USER MANUAL

for the

Telonics Dual Band NOAA-HRPT/DMSP Earth Station

Model THRPT-2-H/D

10 September 1996

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Telonics HRPT/DMSP Earth Station

1.0 INTRODUCTION and SCOPE

This document is an installation, operation, and usage guide for the Telonics model THRPT-2-H/D DMSP Earth Station. Like the earlier model THRPT-1 system, the model THRPT-2-H/D Earth Station is a fully automated, portable 1698/1707 MHz (D-Band), and 2252.5 MHz (E-Band) downlink reception station which automatically receives and bit synchronizes data from polar orbiting satellites. The THRPT-2-H/D is supplied for the specific purpose of providing data, clocks, and Bi-phase recorder outputs to imaging systems. This manual is specific to the configuration which provides bit synchronized data outputs for processing by both HRPT and DMSP imaging systems.

Telonics supplies receivers, antennas, and controllers which are tailored specifically for either HRPT or DMSP as well as this configuration which is switchable, accommodating both downlinks. The bit synchronizer supplied with this system allows users working with tape storage data to process DMSP or HRPT data from tape, as well as real-time reception capability. (The specialized nature of DMSP data requires that the user's frame synchronizer tests for proper data polarity and corrects as necessary.)

The system is supplied with an antenna positioner which lends itself to convenient portability, and for use in conditions of reasonably heavy windloading and wide temperature excursions. (The positioner serves as the mount for both HRPT and DMSP downconverters.) Telonics antenna positioners are environmentally protected and are plug-in interchangeable (within the same antenna size class) with the Telonics antenna controller system for applications where it is desirable to utilize both fixed, and portable antenna assemblies with the same receiving, synchronization, and processing hardware.

The antenna/receiving system incorporates extremely low noise temperature amplifiers, a custom cavity feed and wide temperature range down-converters. The assembly is manipulated by a full 180 degree elevation over 360 degree azimuth antenna positioner The positioner is mounted on custom heavy duty pedestals constructed of heavy, corrosion resistent alloy aircraft aluminum.

The antenna assembly can be located up to 100 meters from the receiver/controller assembly without additional interfaces (special modifications are available for longer cable runs). The down-feed from the antenna system is processed by a specially designed receiver and an advanced bit synchronizer which provides 0^{o} and 90^{o} clock outputs as well as NRZ data and a bi-phase output/input for analog recorders. A fifth generation intelligent controller is integral to the bit-sync assembly which interfaces with the antenna positioner, interpreting angular instructions and feedback information as provided by an RS-232-C Serial Interface. Some systems are supplied with an IBM compatible computer and color display. When supplied, the Telonics computer prediction and display system incorporates specialized software which provides real-time color display of orbitography, radio horizon, and scan width coverage information while interfacing to the antenna controller. A specialized TSR time code program is supplied which continually runs in the background, interfacing to one of several optional high accuracy time bases which provides the timing component for antenna pointing.

Telonics HRPT/DMSP Earth Station

The Telonics THRPT-2 antenna positioning system is based on real-time correction of angular error with respect to computed angle to the satellite as opposed to pre-computed table program track as a function of time interval alone.

1.1 Configuration

The THRPT-2-H/D Earth Station is comprised of the following items:

- 1.5 meter parabolic antenna and mount
- Antenna positioner
- Dual Band helix radiator/feed
- Low Noise HRPT Amplifier (LNA)
- Low Noise DMSP Amplifier (LNA)
- Interdigital HRPT Downconverter
- Interdigital DMSP Downconverter
- Interface cabling for both systems
- HRPT IF Receiver/demodulator
- DMSP IF Receiver/demodulator
- HRPT/DMSP format bit synchronizers with NRZ, 0^{o} and 90^{o} clock outputs, and a bi-phase recorder output.
- Time source
- Interface and control system consisting of:

    1. Prediction and drive software with automatic real-time interface
    2. IBM compatible computer
    3. Color real-time world map display showing SSP Ground track, actual and predicted antenna pointing coordinates, doppler shift parameters, orbital status, AVHRR scan coverage width, past and predicted tracks including moving radio horizon coverage relative to sixteen observation points world-wide for up to sixteen satellites automatically.

1.2 Background

The model THRPT-2 earth station is a fifth generation effort designed for both in-house reception of DCLS data by Telonics, and for reception of AVHRR, DMSP, and TIP data, by other users. The THRPT-2 incorporates much of the technology and experience gained from years of VHF and S-band efforts to receive noise-free TIP data. This new system eliminates persistent interference from the increasing world-wide VHF noise floor by utilizing the 1.70 GHz and 2.25 GHz "D & E-Bands" down-link frequencies, as well as through the use of the advanced hermetic low noise Telonics LNAs and downconverters employing special filters. The THRPT-2 incorporates a revised pedestal design which may be installed in any orientation, along with astronomical alignment software which eliminates the need for site surveys and critical base mount design. In replacing the large VHF antenna systems used previously with a small, 1.5 meter diameter parabolic "dish" antenna, we have clearly established the capability of small earth stations to provide noise-free reception of HRPT and DMSP (THRPT-2-H/D) imaging data (as well as the embedded TIP data for which it was originally designed), at low horizon angles. Larger antenna systems in the 1.73, and 2.4 meter size classes are available for use with HRPT as well as other satellite systems.

2.0 DOWNLINK RECEIVER AND TRACKING OPERATION

2.1 General Information

The Downlink Receiving System consists of three major functional subsystems:

2.1.1 Antenna

The antenna subsystem consists of a pedestal mounted positioner, a circularly polarized parabolic antenna and wide-band feed, a high gain interdigitally filtered down-converter, and a pair of hermetically sealed Low Noise preAmplifiers. This subsystem has sufficient gain and low noise temperature characteristics to provide a positive 10 dB signal-to-noise margin at satellite elevation angles of 10 degrees and higher, and an RF bandwidth sufficient to cover the satellite downlink frequencies including worst-case doppler shift and temperature variation. Users of these systems in outlying installation sites have reported noise-free HRPT and DMSP data reception from horizon-to-horizon since their inception. User sites centered in the largest metropolitan environments report reliable noise-free data reception in the 3 - 8 degree elevation angle range.

2.1.2 Receiver

The receiving subsystem consists of two remote controlled, superheterodyne down-link Intermediate Frequency units designed specifically for the reception of HRPT and DMSP downlink data. The Low Noise Amplifier and down-converter mounted on the antenna assembly are companion components of the receiver subsystems.

Computer interaction with the receiver is provided by a microprocessor port interface between the antenna controller and the receiver for switching between HRPT and DMSP, as well as automatic frequency selection for HRPT. The controller receives all control interface signals for the receiver by means of an RS-232C link from an ephemeris/orbitography computer.

2.1.3 Bit Synchronizer

Telonics' bit synchronization circuitry provides NRZ data and a choice of 0^{o} or 90^{o} clock outputs. These outputs may be utilized either by imaging systems, or by other data processors. The hardware connected to the bit sync outputs must perform all frame synchronization and decommutation functions. The Telonics bit synchronizer is designed for stand-alone tape usage as well as real-time processing, and includes a bi-phase tape output.

3.0 SYSTEM INSTALLATION AND START-UP

This section describes installation, subsequent hardware interconnection and start-up procedures.

3.1 Antenna Installation

The antenna subsystem should be installed on a level concrete or other suitable mounting surface in accordance with the pedestal mounting bolt drawing provided in Appendix B. The location should be chosen in accordance with the following guidelines:

3.1.1 Site Selection

The propagation characteristics of signals at D and E-Band frequencies are directional, as well as extremely subject to attenuation by intervening objects such as trees, arrays of power wires, other antennas, or any other material object(s) (including high moisture content in the atmosphere such as rain). Although losses during periods of intense rain are unavoidable, the user must avoid placing the antenna system in positions where buildings, high fences, or other objects obscure its view of satellites at any time. System performance is, of course, optimal when the Remote Antenna Assembly is located high and clear (above surrounding obstructions). It is therefore necessary to place the antenna such that its "view" of surrounding obstructions clears the object(s) by as great an angle as practical.

3.1.2 Standard (Portable) Systems

The portable standard antenna/positioner assembly can be mounted on very simple, inexpensive wood or metal platforms which are adequate to prevent overturning under conditions of local winds. A configuration found to be suitable for many systems in the past has consisted of an eight foot square wood platform using screw and glue construction. Some users have fabricated the platform using four pieces of 3/4 or 1.0 inch exterior plywood and six 2x8 or 2x10 fir beams approximately eight feet in length. The beams are typically placed on edge to form an eight foot square foundation, with additional supports crisscrossing at the center of the square. Two sheets of heavy exterior plywood are then glued and screwed across the foundation frame. The last two sheets of plywood are then turned 90^{o} with respect to the first two, and similarly screwed and glued to both the lower sheets of plywood and the heavy frame assembly. After allowing the glue to dry, the platform should be coated with suitable protective sealer or paint as desired. This type of platform has been shown to be suitable for use on both solid roofs and the "river-rock" pebble roofs utilized on many institutional buildings. Alternatively, the positioner assemblies can be bolted to a large metal plate/platform, or bolted directly to a concrete pad. A specification drawing for the pedestal "footprint" is provided in Appendix B of this manual. Prior users should note that the bolt pattern footprint is slightly smaller than that of the THRPT-1 system.

NOTE: It is important that the mounting surface and hold-down mechanics be reasonably level in order to assure that adjustment range of the positioner

leveling base plate is not exceeded. In general, if the mounting base looks fairly level to the unaided eye, it will be quite adequate. (As an information note to readers familiar with earlier systems, unlike the THRPT-1 system, the THRPT-2-H/D **does not require** the mounting bolt pattern for the pedestal to be physically positioned in such a manner that the antenna pedestal can be accurately aligned in a north-south plane (within $\pm$2-3^{o}). The adjustment range capability of the THRPT-1 pedestal was only adequate to correct the pointing angle $\pm$5.0^{o}, however, the pedestal design incorporated in the THRPT-2-H/D system is continuously adjustable over the full 360 degree range. It is now only necessary to position the four mounting bolts in the square pattern as indicated by the pedestal footprint dimensional drawing in appendix B.) Compass orientation with respect to pedestal base plate is no longer a concern.

3.1.3 Heavy Duty Assemblies

Heavy Duty antenna/positioner assemblies can be utilized in portable applications, however weight and size may limit portability in some cases. A platform of heavy metal or concrete with imbedded anchor bolts is most suitable for Heavy Duty positioner units and will allow the user to take full advantage of the inherent high torque and superior wind loading capabilities. Detailed footprint drawings are supplied prior to delivery of each heavy duty system to allow adequate site preparation time.

3.1.4 Static Discharge

Static discharge due to lightning is of paramount concern in some locations. In general, the installation site should have a grounding system installed which is engineered to be adequate for lightning activity in the region. The antenna system is designed electrically such that a large copper earth grounding cable (0.25-0.50 in. diameter), can be connected by means of the bronze ground wire fitting mounted at the base of the pedestal.
Three static discharge monopoles are provided on the antenna assembly to ensure that at least one element is generally pointed skyward regardless of antenna orientation.

3.2 Hardware Interconnection and Setup

Interconnection of the hardware is largely accomplished in the manner of standard personal computer interconnection, with the exception of the remote antenna and positioner assemblies. A complete set of color photographs of each new system in operation at Telonics prior to shipment is provided for use in conjunction with Figure 3-1, "System Cable Interconnect Diagram", to assist the user during initial assembly and system operational tests. Please refer to Figure 3-1 and the example photographs while performing the operations detailed in the following paragraphs. For clarification, the Earth Station receiving system is broken down into three sub-systems. The interconnections for each subsystem are discussed in the following paragraphs:

1) Remote Antenna Subsystem (paragraph 3.2.1)

2) IF Receiver/Controller and Bit Synchronizer (paragraph 3.2.2)

3) Real-Time Orbital Prediction/Display paragraph 3.2.3)

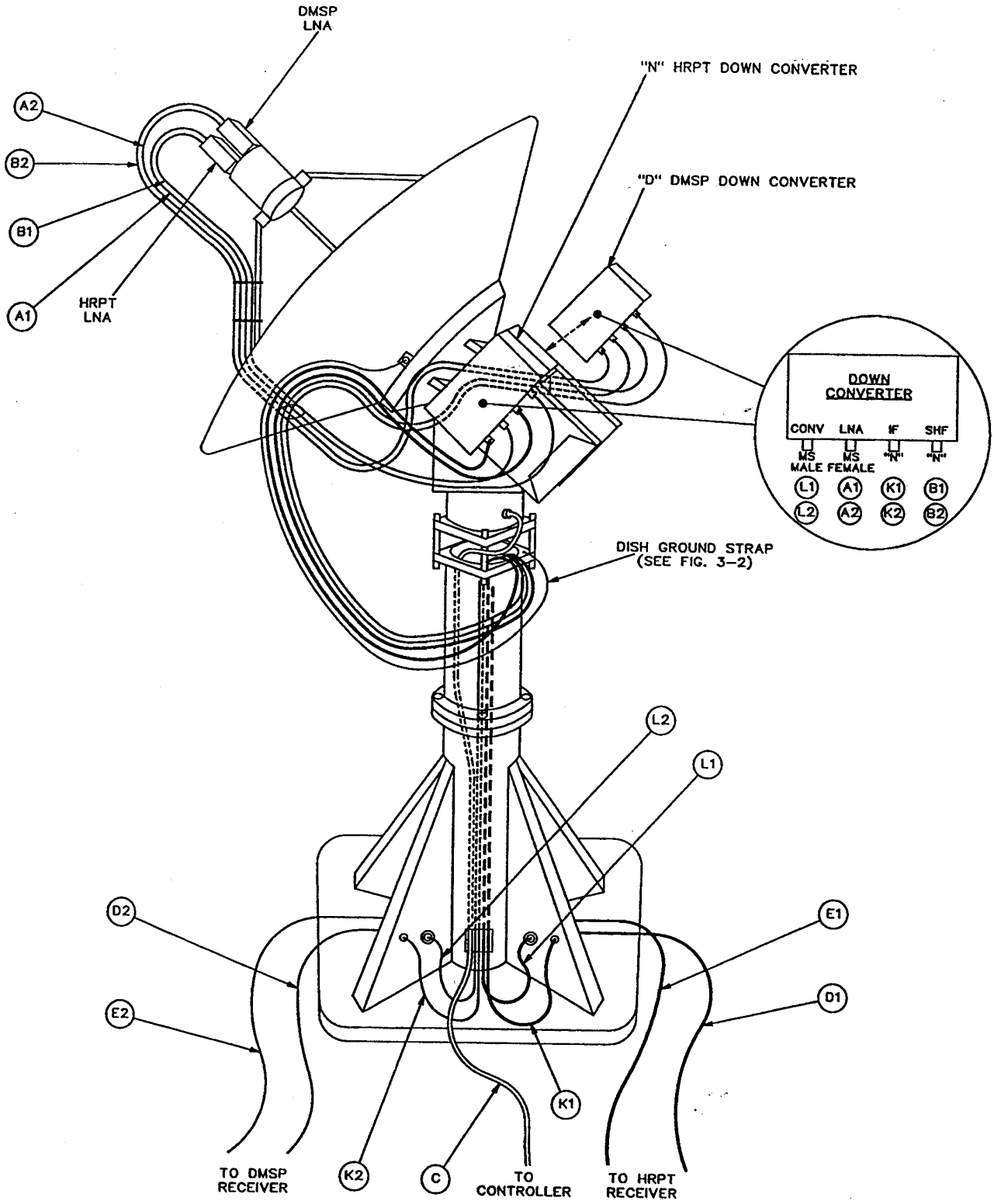


Figure 3-1, THRPT-2-H/D System Cable Interconnect Diagram

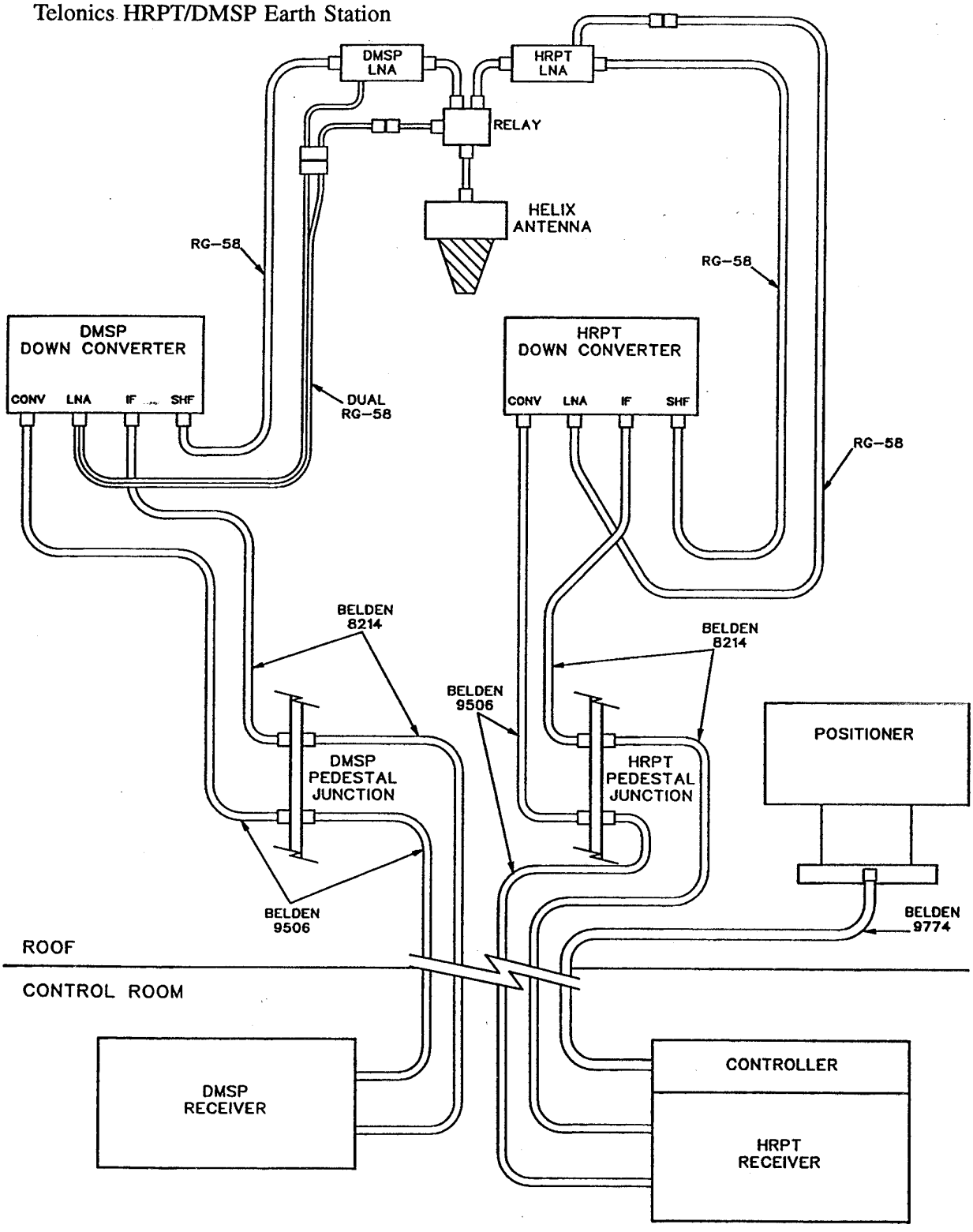


Figure 3-1.1, THRPT-2-H/D System Interconnect Diagram

THRPT-2 FUSE RATINGS

FUSE ID	FUSE TYPE
F1 & F2 CONTROLLER (INTERNAL)	3 AMP 250V SLOW BLOW AGC
F3 CONTROLLER POWER FUSE (J5)	2 AMP 250V GGS 5 X 20mm
F1 RECEIVER (J5)	2 AMP 250V GGS 5 X 20mm
F2 RECEIVER	1 AMP 250V GGS 5 X 20mm

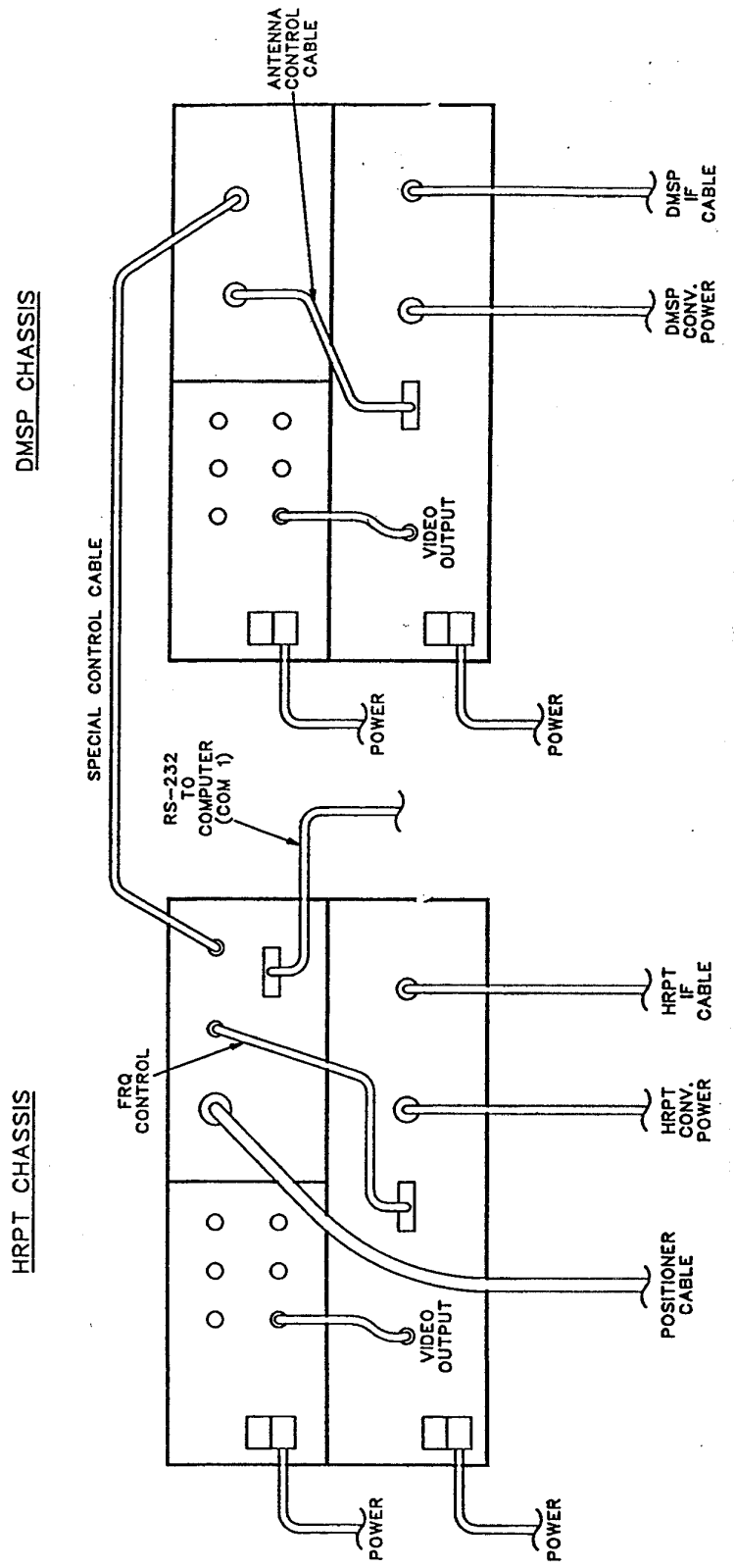


Figure 3-1.2, THRPT-2-H/D System Interconnect Diagram and Fuse Ratings

CABLE	CABLE TYPE	CONNECTOR 1		CONNECTOR 2	
		TYPE	PIN	TYPE	PIN
A1,A2	RG58 COAX	ADAPTED TO 2-PIN AUTOMOTIVE CONNECTOR	CENTER CONDUCTOR TO RED. SHIELD TO BLACK.	MS3106 MALE CONNECTOR	CENTER CONDUCTOR TO A. SHIELD TO B.
B1,B2	RG-58 COAX	"N" MALE CONNECTOR	STANDARD COAX. CONNECTION	"N" MALE CONNECTOR	STANDARD COAX. CONNECTION
C1,C2	12 CONDUCTOR CABLE SHIELDED	AMP 206037-1 CONNECTOR	1 GRN, 9 BLU/BLK 2 RED/BLK, 10 BLU 3 GRN/BLK, 11 YEL 4 WHT/BLK, 12 YEL/BLK 5 WHT, 13 BRN/BLK 6 RED, 14 BRN 7 SHLD/GND, 15 N/C 8 N/C, 16 N/C	AMP 206037-1 CONNECTOR	1 GRN, 9 BLU/BLK 2 RED/BLK, 10 BLU 3 GRN/BLK, 11 YEL 4 WHT/BLK, 12 YEL/BLK 5 WHT, 13 BRN/BLK 6 RED, 14 BRN 7 SHLD/GND, 15 N/C 8 N/C, 16 N/C
D1,D2	RG-8 COAX	"N" MALE CONNECTOR	STANDARD COAX. CONNECTION	"N" MALE CONNECTOR	STANDARD COAX. CONNECTION
E1,E2	3 CONDUCTOR SHIELDED	3-PIN DIN MALE CONNECTOR	A YEL B GRN (SHLD) C RED	MS3106 FEMALE CONNECTOR	A YEL B GRN (SHLD) C RED
G1,G2	RG58 COAX	BNC MALE CONNECTOR	STANDARD COAX. CONNECTION	BNC MALE CONNECTOR	STANDARD COAX. CONNECTION
H	25 CONDUCTOR CABLE	DB25 FEMALE CONNECTOR	STANDARD CABLE	DB25 FEMALE CONNECTOR	STANDARD CABLE
K1,K2	RG-8 COAX	"N" MALE CONNECTOR	STANDARD COAX. CONNECTION	"N" MALE CONNECTOR	STANDARD COAX. CONNECTION
L1,L2	3 CONDUCTOR SHIELDED	MS3106 MALE CONNECTOR	A YEL B GRN (SHLD) C RED	MS3106 FEMALE CONNECTOR	A YEL B GRN (SHLD) C RED

Figure 3-1.3, THRPT-2-H/D Cable Connections

3.2.1 Remote Antenna Subsystem

3.2.1.1 Remote Antenna Assembly

Every Telonics Earth Station is assembled, burn-in tested and carefully disassembled prior to shipment at our laboratories. The following process delineates the procedure for re-assembly on-site:

a. Carefully review the interconnect drawings and any photos supplied.

b. Inspect the pedestal mounting surface to ensure that it's structure and bolt pattern is in accordance with paragraph 3.1.2.

c. Install the four large, tubular aluminum spacers on mounting frame bolts. Mount the lower portion of the pedestal on the mounting surface and tighten the four large bolts and nuts (or lag screws for some wood platforms) permanently (be sure to use the lock washers). (The four large spacers must be used between the pedestal base and the mounting surface. **DO NOT MOUNT THE BASE OF THE PEDESTAL DIRECTLY AGAINST THE MOUNTING SURFACE - USE THE SPACERS!**)

d. Mount the upper section of the pedestal assembly, mating the circular azimuth adjustment rings carefully (be sure to use the flat washers against the adjustment ring surface and the lock washers under the head of each bolt). Snug two opposing bolts down securely. Snug the other two opposing bolts down finger tight.

e. Mount the positioner leveling base plate at the top of the pedestal as shown, using both flat and locking hardware. Level the plate as follows:

   Adjustment of the pedestal leveling assembly to set positioner base to true level attitude.

   Place the small level/protractor provided with the system on the upper surface of the positioner assembly base plate in an East/West orientation. Adjust the leveling nuts on the appropriate side of the pedestal leveling assembly equally as necessary to true the base of the positioner in this orientation (this adjustment must be within +/- 0.5 degree or better). **NOTE: Some models incorporate a built-in bubble level in the mounting plate on which the positioner sits.**

   Move the level/protractor 90 degrees (to the next side of the positioner assembly base plate) to a North/South orientation, and adjust the appropriate leveling nuts on the proper side of the pedestal leveling assembly equally as necessary to level the positioner base in this orientation (this adjustment must also be within +/- 0.5 degree or better).

Recheck both orientations for the proper leveling.

f. Assemble the three LNA Tripod legs to the LNA/Feed support clamp, leaving the six screws quite loose

NOTE: THE TRIPOD LEG, WITH THE CABLE ON IT, MOUNTS NEXT TO THE TWO INCH CABLE HOLE IN THE DISH.

g. Assemble the reflector ("dish") in accordance with Appendix C of this manual. Leaving the six screws provided very loose, mount the assembled feed/tripod to the dish. When you are satisfied that the tripod assembly is properly mounted and feels centered in the parabolic "dish" antenna, tighten the six screws permanently.

h. Remove the positioner from it's carton, carefully remove any foreign material from the bottom of the positioner and the surface of the pedestal mounting plate. Set the positioner on the previously leveled mounting plate atop the pedestal, in such an azimuth orientation that it's power/control connector faces toward the equator (or south from sites in the northern hemisphere). Align it over the mounting holes, and install the bolt/hardware sets as shown in the Manual. Tighten them permanently.

i. Using the azimuth adjustment ring assembly on the pedestal, rotate the positioner/upper pedestal slightly as required to point the connector on the positioner as exactly toward the equator as possible (usually this can be done within $\pm$3 to 5 degrees). **(Note that this direction is "True" bearing, as opposed to magnetic.)** Tighten two opposing locking bolts on the azimuth adjustment ring fairly secure, leave the other two only finger tight.

j. Be sure the bottom of the positioner and the top of the leveling plate are free of any foreign matter, to ensure a flat mating surface. With the aid of an assistant, lift the dish/feed assembly and place it atop the positioner (which must be oriented to the vertical and fully counter-clockwise - as shipped from Telonics). Use care to align the protruding locating pin in the dish assembly with its mating hole in the top of the positioner.

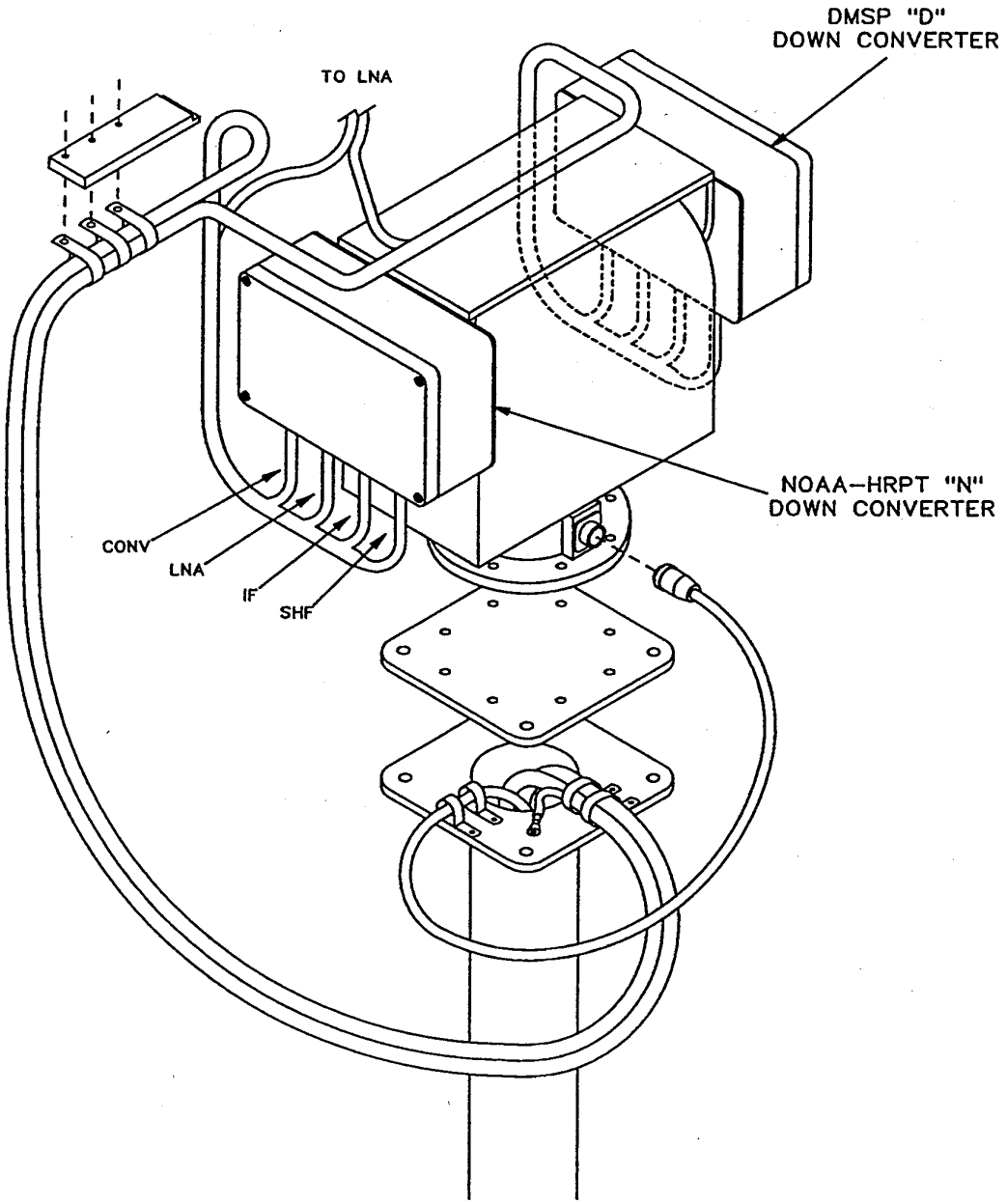
   Loosely install the four mounting bolts as shown by the photos provided. Gently rotate the dish assembly back and forth to ascertain that it is approximately "centered" on it's mounting bolts, then tighten the four bolts permanently.

k. Carefully install all cabling in accordance with Figure 3-2, Upper Pedestal Cable Dress, on page 14 and the following paragraphs:

   NOTE: Be certain to install the proper downconverters on the proper sides of the positioner. Note also that the DMSP cables must run back under the dish to reach the DMSP downconverter.

NOTE: Leave all cable clamps very loose until you are pleased with the cable dress. Then, tighten the clamps, install the black spiral cable wrap, tighten the connectors permanently, and tape all connectors with red self-vulcanizing tape.

NOTE: BE CERTAIN THAT THE LONG FEED/CONTROL CABLE LOOP IS "WRAPPED" IN THE PROPER DIRECTION OR IT MAY BE DAMAGED WHEN THE ANTENNA IS MOVED.



NOTE: POSITIONER MUST BE FULLY CCW AND AT 90° ELEVATION AS SHIPPED FROM TELONICS!

Figure 3-2, Upper Pedestal Cable Dress

The Remote Antenna Assembly requires the following connections:

a. Five (5) long system interface cables, (D1), (D2), (E1), (E2) and (C).

b. The antenna assembly proper requires four short cables to interconnect the LNAs and down-converters, (A1), (A2), (B1) and (B2). (Please refer to Page 7, Figure 3.1, System Cable Interconnect Diagram).

Power to each LNA is conducted by a short length of RG-58A/U cable (A), with a 3-pin MS type connector which mates with the female connector on the down-converter marked LNA.

Amplified D and E-Band RF signals are conducted from the LNAs to the down-converters by means of a RG-58 A/U shielded coaxial cable (B).

REMINDER: It is often helpful in assembly to leave all connections slightly loose until all cables have been properly positioned, then tighten all fittings snugly to seal the moisture gasket in the type "N" connectors. Assembly of these cables is critical. Connectors must be properly connected as indicated. Lead dress is shown in the accompanying color photographs. In general, each cable must be connected firmly and securely to its mating connector, then dressed properly to the positioner in such a way that the cables avoid mechanical interference as the antenna assembly moves.

The short system interface cables and dish ground cable must be connected and dressed properly or they will be damaged by positioner movement. The short system cables should enter the pedestal through the hole provided. The cables should then be brought up through the pedestal from the junction box and made to exit the top of the pedestal prior to connection at the positioner and downconverter.

NOTE: These cables should be dressed carefully in accordance with the color photos provided, allowing a free loop to track both elevation and azimuth movement easily without binding. Make certain any burrs and/or sharp metal edges created on bolt heads or any other portion of the pedestal hardware during assembly are removed to avoid cutting or other damage to the cable insulation in later use.

All five cables which move with the antenna assembly are covered with a protective spiral wrap.

The five long system interface cables are normally supplied in 250 foot (76.2 meters) length with all connectors installed and tested, but may vary on special order systems.

The first long system interconnect cable is the heavy, gray positioner control and power cable (Belden type 9774, style 1354, 12 conductor cable) (C). This cable provides interconnection

of all antenna power and positioning/control lines between the Remote Antenna Assembly Positioner and the Antenna Controller.

>>> CAUTION! <<<

High voltage motor power is carried by this cable assembly to the positioner when the antenna is moving. Fast-blow fuses are provided in series. A separate safety ground wire is also provided throughout this cable and the remainder of the system.

This cable does not move with antenna rotation and can therefore be mounted securely through the base of the positioner. The main consideration for this cable is that it remain clear of any movement or abrasion from contacting the moving downconverter control and RF coaxial cables. The end with the connector marked POSITIONER is to be mated to the connector on the base of the antenna positioner. The connector must be locked in place with the rotating collar provided as motor power and relatively high surge currents must pass through this connector to the positioner control motors.

The second and third long cables are black Belden type 8214 (RG-8/U) coaxial RF cable (D1) (D2), which carries the amplified RF/IF signals from the pedestal junctions to the IF receivers.

NOTE: The special type "N" connectors utilized with this cable are unique to this cable and cannot be substituted with conventional type "N" connectors.

The connector on the end should then be connected firmly to the lightning arrestors at the IF output connector on the down-converter unit.

The fourth and fifth cables are small gray Belden type 9506, power and control cables (E1) (E2) for the down-converters. Carefully route this cable from the pedestal junctions to the receivers as shown in the photos provided.

NOTE: In the event that the user should desire to secure the down-feed coaxial cable (D) or the down-converter power/control wires (C1) (C2) in any manner, it is suggested that the use of rigid cable ties for attachment of cables be avoided in favor of good quality electrical tape such as Scotch 3-M type 271 vinyl. The tape provides "soft" radii at the bend point of the cable (as opposed to sharp corners which result in cold flow of the dielectric and resultant variations in the characteristic impedance of the cables).

NOTE: Upon completion of the interconnects, the antenna assembly should be directed to move manually to the extremes of both planes of movement in order to check the cables for proper service loops.

To accomplish this task, first place the AUTO/MANUAL switch located on the front panel of the Antenna Control/Bit Synchronizer, in the MANUAL position (the red LED indicator will begin to flash). While in communication with a second individual who is at the remote antenna site observing the antenna and cable movement, the operator should direct the antenna through all possible positions of azimuth (0-360^{o}) and elevation (0-180^{o}).

Any necessary modification in cable dress to avoid damage should be made at this time.

3.2.2 IF Receiver/Controller & Bit Synchronizer

The IF Receiver/Controller and Bit Synchronizer Subsystems are composed of the following hardware items: the IF receivers, the bit synchronizer and antenna controller unit.

NOTE: All hardware items connected to AC power should use a surge-protected 120 Volt, 50/60 Hz AC power strip. The AC power should be suitably polarized and protected with common ground lines and third-wire ground prongs on AC plugs.

The receivers and bit synchronizer, and controller for the antenna positioner are mounted in two small rack cabinets. The DMSP receiver and it's bit sync occupies one rack, while the NOAA receiver, bit sync, it's antenna and controller are fitted in a second rack assembly.

Each IF receiver requires four cables in addition to AC power.

1.) A connection to the Belden #8214 coaxial cable (D1) or (D2) from the proper down-converter at the remote antenna/positioner subsystem discussed previously. This cable should be directly connected to the lightning arrestor on the type "N" jack (J1) on the rear apron of the receiver.

2.) The Belden 9506 cable with a 3-pin DIN connector (E1) or (E2) conducts system control signals between (J2) on the receiver and the proper down converter.

3.) A cable with a DB 9 connector (F), connecting from (J4) on the receiver, to (J7) on the controller for automatic frequency switching or antenna switching control.

4.) A RG-58/U coaxial cable (G) connecting the IF receiver Bi-Phase Video output (J3) to the bit synchronizer (J2).

The bit sync/antenna controller portion of the assembly requires five cables in addition to AC power.

1.) A RS-232C cable (H) connecting between connector (J1) labeled COMPUTER on the controller unit, and the COM1 (RS-232C) port on the computer.

2.) On the NOAA-HRPT cabinet only, the Belden #9774 type 1354 antenna control cable (C) which connects the controller output jack (labeled POSITIONER J3), to the remote antenna positioner.

3.) The cable with a DB 9 connector (F), connecting from (J4) on the receiver, to (J7) on the controller for automatic frequency switching or antenna switching control.

4.) A RG-58/U coaxial cable (G) connecting the IF receiver video output (J3) to the bit synchronizer (J2).

5.) A 1/4" stereo phone plug and special control cable to interconnect the control circuits in each chassis.

3.3 Interference Considerations

Interference from nearby electronic devices which radiate spurious Radio Frequency signals are rarely a problem with the DMSP earth station due to two primary factors:

1. The directionality of the system is exceptional. It is generally "looking" only at a very narrow, well-defined region of space, ignoring surrounding noise sources.

2. The noise level at the frequencies involved is highly directional, and less frequently encountered than that of the lower VHF and UHF frequencies.

In time, the noise level will doubtless increase as more equipment near this portion of the spectrum reaches the public sector (radar security detectors, etc.). The user should be aware and concerned, however, that the Intermediate Frequency (IF), from the antenna mounted down-converter is in the VHF region, and although well shielded, may be subject to interference from nearby high-level RF sources. The user should become acquainted with, and be aware of, possible sources of interference to avoid future problems.

Since this receiving system is extremely sensitive (receiving a five watt transmitter from space), any source of Radio Frequency Interference in the downlink regions may interfere with reception. It is therefore advisable to locate the remote antenna assembly well away from any possible sources of interference. Should interference be encountered, the antenna controller can be readily switched to the MANUAL mode, then directed toward the exact source of the interference based on the receiver's signal strength meter.

4.0 SPECIFICATIONS

The following specifications define the basic Telonics DMSP Earth Station. All system hardware operates from standard 110-120 VAC, 50-60 Hz mains power.

4.1 Antenna System

Antenna Type	Aluminum mesh Parabolic Dish
F/D	0.4
Diameter	1.5 m
Beamwidth (1db beamwidth) (3db beamwidth)	$\pm$ 4° $\pm$ 7.5°
Acquisition Elevation	10° Maximum (typically less than 5°)
LNA Noise Temperature	55-65 Kelvin (typical)
System Noise Temperature	better than 100 K typical
System G/t	4dB/dgK typical
Sun Noise Y-value	5.5-6 dB (typical) with 10 cm ref. noise value=187
Interdigital Filter	4 pole Chebycheff, 2% BW, passband loss <1dB
Positioner Movement	180° elevation over 360 azimuth - with automatic zenith stowing -Automatic 180° "flip" operation
Limit switch protection	Full override

4.2 Antenna Control

Tracking mode	Program controlled - Updated automatically in real time

The controller and positioner is capable of maintaining pointing resolution of ≤ two degrees, dependent upon the particular model Telonics antenna positioner selected for the respective system. System performance assures operation without loss of lock throughout all pass geometries. Real-time program positioning with angular contingent updating is utilized.

The antenna may be positioned manually over its entire control range at any time. When returned to the AUTO mode, the system will resume automatic control, and will immediately begin to track in the event of an on-going pass, dependant upon computer commands.

4.3 Preamplifier/Downconverter

RF Input	1698-1707 and 2250 MHz Bands
IF Output	137.0 MHz
Cable Length	100 meters max. (can be extended with factory modification)

4.4 Receiver

IF Input	137.0 MHz
Doppler Sweep Range	± 100 KHz
Acquisition Sensitivity	≤ 80 dbm minimum
Frequency Selection	Automatic under software control, with MANUAL override
Output	Bi-phase (low impedance output)

4.4.1 Bit Synchronizer

Input Compatibility	
Bit Sync 1	NRZ 1024 Kbits/sec
Bit Sync 2	665. Kbits/sc B0-L
Input Voltage Range	0.25 to 10.0 Vpp
Input Impedance	10K shunted by 100 ohms (also available shunted by 100 pf)
Tracking Range	± 10% of center frequency plus an additional 10% through the use of the front panel loop stress null control and meter.
Outputs	NRZ, 0^{o} and 90^{o} clock and bi-phase Tape and sync status.
Tape Recorder Output	Bi-phase
Sync Threshold vs. Noise	Synchronization is maintained down to a S/N ratio of 6dB.
Sync vs. Jitter	Synchronization is maintained with jitter amplitudes less than 1% of the bit rate occurring at any rate of change.
Sync vs. Acquisition Time	Average acquisition time for an input signal within the loop band-width is 200 bit periods.
Resolution of Clock Ambiguity	The Telonics Bit Synchronizer will resolve subsequent to Initial loop Sync, clock ambiguity after 16 data transitions in Bi-phase. Resolution is then held indefinitely as long as the noise or jitter threshold of the loop is not exceeded.
Bit Error Rate vs. Noise	Within 2 dB of theoretical down to S/N ratios of 6 dB. (standard B.E. curve)

5.0 MECHANICAL/ENVIRONMENTAL

5.1 Outdoor Hardware

Windloading:

Operational	55 MPH
Stowed at zenith	90 MPH

NOTE: Radomes for installations requiring 110 MPH capability can be supplied.

Maximum Antenna Weight:	75 lbs
Temperature Range:	
Operational	-25°C to +80°C
Storage	-55°C to +85°C
Weight:	
Pedestal	55 lbs
Positioner	50 lbs
Dish/mount Assembly	55 lbs
Antenna Mounted Electronics	15 lbs
Assembly Weight:	175 lbs
Dimensions:	
Height at Zenith	86 in.
Height at Horizon	74 in.
Radius for Radome Clearance	40 in.
Humidity:	100%
Allowable Icing: (Mechanical consideration only - RF attenuation varies with ice composition). Suitable for use in driving rain.	minimal

Positioner housing:

Telonics antenna positioners employ robust metal housings with neoprene flat and/or O-ring seals incorporating teflon bearing sealing surfaces and/or sealed metal bearings. All units incorporate motor drive limit switches, with all electronics enclosed within a sealed metal housing.

5.2 Indoor Hardware

Humidity:		
	Operating:	5% to 95% non-condensing
Temperature:		
	Operating	0°C to 50°C
	Storage	-20°C to +85°C

APPENDIX A

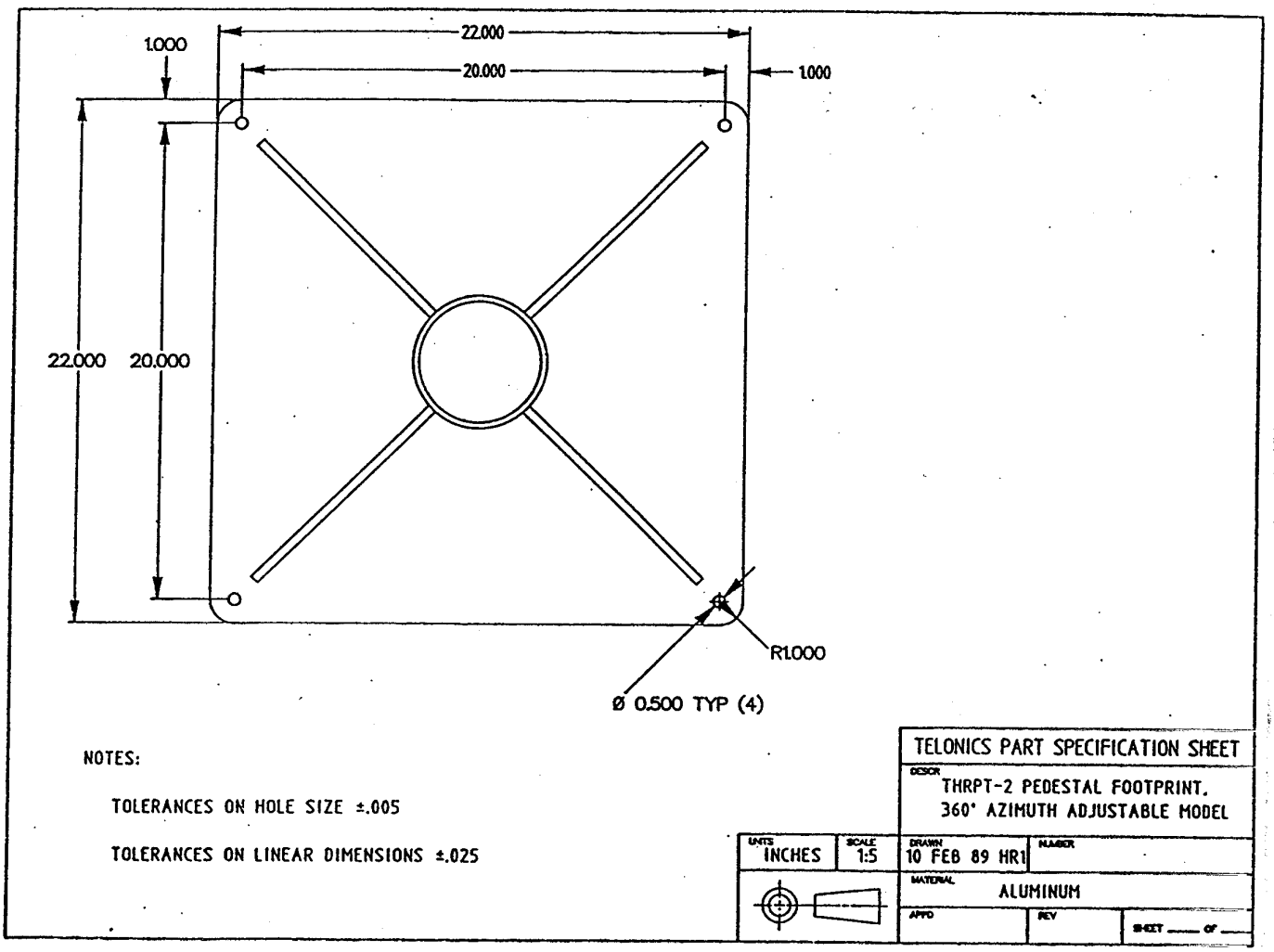


Figure A-1, Positioner Pedestal Footprint Drawing

APPENDIX B

Antenna/Positioner Calibration

The following procedure delineates alignment of the receiving antenna and position controller system as required to ensure proper boresight tracking at all angles. It is suggested that the following instructions be followed sequentially for best results.

Two alignment processes are discussed:

The first is a very simple method which involves only leveling of the positioner mounting base plate, and a simple sun/moon alignment. Since all Telonics antenna positioners are laser aligned as of September 1989, systems utilizing antenna positioner/controller units shipped from Telonics as matched pairs will require only the simplified alignment (all new systems utilize matched units and will require only simple alignment).

The second method of alignment is quite detailed and need only be utilized when either the antenna positioner, or the controller unit is replaced or updated, or anytime you are dealing with positioners or controllers which were not laser aligned at the Telonics laboratory as a matched pair.

NOTE: These instructions are written for installations in the northern hemisphere (systems oriented such that the antenna positioner limit switch is facing south). In general, the system must always be installed such that the azimuth positioner limit switch faces in the direction of the equator.

(When installing the system in the **southern hemisphere**, the antenna positioner limit switch must face north. Additionally, Jumper switch JP 2 Pins 13,14 on the RS-232 antenna drive board in the antenna controller drawer must be changed to the OFF (open) position. This change will be accomplished during factory test and alignment procedures when it is known that the system will be installed in the southern hemisphere at the time of initial shipment.)

Switch JP 2 is normally configured as follows prior to shipment from the factory:

JP 2 pins	Condition	Description
1 2	closed	} Switches 1 and 2 determine interface
3 4	open	} baud rate - factory set at 2400 baud.
5 6	closed	Terminate messages returned to host with CR/LF.

7 8	open	Set Reporting Mode to host at power-up equal to: "None"
9 10	closed	Set Reporting Format to host at power-up equal to : "fractional"
11 12	open	Controller configured for 60 Hz AC power.
13 14	closed	Azimuth limit switches facing South.

As previously noted, the entire antenna assembly must be physically positioned with the positioner limit switch stop facing the equator.
The procedure begins by assuring that the base of the positioner unit is mechanically level, and continues through the entire positioner assembly using the alignment fixturing provided.

1. Adjustment of the pedestal leveling assembly to set positioner base to true level attitude.

    a. Place the small level/protractor provided with the system on the upper surface of the positioner assembly base plate in an East/West orientation. Adjust the leveling nuts on the appropriate side of the pedestal leveling assembly equally as necessary to true the base of the positioner in this orientation (this adjustment must be within +/- 0.5 degree or better).

    b. Move the level/protractor 90 degrees (to the next side of the positioner assembly base plate) to a North/South orientation, and adjust the appropriate leveling nuts on the proper side of the pedestal leveling assembly equally as necessary to level the positioner base in this orientation (this adjustment must also be within +/- 0.5 degree or better).

    c. Recheck both orientations for the proper leveling.

If you are working with a matched positioner/controller unit which has been laser aligned at Telonics (all new systems are now aligned in this manner), you need only do the following simple sun (or moon) azimuth alignment.

(If you are replacing or updating either the antenna positioner or antenna controller, you must proceed with the detailed alignment, continuing with step (2).)

d. **SIMPLIFIED AZIMUTH SUN/MOON ALIGNMENT**

The leveling operations accomplished in step (1) above are adequate to assure proper tracking in the elevation axis. It therefore remains to adjust the antenna system for proper calibration in the azimuth axis. This is readily accomplished

without the aid of survey instruments by directing the antenna to track either the sun or the moon with your computer (this alignment procedure assumes that the sun is presently out and available as a reference, however the moon may alternatively used if it is out and the night is clear. In the event that neither object is available and you cannot wait for favorable conditions, you must proceed with the detailed procedure at step (2)):

- Move the **AUTOMATIC/MANUAL** control switch on the antenna controller to the **AUTOMATIC** position. (The green LED indicator will light).

- Direct the antenna to track the desired object with your computer. Press the [**S**] key once again to sequence to the next object, which is the sun. The notation **SUN ET** will appear at the top center of the display. If the sun is above the horizon, the antenna will begin to slave to the current position of the sun. As a side note, you might wish to observe the **SIGNAL** strength meter at the left of the receiver panel. At the last moment as (and if), the antenna reaches the exact bearing of the sun, the inherent sun temperature noise will be received by the system, causing the **SIGNAL** meter to increase a few minor divisions.

NOTE: It is not advisable to leave the antenna in the sun tracking mode for extended periods of time. Normal alignment periods of less than 15 minutes or less are no problem.

-Once a suitable shadow from either the moon or the sun is obtained at the center of the parabolic reflector, you may now proceed to the antenna site to observe the shadow beneath the feed horn. If the antenna positioner is oriented exactly correct on the mounting pedestal, you will note a round shadow precisely in the center of the parabolic "dish", exactly under the LNA/tubular radiator assembly on the tripod mount. Remember that the antenna is still tracking the sun and will move very slightly periodically to adjust for the movement of the earth. It is normal for the shadow to move very slightly off-center between automatic antenna adjustments by the controller system, but it should re-center approximately with each correction. If your positioner is a type which normally exhibits one or two degrees of mechanical play in each direction, gently move the antenna back and forth in azimuth to determine that the shadow is generally centered in the mechanical "dead band" between which extremes the system automatically corrects.

-If the shadow generally is noted to be off center or is favoring one side more than the other, back out two opposing bolts on the azimuth adjustment ring of the pedestal assembly substantially, then loosen the two remaining opposing bolts just enough that you are able to rotate the upper portion of the positioner easily when holding the edges of the pedestal just under the positioner leveling plate.

-gently rotate the positioner as necessary to center the shadow within any mechanical dead band. **DO NOT USE THE DISH AS A HANDLE TO ROTATE THE ASSEMBLY**, as the system will sense the movement on each side of the mechanical dead band and will continually attempt to compensate, making alignment very difficult or impossible. When the shadow is satisfactorily centered in the dish, tighten down all four bolts. Verify proper centering of the shadow to complete the process.

NOTE: In the event that you note the shadow to be improperly centered in the vertical axis, you must complete the initial vertical alignment portion of the detailed procedure beginning with paragraph (2) and specifically paragraph (6) following this discussion, which involves a simple alignment using the level supplied with the system on the face of the antenna (or alternatively, the side of the tubular radiator feed). When the elevation has been satisfactorily aligned, repeat the simple sun (moon) azimuth alignment.

-You may now direct your computer system to resume normal automatic real-time satellite tracking operation (the system may either be tracking a satellite in a current pass, or the antenna may stow to the zenith and await the next satellite).

(NOTE: Although signal strength increase due to sun noise which was discussed in the previous paragraphs is moderated by the internal Automatic Gain Control system within the receiver, this technique actually tests your entire system totally, from the reflector through the LNA and receiver. This signal increase due to solar noise can be readily compared to scientific solar measurements at any time of day. When compared to readings from "cold" areas of the sky, this procedure is recognized as the best and final test of a modern receiving system. You may use this technique as a confidence test of your system any time you wish).

CONTINUATION OF DETAILED ALIGNMENT PROCEDURE

2. Turn on the power to the controller/bit-synchronizer and move the **AUTOMATIC/MANUAL** switch to the **MANUAL** position. (The red LED indicator will begin to flash).

3. Adjustment of the RF tubular radiator feed assembly (assumes the dish antenna is not facing directly skyward initially).

   a. With the antenna facing the horizon, hold a long level (or a straight edge with a good level) vertically across the face of the parabolic reflector "dish".

   b. Have an assistant move the dish as necessary using the manual **UP/DOWN** switch on the front of the controller until the level indicates the dish to be exactly at 90 degree elevation (facing directly upward).

   c. Have the assistant rotate the level 90 degrees across the face of the dish to check the parabolic dish reflector for a level condition. Recheck both orientations for a level condition within 0.5 degrees.

   NOTE: If the condition is not level in both planes, re-adjust the positioner mounting plates on the pedestal.

   d. Without moving the dish from its true vertical (zenith) position, assure that the distance from the front of the feedhorn to the center of the dish is exactly 54.25 centimeters (21.36 inches). If adjustment is necessary, slightly loosen the two clamp bolts on the tubular radiator feed unit and slide it toward or away from the center of the dish as necessary. Do not overtighten the clamp bolts and deform the feed! (Double check your measurements prior to actually moving the feed assembly, as it is rarely necessary to make this adjustment.)

   e. Again, without moving the dish from it's true vertical (zenith) position, using the supplied small level/protractor, adjust the tubular radiator feed so that it is perpendicular to the center of the dish. This is done by making sure the sides of the feedhorn are vertical since the antenna is (at this point in the alignment) accurately pointing to the zenith. Place the small level on at least two places on the sides of the feedhorn at right angles to each other. If adjustment is necessary, slightly loosen the two clamps on the tubular radiator feed unit and slightly "cock" it at the appropriate slight angle as necessary as necessary for correction. Do not overtighten the clamp bolts and deform the feed! (Again, double check your measurements prior to actually moving the feed assembly, as it is very rarely necessary to make this adjustment.) This adjustment MUST be within 0.5 degrees of true. Also, be certain that the focal length adjustment made previously in step (c.) is not adversely effected.

4. Azimuth/Elevation Alignment

a. Turn on the power to the controller/bit-synchronizer and move the **AUTOMATIC/MANUAL** switch to the **MANUAL** position (red LED flashing).

b. Execute a suitable terminal program on the Host computer.

c. Set the communication parameters to: 2400 baud, No parity, 8 data bits, and 1 stop bit. (2400, N, 8, 1, COM1)

d. For alignment, it is necessary to temporarily feed specific instructions to the microprocessor in the controller in order to avoid automatic offsets in the azimuth plane. This is easily accomplished by directly typing the following commands through the communications program. They will be sent to the controller which will act upon them until such time as power is interrupted. In the event that power to the controller is interrupted during alignment, it will be necessary to reload the following commands. (The antenna controller automatically resets upon a power interrupt.) **Enter only the bold text**, not the descriptive comments.

STEP	INPUT	DESCRIPTION
1)	**RN <ENTER>**	Set the reporting mode to None. (Upper or Lower case is o.k.)

NOTE: You must be sure to enter all **spaces** between input data!

2)	**XC <ENTER>**	Examine constants.

The screen will display the following for current model THRPT-2 systems:

015 000 000 002 001 005 000 002 002 002 002 005 005 005 016 000 016

3)	**XC 08 000 <ENTER>**	This sets the eighth constant to zero and changes the azimuth minimum dead band to zero degrees.

NOTE: You must be sure to enter all **spaces** between input data!

4)	**XC <ENTER>**	Check the eighth constant for a change to zero.

For THRPT-2 systems, the computer should report back:

015 000 000 002 001 005 000 <u>000</u> 002 002 002 005 005 005 016 000 016

5) **RC** <**ENTER**> Set reporting mode to **C**hange.

R2 <**ENTER**> Set reporting format to **F**ractional.

The screen now will display azimuth and elevation as follows:

000.0	**000.0**
(Elevation)	(Azimuth)

6) <u>Elevation Alignment</u>

(A) The **AUTOMATIC/MANUAL** switch on the controller must be in the **MANUAL** position (Red LED flashing). Move the antenna to 0° Elevation with the **UP/DOWN** Switch, then check the actual elevation with a long level placed vertically between the top and bottom edges of the dish antenna. Move the **UP/DOWN** switch to position the antenna at 0° elevation. Check the computer screen for indicated elevation. If it is not 0.0 $\pm$ 0.5°, adjust the **elevation zero adjustment** on the back panel of the controller chassis. (please refer to Figure B-1, Controller Chassis - Back Panel.)

NOTE: The readout on the display monitor will not indicate less than zero even if the positioner moves below the 0° horizon. It is therefore necessary to start above zero and "bump" the dish down in very fine increments - taking care not to "pass" zero.

(B) Move the antenna to 180° elevation with the **UP/DOWN** switch. Then check the actual elevation with the long level held vertically. With the dish positioned at 180°, check the computer screen for indicated elevation. If it is not 180.0 $\pm$ 0.5°, adjust the **elevation full scale** adjustment on the back panel of the controller chassis. (Please refer to Figure B-1, Controller Chassis - Back panel.)

(C) Recheck the 0° elevation and 180° elevation positions, then check the 90° elevation position using the long level. If all indications are $\pm$ 1° or less, go to the next step.

7) Azimuth Alignment

(A) With the **AUTOMATIC/MANUAL** switch set for **AUTOMATIC** (the green indicator LED will be on), enter the following commands to the computer:

NOTE: Be sure to enter the space in each command.

STEP	INPUT	DESCRIPTION
(1)	**PA 10 <ENTER>**	Moves antenna to 10° elevation
(2)	**PB 200 <ENTER>**	Moves antenna to 200° Azimuth
(3)	**PA 0 <ENTER>**	Moves antenna to 0° elevation
(4)	**PB 180 <ENTER>**	Moves antenna to 180° elevation

(B) Adjustment of the **AZIMUTH Zero Adjustment Pot**entiometer (on the back panel of the antenna controller) is normally required **only in the event that the positioner or controller is replaced as a separate unit**. In general, DO NOT MOVE THE AZIMUTH ZERO ADJUSTMENT. If, however, the factory supplied antenna controller/positioner matched set is separated or if either unit must be matched to a replacement unit, the following procedure must be followed in order to properly adjust this control:

NOTE: The following procedure assumes the continuing use of terminal software in accordance with the preceding paragraphs.

1) Ascertain that the controller's **AUTOMATIC/MANUAL** switch is in the **MANUAL** mode (this position is indicated by a flashing RED indicator light).

2) Using the MANUAL CCW/CW switch, rotate the positioner to the FULLY CCW position (until it stops due to the internal limit switch), and note the AZimuth bearing display indicated on the monitor. The indicated reading should be 180 to 182°.

3) Using the same CCW/CW switch, rotate the positioner ClockWise until the AZimuth display increases by an additional 10° (it should indicate 190° or very slightly higher).

4) While watching the AZimuth feedback numbers on the display (the right-hand column), turn the **AZ Zero Pot** on the back panel of the controller **C**lock**W**ise until the indicated AZimuth value indicates **10° higher** than the value obtained in step (3) above. (Typically 200 to 202°).

5) Rotate the positioner fully CCW in azimuth until it automatically stops due to it's internal limit switches.

6) Note the AZimuth feedback number once again, it **must be greater than 180°. If the value displayed is equal to 180°, repeat steps 2 through 6 above until an indicated value greater than 180 degrees is obtained**.

7) With the positioner remaining in the FULLY CCW position from step (5) above, adjust the **AZ**imuth **Zero Adjustment** potentiometer **very slowly ClockWise** until the indicated Azimuth feedback indication on the display **just** reaches 180° - **do not turn the pot further ClockWise beyond this point** (the circuitry will not indicate less than 180° by design). In the event that you accidentally rotate the pot further CW, turn it back a turn or two CCW and repeat this step until the display just "ticks" over to 180°.

This completes the alignment of the Azimuth Zero Adjustment Potentiometer.

(C) Next, move the positioner manually to 90° elevation. Then install the supplied large calibration plate on the bottom of the positioner by placing it over two of the four large mounting bolts on the bottom of the lower leveling plate using the two extra 1/2-13 nuts supplied in the calibration kit. The calibration mark labeled (**E**) must be facing the Equator, which will place the mark labeled (**P**) toward the Pole of the earth for the particular hemisphere in which the installation is located. (Please refer to Figure B-2 - Alignment Fixture).

Next you install the small upper calibration plate. You will note that the dish assembly mounting screws are countersunk and cannot be used to mount the upper calibration plate due to the small distance between the movable positioner mounting plate and the cover of the positioner. Accordingly, it is necessary to make sure the dish is in a position of 90 degrees elevation, and remove the appropriate two dish mounting bolts. Using the two bolts/nuts supplied with the small calibration plate, mount the plate as described above. **CAUTION, do not move the dish from it's vertical position at any time during azimuth calibration, or the mounting bolts will damage the positioner housing**. Be sure to remove

the two temporary mounting bolts upon completion of alignment and replace them with the two countersunk bolts originally removed from the dish mounting plate.

CAUTIONS: When moving the antenna positioner with calibration plates installed, it is necessary to manually keep the cables from catching on the plate! The cable assembly can be destroyed if this caution is not heeded!

After using the calibration plate with THRPT-2 units, be certain to remove the two temporary attachment bolts. If left in place, these bolts will protrude sufficiently to damage the housing of the positioner as the antenna moves in elevation.

(D) Install the supplied pointer on the upper calibration plate, then physically adjust the pointer to align exactly with the (**E**) mark on the large lower calibration plate and tighten securely in position. It may be necessary to bend the pointer slightly in order to align the pointer exactly with the (**E**) (Equator) alignment mark on the calibration plate.

(E) Enter the command **PA 90** <**ENTER**>, then enter the command **PB 170** <**ENTER**>. (Be sure to put in the space between the [**A**] and the [**9**]; and the [**B**] and the [**1**]). Move the **AUTOMATIC/MANUAL** switch to **AUTOMATIC**. After the positioner has stopped moving, turn the **AUTOMATIC/MANUAL** switch to **MANUAL** (the red indicator LED will begin to flash). Then move the **CCW/CW** switch until the pointer on the positioner exactly matches the 170^{o} mark ("O" on the calibration plate). The computer screen should now display $170.0^{o} \pm 0.5^{o}$. If adjustment is required, adjust the **Full Scale Azimuth** trimpot on the back panel of the controller chassis until the display indicates $170.0^{o} \pm 0.5^{o}$. (Please refer to Figure B-1 - Controller Chassis - Back Panel.)

(F) After successful completion of the preceding adjustments, move the **AUTOMATIC/MANUAL** switch to **AUTOMATIC** (the green indicator LED will come on). Enter the following commands:

PB 160 <**ENTER**> and wait for the positioner to stop, then enter **PB 170** <**ENTER**> and wait for the positioner to stop. This causes the controller to move the positioner to 160 degrees azimuth and then back to 170 degrees azimuth in order to check for hysteresis and repeatability. Again, check the pointer to see if it points exactly to the (**O**) mark on the calibration plate when displaying 170 degrees.

Repeat steps (D) through (F) until the positioner accurately places the pointer over the "E" mark when at 180 degrees, and over the "O" mark when at 170 degrees (using the computer to direct the positioner to the necessary azimuth bearings). **Be sure to have an assistant guide the cable assembly past the alignment plate at all times.**

(G) Remove the calibration plate and pointer from the positioner.

With the **AUTOMATIC/MANUAL** switch set for **AUTOMATIC** (the green indicator LED will be on), enter the following commands to the computer:

STEP	INPUT	DESCRIPTION
(a)	**PA 10 <ENTER>**	Moves antenna to 10° elevation
(b)	**PB 200 <ENTER>**	Moves antenna to 200° Azimuth
(c)	**PA 0 <ENTER>**	Moves antenna to 0° elevation
(d)	**PB 180 <ENTER>**	Moves antenna to 180° elevation

(I) The positioner will now be pointing the antenna in the direction it "believes" to be 180.0 degrees (due South in northern hemisphere installations). Sight across the dish (90° from the South) using the magnetic compass and adjust the compass reading by adding or subtracting the local declination (**CAUTION: SOME BUILDINGS WILL DISTORT THE COMPASS READING**), then physically rotate the positioner unit until the dish actually faces 180 degrees (due south in northern hemisphere installations). This is accomplished by loosening the four large bolts at the rotation ring in the center of the pedestal, and very slightly . . .rotating the positioner by hand. An adjustment of 360° is possible by moving the four bolts to their alternate position. Securely tighten the nuts when alignment is completed, then final check the alignment. Don't forget to adjust compass readings by the proper magnetic declination to arrive at the true heading.

NOTE: Step (I) is to be used only if not using sun alignment.

Turn off the power to the controller and **leave it off for at least 5 seconds to completely reset the controller.**

Turn controller power on.

Execute your automatic software, restoring the system to full operation.

Conduct the simplified Sun (or Moon), azimuth alignment in accordance with paragraph 1.(d.) as a final means of checking total tracking.

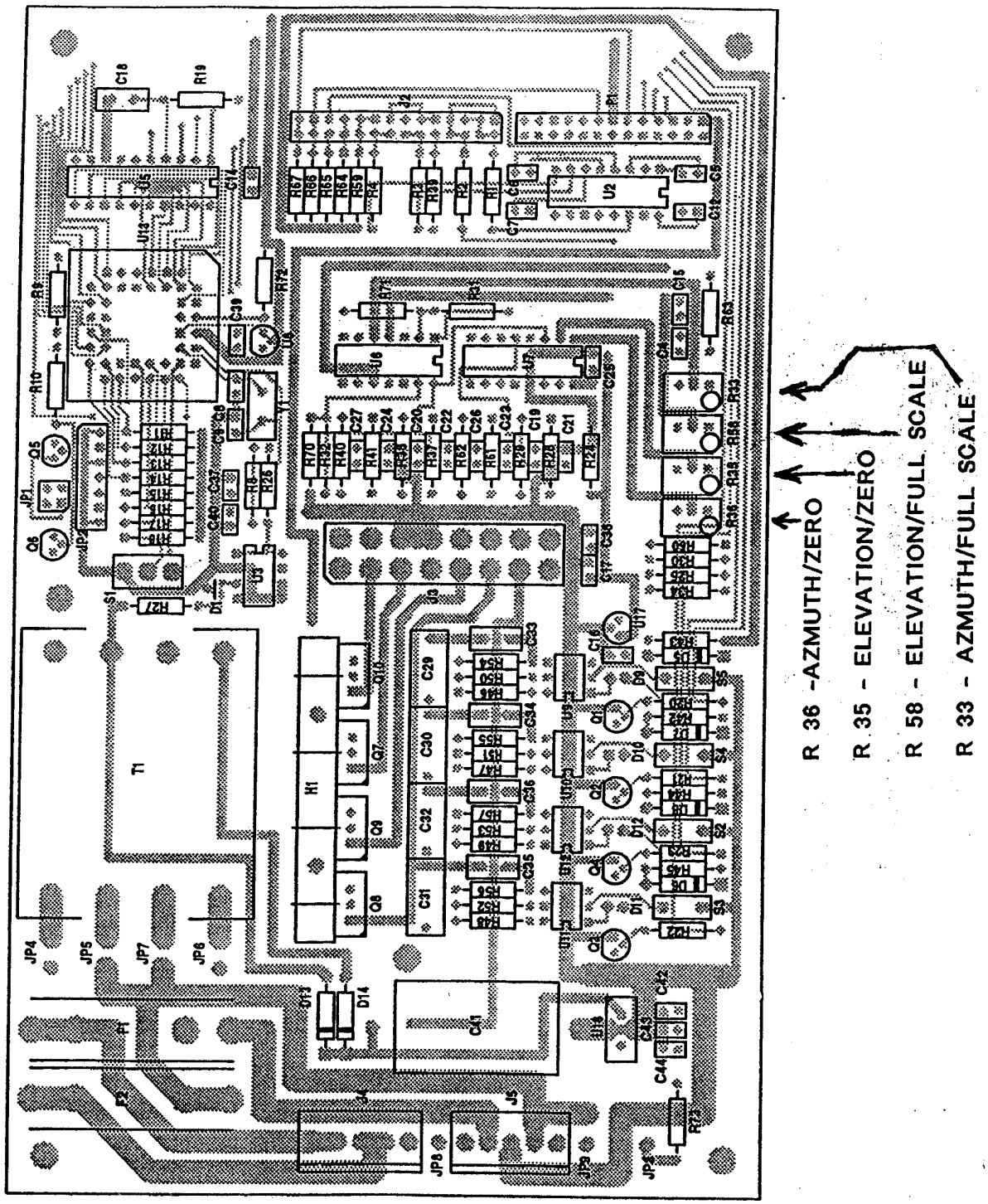


Figure B-1, Controller Chassis - Back Panel

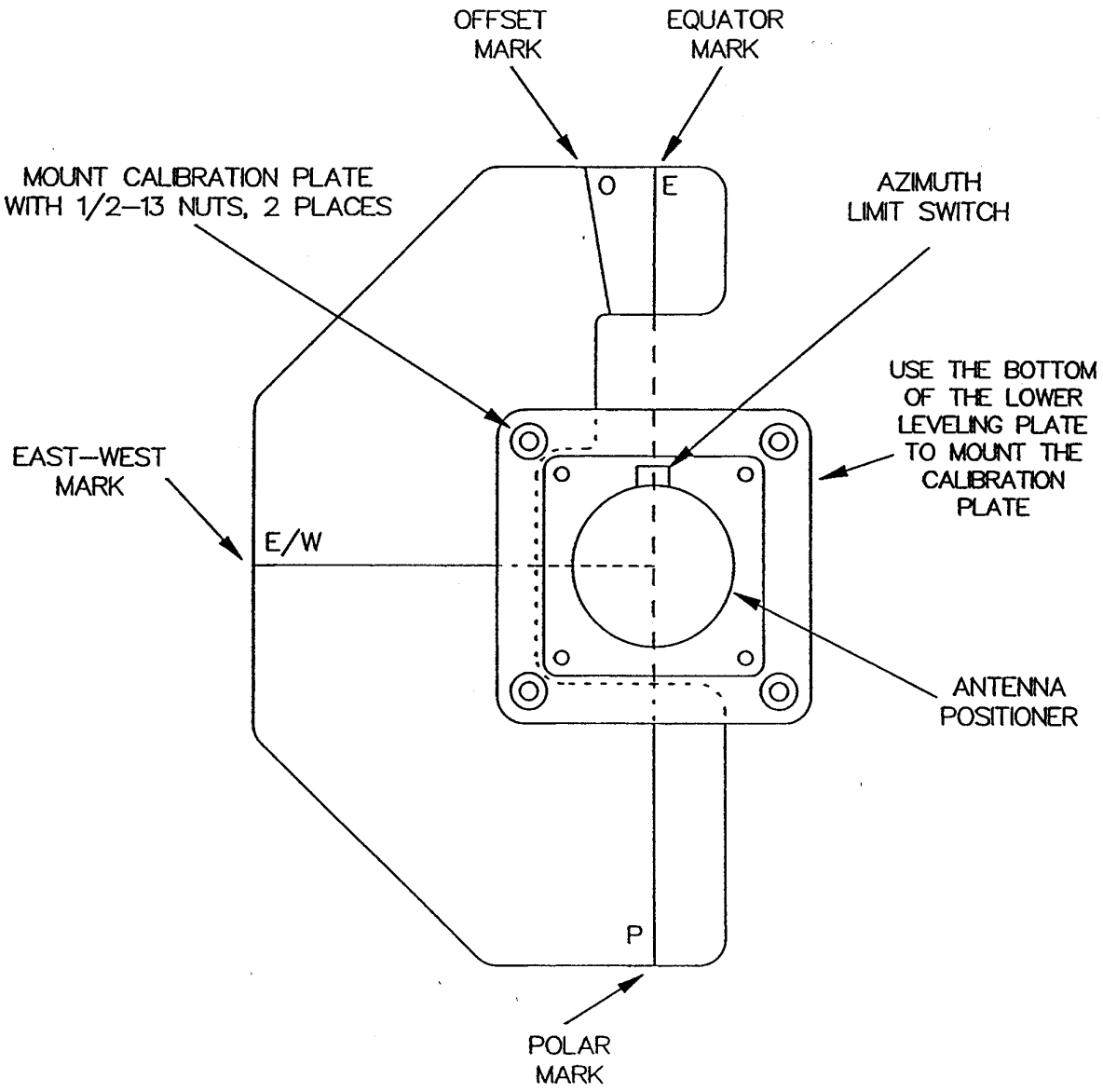


Figure B-2, Alignment Fixture

APPENDIX C

Please refer to Figure C-1, Antenna Reflector/"dish" Assembly. The mesh antenna reflector (or "dish"), is fabricated in four (4) quarter sections. As part of the alignment, test, and burn-in process at our laboratories, each antenna was marked with colored dot patterns so that it can be re-assembled in the field in exactly the same orientation. (Both colors and dot patterns were utilized to preclude difficulties with color blindness.)

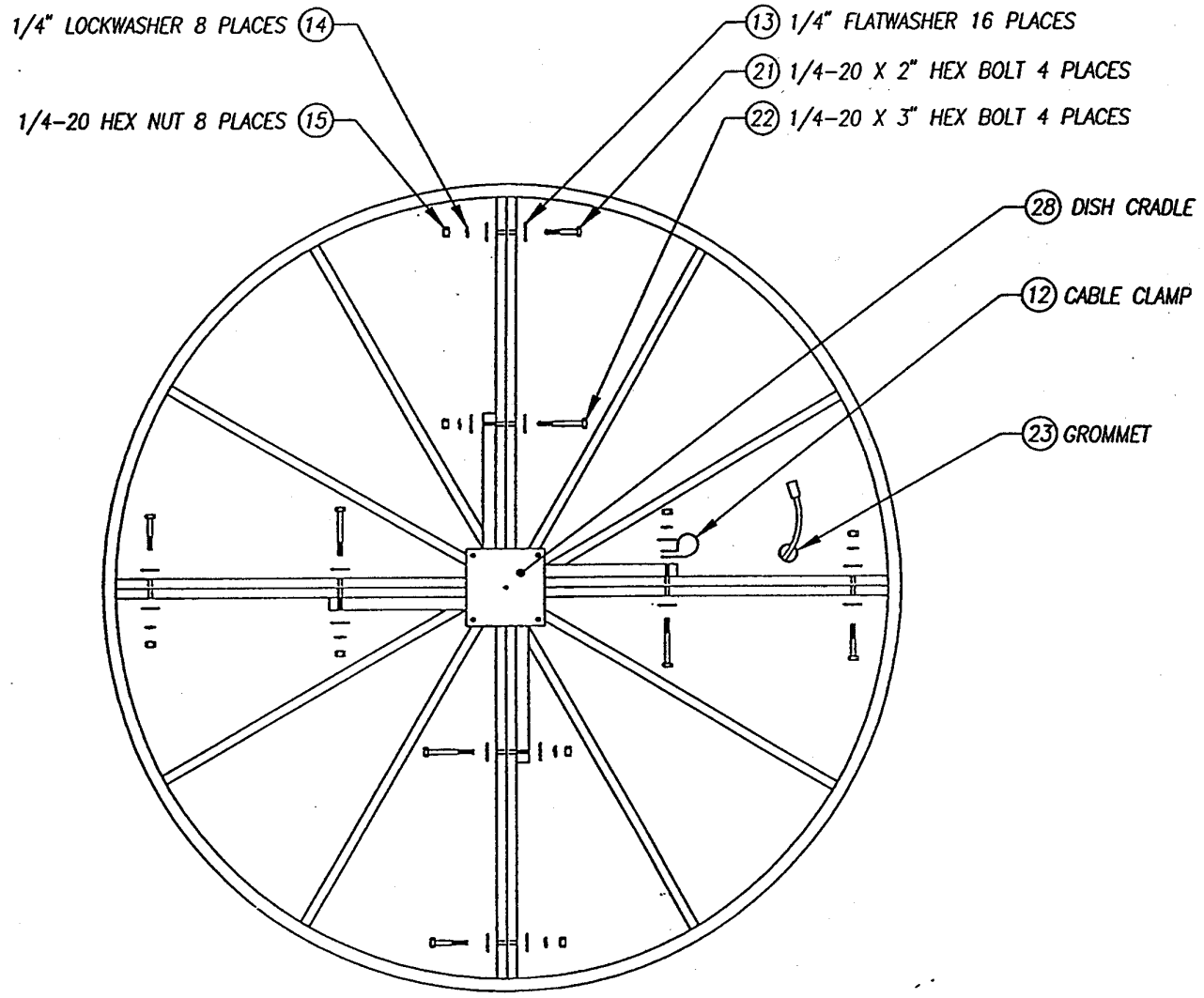


Figure C-1, Antenna Reflector Assembly

Inspect each of the four sections, and lay the dish down on a clean surface with the cradle side UP (concave face DOWN). Take care to match dot patterns/colors on the ribs of each section, with the same dot pattern/color on adjoining dish sections. When all dot coding groups match, carefully place four (4) 1/4"-20 x 2" hex bolts {**21**} in position as shown near the outside of the dish. Note that the four (4) shorter 1/2"-20 x 2" hex bolts {**21**} are used in the holes in the dish ribs near the outer circumference of the dish, and the four (4) longer 1/2"-20 x 3" hex bolts {**22**} are installed in the four holes nearest the center of the dish. Next, place the dish cradle {**28**} in position as shown, matching the dot patterns/colors coincident with the ribs of the dish. Insert the four (4) 1/4"-20 x 3" long hex bolts {**22**} through both the adjacent ribs of the dish, and the legs of the dish cradle {**28**} **in the direction shown**. **Please note that the 3" long bolt nearest the section with a grommeted hole in the mesh, must have a cable clamp {12} installed <u>on the side of the rib nearest the grommeted hole</u> - when properly installed, the cable must pass along the rib, through the cable clamp, and then to the RF connector on the side of the positioner on which the RF side counterweight {30} is mounted**. First, place 1/4" lock washers {**14**}, then **loosely** thread 1/4-20 hex nuts {**15**} on each of the eight (8) hex bolts {**21**}&{**22**}, including the one with the cable clamp {**12**}.

Carefully adjust the adjacent ribs of each section until they are as even with each other and accurately aligned as possible. As each pair of ribs is aligned, tighten the 1/4"-20 nuts {**15**} and bolts {**21**}&{**22**} on that pair of ribs as tightly as possible **using only your fingers**. Repeat the process as necessary to arrive at as totally a perfect dish alignment as practical to the eye. Carefully tighten seven (7) of the 1/4"-20 hex nuts using the wrenches supplied in the tool kit conclusively - do not over tighten to the extent that the ribs are crushed. **<u>Do not</u> tighten the nut on the long bolt with the cable clamp** {**12**} - it will be utilized in the next assembly step. Carefully invert the assembled dish, resting it on the square, flat surface of the mounting plate of its cradle {**28**}.

12.) Note that the feed assembly mounts in a tripod arrangement, with its pre-assembled coaxial cable running down the feed arm.

NOTE: <u>THE FEED ASSEMBLY IS EXTREMELY SENSITIVE AND CAN BE MECHANICALLY FRAGILE</u>. Once assembled, nothing the system can do to it will hurt it, but it can be destroyed if you drop it during assembly. <u>Handle it accordingly</u>, and be as careful as possible during assembly.

With the help of an assistant, hold the feed assembly in position , and attach the two remaining feed arms to the feed using two 8 x 32 phillips pan head screws {**25**}, #8 lock washers {**27**}, and #8 flat washers {**26**} at the point where the feed arms meet with the feed assembly ,Tighten these screws conclusively.

13.) Place the assembled feed/tripod assembly in the center of the dish as shown, being careful to orient the assembly such that the tripod leg (to which the coaxial cable is attached), rests on the dish rib near the grommeted hole in the mesh inner surface of the dish . Check to see that the adjacent dot/color patterns match, then affix each arm of the feed assembly tripod loosely in place using two 10-32 x 1 3/4" pan head screws and #10 lock washers , and #10 flat washers at the points where each of the three feed arms meet the ribs of the antenna reflector ("dish" assembly). When the tripod feed assembly is evenly positioned, tighten the mounting screws conclusively.

14.) Feed the connector on the free end of the feed assembly coaxial cable through the grommeted hole in the dish and position the cable along the rib of the dish, inward toward the center of the dish. Remove the 1/4"-20 hex nut {**15**} and 1/4" lock washer {**14**} on the 1/4"-20 x 3" long hex bolt {**22**} with the cable clamp {**12**} on it. Open the clamp and place it around the cable, then carefully replace the nut and lock washer and finger tighten the nut. **Being careful not to crush the cable in the clamp**, fully tighten the nut on the bolt using the wrench from the tool kit. The assembly is now ready to mount on the positioner.

With the assistance of a second person, carefully lift the completed dish assembly, orient it such that the side with the coaxial cable and grommeted hole in the mesh, is on the side of the positioner with the Downconverter (the dish will only fit one way) {**30**}. Place the flat plate of the dish cradle {**28**} down against the top of the positioner {**1**} and place four 1/2"-20 x 1 1/4" hex bolts {**20**} **upward** through the positioner's moveable elevation arm assembly and the mounting plate of the dish cradle. Affix each of the four bolts in place by installing a 1/4" flat washer {**13**}, then a 1/4" lock washer {**14**}, and finally a 1/4"-20 hex nut {**15**} on each bolt **loosely**, finger tight. While the four bolts are still somewhat loose, carefully position the dish/mounting cradle assembly atop the positioner until it is centered, and the dish cradle's {**28**} flat plate is as "square" with the positioner as possible using the naked eye. Tighten the four bolts through the dish mounting cradle firmly, using the tool kit supplied.

16.) Remove the protective caps on both the connector at the end of the coaxial cable from the feed assembly, and the mating connector on the downconverter.

Carefully inspect both connecters to make certain that no contaminants such as dirt, water, etc., are trapped within the connectors. If contaminants are found **do not mate the two connectors**. If necessary, clean the inside of a contaminated

connector with **isopropyl alcohol**, flushing it well, then let stand and drain for several hours to make certain that all residue has evaporated. If necessary, blow out the connectors with a source of clean, dry air. **DO NOT blow foreign material out of the connectors with your breath, (this leaves residual corrosive moisture), nor DO NOT use air from a compressor without an oil removing filter**. Although it is not recommended, if you have chosen to assemble the system in the rain, you must ascertain that no moisture is allowed in either connector.

When you are convinced that the connectors are clean and dry, carefully screw the cable connector onto the mating connector on the positioner **using only your fingers**. **Tighten it as tightly as you can by hand, but under no circumstances use pliers or other tools to tighten the connector**. While screwing the front shell of the connector on, it is advisable to hold the rear part of the connector stable to prevent the cable from twisting with the connector as it is tightened (damage to the cable could result where it attaches to the connector).

When the connector is firmly tightened by hand, carefully tape the entire connector and a 1.5" to 3" portion of the cable using the red self-vulcanizing tape supplied in the tool kit. This process is virtually impossible in the rain, and difficult in extremely cold weather, but is it absolutely essentially essential to the long-term reliability of the system. Note that this tape must be stretched slightly during the process to bond well, and contaminants must not be allowed on the mating surfaces or it will not stick properly. If desired, cover the self-vulcanizing tape with conventional vinyl electrical tape to hold it in place and protect it from the sun. **Using the red self-vulcanizing tape cannot be omitted under any conditions, even when the system is installed in a radome**.

APPENDIX D

DUAL BAND SYSTEM "O" CODE CONTROL LOGIC

O 0X = DMSP ON
HRPT/DMSP RECEIVER SWITCH
O 1X = HRPT ON

O X1 = NORMAL
DMSP BIT SYNC INPUT SWITCH
O X0 = INVERT

O X1 = 1698 MHZ
HRPT RECEIVER FREQUENCY SWITCH
O X0 = 1707 MHZ

NOTE: X = dont care.
NOTE: Dmsp bit sync manual switch must be in normal position for automatic operation.

WARRANTY and SERVICE

The THRPT-2 Earth Station is warranted against defects in materials and workmanship for a period of ninety (90) days from the date of shipment. Damage to equipment resulting from misuse, accidents, unauthorized service or other causes, and not from defects in materials or workmanship, is excluded from this warranty. The warranty includes repair or replacement, at factory discretion, of any hardware or software determined by Telonics to be defective. Additionally, during the first ninety (90) days a full service warranty is in effect. This initial warranty includes, at factory discretion, full service either on-site or upon return of the hardware to Telonics. The initial 90-day warranty covers all costs associated with shipment of hardware from, or to, any point in the continental United States and/or travel expenses incurred by Telonics personnel conducting on-site service within the continental United States. Full service during the initial ninety day warranty period is available outside the continental United States but does not include hardware shipping costs or travel expenses incurred during on-site visits. The service warranty may be extended beyond the ninety (90) day period by purchasing a twelve (12) month service contract with the same service terms and conditions which apply during the first ninety (90) days. Service contracts are available on an annual basis, the first year beginning commensurate with the termination of the initial ninety day warranty period. Published service contract costs are available from Telonics for a five year period. Service contracts are negotiated on an annual basis after the first five years.

Service not covered by warranty or service contract is available at current laboratory rates.

Telonics does not warrant, guarantee, or make any representations regarding the use or the results of the use of the THRPT-2 for any particular user application and will not be responsible for damages incidental to its use in a user system.

During the past twenty-five years Telonics has built a reputation based on product support, service and customer satisfaction. Telonics strives to produce the highest quality products and to warrant those products fairly. As a result, we encounter very few problems, and have found that most problems can be resolved quickly and easily.

In all cases we hope to be able to always work in partnership with users to resolve problems to the user's satisfaction and to uphold our demonstrated commitment to excellence and fair price.