1 BASE STATION INSTALLATION: Velocity2000™ WLL System

1.1 General

This document provides installation and reference information for the Remote Base Station Controller components of the Velocity2000™ Wireless Local Loop System. Components included are: the Host Digital Terminal (HDT), Cooling Fan Unit (CFU), Power Supply (PS), and the Fuse Panel (FP). All this equipment mounts in a standard 19" rack assembly, which is then housed in a Central Office (CO) or an enclosed Remote Base Station (RBS).

1.1.1 Host Digital Terminal (HDT)

The Host Digital Terminal (HDT) is an EMI protected chassis. It is designed to house eight types of cards with standard plug-in modules (circuit cards). A lockable front door pulls down to provide access. Air from the CFU enters the HDT through the front and exists out the top. An air deflector is integrated into the bottom of the chassis to prevent preheated air from entering the chassis. Dual 48V input power is provided through a protected screw terminal block in the rear. Chassis and signal ground are strapped together with a bus bar in the rear. A #10-32 single point ground terminal is provided to tie to earth ground. Nominal power consumption is 130W (including fans and power supplies). Two dB9 connectors on the rear panel provide an RS232 interface. Two shielded RJ45 connectors provide a 10 base T interface and 1 shielded RJ45 provides a 10/100 base T interface. Eight 50-position shielded telephone connectors provide 4 T1, E1 or low voltage digital timing interface, and 4 expansion options. The first HDT chassis (mounted in the topmost position) is considered the master unit and all others are considered slave units. The antenna interface uses a type N bulkhead connector (jack). All incoming signals to the HDT require primary lightning protection.

1.1.2 Cooling Fan Unit (CFU)

A fan assembly is mounted directly above each of the HDT chassis. A single pigtail cable is provided to tie the fan power to the rear of the HDT chassis. The CFU is turned on/off by the HDT power supplies as needed. The fan chassis runs on 48V and consumes 20W of power.

1.1.3 Power Supply (PS)

The Power Supply (PS) is a 150W 48-volt dual input, redundant 5V/1.2V out switching supply. The power supply connects to the backplane with a DIN standard, type F connector. The supply provides alarms for excess temperature, current, and voltage. A temperature sensor on the PS controls the fan activation. The power dissipated by a single supply (not sharing) is 37W.

1.1.4 Fuse Panel (FP)

The Fuse Panel is equipped with built in "or-ing" diodes (i.e. supply "A" or "B" will power the HDT). The FP uses GMT type fuses. Terminal blocks are provided on the rear for input (6 AWG) and output wiring (12 AWG).

Warning: Modifications not expressly approved by the manufacturer could render the equipment non-compliant with FCC regulations and thus invalidate the user's right to operate the equipment.

2 ELECTRO STATIC DISCHARGE (ESD) PROCEDURE

2.1 General

When you see this symbol in text, be aware that you are working with ESD-sensitive components. Take the recommended precautions.

2.1.1 Wear A Grounding Wrist Strap

Wear a grounding wrist strap when installing or removing components.

NOTE: To properly use a grounding wrist strap, perform the following test using an ohmmeter:

1. Set the Ohmmeter to the maximum resistance scale
2. Connect one meter-lead to the contact point of the wrist strap and the other lead to the clip or banana plug on the far end of the wrist strap. Hold one lead (not both) while performing this measurement.

A resistance reading in the vicinity of 1 megohm (one million ohms) indicates that the wrist strap is acceptable. A reading of less than 900,000 ohms indicates that the wrist strap is inadequate and may not provide proper protection. An “open” reading indicates that the internal resistance of the wrist strap has failed and it **will not** protect the equipment from ESD damage.

2.1.2 Use

Attach the wrist strap securely to your wrist and clip the far end to a ground post on the equipment rack or elsewhere on the metal mounting assembly. (Alternatively, insert the banana plug into the jack provided on the equipment rack or metal mounting assembly.)

Momentarily touch the grounded equipment rack to discharge any static build-up before handling modules or other static sensitive devices. Momentarily touch the anti-static storage bag to the grounded equipment rack before removing or re-inserting a component. Always store unused and spare ESD-sensitive devices and components in their original anti-static storage bags.

DO NOT touch any circuit traces or board components during installation. Hold the boards and assemblies by the front panel or by the board edges.

2.1.3 Caution

To reduce the risk of electric shock or energy hazards:

1. **Connect to a reliably grounded Safety Extra Low Voltage (SELV) source.**
2. **Rate the branch circuit over current protection at a maximum of 15A.**
3. **Use 12 AWG or 14 AWG solid copper conductors only.**
4. **Incorporate a readily accessible disconnect device that is suitably approved and rated in the field wiring.**
5. **Install in a restricted access area in accordance with the NEC or the authority having jurisdiction.**

3 MECHANICAL INSTALLATION

3.1 General

Following the order outlined here facilitates mechanical installation. Install the Fuse Panel (FP), Cooling Fan Unit (CFU), and Host Digital Terminal (HDT), from top to bottom in the rack. Figure 1 shows the arrangement of the rack assembly.

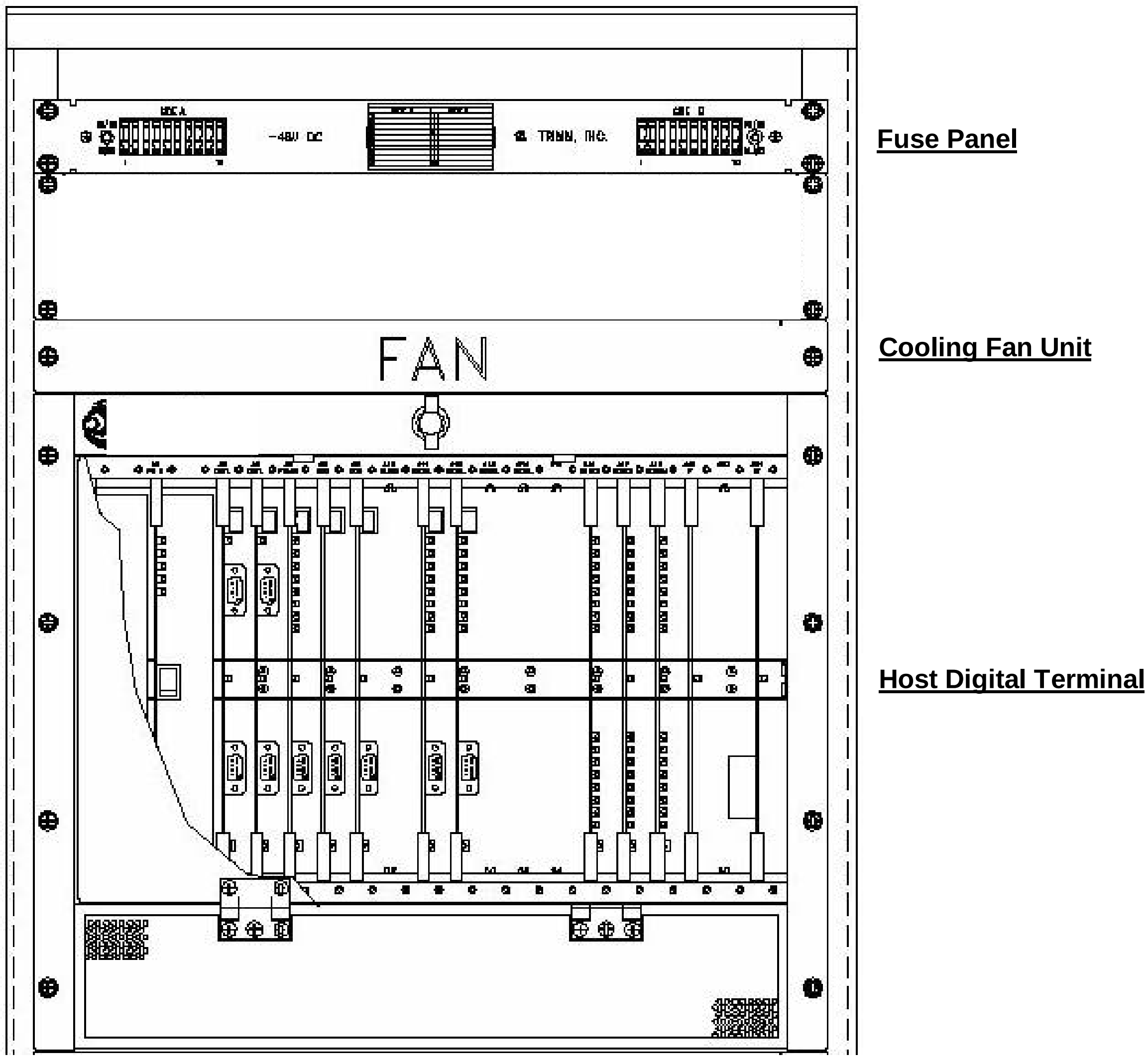


Figure 1 – Rack Assembly

3.1.1 Fuse Panel (FP)

Following the order outlined here facilitates mechanical installation. Install the Fuse Panel (FP), Cooling Fan Unit (CFU), and Host Digital Terminal (HDT), from top to bottom in the rack. Figure 1 shows the arrangement of the rack assembly.

Figure 2 – Fuse Panel

3.1.2 Cooling Fan Unit (CFU)

The Cooling Fan Unit (CFU) mounts in the same manner as the FP and PS and is just below the PS in the equipment rack.

3.1.3 Host Digital Terminal (HDT)

The Host Digital Terminal (HDT) mounts directly below the CFU and requires eight screws to mount into the equipment rack. Figure 3 shows the CFU and HDT mounted.

Note: Additional equipment is added (where required), in the order CFU, HDT, CFU, HDT, etc. Figure 3 shows the CFU and HDT terminal.

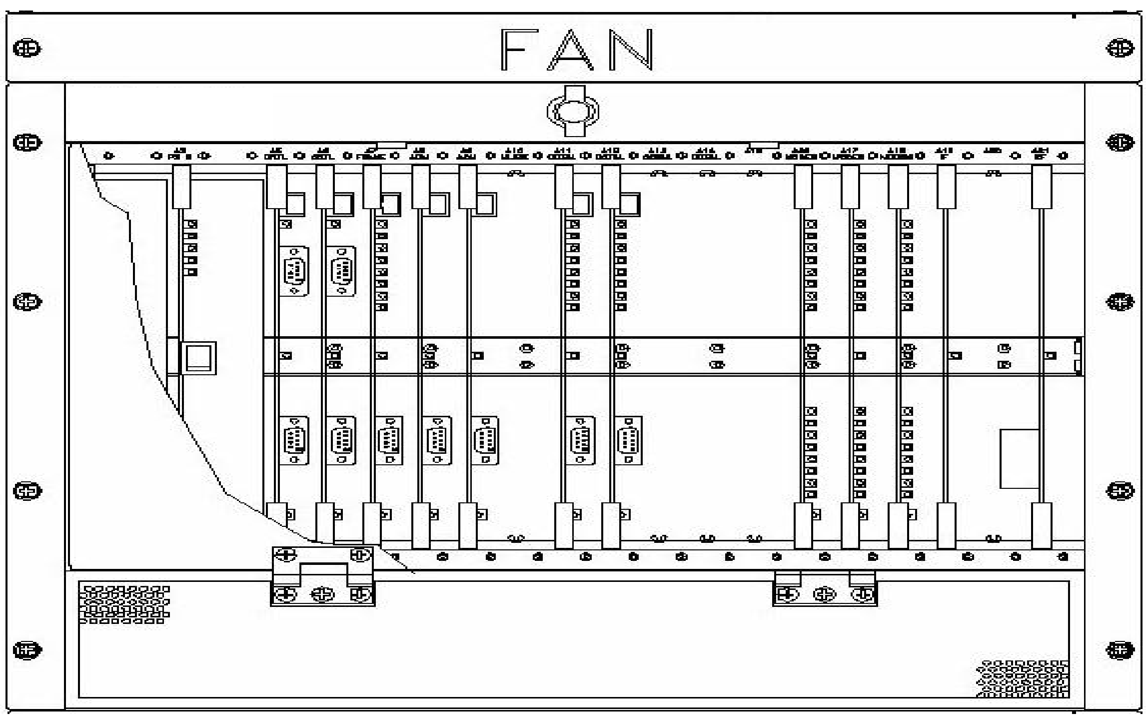


Figure 3 – Cooling Fan and Host Digital Terminal

4 ELECTRICAL INSTALLATION

4.1 General

Following the order outlined here facilitates the electrical installation. Install the Fuse Panel (FP), System Interface Panel (SIP) (Optional), Cooling Fan Unit (CFU), Host Digital Terminal (HDT), and the Power Supply (PS).

Wear a ground strap for all of the electrical installation procedures in this section. Do not connect Central Office (CO) or Remote Base Stations (RBS) power mains to the equipment until all equipment rack wiring has been completed and checked.

4.1.1 Fuse Panel (FP)

Terminal blocks are provided, at the rear of the FP, for A-side and B-side power connections (A-side shown). Follow the steps to apply power lines to the Fuse Panel. Figure 4 shows the rear view of the fuse panel.

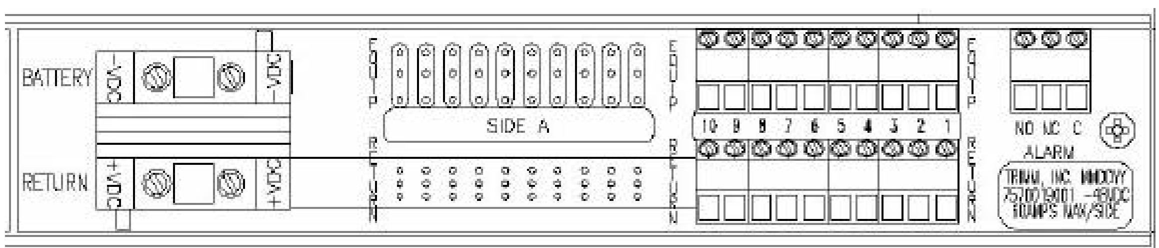


Figure 4 – Fuse Panel – Rear View

1. Loosen the 8-32 ground screw terminal at the right rear of the panel.
2. Insert a 6AWG ground wire into the terminal and tighten.
3. Route the ground lead down the equipment rack to the master ground connection and terminate there. (This step assumes that the CO or Base Station has been configured with appropriate ground line distribution.)
4. Loosen the Battery +/– INPUT terminal screws and dress power cables to these points.
5. Attach 6AWG wires to the terminals and tighten the screws.
6. Loosen the Battery +/– OUTPUT terminal screws and dress power cables to these points.
7. Attach 12AWG wires to the terminals and tighten the screws.

48V DC Supply Source Markings

In accordance with Sub-Clause 3.4, Annex NAA and UL's Bulletin to the Industry dated May 14, 1993.

Equipment intended to receive power from a 48V DC source will be considered connected to a branch circuit, with SELV circuit characteristics, if it can be determined that.

(1) The supply potential will be operating at SELV levels and

(2) The supply is electrically isolated from an AC source.

If the above-mentioned conditions were met, the equipment would therefore not be subject to the requirements for wiring terminals for external primary power supply conductor, Sub-Clause 3.3.

Detail of Equipment Rack Ground Block

4.1.2 Cooling Fan Unit (CFU)

At the rear of the CFU, there is a pigtail cable that connects to the rear panel of the HDT. Route this cable down to the HDT connector labeled “FAN” and connect there. Figure 5 shows the top and front views of the cooling Fan.

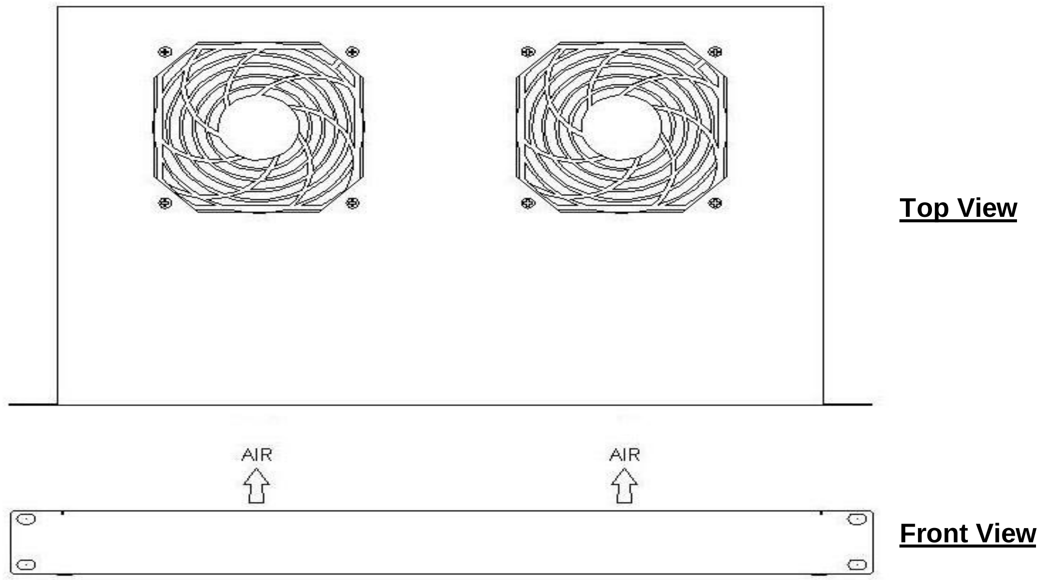


Figure 5 – Cooling Fan- Top and Front View

4.1.3 Host Digital Terminal (HDT)

At the rear of the HDT a terminal block is provided for dual 48-volt input power. Follow the steps to apply power lines to the Host Digital Terminal. Figure 6 shows the rear view of the Host Digital Terminal and Figure 7 shows the detail of the Terminal Block.

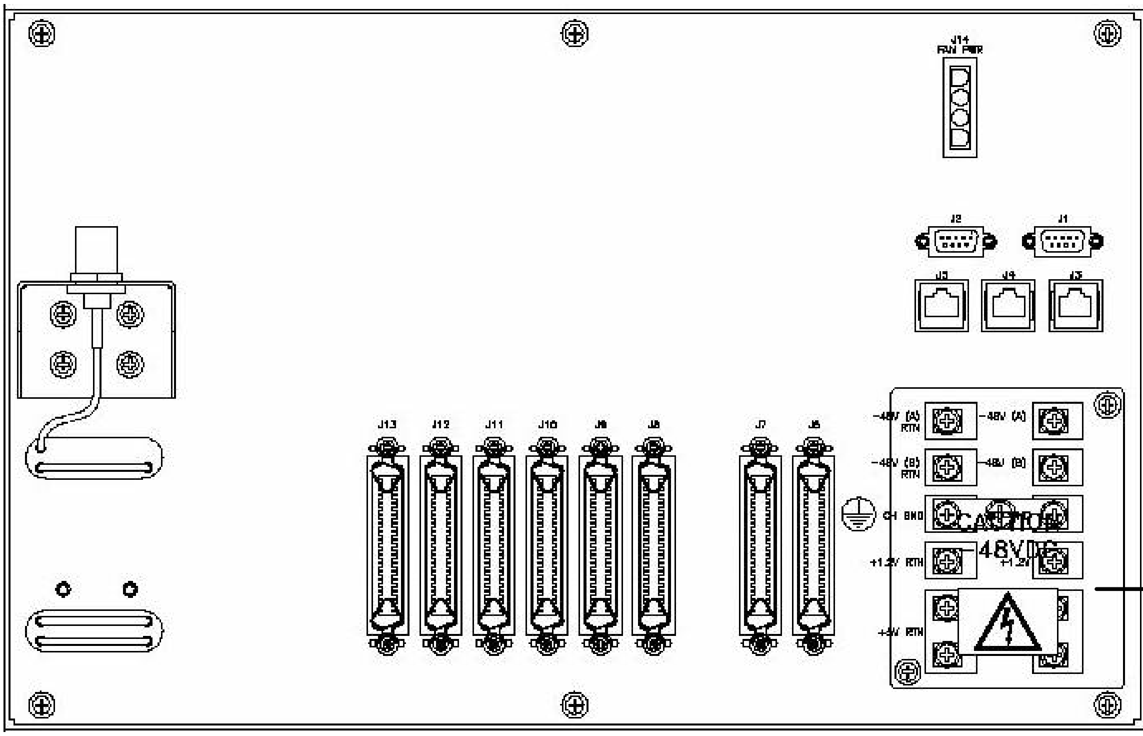


Figure 6 – Host Digital Terminal – Rear View

1. Remove the screws that secure the protective plastic panel and remove the panel.
2. Loosen the 8-32 ground screw terminal at the right rear of the panel.
3. Insert a 6AWG ground wire into the terminal and tighten the screw.
4. Loosen the Battery +/– INPUT terminal screws and dress power cables to these points.
5. Attach 16AWG wires to the terminals and tighten the screws.
6. Replace the protective cover.

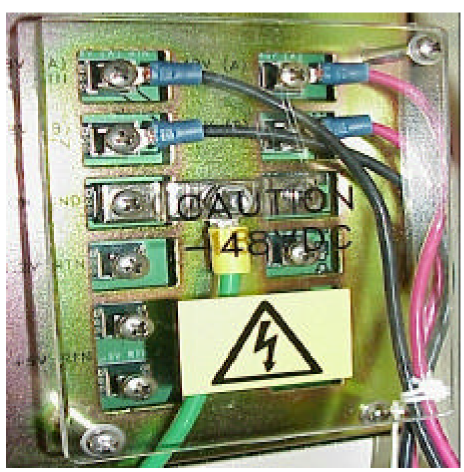


Figure 7 – Detail of Terminal Block

4.1.4

4.1.5 Power Supply (PS)

The Power Supply is a plug-in module that inserts in the leftmost slot of the HDT. Figure 8 shows the Power Supply Module.

⚠ Using ESD Procedures for modules, insert the PS into the HDT and confirm proper seating.

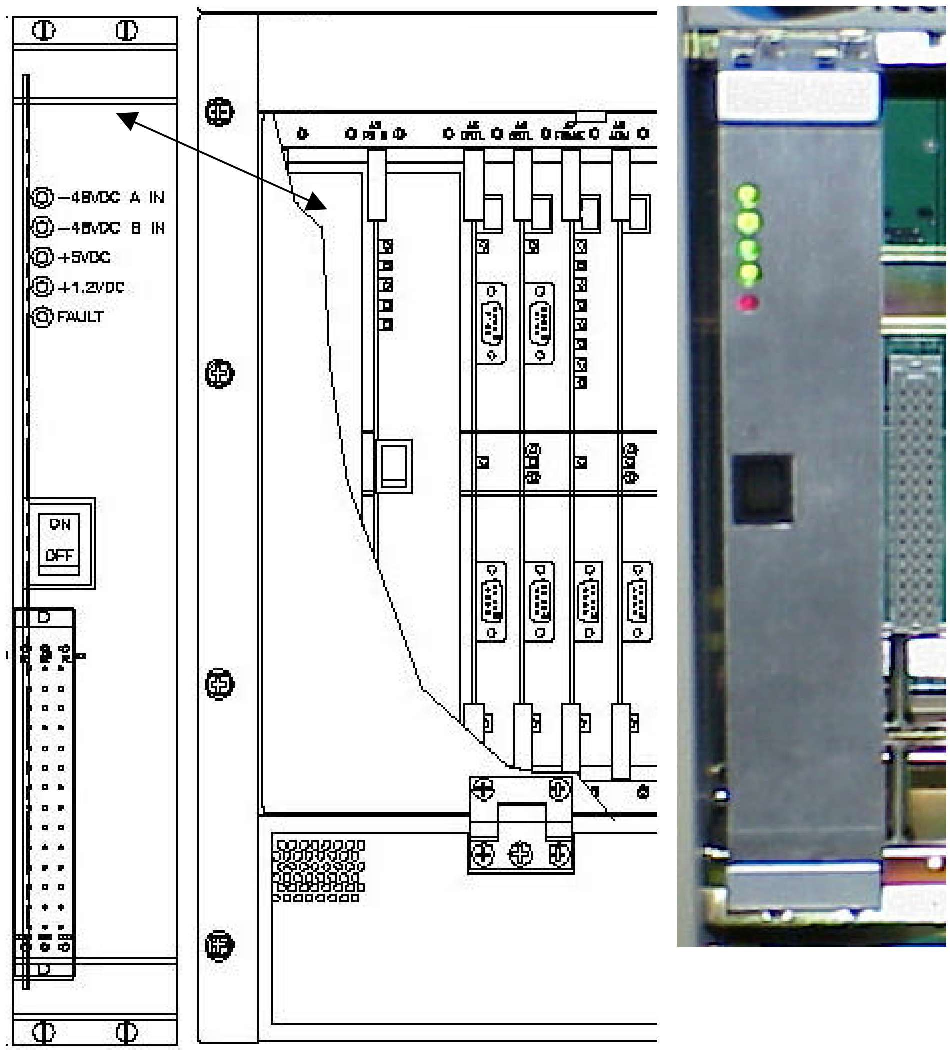


Figure 8 – Power Supply Module

5 LIGHTNING PROTECTION

5.1 General

Following the order outlined here facilitates the lightning protection for: the Electro Motive Pulse (EMP)/Lightning Arrestor, Host Digital Terminal (HDT), Cable Specifications, and Link Budget and Link Range (2.4 GHZ).

Note: It is important that a qualified technician perform the installation.

The unit must be located in a secure enclosure. The installer is responsible for meeting FCC and EIRP limits.

5.1.1 Electro Motive Pulse (EMP)/Lightning Arrestor

Electro Motive Pulse (EMP) protection is provided at the top of the shelf enclosure or at the access port of the Remote Base Station shelter. An earth ground conductor **is required**. Figure 9 shows component arrangement and ground wire path(s).

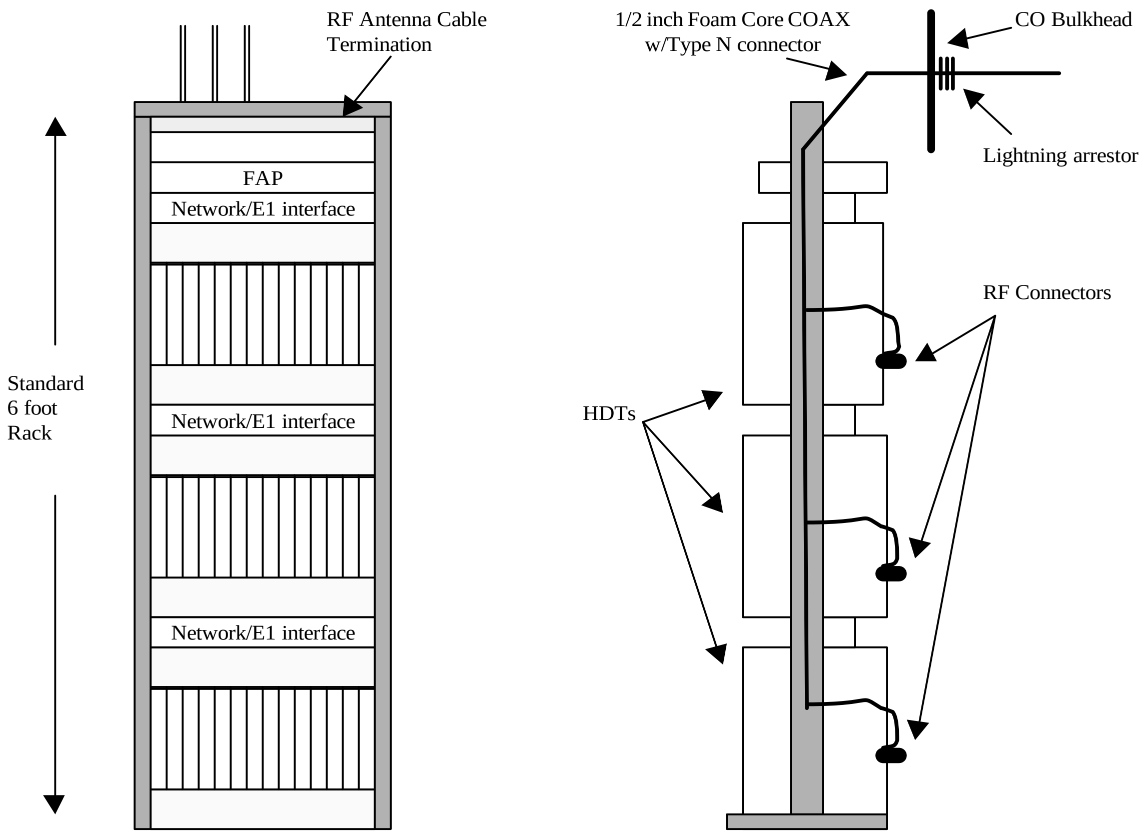


Figure 9 – WLL Rack/Shelf

The lightning arrestor connection is made directly to the antenna terminal on the back of the HDT and is tied into the master earth ground system. The RF handles 20kA of surge-current with activation at a nominal 600 VDC threshold, within 3nsec.

5.1.2 Host Digital Terminal (HDT)

Lightning protection is applied to the RF connector on the back panel of the HDT, *after* it is mounted into the rack assembly. Figure 10 shows the position of the RF connector. Figure 11 shows RF Cable and Lightning Arrestor ground wiring.

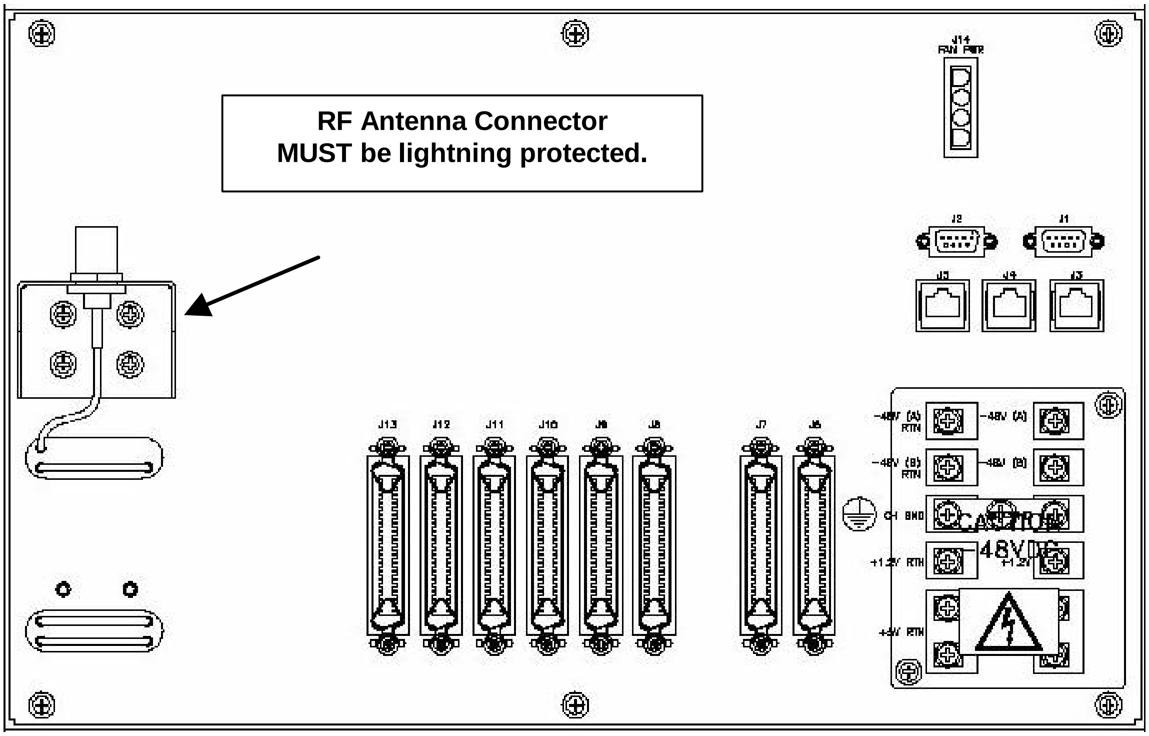


Figure 10 – Location of RF Antenna Connector

WARNING: To comply with the FCC RF exposure operating configurations, the antenna shall be mounted to ensure the antenna/person separation distance of **at least 2 meters**.

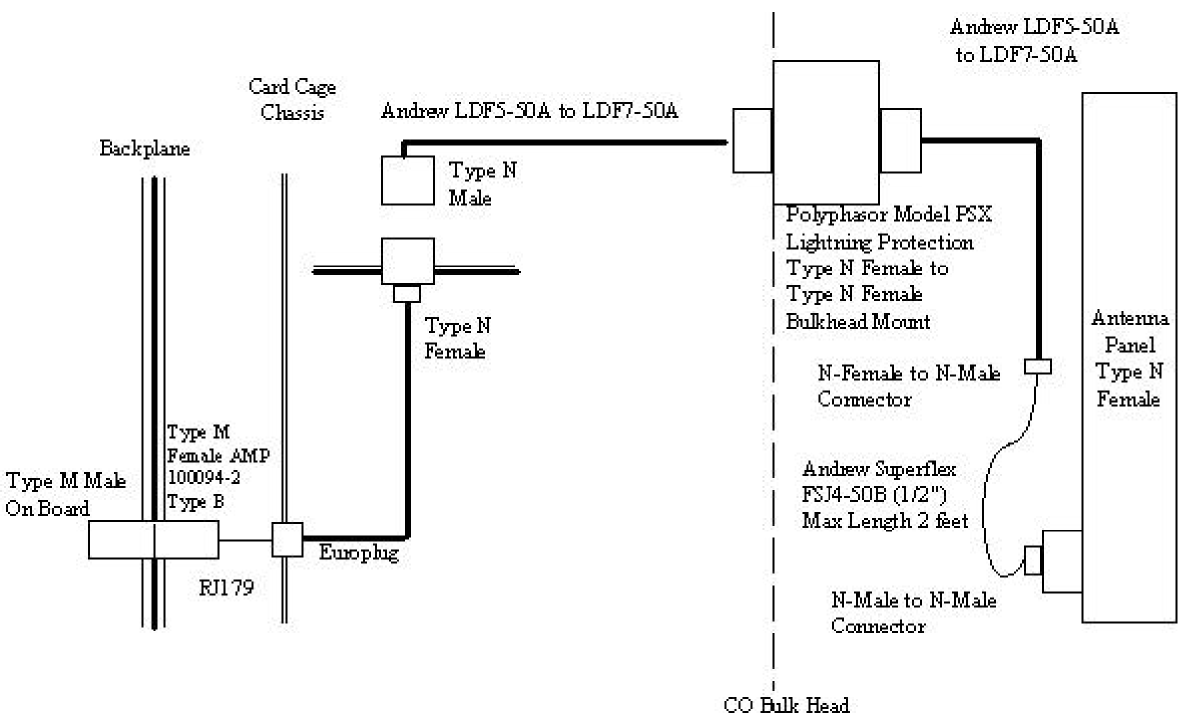


Figure 11 – RF Cable Route and Lightning Protection

5.1.3 Cable Specifications

Table 1 shows the Coaxial Cable – 50-ohm, Foam Dielectric.

Heliaxâ Coaxial Cable – 50-ohm, Foam Dielectric, LDF			
	7/8 inches	**1-1/4 inches**	**1-5/8 inches**
Standard Cables			
Standard Black Jacket	LDF5-50A	LDF6-50	LDF7-50A
Fire Retardant Cables			
CATVX, VW-1, IEC 332-1	LDF5RN-50A	LDF6RN-50	LDF7RN-50A
CATV, UL1581, IEC 332-3 IEEE 383	LDF5RN-50A	LDF6RN-50	LDF7RN-50A
CATVR, UL1666 (Riser)	LDF5RN-50A	LDF6RN-50	LDF7RN-50A
Low VSWR Cables, Specially Tested			
Standard Black Jacket	LDF5P- 50A-(**)	LDF6P- 50-(**)	LDF7P- 50A-(**)
Fire Retardant (CATVR), 824-894 MHz, 1.20 VSWR maximum	41690-76	41690-73	
Characteristics			
Maximum Operating Frequency, MHz	5000	3300	2500
Peak Power Rating, KW	91	205	315
Relative Propagation Velocity, %	89	89	88
Minimum Bend Radius, in (mm)	10 (250)	15 (380)	20 (510)
Attenuation, dB/100 ft (dB/100 m) Standard Conditions: VSWR 1.0; Ambient Temperature 24°C (75°F)			
2300 MHz	2.15 (7.05)	1.58 (5.18)	1.37 (4.48)
Average Power Rating, kW Standard Conditions: VSWR 1.0; Ambient Temperature 40°C (104°F); Inner Conductor Temperature 100°C (212°F); No Solar Loading			
2300 MHz	1.29	1.95	2.53

Table 1 – Coaxial Cable – 50-ohm, Foam Dielectric

5.1.4 Link Budget And Link Range (2.4 GHz)

The following link budget is based on a modified ground reflection propagation model. This model divides the link into two sections. The initial section has R^2 propagation loss. The following factors were included in the calculation:

- Base station EIRP 30 dBm (FCC limit is 1W EIRP)
- Base station antenna height 50 meters (typical)
- 24 CDMA channels (loss of 10 log (24) = -14.1 dB)
- Subscriber antenna height 3 meters (typical)
- Subscriber antenna gain 10 dBi

- Subscriber sensitivity = -100 dBm for BER = 10^{-5}
- 2.483 GHz frequency/lambda (wave length) = 12 cm

The first step is to calculate the distance, D0, for which the propagation is proportional to R^2.

$$D0 = (4 \times H_{base\ station} \times H_{subscriber})/lambda = 4966 \text{ meters}$$

The frequency corrected propagation R^2 loss at D0 would be is –114.25 dB.

Table 2 shows the link calculation for log distance with R^4 propagation loss.

TX EIRP (dBm)	+30
CDMA channel loss (dB)	- 14.1
Fade margin (dB)	- 10
D0 propagation loss at 2.483 GHz	-114.25
Receiver gain	+ 10
1/Receiver sensitivity	+100
Additional prop distance (R^4)	1.64

Table 2 – Link calculation for log distance with R^4 propagation loss

The additional propagation at R^4 loss is:

$$\text{Propagation distance} = D0 \times 10^{1.64/40} = 5458 \text{ Meters}$$

The other limiting factor is the round trip RX/TX propagation delay relative to the guard time in the TDD frame structure. The subscriber terminal TX burst has 3 symbols of guard time. Each symbol represents 12.5 usec or 37.5 usec total. As the subscriber distance from the base station increases, the subscriber transmitter must advance the start of the TX burst to achieve alignment with the base station. The total propagation delay is 2 times the one-way delay. Only half the guard time can be allocated to RX or TX burst delays. Due to limitations in TX power ramp up and RX ramp down, roughly ½ a symbol or 6 µsec of this guard time must be reserved.

Table 3 provides calculation of one way, round trip, and guard time slack.

Subscriber distance (KM)	RX propagation delay (µsec)	TX/RX propagation delay (µsec)	Guard time slack symbols
1	3.3	6.6	2.4
2	6.6	13.3	1.9
3	10	20	1.4
4	13.3	26.6	0.864
4.5	15	30	0.6
4.75	15.8	31.6	0.46 Limit of TX ramp up

Table 3 – Calculation of one-way, round trip, and guard time slack

6 SECTORAL ANTENNA

6.1 General

The TA-2304-2 Adjustable Sectoral Antenna is a vertically polarized sectoral antenna. It can be ordered with three different kinds of side panels, depending on the horizontal beamwidth required: fixed at 45 degrees, fixed at 180 degrees or field adjustable to 60, 90, 120, or 160 degrees. Radiating elements are protected by a weatherproof radome for operation under severe weather conditions (icing, salt air, acid rain, etc.) and are at DC ground for lightning protection.

It is imperative that a qualified technician performs the installation. The unit must be located in a secure enclosure and the installer is responsible for meeting FCC and EIRP limits.

Referring to the back of the Host Digital Terminal – Rear View in Figure 10 on page 11, the installer will use an RF Power meter attached to the RF Antenna Connector to gage the power output of the transmitter. The installer can refer to the example and calculation worksheet and formula on pages 15-17 to determine if the power output of the transmitter is too high or too low. To adjust the power output of the use the gain control. Table 4 shows the Adjustable Sectoral Antenna Specifications.

Electrical Specifications	
Frequency Range	2300 – 2500 MHz
Gain	18.5 dBi for 45 degree sector; 17.5 dBi for 60 degree sector; 15.5 dBi for 90 degree sector; 14.5 dBi for 120 degree sector; 13.0 dBi for 160 degree sector; 12.5 dBi for 180 degree sector
VSWR	1.5:1 maximum
Polarization	Vertical
Power Rating	25 watts
H-Plane Beamwidth (-3 dB)	Fixed at 45 degrees; Fixed at 180 degrees; Or field adjustable to 60, 90, 120, or 160 degrees (nominal mid-band values)
E-Plane Beamwidth (-3 dB)	7.2 degrees
Cross-Polarization Discrimination	20 dB minimum
Impedance	50 ohms nominal
Termination	Type N female (7/16 jack optional)
Mechanical Specifications	
Length	40 in. (1016 mm)
Width	4.9 in. (124 mm)
Depth	4.6 in. (117 mm)
Weight Including Clamps	8 lb. (3.6 kg)
Rated Wind Velocity	125 mph (200 km/hr)
Horizontal Thrust at Rated Wind	86 lb. (39 kg)
Mounting	Mounts to a 0.75 – 3.0 O.D. (19 – 76 mm) pipe using the clamps supplied
Materials	
Radiating Elements	Tin plated copper on PCB
Radome	White ASA, UV stabilized
Reflector	Irridited aluminum
Clamps	Hot dip galvanized steel

Table 4 – Adjustable Sectoral Antenna Specifications

Example Calculation Worksheet

Table 5 shows an example of the calculation worksheet filled out.

Cable Loss Calculation	
Cable Type	LDF 7/8"
Cable Loss/100 feet	2.15
Length of Cable in feet	200
Cable Loss (dB)	4.3
Antenna Gain Information	
Model Number	TA-2304-2
Sector Angle (degrees)	45
Antenna Gain (dBi)	18.5
FCC Section 15.247 (b)(i) Power Adjustment	
Antenna Gain (dBi)	18.5
Antenna Gain Exceeds 6 dB	12.5
FCC Sec. 15.247 (b)(i) Adjustment	4.2
Basic Equation	
Calculated Transmitter Power (dBm)	13.0
FCC Sec. 15.247 (b)(i) Adjustment	4.2
Cable Loss (dB)	4.3
Antenna Gain (dBi)	18.5
Power Amplifier Output Power (dBm)	23
Power Amplifier Output Power (watts)	0.2
Calculated Transmitter Power (P_T dBm = 30 dBm + Adj. + L_C – G_A)	13.0
Measured Transmitter Power	10
Difference	-3.0

Table 5 – Example Calculation Worksheet

NOTE:

Formula $\mathbf{P_T = P_O - G_A + L_C + Adj.}$ is implemented in this worksheet.

Refer to Heliax® Coaxial Cable – 50 –ohm, Foam Dielectric, LDF Specifications on page 11 and TA-2304-2 Adjustable Sectoral Antenna Specifications on page 14 for data used in this example calculation worksheet.

Calculation Worksheet

Table 6 shows an example of the calculation worksheet to be filled out.

Cable Loss Calculation	
Cable Type	
Cable Loss/100 feet	
Length of Cable in feet	
Cable Loss (dB)	
Antenna Gain Information	
Model Number	
Sector Angle (degrees)	
Antenna Gain (dBi)	
FCC Section 15.247 (b)(i) Power Adjustment	
Antenna Gain (dBi)	
Antenna Gain Exceeds 6 dB	
FCC Sec. 15.247 (b)(i) Adjustment	
Basic Equation	
Calculated Transmitter Power (dBm)	
FCC Sec. 15.247 (b)(i) Adjustment	
Cable Loss (dB)	
Antenna Gain (dBi)	
Power Amplifier Output Power (dBm)	
Power Amplifier Output Power (watts)	
Calculated Transmitter Power (P_T dBm = 30 dBm + Adj. + L_C – G_A)	
Measured Transmitter Power	
Difference	

Table 6 – Calculation Worksheet

NOTE:

Formula **$P_T = P_O - G_A + L_C$ + Adj.** is implemented in this worksheet.

Refer to Heliax® Coaxial Cable – 50 –ohm, Foam Dielectric, LDF Specifications on page 11 and TA-2304-2 Adjustable Sectoral Antenna Specifications on page 13 and 14 for data used in this example calculation worksheet.

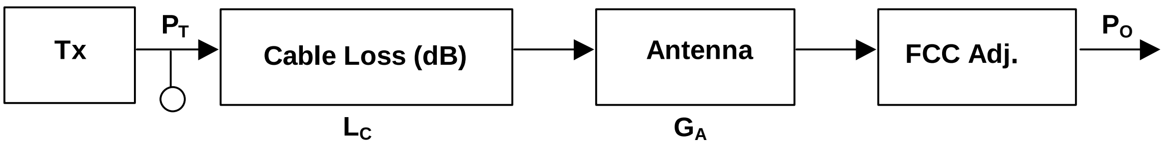
Formula

In order to calculate the maximum power being delivered to the antenna, based on the antenna gain, use the formula:

$$P_T - L_C + G_A - Adj. = P_O$$

Determining the transmitter output power, subtracting the cable loss, adding the antenna gain, and subtracting the FCC Section 15.247 (b)(i) adjustment will give you the power output of the antenna.

Worksheet



	–		+		–		=	
P_T		L_C		G_A		Adj.		P_O