USER MANUAL

L2700 Millimeter-wave Point-to-Point Radio

Version 1.0
August 15, 2007

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GENERAL SAFETY NOTICES

FCC NOTICE

This equipment complies with the FCC radiation exposure limits set forth for an uncontrolled environment when installed as directed. This equipment should be installed and operated with fixed mounted antennas that are installed such that these antennas will have a minimum of 2m of separation distance between the antenna and all persons during normal operation.

This device complies with Part 101 of the FCC Rules.

This device is labeled with the following FCC ID number:

S2N-L2700-2

PROFESSIONAL INSTALLATION REQUIRED

The L2700 must be installed as a system by experienced antenna installation professionals who are familiar with Radio Frequency (RF) issues such as gains and losses, as well as local building and safety codes. Failure to do so will void the product warranty and may expose the end user to excessive RF hazard.

Regulations regarding maximum antenna gains, power output and maximum permissible exposure vary from country to country. It is the responsibility of the end user to operate within the limits of these regulations and to ensure that the professional installers who install this device are aware of these regulations. All antennas are intended to be installed outdoors.

MICROWAVE RADIO RADIATION WARNING

When installed properly, this product complies with the limits for human exposure to radio frequency (RF) fields adopted by the Federal Communications Commission (FCC). The product is designed so that under normal working conditions, microwave radiation directly from the transceiver is negligible when compared with the permissible limit of continuous daily exposure recommended in the United States by ANSI/IEEE C95.1-1991 (R1997), Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3kHz to 300GHz.

Microwave signal levels that give rise to hazardous radiation levels can exist within transmitter power amplifiers, associated RF multiplexers, and antenna systems. Do not disconnect RF coaxial connectors, open microwave units, or break down any microwave screening while the radio equipment is operating.

LASER SAFETY NOTICE

This product complies with CFR 1040.10 and 1040.11. The product includes a Class I laser utilized as a fiber optic driver. Class I lasers do not emit radiation at known hazardous levels. However, it is recommended that maintenance or service personnel should never look at an open fiber end or connector that is carrying a live signal. During use, this optical fiber communications system is completely enclosed except if an accidental break occurs in the system cable, or if the patch cable becomes accidentally disconnected from the demarcation box. There are no controls or adjustments other than power ON/OFF that may be accessed by the user.

CAUTION: Use of controls or adjustments or performance of procedure other than those specified in this Manual may result in hazardous radiation exposure.

CONSTRUCTION SAFETY NOTICE

Note that every area of the country has its own codes of safety and construction. Installations like this must comply with these codes. It is the installer/user's responsibility to understand what codes apply and to ensure that the installation conforms to these codes.

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1. Overview

1.1 Description

The L2700 is a point-to-point, fixed wireless, ultra-broadband access product which operates in the licensed upper millimeter wave spectrum from 71.0-86.0GHz. The L2700 can carry high capacity payloads (up to 1.25Gbps- full duplex) with high availability in all weather. In most locations in the United States, the L2700 will have 99.999% weather availability at roughly 1.6 kilometer. It deploys quickly and inexpensively with proper planning and preparation as outlined in this manual. Loea RF products are intended for installation by professional Loea certified installers only.

1.2 L2700 Common Applications and Features

The L2700 is a last mile access solution and a replacement for buried/aerial fiber cable such as wireless backhaul, last mile access and LAN/WAN extensions.

The L2700 is rapidly deployable and re-commissionable making it an ideal solution for temporary bandwidth or for emergency situations that could cause an interruption to buried technologies.

In short, most applications of fiber cable in the last mile are potential applications for the L2700.

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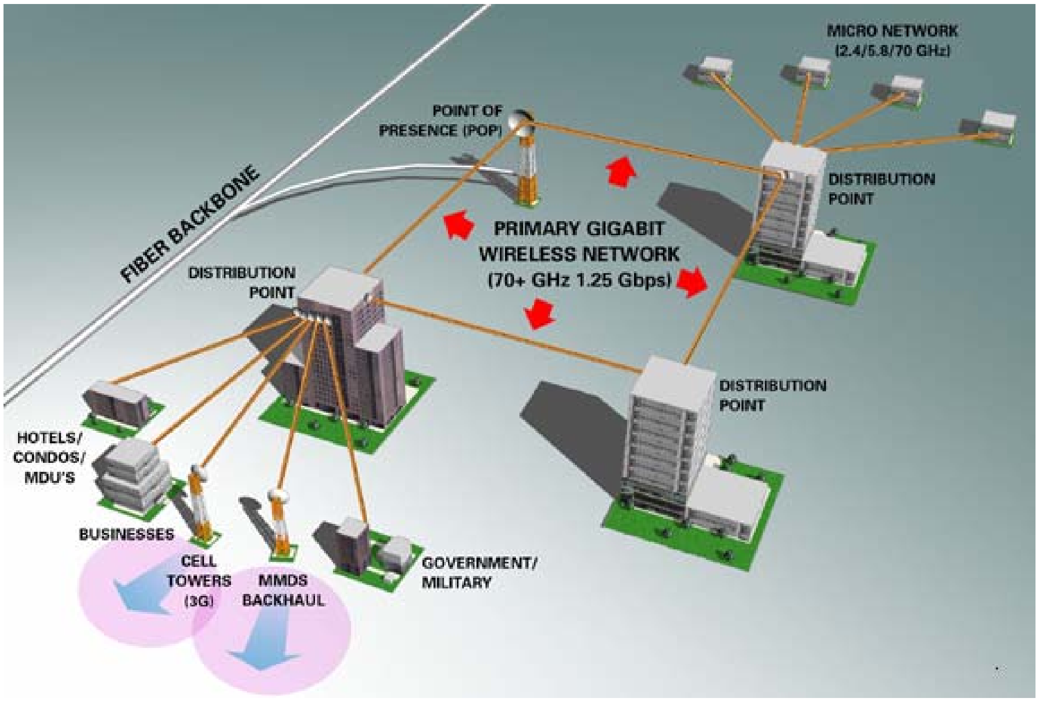

Figure 1. Typical L2700 Applications.

Product Features:

- Operation in the Part 101 licensed 71.0-76.0GHz & 81.0-86.0GHz band.
- FCC and NTIA certified
- Standard LC fiber optic interface
- 110V AC power, 50W peak consumption
- -48 Volt telecom standard DC power (option)
- 19 dBm peak output power – OOK Modulation
- All weather performance
- OSI Layer 1 data transmission
    - Interoperable with most fiber optic COTS switch, router and encryption devices.
    - Plug and play with existing networks.
- Secure Transmission and narrow beam widths
    - Low Probability Intercept and Low Probability Detection (LPILPD)
    - Co-existence of many users with low likelihood of interference
- Operating Temperature from -20C to +50C

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Figure 2. L2700 with 2 Foot Antenna

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2. Installation Procedures

2.1 Introduction

This manual provides basic instructions on the assembly, alignment and verification of the Loea L2700 system. In doing so, it outlines recommended tools and processes to use. A detailed understanding of this manual and participation in a Loea training class is highly recommended prior to starting any work on site. Only Loea Trained and Certified installers should perform installation services on the L2700.

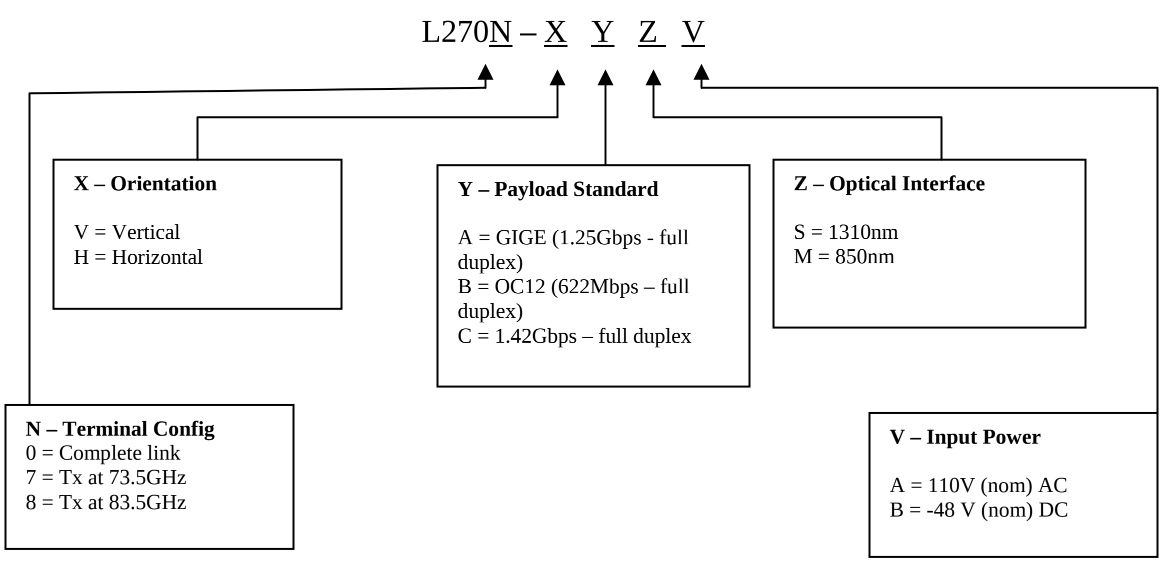
Please note that every area of the country has its own codes of safety and construction. Installations must comply with these codes. It is the installer/user's responsibility to understand what codes apply and to ensure that the installation conforms to these codes.

2.2 Standard Link Components

Description	Part #	Comments
Transceiver Pair	L2700-XYZV	Radio Pair Only
2' antenna	A24-FCM	Two (2) Antenna's required for a link
Steering Mechanism	MT-24	Two (2) Steering Mechanisms required for a link

Table 1 – Basic L2700 Components

Part Number Format



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2.3 General Installation Requirements

Before the installation of a Loea link, certain steps must be taken to ensure that the installation will be successful.

A. Site Survey: During a site survey a certified Loea surveyor can assess the environment of the installation, ensure that the physical conditions of the site are appropriate, indicate where building connections need to be available and ensure that Line of Sight (LOS) exists between the two end points.
B. FCC Part 101 License: Loea's band of operation is licensed by the FCC for non-federal government users and by the NTIA for federal government and DOD users. Prior to deployment, a license is required. For more information on obtaining a license for operation of this radio in the 70 and 80 GHz bands see http://wireless.fcc.gov/services/millimeterwave/ and select the "nationwide license" link. There is an application form and information pertaining to current license fees at this site. If you are a federal government user, your spectrum officer should be able to get a license with our J/F12 number 8138. Please contact Loea directly with any questions.
C. Installation of Mast and Demarcation: A standard 4in mast (4.5in O.D.) must be installed at a position and specific height as specified in the Site Survey. To facilitate connection to the building's network; fiber for communications, 110V AC (Required UPS -Cyber Power UPS Model #CPS625AVR or equivalent for AC mode) or optional -48VDC, and optional Ethernet for monitoring are required in a demarcation box per the specifications in this manual and specifically as defined in the Site Survey.
D. Bench Test: Loea recommends that the transceivers be tested after delivery to the site and prior to installation on the mast to ensure that no damage occurred during shipping and to familiarize customer with radio operation. To perform a bench test:
   a) Separate the transceivers by approximately 5 feet on a wooden or non-metallic surface without the antennas attached. Align the radios so that the feed horns are in the same RF orientation (to do this situate the radio housing so that the conduit hole on each radio is pointing upward) and pointed directly at each other with absorber material between the feed horn. When user can verify an RSSI (Receive Signal Strength Indicator) value a link has been established. Then when BER performance is verified the link is functional. See reference Sections 2.7, 2.8 and 2.9.
   b) If possible, a complete end-to-end test is recommended with switching and/or encryption devices. The L2700 is generally a plug and play device, it is recommended to do this to avoid de-bugging in the field.
E. System Commissioning: Upon install completion, metrics from the install site must be recorded and verified to ensure that the transceivers are performing as expected. The "Loea Field Service Data" form (see Appendix A) should be forwarded to Loea following the installation. This will assist Loea's technical service and help desk personnel assess problems should a link fail to operate. It is also recommended that the end user/owner keep a copy for their records.

2.4 Construction of Steering System (Part Number MT-24)

2.4.1 Assemble Azimuth and Elevation Control Arms (see Figure 3)

> Note: Some parts may come pre-assembled. Each assembly step is included for reference. A Loea training class is highly recommended prior to a user installation.

> **Requires:** two MRP-2003 Azimuth arms (**5**), one MRP-2005/1 Gross adjustment nut (**2**), one MRP-2005/2 Fine adjustment nut (**4**), one MRP-2007 Elevation adjustment nut (**6**), two RH threaded ball joint ends (**3**), one LH threaded ball joint end (**1**), ¾"-10 Threaded rod (**7**), and one ¾" jam nut (**8**).

Thread the left hand threaded ball joint (1) halfway into the gross adjustment nut (2). Thread one right hand threaded ball joint (3) equally into the fine adjustment nut (4). Thread each adjustment nut about halfway into an Azimuth arm (5).

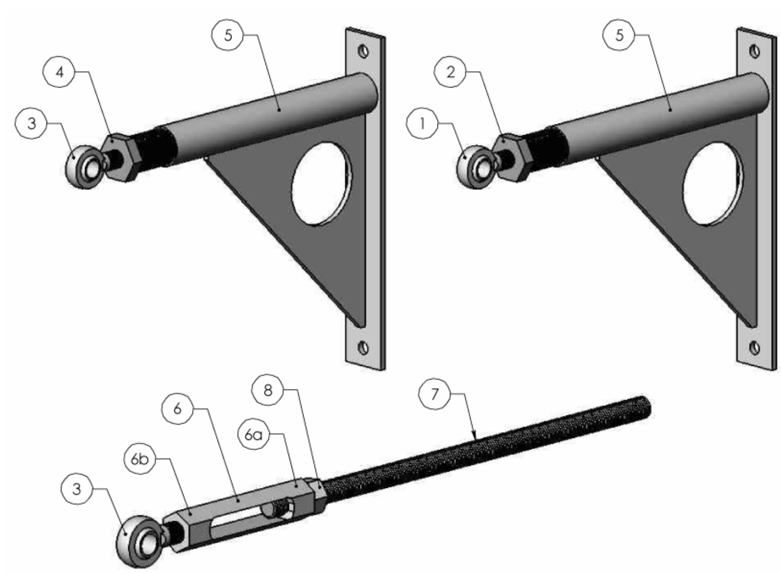

Figure 3. Azimuth and Elevation Control Arms.

Thread the jam nut (8) and the course end (6a) of the Elevation adjustment nut (6) onto the one end of the ¾"-10 threaded rod (7) far enough to reach the hollow portion of the Elevation nut. Thread the ball joint (3) equally into the fine end of the adjustment nut (6b).

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2.4.2 Assemble Antenna Mount Plate and Azimuth Arms (see Figure 4)

Requires: one MRP-2006 Mount plate (9), one MRP-2008 pillow block (10), four ½" Hardware Assemblies (11) consisting of [½"- 13 x 1-3/4" bolt, hex nut, lock washer, flat washer], and three ¼"-20 socket head cap screws (12).

Position the mount plate (**9**) so the offset tab is on the lower right. Locate the three ¼"-20 threaded holes on the tab and fasten the pillow block (**10**) to the mount plate with the socket head cap screws (**12**). The application of Lock-Tite™ or an equivalent compound during this step is recommended.

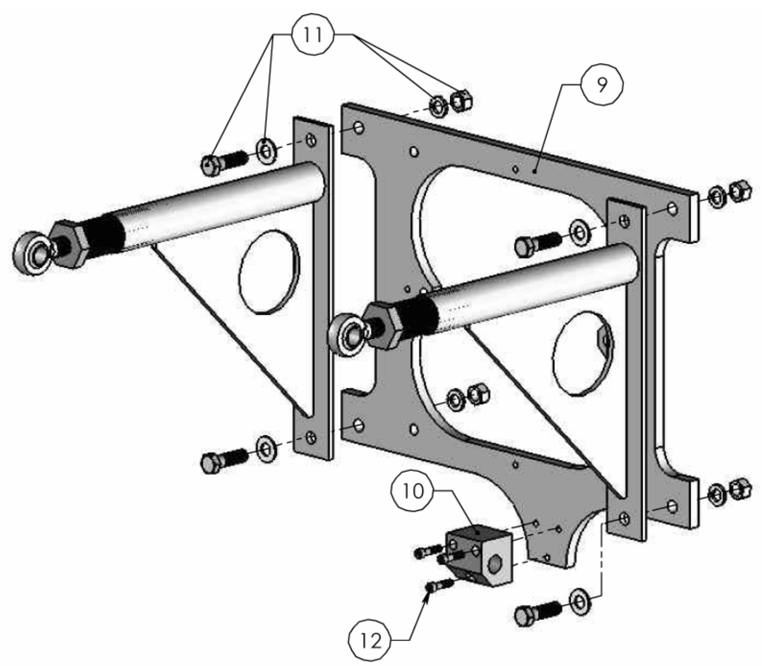

Figure 4. Assembly of Antenna Mount Plate and Azimuth Control Arms.

Position each Azimuth arm with adjustment controls up, on the backside of the mount plate capturing the ½" through holes of the upper and lower tabs on each side of the mount plate. Fasten the arms to the mount plate using the ½" hardware assemblies (**11**).

2.4.3 Assemble Antenna Mount Plate and Pole Plate (see Figure 5)

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Requires: one MRP-2002 Pole plate (**13**), one MRP-2010 Elevation Lock nut (**14**), one ball joint bearing (**15**), three ¾"-10 socket head cap screws (**16**), and one ¾" jam nut (**8**).

Position the pole plate (13) so that the bearing block for the Elevation control arm is on the lower left. Securely brace the pole plate and gently tap the ball joint bearing (15) into the block with a bearing drift or large socket. Orient the two plates so that the ball joint ends of the Azimuth control arms line up with the ¾" tapped holes on each end of the pole plate cross beam. Next, fasten the ball joint ends to the cross beam of the pole plate by inserting the ¾" socket head screws (16) through the ball joint and thread into the tapped ends. Tighten until snug, do not over tighten or torque the ball joint screws.

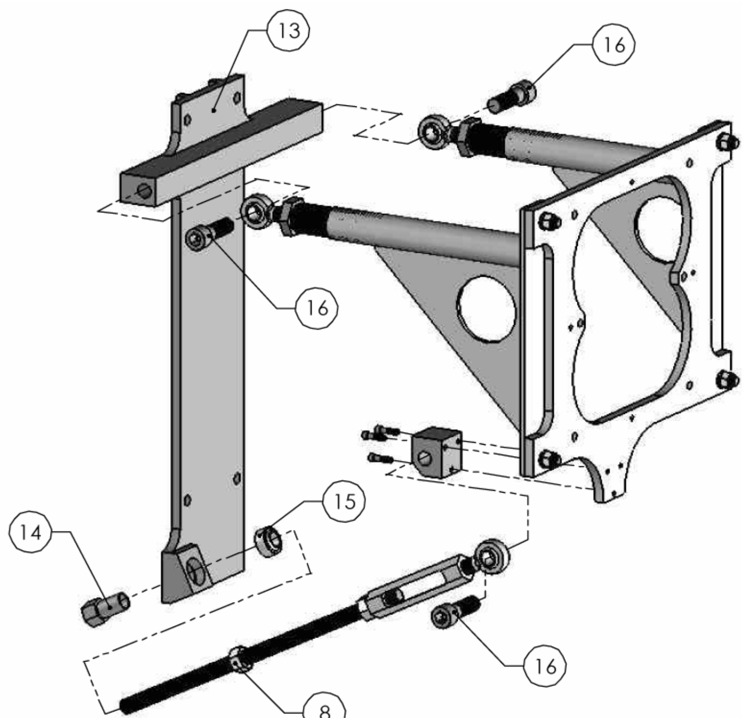

Figure 5. Antenna Mount Plate and Pole Plate Assembly.

Thread the jam nut (8) halfway up the free end of the Elevation (threaded rod) arm. Slide the free end through the ball joint bearing (15) of the pole plate. Rotate the antenna mount plate so the ball joint end attached to the other end of the Elevation arm lines up with the ¾" tapped hole in the adjacent side of the pillow block. Secure the Elevation arm to the pillow block in the same manner as the Azimuth arms. Thread the Elevation lock nut (14) onto the free end of the Elevation arm. Adjust the Elevation lock nut and the ¾" jam nut (8) as needed to minimize movement of the antenna mount plate during final assembly.

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2.5 Attach Assembly to Mast and Attach Antenna (see Figure 6)

Requires: two U-Bolt Assemblies (**17**) consisting of [one standard 4''mast (4.5" diameter actual), ½"-13 U-bolts, two hex nuts, two lock washers], four 3/8"-16 bolts and flat washers (**18**), and Antenna (**19**).

Lifting the steering assembly from the front, press the pole plate against the mast using the parallel runners on the backside to steady the assembly while the two U-bolts (17) are installed. Once the steering system is shifted into the desired position the plate's runners will bind to the mast as the U-bolts are tightened so as to prevent the mount from inadvertently slipping.

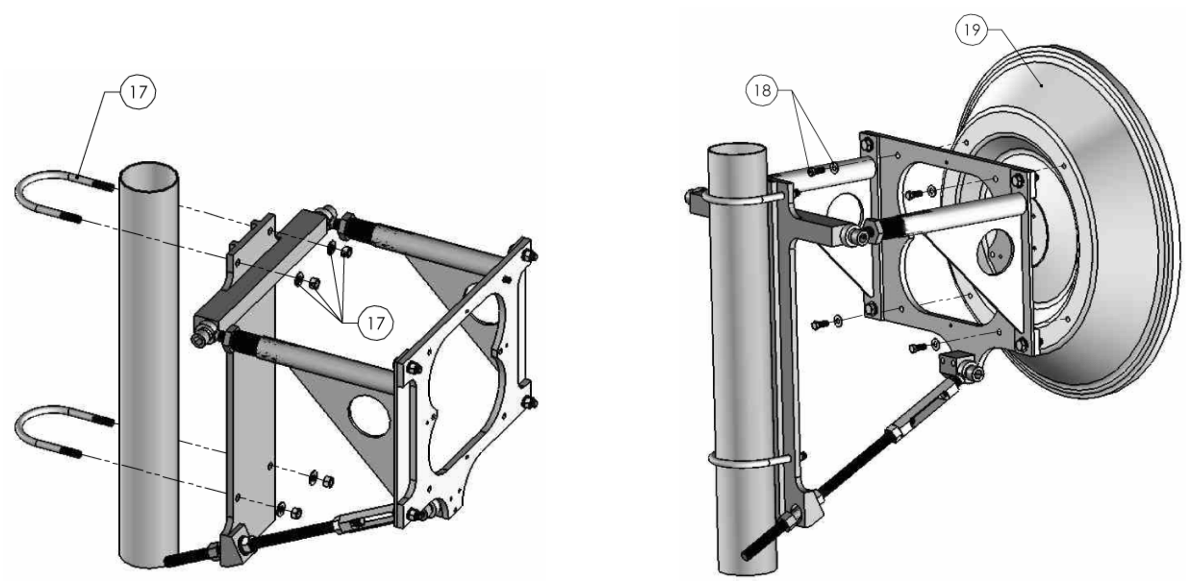

Figure 6. Attaching Assembly to Mast and Attach Antenna.

Once the steering assembly is secured to the mast, locate the four 3/8" through holes correlating with the four threaded holes located on the backside of the antenna. Position the antenna (19) onto the mount plate. Secure the antenna to the mount using the 3/8" bolts and flat washers (18). Although the steering system can accommodate course adjustments, steering assembly may need to shift beyond the range of the Azimuth arms. The U-bolts can always be loosened enough to permit a slightly greater rotation to correct such alignment issues.

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2.6 Attach Transceiver to Steering System (see Figure 7)

Once the steering assembly with antenna attached is secured to the mast per 2.5 above, lift the transceiver and pass it through opening 'A' in the steering assembly aligning the four 3/8" through holes on the transceiver (21) with the four threaded holes (22) located on the mount plate.

NOTE: Ensure the transceiver housing is positioned such that the correct RF orientation of the radio is being installed.

Secure the transceiver to the mount plate using the 1/4"-20 bolts, and lock washers (20).

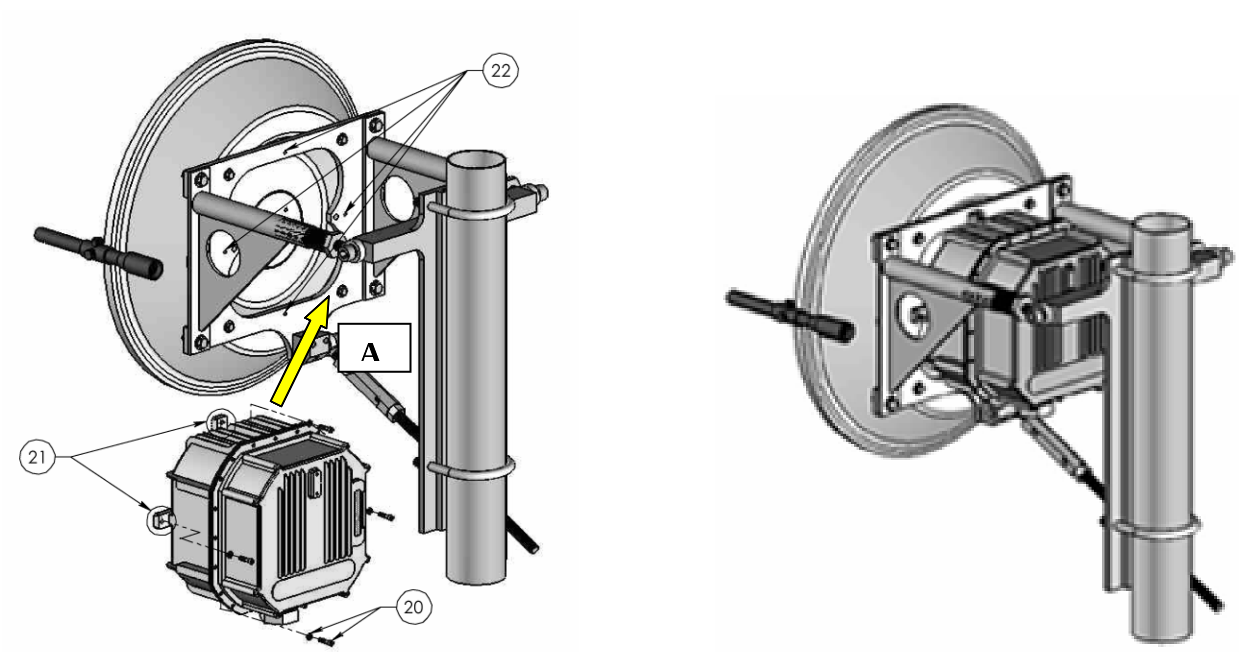

Figure 7. Attaching Transceiver to Steering System.

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2.7 Cabling to the Radio (see Figure 8)

Before proceeding to the alignment of the link, the installer must complete the fiber, AC power and Ethernet connections to the radio. Typically this will be carried out by passing the associated cables thru a 1" diameter industry standard liquid-tight conduit from a demarcation box to the radio.

Note: Make the network and power connections to the radio by removing the rear cover from the radio to reveal the service compartment as shown in Figure 8.

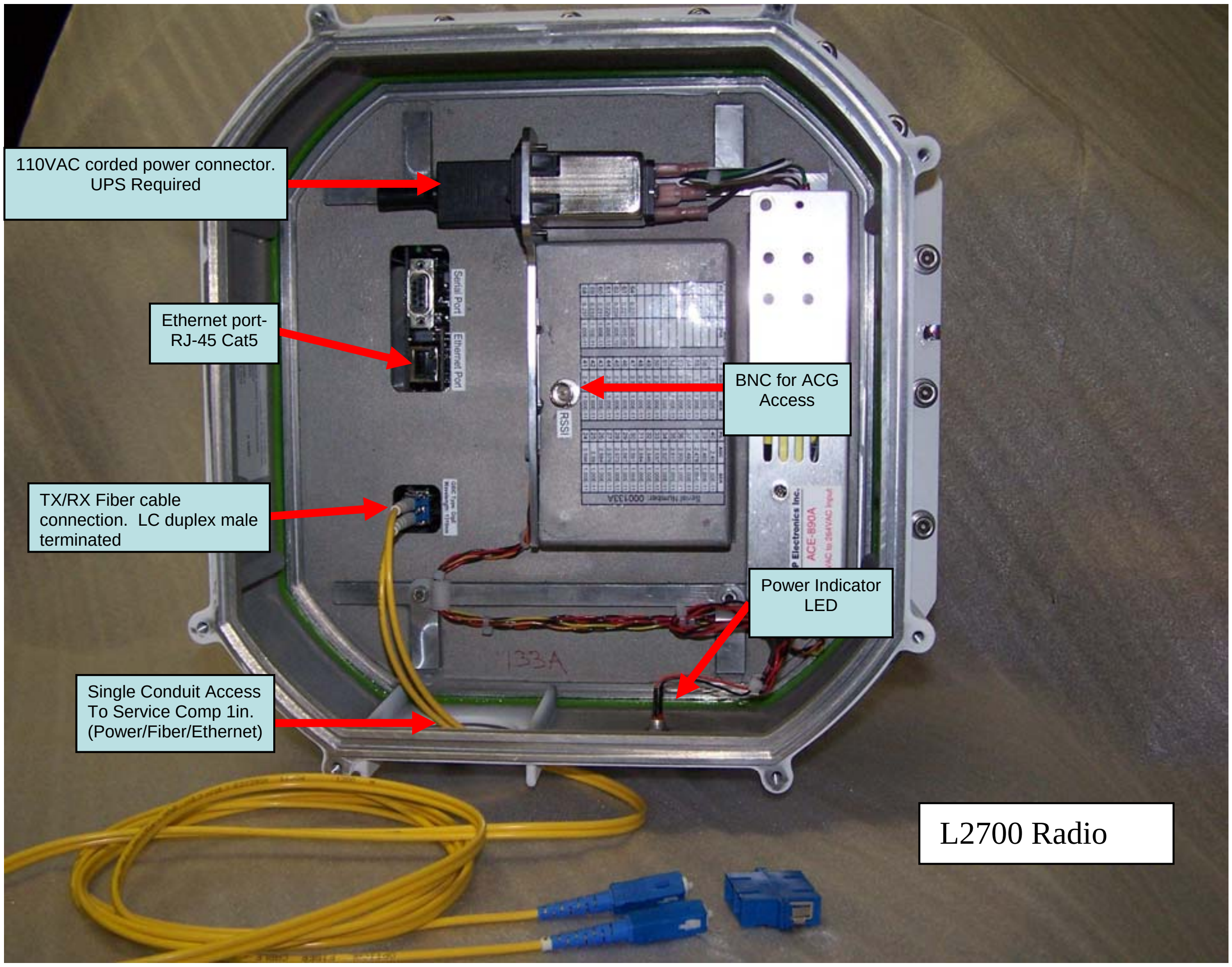

Figure 8. Inside Radio Service Compartment

Begin by first passing the AC power cord (without connector) thru the conduit before attaching a female AC power connector to the radio side of the power cord. Once the power cord has been pulled thru, attach the female AC power connector (Fig.9) to the AC power cord. Then connect the power cord to the AC plug located in the service compartment (see Fig 8).

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Figure 9 Female AC Power Receptacle

Note: The Loea transceiver's standard configuration requires an 110V (nom) AC connection with transient conditioning via an Un-interruptible Power Supply (UPS). Cyber Power's CPS625AVR or equivalent must be used and is to be supplied by the customer.

An optional telecom -48 Volt DC power supply is also available. If using the -48 volt Option for power, with the power off, connect the RG6U cable supplied by Loea to the radio and connect the other end to the demark box as shown in Figure 10. Figure 11 depicts the view from inside the service compartment.

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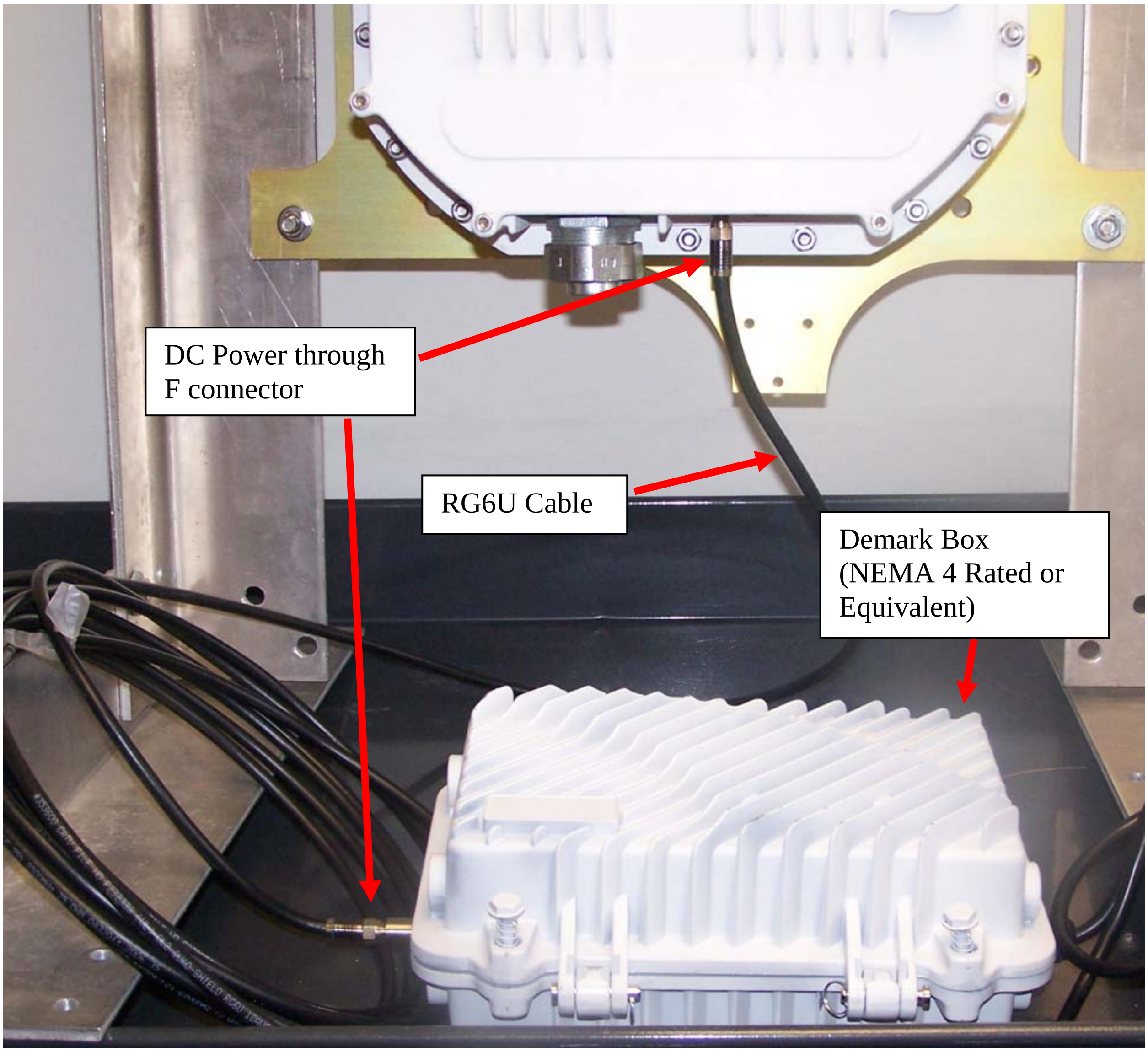

Figure 10. Example of DC Power Connection using RG6 Cable.

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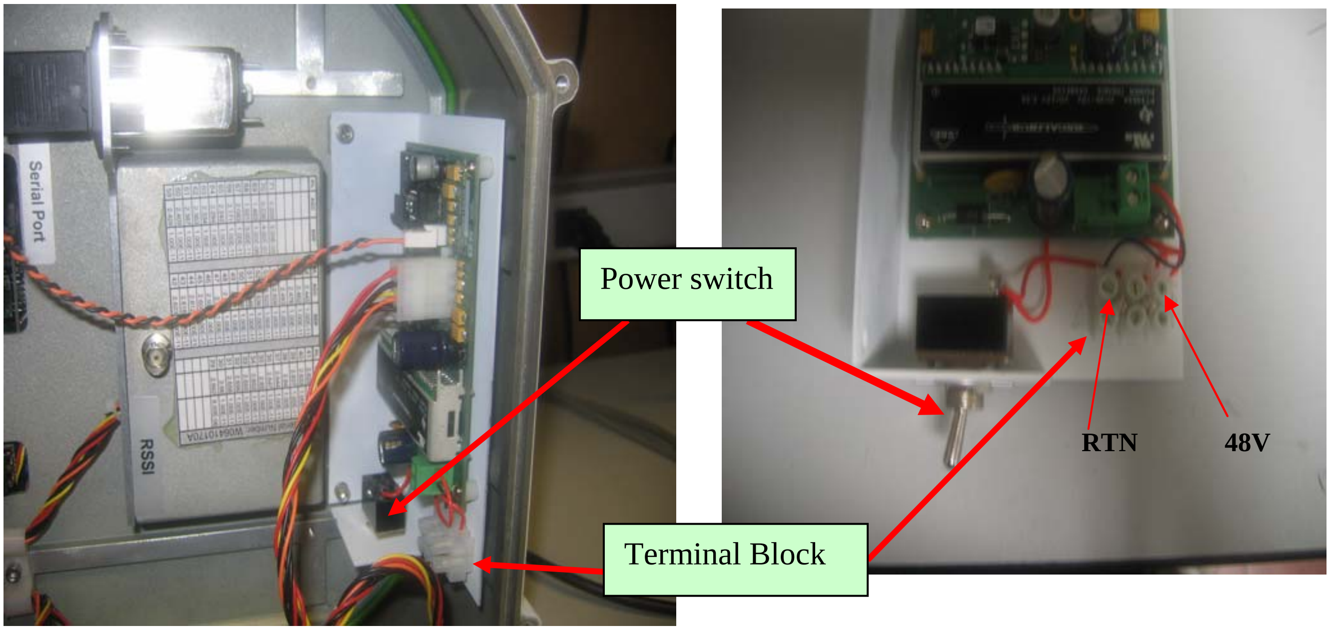

Figure 11. Inside the Radio Service Compartment

<u>Fiber Signal interface</u>: A duplex male LC terminated fiber optic connection is the standard interface inside the L2700 radio. For applications using the Gigabit Ethernet standard, it is recommended the customer use Single Mode 1310nm. Multimode 850nm fiber is available as an option but is not recommended due to the limited temperature and distance performance of Multimode fiber and related components. For the OC-12 standard, it is required that the customer use Single-mode 1310nm fiber.

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A graphic showing the required LC fiber connector to be used is shown in Fig. 12.

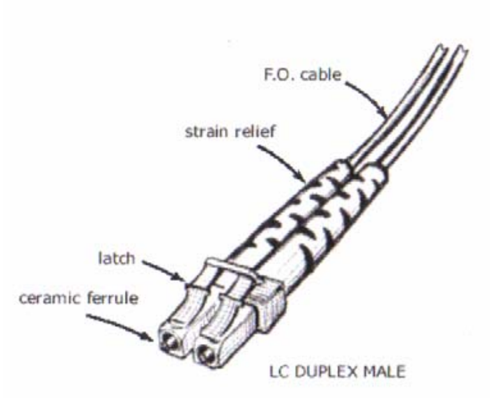

Figure 12: Typical LC Duplex Male Connector

The fiber connector will mate with the GBIC located in the service panel as shown in Fig.8. A typical pluggable GBIC is shown in Fig. 13. Do not attempt to remove the GBIC unless instructed to do so by a Loea engineer.

Figure 13: Typical Pluggable GBIC

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The optical interface specifications for the Single Mode GBIC and Multimode GBIC connections are shown in Table 2a and 2b respectively.

Optical Specifications	Min	Typ	Max	Unit
Transmitter				
Output Opt. Power	-9.5		-3	dBm
Optical Wavelength	1270		1360	nm
Spectral Width			3	nm
Receiver				
Average Rx Sensitivity @ 1.25 Gb/s (Gigabit Ethernet)			-22	dBm
Average Received Power			0	dBm
Optical Center Wavelength	1265		1600	nm
General Specifications				
Data Rate	1062		2125	Mb/sec
Bit Error Rate			10^{-12}	
Max. Supported Link Length on 9/125um SMF @ Gigabit Ethernet		10		Km [1]

Table 2a: Single-mode Fiber Optic Interface Specification

Note
1. Attenuation of 0.55 dB/km is used for the link length calculations. Please refer to the Optical Specifications above to calculate a more accurate link budget based on specific conditions in your application and the L2700 User's Manual prior to connecting to the network to ensure that optical power is in the proper range based on the specifics of the installation.

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Optical Parameters	Min	Typ	Max	Unit
Transmitter				
Output Opt. Power	-9		-3.5	dBm
Optical Wavelength	830		860	nm
Spectral Width			0.85	nm
Receiver				
Average Rx Sensitivity @ 1.0625 Gb/s		-22	-20	dBm
Average Received Power			0	dBm
Optical Center Wavelength	770		860	nm
General Parameters				
Data Rate		1062		Mb/sec
Bit Error Rate			10^{-12}	
Max. Supported Link Length on 50/125um MMF		550		m

Table 2b: Multi-mode Fiber Optic Interface Specification

A demarcation box must be provided by the customer in accordance with a site survey which must be conducted prior to any attempted installation. The demarcation box should be located no further than 15' away from the base of the radio installation or as specified in the site survey report.

After all connections have been made the power switch should be turned ON at the AC or DC connection located in the service compartment. The 'red' LED located on the outside of the radio will turn on indicating the unit has power. The user should wait a minimum of 10 minutes before making RSSI measurements to allow the unit to warm up.

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2.8 Interfacing to RSSI Port (see Figure 14)

The RSSI (Received Signal Strength Indicator) voltage is a measure of received signal strength which will be used to assess alignment. To measure the RSSI voltage, remove the service compartment cover (G) of the Loea transceiver (see Figure 14). In the service compartment is a BNC connector (J). Connect a Fluke DMM Series 77 or similar to the BNC connector and note the RSSI mV reading. The chart (H) pasted to the flat surface to which the BNC connector is mounted will provide an indication of the correlation between mV and dB of link margin.

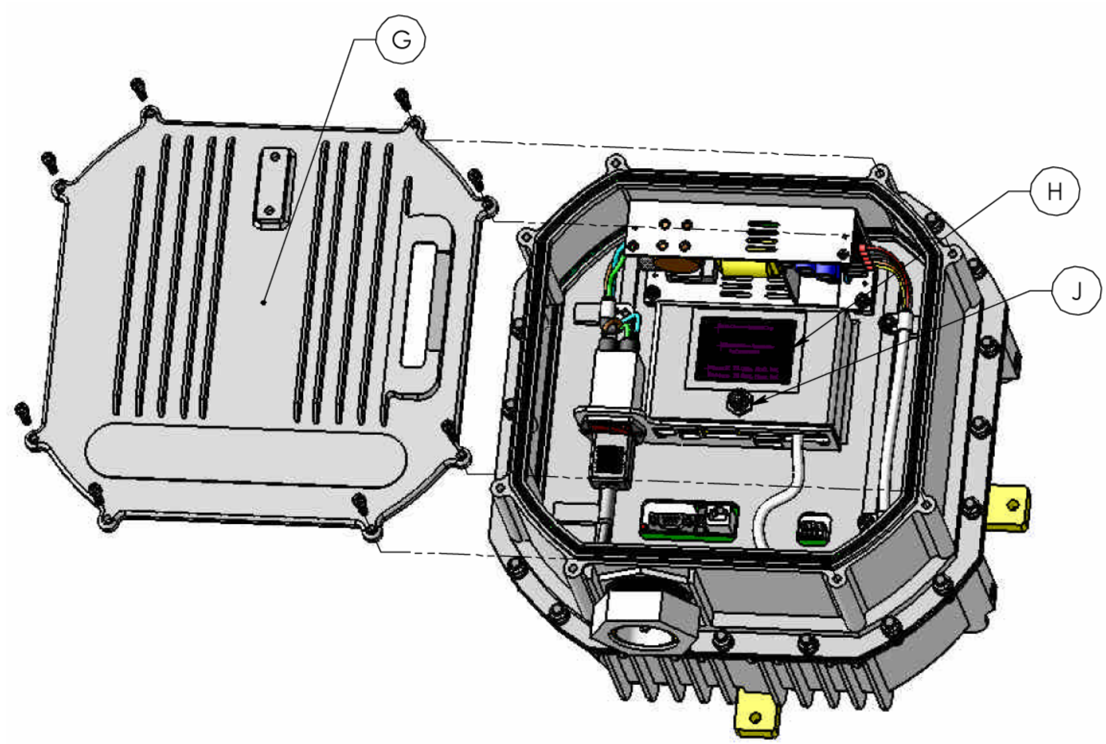

Figure 14. Radio Rear Cover Removed Showing Service Compartment.

For each RSSI (in mV) reading there is an equivalent link margin reading (in dB). An example of the Chart is shown in Figure 14. By fine-tuning the alignment, try to get the RSSI voltage within +/-5dB of the link margin specified in your final proposal and/or site survey report provided by a Loea certified engineer.

P/L	RSSI	BER		P/L	RSSI	BER		P/L	RSSI	BER	Serial Number:
				67	0.65	1.00E-11		50	2.45	1.00E-11	
				66	1.763	1.00E-11		49	2.465	1.00E-11	
				65	1.98	1.00E-11		48	2.478	1.00E-11	
				64	2.085	1.00E-11		47	2.492	1.00E-11	
				63	2.152	1.00E-11		46	2.505	1.00E-11	
				62	2.198	1.00E-11		45	2.517	1.00E-11	
				61	2.233	1.00E-11		44	2.527	1.00E-11	
				60	2.261	1.00E-11		43	2.537	1.00E-11	
				59	2.285	1.00E-11		42	2.546	1.00E-11	
				58	2.307	1.00E-11		41	2.554	1.00E-11	
74	0.226	1.00E-05		57	2.327	1.00E-11		40	2.561	1.00E-11	
73	0.227	5.00E-08		56	2.345	1.00E-11		39	2.567	1.00E-11	
72	0.228	1.00E-10		55	2.363	1.00E-11		38	2.573	1.00E-11	150
71	0.229	1.00E-11		54	2.381	1.00E-11		37	2.579	1.00E-11	
70	0.231	1.00E-11		53	2.399	1.00E-11		36	2.584	1.00E-11	
69	0.233	1.00E-11		52	2.417	1.00E-11		35	2.59	1.00E-11	
68	0.237	1.00E-11		51	2.434	1.00E-11		34	2.596	1.00E-11	

Figure 15. Typical RSSI Chart .

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2.9 **Alignment Techniques** (see Figure 16)

The alignment process for a Loea link is performed manually and requires two people, one at each end of the link. The Loea steering assembly has vertical (V) and horizontal (H) tuning bars along with a scope mounted on the side of the antenna for fine alignment.

General coarse alignment is achieved by first using the scope to obtain visual alignment of the opposite antenna. The U-bolts (U) are loosened slightly to enable rotation of the steering assembly around the pole.

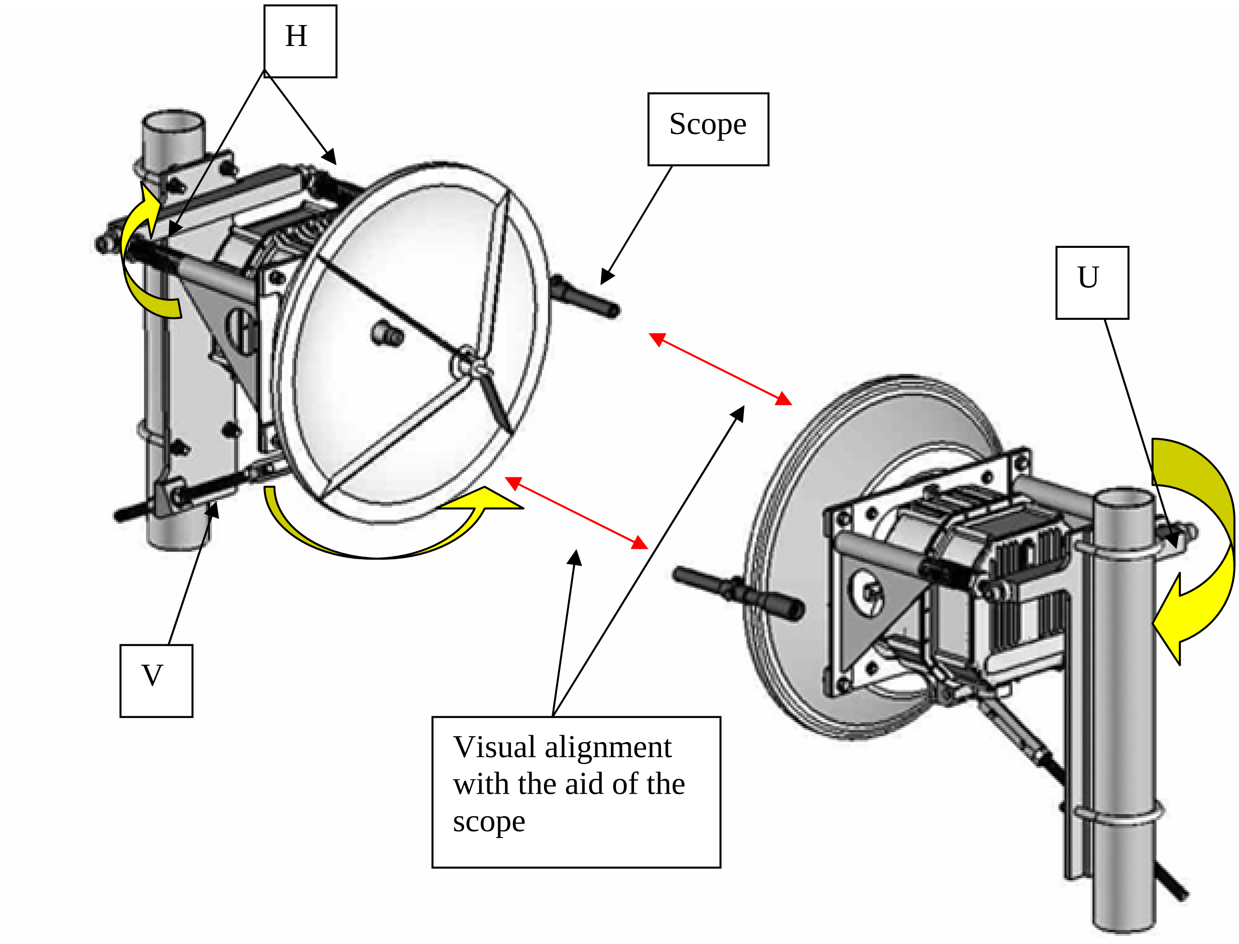

Figure 16. Alignment Technique.

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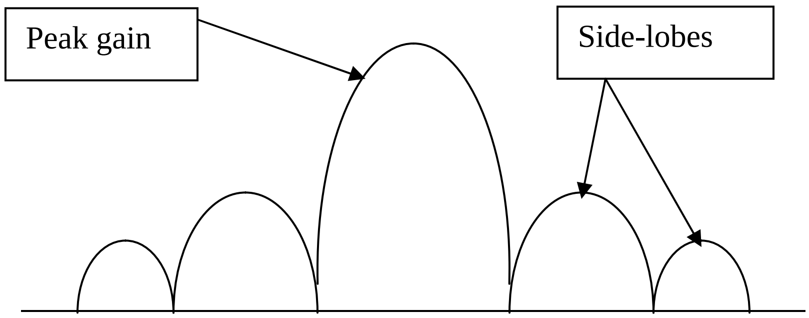

Figure 17. Antenna Pattern with Side Lobes.

Once coarse visual alignment is complete, use a Fluke Digital Multi-Meter (DMM) Series 77 or similar and connect it to the RSSI port. Begin the peaking of the link by using the following method:

Using the steering assembly to adjust the Azimuth and Elevation, the scope on the antenna to track position visually and the RSSI reading to fine tune, sweep the dish slowly over a pre-determined pattern. For example, begin with a coarse optical alignment slightly off to one side and elevated. Sweep across the location where the RF path should be to the opposite side of the expected RF beam and then come down slightly in Elevation, sweep back to the original side and repeat. Look for a peak in the RSSI value and continue until RSSI is peaked on one end.

Apply the above peaking method in the following manner to the link:

- Peak radio at end A of link
- Repeat at end B of link
- Repeat again at end A of link
- Repeat at end B of link if necessary.

Once the installer is satisfied that the link has reach a peak level, each radio, one at a time, should be adjusted one last time off the main beam roughly 1 full rotation clockwise and ant-clockwise of the fine adjustment bars in the vertical and horizontal direction. If no greater peak is found then it is likely that the alignment is optimal. Ensure the adjustment bars are locked in place. Proceed to section 2.10.

2.10 Verification of Bit Error Rate (BER)

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Verification of Bit Error Rate (BER) is achieved by using a fiber optic line tester to validate the L2700. Typical fiber line testers can verify the protocol (Gigabit Ethernet or OC-12 SONET), bandwidth, and optical signal quality in addition to BER ensuring a properly working link. Using a BER tester, the installer must verify that the TX optical power level from the network and radio at each end of the link are within the GBIC specifications given in Table 2a and 2b. If the measured values are found to exceed these levels the installer must call Loea or insert appropriate optical attenuators to bring the optical levels back into specification prior to making the final fiber optic connection. The installer must record these measurements in the fiber information section of the "Loea Field Service Data" report given in Appendix A.

Loea installers use the Sunrise Model # Sunset MTT-C Chassis with module MTT-29B for Gigabit Ethernet link testing. This includes 1310 patch cords and an optics container. For OC-12 links the Sunrise Model # SSOCx is recommended which provides DSO Drop and Insert, FT1 and a Data Storage Card.

2.11 Final System Commissioning

Run the BER test for 30 minutes. If the BER is approximately 10^{-10} and a RSSI reading within and +/-5dB of the expected value in the Site Survey, the system is now ready to be integrated into your network. After integration into the network the BER for the system should be greater than 10^{-6}. If this is not the case contact a Loea engineer.

Ensure that the back cover of the L2700 is fastened down and that the lock nuts on the Azimuth and Elevation arms have been tightened. Finally, make sure the conduit has been secured to the l2700 and that the demarcation box has been properly sealed.

Prior to leaving the site, please complete a copy of the "Field Service Data Report" found in Appendix "A", save a copy for yourself and send a copy to Loea.

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3. Systems Integration

3.1 Standard System Demarcation Box Requirements

The Loea L2700 Transceivers will be provided with standard cable connections for a demarcation box. The demarcation box is the key interface between customer premise equipment and the radio. In the cases of system repair and diagnostics, should a Loea system problem be reported, it can be isolated from the user's physical plant at this demarcation point to help isolate the problem. The demarcation box will be installed prior to Loea system installation per the requirements stated in the site survey and must provide the following connections:

- 90-130 VAC, 60 Hz from UPS.
- Fiber-optic connection (Communication Signal)
- RJ45- CAT5 10/100baseT Ethernet (SNMP interface).
- -48 Volt supply is available (optional).
- Cabling is required from the batteries or power supply.
- Enclosure must be weather proof and is recommended to comply with NEMA4 standards.

3.2 Basic Information on Loea Interface

The Loea transceiver operates at the Physical Layer (Layer 1) of the OSI network stack. Loea's system will appear to be a fiber cable.

The transceiver has three connections as follows:

1.) Signal interface: At the radio, an LC fiber optic connector is the standard interface. Single Mode 1310nm is recommended for most applications. The L2700 has a Multimode 850nm option which may be used in some cases; please consult Loea for more information.
2.) An 110V (nom) AC connection with transient conditioning via an Un-interruptible Power Supply (UPS) Cyber Power's CPS625AVR or equivalent must be used.
    a. The optional DC power configuration requires a -48V DC connected with an F connector and RG6 coax cable.

NOTE: Without a UPS the FCC license and Product WARRANTY will be VOIDED.

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3.) The Ethernet connection is for Link monitoring. Because the transceiver can be viewed as a network element, there is a standard RJ-45 connection for SNMP.v3 access.

The Loea system is OSI Layer 1 (physical layer) and it will interoperate with most commercial off the shelf (COTS) switches, routers and encryption devices. For further information on tested devices please contact Loea.

3.3 Link Monitoring

The L2700 series operates SNMP v.3 (factory default) or SNMP v.1

3.3.1 Network Management System Operation

The L2700 radio links are configured, operated and monitored through the SNMP interface by using a SNMP based Network Management System (NMS) and an SNMP agent in the L2700 radio. Each L2700 radio can send SNMP traps to the NMS over the RJ-45 Ethernet port located on the back of each radio. At this time Loea does not have its own element manager application.

Workstation

The NMS workstation manages all L2700 uniquely assigned IP addresses. See Appendix C for an example on how to install the L2700 MIB using an off-the-shelf NMS application. The workstation also provides a graphical display of the network objects showing the status, performance and configuration parameters. The SNMP interface also allows operators real-time notification of radio problems.

Agent

The SNMP local agent is a standard MIB-II compliant software module that resides in each L2700 radio. The agent collects information from different L2700 components internal to the radio as defined in the Management Information Base (MIB) structure. The L2700 incorporates a private MIB. See Appendix B for details of the L2700 MIB and the associated variable descriptions.

3.3.2 NMS Data Transfer

The NMS data transfer between the manager (Workstation running the NMS application) and the SNMP agents (Radios) is accomplished using either polling or trapping techniques.

Polling
The NMS polls each L2700 SNMP agent at specific intervals. These are set according to user requirements during SNMP NMS configuration.

Traps
The L2700a agent sends an SNMP trap to the manager whenever a predefined event occurs. Groups of traps can be defined according to their level of severity. The operator can choose to enable or disable any traps or group of traps according to their level of severity (and his or her own security level).

3.4 RS-232 Serial Link Interface

The RS-232 interface provides an access port for a craft terminal used by installation or maintenance personnel.

The RS-232 port is located in the service compartment of the radio (See Figure 8). A laptop computer running HyperTerminal communicates with the radio via ASCII commands. The RS-232 port offers different menu options to locally configure the radio.

After connecting a laptop PC to the RS-232 port on the radio, press 'ENTER' on the PC keyboard and the screen in Figure 16 will appear showing the Main Menu. From this menu only two of the options will be available to the end user. They are option I and S. These two options will enable the following to be performed by the end user:

a) Set or Read IP address
b) Set or Read SNMP v1 ON or OFF
c) Set Read community string
d) Set Write community string

The rest of the options in the Main Menu (A, D, M, P, R and T) are reserved for the exclusive use of those certified to perform field diagnostics.

THIS PORT SHOULD ONLY BE USED BY A CERTIFIED LOEA TECHNICIAN, AND ANY UNAUTHORIZED USE OF THE RS232 CRAFT TERMINAL WILL VOID THE WARRANTY.

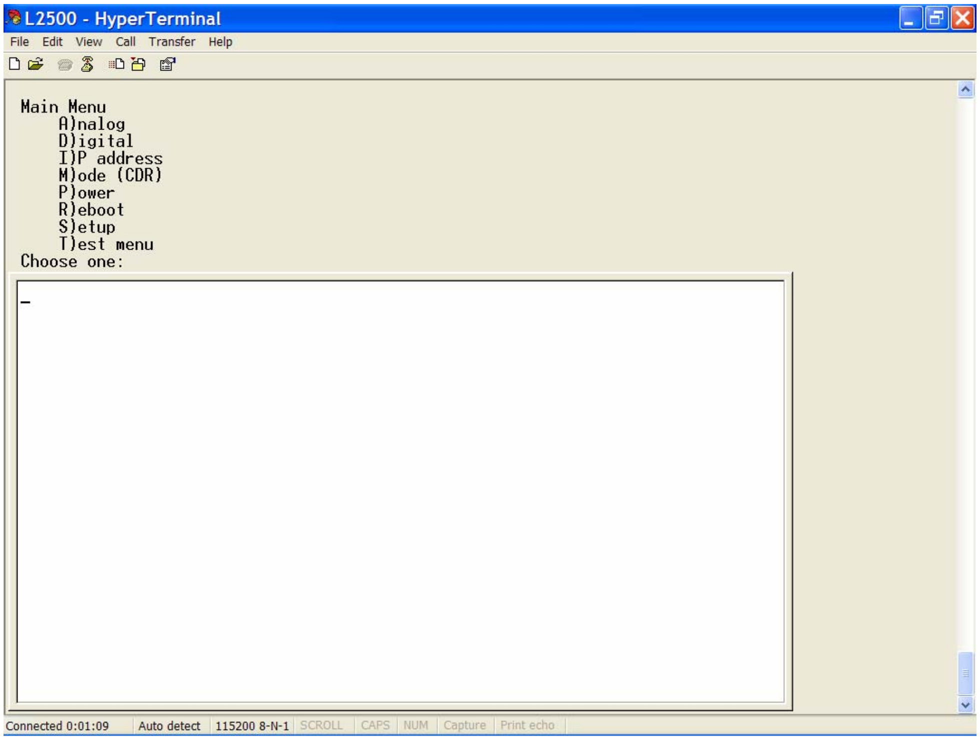

Figure 17. Main Menu as shown in (Windows) HyperTerminal.

Note that commands appearing in the white background pane reflect the active window. The commands in the beige background flow from the active window (white background) and are historical.

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Option I:

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Selecting this option allows one to Set or Read the IP address for the radio (Figure 18). To Set the IP address perform the following steps:

i) Reboot the NetBurner, by cycling power off and on
ii) Within 2 seconds, press A (capital A)
iii) Type 'setup'
iv) Press 1, then Enter
v) Enter the new IP address
vi) Press s, then Enter
vii)Answer y to the question
viii) The NetBurner will reboot with the new address …………………..

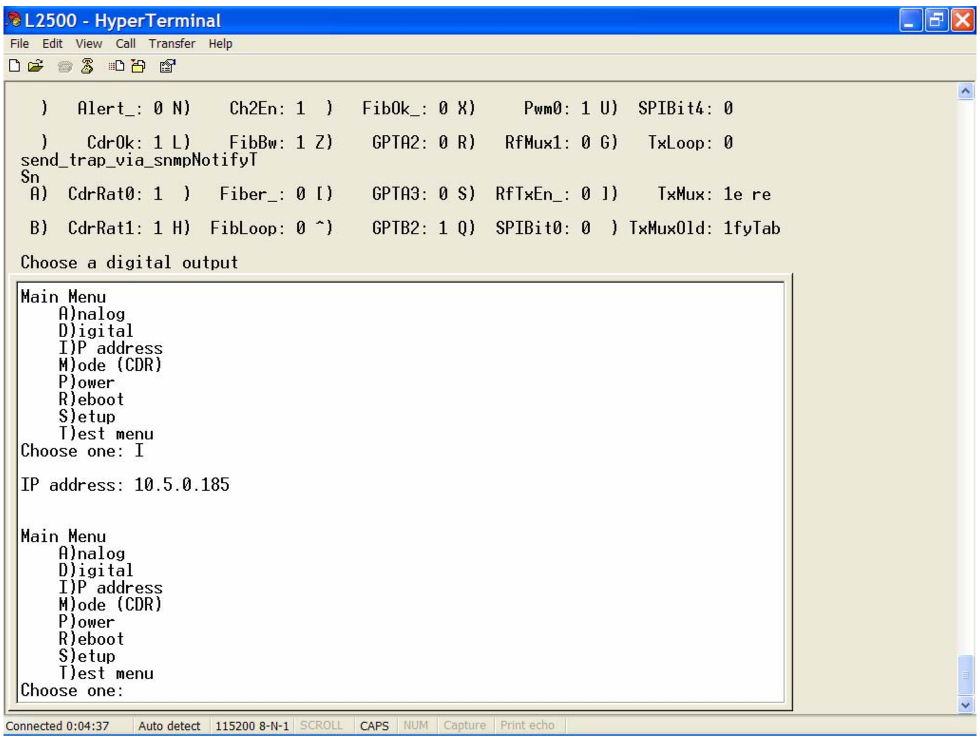

Figure 18 Main Menu option I shows IP address for radio.

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Option S:

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Selecting this option brings up the Setup Menu (Figure 19). Only the v), R) and W) options can be modified by the end user.

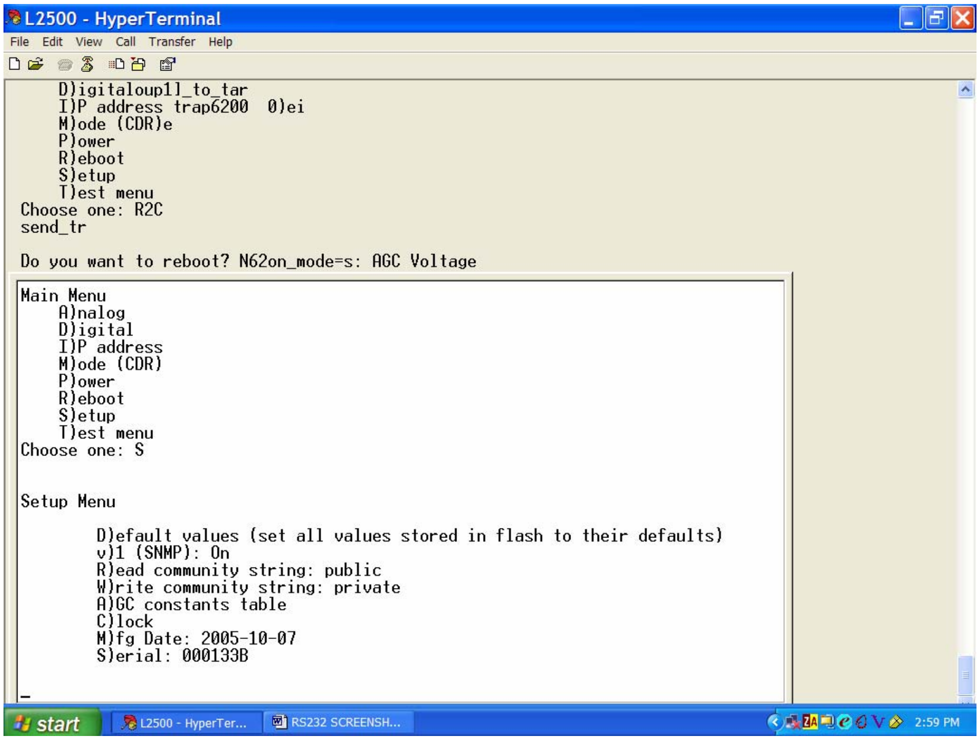

Figure 19. Main Menu option S with Setup Menu options.

Selecting Setup Menu option:

V)Toggles the SNMP version 1) between ON or OFF. If toggled OFF then SNMP v3 is configured and a password will need to be entered.
R) Sets the read community string.
W) Sets the write community string.

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3.5 Grounding Procedures

3.5.1 Single Point Grounding

The majority of surge arrestor devices are installed in shunt between the line and ground, which can be either an earth ground or the power line neutral, which is in turn connected to ground. Thus, the quality of the ground connection is as important as the surge arrestor itself, which can only operate if it has someplace to send the surge. Equally as important as the quality of the ground connection is the topology of the connection itself.

Most system installations have many pieces of interconnected equipment, all of which require grounding. If each device has a different path to earth ground, voltage differentials will develop between these grounds, and currents will flow between them resulting in Electromagnetic field across Transmitting device. In the event of a high rise-time surge, the currents tend to act in a conductor more like AC than DC. The currents will oscillate inside a conductor as damped wave at a frequency in the RF region. Further, it results in harmonics and Electromagnetic Interference.

There are three methods generally accepted to reduce the inductance and equalize ground voltages in a system installation:

1. Make all connections to ground as short and straight as possible, to reduce the inductance to a minimum.

2. Use large cross-section conductors to maximize the current carrying capacity in consideration of the skin effect, such as copper strap or large cross-section multiple-strand cables.

3. Use a single point grounding system to avoid circulating currents caused by multiple ground connections.

This last point requires more explanation.
If a piece of equipment is grounded at more than one location, utilizing different paths that eventually connect to earth ground, differences in potential may develop between the two connections for the reasons just discussed. These grounds will attempt to equalize themselves, resulting in a current passing through the equipment itself. Further, standing waves can be established in the loop formed between the two pieces of equipment, their connections and the ground itself, resulting in circulating currents which can damage the equipment or impede its proper operation.

In a single point ground system, only one ground reference is established in a system, which is well bonded to an earth ground.

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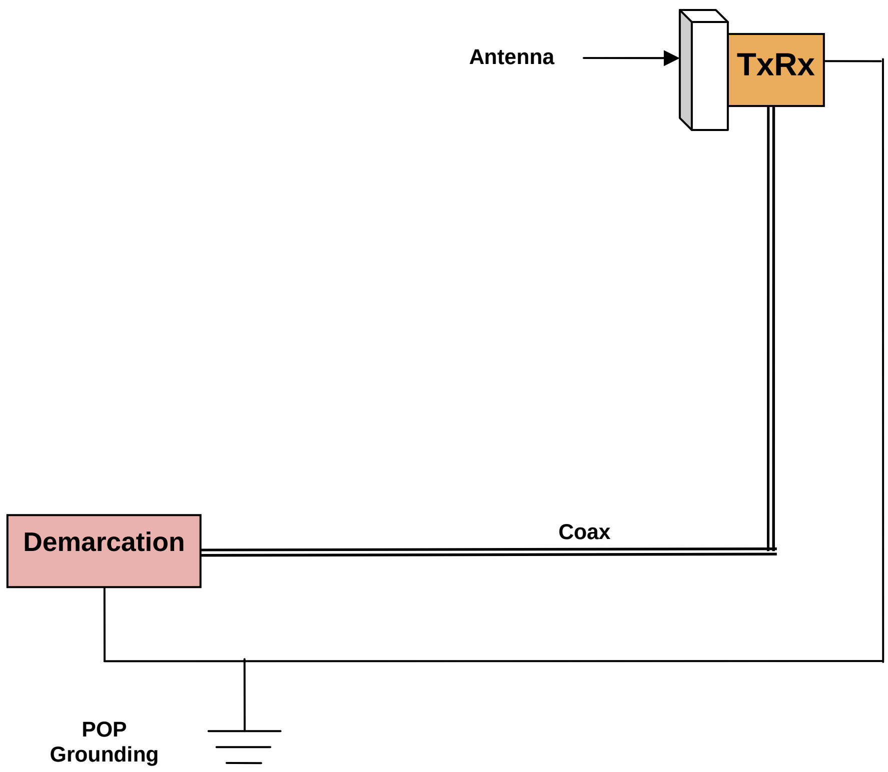

Figure 20. Single point grounding

The single point ground is an important part of reducing noise generated by RF via the grounding system or return line.

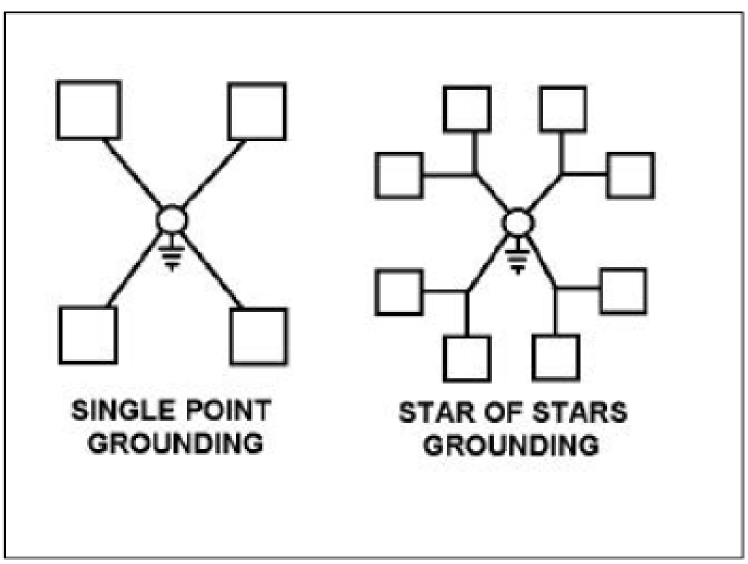

Figure 21. Two Methods of Single Point Grounding

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All ground connections branch out from here so that there is only one ground path for each piece of equipment. This method eliminates the possibility of ground loops and equalizes the ground voltage differentials within the system. The single point ground system is also sometimes referred to as a "star" grounding system. Larger systems can be connected using what is called a "star of stars" system.

Even if a piece of equipment has been protected by a surge arrestor and is connected to a proper earth ground, the problem is only partially solved. Presuming that the equipment the arrestor is protecting is also grounded, not all the surge current will flow through the arrestor – some of the current will still pass to ground by means of the other path going through the equipment. If we want to maximize the current flow through the surge arrestor and minimize the current through the equipment, we do this by lowering the inductance of the path through the arrestor as much as possible.

3.5.2 Rack Cabinet Grounding

The single point grounding technique can also be effective to protect multiple pieces of equipment installed inside an equipment rack cabinet. Treat the rack the same as you would a building, and mount a panel on the cabinet to act as both an entrance panel and reference ground for all conductors entering and leaving the rack. Install AC surge protectors at this point in shunt to ground, and install series impedance between the panel and the equipment. Don't count on the metal cabinet itself to serve as a ground conductor – paint and oxidation may conspire to prevent a good connection. A copper strap should be run along the inside of the cabinet, bonded to the cabinet along its length, and also bonded to the access panel. The chassis of each piece of equipment is then bonded to this buss bar with a single copper braid or strap. Finally, connect the rack's access panel to the building reference ground.

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3.5.3 An Effective Earth Ground

Once all connections have been made to the master ground point in the building, it must be bonded to an effective earth ground system outside the building.

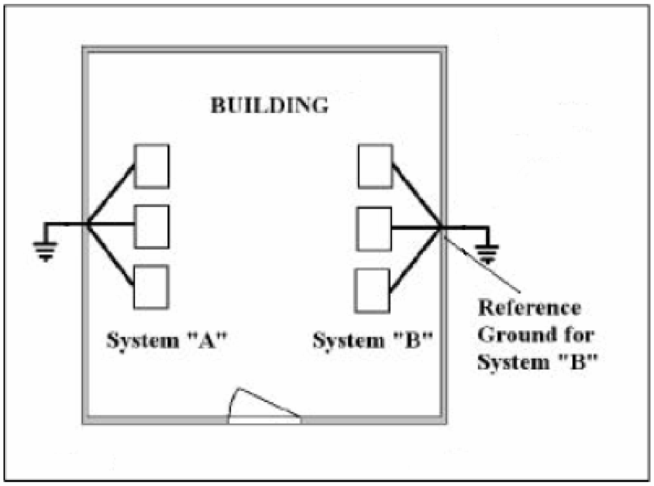

Figure 22. Earth Ground

Four inch or larger copper strap is recommended, with short, straight connections. Corrosion will dramatically increase the resistance of a connection; so use silver soldering or cad welding for all connections exposed to the weather.

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3.5.4 At the Tower

The following are some of the important steps to be taken at the base of a tower to maximize protection against a lightning strike:

1. Tack weld all tower sections together running down at least at one leg, to provide corrosion free electrical continuity to ground.

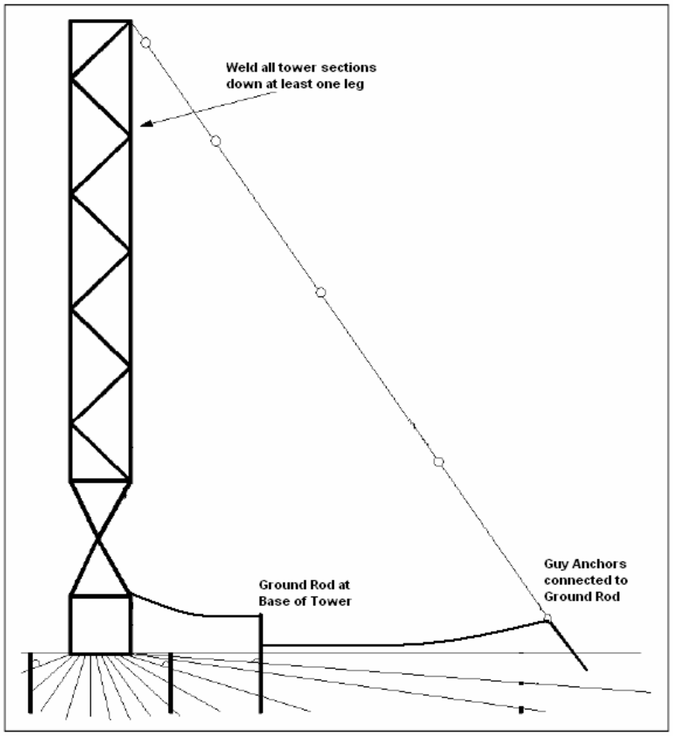

Figure 23. Tower Ground

2. Drive four or more ground rods at ten-foot intervals around the base of the tower, and ground these to the tower.

3. Connect all the guy wire anchors to the Ground with a short jumper cable.

4. Use 16 AWG minimum and 6 AWG maximum insulated copper conductor. Typically, 10 AWG is the nominal size used in most installations.

5. National Electric Code (NEC) Chapter 8 on "Communication Systems" covers general requirements for grounding, bonding and protection of low-voltage communications equipment.

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3.5.5 Conclusion

Unpredictable and intermittent data loss and outright system failure can result from a transient. To help ensure the safety and operation of sensitive telecommunications equipment, as well as the safety of personnel. The electrical contractor should install an effective grounding system that will circumvent such disturbances. To ensure effective equalization, the telecommunications ground should be directly attached to the electrical service ground. However, an electrode such as a ground rod or other grounding electrode system can be used when no electrical service is present.

This article offers a brief explanation of how to install a telecommunications grounding system. To help better understand the schematics of telecommunications grounding, consult ANSI/EIA/TIA 607 that covers grounding and bonding requirements for telecommunications applications in commercial buildings. Other important standards to consider include EIA/TIA 568-A and 569-A, which, as a set, are Telecommunications Building Wiring Standards. In addition, the National Electric Code (NEC) Chapter 8 on "Communication Systems" covers general requirements for grounding, bonding and protection of low-voltage communications equipment. Chapter 2 and Article 250 discuss grounding requirements. The Canadian Electrical Code (CEC) and other national and local safety codes also should be consulted where applicable.

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Appendix A - Field Service Form

	Loea Field Service Data	**Page: 1 of 1**

To be filled by the Field Service Engineer

Product:	Link Serial #:	Date of Service:	Servive Type:	Customer:	Charge #:

B Radio	A Radio
Location: ***Lattitude:*** ***GPS Coordinates:*** ***Altitude:*** ***Antenna:*** ☐ ***4ft*** ☐ ***2ft*** ☐ ***Other:*** ***Mast Type:*** ☐ ***Tripod*** ☐ ***Wall Mount*** ☐ ***Tower:*** ☐ ***Other:*** ***Height Off Ground:*** ***Extension Beyond Highest Point:*** ☐ ***No*** ☐ ***Yes: ____ft***	***Location:*** ***Lattitude:*** ***GPS Coordinates:*** ***Altitude:*** ***Antenna:*** ☐ ***4ft*** ☐ ***2ft*** ☐ ***Other:*** ***Mast Type:*** ☐ ***Tripod*** ☐ ***Wall Mount*** ☐ ***Tower:*** ☐ ***Other:*** ***Height Off Ground:*** ***Extension Beyond Highest Point:*** ☐ ***No*** ☐ ***Yes: ____ft***

Link Information

Standard: ☐ ***GigE*** ☐ ***OC-12*** ☐ ***Other:***
Link Distance (km):

B Radio	*A Radio*
IP Address: ***Path Loss (dB):*** ***RSSI (mV) Estimated:*** ***RSSI (mV) Actual:*** ***BER Bench:*** ***BER Field:***	***IP Address:*** ***Path Loss (dB):*** ***RSSI (mV) Estimated:*** ***RSSI (mV) Actual:*** ***BER Bench:*** ***BER Field:***

Fiber Information

Fiber Tx Power from B Radio: .... dBm **Fiber Tx Power from Network (B side):…………dBm**	**Fiber Tx Power from A Radio: .... dBm** **Fiber Tx Power from Network (A side): …………dBm**

Fiber Type: ☐ **850nm (MM)** ☐ **1310nm (SM)** ☐ **Other:**
Termination: ☐ **LC** ☐ **SC** ☐ **Other:**

Input Power

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Distance to DEMARC: **Protection:** ☐ **Surge** ☐ **Conditioner** ☐ **UPS** ☐ **None**	
Conditions	
Temperature:	**Relative Humidity**
Wind Direction:	**Wind Speed:**
Atomspheric Cnditions ☐ **Clear** ☐ **Rain** ☐ **Snow** ☐ **Fog**	

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Appendix B – List of SNMP MIB Groups

Glossary
In this Appendix the following terms are used with these specific meanings:

SNMP - Simple Network Monitoring Protocol.
Radio - L2700 series radio
NMS - Network Monitoring Station. (Computer/software application for monitoring).
MIB - Management Information Base (SNMP variables applicable to the L2700)
OID - Object Identifier

Types of SNMP Operations
SNMP information can be described as:

- Query/response: Where the NMS sends a query to the radio, and the radio responds with the appropriate information.
- Trap: Where the radio reports a threshold exception to the NMS.

MIB
The L2700 supports MIB-II, as well as variables specific to each radio model. There are three MIB-II variables

Name	Type	Access	Description
sysContact	String (0..255)	Read only	Name of person to contact about this radio
sysName	String (0..255)	Read only	Name of the radio – this is usually the fully qualified domain name for this radio
sysLocation	String (0..255)	Read only	Location of this radio

The radio-specific SNMP variables are divided into groups. Each group represents one type of variable.

The OID of each radio-specific group starts with 1.3.6.1.4.1.1.11095.1.1. The OID column in each table below contains the final two integers in the full OID for that variable.

System Group (lcSysGroup)
Contains information that identifies the radio:

Name	OID	Type	Access	Description
lcSysModel	.1.1	String (0..5)	Read only	Radio model number, L2700
lcSysSerial	.1.2	String (0..6)	Read only	Serial number
lcSysMfgDate	.1.3	String (0..9)	Read only	Date of manufactured, YYYY-MM-DD
lcSysVer	.1.4	String (0..5)	Read only	Firmware version

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Internal Group (lcIntGroup)
Contains information pertaining to the health of the radio, including voltages and currents:

Name	OID	Type	Access	Description
lcInt5V	.2.1	Integer	Read only	Voltage of 5V supply, in mV
lcInt33V	.2.2	Integer	Read only	Voltage of 3.3V supply, in mV
lcIntTemp	.2.3	Integer	Read only	Temperature of radio, °C
lcInt5AP	.2.4	Integer	Read only	Current of 5V supply to Power Amp, in mA
lcInt5AF	.2.5	Integer	Read only	Current of 5V supply to other boards, in mA

Fiber Group (lcFibGroup)
Contains information that pertains to the fiber link:

Name	OID	Type	Access	Description
lcFibSFPPresent	.3.1	Integer	Read only	1 = SFP module is installed
lcFibSignalPresent	.3.2	Integer	Read only	1 = fiber signal detected
lcFibSignalStrength	.3.3	Integer	Read only	If SFP module supports digital diagnostics, and a fiber signal is detected, this is fiber signal strength, in dBm, otherwise -100
lcFibCDRLock	.3.4	Integer	Read only	1 = Fiber CDR locked
lcFibDataRate	.3.5	Integer	Read only	If rate is manually set, or if automatic and a rate has been detected, this is that rate in MBPS, otherwise 0
lcFibTxOn	.3.6	Integer	Read only	1 = Fiber transmitter on

RF Group (lcRFGroup)
Contains information that pertains to the RF link:

Name	OID	Type	Access	Description
lcRFAGCV	.4.1	Integer	Read only	RSSI voltage, in mV
lcRFPathLoss	.4.2	Integer	Read only	Path loss implied by RSSI voltage, in dB

Trap Control Group (lcTCGroup)
This group defines the thresholds and other controls which are used to control traps. For each analog signal, there is an enable control, a high value, and a low value. If the enable is set to 0, this signal is ignored. If enable is set to 1, then this analog signal is compared to both the high and low values. If it is goes from inside a range to outside, or from outside the range to inside, the corresponding trap is generated. For each digital signal, a trap is generated each time that signal changes state.

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Name	OID	Type	Access	Description
lcTCDestination	.5.1	IP addr	Read only	Address to which traps are sent (if 0.0.0.0, no traps are sent)
lcTCAliveInterval	.5.2	Integer	Read-write	Interval in seconds between sending lcTrapAlive
lcTCFiber	.5.3	Integer	Read-write	Fiber signal strength trap enable
lcTCFiberHi	.5.4	Integer	Read-write	High limit of fiber signal strength, in dBm
lcTCFiberLo	.5.5	Integer	Read-write	Low limit of fiber signal strength
lcTCPathLoss	.5.6	Integer	Read-write	Path loss trap enable
lcTCPathLossHi	.5.7	Integer	Read-write	High limit of path loss, in dB
lcTCPathLossLo	.5.8	Integer	Read-write	Low limit of path loss
lcTCTemp	.5.9	Integer	Read-write	Temperature trap enable
lcTCTempHi	.5.10	Integer	Read-write	High limit of temperature, °C
lcTCTempLo	.5.11	Integer	Read-write	Low limit of temperature, °C

Traps

This table defines the traps that can be sent by the radio.

Name	ID	Description
lcTrapAlive	1	Sent every lcTCInterval seconds, unless lcTCInterval = 0
lcTrapFiberSignalNotOK	2	Sent when fiber signal strength is out of range
lcTrapFiberSignalOK	3	Sent when fiber signal strength is in range
lcTrapPathLossNotOK	4	Sent when path loss is out of range
lcTrapPathLossOK	5	Sent when path loss is in range
lcTrapTempNotOK	6	Sent when temperature is out of range
lcTrapTempOK	7	Sent when temperature is in range

SNMP v1/v3

The two versions of SNMP supported by the Loea radios are SNMPv1 and SNMPv3 (factory default). SNMPv1 is not secure because its community strings (passwords) are sent in clear text. Anyone who has access to your network can discover SNMPv1 passwords, and therefore they can monitor the radio. It is recommended that SNMPv1 not be used in any situation where unauthorized individuals are able to access the network, such as over the Internet.

As shipped, the Loea radios have SNMPv3 enabled and SNMPv1 disabled. SNMPv1 can be enabled by issuing the appropriate commands through the radio's serial port. (See Section 3.4)

Unlike some devices which offer multiple views of the data for different purposes, the Loea radios only have one view of all SNMP variables – anyone who has access to any SNMP functionality has access to all of it.

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Appendix C –Example of Installing the L2700 MIB

This example is based the NMS application SNMPc. Please consult directions in your NMS manual, contact your NMS supplier or contact Loea for assistance.

Begin by installing the SNMPc7 software on a workstation PC. Follow the instructions in the “Getting Started” manual that comes with the software. Once the software has been installed, integrate the L2700 MIB file with the SNMPc program by carrying out the following steps:

a) First locate the other MIB files used by SNMPc on the workstation PC. They should be at:
C:\Program Files\SNMPc Network Manager\mibfiles.

b) Copy the current version of the Loea 2700 MIB file to the same MIB folder.

c) On the SNMPc main menu, choose ‘Config’ then ‘mib database’, then click ‘Add’. Scroll down to the end of the list – the Loea 2700 MIB should be there.

d) Select it and click ‘Ok’. Then click ‘Compile’ and after compilation is finished click ‘Done’.

At this stage the Loea 2700 MIB should be integrated with SNMPc7.

e) Now add the radios in each link to the list of monitored items. Refer to the ‘Getting Started’ manual on how to do this.

A typical example of the SNMPc7 Management Console screen display for a simple network is shown in Figure C1. The green icon indicates that the radioBlab device is connected and responding to polls from the NMS while the red icon indicates that the radioAlab device has a critical failure.

The display layout shows a selection tool pane on the left with tabbed control for selection of objects within different SNMPc functional modules. A network view window is in the centre. At the bottom is an event log tool pane with tabbed control for display of filtered event log entries. Refer to the SNMPc manual for additional screen layout options and use of the main button bar and edit button bar along the top and right side of the screen display.

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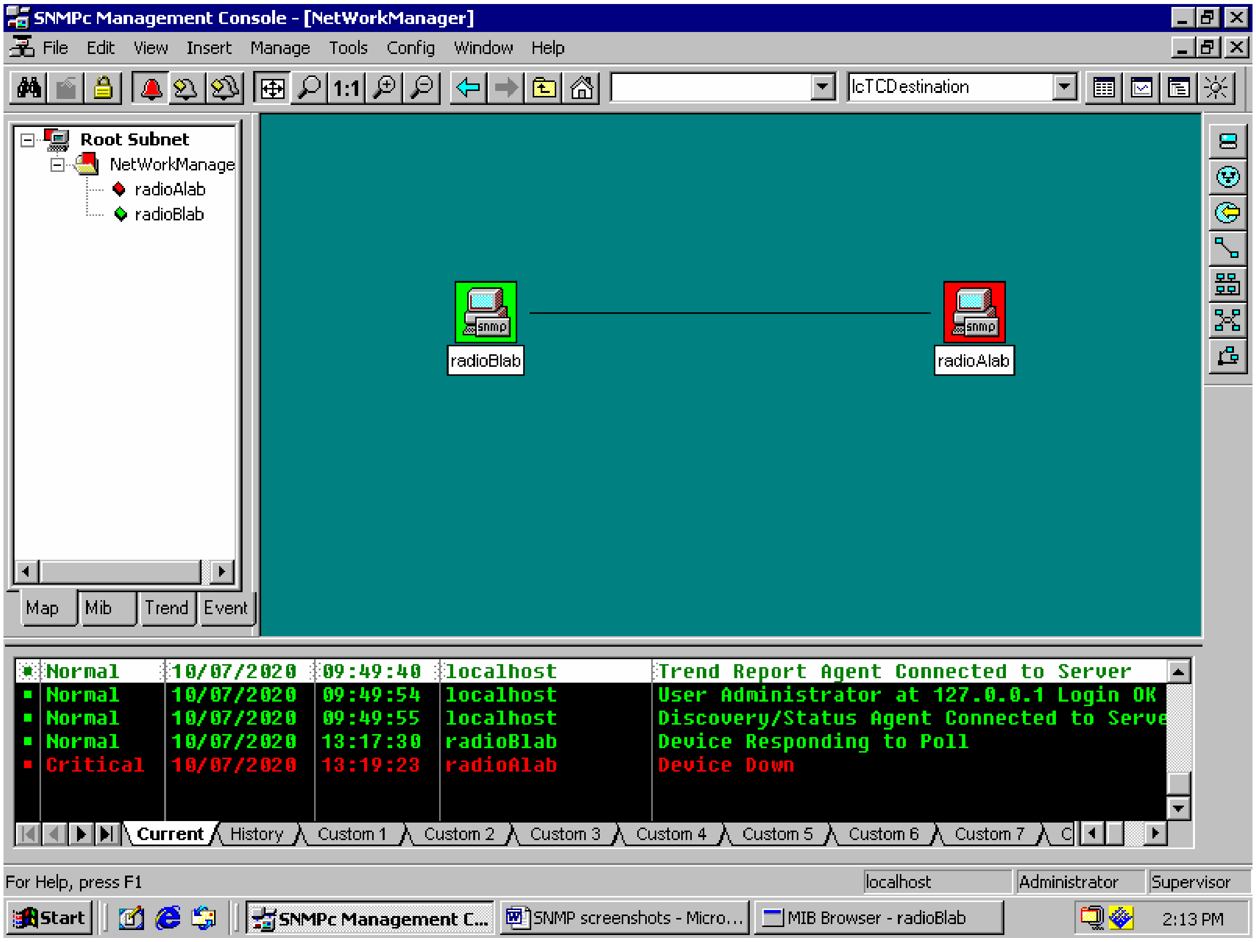

Figure C1. Example of SNMPc Management Console Screen.

To view the MIB groups, right-click on a radio icon and select 'Tools' then 'MIB Browser'. See Figure C2.

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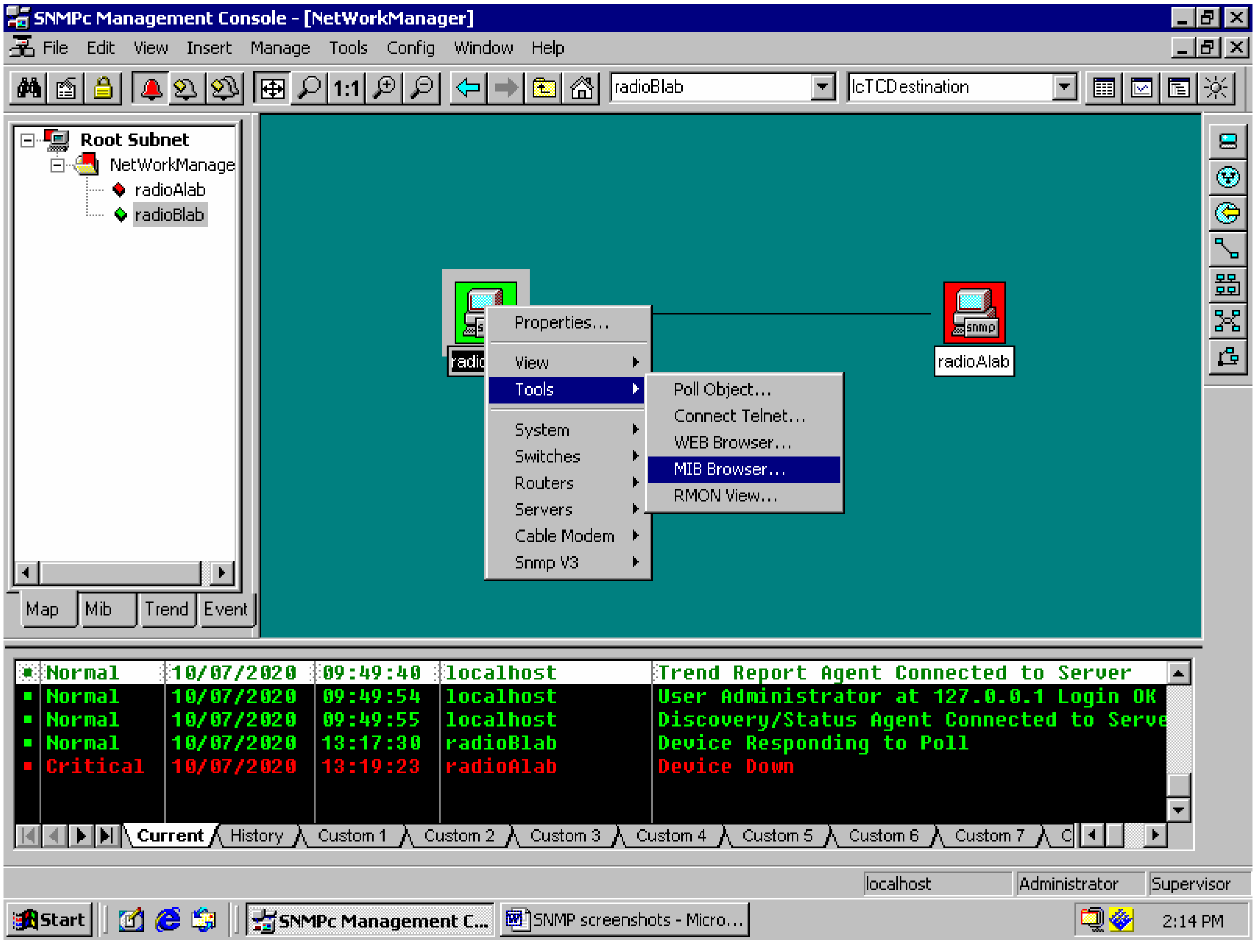

Figure C2 SNMPc MIB Browser Selection.

This will open a new window as shown in Figure C3.

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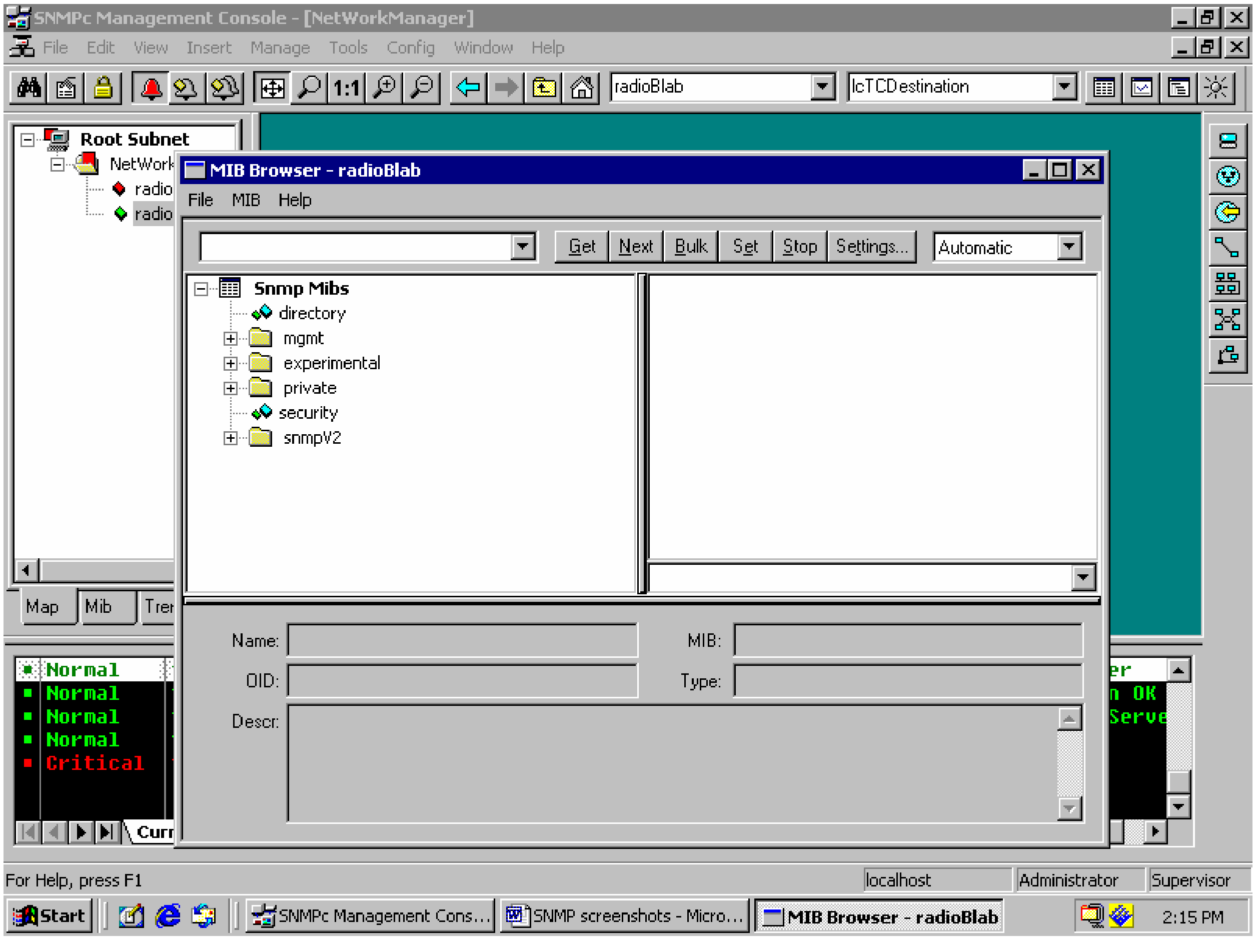

Figure C3 SNMPc MIB Browser.

In SNMPc it is required that the user enter the name of the person to contact about this radio, the name of the radio which would normally be the fully qualified domain name for the radio and the location of the radio. This is carried out by clicking on the + next to the 'mgmt' folder shown near the top of the folder tree in the left side pane shown in Fig C3 above. The resulting screen display is shown in Fig C4.

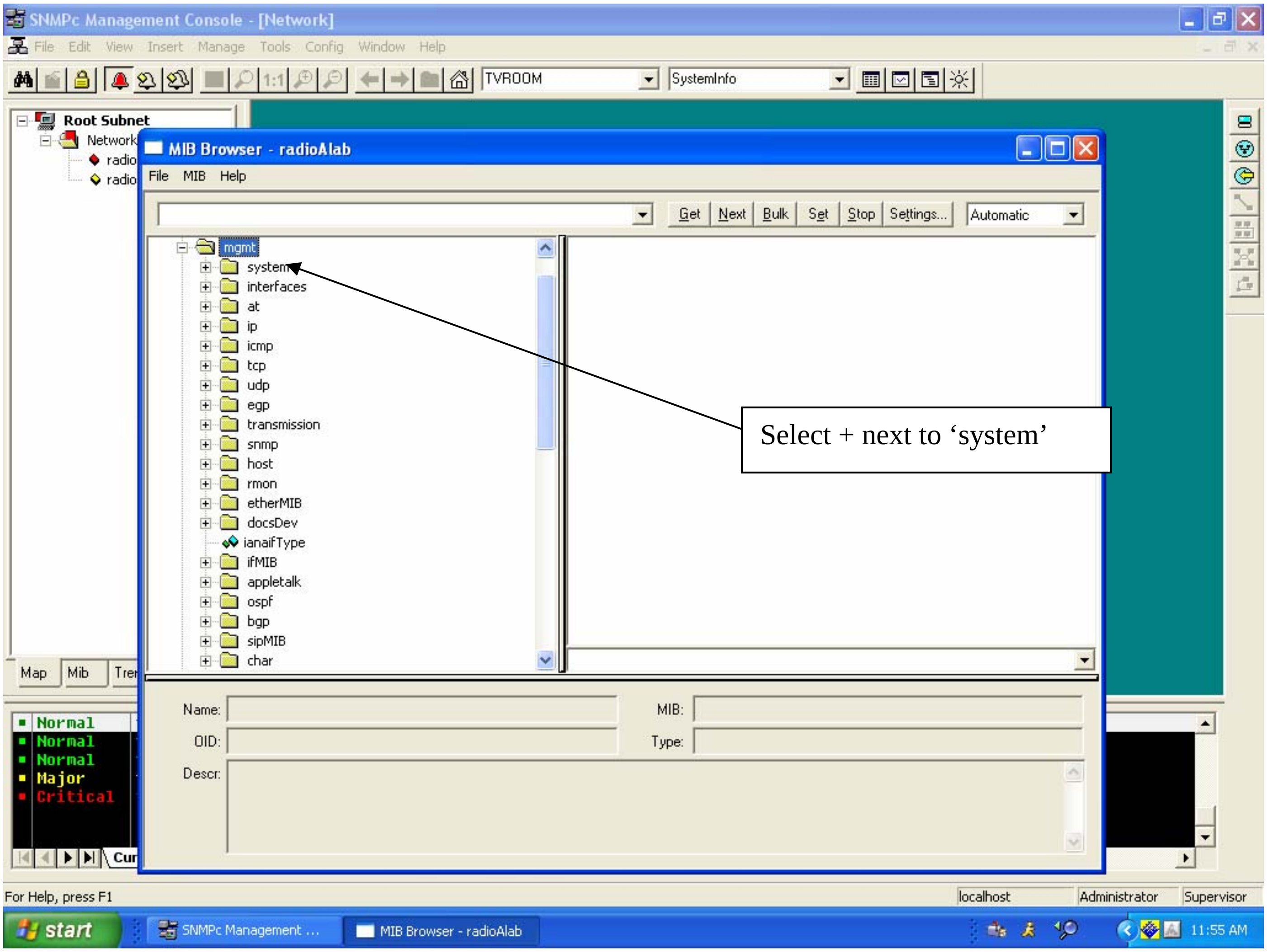

Figure C4. SNMPc 'System' Folder Selection.

In the left side pane click on the + next to the folder 'system'. The screen display in Fig C5 will appear.

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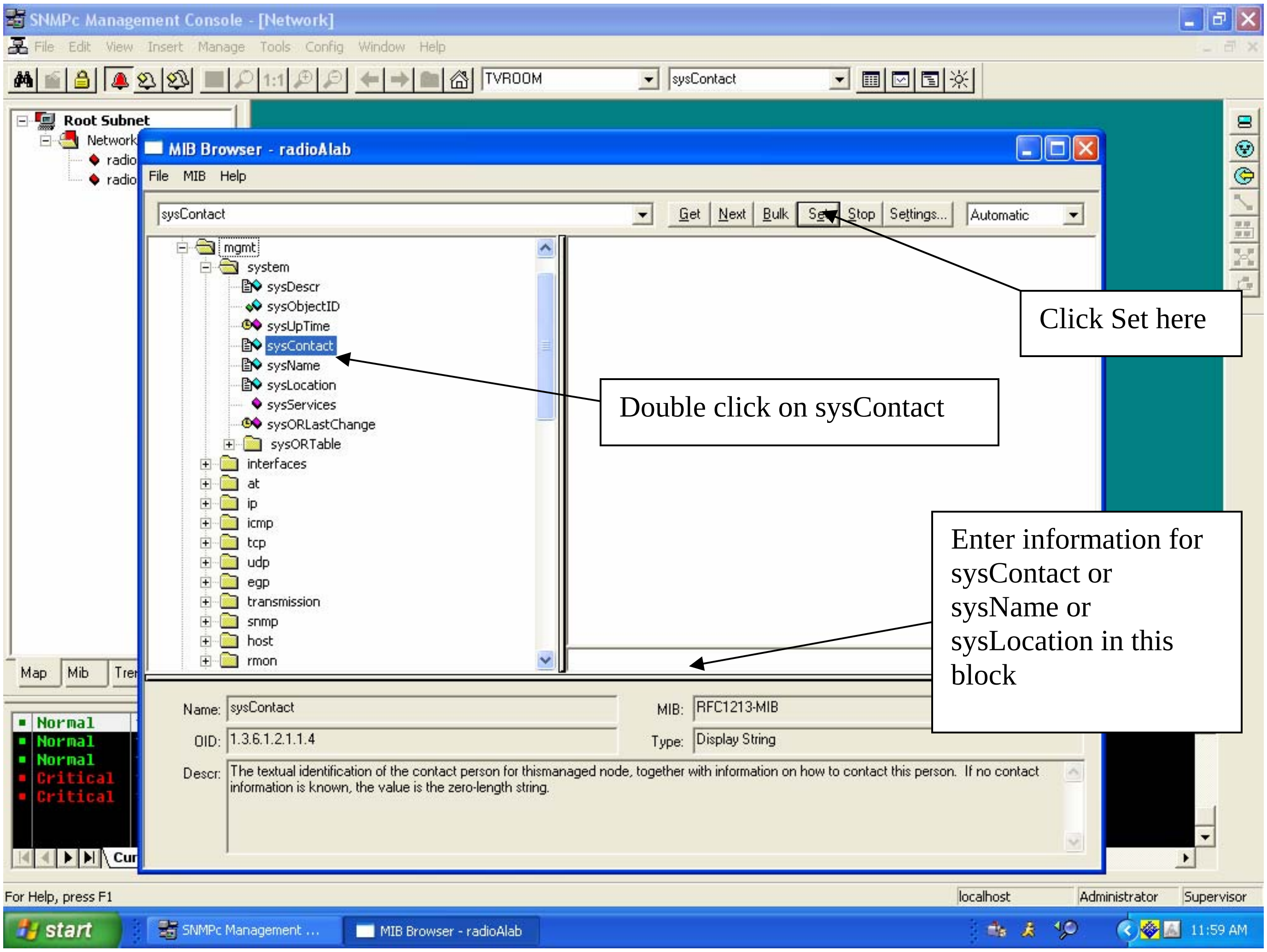

Figure C5. SNMPc 'sysContact', 'sysName' and 'sysLocation' Data Entry.

Double click on 'sysContact' as shown in Fig C5 and enter the name of the contact person in the block indicated. Then click the Set button on the top menu row to have this information saved into the NMS. Repeat this procedure for 'sysName' and 'sysLocation', each time entering the appropriate information into the same block as indicated in Fig C5. When completed click on the - sign next to 'system' to close the folder. The screen display should look like Fig C4 again. Scroll down the folder list to till the 'private' folder is found.

Click on the + next to the 'private' folder. A 'loea' folder should be at the bottom of that list as shown in Figure C6.

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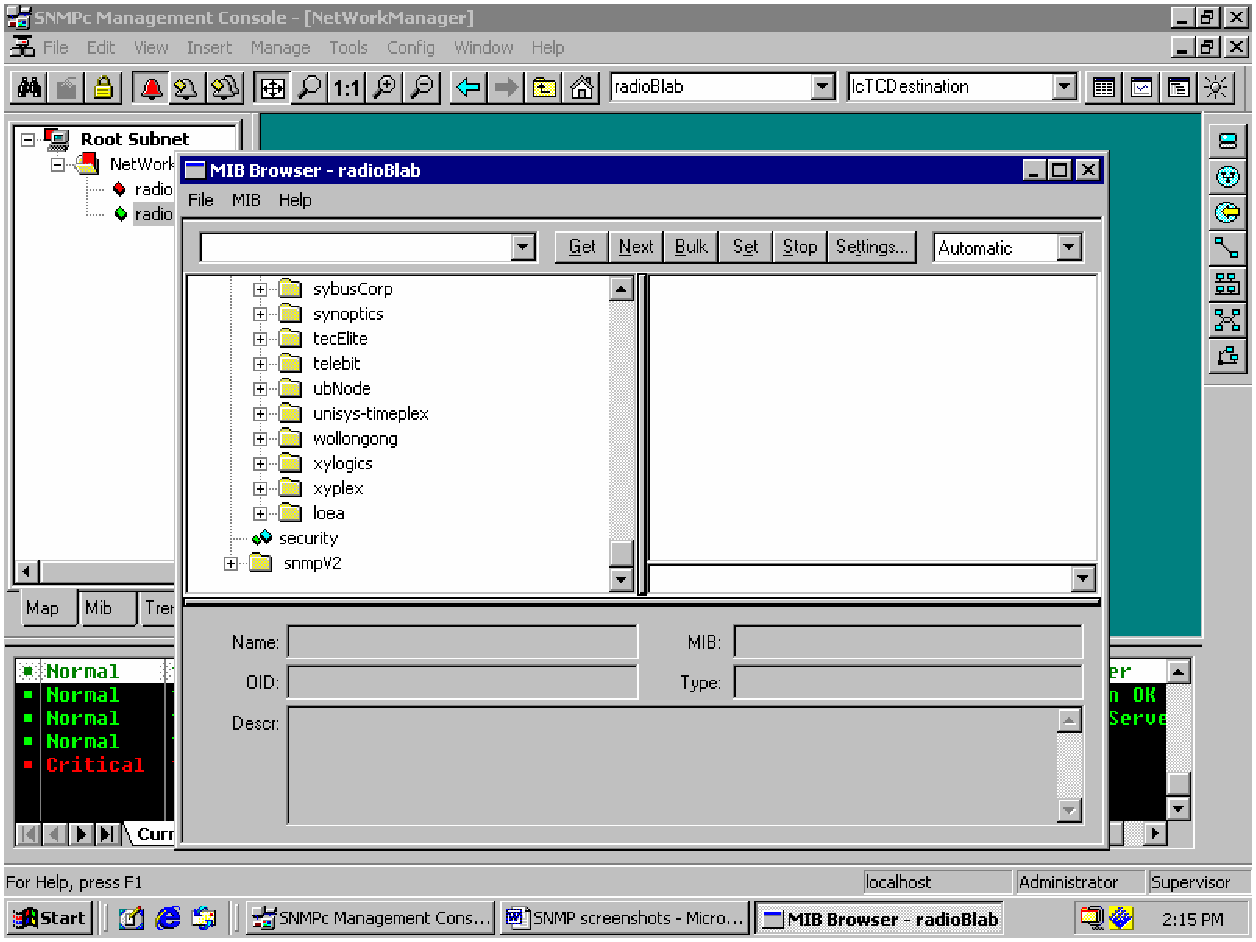

Figure C6. SNMPc Selection of Loea Folder at Bottom of 'Private' Folder List.

Click on the + next to the 'loea' folder to reveal five different Loea 2700 MIB groups as shown in Figure C7.

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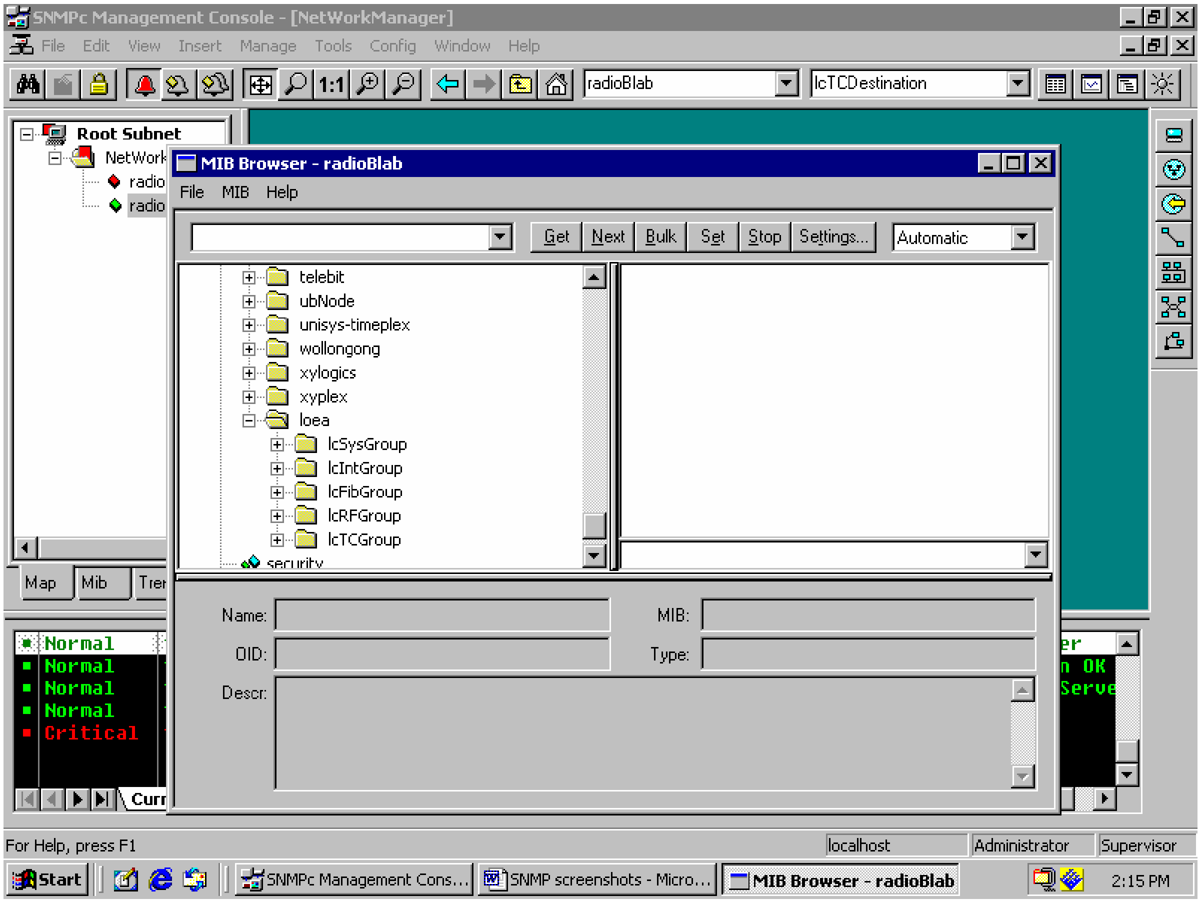

Figure C7 The 'loea' folder showing 5 different Loea MIB groups.

Click on the + next to one of the groups, and the individual SNMP variables should appear as shown in Figure C8.

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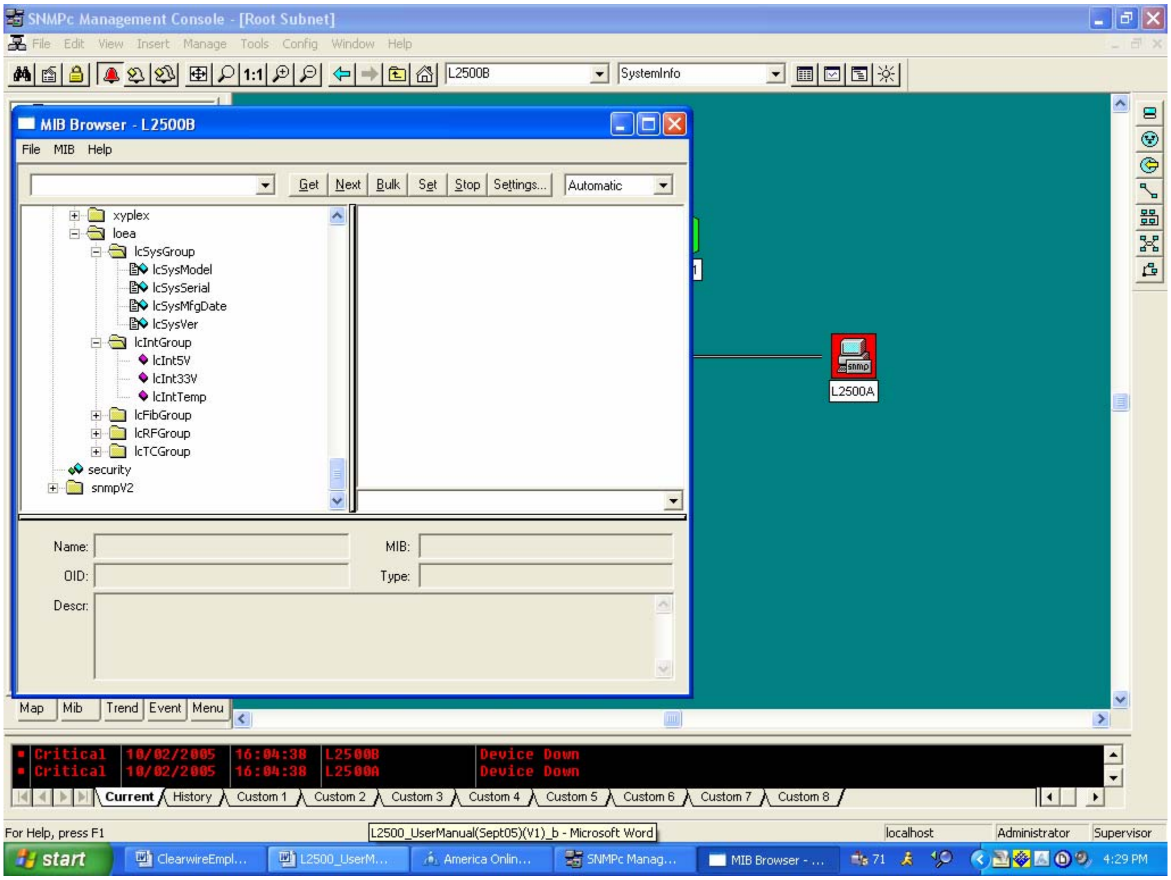

Figure C8. Individual SNMP variables for group.

By double clicking on any of those variables its current value should appear in the window on the right as shown in Figure C9.

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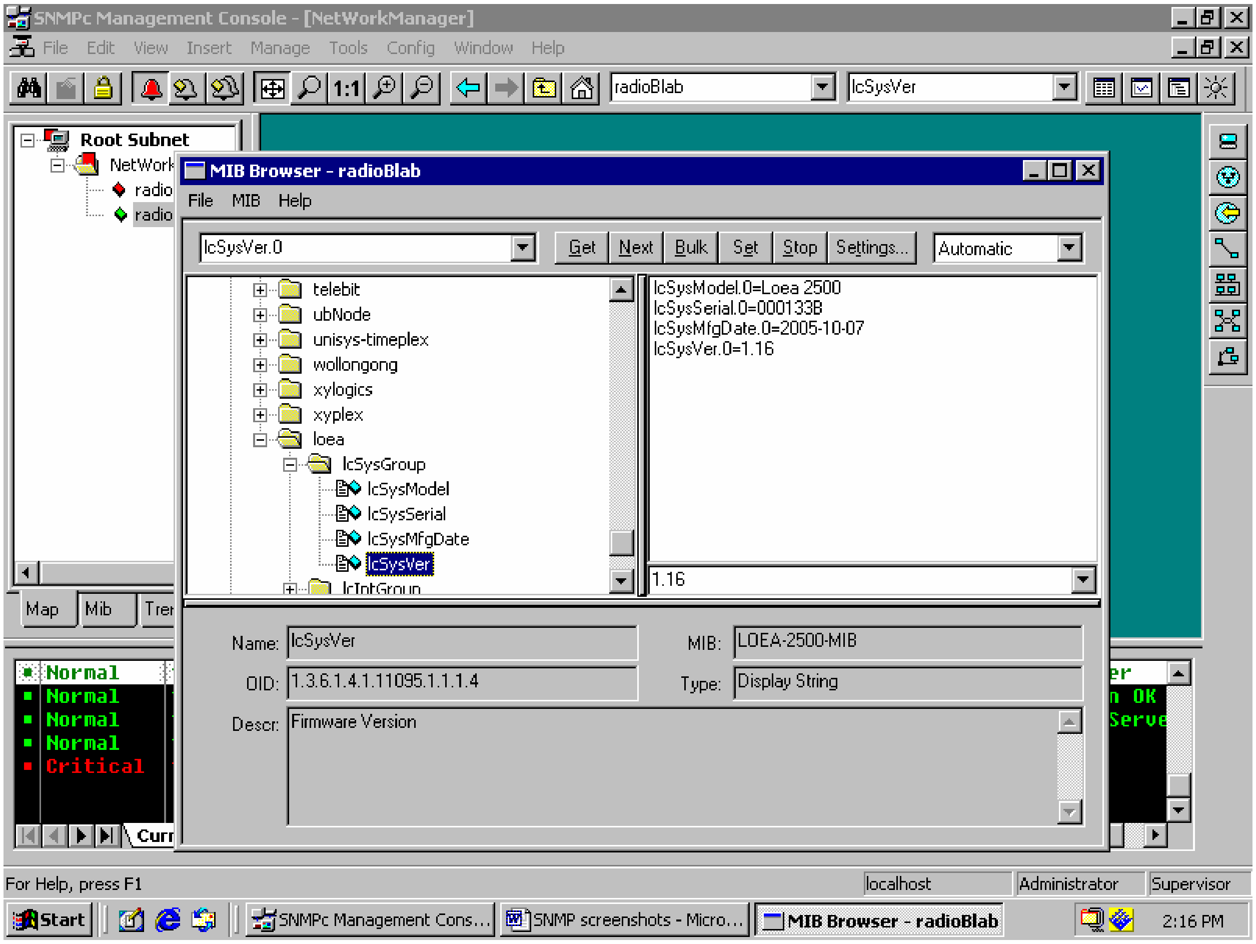

Figure C9. The System Group IcSysGroup.

Double clicking on each of the variables in each of the groups will generate a list of parameters as shown in Figs C10 to C13.

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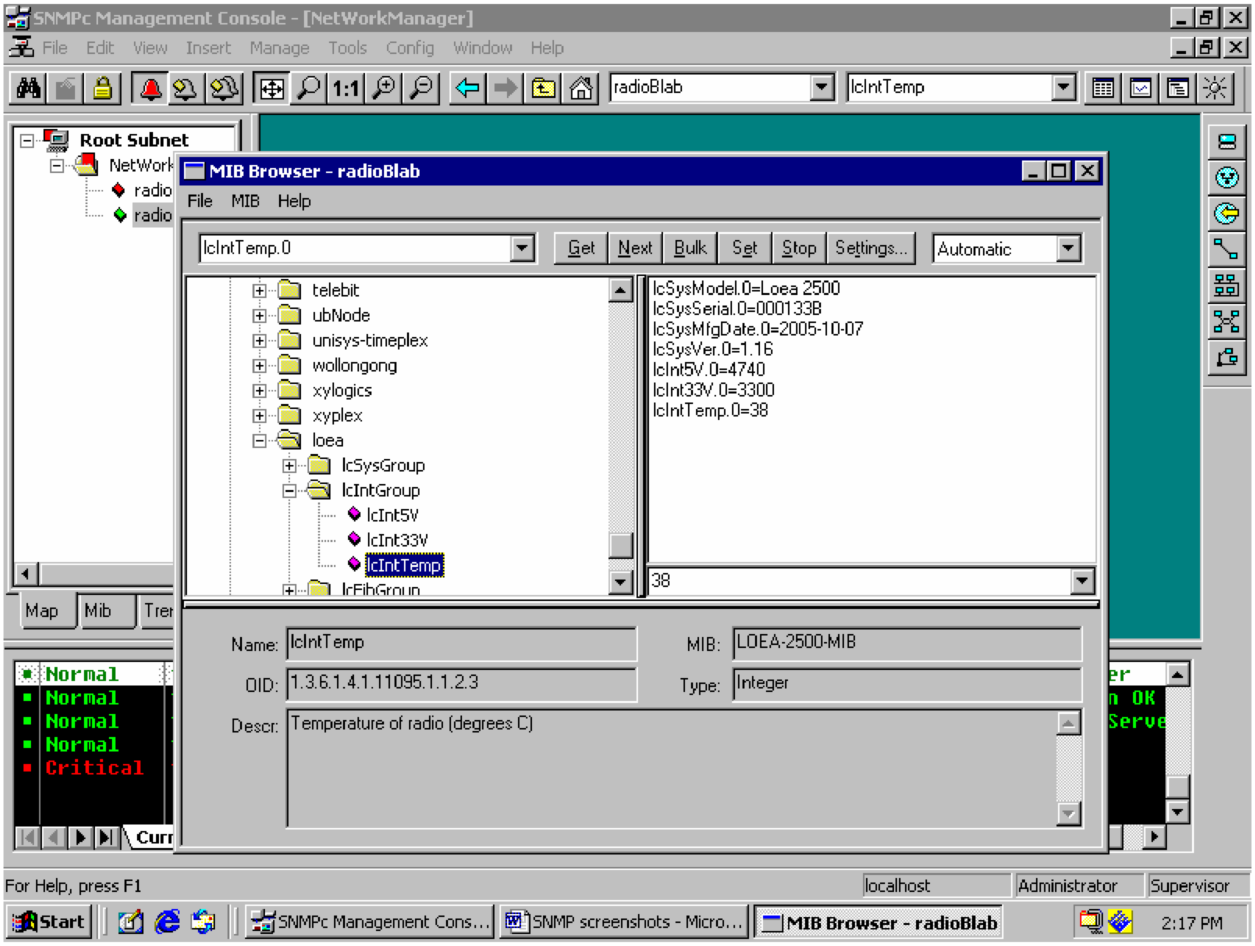

Figure C10. The Internal Group **lcIntGroup:**

This group contains information that is useful to determine the internal health of the radio, including voltages and currents.

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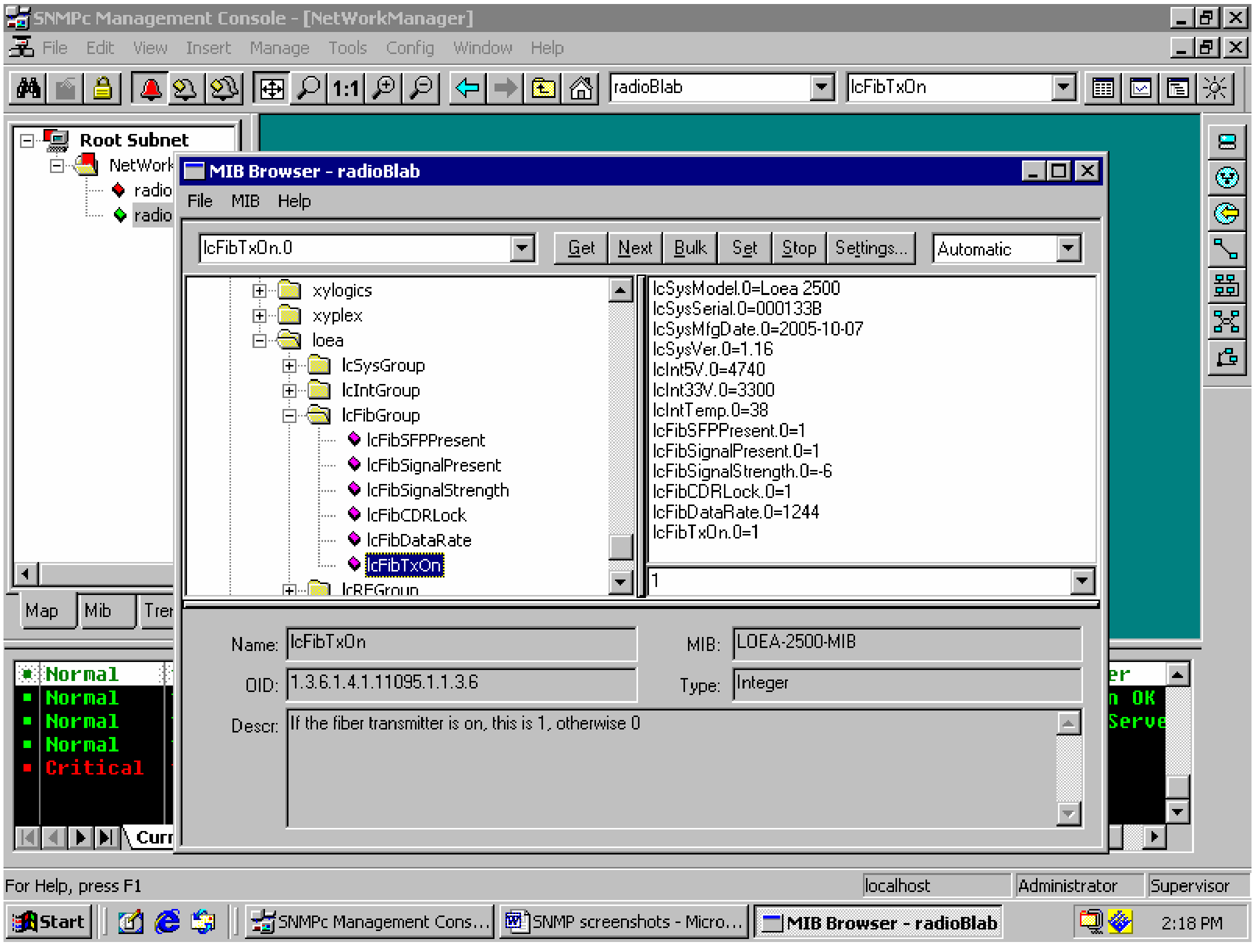

Figure C11. The Fiber Group **lcFibGroup:**

This group contains information that pertains to the fiber link.

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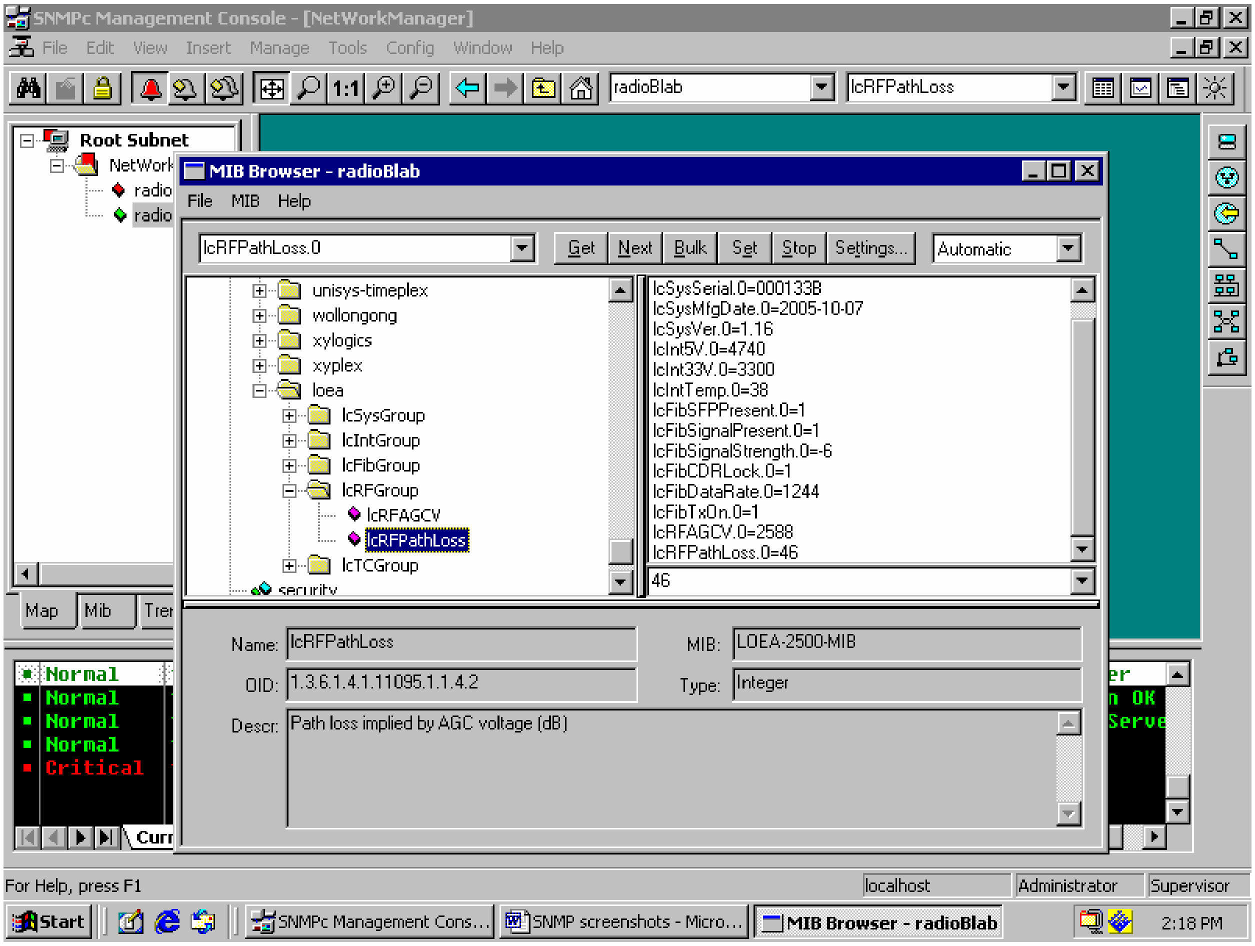

Figure C12. The RF Group **lcRFGroup:**

This group contains information that pertains to the RF link.

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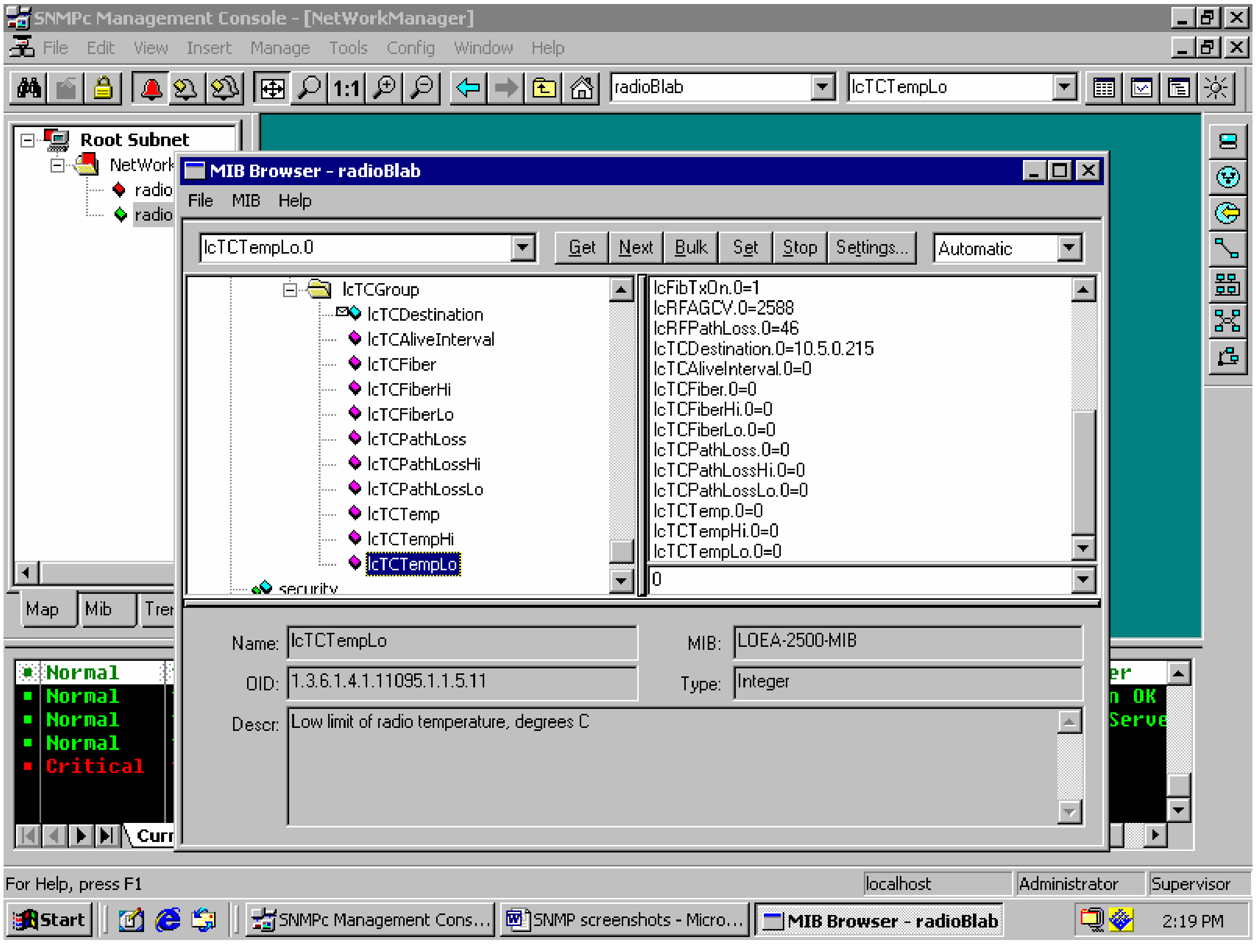

Figure C13. The Trap Control Group **lcTCGroup:**

This group defines the thresholds and other controls which are used to control traps. For each analog signal, there is an enable control, a high value, and a low value. If the enable is set to 0, this signal is ignored. If enable is set to 1, then this analog signal is compared to both the high and low values. If it is goes from inside a range to outside, or from outside the range to inside, the corresponding trap is generated. For each digital signal, a trap is generated each time that signal changes state.

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