed angles, a "-" immediately precedes the angle if it is negative. Positive signed and unsigned angles are identical; there is no leading "+." The AZ output is unsigned. Its range is 0 angle < 360. The EL and POL outputs are signed: -180 angle < 180.

At least one digit will always be both to the left and to the right of the decimal point (Example: 0.0). POL will always return 0.0 degrees if disabled.

Example return: 125.35 53.81 -2.0

Position vectors, sent from the remote to the 7200 ACU, must have at least one digit to the right of the decimal point. If a sign is included, it must immediately precede the number with no space between the sign and the most significant digit.

4.3 Error Codes (at End of Request/Command Response)

000 No error: Request/Command completed successfully.

001 Last Request/Command received successfully; awaiting further input.

1nn Invalid data in field nn on this line. Field 0 is always the checksum field. If there is no checksum, the first field is field 1. In most cases, field 1 is the Request/Command. In the case of multiline input (001> prompt), the checksum is field 0 (if enabled), and the next field is field 1, etc. Invalid data means either that the data makes no sense for the field in question (Example: non-numeric string where number is expected), the data is out of range, or the data is invalid.

100 Indicates checksum failure. If there are extra fields in the input, that field will be flagged as invalid data.

20n Security violation: Insufficient security level to complete command. n indicates the required level: 2 = operator or 3 = supervisor.

300 Could not complete motion command because of ACU/drive fault(s).

301 Intelsat elements failed 170-hour verification.

302 Could not update pointing command because controller is not currently tracking the Immediate target AND in **Move to look angles...** mode.

303 Expired table: All records expired

304 Empty table: No records exist

4.4 Checksums

Checksums are not supported on the GPIB interface.

4.5 Security Level Description

The 7200 ACU has a simple three-level security system to help prevent unauthorized use which may cause problems with operation such as running off the target, changing parameters to improper settings, etc. This system is not designed to hide details of the 7200 ACU's operation; in fact, any user at any time may view any status or parameter settings of the 7200 ACU.

4.5.1 Security Levels and Transitions

The 7200 ACU has three security levels; their rules apply to the remote ports as well as to the front panel with a few exceptions. The levels are:

Monitor: (level 1) All system status and parameter values may be examined; however, none may be modified at this level. The antenna may not be commanded from Monitor level.

Operator: (level 2) All privileges of Monitor level. Additionally, a user with Operator privileges may command the antenna to a new position. This includes the ability to manually command the antenna. A user with Operator privileges may not modify system parameters; however, an Operator may initiate a tracking mode that will modify the stored data, and/or orbit models for the target in question.

Supervisor: (level 3) Supervisor has complete access to the system, and may modify all system parameters.

The 7200 ACU can support several monitor ports simultaneously. Only one port, including the front panel, may be at a security level other than Monitor at a certain time.

One port ("A") may take control from another ("B"), provided that port A has the password for a higher security level then B.

The exceptions to the rules above that apply to the remote ports are:

1. At the 7200 ACU front panel, the [STOP] key is always available for use regardless of user level; however, the remote port must be at Operator or Supervisor level in order to stop the antenna.

2. The 7200 ACU front panel may assume control from a remote port, provided the user has an adequate security level. If both ports are at the same security level, the front panel assumes control. For example, if the antenna is currently being controlled by a remote port in Operator level, and a user logs into the front panel in Operator level, the remote port goes back to Monitor level and cannot assume any level other than Monitor. The front panel only permits it by either dropping down to Monitor level, or the remote asserts Supervisor level. If the front panel is in Supervisor level, no remote port can take control away from it.

When the 7200 ACU power is cycled, the security levels of all ports (including the front panel of the 7200 ACU) remain the same.

4.5.2 Passwords

Passwords are a one to nine digit number. Setting a password to 0 disables password protection for that security level. To completely disable passwords, set both Operator and Supervisor passwords to 0.

Even if both passwords are disabled, the same procedure must be used to change security levels and transfer control to/from the remote ports. The system will not prompt for a password.

5.0 X0nn - GENERAL REQUESTS AND COMMANDS

Note that for all requests, the security level is Monitor (level 1), unless otherwise specified.

All strings must be enclosed in quotation marks (").

C0 Function: No operation.
This command may be used to test whether the remote port is communicating correctly with the 7200 ACU.
Response: < none >
Security: Operator (level 2)

R0 Function: No operation.
This command may be used to test whether the remote port is communicating with the 7200 ACU.
Response: < none >
Security: Monitor (level 1)

C1 n Function: Stop/resume tracking.
n = 0: Stop antenna. Does not return to **Standby**. This is equivalent to pressing the STOP key on the 7200 ACU front panel.
n = 1: Resume tracking. This is equivalent to pressing the RESUME key on the 7200 ACU front panel.
n = 2: Stop tracking and return to **Standby** mode. This has no effect on the STOP/RESUME function.
Response: < none >
Security: Operator (level 2)

R1 n Function: Request position loop information.
n = 0: Request current antenna position vector.
n = 1: Request current command position vector.
R10 Response: v
where v = position vector (azimuth elevation polarization)
R11 Response:
0 (if in Standby) or 1 v (if tracking)
v is a position vector as described above.
Security: Monitor (level 1)

C2 v

Function: Move antenna to new position and hold. If the 7200 ACU is currently tracking a target, the antenna will leave that target to go to the new position given by the vector v.

Response: < none >

Note: The M&C will report an "out of range" error if an element of the position vector is outside of the soft limits; i.e.: 102 > for azimuth outside of soft limits, 103 > for elevation, 104 > for polarization.

Security: Operator (level 2)

R2 [n]

Function: Request basic fault status.
n = 0: (default) Return all faults present at this time.
n = 1: Return only faults that are new since last read by R2.

Response: h, where h is one ASCII encoded hexadecimal digit (0-F), bitmapped as listed in the following table.

BIT	INDICATION
0	Drive cabinet fault is in effect (no power, emergency stop, etc.)
1	Motion fault is in effect (soft limit, immobile, etc.)
2	Tracking fault is in effect.
3	System error condition is in effect (hardware failure, watchdog time out, etc.)

Example: 5 (drive cabinet fault and tracking fault)

Security: Monitor (level 1)

C3

Function: Acknowledge and attempt to clear all system faults. The 7200 ACU will acknowledge all currently active faults, close the FLT relay, and attempt to clear the faults. Some faults (such as the emergency stop) cannot be cleared by the 7200 ACU; however, the FLT relay will still be closed.

Response: < none >

Note: If a drive fault is in effect, resetting the drives takes approximately three (3) seconds. Any faults that occur after this command will cause the FLT to reopen. These faults will then have to be acknowledged (using C3) to close the FLT relay again.

Security: Operator (level 2)

R3 h

Function: Detailed fault report.
Request fault status on fault bits h from R2 request; that is, a detailed fault status will be sent for each bit set in h in the request.

Response: h, where h is eight (8) ASCII encoded hexadecimal digits. Each digit represents four bits in the tables following this section. Response fields are sent in the order shown in the table below, space separated.

Example:
000 > R3 3
00000002 00100010
(Emergency stop, POL CW soft limit, POL runaway)
000 >

Note: "R3 0" will force all four fields to be sent. Fields will be sent in order: drive cabinet faults, motion faults, tracking faults, and system faults.

Security: Monitor (level 1)

DRIVE CABINET FAULTS	
BIT	**INDICATION**
0	No power at drive cabinet
1	Emergency stop at drive cabinet
2	Maintenance override at drive cabinet
3	Travel limit switch (summary)
4	Azimuth drive fault
5	Elevation drive fault
6	Azimuth CW limit switch[1]
7	Azimuth CCW limit switch[1]
8	Elevation upper limit switch[1]
9	Elevation lower limit switch[1]
10	Polarization[2] CW limit switch[1]
11	Polarization[2] CCW limit switch[1]
12	Resetting drive cabinet
13	Drives disabled at console
14	ACU Offline
15	Polarization #2 CW limit switch[3]
16	Polarization #2 CCW limit switch[3]

[1]Not implemented in the current version, and will return a zero. The M&C programmer may check these bits and report errors for them ("unspecified errors" for unused bits). It should not be assumed that unused bits are always zero.

[2]Polarization reads as Polarization #1 in 4 axis systems.

[3]Only applicable in 4 axis systems.

MOTION FAULTS	
BIT	**INDICATION**
0	Azimuth CW soft limit
1	Azimuth CCW soft limit
2	Elevation upper soft limit
3	Elevation lower soft limit
4	Polarization[2] CW soft limit
5	Polarization [2] CCW soft limit
6	West box limit violation
7	East box limit violation
8	North box limit violation
9	South box limit violation
10	Polarization [2] CW box limit violation[1]
11	Polarization [2] CCW box limit violation[1]
12	Azimuth immobile
13	Azimuth reversed
14	Azimuth runaway
15	Elevation immobile
16	Elevation reversed
17	Elevation runaway
18	Polarization[2] immobile
19	Polarization[2] reversed
20	Polarization[2] runaway
21	Keyboard stop
22	Polarization #2 CW soft limit[3]
23	Polarization #2 CCW soft limit[3]
24	Polarization #2 CW box limit violation[1&3]
25	Polarization #2 CCW box limit violation[1&3]
26	Polarization #2 immobile[3]
27	Polarization #2 reversed[3]
28	Polarization #2 runaway[3]

[1] Not implemented in the current version, and will return a zero. The M&C programmer may check these bits and report errors for them ("unspecified errors" for unused bits). It should not be assumed that unused bits are always zero.

[2] Polarization reads as Polarization #1 in 4 axis systems.

[3] Only applicable in 4 axis systems.

TRACKING FAULTS	
BIT	**INDICATION**
0	Target outside of soft limits
1	Low tracking signal level
2	Excessive tracking signal noise
3	Intelsat data expired
4	Intelsat pre-epoch prediction
5	Intelsat data invalid - cannot track
6	OPT cannot track
7	Tracking signal input saturated
8	Invalid target in target schedule
9	Sun outage; Steptrack inhibited
10	Tracking delay in effect
11	Reserved; unused
12	Reserved; unused
13	Reserved; unused
14	Standby (no tracking in progress)
15	Reserved; unused
16	Tracking receiver serial link failure
17	Tracking receiver in LOCAL control
18	Tracking receiver out of band
19	Tracking receiver fault
20	Table Track data expired
21	Orbital elements invalid - - cannot track

SYSTEM FAULTS	
BIT	**INDICATION**
0	LB PROM checksum failure
1	HB PROM checksum failure
2	Azimuth (coarse) LOS
3	Azimuth (coarse) BIT failure
4	Azimuth (fine) LOS
5	Azimuth (fine) BIT failure
6	Elevation (coarse) LOS
7	Elevation (coarse) BIT failure
8	Elevation (fine) LOS
9	Elevation (fine) BIT failure
10	Polarization[1] LOS
11	Polarization[1] BIT failure
12	A/D 1 failure
13	A/D 2 failure
14	Unexpected exception
15	Sanity check failed
16	Non-volatile RAM corrupted
17	Watchdog timeout
18	Simulation
19	Azimuth encoder error
20	Elevation encoder error
21	Polarization[1] encoder error
22	OUINTF task aborted
23	POSITIONER task aborted
24	TARGETER task aborted
25	SCHEDULER task aborted
26	Bus error on boot up
27	SYSFAIL line - timeout
28	SIMULATOR task aborted
29	Remote control panel link failure
30	System date/time invalid

[1]Polarization reads as Polarization #1 in 4 axis systems.
[2]Only applicable in 4 axis systems.

R4 n

Function: Request user level status.
Request the security level for a control port.
n = 0: Request security level for this port.
n = 1: Request port number and security level for the port (if any) in control of the 7200 ACU.

Response: n@m, where n is the port number (0 being the front panel), and m is the security level:
1 = Monitor, 2 = Operator, 3 = Supervisor.

Example: 0@3 (Front panel is at Supervisor level.)

Note: R4 1 implicitly returns the security level of all ports because only one port may be at a level higher than Monitor (1). If all ports are at Monitor level, "0@1" will be returned.

Security: Monitor (level 1)

R5 n [m]

Function: Change security level.
This command was written as a request because a user can only issue commands with Operator or higher security level. If it were a command, the port could never be changed from Monitor level.
n: Security level to change to:
1 = Monitor, 2 = Operator, 3 = Supervisor.
m: Password for the requested level.

Response: < none >

Note: A password is not required if the password option is disabled or if the command is to drop user level to a lower priority. It is not an error to supply a password in this case; it will be ignored. If a password is not supplied with this request and one is required, a "001>" error is returned. A password may then be entered. If the echo option is enabled, the password will be echoed with periods "..." as it is being typed.

Security: Monitor (level 1)

R7 [n]

Function: Is a general status request, which groups a number of pieces of data together.

Response: The following items are returned in the listed order:
Date/Time - same as R240
Target # - same as R300
Target Mode - same as R11
Target submode - new to RC M&C (see list below)
Summary fault - same as R2 (0 or 1) (see arguments for R2)
Signal level - same as R10
Current position - same as R1 0 ONLY (you can not request command position)

0	None
1	Manually Biasing Target
2	Acquiring Target
3	Holding Target Position
4	Holding Present Position; Cannot Track
5	Tracking Target using Model
6	Steptracking: Peaking Azimuth
7	Steptracking: Peaking Elevation
8	Steptracking: Peaking both Axes
9	Awaiting Next Steptrack Cycle
10	Performing Stow Operations
11	Orbit Scan
12	*Monopulse Calibration
13	*Monopulse Active
14	*Holding Position; Awaiting Target
15	*Tracking Remote Data
16	*Monopulse Active Without OPT
17	*Manual Rate Search
18	Acquiring Starting Position
19	Holding Starting Position; Awaiting Start Time
20	*Using Interpolated Data
21	*Table Expired; Awaiting New Data
22	Waiting for 3-Phase Power Loss to Clear
23	*Tracking Target Using SGP4
24	*Tracking Target using SDP4
25	Tracking hold initiated by M&C

*Denotes **FACTORY OPTION** tracking modes.

Note: Takes same argument as R2.
Example: 000>R7 0
09/03/1999 23:17:32 -1 0 0 140 -16.0 86.495 11.665 0.0
000>
Security: Monitor (level 1)

R10 Function: Request tracking signal level.
Response: n, where n is the tracking signal level in dB.
Security: Monitor (level 1)

R11 Function: Request current tracking mode.
Response: m, where m is one of the following tracking modes:

-1	Unused
0	Standby, No Tracking in Progress
1	Move to Look Angles
2	Move to Nominal Longitude
3	Intelsat IESS412 Element Tracking
4	Steptrack
5	Orbit Prediction Tracking (OPT)
6	*NORAD 2 Card Element Tracking
7	Star Tracking
8	*Monopulse/OPT
9	Antenna Stow
10	Antenna Unstow
11	*Moon Tracking
12	Manual Antenna Control
13	Awaiting Next Scheduled Target
14	Restoring Last Target
15	Restoring Target Scheduler
16	*Monopulse/Transfer Orbit Tracking
17	*Tracking Table in Memory
18	*Orbital Element Tracking
19	*Sun Tracking

*Denotes **OPTIONAL** tracking modes.

Security: Monitor (level 1)

R20 Function: Request last steptrack peak information.
Request the last steptrack peak information, time, and target number.
Response: n mm/dd/yyyy hh:mm:ss <vector>, where n is the target number.
If n = -1, no steptrack has been performed since power-up; the remaining fields (date, time, and vector) are not sent.
Security: Monitor (level 1)

5.1 X1nn - Port Configuration Requests and Commands

All requests and commands for port configuration take the port number (m) as an optional argument, defaulting to the port issuing the Request/Command. So, m should always read [m] (indicating that m is optional.) Note that each port can be configured independently. Those commands, which can optionally specify a port, may omit the port number. If this is omitted, the command affects the port issuing the command. In the following commands, m specifies the port number.

C100 n [m] Function: Set newline mode for a port.
n = 0: newline becomes CR only.
n = 1: newline becomes CRLF.
Response: < none >
Note: This command only affects the newline sent by the 7200 ACU. A CR must terminate input to the 7200 only. ALF is not tolerated.
Security: Supervisor (level 3)

R100 m Function: Request newline mode for a port.
This is used to determine which newline mode the current port is in. n is optional and is used to specify a port number. If no port is specified, this request inspects the mode of the requesting port.
Response: n, where n = 0 if newline = CR, or n = 1 if newline = CRLF.
Security: Monitor (level 1)

C101 n [m] Function: Set echo mode for a port.
n = 0: Turns echo off.
n = 1: Turns echo on.
Response: < none >
Security: Supervisor (level 3)

R101 m Function: Request echo mode for a port. Returns the echo mode for the current port if n is omitted, otherwise returns the echo mode for the port specified.
Response: n, where n = 0 if echo = off, or n = 1 if echo = on.
Security: Monitor (level 1)

C102 n [m] Function: Set checksum mode for a port.
n = 0: Turns command line checksumming off for port specified.
n = 1: Turns command line checksumming on for port specified.
Response: < none >
Note: If no port is specified, this command operates on the commanding port.
Security: Supervisor (level 3)

R102 m
Function: Request checksum mode for a port. Returns the checksum mode for the current port if n is omitted, otherwise returns the mode for the port specified.
Response: n, where n = 0 if checksumming = off, or n = 1 if check-summing = on.
Security: Monitor (level 1)

C103 n [m]
Function: Set communications parameters for a port.
n = baud parity data bits stop bits
Response: < none >
Example: C 103 9600 2 7 2 1, where setting is 9600 bps, even parity, seven data bits, 2 stop bits, directed at port 1. The convention for parity is NONE = 0. ODD = 1, EVEN = 2.
Note: If this command is used to change settings on the port that executed the command, the settings will change before the prompt returns; therefore, the prompt will probably be garbled.
Security: Supervisor (level 3)

R103 [m]
Function: Request communications parameters for a port.
Response: < baud rate > < parity > < data bits > < stop bits >
Security: Monitor (level 1)

5.2 X2nn Global ACU Configuration Requests and Commands

C200 c
Function: Enable/disable soft limits.
c = Y: Enables soft limits.
c = N: Disables soft limits.
Response: < none >
Security: Supervisor (level 3)

R200
Function: Request soft limit status.
Response: c, where c = "Y" if soft limits are enabled and c = "N" if soft limits are disabled.
Security: Monitor (level 1)

C201 v
Function: Set lower/CCW soft limits.
v = position vector.
Response: < none >
Security: Supervisor (level 3)

R201
Function: Request lower/CCW soft limits.
Response: < position vector >
Security: Monitor (level 1)

C202 v
Function: Set upper/CW soft limits.
v = position vector
Response: < none >
Note: On any axis, the antenna may travel CW from the CCW (lower) limit to the CW (upper) limit. If the CW soft limit for an axis is greater than the CCW soft limit, the antenna travels through 0 degrees going CW from the CCW limit to the CW limit.
Security: Supervisor (level 3)

R202
Function: Request upper/CW soft limits.
Response: < position vector >
Security: Monitor (level 1)

C203 v
Function: Set immobile/reversed timeout.
Set axis immobile/reversed timeout.
v = time vector, where the units are in seconds.
Response: < none >
Example: C203 2.0 2.0 2.0 sets all three axes to 2.0 second timeout.
Security: Supervisor (level 3)

R203
Function: Request immobile/reversed timeout.
Response: < time vector >
Security: Monitor (level 1)

C204 v
Function: Set immobile/reversed tolerance.
v = position vector
Response: < none >
Security: Supervisor (level 3)

R204
Function: Request immobile/reverse tolerance.
Response: < position vector >
Security: Monitor (level 1)

C205 v
Function: Set runaway error tolerance.
v = position vector
Response: < none >
Security: Supervisor (level 3)

R205
Function: Request runaway error tolerance.
Response: < position vector >
Security: Monitor (level 1)

C210 v
Function: Set slew--> track transition angles.
v = position vector
Set slew--> track speed transition deltas. POL is single speed on standard 7200 ACU's; therefore, the POL value may not be applicable even though the field is required.
Response: < none >
Security: Supervisor (level 3)

R210
Function: Request slew--> track transition angles.
Response: < position vector >
Security: Monitor (level 1)

C211 v
Function: Set position loop deadband.
v = position vector
Response: < none >
Security: Supervisor (level 1)

R211
Function: Request position loop deadband.
Response: < position vector >
Security: Monitor (level 1)

C212 v
Function: Set inching on times.
v = time vector
Response: < none >
Security: Supervisor (level 3)

R212
Function: Request inching on times.
Response: < time vector >
Security: Monitor (level 1)

C213 Function: No function.
This originally was used to change the position loop velocity tolerance, but is now supported for backward compatibility purposes only.
Response: < none >
Security: Supervisor (level 3)

C220 v Function: Set encoder-counting direction.
v = vector
Set encoder-counting direction. For each axis, Y = reversed, N = normal.
Response: < none >
Example: C220 Y N Y, AZ and POL are reversed. EL is not.
Security: Supervisor (level 3)

R220 Function: Request encoder counting direction.
Response: < vector >
Example: R220
Y N Y (shows AZ, EL, POL)
000 >
Security: Monitor (level 1)

C221 v Function: Set encoder offsets directly.
v = position vector
Set offsets directly by supplying offset values.
Response: < none >
Security: Supervisor (level 3)

R221 Function: Request encoder offsets.
Response: < position vector >
Security: Monitor (level 1)

C222 v Function: Set encoder offsets indirectly.
v = position vector
Set offsets indirectly by supplying look angles.
Response: < none >
Note: There is no matching request for C222, use R221.
Security: Supervisor (level 3)

C223 c Function: Set POL enabled flag.
c = "Y" to enable, "N" to disable.
Response: < none >
Security: Supervisor (level 3)

R223 Function: Request POL enabled flag.
Response: c, where c = "Y" if POL flag is enabled, c = "N" if POL flag is disabled.
Security: Monitor (level 1)

C230 s Function: Set antenna name.
s = quoted string of 12 characters.
Response: < none >
Security: Supervisor (level 3)

R230 Function: Request antenna name.
Response: s, where s is a quoted string up to 12 characters long.
Security: Monitor (level 1)

C231 n Function: Set site longitude.
n = angle in degrees.
Response: < none >
Security: Supervisor (level 3)

R231 Function: Request site longitude.
Response: n, where n is an angle in degrees.
Security: Monitor (level 1)

C232 n Function: Set site latitude.
n = angle in degrees North.
Response: < none >
Security: Supervisor (level 3)

R232 Function: Request site latitude.
Response: n, where n is an angle in degrees North.
Security: Monitor (level 1)

C233 n Function: Set site altitude.
n = site altitude in meters.
Response: < none >
Security: Supervisor (level 3)

R233 Function: Request site altitude.
Response: n, where n is the site altitude in meters.
Security: Monitor (level 1)

C234 dt Function: Set local time offset from UTC.
dt is the time offset, in the form " + hh:mm:ss;"
+ = ' + ' for time ahead of UTC;
'-' for time behind UTC.
Response: < none >
Example: -05:00:00 (set offset to -5 hours = Eastern Standard Time.)
Security: Supervisor (level 3)

R234 Function: Request local time offset from UTC.
Response: dt, where dt is the same format as described for the C234 command.
Security: Monitor (level 1)

C235 s Function: Set local time zone abbreviation.
s = quoted string of three characters.
Response: < none >
Example: C235 "EST" for Eastern Standard Time.
Security: Supervisor (level 3)

R235 Function: Request local time zone abbreviation.
Response: s, where s is a quoted string of three characters.
Security: Monitor (level 1)

C240 d t Function: Set current UTC date and time.
d = date in form mm/dd/yyyy
t = time in form hh:mm:ss.
Response: < none >
Example: C240 mm/dd/yyyy hh:mm:ss
Security: Supervisor (level 3)

R240 Function: Request UTC date and time.
Response: d t, where d and t are the same date and time formats, respectively, that are used for the C240 command.
Security: Monitor (level 1)

5.3 X3nn Tracking and Target Requests and Commands

C300 n
Function: Track target by target number.
n = input target number, n = [1,50]
Response: < none >
Security: Operator (level 2)

R300
Function: Request target currently being tracked.
Response: n, where
n = -1 if 7200 ACU is in **Standby** mode,
n = 0 if in **Immediate** mode,
n = 1-50 if tracking a preprogrammed target .
Security: Monitor (level 1)

C301 s
Function: Track target by target name.
s = quoted string holding target name.
Response: < none >
Security: Operator (level 2)

R301
Function: Request name of target currently being tracked.
Response: s, where s is a quoted string containing the target name, or n is sent if in **Standby** mode (n = -1), or **Immediate** mode (n = 0).
Security: Monitor (level 1)

C302 n
Function: Clear target by number
n = input target number, n = [1,50]
Response: < none >
Security: Supervisor (level 3)

R302 n
Function: Request tracking mode and name of target by number.
n = input target number, n = [1,50]
Response: m s, where m is the tracking mode (Refer to R11.), and s is a quoted string containing the target name.
If the target is unused a zero is returned as the mode with NO name (i.e., s is not returned).
Security: Monitor (level 1)

C303 s
Function: Clear target by name
s = quoted string holding target name.
Response: < none >
Security: Supervisor (level 3)

R303 s
Function: Request number and tracking mode of target by name. s = quoted string holding target name.
Response: m n, where n is the target number, and m is the tracking mode of the target. Refer to R11. If the named target does not exist, an error code is returned.
Security: Monitor (level 1)

C305
Function: Begin immediate steptrack.
Response: < none >
Security: Operator (level 2)

R305
Function: Request steptrack status.
Response: c, where c = "Y" if the 7200 ACU is actively steptracking the current target, or c = "N" if the 7200 ACU is not currently in a steptrack cycle.
Note: This request functions while in **Immediate Steptrack** or **OPT** mode (while actively steptracking).
Security: Monitor (level 1)

C306 v
Function: Update command position of tracking started with C2 command with the vector v. This command is only used to update the commanded pointing position of the antenna after a C2 command has been used to start **Move to look angle...** tracking. This command should only be used to continue operations on a single satellite. It will not initiate tracking from **Standby** or any other tracking mode. When changing to a new satellite, the C2 command should be issued.
Response: < none >
Security: Operator (level 2)

C307 n
Function: This **FACTORY OPTION** command to set the radius distance the boresite should be away from the sun center. n = real value in degrees range 0 to 1.0
Response: none
Security: Monitor (System must already be in **Sun track** mode)

R307
Function: This **FACTORY OPTION** command returns the radial distance in degrees and a true/false flag if within deadband from the commanded radius
Response: n.nnn f
Security: Monitor (System must already be in **Sun track** mode)

C308 a

Function: This **FACTORY OPTION** command is used to set the angular rotation off the CW AZ direction for the radius distance (in 307) away from the sun center.
a = real value in degrees range 0 to 360.0
Response: none
Security: Monitor (System must already be in **Sun track** mode)

R308

Function: This **FACTORY OPTION** command returns the angular rotation off the CW AZ direction and a true/false flag if within deadband from the commanded angle
Response: aaa.aaa f
Security: Monitor (System must already be in **Sun track** mode)

R309

Function: This **FACTORY OPTION** command returns the time stamped sun centriod position and the current look angles at the time of the request. The built in receiver voltage (A/D 1) is also returned
For possible future use, also note the millisecond output in the time format is for future expansion and currently set to zero.
Response: MM/DD/YYYY HH:MM:SS.sss
AAA.AAAA EEE.EEEE AAA.AAAA EEE.EEEVV.VVV
Example: 000 > R30901/14/2000 05:58:18.000 098.2358 007.5663
098.2362 007.5693 00.000
Security: Monitor (System must already be in **Sun track** mode)

C310 n

This **command is only available** when the system is NOT configured to use a TRL tracking receiver.
Function: Set current A/D source.
n = channel number, n = [1,2]
Response: < none >
Security: Operator (level 2)

R310

This **command is only available** when the system is NOT configured to use a TRL tracking receiver.
Function: Request current A/D source.
Response: n, where n = channel number.
Security: Monitor (level 1)

C311 n This **command is only available** when the system is NOT configured to use a TRL tracking receiver.
Function: Set current beacon.
n = beacon number, n = [1,4]
Response: < none >
Security: Operator (level 2)

R311 This **command is only available** when the system is NOT configured to use a TRL tracking receiver.
Function: Request current beacon.
Response: n, where n = beacon number, n = [1,4]
Security: Monitor (level 1)

C312 n v Function: Set Bias angles in specified target.
n = input target number, n = [1,50]
v = < bias vector >
Response: < none >
Security: Operator (level 2)

R312 n Function: Request Bias angles of specified target.
n = input target number, n = [1,50]
Response: v, where v = < bias vector > .
Security: Monitor (level 1)

C313 n This **command is only available** when the system is configured to use a TRL tracking receiver.
Function: Set current Frequency [MHz]
n = frequency in MHz for the tracking receiver range [900.000 to 12750.000]
Response: < none > .
Security: Operator (level 2)

R313 This **command is only available** when the system is configured to use a TRL tracking receiver.
Function: Request current Frequency [MHz]
Response: n, where n = frequency in MHz range [900.000 to 12750.000]
Security: Monitor (level 1)

C314 n This **command is only available** when the system is configured to use a TRL tracking receiver.
Function: Set RF input
n = RF (POL) input to the tracking receiver
n = [1,2]
Response: < none > .
Security: Operator (level 2)

R314 This **command is only available** when the system is configured to use a TRL tracking receiver.
Function: Request current RF input
Response: n, where n = RF (POL) input to tracking receiver
n = [1,2]
Security: Monitor (level 1)

C315 n This **command is only available** when the system is configured to use a TRL tracking receiver.
Function: Set Attenuation [dB]
n = attenuation in dB for the tracking receiver
n = range [0.0 to 50.0]
Response: < none >
Security: Operator (level 2)

R315 This **command is only available** when the system is configured to use a TRL tracking receiver.
Function: Request current Attenuation [dB]
Response: n, where
n = attenuation in dB for the tracking receiver.
n = range [0.0 to 50.0]
Security: Monitor (level 1)

C316 n This **command is only effective** with a CP/LP controller connected to a 7200 ACU and while the CP/LP controller is in **REMOTE Control** mode.
Function: Set feed polarization mode of CP/LP controller, which may be Circular or Linear.
n = polarization mode command
n = 0: polarization switches are commanded to Circular path
n = 1: polarization switches are commanded to Linear path
Response: < none >
Security: Operator (level 2)

R316 This **command is only effective** with a CP/LP controller connected to a 7200 ACU.
Function: Request current CP/LP controller status
Response: **m n**
m = CP/LP controller mode
m = 0: CP/LP controller in LOCAL Control mode
m = 1: CP/LP controller in REMOTE Control mode
n = current polarization mode
n = 0: polarization switches are set to Circular path
n = 1: polarization switches are set to Linear path
Security: Monitor (level 1)

C318 n "Reset OPT target" is used to clear the target's stored steptrack data and orbital elements. This is used in the event that OPT comes up with bad solutions and is unable to track properly. "Reset OPT target" does not affect any of the spacecraft, steptrack, or OPT parameters.

Function: Reset OPT target
n = target number of a valid OPT mode target
if n = 0 then reset the current OPT target under track. This has the same effect as selecting the target number of the current target in track.
Response: < none >
Security: Operator (level 2)

C319 n Function: Stops and resumes tracking in OPT mode only. Does not cause alarm condition and has no effect on other modes.

n = 0 Similar to action of [STOP] key but could have delay
to allow completion of current steptrack cycle. The hold is not in effect until the "Tracking hold initiated by M&C" submode (25) is set. Check submode with R7 request.

n = 1 Clears "Tracking hold initiated by M&C" submode and allows system to continue operation. Hold can also be cleared by taking system to STANDBY or restarting the target.

Response: < none >
Security: Operator (level 2)

C320 n [s] Function: Upload IESS412 element set into target.
n = target number, s = quoted string holding name [optional] used to set name. If target is pre-existing Intelsat, then input data will over write existing data.

Response: An awaiting further input error code will be returned. This command initiates an edit session that must be continued in sequence till completion. Nineteen items are expected, one per line, in the following order:

001>	YYYY	(Year)
001>	MM	(Month)
001>	DD	(Day)
001>	HH	(Hour)
001>	MM	(Minute)
001>	SS	(Second)
001>	sxxx.xxxx	(LM0)
001>	sx.xxxx	(LM1)
001>	sx.xxxxxx	(LM2)
001>	sx.xxxx	(LONC)
001>	sx.xxxx	(LONC1)
001>	sx.xxxx	(LONS)
001>	sx.xxxx	(LONS1)
001>	sx.xxxx	(LATC)
001>	sx.xxxx	(LATC1)
001>	sx.xxxx	(LATS)
001>	sx.xxxx	(LATS1)
001>	sxxx.xxxx	(Longitude predict at 170 hours)
001>	sx.xxxx	(Latitude predict at 170 hours)

Edit session ends and data is checked for 170-hour verification. Upon failure, a 301> error code is returned and the input data is NOT stored into the target area. If the parameters pass the 170- hour verification, they will be stored in the target database. If at any point within the edit session an out of range value or another Request/Command is received, the edit session will be aborted.

Security: Supervisor (level 3)

R320 n

Function: Download IESS412 element set from target.
n = target number.

Response: A multiple line output (19 lines of data) will be returned in the following format:

YYYY	(Year)
MM	(Month)
DD	(Day)
HH	(Hour)
MM	(Minute)
SS	(Second)
sxxx.xxxx	(LM0)
sx.xxxx	(LM1)
sx.xxxxxx	(LM2)
sx.xxxx	(LONC)
sx.xxxx	(LONC1)
sx.xxxx	(LONS)
sx.xxxx	(LONS1)
sx.xxxx	(LATC)
sx.xxxx	(LATC1)
sx.xxxx	(LATS)
sx.xxxx	(LATS1)
sxxx.xxxx	(Longitude predict at 170 hours)
sx.xxxx	(Latitude predict at 170 hours)

Note: 4 digits are required for year (e.g.: 1994, not 94); all others are identical to Intelsat format.
An [ESC] character sent at any time will terminate the output stream.

Security: Monitor (level 1)

C321 n a

Function: Set POL angle in specified Intelsat target.
n = input target number, n = [1,50]
a = POL angle

Response: < none >

Security: Supervisor (level 3)

R321 n

Function: Request POL angle of specified Intelsat target.
n = input target number, n = [1,50]

Response: a, where a = POL angle

Security: Monitor (level 1)

C322 n m

Function: Set Intelsat pointing update time in specified Intelsat target.
n = input target number, n = [1,50]
m = Update time in milliseconds

Response: < none >

Security: Supervisor (level 3)

R322 n
Function: Request pointing update time of specified Intelsat target.
n = input target number, n = [1,50]
Response: m, where m = update time in milliseconds.
Security: Monitor (level 1)

C330
Function: Execute antenna stow. No arguments.
Response: < none >
Security: Operator (level 2)

C331
Function: Execute antenna unstow. No arguments. > = operator required.
Response: < none >
Security: Operator (level 2)

5.3.1 Table Track Support (OPTIONAL)

The following requests and commands provide table track support. A table track record [TTRec] (each entry in the table) consists of date/UTC time tag and look angle set (AZ EL POL); therefore each record in the table is of the following form and format:

Form: [date time < azimuth elevation polarization >]

Format: **[mm/dd/yyyy hh:mm:ss < aaa.aaa eee.eee ppp.ppp >]**

C340 n f Function: Initiate table track upload into ACU NVRAM. **n**th record follows each time a 001 > prompt is returned by the ACU, until total **n** is reached. The time tagged (date/time) records must be ordered sequentially from earliest to latest.

n = integer value representing total # of records. The MAX value of n is 200.

n = 0 causes all records to be erased (count set to 0). No records are accepted when n = 0; replace/append flag still expected.

f = replace/append flag. This flag indicates whether the following records will **replace** the current table in memory or will be **appended** to the current table, starting at the date/time of the first record and replacing all the following records.

f = 0: **replace** current table

f = 1: **append** to current table

Response: 001 > prompt until **n** records are uploaded, then 000 > prompt when done.

Example:

000 > C340 6 0
001 > [TTRec]
001 > [TTRec]
001 > [TTRec]
001 > [TTRec]
001 > [TTRec]
001 > [TTRec]
000 >

Security: Supervisor (level 3)

R340 st end Function: Download records from **st** to **end** from table in ACU NVRAM.
st = integer value, from 1 to 200, representing the starting record to download
end = integer value from **st** + 1 to 200, representing the end record to download

Response: n Table Track records, separated by CR-LF, in the form:

TTRec = [mm/dd/yyyy hh:mm:ss < aaa.aaa eee.eee ppp.ppp >]

Example:
000 > R340 1 6
[TTRec]
[TTRec]
[TTRec]
[TTRec]
[TTRec]
[TTRec]
000 >

Note: If the **end** is greater than the last record in the table ONLY the existing records in the table will be downloaded, and in the case the table is empty the response is an error code 304 Empty table: No records exist.

Security: Monitor (level 1)

C341 Function: Initiate Table Track mode using table in ACU NVRAM.

Response: < none > or error code:
303 Expired table: All records expired
304 Empty table: No records exist

Security: Supervisor (level 3)

5.4 IEEE-488 Compliance

IEEE-488 COMPLIANCE		
FUNCTION	**SYMBOL**	**LEVEL OF COMPLIANCE**
Source Handshake	SH	SH1
Acceptor Handshake	AH	AH1
Talker	T	T2
Extended Talker	TE	TE0
Listener	L	L1
Extended Listener	LE	LE0
Service Request	SR	SR1
Remote Local	RL	RL0
Parallel Poll	PP	PP0
Device Clear	DC	DC0
Device Trigger	DT	DT0
Controller	C	C0

Although this appendix contains the complete interface for the GPIB (IEEE-488), the **DIFFERENCES** between the information in Appendix F and that supplied in Appendix C for the RS232/422 interface are listed here as a quick reference.

Differences Between RS232/422 and GPIB (IEEE-488) Interfaces

The format is as follows:

The paragraph number of both appendices are identical, so they are listed, followed by the difference between Appendix F and Appendix C (RS232/422).

1.0 Introduction
There are no GPIB communication parameters that may be set by the user.

2.0 Input Echo and Line Editing
GPIB transactions are performed without echo. Backspace and escape are not supported on the GPIB interface.

3.0 Request/Command Protocol
Requests/Commands are entered in the following format:
[R or C]n [parameters] (EOI)

where (EOI) is the GPIB EOI (End Or Identify). No carriage return follows the command.

On the GPIB interface, (newline) is always CRLF (ASCII 13 plus ASCII 10).

4.1 White Space
Checksums are not supported on the GPIB interface.

4.4 Checksums
Checksums are not supported on the GPIB interface.

5.1 X1nn - Port Configuration Requests and Commands
These requests and commands are still available to configure RS232/422 ports, however, they cannot be used on the GPIB port.

APPENDIX G - 7200 Troubleshooting Guide

Table 1-1 lists the paragraph number for the probable causes and corrective action for each fault/error topic addressed in this guide.

TABLE 1-1 FAULT/ERROR TOPICS	
FAULT/ERROR	**PARAGRAPH NUMBER**
Drive Cabinet Unresponsive/Inverter Display Blank	1.0
Drive Cabinet Inverter Faults	2.0
7200 ACU Failures	3.0
Soft and Hard Travel Limits	4.0
Resolver Errors	5.0
Motion Errors	6.0
Position Loop Errors	7.0
Target Acquisition Errors	8.0
AST/OPT Tracking Errors	9.0
Intelsat Tracking Errors	10.0
Password Lost	11.0

If after following troubleshooting methods listed in this appendix, a problem still exists, or if a problem is not addressed in this guide, contact technical support, (see Appendix J of this manual).

1.0 Drive Cabinet Unresponsive/Inverter Display Blank

NOTE: This error can occur even if the ACU has not been installed.

If the drive cabinet does not respond to drive commands from local controls and the inverter display is blank (the inverters are not energized), follow these steps.

On the drive cabinet swing-out panel, check to see if the CONTROL POWER rocker switch (breaker) is in the ON position and verify that the green LED on the switch is illuminated. Also verify that the CONTROL switch is in the LOCAL position.

1. If the LED is **not** illuminated, check the following:

    a Verify power to the main power feeder and breaker.
    b. Verify that all emergency stop pushbuttons and interlocks are not activated.
    c. Check the input wiring to the 24 VDC power supply to verify that AC voltage is applied.
    d. If the conditions listed in steps a through c exist, measure the power supply output pins to verify that 24 VDC is available. If DC voltage is not available, disconnect the limit switch wiring from the drive cabinet to be sure that the +24 VDC lines from the cabinet are not shorted to ground. Recheck the power supply and if DC voltage is still not available, replace the power supply.

2. If the LED **is** illuminated and the main contactor is not energized, check the following:

    a. Shorted diode (02) across pins 7 and 8 of relay KC1 on the relay PCB.
    b. Tripped inverter circuit breaker.
    c. Loose wiring on any terminal on the relay PCB.
    d. Relay K7 (and diode D19 across pins 13 and 14) on the relay PCB.

2.0 Drive Cabinet Inverter Faults

NOTE: The fault codes in brackets are indicated on the inverter displays.

These faults are indicated by a display of AZ|EL FLT on the ACU. For other inverter fault possibilities, consult the inverter O&M manual provided in Appendix H of this manual.

2.1 Overcurrent During Acceleration [OCPA]

If overcurrent is detected during acceleration, [OCPA] will appear on the inverter display. The following conditions may be the cause of this error:

1. Torque boost function code (cd06) is set too high -- reduce the setting if possible.

2. Acceleration time is too short -- increase it.

3. Starting frequency is set too high. For maximum starting torque, the inverter starting frequency must be set below the motor slip frequency. (See function code cd16 in Table 4-10 of this manual.

4. Motor connections are incorrect -- verify proper voltage connection.

5. If a motor brake is used, brake coil cannot be fed from the inverter output terminals.

2.2 Overcurrent During Normal Operation [OCS]

If overcurrent is detected during normal operation, [OCS] will appear on the inverter display. The following conditions may be the cause of this error:

1. Phase-to-phase or phase-to-ground short at the inverter output -- check for short in wiring or motor.

2. Output transistor is shorted. Disconnect motor leads from U, V, and W and try to start. If the error code [OCS] still appears, this indicates that a transistor module is shorted. Replace transistor module or the inverter.

2.3 Overvoltage [OU]

[OU] will be displayed on the inverter if overvoltage occurs. This error can occur if the deceleration time is set too fast for load inertia. To correct this problem, increase the deceleration time.

2.4 Undervoltage [LU]

If undervoltage is detected, [LU] will be displayed on the inverter. Low input voltage is the cause of this error. Check for low voltage at inverter input terminals. This can be caused by instantaneous power failure or a brownout.

2.5 Overheating [OH]

If overheating occurs, [OH] will be displayed on the inverter. If this error occurs, check the cooling fans (if applicable) and/or clean the cooling fins on heat sinks. If the fans are operating properly and the fins are clean, check for excessive ambient temperature.

2.6 Overload (Electronic Thermal Setting) [OL]

When an overload is detected, [OL] is displayed on the inverter. When this error occurs, restart the inverter and check output current. If it is higher than the specifications on the nameplate, correct the overload.

3.0 7200 ACU Failures

3.1 No Audible Beep at Power-Up

If an audible beep is not heard upon power up of the ACU, check the following:

1. Verify that power is available at the unit.
2. Check the fuse in the power entry module.
3. Verify that proper voltage/frequency has been selected at power input on the back of the unit.

3.2 Display Shows Blinking Cursor Only

If only a blinking cursor appears in the upper left corner of the screen:

1. Open the lid and check serial connection from CPU port 2 (labeled on right side of CPU board) to the top right serial port on the display driver board.

2. With lid open, disconnect ribbon cables to I\O card and RDC card. Turn on power and observe the light sequence on the CPU card. The status of the lights should be as follows:

   a. Run light: red, then green
   b. BR light: always off
   c. BM light: should flicker green (off in **Simulation** mode)
   d. Fail light: red, then off
   e. BGACK light: always off
   f. RAM light: should flicker green
   g. LAREA light: should flicker green
   h. S1 light: YELLOW, then off
   i. S2 light: YELLOW, then off (after S1)
   j. S3 light: YELLOW, then off (after S2)
   k. S4 light: always off

3. If the lighting sequence is as listed in steps a through k, check DIP switch SW1 on display controller. (See drawing 800399 in Section 8.0 for switch setting.)

4. If the lighting sequence is not as listed in steps a through k:

   a. Verify that all CPU switches are down (toward right side)
   b. Verify rotary switch settings:
      1.) switch 2 should be set to 4
      2.) switch 1 should be set to D
   c. Eject the board and reinsert it.
   d. Contact Vertex for support.

3.3 Bus Error Occurs on Boot Up

If a bus error occurs when system is booted up:

1. A problem with one or more cards on the bus prevented the CPU from "talking" to the card(s). To determine which board has a problem, from the **Main menu**, select **Display system status...** and **Power-up test report**.

2. Verify all cards are properly installed in the 7200 ACU.

3. Contact Vertex for support.

4.0 Soft and Hard Travel Limits

4.1 Axis Immobile With Summary Limit (Hard Limit)

This error occurs when the ACU has reached a travel limit. Because the limit is a summary limit, the ACU cannot tell which axis has reached the limit. An immobile error will soon be displayed, indicating which axis has reached the limit.

4.2 Summary Limit Fault (When Antenna is not in a Limit)

If a summary limit fault is detected when the antenna is not in a limit, verify that polarization summary limits are jumpered out in the drive cabinet (TB1-7, TB1-8, and TB1-9). See Table 4-2 (in Section 4.0 of this manual) for details.

5.0 Resolver Errors

For all resolver errors, check the cable first and make sure that D-subconnector is securely connected to the back of the ACU. Also verify that shield lines are connected to the ACU, but OPEN at the resolver. Shield lines should not short to each other. [Refer to Table 4-4 (in Section 4.0 of this manual) to ensure that shielding pairs are installed correctly.]

The following resolver DC resistance readings are listed as a checklist. It is important that the S lead pairs match each other. If measuring from the D-connector end, there will be some extra cable resistance.

Two-speed:
- R1-R2: 17 ohms
- S1-S3: 152 ohms
- S2-S4: 152 ohms
- S11-S13: 562 ohms
- S12-S14: 562 ohms

Standard (2500 Hz @ 4.4 V RMS)
- R1-R2: 19 ohms
- S1-S3: 6.8 ohms
- S2-S4: 6.8 ohms

High accuracy (400 Hz @ 11.8 V RMS)
- R1-R2: 120 ohms
- S1-S3: 475 ohms
- S2-S4: 475 ohms

5.1 Resolver Readout Bobble

If the resolver readout bobbles, especially in the last few bits on the RDC status display, there may be insufficient excitation voltage (this problem is common with the two-speed resolvers). Use an oscilloscope to measure the AC component on the S2 or S3 lead (it is recommended that the bottom of the appropriate transient suppressor be used as a tie point; refer to the appropriate drawing in Section 8.0). As the spatial angle of the resolver shaft changes, the sine wave should peak at 2 V RMS [5.65 V peak-to-peak (p-p)]. Higher voltages will cause saturation of the RDC's and should be avoided. Lower voltages will reduce the signal to noise level.

5.2 Resolver Readouts Erratic with Antenna Motion

If the resolver readouts become erratic with antenna motion, (i.e., the readout functions properly through a certain angular range, but begins to flicker and roll, large jumps occur, etc), a bad connection is usually the cause. This occurs because a small signal is being coupled into the very high impedance input of the RDC, causing the system to behave erratically.

5.3 Resolver Readouts not Changing with Antenna Motion

When the resolver readouts do not change when the ACU commands the antenna to move, an axis immobile error will occur (unless **Motion limits** are disabled). Refer to paragraph 6.1 for further troubleshooting procedures.

5.4 Resolver Readouts Varying Rapidly or Resolver Jumping by Large Increments

If the resolver readouts are varying rapidly (spinning), or if the resolver is jumping by large increments, determine if the problem is in the ACU or the resolver (+ cable) by following these steps:

1. Connect a spare resolver to ACU, if available.

2. If there is another resolver of the same type in the system, (e.g., if there is a problem with azimuth resolver, the azimuth and elevation resolvers are of the same type), disable motion errors, and switch the resolver cables at the back of the ACU. Manually run the antenna and see if motion is apparent.

   a. If motion is detected, the problem is in the ACU. If a spare RDC card is available, change it out with the old one. If the problem still exists, contact Vertex.
   b. If no motion is detected, buzz out cable. If the cable is good, replace the resolver. Check for water in the resolvers.

6.0 Motion Errors

6.1 Axis Immobile

If an **Axis immobile** error is displayed on the ACU, check for the following conditions:

1. Setting of **Immobile/reversed timeout [ms]** parameter is too low -- reset parameter.

2. Setting of **Immobile/reversed tolerance [deg]** parameter is too high -- reset parameter.

3. Tracking speed potentiometer at drive cabinet is set too low -- reset the tracking speed.

4. Insufficient start torque (low elevation angles)--boost starting torque in the inverter.

5. Encoders are decoupled from the antenna -- reconnect the encoders.

6. Encoders are miswired -- check the wiring on the encoders.

7. The drive cabinet interface cable has failed -- check the cable and replace if necessary.

8. Failure at I/O board -- the ACU cannot successfully command the drive cabinet. Check and/or replace the board.

6.2 Axis Reversed

An **Axis reversed** error may be caused by the following conditions:

1. At installation time, the motor phasing was reversed -- check the phasing and correct if necessary.

2. A sudden slew from one direction to the other could be caused by a low setting of the **Immobile/reversed timeout [ms]** -- reset the parameter.

3. Miswired encoders -- check the wiring on the encoders.

6.3 Axis Runaway

If an **Axis runaway** error is displayed at the ACU, check the following conditions:

1. **Runaway angle** is set too tight -- reset the parameter.

2. Encoder failure (typically cable failure or ground loop) -- check for both conditions.

3. RDC failure -- check and replace if necessary.

4. Drive cabinet interface cable failure -- check the cable and replace if necessary.

5. I/O board failure -- output is "stuck on". Check the board, and replace if necessary.

7.0 Position Loop Errors

7.1 Overshooting (Motor Turning On and Off Repeatedly)

NOTE: For flyaway/small antennas only: decrease Positioning deadband [deg] in the Position loop parameters... menu.

If the motor is turning on and off repeatedly, decrease tracking speed until the overshooting ceases.

7.2 Too Long to Reposition to a New Satellite

If the system is taking too long to reposition to a new satellite:

1. Turn slew speed potentiometer in drive cabinet to maximum.

2. Decrease **Slew -> track transition [deg]** parameter to optimize slewing motion (default value drops out of slew long before the target is acquired).

8.0 Target Acquisition Errors

The following conditions may be the cause of errors occurring during target acquisition:

1. If a western longitude is entered without a leading "-". To enter 99 degrees west, enter "-99.0".

2. Offsets and site data may be incorrect -- verify the data (these should be recorded in Section 6.0).

9.0 AST/OPT Tracking Errors

9.1 Target Tracking from Spacecraft

If a target was initially set up in **Move to longitude...** mode but the mode was changed to OPT and now is tracking from the spacecraft, re-enter the longitude of the spacecraft. This step is necessary because when tracking modes are changed, the target is reset to default values, which includes 0 degrees longitude.

9.2 "Low Tracking Signal Level" Error Displayed

If a "Low tracking signal level" error is displayed:

1. Verify that the target and polarization are correct.

2. Check the tracking receiver:

   a. Verify that the beacon frequency is correct.
   b. If the ACU switches, check to see if the tracking receiver is in REMOTE.
   c. Check the RF to the receiver, especially LNA switches.

9.3 "Excessive Tracking Signal Noise" Error Displayed

This is a notification, NOT a fault. If no other faults are occurring, the system is still functioning nominally.

9.4 Large Signal Fluctuation During AST Operations

If a large signal fluctuation occurs during AST operations, check the low speed potentiometer at the drive cabinet, and verify that the antenna is not overshooting.

9.5 Poor Tracking Performance

If the system is not adequately tracking:

1. Check settings of tracking parameters. Refer to the table in paragraph 5.8 of this manual that lists the parameters for the tracking mode of the target.

2. Verify that the steptrack step size is greater than the position loop deadband. If the step size is equal to or less than the position loop deadband, the steptrack function will not operate correctly.

3. Verify that the signal level into the beacon receiver is within acceptable limits. (The maximum RF levels for the Vertex TRC-14 and TRK-14 receivers are -60 dBm).

4. Check the calibration of the beacon signal. The 0 dBm level should be set at approximately 7.5 V to 8.5 V. Also note that calibration must be performed separately for each A/D in use.

5. Check for proper mechanical/electrical connections of resolvers.

6. Check resolver alignment. (If the bellows coupling between resolver and pickoff shaft appears visibly bent, the resolver is out of alignment.)

10.0 Intelsat (IESS-412) Tracking Errors

10.1 "Intelsat data expired" Error Displayed

An "Intelsat data expired" error may be displayed if the current date/time is greater than 170 hours after the epoch. Update the data as required.

10.2 "Intelsat pre-epoch prediction" Error Displayed

The error "Intelsat pre-epoch prediction" will be displayed if the current date/time is before epoch on the 11-element set report. The previous (unexpired) set should be used until the current date/time is after epoch.

10.3 "Intelsat data invalid--cannot track" Error Displayed

The error "Intelsat data invalid--cannot track" is displayed when the 11-element set entered failed the 170 hour test (i.e., the predictions from the 11-element set at epoch plus 170 hours do not agree with the latitude and longitude at epoch plus 170 hours on the 11-element set report. Check the values entered in the ACU.

11.0 Password Lost

If a password is lost, it must be cleared and a new password must be entered because the 7200 ACU has no provision to recover a lost password. Follow the procedure in Appendix B of this manual to clear the password and enter a new one.

> ***NOTE: To prevent movement of the antenna by the ACU while resetting a password, press the DRIVE ENABLE button on the front panel of the ACU.***

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APPENDIX H - VENDOR DATA

This appendix contains the Sumitomo NTAC 2000 O&M manual for the inverters.

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APPENDIX I - 7200 MENU TREE SOFTWARE

This appendix contains the flow charts for the 7200 menu tree for software Version 3.2.

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APPENDIX J - TECHNICAL SUPPORT

If you have any questions or problems that are not addressed by the manual, there are several ways to contact our technical support team.

1. Phone us at (903) 295-1480.

2. Email us at ***support@vcsd.com.***

3. Make copies of the following Technical Inquiry form and fax us your questions at (903) 295-1479.

4. Contact us on our web site at ***www.vcsd.com.***

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Vertex RSI™ A TriPoint Global Company **Technical Inquiry**	**FAX (903) 295-1479**	
CUSTOMER NAME:	SITE:	
CONTACT:	PHONE:	EXT:
FAX:	EMAIL:	

EQUIPMENT: *(INCLUDE MODEL, NAME, AND SERIAL NUMBER OF ALL PERTINENT EQUIPMENT)*

S/N:

1. **Model:** _____
2. **Model:** _____
3. **Model:** _____
4. **Model:** _____

OTHER EQUIPMENT

TECHNICAL QUESTION/PROBLEM:

VCSD RESPONSE:

VCSD TROUBLESHOOTER	DATE	TIME	REF. NO.

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