WESTERN Multiplex

INSTALLATION AND MAINTENANCE MANUAL

Tsunami™

WIRELESS GIGABIT ETHERNET BRIDGE
(5.3/5.8 GHz UNII/LE-LAN1000BaseF)

MAN-27900

Installation and Maintenance Manual

The information contained in this manual is subject to change without notice. Western Multiplex shall not be liable for errors contained herein or for incidental or consequential damages in connection with the furnishing, performance, or use of this manual or equipment supplied with this manual. Western Multiplex makes no warranty of any kind with regard to this manual or any equipment supplied with this manual, including, but not limited to, the implied warranties of merchantability and fitness for a particular purpose.

Printed in the United States of America

Notice: Y2K (Year 2000 Issue)

All software supplied by and for Western Multiplex products adheres to the four-(4) digit year nomenclature as required for Year 2000 compliance.

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Our facility has been Registered to the International Organization for Standardization ISO 9000 Series Standards for quality.

Issue: January 2001

Revision history:

November 2000:	First version Draft version
December 2000:	Added updated drawings Front panel LED detail Update NMS screen captures
January 2001	Replaced Browser NMS graphics

Regulatory Notice

This equipment has been tested and found to comply with the limits for a class B digital device, pursuant to Part 15 of the FCC Rules. This equipment generates, uses and can radiate radio frequency energy and is to be installed and used in accordance with the instructions.

Shielded cables and I/O cords must be used for this equipment to comply with the relevant FCC regulations.

Changes or modifications not expressly approved in writing by Western Multiplex may void the user's authority to operate this equipment.

This device must be professionally installed.

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WARRANTY

GENERAL TERMS

1.1 All Definitions contained in Western Multiplex's Conditions of Sale (Western Multiplex document number CS96-8), apply to the Warranty.

1.2 Subject to the provisions of the Warranty, Western Multiplex warrants that the equipment described in Paragraph 1.3 shall conform to their specifications described in Paragraph 1.4 in all material respects and that the equipment shall be free from material defects in materials and workmanship.

1.3 This Warranty applies to all original purchases of Western Multiplex manufactured equipment and accessories (collectively the "Equipment").

1.4 This Warranty applies to the specifications contained in the most recent version of the manual for the model of the Equipment purchased (the "Specifications").

1.5 This Warranty does not apply to the following items of Equipment which are covered by the Original Equipment Manufacturer's warranty:

(a) antenna systems, including coax cable, waveguide, connectors flex-sections, mounts, other parts of the antenna system and installation materials;

(b) non-Western Multiplex manufactured rack mounted equipment that is assembled wired and tested at Western Multiplex's factory or supplied as part of a system, including orderwire items, channel banks, multiplexers, fuse/alarm panels, remote alarm items; and

(c) equipment which is not listed in Western Multiplex's price book.

1.6 The effective period of this Warranty shall start on the date of shipment of the Equipment and shall end:

(a) for all spread spectrum unlicensed radio products and for all licensed digital microwave radio products, two (2) years later;

(b) for all analog microwave radio products, three (3) years later; or

(c) for all baseband products, five (5) years later (in each case the "Warranty Period").

1.7 The Customer acknowledges that Western Multiplex does not represent or warrant that the services provided by Western Multiplex under this Warranty will ensure uninterrupted or error-free operation of the Equipment.

RETURN OF EQUIPMENT UNDER WARRANTY

2.1 If an item of Equipment malfunctions or fails in normal intended usage and maintenance within the applicable Warranty Period:

(a) the Customer shall promptly notify Western Multiplex of the problem and the serial number of the defective item;

(b) Western Multiplex shall, at its sole option, either resolve the problem over the telephone or provide the Customer with a Returned Materials Authorization number (RMA #) and the address of the location to which the Customer may ship the defective item;

(c) if the problem is not resolved over the telephone, the Customer shall attach a label to each Returned item describing the fault and the Customer's Return address. The Customer shall, at its cost, properly pack the item to be Returned, prepay the insurance and shipping charges, and ship the item to the specified location;

(d) if the Western Multiplex product shall prove to be defective in material or workmanship upon examination by Western Multiplex, Western Multiplex shall either repair or replace the Returned item at its sole option. The replacement item may be new or refurbished; if refurbished, it shall be equivalent in operation to new Equipment. If a Returned item is replaced by Western Multiplex, the Customer agrees that the Returned item shall become the property of Western Multiplex.

(e) Western Multiplex shall at its cost, ship the repaired item or replacement to any destination within the United States of America by carrier and method of delivery chosen by Western Multiplex. If the Customer has requested some other form of conveyance, such as express shipping, or is located beyond the USA borders, then the Customer shall pay to the cost of return shipment.

2.2 Equipment which is repaired or replaced by *Western Multiplex* under this Warranty shall be covered under all of the provisions of this Warranty for the remainder of the applicable Warranty Period or ninety (90) days from the date of shipment of the repaired item or replacement, whichever period is longer.

DEFAULT AND TERMINATION

3.1 *Western Multiplex* may immediately terminate this Warranty and all of its performance under this Warranty, upon notification to the Customer, if the Customer:

(a) makes any unauthorized modifications to the Equipment;

(b) assigns or transfers the Customer's rights or obligations under this Warranty without the written consent of *Western Multiplex*;

(c) becomes bankrupt or insolvent, or is put into receivership; or

(d) has not paid *Western Multiplex* all amounts for the Equipment, services, or other additional charges within thirty (30) days of receipt of written notice from *Western Multiplex*.

3.2 If this Warranty is terminated by *Western Multiplex*, the Customer shall remain liable for all amounts due to *Western Multiplex*.

FORCE *MAJEURE*

4.1 "Force Majeure" has the same meaning as defined in *Western Multiplex*'s Conditions of Sale (*Western Multiplex* document number CS96-8).

4.2 *Western Multiplex* shall not be responsible for failure to discharge its obligations under this Warranty due to Force Majeure.

LIMITATIONS AND QUALIFICATIONS OF WARRANTY

5.1 This Warranty does not apply to any damage, defect or failure caused by:

(a) any part of the Equipment having been modified, adapted, repaired, or improperly installed, operated, maintained, transported or relocated by any person other than *Western Multiplex* personnel or a *Western Multiplex* authorized service agent, without *Western Multiplex*'s prior written consent;

(b) storage or environmental conditions which do not conform to the applicable sections of the appropriate *Western Multiplex* Equipment Manual;

(c) failure to conform with the Equipment Installation, Operating and Maintenance Instructions of the appropriate *Western Multiplex* Equipment Manual;

(d) external causes, including external electrical stress or lightning, or use in conjunction with incompatible equipment, unless such use was with *Western Multiplex*'s prior written consent;

(e) cosmetic damage;

(f) accidental damage, negligence, neglect, mishandling, abuse or misuse, other than by *Western Multiplex* personnel or a *Western Multiplex* authorized service agent; or

(g) Force *Majeure*.

Please see reverse side for additional limitations on damages.

LIMITATIONS ON DAMAGES (North America)

6.1 THE WARRANTY STATED IN THIS DOCUMENT IS THE CUSTOMER'S EXCLUSIVE WARRANTY FOR THE EQUIPMENT; WESTERN MULTIPLEX SPECIFICALLY DISCLAIMS ALL OTHER WARRANTIES OF ANY KIND, EXPRESS OR IMPLIED, INCLUDING ANY WARRANTIES OF FITNESS FOR A PARTICULAR PURPOSE AND OF MERCHANTABILITY.

6.2 WESTERN MULTIPLEX SHALL NOT BE LIABLE IN TORT, INCLUDING LIABILITY IN NEGLIGENCE OR STRICT LIABILITY, AND SHALL HAVE NO LIABILITY AT ALL FOR INJURY TO PERSONS OR PROPERTY. WESTERN MULTIPLEX'S LIABILITY FOR FAILURE TO FULFIL ITS OBLIGATIONS UNDER THIS WARRANTY OR ANY OTHER LIABILITY UNDER OR IN CONNECTION WITH THE EQUIPMENT SHALL BE LIMITED TO THE AMOUNT OF THE PURCHASE PRICE OF THE EQUIPMENT. THE REMEDIES STATED IN THIS WARRANTY ARE THE CUSTOMER'S EXCLUSIVE REMEDIES AGAINST WESTERN MULTIPLEX REGARDING THE EQUIPMENT.

6.3 EVEN IF WESTERN MULTIPLEX HAS BEEN ADVISED OF THE POSSIBILITY OF THEM, WESTERN MULTIPLEX SHALL NOT BE LIABLE FOR ANY INDIRECT, INCIDENTAL, SPECIAL OR CONSEQUENTIAL DAMAGES, INCLUDING THE COST OF LABOR BY THE CUSTOMER'S OWN EMPLOYEES, AGENTS OR CONTRACTORS IN IDENTIFYING, REMOVING OR REPLACING THE DEFECTIVE ITEM; LOST PROFITS, AND REVENUES; FAILURE TO REALIZE EXPECTED SAVINGS; ANY CLAIM AGAINST A CUSTOMER BY A THIRD PARTY; OR ANY OTHER COMMERCIAL OR ECONOMIC LOSSES OF ANY KIND.

6.4 THESE LIMITATIONS AND DISCLAIMERS ARE NOT MADE BY WESTERN MULTIPLEX WHERE PROHIBITED BY LAW.

LIMITATIONS ON DAMAGES (International)

6.1 THE WARRANTY STATED IN THIS DOCUMENT IS THE CUSTOMER'S EXCLUSIVE WARRANTY FOR THE EQUIPMENT; ALL OTHER WARRANTIES OF ANY KIND, EXPRESS OR IMPLIED, INCLUDING ANY WARRANTIES OF FITNESS FOR A PARTICULAR PURPOSE AND OF MERCHANTABILITY ARE EXCLUDED TO THE FULLEST EXTENT PERMITTED BY LAW.

6.2 WESTERN MULTIPLEX'S LIABILITY FOR FAILURE TO FULFIL ITS OBLIGATIONS UNDER THIS WARRANTY OR IN TORT OR AS A RESULT OF STRICT LIABILITY OR ANY OTHER LIABILITY UNDER OR IN CONNECTION WITH THE EQUIPMENT OR ITS SUPPLY SHALL BE LIMITED, EXCEPT IN RESPECT OF DEATH AND PERSONAL INJURY CAUSED BY WESTERN MULTIPLEX'S NEGLIGENCE, TO THE AMOUNT OF THE PURCHASE PRICE OF THE EQUIPMENT. THE REMEDIES STATED IN THIS WARRANTY ARE THE CUSTOMER'S EXCLUSIVE REMEDIES AGAINST WESTERN MULTIPLEX REGARDING THE EQUIPMENT.

6.3 EVEN IF WESTERN MULTIPLEX HAS BEEN ADVISED OF THE POSSIBILITY OF THEM, WESTERN MULTIPLEX SHALL NOT BE LIABLE FOR ANY INDIRECT, INCIDENTAL, SPECIAL OR CONSEQUENTIAL DAMAGES, INCLUDING THE COST OF LABOR BY THE CUSTOMER'S OWN EMPLOYEES, AGENTS OR CONTRACTORS IN IDENTIFYING, REMOVING OR REPLACING THE DEFECTIVE ITEM; LOST PROFITS, AND REVENUES; FAILURE TO REALIZE EXPECTED SAVINGS; ANY CLAIM AGAINST A CUSTOMER BY A THIRD PARTY; OR ANY OTHER COMMERCIAL OR ECONOMIC LOSSES OF ANY KIND.

CONDITIONS OF SALE

DEFINITIONS

1.1 In these Conditions, unless there is something in the subject matter or context necessarily inconsistent:

(a) "Western Multiplex" means Western Multiplex (d.b.a. Western Multiplex), Sunnyvale, CA;

(b) "Equipment" means the equipment itemized on the Quotation/Order Acknowledgment;

(c) "International" means any location other than United States of America and Canada, including their territories and possessions;

(d) "North America" means any location in the United States of America and Canada, including their territories and possessions;

(e) "Order Acknowledgment" means the sales order acknowledgment provided by Western Multiplex to the Customer;

(f) "Payment Instructions" means Western Multiplex's payment instructions, (Western Multiplex document P197-1);

(g) "Quotation" means the quotation signed by an authorized representative of Western Multiplex and provided to the Customer;

(h) "Shipping Date" means the actual date on which the Equipment left Western Multiplex's factory at Sunnyvale, CA, U.S.A.;

(i) "Warranty" means Western Multiplex's warranty, document W97-1;

(j) "Invoice" means the bill of goods prepared by Western Multiplex for the equipment with the shipping and any insurance costs.

1.2 Headings have been inserted in these Conditions for convenience of reference only and will not effect their construction.

ENTIRE AGREEMENT

2.1 The Quotation, these Conditions of Sale, the Order Acknowledgment, the Payment Instructions and the Warranty shall apply to all sales made by Western Multiplex and shall constitute the entire agreement by Western Multiplex and the Customer (the "Agreement ").

2.2 Any terms and/or conditions of sale, which may be included on the Customer's purchase order form or any communication from the Customer, that are not identical with the terms and conditions steed in this document shall NOT become a part of the agreement of sale unless expressly agreed to in writing in the Quotation.

2.3 Western Multiplex's failure to object to any terms and/or conditions of sale contained in any communication from the Customer shall not be considered as acceptance of such terms and/or conditions or as a waiver of the terms and conditions of sale contained herein.

2.4 Western Multiplex shall sell to the Customer, and the Customer shall purchase from Western Multiplex, the Equipment in accordance with the Agreement. Western Multiplex accepts the Customer's purchase orders for Equipment and agrees to deliver the Equipment to the Customer only on the terms of the Agreement.

2.5 No variation of the Agreement shall be binding unless agreed to in writing by authorized representatives of Western Multiplex and the Customer.

PRICING

3.1 All prices in the Quotation are exclusive of all shipping charges and all applicable taxes including but not limited to, federal, state, local, excise, sales and use taxes.

3.2 All prices in the Quotation unless otherwise stated:

(a) for North American customers are FOB Sunnyvale, CA, USA. (New York Uniform Commercial Code); or

(b) for international customers are Ex-Works, Sunnyvale, CA, U.S.A. (Incoterms 1990).

3.3 All prices in the Quotation include standard domestic packing, unless a separate line item is provided detailing export or special packing charges.

SHIPPING AND INSURANCE

4.1 Western Multiplex shall arrange shipping and insurance when requested by the Customer, and shall bill the Customer for the Equipment with the shipping and any insurance costs as separate items, on an invoice (the "Invoice").

4.2 Delivery dates quoted by Western Multiplex are to be considered estimates only. In no event will Western Multiplex be liable for any loss or damage resulting from its failure to deliver products within a specified time.

TERMS OF PAYMENT

5.1 The Customer shall pay for all Equipment, including shipping and insurance in accordance with the terms of the Invoice.

5.2 All Invoices for North American Customers are due and payable in thirty (30) days from the date of the Invoice.

5.3 International Customers shall make payments in accordance with Western Multiplex's Payment Instructions by either:

(a) providing a wire transfer (telegraphic transfer) for the full amount of the Equipment, shipping and insurance charges contained in the Quotation or the pro-forma Invoice sent to the Customer, prior to the Shipping Date; or

(b) establishing an acceptable Letter of Credit (LC) for the full amount of the Equipment, shipping and insurance charges contained in the Quotation prior to the order being booked and accepted by Western Multiplex.

5.4 If a Customer fails to pay an Invoice when due, Western Multiplex may, without prejudice to am other remedy, postpone shipments, alter payment terms, terminate the Agreement and charge interest on all overdue amounts the rate of 1.5% per month compounded monthly (or if less, the maximum allowed by law). Upon demand, the Customer shall pay all such interest charges and all reasonable collection fees, including reasonable legal expenses.

SECURITY FOR PAYMENT

6.1 If the Customer is located in North America, the Customer grants to Western Multiplex a purchase money security interest in the Equipment to secure the payment of the purchase price of the Equipment and all other amounts due from the Customer.

6.2 If the Customer is not located in North America:

(a) despite delivery and passing of risk in the Equipment and any other provision of these Conditions, the title in the Equipment shall not pass to the Customer until Western Multiplex has received payment in full of the purchase price of the Equipment and all other amounts then due from the Customer, and

(b) until the title in the Equipment passes to the Customer:

(i) the Customer shall hold the equipment as Western Multiplex 's fiduciary agent and bailee, and shall properly store, protect and insure the Equipment and shall identify the Equipment as Western Multiplex property;

(ii) if the Customer fails to pay Western Multiplex in accordance with the agreed payment terms, Western Multiplex may require the Customer to deliver up the Equipment to Western Multiplex, and, if the Customer does not, Western Multiplex may enter on the premises where the Equipment is stored and repossess the Equipment; and

(iii) the Customer shall not pledge the Equipment by way of security for any, indebtedness of the Customer, but if the Customer does so all moneys owed by the Customer to Western Multiplex shall, without prejudice to any other remedy of Western Multiplex, immediately become due.

CHANGES TO PRODUCT SPECIFICATIONS

7.1 Western Multiplex may, without notice to the Customer, make changes to the specifications of Equipment which do not materially affect the quality or performance of the Equipment.

EQUIPMENT CONFIGURATION AND EXPEDITING CHARGES

8.1 At the Customer's request, Western Multiplex may, for a fee agreed in advance:

(a) reconfigure the Equipment; or

(b) expedite the Customer's order.

SHORTAGES

9.1 The customer shall not make any claim for shortages (which are items that the Invoice does not show are on back-order) after twenty-one (21) days after the date of the Invoice.

RETURNS AND EXCHANGES

10.1 The return of defective Equipment is covered by the Warranty .

10.2 The Customer may only return Equipment that is not defective if:

(a) the Equipment does not correspond with the Customer's purchase order; or

(b) the Equipment has been ordered in error by the Customer and Western Multiplex has permitted the Customer to remedy the mistake by ordering the correct equipment and resuming the Equipment and the Customer obtains a Returned Materials Authorization number ("RMA #") from Western Multiplex prior to returning any Equipment.

10.3 Western Multiplex reserves the right to charge a fee for returned equipment under Subparagraph 10.2(b) with the amount of the fee being determined prior to an RMA # being given by Western Multiplex.

10.4 Authorized returns of equipment under Paragraph 10.2 must be in an undamaged condition, in the original configuration, in the original packing materials and within a time period agreed to when the RMA # was issued.

10.5 If the Customer does not comply with the provisions of Paragraphs 10.2, 10.3, and 10.4, the Customer shall pay the full amount of the Invoice.

10.6 The party liable for all shipping, insurance and any other expenses incurred by the Customer in returning the Equipment under Paragraph 10.2 and for all loss or damage to the Equipment until received by Western Multiplex, shall be: (a) for all items returned under Subparagraph 10.2(a), Western Multiplex and (b) for all items resumed under Subparagraph 10.2(b), the Customer.

CANCELLATION

11.1 If the Customer cancels an order before the Shipping Date, Western Multiplex reserves the right to charge the Customer a cancellation charge up to 100% of the amount of the order.

11.2 The Customer shall pay all cancellation charges within thirty (30) days from date of the Invoice.

FORCE MAJEURE

12.1 Western Multiplex shall not be liable if its performance of the Agreement becomes commercially impractical due to any contingency beyond Western Multiplex's reasonable control, including acts of God, fires, floods, wars, sabotage, civil unrest, accidents, labor disputes or shortages, government laws, rules and regulations, whether valid or invalid, inability to obtain material, equipment or transportation, incorrect, delayed or incomplete specifications, drawings or data supplied by the Customer or others (collectively "Force Majeure"). In no event of Force Majeure shall Western Multiplex be required to purchase goods from others to enable it to deliver the Equipment under the Agreement.

ENGINEERING AND SYSTEM DESIGN

13.1 The Customer is solely responsible for the engineering, design, integration and normal preventative and remedial maintenance of the Customer's system for which Western Multiplex supplies Equipment.

13.2 Western Multiplex is not responsible for the satisfactory operation of the Equipment in conjunction with other manufacturer's equipment, nor for any losses which may occur as a result of a failure of the Equipment to operate in conjunction with other manufacturer's equipment.

WARRANTY

14.1 All Equipment is covered by the Warranty.

14.2 THE WARRANTY CONTAINS LIMITATIONS ON THE CUSTOMER'S RIGHTS AND REMEDIES AGAINST WESTERN MULTIPLEX UNDER THE AGREEMENT. THE CUSTOMER ACKNOWLEDGES HAVING READ, UNDERSTOOD AND AGREED TO THOSE LIMITATIONS.

DAMAGES FOR BREACH OF AGREEMENT

15.1 If either party is successful in any litigation between the parties based on the Agreement, the successful party shall recover from the other, in addition to direct damages, the successful party's reasonable attorney's fees and other costs of litigation.

INSOLVENCY OF CUSTOMER, ETC.

16.1 Western Multiplex may cancel the Agreement and suspend any further deliveries under the Agreement without any liability to the Customer, and, if Equipment has been delivered but not paid for, the price shall become immediately due and payable despite any other agreement to the contrary if:

(a) any proceedings in bankruptcy, insolvency, receivership or liquidation are taken against the Customer;

(b) the Customer makes an assignment for the benefit of creditors or commits an act of bankruptcy or insolvency;

(c) the Customer ceases, or threatens to cease, to carry on the ordinary course of its business, or transfers all or substantially all of its property;

(d) the Equipment is seized under any legal process or confiscated; or

(e) Western Multiplex in good faith believes that the ability of the Customer to pay or perform any provision of the Agreement is impaired, or that any of the events mentioned above is about to occur.

NOTICE

17.1 All requests, instructions and notices from one party to the other must be in writing and may be given via registered post or facsimile transmission to the address of the parties shown on the Quotation or Order Acknowledgment.

EXPORT PROVISIONS

18.1 The Customer shall not, whether directly or indirectly (including facilitating a third party) export or re-export the Equipment outside the country in which the Customer has stated these items are to be used without obtaining the licenses required under ail applicable rules. The Customer shall indemnify Western Multiplex against any liability incurred by Western Multiplex due to any violation by the Customer of any of the provisions of this Section, but this indemnity shall not apply if the Customer reasonably relies on information supplied to it by Western Multiplex with respect to export licenses. Upon receipt of a governmental consent to export the receiving party shall immediately notify the other in writing.

MISCELLANEOUS

19.1 No waiver by Western Multiplex of any breach of this Agreement shall be considered as a waiver of any subsequent breach of the same or any other provision.

19.2 Any provision of the Agreement which is, or is deemed to be, unenforceable in any jurisdiction shall be severable from the Agreement in that jurisdiction without in any way invalidating the remaining portions of the Agreement, and that unenforceability shall not make that provision unenforceable in any other jurisdiction.

19.3 The rights which accrue to Western Multiplex by virtue of the Agreement shall inure for the benefit of and be binding upon the successors and assigns of Western Multiplex.

19.4 The agreement shall be governed by the laws of the State of California including the California Uniform Commercial Code. However Western Multiplex may enforce the provisions of the Agreement in accordance with the laws of the jurisdiction in which the Equipment is situated. The United Nations Convention on the Sale of Goods (The Vienna Convention) shall not apply to the Agreement.

19.5 Les parties ont exigés que cette entente soit rédigée en anglais.

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Tables

1. How to Use This Manual

1.1 Manual Organization

The Installation and Maintenance Manual provides information required to install and maintain *Tsunami* and to use its many features to the fullest advantage. This manual is divided into the following sections:

Section 1 Provides instructions on how to most effectively utilize the information in this manual.

Section 2 Provides a brief description and specifications of the *Tsunami*.

Section 3 Explains the *Tsunami* installation and adjustments in detail.

Section 4 Provides maintenance, repair and troubleshooting information for the *Tsunami Fast Ethernet radios*.

Appendices Charts and diagrams are provided for radio connections and DIP switch settings along with other general information.

This device must be professionally installed.

This device is to be used exclusively for fixed point-to-point operation that employs highly directional (<10°) antennas.

1.2 Icons

Throughout this manual, the following icons are used to highlight areas of special interest and importance.

Note

Practical Tip

Caution

2. Product Description

2.1 General Description

The *Tsunami* licensed radios provide high capacity transmission and operational convenience in a digital communications network.

These *Tsunami* radios provide 1000BaseF intelligent bridging between two fixed coordinated locations.

Because each owner controls the operation of the link, there is no reliance on any outside services. *Tsunami* radio operators are able to operate whenever needed, and to be in control of their own network.

The *Tsunami* offers two primary benefits:

- ❖ **CONVENIENCE** — Easy to install and operate with **a user license** coordinated in the USA. (Other countries may also require a user license and/or frequency coordination).
- ❖ **CAPABILITY** — Full transparent Fast Ethernet connections with no throughput reduction over any line-of-sight distance (within legal limits of government regulation)

Tsunami radios are ISO Layer 2 Data Link Layer (use MAC address for filtering) devices where they provide their full stated throughput. At level 2 (bridges) or 3/4 (routers) where hardware plays the major part, the most common tester is the SmartBits 200 product from NetCom Systems. At Application Layer 7, you will see less than 40% throughput from the maximum capacity measured with SmartBits due to the increased protocol/software overhead at that level. Layer 7 can be tested with software such as Ganymede's Chariot or Qcheck product (www.qcheck.net/index.html). Use Qcheck (or equivalent), do NOT use PING for throughput testing (www.qcheck.net/whyqcheck.html)!

As an example: testing copper CAT5e cable with SmartBits will test 100% throughput (let's say you can send/receive a full 100Mbps). At Layer 7 you will be transferring bits at the 100Mbps rate, but approximately only 45Mbps of user data will transfer (Ethernet has a high overhead of bytes added to each data packet frame each time you go up a layer). The advantage is the more complex overhead makes the data virtually resilient to corruption and minor errors (i.e. collisions), it’s easy to reroute and the network can use inexpensive plug/play devices like hubs/switches instead of multiplexers as used in the telco industry (i.e. LYNX T1/E1/DS3 radios)

Western Multiplex tests for stated throughput at Layer 2/3 where bridges are defined. At layer 7 (application layer), you may see less than 50% or more depending on the other traffic that may be on the LAN as this layer is more dependent on the type of data being sent (it does not matter if it's wire, fiber or any Ethernet bridge -wired or wireless). Another way to look at it: the model 31145 12Mbps (10Mbps 10BaseT+T1/E1 wayside) bridge will test the same as a piece of CAT5e Ethernet cable.

2.2 Specifications

All specifications are subject to change without notice.

2.2.1 Transmitter

Frequency Selection	A1 channel model 272XX-G1A1 (center frequency Tx=5775) A2 channel model 272XX-G1A2 (center frequency Tx=5300)	
Frequency Range	5250 – 5350 MHz 5725 – 5825 MHz	(100MHz BW) (100MHz BW)
Output Power	+10 dBm (5.3 GHz band) +17 dBm (5.8 GHz band)	
(Note: output power is specified as guaranteed minimum before attenuation)		
Control Range	16 dB min (at ODU)	

DO NOT exceed the maximum transmit power setting as set at the factory! Exceeding the factory-set power level will degrade the specifications of the radio and may also violate regulatory compliance. Output power may be attenuated from factory setting to comply with regulatory EIRP limits.

2.2.2 Antenna / Antenna Coupling Unit

Mechanics	OutDoor Unit (ODU) attached to antenna w/two short coax cables InDoor Unit (IDU)attached to ODU via two (2) coax cables
Antenna Connection	Dual 'N' female connectors (H and V polar connections)
Impedance	50 ohms
Recommended	2 to 8 foot or 1.5 to 2 foot flat panel
Gain & Beamwidth (3 dB)	
1.5 ft Flat	25.5 dB / 8°
2 ft Flat	28 dB / 4.6°
2 ft Parabolic	28.5 dB / 6°
4 ft Parabolic	35 dB / 3°
6 ft Parabolic	38 dB / 2.9°

2.2.3 Receiver

	All Models
Nominal Receive Level	-30 to -68 dBm
Maximum Receive Level	-10 dBm error free, 0 dBm no damage
Frequency Selection	None-use A1 or A2 models
Threshold Rx Level (typ.) (BER = 10^{-6})	-70 dBm
Frequency Range	5250 – 5350 MHz (100MHz BW) 5725 – 5825 MHz (100MHz BW)
Bandwidths	~97MHz per channel per polarization
RSL Voltage	0.00 to 1.00 VDC (approximate RSL calculated by multiplying voltage times 100 and changing sign to negative value (example: 0.56vdc = –56dBm)

2.2.4 System (Single Hop Performance)

Error Floor	10^{-11}
Transmission delay (radio only) (10 mile path)	 250 µsec, maximum 300 µsec, maximum

2.2.5 Line Interfaces

Gigabit Ethernet Port:

Data Interface	1000BaseF (fully compatible with IEEE 802.3u)
VPN (IEEE 802.1q)	Ethernet port forces the sending device to break up jumbo frames into legal Ethernet frames that do not exceed the 1538 byte limit. In both cases, 802.1q frames are passed through the bridge (IEEE 802.1d)
Connectors	SC (fiber) 1300nm multimode to 2000m
Configuration	Full duplex on the WAN interface
Filtering	15,000 packets per second theoretical, before forwarding
Buffer	400 packets
LAN Table	1,024 MAC addresses
Self-learning	Automatic learning and aging
Digital Capacity (ISO Layer 2)	480 Mbps Model: ~486 Mbps full duplex (>960 Mbps total) 720 Mbps Model: ~726 Mbps full duplex (>1440 Mbps total)

DS-1 (T1) Port:

Data Rate	1.544 Mbps (each of four ports)
Digital Interface *	4 x DSX-1
Connector	8-pin modular jack female (RJ-48C) Pins:1=TT, 2=TR, 4=RT & 5=RR
Line Code	AMI / B8ZS (NMS selectable)
Line Build Out	0-660 feet (NMS selectable)
Blue Code **	Alarm Indication Signal (AIS)
Loopback	Near or far end (NMS selectable)

* Meets AT&T Pub 62411, Bellcore TR-TSY-000499.
** Signal is selectable (on/off) and is generated only on data loss or link failure when enabled.

2.2.6 Auxiliary Connections

Orderwire Interface	2-wire, 4-pin modular jack, female (RJ-11)
REN (Ringer Equivalency Number)	1.0 B
DTMF tones	within ±1.5% of nominal freq. (+0-6 dB)
Ringing Voltage	48 VDC, typical

(use telephones with solid state ringers, NOT adequate for older style mechanical ringers)

VF Orderwire Bridge	600 ohm balanced, 4-wire, 0 dBm, DB-9, male
Diag-nostic Port	RS-232, DB-9, male
Aux Data (clear service channel)	RS-232, ≤9600 baud, DB-9, female
Alarm	2 x Form C, DB-9, female
Test Points	Output Power Near-end and far-end received signal level (RSL)

100BaseT or F NMS Ethernet Port:

Data Interface	100BaseT or 100BaseF
Connectors	RJ-45/48c (wire) Pins:1=Tx+, 2=Tx-, 3=Rx+ & 6=Rx-

2.2.7 Temperature and Environment

Operating Temperature Range (IDU)	-10 to +50°C
Operating Temperature Range (ODU)	-30 to +60°C
Humidity	95% non-condensing
Altitude	4,500 meters, maximum

2.2.8 Power

DC Input Voltage	±37 to ±63 VDC
Power Consumption	~150 Watts
Connector	Barrier strip, plug-in type

2.2.9 Regulatory Information

FCC Identifier	HZB-U5358-480	HZB-U5358-720	HZB-U5358-1000
FCC Rule Parts	15.407 (UNII)	15.407 (UNII)	15.407 (UNII)
Industry Canada ID	TBD	TBD	TBD
IC Rule Parts	RS-210 (LE-LAN)	RS-210 (LE-LAN)	RS-210 (LE-LAN)

2.2.10 Mechanical

Width (for 19-inch EIA rack mounting)	437 mm (17.2") rack mounting brackets supplied	
Height (IDU)	44.5 mm (1.75") (1RU)	
Depth	304 mm (12")	
Weight (IDU)	3 kg. (6.7 lbs.)	ODU w/o Antenna 5.2 kg. (11.4 lbs.)

2.3 Front Panel Description

2.3.1 General

The *Tsunami* radio front panel (no user access on rear panel), as shown in Figure 2-1, has LED indicators, test points, controls and connections that are used for installation, maintenance, operation and troubleshooting. Prior to installation, it is best to be familiarize yourself with the front panel of your particular model. Sections 2.3.2 through 2.3.5 briefly describe the front panel access and indicators.

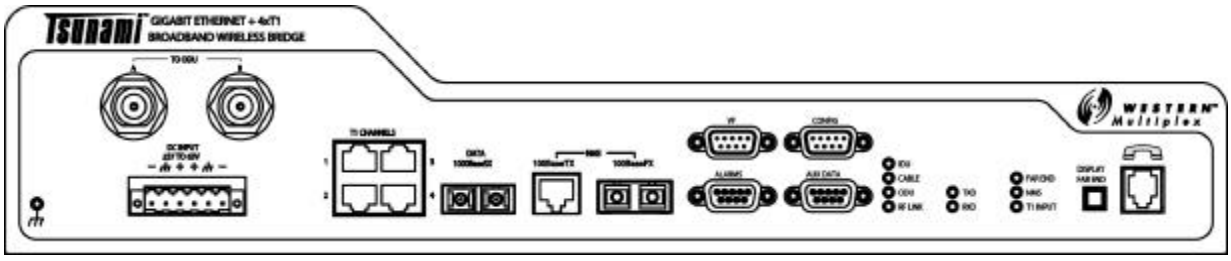


Figure 2-1: IDU Front Panel

Figure 2-2: ODU
(Shown without antenna attached)

2.3.2 Test Points on ODU

The Tsunami radio products do not have an on/off switch.

GND This is a grounding post to connect to earth ground.

RSL This is a test point (BNC connector) that relates to the Received Signal Level (RSL). The voltage is measured with a voltmeter (using the GND test point for reference) which corresponds to the actual power level of the incoming received signal.

This is a test point which corresponds to the output transmit power of the radio. The voltage is measured with a voltmeter (using the GND test point for reference) which corresponds to the actual power level of the outgoing signal. This measurement is used during installation, maintenance and troubleshooting

This voltage only applies to the near-end and does not allow measurement of the far-end output transmit power, even when the DISPLAY FAR END button is pressed.

There is a receptacle on the front panel to the right of the LOCAL TX PWR test point which is an installation adjustment allowing the output transmit power to be increased or decreased within the radio's specified limits. Using a small screwdriver, this adjustment is used to set the output power of the transmitter, in accordance to the path planning.

The Tsunami system requires professional installation. Transmitted output power limits may apply when using this radio. Consult FCC, IC, Western Multiplex or other regulatory authorities for limits which may apply. See Section 3.13.1 for details on setting output power. ***Do not adjust output power above factory settings.***

2.3.3 Alarm and Status Indicators

IDU	Green = Indoor Unit OK Red = Indoor Unit detected hardware failure
Cable	Green = ODU Cable OK Red = ODU Cable shorted
ODU	Green = Outdoor Unit OK Red = Outdoor Unit detected hardware failure
Radio Fail	Green = Radio hardware OK Red = Hardware failure detected
RF Link	Green = Error-free operation Yellow = Bit errors occurring Red = Excessive bit errors or radio link failure Flashing = Link security ID mismatch
TXD	Green = 100BaseT data transmit present Yellow = 100BaseT port connected (no data present) Off = No 100BaseT connection detected
RXD	Green = 100BaseT data receive present Yellow = 100BaseT port connected (no data present) Off = No 100BaseT connection detected
COLL	Yellow = Collisions occurring on 100BaseT (half-duplex mode)
FAR END	Red = Alarm(s) present on the far-end radio**
NMS (100Base)	Green = Tx or Rx data present on the NMS interface Yellow = NMS interface connected (no data present) Off = No NMS interface connection detected
T1 INPUT	Green = Alarm enabled and T1 connection detected Red = Alarm enabled and no T1 connection detected Yellow = Alarm disabled and T1 connection detected Off = Alarm disabled and no T1 connection detected

*** Radio Fail, RF Link (yellow or red), T1 Input (yellow or red)*

2.3.4 Controls

DISPLAY FAR END This push-button provides the capability to determine alarms and status of the far-end radio. When pressed and held, the alarm and status LEDs correspond to the far-end radio's status. This can be used for installation, maintenance and troubleshooting. When the LED on this switch is flashing, no far-end information is available. This typically indicates that there is no link between near-end and far-end radios.

2.3.5 Connections

RF CONNECTION

The RF port of this *Tsunami* radio is an N-type female connector that is used to connect to the ODU using coaxial transmission line.

Use LDF4-50, LMR-400 or equivalent up to 100 meters (300 ft.)
Use LDF4.5-50, LMR-600 or equivalent up to 300 meters (1000 ft.)

.

DATA CONNECTION

The connection for the Gigabit Ethernet interface that carries the signals in and out of the radio is an SC type 1000BaseF fiber connection.

DC POWER CONNECTION

The input accepts positive or negative DC power at any voltage between 37 and 63 Volts.

OPTIONAL CONNECTIONS

There are several connections that are not required for operation, but provide additional facilities to the user.

EOW This connection is used to access the electronic orderwire function. This is a facility for "telephone" style service from one radio to another. A standard electronic telephone [one with a handset and DTMF (push-button tone) dialing] plugs into this connector. The user can dial the orderwire address of the far-end radio (or any radio in the *Tsunami* network) to establish telephone communication between sites. This communication does not interrupt or interfere with the other radio communications. The radio link must be operational to use this facility. The orderwire feature can be very useful for installation, maintenance and troubleshooting.

VF This connector is used to link two *Tsunami* radios at a repeater site for Orderwire operation. This would allow orderwire "telephone" calls to and from any point in the *Tsunami* network.

The Tsunami orderwire circuit can also be connected to other existing orderwire networks. See Section 3.14.1 for details.

ALARM This connector is used for monitoring alarms electrically. The Form C relays can be connected to other transmission equipment for monitoring alarm status locally or remotely.

DIAG This is a serial interface port (RS-232) to the *Tsunami* radio. This port provides configuration and maintenance information about the *Tsunami* radio(s) to a

connected computer or terminal. See section on TELNET session in this manual.

AUX DATA This is a serial interface port (RS-232, ≤9600 baud) which allows the user to connect auxiliary serial data from one point in the radio network to another. It can be used for separate data connection for serial devices.

100Base NMS This is an Ethernet connection for access to the Tsunami NMS (SNMP or HTML). See section 4.11 for more detail for operation.

T1 This is a wayside data channel for T1 (DS-1) interface of auxiliary traffic (27400-51 Models).

2.4 Rear Panel Description

The *Tsunami* radio rear panel, is blank. All connections and indications are on the front panel for “single panel” access

2.5 Installation Accessories

The *Tsunami* radio is shipped with several accessories commonly required for the radio as described below:

Rack Mount Brackets	Two brackets (along with required mounting screws) are provided which allow 19-inch rack mounting of the *Tsunami* radio.
Terminal Connector	This is a 6-pin mating connector used for DC power supply.
D Connector 9-pin	Four of these mating connectors are provided. One is used for the VF port, one for the CONFIG port, one for the ALARMS port and one for the AUX DATA port.

Other accessories are available, such as orderwire handsets, connector adapters and special cables. These can be ordered separately upon request.

3. Installation & Adjustments

3.1 Shipping Container

The equipment is shipped in boxes unless ordered as an integrated system and configured at the factory, in which case the equipment may be racked and shipped in a crate. The equipment is packaged so as to prevent damage in transit.

The boxes should be left intact and sheltered until arrival at the installation site.

If the shipping container shows signs of damage, the transportation company should be notified immediately. Extra care and inspection of the contents is advised immediately upon receipt.

It is recommended that all the packaging materials be retained**. In the unlikely event that the equipment must be returned to the factory, use the original packing materials for return shipment. **The original packaging materials are also recommended for transporting the equipment from location to location.

Inside the primary shipping containers, internal boxes may contain other items. These boxes should also be saved for future use.

Also, save the Tsunami radio test data sheet that is provided. The test data sheet can be placed where the Tsunami terminal will be installed for future quick reference. All Tsunami units are individually tested and the actual measured performance recorded on the Factory Test Data Sheet. You will find this information to be of use during installation, troubleshooting and maintenance.

A set of “quick installation instructions” is also provided which can be useful for easy reference during installation.

3.2 Packing Items Identification

The primary shipping container houses the radio along with other items including:

- This manual
- Installation accessory kit (see Section 2.5)

3.3 Before Installation Task List

There are several tasks that should be accomplished prior to installing the *Tsunami* radio system. This section briefly describes the following:

- Site selection
- Line-of-Sight and Path Clearance determination
- Anticipated RSL calculation
- Fade margin calculation
- Availability calculation
- Frequency plan determination
- Power supply planning
- Antenna (and accessories) purchase

Only directional antennas should be used with Tsunami radios. These are typically flat panel or solid parabolic antennas. Western Multiplex recommends a maximum beamwidth of 10 degrees for directional systems.

3.3.1 Site Selection Requirements

The radio site must have:

- access to the appropriate power
- close proximity to the telephone or computer system you wish to interconnect
- line-of-sight to the other radio location with adequate clearance
- location for mounting the antenna

3.3.2 Line-of-Sight and Path Clearance Guidelines

The *Tsunami* radios will not operate properly unless they have line-of-sight between their corresponding antennas. The *Tsunami* radio transmission will not pass through trees or other obstacles. Factors to consider include:

- Earth curvature

- Future growth of trees

- Height of buildings

In addition to the line-of-sight requirement, a well-engineered path will also have additional path clearance to allow for signal loss due to partial obstructions, atmospheric ducting and ground reflections. To maximize radio reception, 0.6 times the first Fresnel zone should be calculated and this distance added to the path clearance (in addition to trees or buildings).

3.3.3 RSL Calculation and Link Budget

The received signal level (RSL) can be estimated using the following formula:

$RSL\ (dBm) = P_{out} - FL_1 + G_1 + G_2 - FL_2 - L_p$

where: P_{out} is the transmitter output power (in dBm)

FL_1 is the feeder loss of the transmit side (in dB)

G_1 is the gain of the transmit antenna (in dB)

G_2 is the gain of the receive antenna (in dB)

FL_2 is the feeder loss of the receive side (in dB)

L_p is the Path loss, defined by:

$L_p\ (dB) = 96.6 + 20 \log_{10} F + 20 \log_{10} D$

where: F = Frequency in GHz (2.4 or 5.8)

D = Distance of path in miles

This link budget is very important for determining any potential problems during installation. If you have calculated the expected RSL, you can see if it has been achieved during installation, and troubleshoot if necessary.

3.3.4 Fade Margin Calculation

The fade margin is the difference between the actual received signal and the radio's threshold. Using the formula provided in Section 3.3.3, the anticipated RSL can be calculated. Compare this RSL to the specified threshold of the *Tsunami* radio (shown in Section 2.2) and calculate the fade margin as the difference between the two signal levels.

3.3.5 Availability Calculation

Availability of the microwave path is a measure of the percent of the time that the link will operate without producing an excessive BER due to multipath fading. In the absence of direct interference, availability is affected by the following:

- Path length
- Fade margin
- Frequency (5.8 GHz in the case of these *Tsunami* radios)
- Terrain (smooth, average, mountainous)
- Climate (dry, temperate, hot/humid)

Depending on the type of traffic carried over the link, the system designer may wish to design for a specific availability. For example, if the data or voice traffic that is carried by the radio is critical then it may be designed for a very high availability (e.g. 99.999% or 5.3 minutes of outage per year). To improve availability, for example, the fade margin can be increased by making the path shorter, or by using higher gain antennas.

	1 mile	2 miles	3 miles	4 miles	5 miles	10 miles
1.5'						
fade margin	46	40	36.5	34	N/R	N/R
reliability	100	99.999	99.999	99.999		
2.0'						
fade margin	50.6	44.5	41	38.5	36.5	N/R
reliability	100	100	99.999	99.999	99.999	
2.5'						
fade margin	54.8	48.7	45.2	42.7	40.8	34.8
reliability	100	100	99.999	99.999	99.999	99.999
4.0'						
fade margin	62.6	56.5	53	50.5	48.6	42.6
reliability	100	100	100	99.999	99.999	99.999
6.0'						
fade margin	69.4	63.3	59.8	57.3	55.4	49.4
reliability	100	100	100	100	99.999	99.999

Table 3-A: Fade Margin & Availability Calculations

3.3.6 Power Supply Planning

The *Tsunami* radio must have access to a supply of appropriate DC power. The *Tsunami* can be powered from a DC battery system, or from a solar or generator power plant, usually with battery reserves. Typically either a positive or negative 48 volt supply is used. For DC, be sure the cable is of sufficient gauge to carry the necessary current and it is less than three (3) meters (9.75 feet) in length.

Before installing the radio, plan for the continuous power consumption needs in accordance with the specifications given in Section 2.2 of this manual. It is also wise to plan for backup power for critical communication circuits (including the *Tsunami* radio). Backup power allows the radios and associated equipment to continue operation when primary power is interrupted.

3.3.7 Antenna Planning

Using path planning mathematics, proper antenna size can be determined which will yield the desired path performance. In general, the larger the antenna that is used with the *Tsunami* radio, the better the link will perform. Larger antennas have narrower beamwidth and higher gain, which will yield better link performance (higher fade margin, better availability) and improve immunity to interference (due to the smaller beamwidths). However, larger antennas are more costly to purchase and install than smaller antennas, in some cases requiring special equipment for installation. All of these factors should be taken into consideration when selecting antennas.

In areas where transmitted output power restrictions apply, the use of larger antennas will maintain the benefit of narrow beamwidths and receive gain. However, output power may need to be reduced to meet regulations. (See Section 3.13.1)

Prior to installation, the specific antenna location and mounting should be determined. This advanced planning also yields the transmission line requirements.

Only dual-band/dual-polarized directional antennas can be used with these Tsunami radios.

3.4 Tools Required

The following tools may be required for the installation of the *Tsunami* radios:

- Phillips (cross tip) screwdrivers (for 19-inch rack mounting and attachment of brackets)
- Small blade standard screwdriver (for power supply connector and RF output power adjust)
- Soldering iron (if using any D-type connectors)
- Wire strippers (for removing insulation from power supply and other wiring)
- Wire crimpers (if using any RJ-style connectors that are not pre-made)
- Digital Voltmeter (to measure RSL, Tx output power, Alarms)

The following tools are recommended for the installation of the *Tsunami* radios:

- RF power meter (to measure transmitter output power)
- Cellular phone or two-way radio (for talking with far-end crew and tower crew)
- Bit Error Rate test set (to test link after installation)
- Computer (for NMS access with 10BaseT interface and cable)
- Touch-tone Telephone* (to test orderwire circuits and for communication with far-end)

Additional tools will likely be needed for antenna and transmission line installation and antenna alignment. Consult Sections 3.8 through 3.10 of this manual for more details.

*Telephone connection specifications:

REN (Ringer Equivalency Number)	1.0 B
DTMF tones	within ±1.5% of nominal freq.
Ringing Voltage	48 VDC, typical

(Ringing voltage is adequate for modern solid state ringers, NOT for the older mechanical type ringers)

3.6 Mounting the *Tsunami* Radio

The *Tsunami* radio can be mounted at any height in a standard 19-inch rack. Blank rack-mounting spaces above and below the *Tsunami* are recommended, especially if the surrounding equipment dissipates a considerable amount of heat.

The *Tsunami* radio may be set up for mounting with the front edge projecting from the front face of a standard 19-inch rack using the rack mounting brackets enclosed with the screws in the Accessory Kit (4 per bracket). The rack mounting brackets may be reversed, in order to install for flush or cabinet mounting if preferred. Depending on rack configuration, it may be necessary to remove the four adhesive backed rubber feet on the bottom of the unit.

The Tsunami radio has internal fans which intake and exhaust on the left and right sides of the chassis. When rack mounting, it is important to leave a small gap between the outer edges of the radio and the inside edge of the rack.

The Tsunami radio may alternatively be placed on a table or shelf attached to a wall. Because of the low weight of the Tsunami, any mounting option other than rack mounting will be less secure.

The ODU is mounted on a substantial mounting pole (minimum 2.5 inches) to accommodate the supplied mounting bracket.

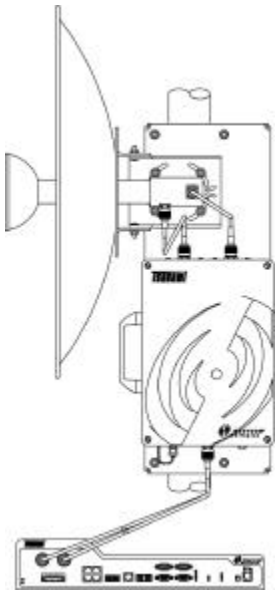


Figure 3-1: IDU and ODU Overview

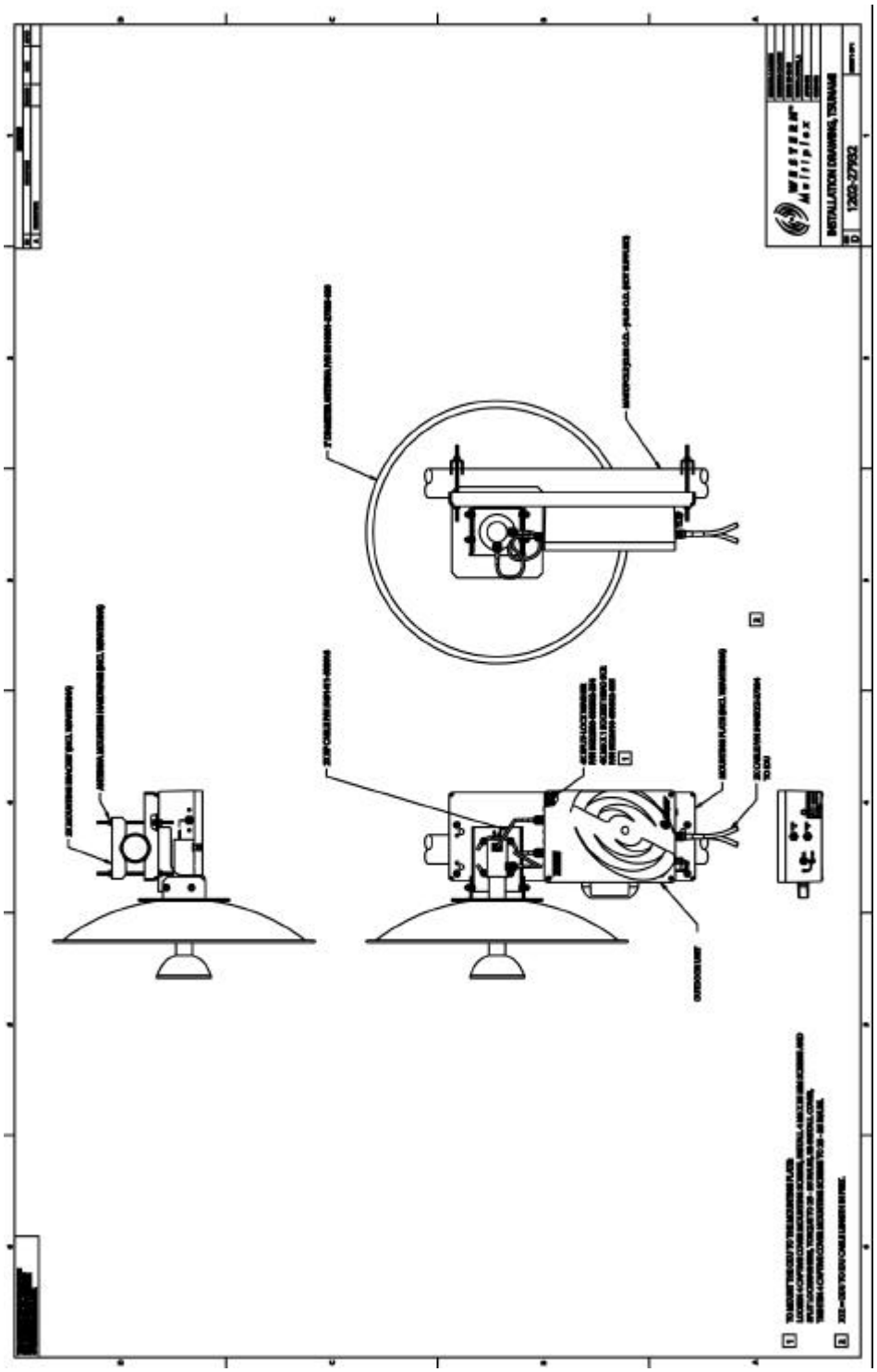


Figure 3-2: ODU mount with Antenna Detail

3.7 Power Connection and Wiring

There is no ON/OFF switch on the Tsunami. As soon as power is applied, the equipment will be operational. This means that there can be up to 1W of RF power present at the antenna port. The antenna port should be terminated before power is applied.

Power is connected using the DC power plug contained in the Accessory Kit. Use Table 3-B or 3-C along with the associated diagram of Figure 3-3 or 3-4 to connect the DC power cables. For example, for a negative DC power input, use Table 3-B and Figure 3-4.

NEGATIVE DC POWER INPUT (–20 TO –63 VDC)	
PIN	**FUNCTION**
1	**Power (–DC)**
2	**Ground (see figure 3-1)**
3	**Return (+DC)**
4	**Return (+DC)**
5	**Ground (see figure 3-1)**
6	**Power (–DC)**

Table 3-B: DC Power Connection for Negative Supply

POSITIVE DC POWER INPUT (+20 TO +63 VDC)	
PIN	**FUNCTION**
1	**Return (–DC)**
2	**Ground (see figure 3-2)**
3	**Power (+DC)**
4	**Power (+DC)**
5	**Ground (see figure 3-2)**
6	**Return (–DC)**

Table 3-C: DC Power Connection for Positive Supply

Pins 1 and 6 are connected together on the motherboard. Either pin may be used to apply (-DC) DC power input. Similarly, pins 3 and 4 are connected together on the motherboard and may be used to apply (+DC) DC power input.

For DC power return connection, connect to the opposite voltage (either the -DC or the +DC Pin) and connect the return to ground at the DC power plug on pins 2 and/or 5.

3.7.1 DC Power Wiring

Connect the power cable with adequate current rating (minimum of 20 AWG) to the terminals shown on the removed (not plugged into the radio) DC power plug using the screw connections. The recommended minimum current rating of external fuses and cables is 5 Amps. The *Tsunami* radios consume less than 4 Amps at ±48V. Be sure the DC power cable is less than 3 meters (9.75 feet) in length.

Each Tsunami terminal should be externally fused separately with a 8 Amp maximum fuse. The DC power cable must be less than three (3) meters in length.

If using **negative** power, connect the negative voltage to pins 1 or 6. Connect the ground return connection to pins 3 or 4. See Figure 3-3.

If using **positive** power, connect the positive voltage to pins 3 or 4. Connect the ground return connection to pins 1 or 6. See Figure 3-4.

The **ground** connection is available at pins 2 and 5. Either pin may be used to ground the return side of the power supply. Do not ground both sides of the power supply.

Proper grounding, either through the chassis and/or the power supply, can be very important for protection from lightning. A grounding screw hole is provided on the rear panel.

The ground connection may be left floating if the power supply is referenced to ground externally and to avoid ground loops in some configurations. However, this may not provide adequate grounding for lightning protection.

Use a DVM (digital voltmeter) to verify voltage and polarity on the DC power plug.

Do not connect the DC power plug to the rear of the Tsunami terminal until a load is connected to the antenna port (either an RF pad, or an RF cable and antenna).

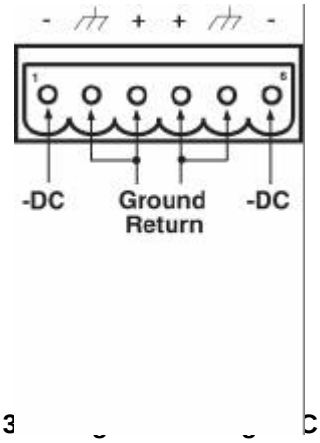


Figure 3 C Connection

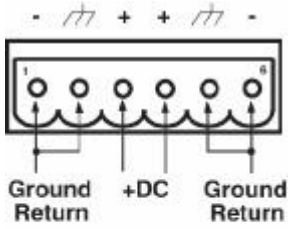


Figure 3-4: Positive Voltage DC Connection

Make sure that when connecting the mating plug that it is properly oriented (terminal screws pointing up) and securely fastened.

3.7.2 AC Power Connection

Not available with this product

Figure 3-5:

3.8 Antenna Installation & Alignment

INSTALLER CAUTION: Antennas used for this device must be fix-mounted on permanent outdoor structures to provide 5 meter or more separation from all persons during device operation to comply with FCC and other regulatory RF Exposure requirements. Installers should contact the manufacturer for applicable antenna gain and type restrictions to ensure compliance.

The antenna installation consists of permanently mounting the antenna and then attaching the ODU mounting plate and then the ODU itself to the mount. The antenna and ODU assembly must be mounted outdoors on a tower, building roof, or other location that provides line-of-sight path clearance to the far-end location. In general, antennas smaller than 1.5 feet diameter are not recommended for urban.

Antennas should be ordered with the suitable mounting kit specific to the site requirements. The antenna must be very rigidly mounted, with adequate room for azimuth and elevation adjustment from the rear. The antenna polarization must be the same at both ends of the link, either vertical or horizontal. The mounting kit includes the details on how to mount and adjust azimuth and tilt. Here, the details on how to mount the adapter plate and ODU are described.

In general, antenna mountings require a support pipe to which upper and lower support brackets are attached with “U” bolts. The antenna and optional elevation and azimuth adjustment rods are then mounted onto the support brackets. The whole structure must be adequately grounded for lightning protection. The antenna system must always be installed according to the manufacturer’s instructions.

Unless special test equipment is available, two operating *Tsunami* radios are required to align the antennas. The antenna is coarse aligned using visual sighting and then fine aligned using the receive signal level (RSL) voltage of the *Tsunami*. See figure 3-8.

The RSL voltage reading can still be used to peak antennas even if the radios have not synchronized, however far-end RSL cannot be measured from the near-end terminal until radios are synchronized.

3.8.1 Mounting plate to pole mounting assembly:

Refer to the diagram below-

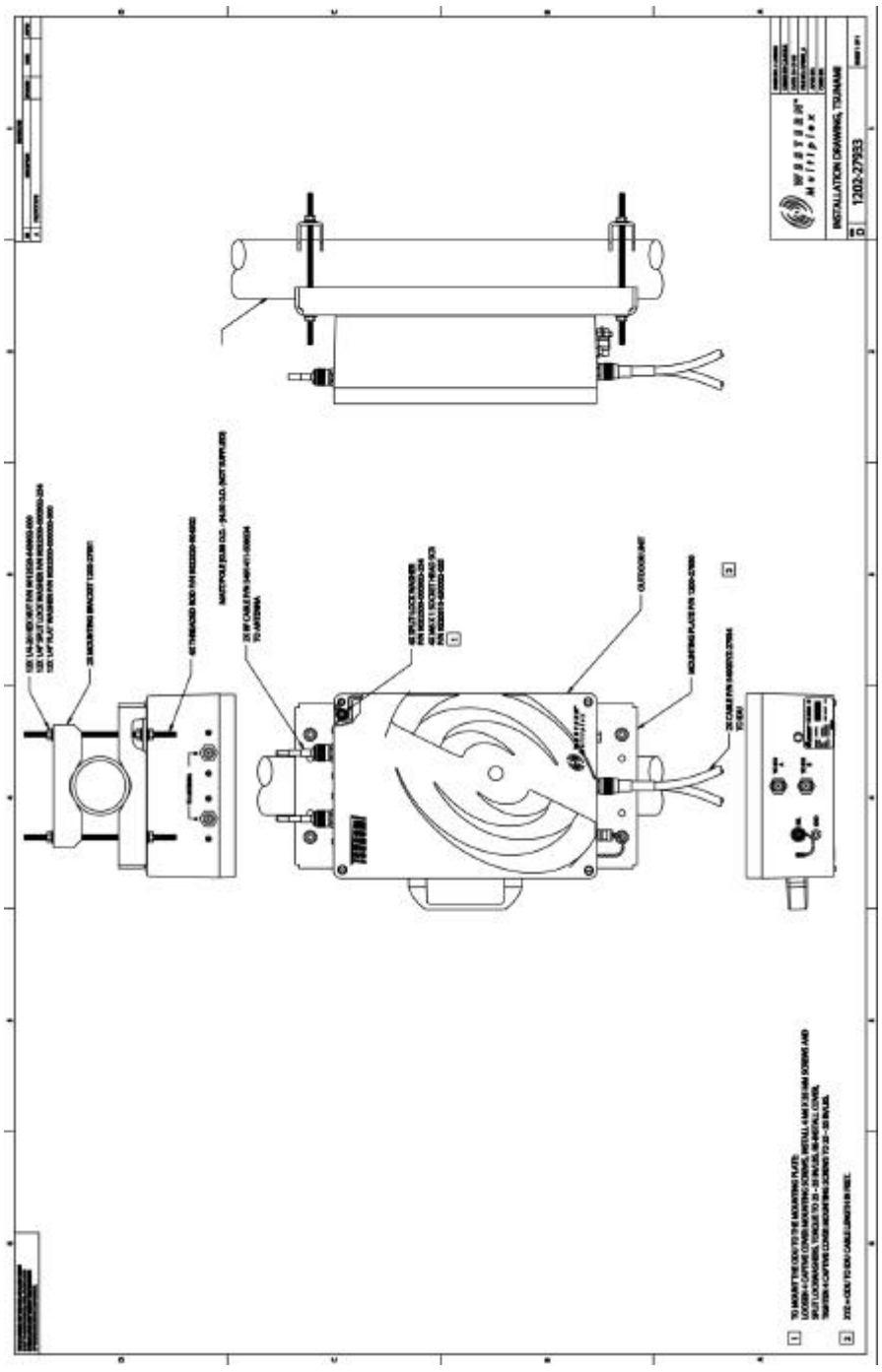


Figure 3-6: ODU Mounting

After attaching the antenna assembly per their enclosed instructions, attach the mounting plate as shown in Figures 3-2, 3-6 and/or 3-7 below.

After attaching the mounting plate, use the antenna in either the horizontal or vertical polarization position (remember, both ends of the link MUST use the same polarization).

Note: the A and B feed coax cables must be used for horizontal or vertical polarization with the ODU.

After mounting the antenna, attach the dual coax cables that connects the ODU with the IDU.

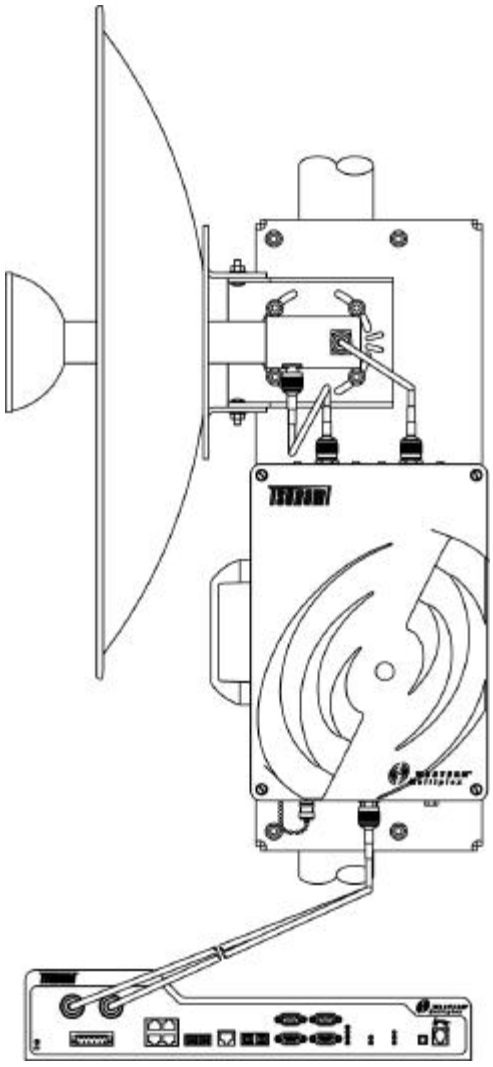


Figure 3-7: IDU and ODU Dual Coaxial Connections

3.8.2 Course Antenna Alignment

To coarse-align the antenna, first set it for flat elevation (no up or down tilt) using a spirit level. Then point it at a heading marker obtained using a compass/GPS (magnetic corrected) back-bearing from an adjacent location, (ideally, 100 feet or more away from the antenna).

If a heading marker cannot be set sufficiently far away (for example when on a city building roof or looking through a window) then a rough azimuth setting can be obtained by sighting along the antenna feed.

It should be verified that both antennas are on the same polarization by using the manufacturer's instructions. Otherwise the RSL will be approximately 25 to 30 dB below the calculated level.

Most antennas will also need fine alignment obtained using an operating link because it is very important to maximize the receive RF signal level at each end of the radio link.

Read Section 3.7 before applying DC power to the Tsunami radio.

Once the coarse alignment has been set-up at both ends, then the link can be powered and some level of reliable communication established. The voltage at the *Tsunami* ODU RSL test point (BNC connector) should be measured with a DVM to determine the relative receive RF signal level.

For the fine alignment, adjusting first the azimuth and then the elevation of the local antenna will maximize the RSL voltage. Then, the far antenna is aligned in the same way, using the RSL voltage of its local *Tsunami* radio ODU.

When aligning antennas it may be convenient to allow direct visiblity to the technicians aligning the antenna.

An orderwire telephone will provide end-to-end voice communications once radios are synchronized. Synchronization usually can be accomplished by coarse alignment only. After synchronization, the orderwire phones can be used to communicate between radio sites for antenna fine alignment. The phone interconnect cable can be extended to the antenna when desired.

The larger the antenna size, the more critical alignment becomes: for example, with a 2 foot dish, the antenna can be moved ±3 degrees off the correct heading before the receive signal level drops by 3 dB. This compares with a 6-foot dish which may only be moved ±1 degree for the same degradation.

The graph shown in Figure 3-8 shows the typical variation of RSL voltage as the receive signal level is increased from threshold to a higher level. There is some variation between *Tsunami* receivers, but an approximate estimate of the potential RSL value may be made using this figure.

Use the Factory Test Data Sheet shipped with your Tsunami terminal to obtain the best estimate of your RSL.

Above 0 dBm RSL, the receiver may produce errors: however this level is rarely likely to be exceeded. A link budget calculation should be made to calculate the anticipated RSL as described in Section 3.3.3. During anomalous propagation conditions, the RSL may fade but will not increase up more than 10 dB (except in unusual very long paths which may fade up by 15 dB).

Antenna alignment should enable the RSL to be peaked to the level calculated in the link budget. If the RSL is peaked but is approximately 20 dB below the calculated level, then it is likely that the antennas are aligned on a sidelobe of the antenna's radiated signal. In this case, the antennas should be rotated in a wide arc until the main lobe is located. (Other possible causes of low RSL are path obstructions, loss in connectors, adapters and pigtail jumper cables or different antenna polarization at each end of the link.)

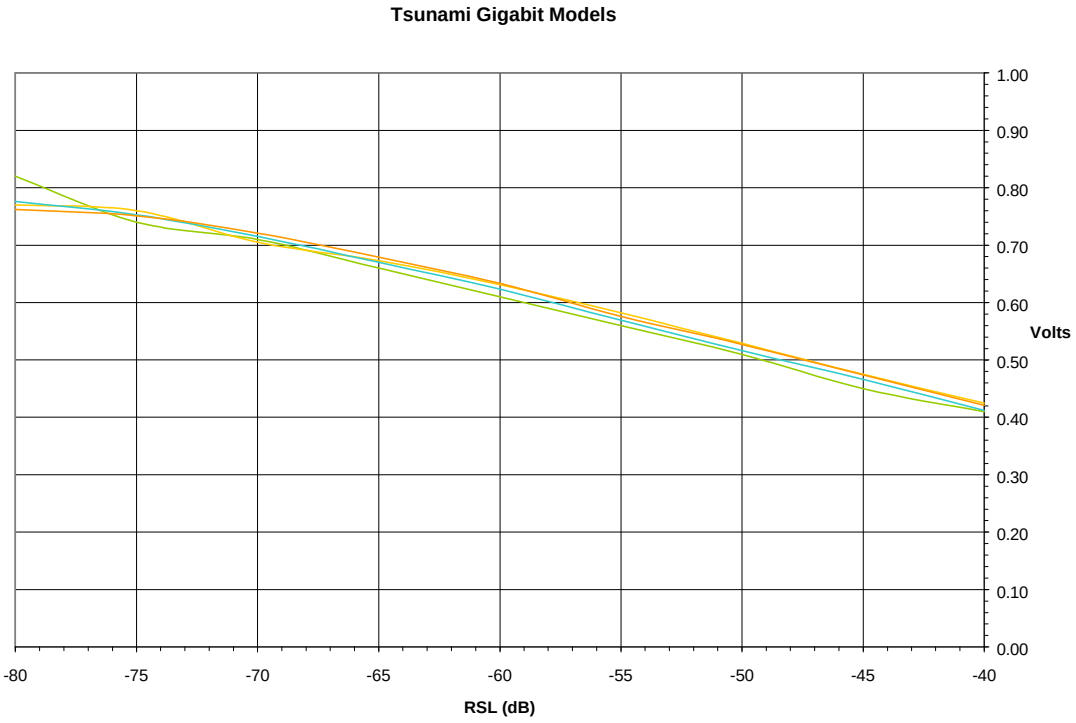


Figure 3-8: Typical RSL Voltage versus Received Signal Level (RSL)

3.9 Ethernet Interface Connection

The radio link's 1000BaseF interface connection to the *Tsunami* radio is on the front panel.

Additional external lightning protection devices are recommended for the connections if the radio is installed in an area prone to lightning. Use only PolyPhaser or equivalent protectors that are rated for at least 2000MHz and pass DC current (non DC blocking type).

The 1000BaseF connection to the *Tsunami* is at the data interface on the front of the shelf.

3.10 System Turn-up to Service

1. Prior to installing the system, it may be desirable to perform a back-to-back test of the *Tsunami* radio pair. Consult Section 4.9 for further details. Back-to-back testing is a simple way to verify that the *Tsunami* radios are fully operational before they are installed. Installation adds several variables (such as antenna alignment) which can lead to system turn-up delays. Also, during back-to-back testing, the DIP switch settings and some connections can be tested. This step can eliminate a majority of troubleshooting once the radios are installed.

A cellular phone or two-way radio system (walkie talkie, CB, mobile radio) can be very useful during installation. These can be used for temporary near-end and far-end communications between the installation personnel at one site and installation personnel at the other site while installing the system. These can also be helpful for communication between a person at the top of a very tall tower and ground personnel.

The Tsunami radio incorporates an internal Orderwire feature that provides end-to-end "telephone" style communications. However, the link must be partially operational to use this feature. In lieu of, or in addition to the use of cellular phones or two-way radio, this Orderwire feature can also be very useful for installation, but typically cannot be put into service until step 8 or 9 of this procedure is completed. See Section 3.14.1 for more details.

2. Perform a general alignment of the antennas on both ends of the path using binoculars, compass or other related tools. It is important to have the antennas aligned as accurately as possible before putting radio traffic over the link. This will help in getting the system running more rapidly. See Section 3.10 for more details.

3. Connect the transmission line to the antenna, and feed it to the *Tsunami* radio location (see Section 3.9). Connect the opposite end of the transmission line to the N-type female connector located on the filter assembly which occupies the top half of the *Tsunami* rear panel. The connection must be terminated into an antenna or a load before DC power is applied to the radio.

4. Verify that the same channel plan (e.g. A, B) as the near-end radio, and the opposite Tx and Rx frequencies (e.g. A1 and A2 make up a matched pair of radios).

5. With the DC power source active, but not plugged into the *Tsunami* radio, using a voltmeter, confirm that the DC mating connector has the proper power connections in accordance with Section 3.7. Verify the polarity and the absolute voltage on all pins. Verify ground connection for power.

6. Connect power to the *Tsunami* radio. Verify that the Front Panel "ON" LED indication is illuminated. This confirms that power has been properly applied.

Ensure that the RF Antenna port connection is properly terminated before applying power to the Tsunami terminal, as in step 3.

When the Tsunami radio is initially powered-on, some alarm conditions may be present. This is normal and alarms can be ignored at this time.

The Tsunami radio requires professional installation. With some Tsunami models, in certain countries, there may be Effective Isotropic Radiated Power (EIRP) limits which dictate the maximum output power that the Tsunami radio can transmit given the transmission line loss and the gain of the antenna. Consult with appropriate government agencies or Western Multiplex if there is any question regarding maximum output power allowed. ***Do not adjust output power above factory settings.***

7. Connect a voltmeter to the ODU's test points (BNC connection). This voltage reading corresponds to the Received Signal Level (RSL) of the near-end radio. In other words, RSL is the "amount" of signal the near-end radio is receiving from the far-end radio. Since the antennas have not been finely aligned, it is not expected at this time that the RSL will read very high. However, at this point it can be verified that some communication is taking place between the two *Tsunami* terminals. Use the RSL voltage reading to align the antennas. Align one antenna at a time in accordance with Section 3.10. Complete alignment of both ends of the radio link before going further.

The RSL voltage output on the radio's front panel will output a voltage over the usable range of the radio. Refer to Figure 3-8 in Section 3.8.2.

RSL of both ends should be verified to be within approximately 2 dB of predicted value (see Section 3.3.3). There are several factors that can contribute to low RSL:

- Incorrect antenna alignment (aligned on a lobe and not on the main signal)
- Improper polarization alignment of antennas (horizontal vs. vertical)
- Transmission line problems (loose connections, bent or damaged cables, lossy adapters)
- Path obstructions (trees, buildings, hills, etc.)
- Path clearance (line-of-sight, earth curvature, Fresnel zone, diffraction and partial obstruction)
- Weather (inversion layers, ducting and multipath)
- Antenna feed (coaxial/connector) problem

The Tsunami radio requires professional installation. Don't forget that the transmitter output power adjustment on the Tsunami radio effects the RSL. Depending on EIRP limits (if any), path distance, and antenna gain, you may need to adjust the output transmit power to the proper level before putting the radios in service.

If radio synchronization has been established, the radio link may be able to provide some limited communications over the link. It can be helpful to establish voice communications from one end of the radio link to the other using the Orderwire feature of the Tsunami radio. See Section 3.14.1 for details.

If RSL is lower than anticipated, recheck the path clearance and transmission line as these are the typical causes of low RSL. Radio operations can be verified by connecting radios back-to-back with attenuators (40-60 dB), (see Section 4.9). If the problem remains, consult Section 4 of this manual for troubleshooting techniques which will help determine the source of the problem.

8. Once radio performance is verified and acceptable, the *Tsunami* radios can now be put into service with the intended Gigabit Ethernet traffic. Connect to the LAN or computer using the SC (fiber) 1000BaseF connector. With Ethernet traffic applied in both directions, all front panel LEDs, except for POWER and the data TXD/RXD lights should be off. If any other LEDs are on, consult the trouble shooting sections of this manual.

9. Now that the link is operational, other services can be connected including T1 (DSX-1), Orderwire, Diagnostics, Alarms and Aux Data (Service Channel). Consult Section 3.14 for details on these connections.

3.11 Additional Connections

There are additional customer connections which are optional and are **not required** to make the *Tsunami* operational but may prove useful.

3.11.1 Orderwire Connection

Orderwire is a "telephone" type wayside service which allows users of the *Tsunami* radio to establish voice communications from one radio to another, either directly to the companion far-end, or through a repeater configuration, or several repeater configurations.

Telephone connection specifications:

REN (Ringer Equivalency Number)	1.0 B
DTMF tones	within ±1.5% of nominal freq.
Ringing Voltage	48 VDC, typical
(Ringing voltage is adequate for modern solid state ringers, NOT for the older mechanical type ringers)	

This Orderwire service does not affect the normal radio transmission of traffic. Refer to Section 2.3.5 for the telephone specifications. For simple near-end to far-end communications, follow the steps below:

1. Using a standard RJ-11 telephone cable, connect a standard electronic telephone (a touch tone phone, complete with dialer; a handset by itself will not work) to the Orderwire connector on the *Tsunami* front panel. This connector is wired identically to a standard two-wire telephone jack, see Figure 3-9 for details.

2. With a telephone connected to each *Tsunami* terminal on opposite ends of the link, either telephone can be used to "dial-up" the far-end location. The far-end terminal's internal ringer and the connected telephone will ring, and if answered, two-way full-duplex voice communication is established.

If using the Orderwire or Network management functions, all Tsunami radios connected must have unique address settings (telephone numbers).

4. If the *Tsunami* radios are connected in a repeater configuration, Orderwire services can be established to all *Tsunami* terminals in the network by implementing a connection of their rear-panel connectors between repeater terminals. At the repeater site, a cable can be connected to the two *Tsunami* terminals between their rear panel VF 9-pin connectors as shown in Figure 3-6. With this cable in place, the Orderwire function will operate at terminals at each end of the repeater and at the repeater site. This function can be continued through several repeater sites if desired. For hub connections of 3 or more *Tsunami* radios at the same site, an external 4-wire bridge is required to connect all radios to the orderwire.

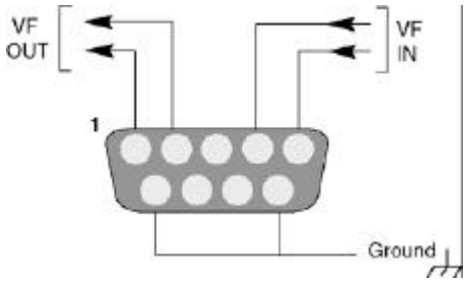
The orderwire system can be integrated with orderwire equipment supported by many other vendors. If your existing orderwire

network uses 2 digit addressing, and 0 dBm VF interface, it can be connected to a Tsunami as shown in Figure 3-9.

Dialing a ✶ (star key) on the orderwire telephone implements an "all call" feature which rings all connected radios. Also, if a phone anywhere in the connected network has accidentally been left off-hook, the # (pound key) key can be used to mute all off-hook handsets until they are placed on and off hook again.

The orderwire operates like a "party line". All telephones provide communication to all other telephones in the connected network. Even if a particular telephone does not ring, it can still be used to talk and listen to any ongoing orderwire activity if the orderwire is in use at other terminal locations.

Orderwire Connection



VF Port Connection

Figure 3-9: Orderwire & VF Port Connection

3.11.2 Alarm Connections

External alarm outputs are provided at the 9-pin, D-type subminiature ALARM connector. There are two Form C summary alarm relays capable of switching 30 VDC at 1 A. See Table 3-D and Figure 3-10 for Alarm Connections.

The “summary” alarm (Form C relay) is activated by any near-end front panel LED alarm condition, including if the internal test mode is enabled.

The “out-of-service summary” alarm (Form C relay) is activated by any of the following alarm conditions:

- RF LINK
- Radio Fail
- Internal Test

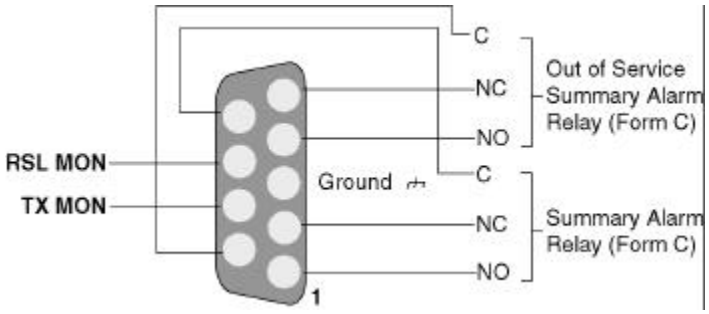


Figure 3-10: Pin Connections, ALARM Interface

PIN 1	**NO, SUMMARY ALARM, FORM C -** normally open connection on summary alarm relay. Closed when in alarm.	**PIN 4**	**NO, OUT OF SERVICE SUMMARY ALARM, FORM C -** normally open connection on out-of-service summary alarm relay. Closed when in alarm.
PIN 6	**C, SUMMARY ALARM, FORM C -** common connection on the summary alarm relay.	**PIN 9**	**C, OUT OF SERVICE SUMMARY ALARM, FORM C -** common connection for the out-of-service summary alarm relay.
PIN 2	**NC, SUMMARY ALARM, FORM C -** normally closed connection on summary alarm relay.	**PIN 5**	**NC, OUT OF SERVICE SUMMARY ALARM, FORM C -** normally closed connection on out-of-service summary alarm relay. Open when in alarm.
PIN 7	RSL output DC voltage referenced to pin 3	**PIN 8**	Tx Power output DC voltage referenced to pin 3

Table 3-D: Alarm Interface Connections

All alarms are active for a minimum of one second, or as long as the alarm condition persists, which ever is longer.

3.11.3 Configuration (Diagnostic) Port Operation

The “Config” Port is used to retrieve diagnostic information and to configure additional features within the *Tsunami* radios by means of a computer connection via SERIAL interface. Also can be used as an RS-232 port to download the latest revision radio operation software.

The config port allows connection of RS-232 devices to receive status of the *Tsunami* radio and provide configuration.

For RS-232 diagnostics connection (Section 4.11) to the *Tsunami* radio, connect the serial device (modem, computer, terminal) to the male 9-pin subminiature connector in accordance with Figure 3-11.

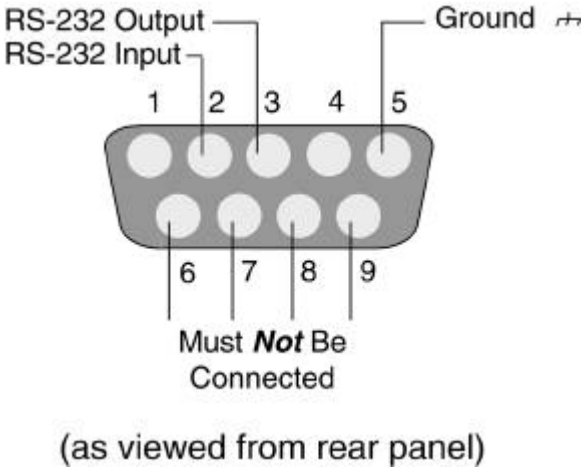


Figure 3-11: RS-232 Config Port Connections

Pins 6 through 9 must not be connected for RS-232 communications to operate properly.

3.11.4 AUX DATA (Digital Service Channel) Connection

The AUX DATA port is a separate wayside serial port which can be configured to allow the connection of any user serial data (to 9600 baud) through the radio network. Connection to the AUX DATA port is an RS-232 serial interface, identical to the config port (see Section 3.14.3). This port does not affect the Ethernet traffic on the *Tsunami* radio.

3.11.5 T1 (DSX-1) Interface Connection

The Tsunami radio also provides four wayside T1 connections. These connections allows for standard DSX-1 connect of voice circuits without affecting the Ethernet traffic. A standard RJ-48c connector is provided for this connection.

3.11.6 CEPT-1 (E1) InterfaceConnection

Not provided with this model at this time

3.11.7 NMS Interface Connection

The NMS connection provides connection for the network management system. This allows an HTML interface to the Tsunami radio for purposes of monitoring, configuration and security settings. This connection is an RJ-45 style connection and complies to standard 100BaseT or F interface. Typically, the installer or manager will connect to the NMS with a stand-alone computer to initially configure the radio prior to installation. If IP addresses and security are set properly, the connection can also be used as an out-of-band connection for radio management. Alternatively, if the 100BaseT/F is connected to a network, or combined with the 100BaseT traffic on the link, via an external 10/100 switch, hub or router, full wireless NMS can be achieved for all radios in the network.

The factory default IP address is set to 10.0.0.1. To reset the radio back to the factory default, Hold down the far-end test button while powering up the radio. Release the switch after 6 seconds.

More details on the NMS connection can be found in Section 4 of this manual. In the future, this connection will also allow NMS via SNMP (Simple Network Management Protocol) in addition to the HTML interface that is presently supplied. Consult factory for details or assistance with NMS connections, if required.

Ethernet Cable: Straight version to hub/switch, crossed version direct to PC.
Pins:1=Tx+, 2=Tx-, 3=Rx+ & 6=Rx

Your Notes on the *Tsunami* Radio

4. Troubleshooting

4.1 Regular Maintenance

The *Tsunami* radios do not require any regular maintenance, however, it is prudent to monitor the radio link at regular intervals to assure that the link conditions are not changing. When visiting a radio site for maintenance, the following items may be checked and their results recorded:

- RSL Voltage
- PWR Voltage
- Far-end RSL Voltage
- Alarm conditions
- Verify radio has adequate ventilation
- Verify security ID is set the same at each radio through NMS

If any alarm conditions exist, they should be recorded, and troubleshooting procedures from this Section of the manual should be followed.

4.2 Technical Support

Western Multiplex provides 24-hour telephone technical support for installed *Tsunami* radios. Customers are encouraged to troubleshoot the radio and link in accordance with the latter part of this section in this manual before contacting Western Multiplex. Western Multiplex also has a limited supply of *Tsunami* radios that can be loaned to out-of-service customers for installation while units are being repaired. Loaner supply is limited, and is only used for critical applications on a first-come, first-served basis.

Customer service #: +1 408 542-5390

4.3 Repair Policy

The *Tsunami* terminal includes comprehensive alarm indicators designed to diagnose potential faults. Should a fault occur, it often may be resolved by operator adjustment.

Should a fault occur that cannot be resolved by operator adjustment and has been confirmed by looping terminals together on the bench (See Section 4.7), then the equipment should be returned to the factory for repair.

The *Tsunami* radio is a complex system not designed for user repair. Do not remove the cover or open any part of the *Tsunami* terminal. The complete *Tsunami* terminal should be sent back in its original packing material for factory repair.

Please contact the factory in advance of returning the product. You will be assigned a Return Material Authorization (RMA) number that authorizes your return. Units sent to the factory without an RMA number may be delayed in the processing of the repair. Be sure to include the following information:

- RMA number
- description of the problem
- your name and telephone number
- return shipping address
- urgency of repair

Please refer to the published Warranty policy for repair policy details.

Tsunami radios should be packaged in their original packing boxes for shipment whenever possible Western Multiplex can provide an empty box shipment to facilitate proper packaging. Regardless, proper and adequate packaging must be used for shipments to protect the radio(s) from damage. Western Multiplex can not be held responsible for any repairs due to inadequately packed materials. Damage caused by improper packing will likely result in higher repair costs and delays (refer to the Warranty section at the beginning of this manual).

4.4 Front Panel Status LEDs

There are several front panel status LEDs on the *Tsunami* radio. These LEDs indicate conditions where either a hardware failure has occurred or the radio link is not optimum. In many cases, a combination of LEDs may be illuminated. The following sections describe the necessary troubleshooting procedures should any LED(s) indicate a problem during or after installation.

IDU	Green = Indoor Unit OK Red = Indoor Unit detected hardware failure
Cable	Green = ODU Cable OK Red = ODU Cable shorted
ODU	Green = Outdoor Unit OK Red = Outdoor Unit detected hardware failure
Radio Fail	Green = Radio hardware OK Red = Hardware failure detected
RF Link	Green = Error-free operation Yellow = Bit errors occurring Red = Excessive bit errors or radio link failure Flashing = Link ID mismatched
TXD	Green = 100BaseT data transmit present Yellow = 100BaseT port connected (no data present) Off = No 100BaseT connection detected
RXD	Green = 100BaseT data receive present Yellow = 100BaseT port connected (no data present) Off = No 100BaseT connection detected
COLL	Yellow = Collisions occurring on 100BaseT (half-duplex mode)
FAR END	Red = Alarm(s) present on the far-end radio**
NMS (10BaseT)	Green = Tx or Rx data present on the NMS interface Yellow = NMS interface connected (no data present) Off = No NMS interface connection detected
T1 INPUT	Green = Alarm enabled and T1 connection detected Red = Alarm enabled and no T1 connection detected Yellow = Alarm disabled and T1 connection detected Off = Alarm disabled and no T1 connection detected

** Radio Fail, RF Link (yellow or red), T1 Input (yellow or red)

4.4.1 RF LINK Alarm

Function:

This LED indicates that the demodulator function is not synchronizing with the intended received signal.

Possible Causes:

- Severe path fading due to atmospheric conditions, usually accompanied by low RSL voltage reading
- Poor transmission line connections usually accompanied by low RSL voltage reading
- Antenna problems, misalignment, or path clearance usually accompanied by low RSL voltage reading
- Improper radio settings (e.g. frequency channel)
- Received signal level (RSL) is too strong
- Interference
- Far-End radio transmitter circuitry is faulty
- Near-End radio receiver circuitry is faulty
- Link security ID not the same for each radio

Recommended Actions:

Check the following at each end of the link:

- Verify that rear panel filters are opposite channel plans on each end (e.g. one is A1 and other is A2).
- Verify that radio frequency settings match each installed filter (in NMS menus).
- Verify that all connections between radios and antennas are secure and all devices between radios and antennas are rated for the radio frequency band (5.3/5.8 GHz).

Measure RSL by placing a voltmeter across RSL and GND test points. Compare this voltage to the Factory Test Data Sheet and estimate the RSL in dBm. Compare this to the RSL that was expected using path calculations (see Section 3.3.3). Press and hold the DISPLAY FAR END button and measure the far-end RSL (while continuing to hold the button). Compare this RSL to the Factory Test Data Sheet for the far-end radio and estimate the RSL in dBm. Again, compare this RSL to the expected RSL from the link budget calculations.

If RSL from both ends of the radio are approximately the same as each other, but lower than anticipated for this installation, then the likely cause of the BER alarm(s) is excessive losses between the radios. Excessive loss problems could include the transmission line at either end, all adapters, connectors, the antennas, the antenna alignment as well as the path itself (any obstructions or clearance problems). Antenna alignment, line-of-sight and path clearance should be verified; if this does not improve RSL, all devices between the radios and their antennas at both ends should be checked. Make sure all transmission line, connectors and any other devices are properly rated for operation at the radio's frequency (5.3/5.8 GHz).

If only one end has low RSL, this could be caused by low transmit output power from the opposite end radio. Verify that the transmitter output power of the radio opposite to the low RSL receiver has been set in accordance to path calculations, or EIRP restrictions (where applicable). Power adjustment must be performed by professional installation personnel only. The PWR test point can be used and compared with the Factory Test Data Sheet, the front panel recessed potentiometer can be turned clockwise to increase power. If an RF power meter is available, this can be connected to the RF output of the radio for precision measurement. This test will also verify that the radio transmitter is working properly.

If one terminal (or both) has high RSL, this could be caused by a very short path or interference. To verify the possible presence of interference, remove DC power to the radio which is opposite to the one that is reading high RSL. Once power is removed, measure RSL on the remaining radio. If RSL voltage is lower than that which is listed for "Threshold" in the Factory Test Data Sheet, then an interfering signal is present. If interference is suspected, the easiest potential remedy is to swap frequency channels on both sides of the link. See Section 4.2 for details. Swap terminals at both ends of the link so that they are the opposite from their original installation. After both ends are moved, reconnect the radios and determine if the BER alarm is still active. If the BER alarm is still active, other frequency channels can be installed, or other interference countermeasures can be tried, in accordance with Section 4.8.

If all path related and data input problems have been pursued and the BER alarm is still active, the problem could be related to a radio failure. While radio failure is typically indicated by more severe alarm conditions, it is possible that one of the radios may be out of specification, and this could be the cause of the BER alarm. A back-to-back test will verify proper radio operation. See Section 4.9 for details. A threshold test on both radios along with a test to verify proper RF output power would be beneficial.

Perform a back-to-back test before returning any radio terminal to the factory for repair. A back-to-back test verifies radio operation. (See Section 4.7).

If the radios successfully pass their back-to-back testing, the problem is likely with the path or the connections between the radio and the antenna or interference. Before reinstalling the radios, be sure to set the output power to the appropriate level for the installation.

4.4.2 RADIO FAIL Alarm

Function:

The RADIO FAIL alarm indicates a known problem with the radio hardware.

Possible Causes:

- Internal synthesizers are unlocked
- Internal digital circuits have failed

Recommended Actions:

1. Remove power from the unit.
2. Check to make sure power supply voltages are within specification.
3. Even if the voltages were within specification, reapply power to the unit.
4. If RADIO FAIL alarm clears, place the radio back into service.
5. If RADIO FAIL alarm does not clear, perform a back-to-back test to verify radio operation, as described in Section 4.7.
6. If RADIO FAIL alarm is still active in a back-to-back test, return the radio to the factory for repair (see Section 4.3).

4.4.3 FAR END Alarm

Function:

This LED indicates that there is an alarm condition present on the far-end radio. When the DISPLAY FAR END button is pressed (and held), the status LEDs indicate the alarm conditions of the far-end radio.

Possible Cause:

- One or more alarm condition(s) exist on the far-end radio

Recommended Actions:

1. Press and hold the DISPLAY FAR END button and observe the LED status.

2. Follow instructions for troubleshooting the far-end radio in accordance to the appropriate LEDs which are in alarm, as described in Section 4.6.1.

4.5 Errors in the Data Stream

When the radio is in service, errors in the data stream may occur. This is usually known to the operator by either faulty data indications of downstream equipment or external bit error rate testing.

It is possible that no alarms appear on the front panel during normal operations, but there are errors present in the data stream. Some errors will not result in no alarm (such as bipolar violations, slow "dribbling" errors, improperly terminated connections or incorrect settings), but will be exhibited on downstream data processing equipment or during a BER test. In other cases, there may be data errors due to atmospheric conditions (fading), interference or other reasons, but not at a high enough error level to be indicated with the BER alarm LED. In the case of these types of errors, the following information can be helpful to troubleshoot the radio link.

Indications:

- During external BER test, test equipment indicates errors
- Downstream equipment (mux, channel bank, CODEC, router, etc.) indicates errors

Possible Causes:

- Path fading due to atmospheric conditions
- Poor transmission line connections
- Antenna problems, misalignment or path clearance
- Received signal level (RSL) is too strong
- Far-End radio transmitter circuitry is faulty
- Near-End radio receiver circuitry is faulty
- Interference

Recommended Actions:

1. Verify 1000BaseF fiber connection and cable.
2. Follow the instructions described in Section 4.4.1

4.6 Back-to-Back Testing

Back-to-back testing, as shown in Figure 4-1, is an ideal method of testing the *Tsunami* radios. This testing eliminates link problems caused by auxiliary equipment, installation, or the radio path and isolates potential radio hardware problems. Back-to-back testing must be performed with both radios at the same location. The following test equipment is required:

- DC power source capable of supplying approximately 250 Watts (total) to the radios.
- Two coax couplings and 70dB loss attenuation per cable.
- BER tester

Back-to-back testing must be performed to verify a radio problem before returning any radio to the factory for repair.

Use two coax cables and approximately 70dB attenuation per cable

When the equipment is connected as shown in Figure 4-1, both *Tsunami* radios should have no alarm conditions. If these conditions have been met, then it is likely that the *Tsunami* radio is operating in accordance to specifications. If errors or alarms occur during this test, verify that all configuration settings are properly set. If alarms or errors are still present, the radio is likely to be faulty.

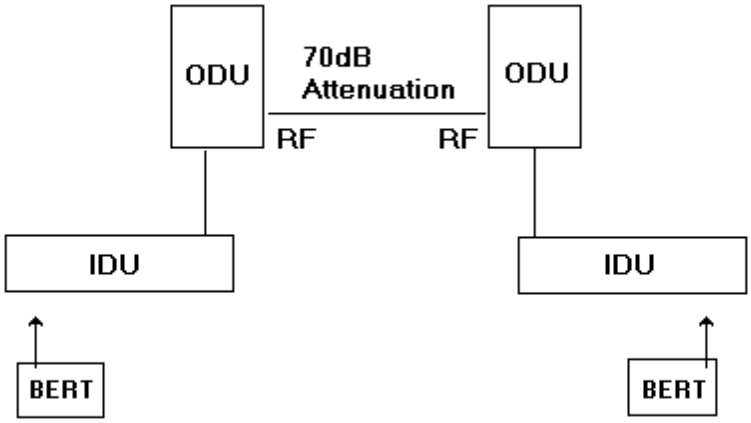


Figure 4-1: Back-to-Back Test Configuration

The Tsunami radios will be damaged if appropriate attenuation is not supplied between radios. You must provide a minimum of 40 dB and no more than 80 dB attenuation between the two radios. Use this attenuation in EACH of the two connection cables!

4.7 LINK Testing

Link testing is the preferred way to evaluate a radio link's performance. It can be performed from end-to-end or in link test mode (which tests both directions of the radio path). Figure 4-2 illustrates a typical test configuration (which may include the radio's path instead of in-line attenuators). Figure 4-2 illustrates a typical test configuration for end-to-end testing.

When performing testing, make sure of the following:

- Disconnect all 1000BaseF inputs and outputs to both radios.
- Verify all configuration settings.

Link testing may be performed on the bench, with two terminals back to back, or over the radio path. Also, it may be performed from end-to-end (which requires two 1000BaseF test sets over a link, the far-end unit slaved to the near-end unit's clock) or in loopback mode)

If link testing indicates an unacceptable level of errors, follow the instructions in Section 4.4.1. or perform a back-to-back test.

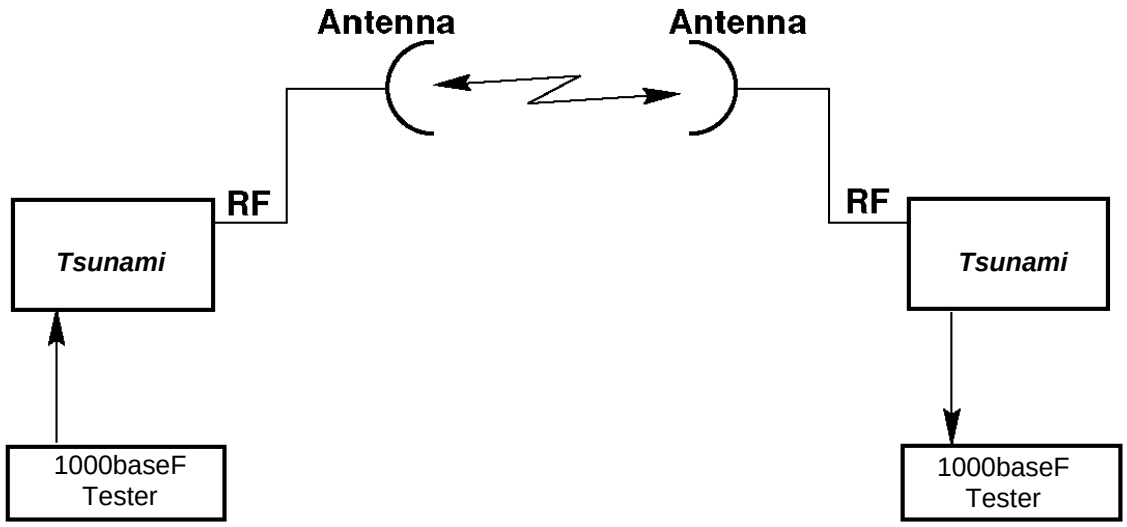


Figure 4-2: End-to-End Test Configuration

4.8 Network Management System (NMS)

The Tsunami 1000BaseF radio platform provides multiple methods of managing the radio network:

1) SNMP
2) Browser (IE, Netscape, etc.) graphical user interface
3) Software upgrade procedure
4) TelNet (via VT100 session using Windows™ Hyperlink)

4.8.1 SNMP

Use your favorite SNMP access software such as HP OpenView. Please contact customer service/support to get a copy of the MIB file e-mailed to you or from our FTP site.

4.8.2 Browser GUI

Use Internet Explorer™ or Netscape™ to access the radio by typing in its IP address. If you are setting up the radios for the first time, the default IP address is: 10.0.0.1 You will have to configure your computer to this domain first by setting its address to 10.0.0.5 and then changing the radio's IP to one within the domain of your network. After changing one radio's IP address (see Configuration tab) change the other radio's IP address also, but not to the same address of the previous radio. Reconfigure the IP address of your computer to it's original address and then restart the PC so it is now in the same domain as the radios.

The browser interface shows a "virtual" front panel of the radio that is addressed. To view the front panel of the associated far-end radio, click on the window that is located on the virtual front panel (see following illustrations). Illustrations on the next few pages of this manual provide details on all browser screens and operations.

4.8.3 In-band NMS Set-up

Use a 4-port (or larger) 100/1000 switch (recommended as opposed to a hub that will also work) at each radio to operate the NMS in-band with the 100BaseT/F traffic. The NMS port can have a unique domain that is valid only with the PC that is being used for network management and system-wide operational status and will not interfere with 100BaseT/F traffic as the radio's MAC address plus its IP address are unique.

Radios are set at the factory to IP addr: 10.0.0.1. Temporally set your PCs domain (write down its present IP address) to a suggested setting of PC=10.0.0.5-the PC will force a re-boot. Re-boot the PC computer attached to the first radio's 100BaseT NMS port and log-in to radio NMS w/favorite browser (IE or Netscape) after log-in (manager:manager). Change the IP address (Configuration) to an unused one in your domain (if you want to also change the password at this time, do this first). Do the same with other radio (may have to reboot computer attached to this other 10.0.0.1 radio as the other's MAC address does not match the MAC/IP address the PC knows about). Set the IP address this radio to a different IP address in your normal operating domain. Set your PC back to its original domain (will force reboot again). This should allow for typical LAN operation. **Type http://10.0.0.1/index.htm to gain initial access.**

Login Screen 1

Enter User Name and Password. If using for the first time or the radio has been reset, use:
Full User Rights:
User Name: manager
Password: manager
Limited User Rights:
User Name: operator
Password: operator

It's advisable to change the password setting on the administration (Admin) page to protect radio settings, configuration and illegal entry into the radio system.

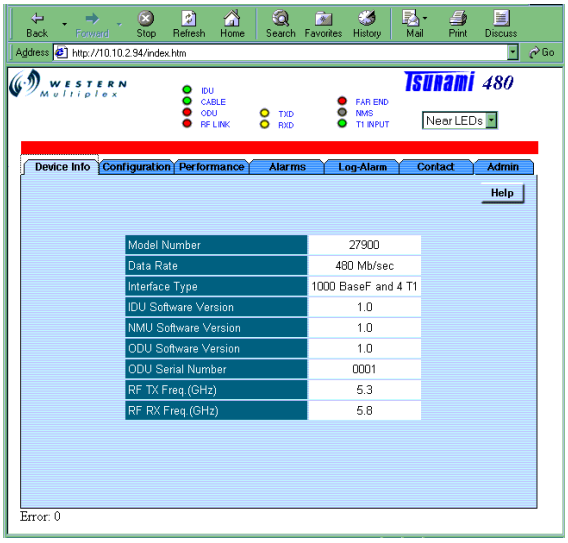
Login Screen 2

With default Name and Password

Click on "Log On" to gain entry

Device Screen

Tsunami model information including software revision versions and product serial number.

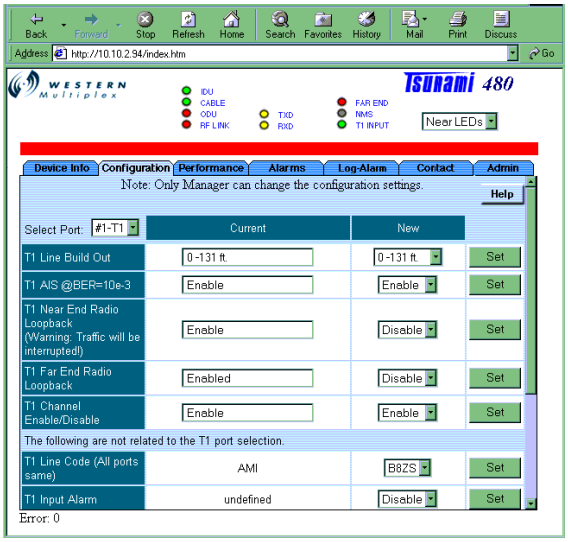


Configuration 1

The radio's characteristics can be modified from this page. The 'Current' column indicates current settings and the 'New' column the radio setting(s) that can be changed. Use the pull-down menus to select the new setting. Then, click on the Set button to invoke the setting.

In some cases it may be necessary to "refresh" the screen to see changes to settings.

Warning: the Tx/Rx Frequency can not be changed without also changing the physical diplexer.



Help Screen

At any time, on any page, clicking on Help will open a separate help window to facilitate operation of the Browser NMS.

Use the help page to provide details on the configuration settings.

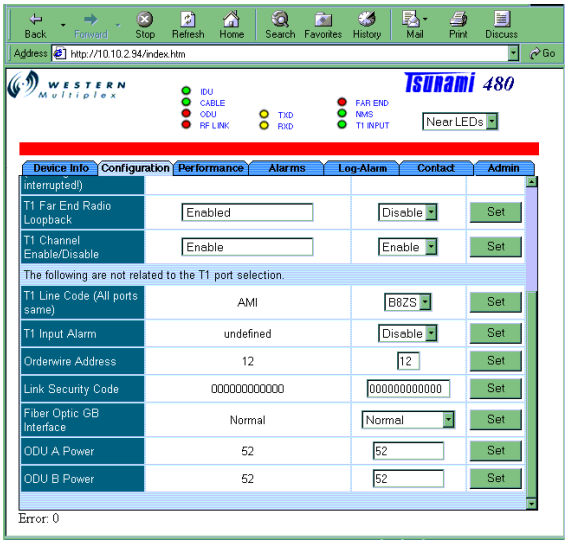
Use the window close box to dispense with the help screen when finished.

Configuration 2

Scroll down to see the complete list of radio configuration settings.

Here is where the radio's IP setting can be modified from the factory default 10.0.0.1

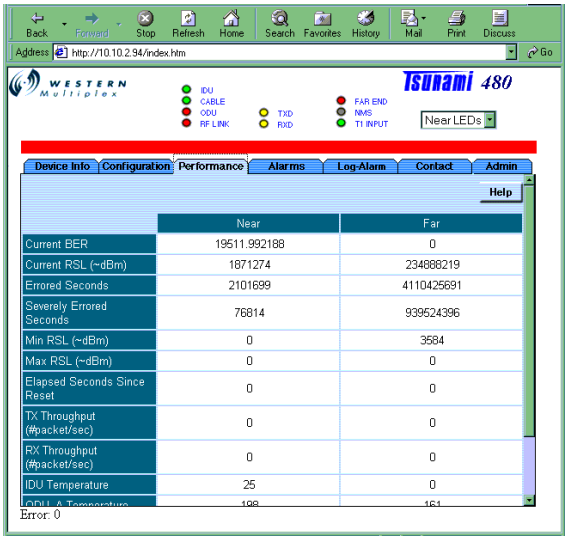
Note: To return to defaults, power up the radio while depressing the link test button and holding until the LEDs flash RED.



Performance 1

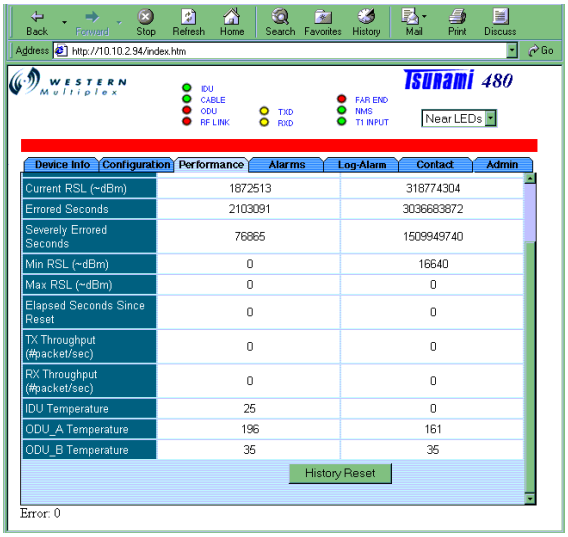
Running data on the operation of the radio link. To reset the historical data, click on History Reset.

Note alarm bar between front panel depiction and performance data.



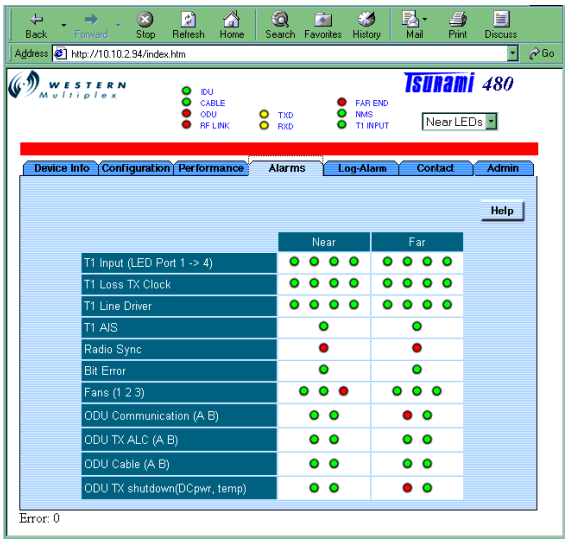
Performance 2

New screen after resetting history.



Alarms

Both near-end and Far-end information on the running status of the link are displayed on this single page.



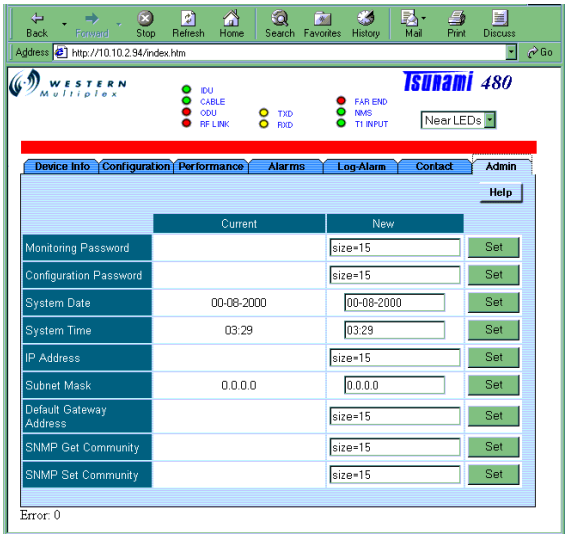
Administration

Change the default password (manager or operator) for subsequent entry into the browser NMS.

Click on set after changing the password.

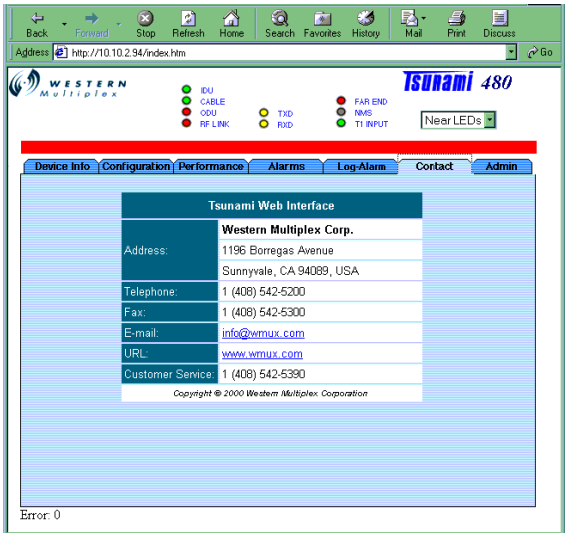
If you forget the password, you must fully reset the radio by holding in the far-end button on the front of the radio while powering it up.

Here is also where the IP address, subnet mask, default gateway and SNMP community information is located.



Contact Information

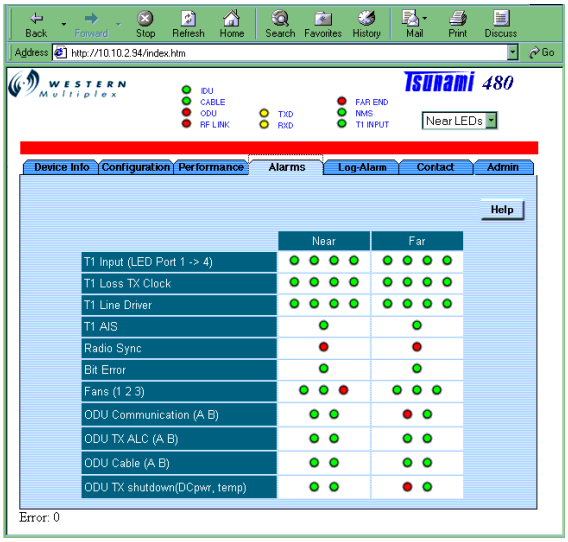
The E-mail and the URL links are active text if selected. Each will start your e-mail or browser when either is clicked on.



Link failure indication!

If the link is lost, the severely errored seconds will display the amount of time the link was not passing sufficient data (see above).

In this example, the near-end radio lost sync with the far-end radio.



4.8.2.1 NMS Help screen details:

LEDs

IDU	Green = Indoor Unit OK Red = Indoor Unit detected hardware failure
Cable	Green = ODU Cable OK Red = ODU Cable shorted
ODU	Green = Outdoor Unit OK Red = Outdoor Unit detected hardware failure
Radio Fail	Green = Radio hardware OK Red = Hardware failure detected
RF Link	Green = Error-free operation Yellow = Bit errors occurring Red = Excessive bit errors or radio link failure
TXD	Green = 100BaseT data transmit present Yellow = 100BaseT port connected (no data present) Off = No 100BaseT connection detected
RXD	Green = 100BaseT data receive present Yellow = 100BaseT port connected (no data present) Off = No 100BaseT connection detected
COLL	Yellow = Collisions occurring on 100BaseT (half-duplex mode)
FAR END	Red = Alarm(s) present on the far-end radio**
NMS (10BaseT)	Green = Tx or Rx data present on the NMS interface Yellow = NMS interface connected (no data present) Off = No NMS interface connection detected
T1 INPUT	Green = Alarm enabled and T1 connection detected Red = Alarm enabled and no T1 connection detected Yellow = Alarm disabled and T1 connection detected Off = Alarm disabled and no T1 connection detected

** Radio Fail, RF Link (yellow or red), T1 Input (yellow or red)

Configuration

T1 Line Code	AMI/B8ZS setting for the T1 interface
T1 Line Build Out	T1 interface line length setting
T1 AIS @BER=10e-3	If selected, automatic injection of 1's into the T1 data stream during RF Link red alarm state
T1 Input Alarm	If selected, activates alarm on loss of T1 signal
T1 Near-end Radio Loopback	Activates loopback at the T1 input port of the near-end, towards the far-end of the link
T1 Far-end Radio Loopback	Activates loopback at the T1 input port of the far-end, towards the near-end of the link
Orderwire Address	Orderwire telephone address (any 2 digit number 00-99)
Link Security Code	Security code set by user (any 6 bytes=12 characters) Valid characters are 0-9, A-F only (2 to the 48th codes) Note: Must match code on far-end radio to establish link Example: 3A45EBA27F65 or BDAF3976D2C5
Tx/Rx Frequency	Selects Tx and Rx frequencies – setting must match installed diplexer filter assembly – see manual for details
Ethernet Duplex	Selects half or full duplex for the 100BaseT interface
Learning Filter	Enables the ability to acquire and store IP addresses for efficient bridging operation (normally enabled)
Fiber Optic Interface	Enables the fiber 100BaseT interface
Device IP Address	Configure the IP address for the network management Ethernet interface
Device Subnet Mask	Configure the subnet mask for the network management Ethernet interface
SNMP Get Community	Configure the ‘Get’ community string for the radio's SNMP network management agent
SNMP Set Community	Configure the ‘Set’ community string for the radio's SNMP network management agent

Performance

Current BER	Current estimated RF link bit error rate
Current RSL (dBm)	Current estimated received signal level, in dBm
Errored Seconds	Number of seconds that incurred an error since the last reset of the "clear history" function. Indicates errored packets.
Severely Errored Seconds	Number of seconds that incurred errors in excess of BER=10e-6 since the last reset of the "clear history" function Usually indicates total loss of data/packets, not just errors
Min RSL (dBm)	Minimum estimated received signal level (in dBm) measured since the last reset of the "clear history" function
Max RSL (dBm)	Maximum estimated received signal level (in dBm) measured since the last reset of the "clear history" function
Elapsed Seconds Since Reset	Number of seconds since the last reset of the "clear history" function

Alarms

	IF GREEN	IF RED
T1 Input	T1 Input is present or T1 input alarm is disabled	T1 Input is NOT present and T1 input alarm is enabled
T1 Code Violation	No T1 code violation error detected	T1 code violation error detected
T1 Line Driver	Line driver is adequate	Line driver is in fault condition
T1 AIS	NOT injecting all 1s	Injecting all 1s in data stream
Radio Sync	Radio link is synchronized	Radio link NOT established
Bit Error	Error-free operation	Bit Error Rate worse than 10e-7
Fan 1	Fan 1 is operating correctly	Fan 1 is NOT operating correctly
Fan 2	Fan 2 is operating correctly	Fan 2 is NOT operating correctly
Rx Synth	Receive synthesizer is locked	Receive synthesizer NOT locked

Tx Synth	Transmit synthesizer is locked	Transmit synthesizer NOT locked
ODU PLO Alarm	ODU Phase Lock Loop is locked	ODU PLL is not locked
ODU Synth Alarm	ODU Synthesizer is locked	ODU Synthesizer is NOT locked
ODU Comm	ODU is communicating w/IDU	ODU NOT communicating w/IDU
ODU PWS15V	15V Power Supply is normal	15V Power Supply is out of range
ODU Cable Alarm	ODU Cable is normal	ODU Cable is shorted

4.8.4 Software Update Download Procedure

Software download procedure on Tsunami 100 (second release V 2.0):

1) Connect the host PC tot the radio terminal through the NMS 10BaseT port.

2) Point the browser to the radio's Web page "http//xxx.xxx.xxx.xxx/upload.htm". (For factory default use 10.0.0.1 for the http: address)

3) Login as "manager" for name and password on the GUI prompt.

4) Follow the instructions on the screen.

   a) Enter the file name you want to upload, e.g. (a:ts_nmu.udl *software bianary image file*), or select the browse button and point to the proper location.

   b) While the file name is displayed on the screen, select the install button.

   c) It will display a status child window indicating it is erasing and writing to the *unused Bank*.. (Note the Bank # for ref.)

   d) After it is complete, you will see this message "File upload finished and system will reboot! Restart browser to logon again"

   e) Now, you can re-enter the upload GUI and insure the new uploaded Bank is valid and is the current Bank in use.

Memory Banks:

The radio has two banks of flash memory available, *Bank 0* and *Bank 1,* only one bank will be in use at a time. The radio will *automatically* utilize the new uploaded bank.

In addition, through the procedure, you can also manually select Bank 0 or Bank 1 by selecting the (switch) button. Switching between Banks is quick and you will need to re-start the browser. Also, to determine if a flash memory Bank has any software, you can read the Bank *status*. E.g. Valid or invalid, invalid indicating that it is an empty memory Bank.

4.8.5 Telnet

Use a standard TELNET session (i.e. Windows™ Hyperlink). Program will emulate a VT100 monitor. Plug into the radio's CONFIGuration port.

Set the session to an unused COM port (e.g. COM1) and use 19,200 baud, 8 bits, No parity and One stop bit. Cable is two (2) DB-9F connectors with pins 2-3, 3-2 and 5-5 using 3 conductor wire.

To start a session (type what is within the single quotes and then the Enter key):

Hit the PC's CR/Enter key two (2) times after the radio has reinitialized

Type '1' and CR/Enter to enter the User Name and then Enter key (factory default=manager)

Type '2' and CR/Enter to enter the Password and then the Enter key (factory default=manager)

Type 'a' and Enter Key to accept the two entries - you should now see a menu list (a=accept)

Any time you wish to go back to a previous screen, type 'o' for out (if an 'o' does not exit from the page you working from, use 'logout' to exit).

There are many user changeable functions that may not be present in the browser such as setting the "Default Gateway" if the radio's NMS port is connected through a router.

As an example, the following steps can be used to check the radio's Network Status:

From the NMU Main Menu, type 3 and Enter.

Note the radio's IP address, subnet mask, MAC address and other radio parameters.

Example 2: Set a Default Gateway:

From the main menu (after logging in), type '11' to get to the VxWorks Shell prompt (->).

Type 'help' to get a list of all the advanced commands. Use the Enter key or 'Q' to complete.

From the -> prompt, type 'netHelp' to see a list of the network help commands
(Use Enter key or 'Q' to quit/stop).

From the -> prompt, type 'nmuHelp' to see a list of the nmu (Network Management Unit) commands (Use Enter key or 'Q' to quit/stop).

From the -> prompt, type 'staticShow' to check to see if there is a current Default Gateway already set (if set, you may want to write down the settings for future re-use).

Type 'staticAdd' to get to the Default Gateway setup command. Note the example.

You can always type 'help' to get the appropriate help for the area you are accessing.

Follow the guidelines to set the Default Gateway command string:

For example: staticAdd "0.0.0.0", "100.0.0.111", "255.255.255.0"

Check to confirm that the Default Gateway has been set properly by typing 'staticShow' again

When done with the TELNET session, type 'o' or 'logout' until back to the Name-Password entry page you started from.

To print a complete list of available functions, type 'help' from a main menu screen and then print the page to your default printer connected to your PC.

Your Notes on the *Tsunami* Radio

5. Appendices

Appendix A - Digital Interface Specifications

1. General Characteristics (Regulatory)

1000baseF (IEEE 802.3u) Fully compliant to Ethernet V.2

Model	Model 27200-G1XX Tsunami 5.3/5.8 GHz 1000BaseF Ethernet Bridge
Manufacturer	Western Multiplex Corp.
Frequency Band	5.3 and 5.8 GHz bands
Identifier	HZB-U5358-1000
Emission Designator	UNII
Transmitter Power Output	5.3 band: +10 dBm (~15 mW) 5.8 band: +17 dBm (50 mW)
Tolerance (%)	0.001
Baseband Type Signal	Digital
Maximum Channel Capacity	Both channels
Digital Modulation Rate	50.791 Mbps
Digital Modulation	16 QAM or 32 QAM
Automatic Power Control	No
Receive Threshold at BER = 1 x 10^{-6}	-77 dBm
RF Bandwidth	100 MHz each band, both polarizations

Table A-1: Regulatory Information

2. Specifications

Transmission Medium	UTP
Signaling Technique	Manchester
Topology	Star
LAN Table	1,024 addresses (automatic learning and aging)
Filtering	15,000 pps
Data Rate	Up to throughput of particular radio model
Delay	2-5 frames
Buffer	400 packets
Duplex	Full

Table A-2: Interconnection Specification

Appendix B – Networking Q&As

Q: What is Ethernet?

A: Ethernet is a type of network cabling and signaling specifications (OSI Model layers 1 [physical] and 2 [data link]) originally developed by Xerox in the late 1970. The IEEE's (Institute of Electrical and Electronics Engineers) used Ethernet Version 2 as the basis for the 802.3 CSMA/CD network standard.

Q: What is an 802.3 network?

A: That's IEEE-ish for Ethernet.

Q: What is CSMA/CD?

A: CSMA/CD is the media access control mechanism used by Ethernet and 802.3 networks; in other words, it determines how a packet of data is placed on the wire. CSMA/CD stands for "Carrier Sense Multiple Access, with Collision Detection". Before an Ethernet device puts a packet "on the wire", it listens to find if another device is already transmitting. Once the device finds the wire is clear, it starts sending the packet while also listening to hear if another device started sending at the same time (which is called a collision). Refer to the Q&A on collisions for more info about this phenomena.

Q: What is an OSI Model?

A: The Open Systems Interconnect (OSI) reference model is the ISO (International Standards Organization) structure for the "ideal" network architecture. This Model outlines seven areas, or layers, for the network. These layers are (from highest to lowest):

LAYER

7) Applications: Where the user applications software lies. Such issues as file access and transfer (FTP), virtual terminal emulation, Internet connections (HTTP), inter-process communication and the like are handled here.

6) Presentation: Differences in data representation are dealt with at this level. For example, UNIX-style line endings (CR only) might be converted to MS-DOS style (CRLF), or EBCIDIC to ASCII character sets.

5) Session: Communications between applications across a net- work is controlled at the session layer. Testing for out-of-sequence packets and handling two-way communication are handled here.

4) Transport: Makes sure the lower three layers are doing their job correctly, and provides a transparent, logical data stream between the end user and the network service s/he is using. This is the lower layer that provides local user services.

3) Network: This layer makes certain that a packet sent from one device to another actually gets there in a reasonable period of time. Routing and flow control are performed here. This is the lowest layer of the OSI model that can remain ignorant of the physical network.

2) Data Link: This layer deals with getting data packets on and off the physical layer, error detection and correction and retransmission. This layer is generally broken into two sub-layers: The LLC (Logical Link Control) on the upper half, which does the error checking, and the MAC (Medium Access Control) on the lower half, which deals with getting the data on and off the physical layer (wire, fiber and Tsunami Wireless Bridges).

1) Physical: The nuts and bolts layer. Here is where the cable, fiber, radio, connector and signaling specifications are defined.

Q: What does an Ethernet packet look like?

A. See the information below, as described in the National Databook. The Ethernet packet preamble is normally generated by the chipset. Software is responsible for the destination address, source address, type, and data. The chips normally will append the frame check sequence.

62 bits	Preamble – A series of alternating 1's and 0's used by the Ethernet receiver to acquire bit synchronization.
2 bits	Start Of Frame Delimiter – Two consecutive 1 bits used to acquire byte alignment.
6 bytes	Destination Ethernet Address – Address of the intended receiver. The broadcast address is all 1's.
6 bytes	Source Ethernet Address – The unique Ethernet address of the sending station.
2 bytes	Length or Type field – For IEEE 802.3 this is the number of bytes of data.
46 bytes to 1500 bytes	Data – Short packets must be padded to 46 bytes.
4 bytes	Frame Check Sequence(CRC) - The FCS is a 32 bit CRC calculated using the AUTODIN II polynomial.

The shortest packet is: 6 + 6 + 2 + 46 = 60 bytes The longest packet is: 6 + 6 + 2 + 1500 = 1514 bytes

Q: What is a MAC address?

A: It is the unique hexadecimal (numbering base 16) serial number assigned to each Ethernet network device to identify it on the network.. With Ethernet devices (as with most

other network types), this address is permanently set at the time of manufacturer, though it can usually be changed through software (though this is generally a Very Bad Thing to do).

Q: Why must the MAC address to be unique?

A: Each communicating end device (not bridges) has a unique MAC address, so that it will be able to exclusively grab packets off the network meant for it. If MAC addresses are not unique, there is no way to distinguish between two devices. Devices on the network watch network traffic and look for their own MAC address in each packet to determine whether they should decode it or not. Special circumstances exist for broadcasting to every device.

Q: Is there a special numbering scheme for MAC addresses?

A: The MAC addresses are exactly 6 bytes in length, and are usually written in hexadecimal as 12:34:56:78:90:AB (the colons may be omitted, but generally make the address more readable). Each manufacturer of Ethernet devices applies for a certain range of MAC addresses they can use. The first three bytes of the address determine the manufacturer. RFC-1700 (available via FTP) lists some of the manufacturer-assigned MAC addresses. A more up-to-date listing of vendor MAC address assignments is available on ftp.lcs.mit.edu in pub/map/Ethernet-codes.

Q: What does CRC mean?

A: Cyclical Redundancy Check - A method of detecting errors in a message by performing a mathematical calculation on the bits in the message and then sending the results of the calculation along with the message. The receiving work-station performs the same calculation on the message data as it receives it and then checks the results against those transmitted at the end of the message. If the results don't match, the receiving end asks the sending end to send again.

Q: What do 10Base5, 10BaseT, 10Base2, etc mean?

A: These are the IEEE names for the different physical types of Ethernet. The "10" stands for maximum signaling speed: 10MHz. "Base" means Baseband. 10BaseT, where the T means twisted pair, and 10BaseF where the F means fiber (see the following Q&A for specifics). This actually comes from the IEEE committee number for that media.

In actual practice:

10Base2 Is a maximum of 10MHz Ethernet running over thin, 50 Ohm baseband coaxial cable. 10Base2 is also commonly referred to as thin-Ethernet or Cheapernet. 10Base5 is 10MHz Ethernet running over standard (thick) 50 Ohm baseband coaxial cabling. 10BaseF is Ethernet running over fiber-optic cabling. 10BaseT is Ethernet running over unshielded, twisted-pair cabling.

Q: What is UTP?

A: Twisted pair cables. UTP is for Unshielded, Twisted Pair, while STP is for Shielded,

Twisted Pair. UTP is what's typically installed by phone companies (though this is often not of high enough quality for high- speed network use) and is what 10BaseT Ethernet runs over. UTP is graded according to its data carrying ability (e.g., Level 3, Level 4, Level 5). 10BaseT Ethernet requires at least Level 3 cable. Many sites now install only Level-5 UTP (CATegory 5), even though level 4 is more than sufficient for 10BaseT, because of the greater likelihood that emerging high-speed standards will require cable with better bandwidth capabilities.

Q: Are there any restrictions on how Ethernet is cabled?

A: Yes, there are many, and they vary according to the media used. First of all, there are distance limitations: 10BaseT generally accepted to have a maximum run of 100-150M, but is really based on signal loss in dB's (11.5db maximum loss source to destination). Then there are limitations on the number of repeaters and cable segments allowed between any two stations on the network.

The rule is, any possible path between two network devices on an unbridged/unrouted network cannot pass through more than 4 repeaters or hubs, nor more than 3 populated cable segments. 10BaseT and 10BaseF are star-wired, so there is no minimum distance requirement between devices, since devices cannot be connected serially. You can install up to the Ethernet maximum of 1024 stations per network with both 10BaseT and 10BaseF.

Q: When should I choose BaseT, BaseF (or others)?

A: The specific environment and application must be considered when selecting your media type. However, there are some general rules-of-thumb that you can consider:

Avoid using copper between buildings. The electrical disturbances caused by lightning, as well as naturally occurring differences in ground potential over distance, can very quickly and easily cause considerable damage to equipment and people. The use of fiber-optic cabling between buildings eliminates network cabling as a safety risk. There are also various wireless media available for inter-building links, such as laser, spread-spectrum RF and microwave.

10BaseT is the most flexible topology for LANs, and is generally the best choice for most network installations. 10/100/1000BaseT hubs, or multi-hub concentrators, are typically installed in a central location to the user community, and inexpensive UTP cabling is run to each network device (which may be 100m, or 330ft, from the hub). The signaling technology is very reliable, even in somewhat noisy environments, and 1 hubs will usually detect many network error conditions and automatically shut-down the offending port(s) without affecting the rest of the network (unless, of course, the offending port was your server, shared printer, or router to the rest of the world.

100/1000BaseF, and its predecessor, FOIRL, are the only recommended topologies for inter-building links. However, they need not be limited to this role. 100/1000BaseF can also be run to the desktop, though the cost is prohibitively high in all but the most specialized environments (generally, extremely noisy manufacturing facilities, or very security-conscious installations). More commonly, FOIRL (and now, 10BaseF) is used inside buildings and long distance wireless connections to form backbone networks.

Q: Is there an official "standard" punch down scheme for 10BaseT?

A: Get a copy of EIA/TIA-568, it covers all of that sort of stuff: horizontal, vertical, connectors, patch cords, cross-connects, etc.

Q: Is it safe to run Unshield Twisted Pair next to power cable?

A: According to EIA/TIA-569, the standard wiring practices for running data cabling and companion to the above referenced EIA/TIA-568, you should not run data cable parallel to power cables. However, in reality, this should not be a problem with networks such as 10BaseT. 10BaseT uses differential signaling to pick the data signals off the wire. Since any interference from nearby power lines will usually affect all pairs equally, anything that is not canceled-out by the twists in the UTP should be ignored by the receiving network interface.

Q: Can I connect the 10BaseT interface of two devices directly together, without using a hub?

A: Yes, but not more than 2 devices, and you also need a special jumper cable between the two 10BaseT ports:

```
RJ45 pin            RJ45 pin
========            ========
1 <--[TX+]--------[RX+]--> 3
2 <--[TX-]--------[RX-]--> 6
3 <--[RX+]--------[TX+]--> 1
6 <--[RX-]--------[TX-]--> 2
```

Q: What is a "segment"?

A: A piece of network wire bounded by bridges, routers, repeaters or terminators.

Q: What is a "subnet"?

A: Another overloaded term. It can mean, depending on the usage, a segment, a set of machines grouped together by a specific protocol feature (note that these machines do not have to be on the same segment, but they could be) or a big nylon thing used to capture enemy subs.

Q: What is a repeater?

A: A repeater acts on a purely electrical level to connect to segments. All it does is amplify and reshape (and, depending on the type, possibly retime) the analog waveform to extend network segment distances. It does not know anything about addresses or forwarding, thus it cannot be used to reduce traffic as a bridge can in the example above.

Q: What is a "hub"?

A: A hub is a common wiring point for star-topology networks, and is a common synonym for concentrator (though the latter generally has additional features or capabilities). 10BaseT and 10BaseF Ethernet and many proprietary network topologies use hubs to connect multiple cable runs in a star-wired network topology into a single network. Hubs have

multiple ports to attach the different cable runs. Some hubs (such as 10BaseT) include electronics to regenerate and retime the signal between each hub port. Others (such as 10BaseF) simply act as signal splitters, similar to the multi-tap cable-TV splitters you might use on your home antenna coax (of course, 10BaseF uses mirrors to split the signals between cables).

Q: What is a bridge?

A: A bridge will connect to distinct segments and transmit traffic between them. This allows you to extend the maximum size of the network while still not breaking the maximum wire length, attached device count, or number of repeaters for a network segment.

Q: What does a "learning bridge"?

A: A learning bridge monitors MAC (OSI layer 2) addresses on both sides of its connection and attempts to learn which addresses are on which side. It can then decide when it receives a packet whether it should cross the bridge or stay local (some packets may not need to cross the bridge because the source and destination addresses are both on one side). If the bridge receives a packet that it doesn't know the addresses of, it will forward it by default. IEEE's standard for a learning bridge is 802.1D.

Q: Is there a maximum number of bridges allowed on a network?

A: Per IEEE 802.1 (d), the maximum number of concatenated brides in a bridged LAN is 7. This number is rather arbitrary, however, and is based on simulations of application performance with expected bridge delays.

In addition, the number assumes that all bridges are LOCAL (no remote WAN connections), and that the default Hold Time of 1 second is in place (this is the time after which a bridge will discard a frame it is holding). This prevents extra-late frame delivery. (i.e, a frame should never be delivered more than ~7 seconds after is it sent). The rule of thumb for wireless WAN bridged LANs is to limit the number of hops to 4.

Q: What is a router?

A: Routers work much like bridges, but they pay attention to the upper network layer protocols (OSI layer 3) rather than data link layer (OSI layer 2) protocols. A router will decide whether to forward a packet by looking at the protocol level addresses (for instance, TCP/IP addresses) rather than the MAC address. Because routers work at layer 3 of the OSI stack, it is possible for them to transfer packets between different media types (i.e., leased lines, Ethernet, token ring, X.25, Frame Relay and FDDI). Many routers can also function as bridges.

Q: So should I use a router or a bridge?

A: There is no absolute answer to this. Your network layout, type and amount of hosts and traffic, and other issues (both technical and non-technical) must be considered. Routing would always be preferable to bridging except that routers are slower and usually more expensive (due to the amount of processing required to look inside the physical packet

and determine which interface that packet needs to get sent out), and that many applications use non-routable protocols.

Rules of thumb:

Bridges are usually good choices for small networks with few, if any, slow redundant links between destinations or for connecting distant LANs. Further, bridges may be your only choice for certain protocols, unless you have the means to encapsulate (tunnel) the un-routable protocol inside a routable protocol.

Routers are usually much better choices for larger networks, particularly where you want to have a relatively clean WAN backbone. Routers are better at protecting against protocol errors (such as broadcast storms) and bandwidth utilization. Since routers look deeper inside the data packet, they can also make forwarding decisions based on the upper-layer protocols.

Occasionally, a combination of the two devices are the best way to go. Bridges can be used to segment small networks that are geographically close to each other, between each other and the router to the rest of the WAN.

Q: Are there problems mixing Bridging & Routing?

A: Only if you plan on having bridged links in parallel with routed links. You need to be very careful about running bridges providing links in parallel to a router. Bridges may forward broadcast requests which will confuse the router there are lots of protocols you may not think of filtering (e.g. ARP, Apple ARP over 802.3 etc. etc.). Also, DECnet routers have the same MAC address on all ports. This will probably cause the bridge to think it is seeing an Ethernet loop.

Q: Who makes the fastest/easiest/most advanced bridges or routers?

A: The IETF runs bench marks on a wide selection of wired/fiber bridges and routers. Network Computing runs bench marks for wireless routers (point-to-multipoint) and bridges (point-to-point).

Q: What does "IPG" mean?

A: The InterPacket Gap (more properly referred to as the InterFrame Gap, or IFG) is an enforced quiet time of 9.6 us between transmitted Ethernet frames.

Q: What means "promiscuous mode"?

A: Promiscuous mode is a condition where the network interface controller will pass all Ethernet frames, regardless of destination address, up to the higher level network layers. Normally the network controller will only pass up frames that have that device's destination address. However, when put in promiscuous mode, all frames are passed on up the network stack regardless of destination address. Promiscuous mode is usually used by network monitoring tools and transparent bridges.

Q: What is a collision?

A: A condition where two devices detect that the network is idle and end up trying to send packets at exactly the same time (within 1 round-trip delay). Since only one device can transmit at a time, both devices must back off and attempt to retransmit again.

The retransmission algorithm requires each device to wait a random amount of time, so the two are very likely to retry at different times, and thus the second one will sense that the network is busy and wait until the packet is finished. If the two devices retry at the same time (or almost the same time) they will collide again, and the process repeats until either the packet finally makes it onto the network without collisions, or 16 consecutive collision occur and the packet is aborted.

Q: What causes a collision?

A: See above. Ethernet is a CSMA/CD (Carrier Sense Multiple Access/ Collision Detect) system. It is possible to not sense carrier from a previous device and attempt to transmit anyway, or to have two devices attempt to transmit at the same time; in either case a collision results. Ethernet is particularly susceptible to performance loss from such problems when people ignore the "rules" for wiring Ethernet.

Q: How many collisions are too many?

A: This depends on your application and protocol. In many cases, collision rates of 50% will not cause a large decrease in perceived throughput. If your network is slowing down and you notice the percentage of collisions is on the high side, you may want try segmenting your network with either a bridge or router to see if performance improves.

Q: How do I reduce the number of collisions?

A: Disconnect devices from the network. Seriously, you need to cut- down on the number of devices on the network segment to affect the collision rate. This is usually accomplished by splitting the segment into two pieces and putting a bridge or router in between them.

Q: What is a late collision?

A: A late collision occurs when two devices transmit at the same time, but due to cabling errors (most commonly, excessive network segment length or repeaters between devices) neither detects a collision. The reason this happens is because the time to propagate the signal from one end of the network to another is longer than the time to put the entire packet on the network, so the two devices that cause the late collision never see that the other's sending until after it puts the entire packet on the network. Late collisions are detected by the transmitter after the first "slot time" of 64 byte times. They are only detected during transmissions of packets longer than 64 bytes. It's detection is exactly the same as for a normal collision; it just happens "too late."

Typical causes of late collisions are segment cable lengths in excess of the maximum permitted for the cable type, faulty connectors or improper cabling, excessive numbers of repeaters between network devices, and defective Ethernet transceivers or controllers.

Another negative concerning late collisions is that they occur for small packets also, but cannot be detected by the transmitter. A network suffering a measurable rate of late collisions (on large packets) is also suffering lost small packets. The higher protocols do not cope well with such losses. Well, they cope, but at much reduced speed. A 1% packet

loss is enough to reduce the speed of NFS by 90% with the default retransmission timers. That's a 10 times increase of the problem!

Finally, Ethernet controllers do not retransmit packets lost to late collisions.

Q: What is a jam?

A: When a workstation receives a collision, and it is transmitting, it puts out a jam so all other stations will see the collision also. When a repeater detects a collision on one port, it puts out a jam on all other ports, causing a collision to occur on those lines that are transmitting, and causing any non-transmitting stations to wait to transmit.

Q: What is a broadcast storm?

A: An overloaded term that describes an overloaded protocol. Basically it describes a condition where devices on the network are generating traffic that by its nature causes the generation of even more traffic. The inevitable result is a huge degradation of performance or complete loss of the network as the devices continue to generate more and more traffic. This can be related to the physical transmission or to very high level protocols.

Q: How do I recognize a broadcast storm?

A: That depends on what level it is occurring. Basically you have to be aware of the potential for it beforehand and be looking for it, because in a true broadcast storm you will probably be unable to access the network. This can change dramatically for a higher level protocol. NFS contention can result in a dramatic DROP in Ethernet traffic, yet no one will have access to resources.

Q: How can I prevent a broadcast storm?

A: Avoid protocols that are prone to it. Route (with routers) or Bridge (with wired/wireless bridges) when it is practical.

Q: What is *high* traffic on an Ethernet? 5%? 20%? 90%?

A: High traffic is when things start slowing down to the point they are no longer acceptable. There is not set percentage point, in other words. Usually start paying attention when it gets over 40-50%.

Q: Why do I see different throughput speeds?

A: Bridges (such as Tsunami) are ISO Layer 2 Data Link Layer (use MAC address for filtering) devices where they provide their full stated throughput. At level 2 (bridges) or 3 (routers) where hardware plays the major part, the most common tester is the SmartBits 200 product from NetCom Systems. At Application Layer 7, you will see less than 40% throughput from the maximum capacity measured w/SmartBits due to the increased protocol/software overhead at that level. Layer 7 can be tested with software such as Ganymede's Chariot or Qcheck product.

As an example: testing copper CAT5 cable with SmartBits will test 100% throughput (let's say you can send/rcv a full 10Mbps). At Layer 7 you will be transferring data at the 10Mbps rate, but only 4Mbps of user data will transfer (Ethernet has a high overhead of bytes added to each data packet each time you go up a layer). The advantage is the more complex overhead makes the data virtually resilient to corruption and minor errors (i.e. collisions), it's easy to reroute and can use inexpensive plug/play devices like hubs/switches instead of multiplexers as used in the telco industry (i.e. LYNX T1 radios)

Western Multiplex tests at Layer 2 where bridges are defined. At layer 7 (Application Layer), you will see less than 40% or more depending on the other traffic that may be on the LAN as this layer is more dependent on the type of data being sent (it does not matter if it's wire, fiber or any Ethernet bridge -wired or wireless). Another way to look at it: the model 31145 12Mbps (10Mbps 10BaseT+T1/E1 wayside) bridge will test the same as a piece of CAT5 Ethernet cable.

Q: How can I test an Ethernet?

A: This depends on what level you want to test. The most basic test (a.k.a., "the fire test") is to connect a pair of devices to the network and see if they can communicate with each other. If you want to test the electrical integrity of the wire (i.e., will it carry a signal properly), a TDR or cable scanner that incorporates TDR and other functions, would be the most comprehensive tool. If you need to test the performance or troubleshoot protocol transmission problems, you will need special and usually very expensive software, usually coupled with custom hardware, to capture, optionally filter, and analyze the network packets. Also, see the answer to the question above.

Q: What is a "TDR"?

A: A Time-Domain Reflectometer is a tool used to detect cable faults. This device operates by sending a brief signal pulse down the cable and looking for its reflection to bounce back. By analyzing the reflected pulse, it is possible to make judgments about the quality of the cable segment. More advanced units can not only detect and identify the nature of the problem, but give a reasonably accurate indication of the problem's location (distance from the point of the test). There is also a device known as an OTDR, which is an Optical Time-Domain Reflectometer for fiber-optic cables.

Q: What is a "BERT"?

A: Bit Error Rate Tester. This equipment is used to analyze the amount and types of errors that occur on a cable segment.

Q: What (free) tools are there to monitor/decode/etc an Ethernet?

A: There are many built into most DOS ,Unix and other operating systems. For example, the ping command can be used to determine if a given host is alive, and will also tell you the round trip transmission time. The command “ifconfig” will tell you the status of the network interfaces. “netstat” will summarize statistics for network usage.

DOS commands (through Windows DOS application) are:

ARP

Displays and modifies the IP-to-Physical address translation tables used by address resolution protocol (ARP).

ARP -a [inet_addr] [-N if_addr]

-a Displays current ARP entries by interrogating the current protocol data. If inet_addr is specified, the IP and Physical addresses for only the specified computer are displayed. If more than one network interface uses ARP, entries for each ARP table are displayed.
-g Same as -a.
inet_addr Specifies an internet address.
-N if_addr Displays the ARP entries for the network interface specified by if_addr.
-d Deletes the host specified by inet_addr.
-s Adds the host and associates the Internet address inet_addr with the Physical address eth_addr. The Physical address is given as 6 hexadecimal bytes separated by hyphens. The entry is permanent.
eth_addr Specifies a physical address.
if_addr If present, this specifies the Internet address of the interface whose address translation table should be modified. If not present, the first applicable interface will be used.
Example:
> arp -s 157.55.85.212 00-aa-00-62-c6-09 .... Adds a static entry.
> arp -a .... Displays the arp table.

FTP

Transfers files to and from a computer running an FTP server service (sometimes called a daemon). FTP can be used interactively.

FTP [-v] [-d] [-i] [-n] [-g] [-s:filename] [-a] [-w:windowsize] [-A] [host]

-v	Suppresses display of remote server responses.
-n	Suppresses auto-login upon initial connection.
-i	Turns off interactive prompting during multiple file transfers.
-d	Enables debugging.
-g	Disables filename globbing (see GLOB command).
-s:filename	Specifies a text file containing FTP commands; the commands will automatically run after FTP starts.
-a	Use any local interface when binding data connection.
-A	login as anonymous.
-w:buffersize	Overrides the default transfer buffer size of 4096.
host	Specifies the host name or IP address of the remote host to connect to.

Notes:
- mget and mput commands take y/n/q for yes/no/quit.
- Use Control-C to abort commands.

NET CONFIG	Displays your current workgroup settings.
NET DIAG	Runs the Microsoft Network Diagnostics program to display diagnostic information about your network.
NET HELP	Provides information about commands and error messages.

NET INIT	Loads protocol and network-adapter drivers without binding them to Protocol Manager.
NET LOGOFF	Breaks the connection between your computer and the shared resources to which it is connected.
NET LOGON	Identifies you as a member of a workgroup.
NET PASSWORD	Changes your logon password.
NET PRINT	Displays information about print queues and controls print jobs.
NET START	Starts services.
NET STOP	Stops services.
NET TIME	Displays the time on or synchronizes your computer's clock with the clock on a Microsoft Windows for Workgroups, Windows NT, Windows 95, or NetWare time server.
NET USE	Connects to or disconnects from a shared resource or displays information about connections.
NET VER	Displays the type and version number of the workgroup redirector you are using.
NET VIEW	Displays a list of computers that share resources or a list of shared resources on a specific computer.

For more information about a specific Microsoft NET command, type the command name followed by /? (for example, NET VIEW /?).

PING

PING [-t] [-a] [-n count] [-l size] [-f] [-i TTL] [-v TOS] [-r count] [-s count] [[-j host-list] | [-k host-list]] [-w timeout] destination-list

-t	Ping the specified host until stopped. To see statistics and continue - type Control-Break; To stop - type Control-C.
-a	Resolve addresses to hostnames.
-n count	Number of echo requests to send.
-l size	Send buffer size.
-f	Set Don't Fragment flag in packet.
-i TTL	Time To Live.
-v TOS	Type Of Service.
-r count	Record route for count hops.
-s count	Timestamp for count hops.
-j host-list	Loose source route along host-list.
-k host-list	Strict source route along host-list.
-w timeout	Timeout in milliseconds to wait for each reply.

ROUTE

Manipulates network routing tables.

ROUTE [-f] [command [destination] [MASK netmask] [gateway] [METRIC metric]]

-f Clears the routing tables of all gateway entries. If this is used in conjunction with one of the commands, the tables are cleared prior to running the command.

command Must be one of four:

PRINT	Prints a route
ADD	Adds a route
DELETE	Deletes a route
CHANGE	Modifies an existing route

destination Specifies the destination host.

MASK Specifies that the next parameter is the 'netmask' value.

netmask Specifies a subnet mask value to be associated with this route entry. If not specified, it defaults to 255.255.255.255.

gateway Specifies gateway.

METRIC Specifies that the next paramenter 'metric' is the cost for this destination

All symbolic names used for destination are looked up in the network database file NETWORKS. The symbolic names for gateway are looked up in the host name database file HOSTS.

If the command is PRINT or DELETE, wildcards may be used for the destination and gateway, or the gateway argument may be omitted.

Diagnostic Notes:
Invalid MASK generates an error, that is when (DEST & MASK) != DEST.
Example> route ADD 157.0.0.0 MASK 155.0.0.0 157.55.80.1
The route addition failed: 87

Examples:

```
> route     PRINT
> route     ADD 157.0.0.0    MASK 255.0.0.0   157.55.80.1     METRIC  3
            ^destination     ^mask            ^gateway                ^metric
> route     PRINT
> route     DELETE 157.0.0.0
> route     PRINT
```

SNMP

Starts SNMP agent

-close Closes previously running instance of snmp
-help Displays SNMP help dialog box

TELNET

Opens telnet window

TRACERT

TRACERT [-d] [-h maximum_hops] [-j host-list] [-w timeout] target_name

-d	Do not resolve addresses to hostnames.
-h maximum_hops	Maximum number of hops to search for target.
-j host-list	Loose source route along host-list.
-w timeout	Wait timeout milliseconds for each reply.

WINIPCFG

Opens IP configuration window

/All - Display detailed information
/Batch - [filename] Write to file or .\winipcfg.out
/renew_all - Renew all adapters
/release_all - Release all adapters
/renew N - Renew adapter N
/release N - Release adapter N

Q: What books are good about Ethernet LAN's?

A: The IEEE 802.3 documents are considered the definitive source for information on Ethernet. However, these may not be suitable for all levels of users. Surprisingly, there are few good books specifically dealing with Ethernet LANs, but here are a few that you might find useful:

Local Area Networks, An introduction to the technology by John E. McNamara, published by Digital Press, 1985 165 pps. with index and glossary, $29.00 ISBN 0-932376-79-7, Digital Press part number EY-00051-DP.

Network Troubleshooting Guide by Digital Equipment Corporation, August 1990 Approx. 278 pps. with index and glossary, $95.00 Digital Press part number EK-339AB-GD-002.

These books and others are recommended in the network reading list, net-read.txt, from ftp.utexas.edu.

Q: Where can I get IEEE802.x docs online?

A: Not available online. IEEE documents can be ordered directly from the IEEE themselves. You can contact them at:

Institute of Electrical and Electronic Engineers 445 Hoes Lane P.O. Box 1331 Piscataway, NJ 08855-1331 U.S.A. (800) 678-IEEE

Q: Where can I get EIA/TIA docs online?

A: Not available online They can be ordered from:

Global Engineering 800-854-7179

Appendix C – Auxiliary Data Connectors

The following figures illustrate the pin structure for all auxiliary connections. All figures are oriented as a customer would view them, facing the connector. DC power connection information is found in Section 3.7 of this manual.

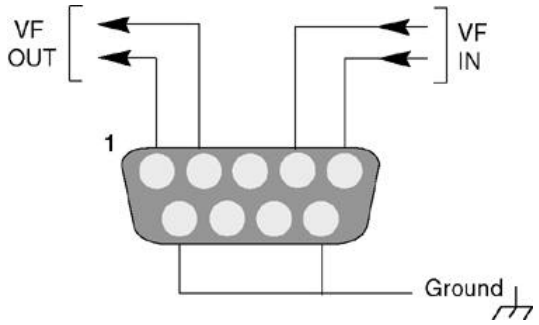


Figure D-1: VF Port Connection

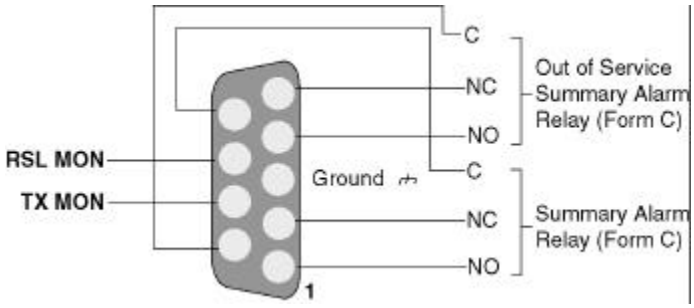
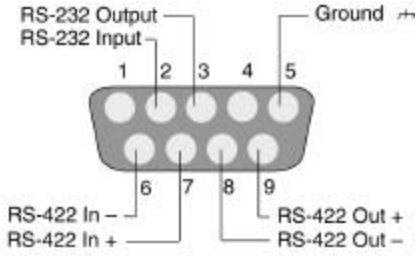


Figure D-2: Alarm Port Connections



(as viewed from rear panel)

Figure D-3: Config(uration) Port 9-Pin D-Style Connector

Do NOT connect to RS-422 pins at any time.

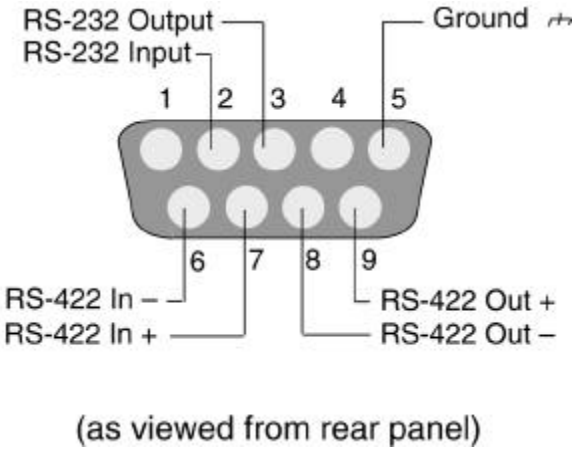


Figure D-4: AUX DATA Port 9-Pin D-Style Connector

Do NOT connect to RS-422 pins at any time.

Appendix D – Installation and Troubleshooting (foldout)

Fold-out page inserted after this page

Your Notes on the Tsunami Radio

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