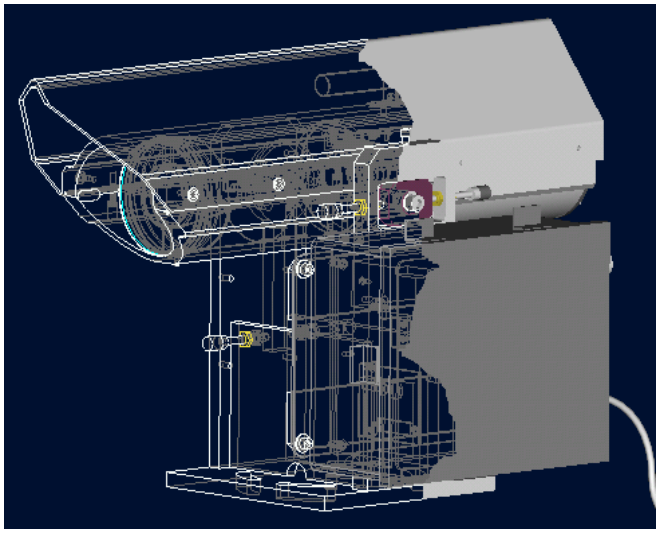
TereScope™ 1000 and 1000X Free Space Optics Systems



SET-UP AND OPERATIONS MANUAL

July 2002

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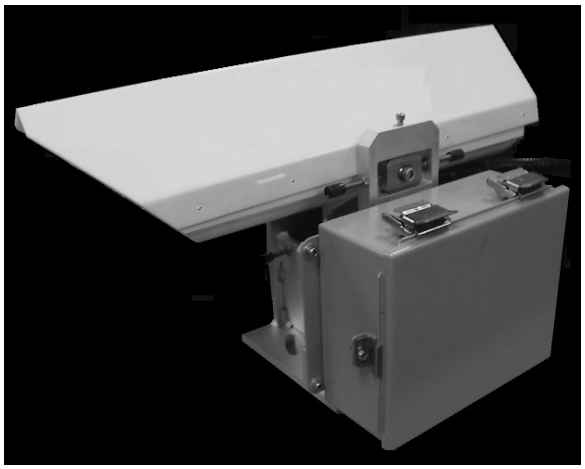


Figure 1. MRV Communications' TereScope 1000 transceiver terminal.

Thank you for your purchase of our TereScope™ Free Space Optics system. Along with the TereScope, you should have received copies of support software and documentation for your particular system. Please read this set-up and operations manual and support documentation before installing and operating the TereScope equipment.

MRV Communications is committed to providing our customers with products of the finest quality and construction. If you have any questions or would like more information regarding your system, please contact us in the United States at (858) 792-8501.

MRV Communications' TereScope™ 1000 and 1000X free space optics systems provide wireless data communication links between two line-of-sight points. The TereScope 1000 and 1000X typically supports data rates between 10 Mbps and 155 Mbps. Because these systems are protocol-independent, they are capable of transmitting Ethernet, Fast Ethernet, FDDI, ATM and a variety of proprietary protocols. Acting as a simple wireless repeater, the TereScope can be directly connected to a user's LAN without altering the form of the data transmitted. The link consists of two transceiver terminals (see Figure 1). Line of sight must be available between the two links.

This manual provides the user with the necessary information to install and maintain the TereScope 1000 and TereScope 1000X systems in the field. Please refer to our Site Survey Guide for information about site preparations and mounting considerations prior to beginning the installation of the systems.

Although technical information and operating instructions are provided in this manual, the user should never attempt to open the TereScope optical heads or attempt to make alterations not specified in this document. **Warning: Any attempt to perform maintenance not detailed in this manual will void your warranty and could be potentially hazardous.**

SAFETY WARNING

Set-up and operation of the TereScope 1000 and 1000X is not complicated; however, to achieve optimum performance and ensure a safe work environment, you should read through this manual completely before beginning the installation process.

CAUTION – Use of controls or adjustments or performance of procedures other than those specified here may result in hazardous laser radiation exposure.

EYE SAFETY

The TereScope 1000 and 1000X are Class 1M laser products, as defined in IEC/EN 60825-1:1994 and IEC/EN 60825-1/A2:2001. Although the TereScope 1000 and 1000X laser transmitters meet ANSI and IEC standards for eye safety when not viewed with binoculars or other optical collecting devices at the telescope output aperture, you should avoid looking directly into the laser aperture during operation. The lasers operate at a wavelength of 785 nm, which is in the infrared region of the electromagnetic spectrum and is not visible to the human eye. Figure 2 summarizes this information.

Figure 2. Laser information.

The TereScope 1000 and 1000X contain a Class 3b laser. The user should NEVER ATTEMPT TO OPEN THE OPTICAL HOUSING. Doing so could expose the user to diode laser power up to 50 mW in the 780-860 nm range and may result in hazardous laser radiation contact.

Vorischt-wenn andere als die hier angebenen Kontrollfunktionen oder Einstellungen oder die Ausführung von Abläufen, Kann zu einer Aussetzung von gefährlicher Strahlung führen.

REGULATORY COMPLIANCES

This device complies with the regulations for laser radiation control established by the Center for Devices and Radiological Health, which is part of the Food and Drug Administration under the U.S. Department of Health and Human Services, 21 CFR Chapter 1, Subchapter J.

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Changes or modifications not expressly approved by the party responsible for compliance could void the warranty and the user's authority to operate the equipment.

SITE PREPARATION CHECK LIST

Before you begin installation of the TereScope 1000 and 1000X units, you should check the following items (a more detailed procedure for site preparation can be found in the Site Survey Guide):

- Verify that the fiber transceiver wavelength (either 1300 nm or 850 nm) on your switch/router matches the fiber transceiver wavelength of the TereScope unit (this information is found on the serial number tag).

- For data transmission, 2 strands of **multimode** fiber optic cable (do not use single-mode fiber unless the single mode option unit has been purchased) should be run with enough length to comfortably reach the TereScope unit. ST connectors should be used unless other arrangements have been made with MRV Communications in advance. If remote management will be used, additional cabling must be run from the control room to the TereScope. An additional 3 strands of multimode fiber (for a total of 5 strands), two for the serial line and one for video are necessary. Running additional strands of multimode fiber is recommended for redundancy. Fiber transceivers in the electronics box of the TereScope and in the control room will be required. Contact the MRV Communications Technical Services Center for more details about the fiber transceivers.

- **A weather rated power source** must be available. This line should be isolated from other heavy equipment (such as air conditioners) and should provide 100-120 VAC or 200-240 VAC (depending on model purchased), 50-60 Hz, with at least a 15 amp capability, unless other arrangements have been made with MRV Communications in advance.

STANDARD MOUNTING INSTRUCTIONS

Due to the narrowness of the laser beam, alignment is critical and because of this the units must be attached to a rigid mounting surface. The bolt circle on the base plate of the TereScope is 6 inches in diameter. The units can therefore be mounted directly to a concrete ledge around a rooftop at least 8 inches wide. A variety of mounting options are displayed in Appendix B of this manual. More information on different mounting scenarios can be found in the Site Survey Guide.

Standard Mounting Procedure: (Mounting to the top of a concrete wall top at least 8 inches wide)

Supplies needed:

- Four 3/8” concrete anchors
- Appropriate drill for above anchors
- Drill Template provided in Appendix A (another option is to set the unit in place and mark the holes)

Using either the template provided or the TereScope, orient so that the template or link is facing towards the opposite site. The base plates are slotted to allow for 15 degrees of coarse adjustment in both directions. Mark the hole locations and drill the appropriate holes using a masonry/concrete drill bit. Once the holes have been drilled, bolt the unit in place with the concrete anchors. **All appropriate safety procedures, including the use of safety goggles, should be observed during drilling**.

Optional Mounts:

The same basic mounting procedures apply to all TereScope mounts. Typically, the mount will be anchored, using the appropriate anchors, to a concrete structure on the building. The unit is then mounted to the pedestal or bracket using (4) 3/8-16 bolts. All mounts supplied by MRV Communications have a complete bolt circle enabling any Azimuth orientation of the unit.

Optional mount types:

1. Floor mounted pedestals or tripods
2. Wall mounted pedestals

3. Wall angle brackets
4. Consult the MRV Communications Technical Services Center for other options

A tripod is approved as a mount for temporary installations (contact MRV Communications for additional information about tripods). Again, it is important to place the tripod on a rigid surface. If the tripod is to be used on the roof, place the tripod as close as possible to the edge (preferably near a corner). If the roof surface seems "soft", it is advisable to place the tripod on top of plywood. The tripod should be bolted to the plywood from below (removing the tripod's rubber footpads that reveal 1/2-13 threaded holes). It is also advisable to weigh down the tripod and/or plywood using sandbags or concrete blocks.

Be certain that the mounts are stable and have been securely affixed to the building structure. Once the unit is bolted in place, the fiber and AC should be run to the units.

STANDARD CABLING INSTRUCTIONS

We recommend running the AC power, the two **multimode** data fibers (do not use single-mode fiber unless the single mode option unit has been purchased), and any optional remote management control cables to a weatherproof junction box close to the mounting location. From this junction, the fiber and AC power and the remote management cables will be run to the TereScope electronics box (see Figure 3). For installations using remote management, at least five strands of multimode fiber should be run - two for data, two for RS232 data, and one for video. If fibers are run for remote management, fiber/RS-232 and fiber/RG-59 transceivers will be required inside the electronics box.

Please note: a qualified electrician or other properly trained individual should supervise the installation of the AC cable. Installations should comply with all local electrical codes.

There are two main methods for installing AC cable:

1. Remove the standard AC cable (if present) from the TereScope electronics box and run weatherproof flexible ¾" NPT conduit from a junction box to the AC knockout in the electronics box. The AC wiring should be connected using wire no smaller than 18 AWG terminated with either #6 ring terminals or #6 flanged spade terminals. The wires should be connected to the terminal block in the electronics box as shown in Figure 4.

2. As a temporary connection, 110VAC units are shipped with outdoor rated AC cables. In this configuration, for temporary outdoor installations, a weather-rated outlet with a cover should be wired within 4 feet of the installation location. The fiber should be routed directly to the unit's electronics enclosure through flexible ¾" NPT conduit. Fiber should be terminated with ST connectors.

Terminals are provided for the option of installing an interlock switch (see right side of Figure 4). An interlock switch will turn off the laser power if the switch opens. For example, if the switch were attached to a lab door and someone opens the door, the lasers will turn off. The lasers will only be on if the interlock switch is closed or shorted. If this option is desired, the user-supplied interlock switch should be connected using wire no smaller than 18 AWG terminated with #6 terminal lugs.

If desired, the two data fiber cables can be run in the same conduit as the AC, or the other hole in the TereScope electronics box can be used (recommended if running more than one pair of fiber.) The two data fibers and the AC power lines are the minimum requirements to operate the laser link. If

remote management is desired, additional cabling needs to be run. A 6 or 12 strand fiber can be run up to the junction box and terminated with ST connections. ST-ST patch cable can then be routed through the conduit. Remote management requires that two multimode fibers for the RS-232 data and one multimode fiber for the video data are run to the TereScope. In the TereScope electronics box, fiber/RS-232 and fiber/RG-59 transceivers will convert the fiber signals to RS-232 serial and RG-59 video signals. In the control room, if fiber is run, transceivers will be required to convert the fiber signals back to RS-232 and RG-59 signals. The RS-232 & RG-59 signals will then be plugged into the remote management computer.

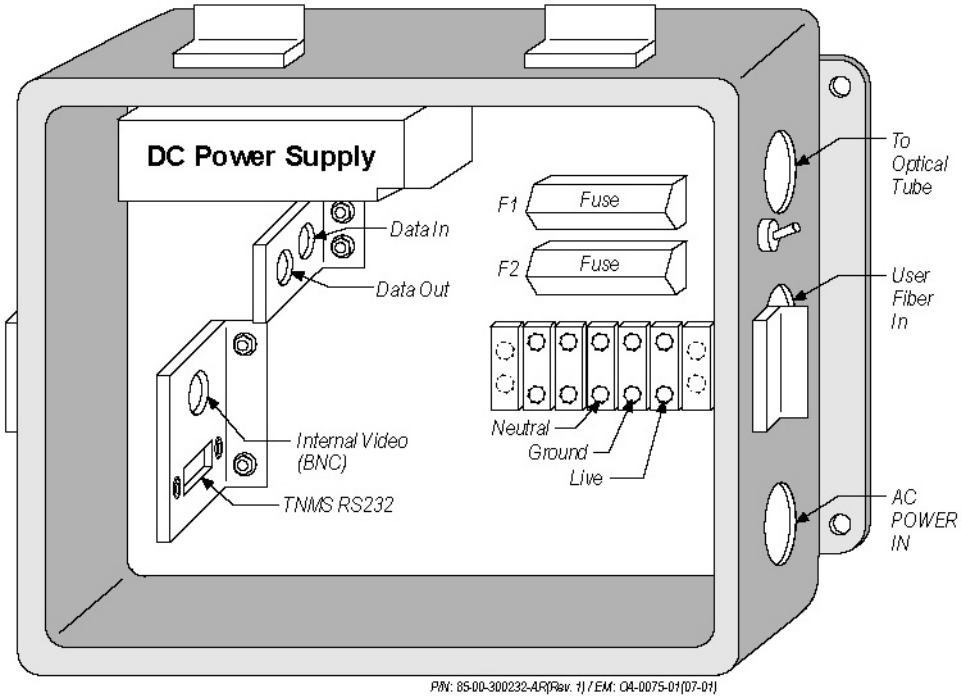


Figure 3. Diagram of Electronics Box.

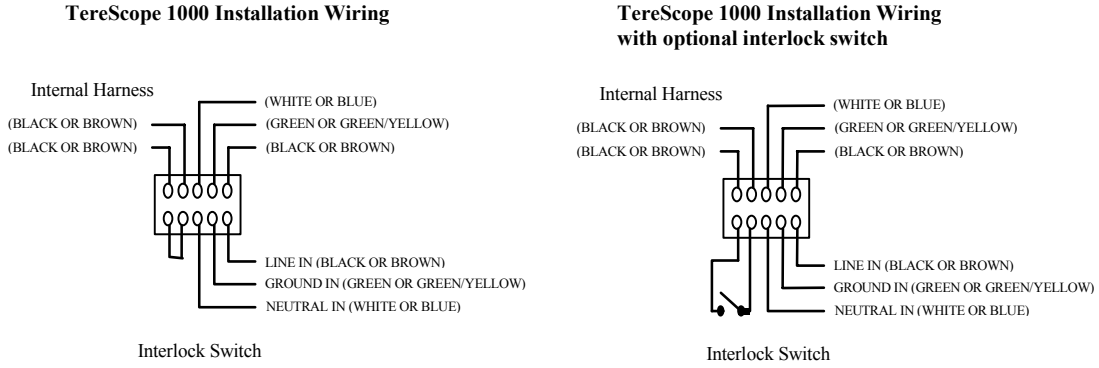


Figure 4. Wiring configuration with and without optional interlock switch.

WARNING: BECAUSE THESE SYSTEMS ARE EXPOSED TO THE ELEMENTS, IT IS NECESSARY TO ENSURE THEY ARE CLOSED CORRECTLY. THIS PREVENTS MOISTURE FROM ENTEREING THE EBOX AND CORRODING THE ELEMENTS. FOLLOW THE CLOSING INSTRUCTIONS BELOW:

TereScope™ 1000, 1000X and 3000

Step 1:

- ✓ Check to see that all conduit connections are tight and silicone sealant is used around the connectors to help waterproof the electronics box.
- ✓ Make sure that any excess fiber is placed inside the electronics box so that when closing its cover, the fiber is not damaged.

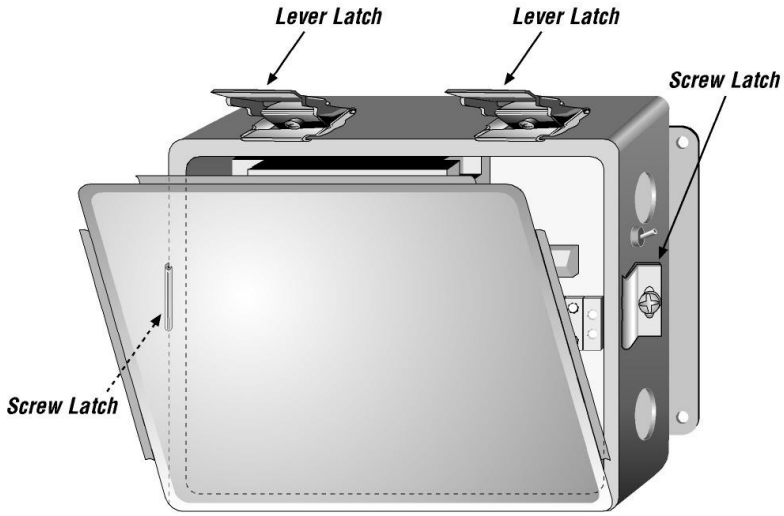


Figure 15-1.

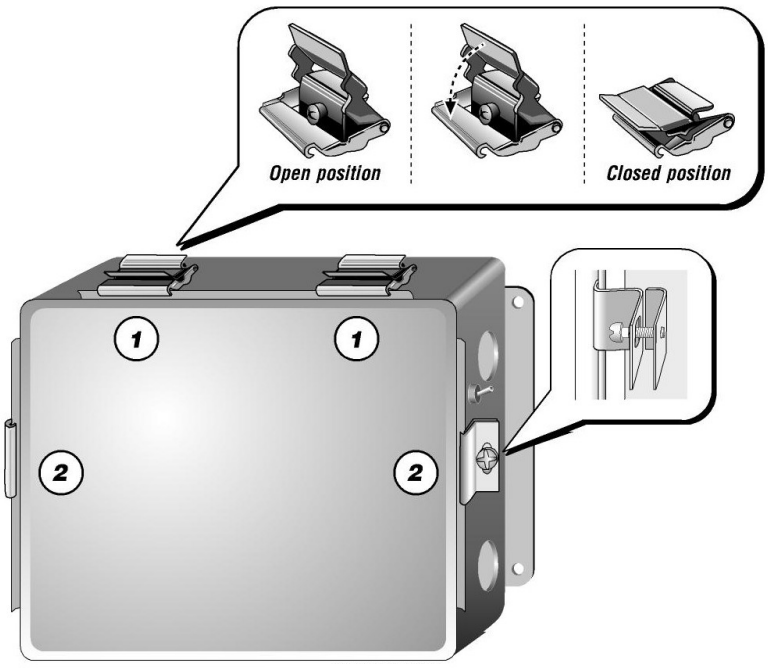


Figure 15-2.

Step 2:

- ✓ After completing work on the electronics box, follow the latch closing procedure shown in figure 2. After closing the top two lever latches, tighten the side screw latches for a snug fit, creating a weatherproof seal.* NOTE: Failure to properly close the Electronics Box will void warranty.

*Screw latches are necessary to meet specific industry safety requirements.

EQUIPMENT RECOMMENDED FOR SET-UP AND ALIGNMENT

- Voice communication devices (i.e. 2-way radio or cellular phones)
- 3/16" hex driver
- 5/16" hex driver
- Blade screwdriver
- 7/16" open ended wrench
- Television monitor with video input jack
- Adapter cable from TV monitor to BNC (i.e. RCA to BNC)
- PalmPilot™[1] or PC with MRV Communications supplied software installed

The set-up will be nearly the same at both ends of the link. Each side should have the recommended equipment on hand.

INITIAL ALIGNMENT PROCEDURE

To turn on the TereScope 1000 or 1000X systems, first make sure that the power is correctly connected and functioning. Turn the power switch to the ON (|) position. The power switch is located at the back of the electronics box (see Figure 5).

Figure 5. Location of the power switch at the back of the electronics box.

Turn the laser power key switch to the ON position so that the key may not be removed (see Figure 6). The green power indicator on the back of the optical transceiver should be visible, indicating that the transmit lasers are now on. Although the TereScope laser transmitters meet ANSI standards for eye safety at the transmit aperture, never look through binoculars in the direction of the other transceiver, which could magnify the apparent intensity (The units are safe to view through binoculars when you are more than 120 meters from the source). The spotting scope mounted beneath the weather shield has been treated with a special IR filter, making it eye-safe during installation.

[1] PalmPilot™ is a registered trademark of 3Com Corporation.

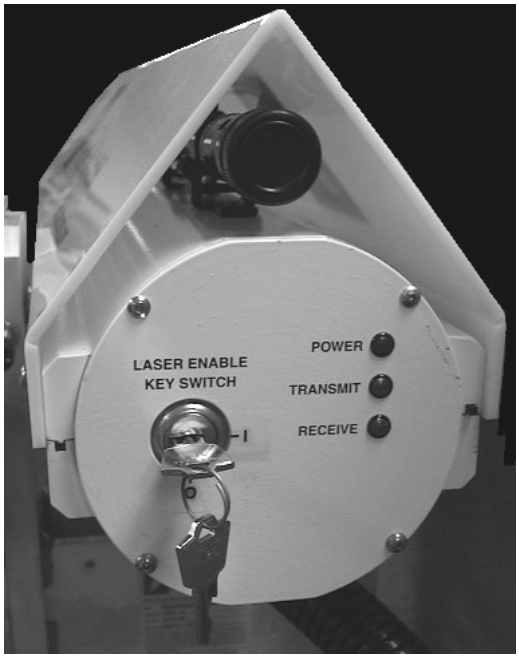


Figure 6. Back of TereScope 1000 System.

The TereScope 1000 and 1000X were designed for easy and quick alignment. Two diagnostic tools which greatly simplify the alignment are an NTSC TV (or other video monitor) and a PalmPilot™ or laptop PC.

1. Set up a TV or other video monitor that is shaded from the sun. Open the electronics box. Attach a RG-59 video coaxial cable to the BNC video connector located inside the electronics box (see Figure 3) and plug the other end of the cable into the video input of the TV (a BNC-to-RCA adapter may be required). The TV will be used for visual alignment.

2. Plug in either a PalmPilot™ running the TereScope Control software or a laptop PC running the TereScope Monitor software to the RS-232 serial port connector located inside the electronics box (see Figure 3). The PalmPilot™ Control or PC Monitoring software will display quantitative information about link quality during alignment.

3. If a data source (such as a switch or router) is available, plug in the fibers from that data source to the DATA fiber ports located inside the electronics box of the TereScope. It is important to match the transmit fiber from the data source to the DATA IN port at the TereScope, and the receive fiber from the data source to the DATA OUT port at the TereScope. One way of distinguishing fibers that are paired is that one of the fibers has writing printed on the outer jacket.

If an active data source is plugged into the DATA IN port of the TereScope, then the transmit (Tx) light comes ON. The TereScope is now transmitting modulated light. If no data source is plugged into the TereScope, the transmit (TX) light will be off.

At this point, it is important to know about the **Squelch Mode** feature. If Squelch Mode is on and no data is being sent to the TereScope, the lasers will be turned (more information is provided in the Squelch Mode section of this manual). The default mode of operation is *Squelch Mode ON*. If no data source is available during alignment, Squelch Mode should be turned off using the PalmPilot™'s Control or PC's Monitor software. Select "Sq Off" on the laser menu of TereScope Control or make

sure that the Transmit Squelch check box in the Advanced\APD\Laser Enable Menu is clear in the TereScope Monitor (see the TereScope Control for Palm Pilot or TereScope Monitor software manual for more details). Turning Squelch Mode off will turn the lasers on. The TereScope will now be transmitting random modulated light, which is necessary for alignment of the other side. When alignment is complete, *Transmit Squelch* should be turned back on for best performance.

Note that if no data source is plugged into the TereScope, the transmit light will be off. If Squelch Mode is then turned off to turn on the lasers, the transmit light will remain off.

Alignment Procedure:

1. Sighting along the tube, coarsely point the unit towards its counterpart in the azimuth axis by rotating the entire unit on its mounting bolts. Once close to alignment, lock the unit in place.

2. If a large elevation motion is necessary (more than 5 degrees), loosen the two bolts on the black lever arm using the 7/16" open end wrench and loosen the 3/8" Socket head cap screw on that same side of the gimbal. At this point, the entire tube will pivot about its center. Using the spotting scope, point roughly towards the other unit and tighten the three bolts loosened previously (see Figure 7).

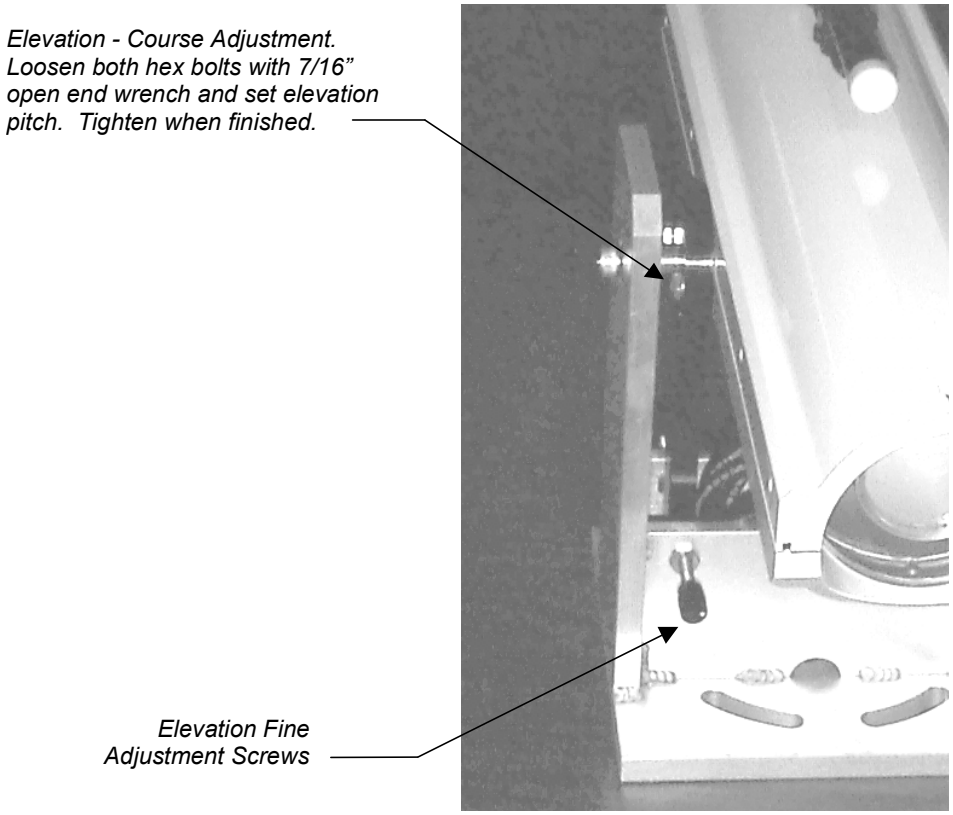


Figure 7. Elevation course and fine adjustments.

3. At this point, you should be within the fine adjustment range of the unit. The adjustment screws above the electronics box allow for Azimuth adjustment and the ones below the tube accommodate elevation. The screws work against each other. As you loosen one,

the other should be tightened against it. This provides a locking mechanism (see Figure 8). Using the spotting scope, align the crosshairs to the other site.

4. Once both sites are at this point, final alignment is performed using the internal camera and either a PalmPilot™ running TereScope Control or a PC running the TereScope Monitor software (please see the TereScope Control for PalmPilot™ User's Manual or the TereScope Monitor Manual for additional information).

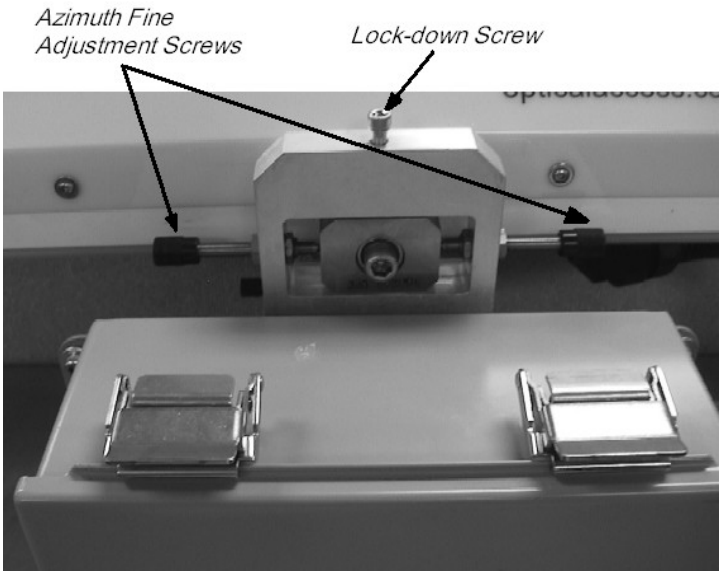


Figure 8. Azimuth Fine Alignment and Lock-down Screws.

5. Watch the TV as the fine alignment screws are adjusted. The TV is monitoring the internal camera, which is focused on the detector. The center of the detector is located in the center of the display. The goal is to adjust the alignment such that the light from the other unit is centered on the detector (see Figures 9 and 10 for examples). Note that the appearance of the detector on the screen may be affected by the amount of ambient light. For this reason, the picture will appear brighter during the day and darker at night. Once both units are aligned, double check that the adjustment screws are tight against each other and that the top lockdown screw on the azimuth axis is tight (see Figure 8).

6. Connect the data source at both ends of the link. The transmit light should illuminate when the local data source has been plugged in; once the opposite end of the link is transmitting, then the receive light should be lit as well.

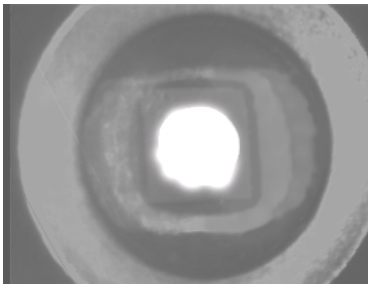


Figure 9. Picture of laser aligned in center of detector.

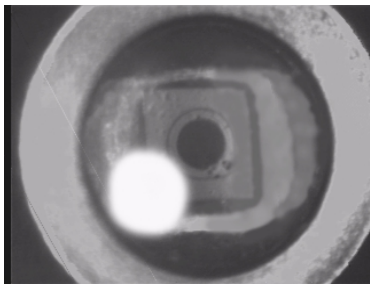


Figure 10. Picture of laser misaligned to the left. Note that this image may be lighter due to the presence of more ambient light during installation.

7. You can determine the value of the Receive Signal Strength Indicator (RSSI), at the main window of your TereScope Control or TereScope Monitor interface. If the RSSI lies between 1.9 and 2.35, there should be enough *signal-to-noise* to receive data with a bit error rate (BER) of 10^{-9} or better. If there is not enough modulated light (due to either misalignment or very poor visibility conditions), the RSSI will drop below 1.9 and the BER will begin to increase. If there is too much light, there is the chance that the detector will become saturated and the TereScope will stop receiving data. This can occur in a demonstration if the TereScopes are set up too close to each other (<150 m). If two TereScopes are set up 200 meters apart and slowly brought together, the RSSI will rise as the distance between the TereScopes decrease. This is because the received power increases as the range decreases. As the range gets smaller, the RSSI value will increase to a maximum value of 2.35. As the range continues to decrease, the RSSI will level off at 2.35, but the detector current will continue to rise. Once the detector current reaches a value of approximately 400 μA, saturation of the detector will occur and the link will stop functioning. Detector current can be monitored with the TereScope monitoring software. If a short-range demonstration is required, neutral density filters can be placed over the transmit aperture to attenuate the light (see Figure 11). More information about close range demonstration-type set-up can be found in Appendix C of this manual. For permanent installations at close range, a Close Range Attenuator should be installed. This is discussed in Appendix C as well.

Figure 11. Placement of neutral density filters over the transmit aperture prevents saturation of the detector at close, demonstration-type ranges.

8. Once alignment is complete, Squelch Mode should be turned back on. At this point the serial cable from the PalmPilot™ or PC and the video cable from the TV should be disconnected from the TereScope.

9. If you are installing remote management, the remote management cables need to be connected to the TereScope. Either the RS-232/fiber transceivers and fiber cables, or the RS-232 cable should be plugged into the RS-232 port. Plug the video/fiber transceiver and fiber cable or the RG-59 cable run to the control room into the video BNC connector. See the remote management documentation provided for operational instructions.

SQUELCH MODE

TereScope systems with firmware 1.11 or higher come with the Transmit Squelch Mode of operation. When Transmit Squelch Mode is enabled and there is no signal on the incoming fiber, the laser will be turned off. With Transmit Squelch Mode disabled, the laser will be randomly modulated, which occurred with earlier firmware versions. This can cause problems with some communication protocols, specifically FDDI. Problems occur when a transmit fiber is disconnected, causing the remote switch to see the random modulation. The remote switch interprets this as a bad connection and shuts down its own transmitter, causing the same problem at the local switch.

To avoid these problems, Transmit Squelch Mode is the default mode of operation. However, during system installation, a data source is not always available. In this case, it may be necessary to disable Transmit Squelch Mode to keep the laser on for alignment. Transmit Squelch Mode may be enabled or disabled with TereScope Monitor version 1.01 or higher, or TereScope Control for PalmPilot™ version 1.11 or higher, through the laser enable controls. When alignment is complete, Transmit Squelch needs to be re-enabled for best performance.

SPECIAL CONSIDERATION FOR CLOSE RANGE ALIGNMENT

If the TereScope 1000 or 1000X is being set up in a lab environment for demonstration or general test purposes, there are three special considerations that need to be addressed to ensure a proper connection at close ranges (<150 meters). For general operation at ranges less than 150 meters, install the optional Close Range Attenuator (see Appendix C).

1. Narrow Divergence

Since the divergence of the beam is 2.5 milliradians for short lab-type ranges (3-10 meters), the divergence of the beam will barely increase over the size of the transmit aperture (see Figure 12). For example, at 3 meters the beam will increase in size by 7.5 mm. The top part of Figure 12 shows the TereScope as viewed from the front. The inside circle (shown in gray) is the transmit aperture. This is where the laser light leaves the TereScope transceiver. The annulus ring between the transmit aperture and the edge of the unit is the receive aperture. This is where the laser light enters the TereScope transceiver.

In the lower portion of Figure 12, TereScope A is transmitting to TereScope B. If the TereScopes are aligned properly (axis-to-axis), most of the laser light from A would be blocked by the transmit aperture of B. Only a very small amount of light from just outside of B's transmit aperture will make it into B's receive aperture. There will probably not be enough light entering B's receive aperture to produce a link. To combat this problem, during initial alignment it is necessary to purposely offset the units when the two units are this close in range.

In Figure 13, the TereScope B unit has been offset about 2.5 cm from the axis. Now much more of the transmit light from A enters the receive aperture of B, so the short range laser link can be established. Depending on your actual range, it may be necessary to experiment with how much offset is necessary to achieve an acceptable RSSI value, and as a result, a good laser link.

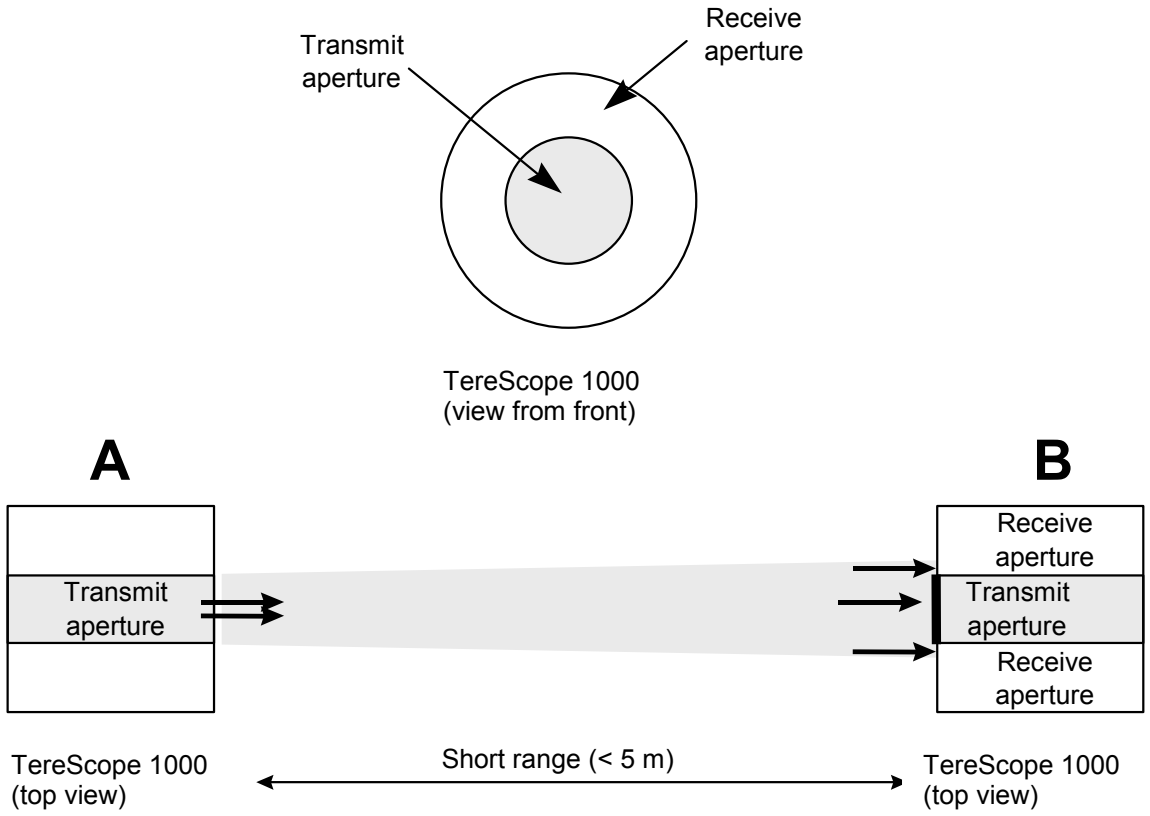


Figure 12. View of the TereScope from the front showing the transmit aperture (in gray), and the annular receive aperture (bottom) and a view of TereScopes A and B properly aligned from above. Because the divergence is so narrow (3 mrad), the transmit laser beam from A barely has a chance to expand before it hits the front of B. Only a very small portion of the light makes it into B's receive aperture because most of the incoming light is blocked by B's transmit aperture.

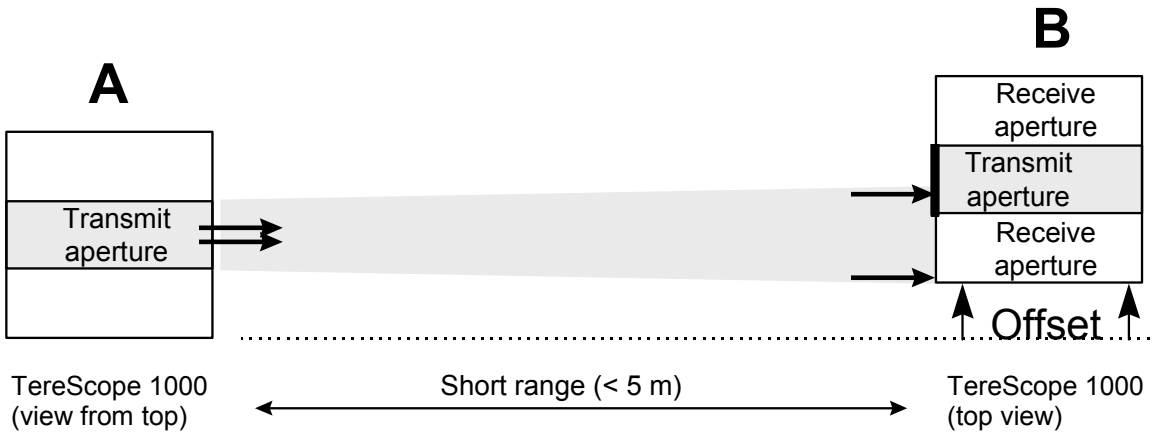


Figure 13. TereScope B has been offset about 2.5 cm to the right (it doesn't matter which direction you offset the unit). Now much more laser light from A enters B's receive aperture.

2. Saturating the Detector

The receive detector (which turns the pulses of laser light into an electrical signal) is very sensitive to low levels of laser light. This is why the TereScopes work well at long ranges. However, for shorter ranges, there might be too much light on the detector. If the detector becomes saturated with too much light, it will stop working properly. To prevent this from occurring in the lab at these short ranges, it might be necessary to place neutral density (ND) filters in front of the transmit apertures to reduce the power of the transmitted laser light (see Figure 11). Indications of detector saturation are a receive current above 400 μA which can be monitored with the TereScope monitoring software. To combat this problem we recommend Kodak Wratten gelatin ND filters (75mm by 75mm). It is important to place the filter so that it covers all of the transmit aperture. Again we recommend having a complete set (ND 4, ND 3, ND 2, ND 1) of filters and experimenting to determine how much ND filtering is necessary to reduce the light to the point of no saturation. For permanent installations of close range, the optional Close Range Attenuator should be installed as discussed in Appendix C.

3. Retroreflection off the front of the other unit

If the TereScope units are set-up in a short-range lab environment in loopback mode, there is a chance that what would appear to be a proper link might only be the laser light leaving TereScope A, reflecting off the front optics of TereScope B and then returning into the receive aperture of TereScope A (see Figure 14). To determine if this is occurring, disconnect the loopback fiber in TereScope B. If the BER tester continues to indicate a good link, this indicates retroflection. Again, offsetting the units from the common axis (see bottom of Figure 2) is the best solution to avoid this problem.

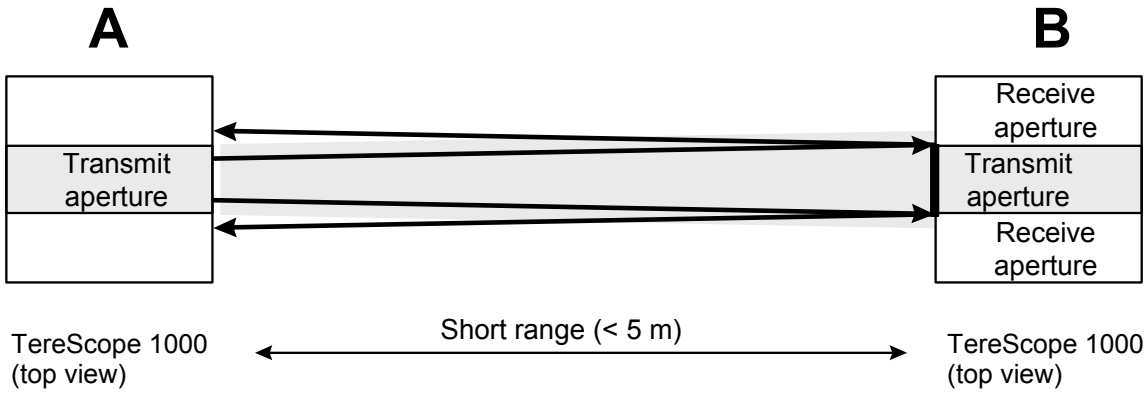


Figure 14. Retroreflection of the transmit beam from TereScope A off the front of the optics of TereScope B and back into the receive aperture of TereScope A.

MAINTENANCE & SERVICE

MAINTENANCE: Very little maintenance is required to assure the performance of your TereScope system. The optics lens at the front of the transceiver should be cleaned periodically. To avoid radiation exposure at the window aperture, turn off the system power using the power switch found on the back of the telescope. Wipe the glass using a regular glass cleaner and soft cloth or lint-free paper towel. We recommend cleaning approximately every three months; however, depending on weather conditions, the glass may require more frequent attention.

Your TereScope has been equipped with an anticorrosive device, designed to protect components against corrosion in non-ventilated housings. This emitter releases a vapor into the interior of the electronics box, which deposits on the metal surfaces, forming a protective molecular layer. It is non-toxic and safe to handle and apply and has been designed to help protect the TereScope's electronics box for two years. If the access door is opened frequently, we recommend replacing it more often than every two years. If the emitter is moist, possibly due to moisture in the electronics box, it is recommended that the emitter be replaced. Contact the MRV Communications Technical Services Center for replacements.

Correct alignment of the TereScope 1000 and 1000X is critical. We recommend checking the alignment of the TereScope system on a regular basis. Another suggestion is to record the system data for three to six months to create a baseline.

Please note: Although the TereScope 1000 and 1000X comply with ANSI standards for eye safety (see safety warning), prior to performing routine maintenance, the units should be powered down with the Laser Enable power switch.

Take care when standing near or touching the TereScope unit. A small amount of motion can cause the units to become misaligned. If this occurs, realign the system using the fine alignment procedure described previously in this manual.

SERVICE: The TereScope 1000 and 1000X are not field serviceable. Contact the MRV Communications Technical Services Center to obtain instructions regarding product service by our personnel. Do not attempt to remove the protective housing from the back of the unit. The warranty will be void if the tamper-resistant screws and warranty labels if the cap has been taken off and.

Please note: Failure to follow this warning could result in exposure to Class IIIb invisible laser radiation.

All defective equipment must be returned to MRV Communications for repair in the original shipping container. If MRV Communications Technical Services Center determines that your equipment, or any part of it, will need to be returned to the factory for repair, an RMA (Return Merchandise Authorization) number must be obtained prior to shipping equipment. Failure to obtain an RMA number prior to shipment will result in delays with repairing the equipment. The RMA number must be clearly marked on the outside of the shipping container.

TROUBLESHOOTING GUIDE

To effectively troubleshoot any problems that arise, personnel on site should have the equipment listed previously for set-up and installation - specifically a television monitor and either a PC or a PalmPilot™. If remote management has been installed, this can be done without gaining access to the units.

Indication	Potential Cause
Receive Light is out on one side	• Other unit's laser has been disabled. Check to see that the laser lockout switch is turned to the position where the key cannot be removed. • Check alignment of BOTH units with the TV monitor. • Laser failure on the other unit. Check the monitor photodiode (MPD) readout on the TereScope monitoring program or the PalmPilot interface. If it reads zero and the laser is enabled, contact MRV Communications for replacement options.
Receive Light is intermittent or the Receive Signal Strength (RSSI) is low and erratic.	• Other unit may not be "transmitting". Check to see that the transmit light is on. This is an indication of whether or not there is a data source connected to the unit. Without a data source, the TereScope transmits noise - which can give a false receive light at close ranges. • If the transmit light is on, verify alignment of BOTH units.
Transmit LED is off	• Check the fiber connection between the switch and TereScope. • Check alignment. If either end of the link is misaligned, most switches will re-route traffic to the backup (if there is one) and won't provide a signal to the unit until the link is aligned and provides an open channel for the router/switch.
All LED's are off	• Check ON/OFF switch. • Verify AC line in. • Possible DC power supply failure. Contact the MRV Communications Technical Services Center.

WARRANTY INFORMATION

LIMITED WARRANTY

MRV Communications warrants its equipment to be in good working order for thirteen (13) months from the date of shipment. If equipment proves to be defective and MRV Communications is notified within the warranty period, MRV Communications will, at its option, repair or replace the equipment at no charge. All repairs will be done at MRV Communications' repair facility. Damage to equipment resulting from negligence, misuse, tampering or acts of God is not covered by this warranty. MRV Communications will make every effort to rerun your equipment to you as quickly as possible. Shipping costs for the return of equipment for repair by MRV Communications shall be the responsibility of the purchaser.

All defective equipment must be returned to MRV Communications for repair in the original shipping container. If MRV Communications' Technical Support Department determines that your equipment, or any part of it, will need to be returned to the factory for repair, an RMA number must be obtained prior to shipping equipment. Failure to obtain an RMA number prior to shipment will result in delays with repairing the equipment. This number must be marked clearly on the outside of the shipping container.

Limitations of Liability: Except for liability allowed by applicable law, (I) in no event shall MRV Communications be liable under any legal theory, however caused, for any loss of profits, loss of business, loss of use or data, interruption of business, or for indirect, special, incidental or consequential damages of any kind, even if MRV Communications has been advised of the possibility of such damages and (II) in no event will MRV Communications' aggregate liability arising out of or related to this warranty exceed the amount paid or payable to MRV Communications for the defective equipment. These limitations of liability will continue beyond the expiration of this warranty. This warranty is in lieu of all other warranties, express or implied or statutory, including any warranty of merchantability or fitness for a particular purpose.

CONTACT US

Equipment Return Address:

Attn: Technical Services Center
MRV Communications - San Diego Operations
10343 Roselle Street
San Diego, California 92121

Phone:
858-657-9663
Fax:
858-657-9677
E-mail:
service@mrv.com

www.mrv.com
www.opticalaccess.com

APPENDIX A: TERESCOPE 1000 AND 1000X HOLE PATTERN

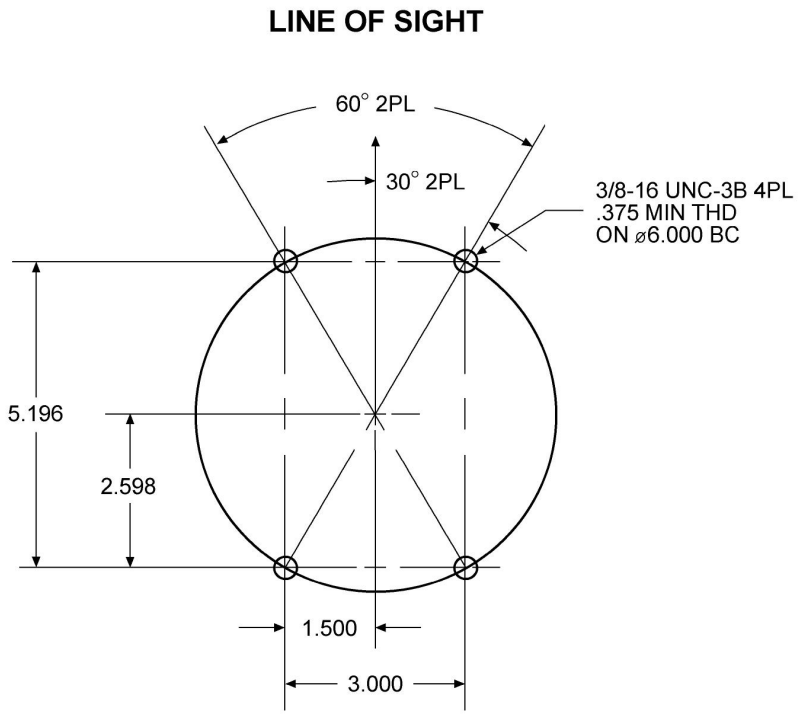
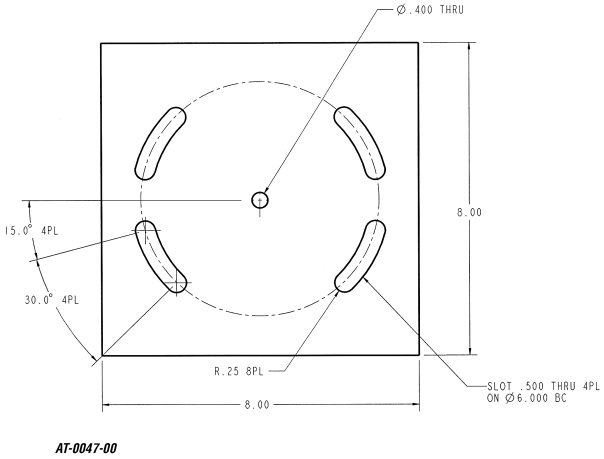


Figure A-1. Hole Pattern for TereScope 1000.

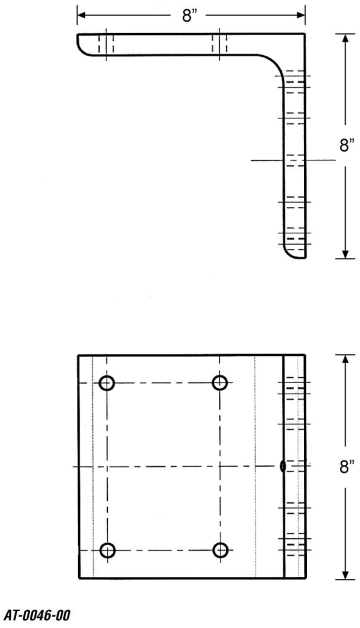
APPENDIX B: MOUNTING OPTIONS

Figure B-1. Mountable Gimbal - Direct to a flat wall surface. Attach with 4-3/8" concrete anchors.



Mountable Gimbal Footprint
Interface material: concrete or metal

Figure B-2. M001 Angle Bracket - Use when the wall is too thin to mount to the top. Can be used on inner or outer wall surface (reversible).

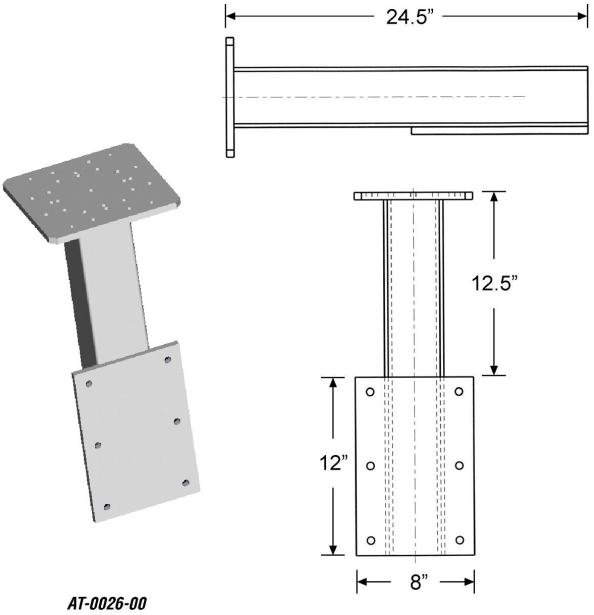


M001 – Angle Bracket Mount
Interface material: concrete or metal

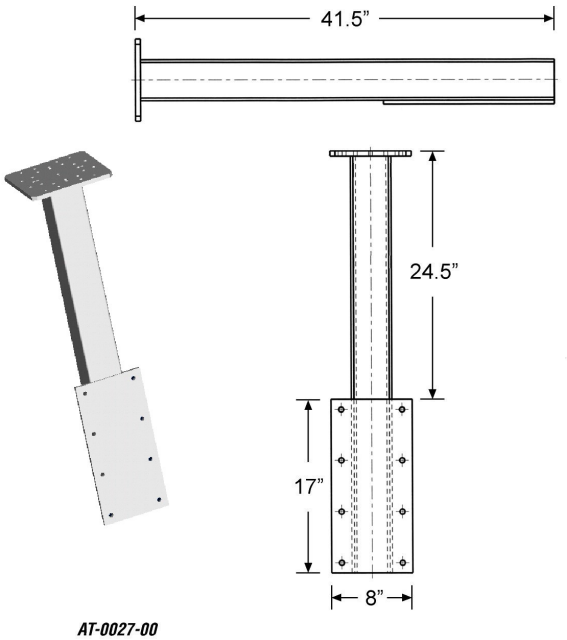
WALL PEDESTAL MOUNTS

Figure B-3. Wall Pedestal Mount - Used when the link needs to be elevated above the top of a wall.

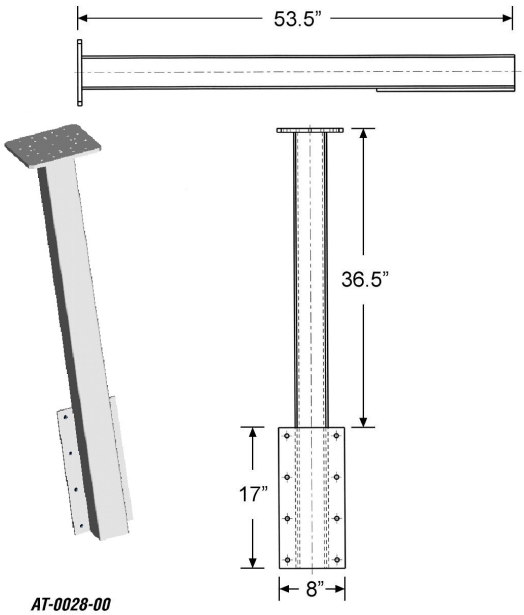
M054 – 12 inch
M053 – 24 inch
M060 – 24 inch w/ spacer
M022 – 36 inch



M054 – 12” Wall Pedestal Mount
Interface material: concrete or metal



M053 – 24” Wall Pedestal Mount
Interface material: concrete or metal



M022 – 36” Wall Pedestal Mount
Interface material: concrete or metal

FLOOR PEDESTAL MOUNTS

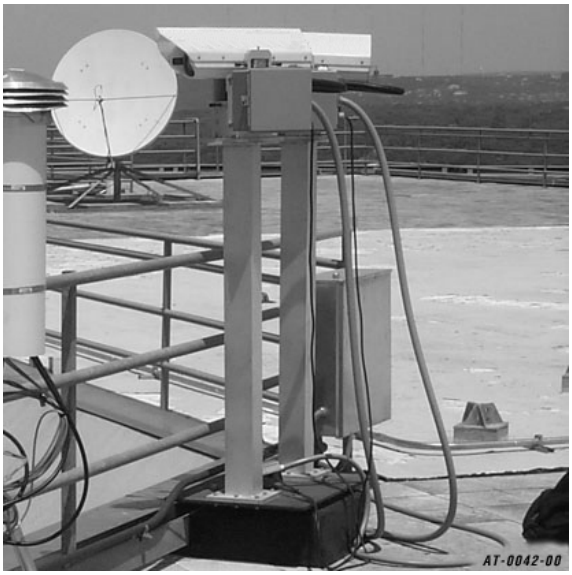
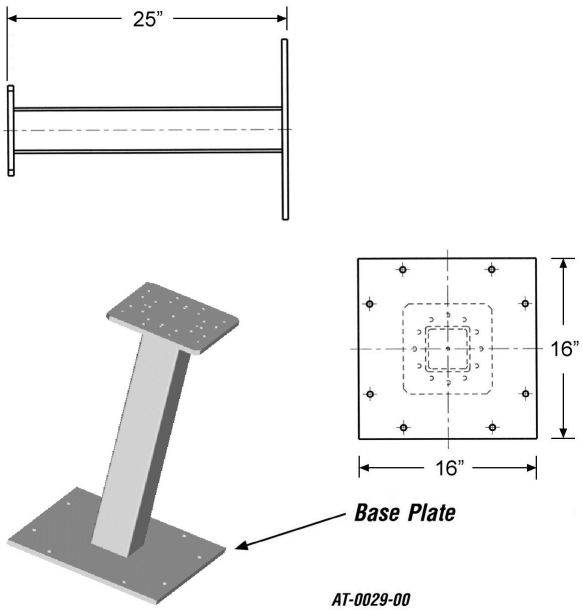
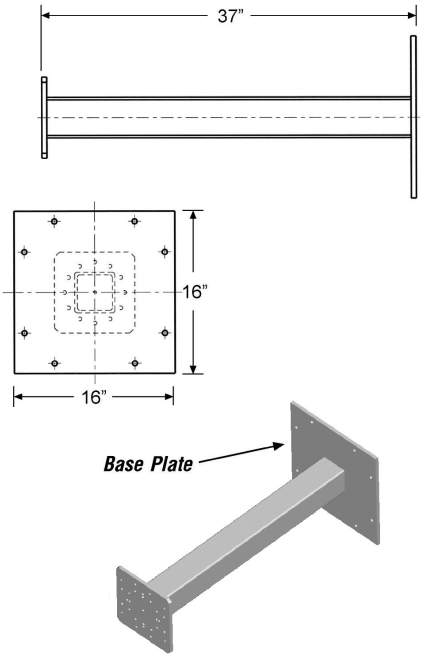


Figure B-4. Floor Pedestal Mount - Similar to the Wall Pedestal Mount.

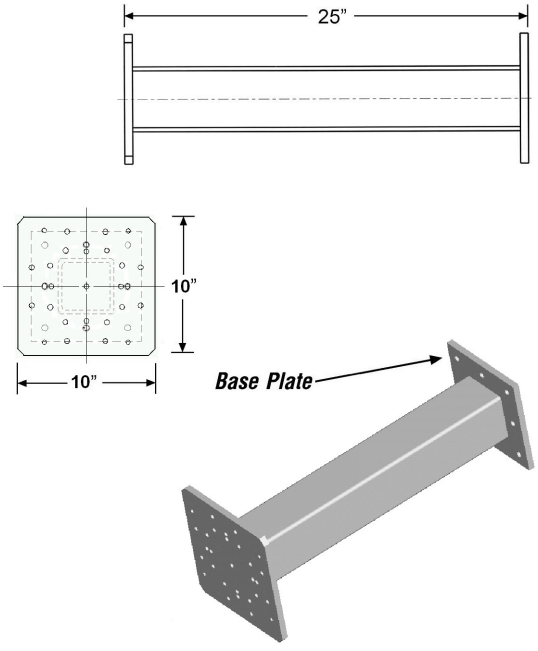
Interface material: concrete	Interface material: metal
M055 – 24 inch	M057 – 24 inch
M050 – 36 inch	M058 – 36 inch
M015 – 48 inch	M059 – 48 inch



M055 – 24” Floor Pedestal Mount
Interface material: concrete

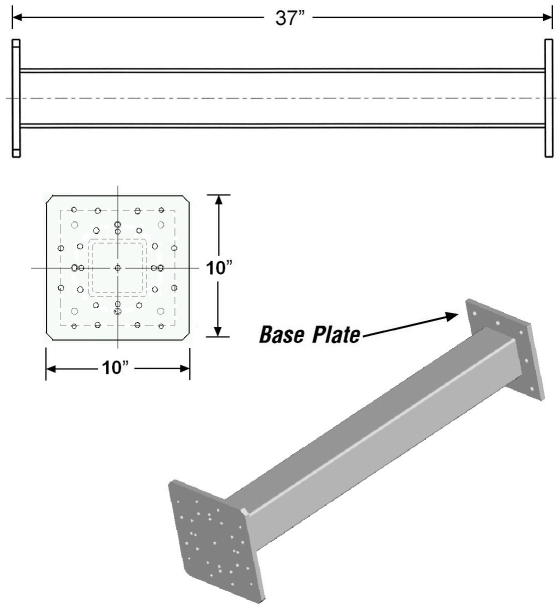


M050 – 36” Floor Pedestal Mount
Interface material: concrete

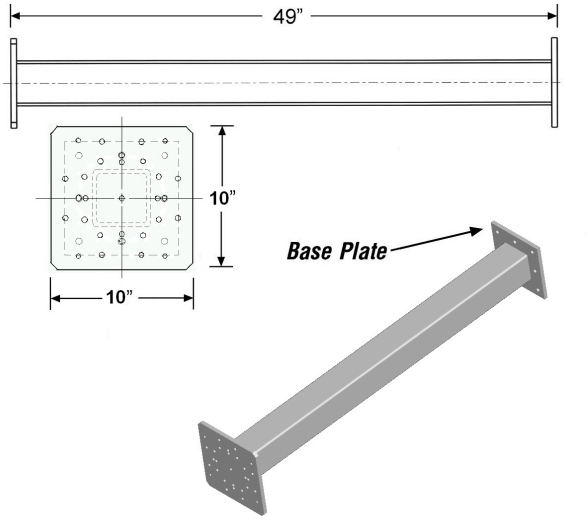


M057 – 24” Floor Pedestal Beam Mount
Interface material: metal

FLOOR PEDESTAL MOUNTS (con't)

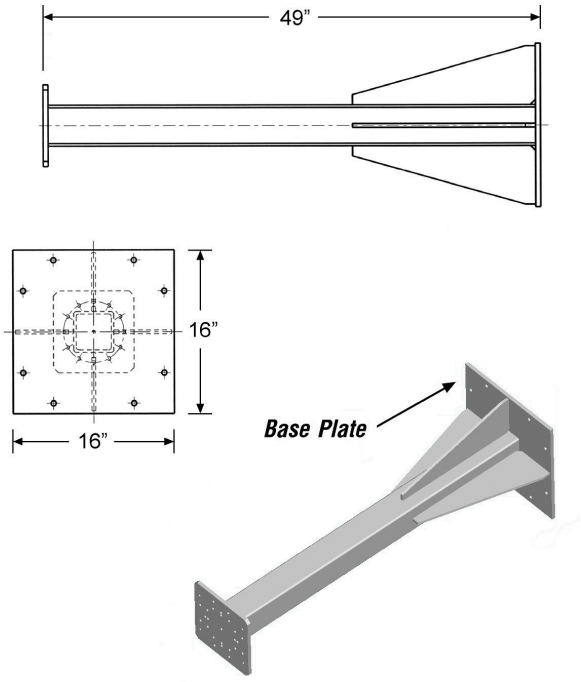


M058 – 36" Floor Pedestal Beam Mount
Interface material: metal



M059 – 48" Floor Pedestal Beam Mount
Interface material: metal

Figure B-5. M015 Reinforced Floor Pedestal Mount
- Similar to the Standard Floor Pedestal.
Standard length: 48".

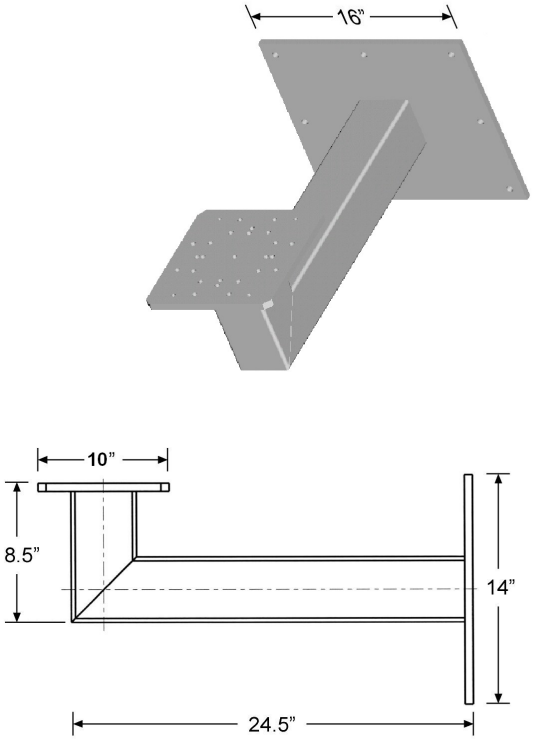


M015 – 48" Reinforced Floor Pedestal Mount
Interface material: concrete

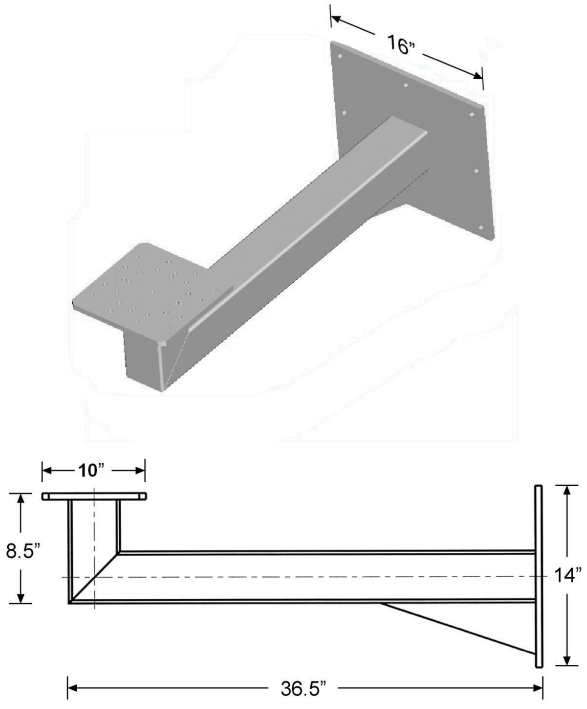
EXTENDED WALL MOUNTS

Figure B-6. Extended Wall Mount – Used when a standard wall pedestal mount is insufficient to clear obstacles or for applications requiring an extension from the wall for better access to the transceiver.

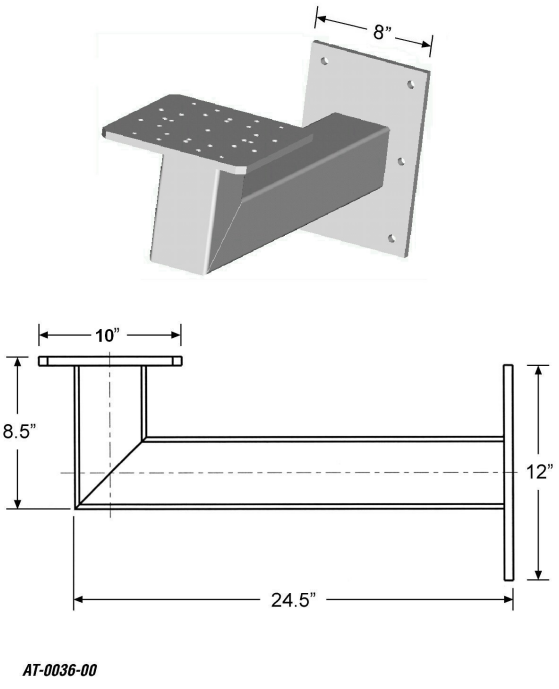
Interface material: concrete	Interface material: metal
M051 – 24 inch	M062 – 24 inch
M056 – 36 inch	M063 – 36 inch



M051 – 24” Extended Wall Concrete Mount
Interface material: concrete

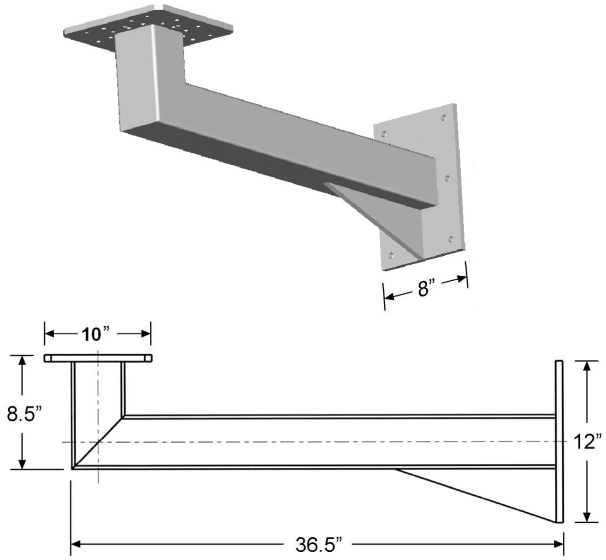


M056 – 36” Extended Wall Concrete Mount
Interface material: concrete



M062 – 24” Extended Wall Beam Mount
Interface material: metal

EXTENDED WALL MOUNTS (con't)



M063 – 36" Extended Wall Beam Mount
Interface material: metal

APPENDIX C: OPTIONAL CLOSE RANGE ATTENUATOR

The TereScope 1000 and 1000X were designed to operate at ranges up to 1 km. If the units are set up too close together, saturation will occur as there will be too much light on the detector. If the TereScopes are to be set up 150 meters or less apart (this distance is dependent on the TereScope product being used), the optional Close Range Attenuator needs to be installed in the front of both units.

Installation of the Close Range Attenuator

The Close Range Attenuator consists of two parts: (1) the mount (see Figure C-1) and (2) the neutral density filter (see Figure C-2).

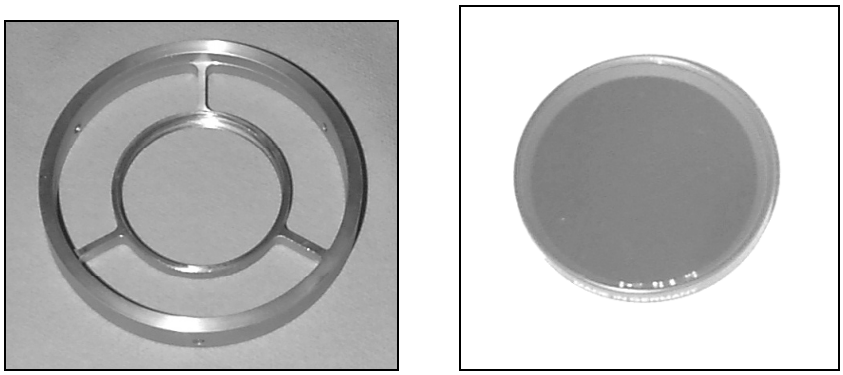


Figure C-1. Left: the Close Range Attenuator Mount. Right: the Neutral Density filter.

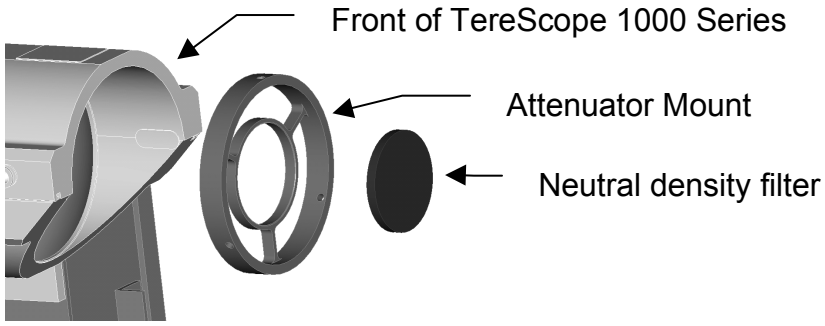


Figure C-2. Relative position of attenuator mount and neutral density filter with respect to the front of the TereScope. The attenuator mount is installed first. Note the orientation of the mount. The radial arms and circular ring that holds the neutral density filter are flush with the back of the mount (which faces the front of the TereScope). The set screws are closer to the front of the attenuator mount. The mount is rotated so that one of the set screws is pointing straight up. After the mount is tightened in place the neutral density filter is screwed into the mount.

STEP 1: Insertion of Close Range Attenuator Mount

DO NOT touch the front glass lens of the TereScope while inserting the attenuator mount. Correctly orient the attenuator mount in your hand before inserting it into the front aperture of the TereScope. There are two factors to consider when orienting the attenuator mount. There is a front and back to the mount. The radial arms and circular filter holder are flush with the back of the mount (see Figure C-2). The mount is inserted so that the back of the mount faces the front aperture lens of the TereScope. If inserted correctly, the circular neutral density filter holder will be flush up against the front lens if inserted correctly (notice that if you place the front end of the mount toward the aperture, there will be a space between the circular filter holder and the front lens of the TereScope –this is incorrect).

The mount has to be rotated to the correct angle. There are three set screws that hold the attenuator mount to the inside of the front aperture of the TereScope 1000 and 1000X. Rotate the mount so one of the set screws is pointing straight up. Once the mount is correctly oriented, carefully place the mount into front aperture of the TereScope and stop when the mount just makes contact with the front lens. Again, be careful not to touch the front lens with your fingers (see Figure C-3). The mount should slide in smoothly. Do not force the mount into the aperture. If the mount does not slide in smoothly, the set screws might need to be loosened.

Figure C-3. Once the mount is correctly oriented (back of the mount towards the TereScope, one set screw pointing upwards), carefully insert it into the front aperture of the TereScope.

Figure C-4 shows the mount in place. Once the mount is in place, gently tighten the set screws with a 5/64" hex key, starting with the top set screw. After the initial gentle tightening, tighten the set screws again in the same rotation so there is equal firm pressure holding the mount in place. The mount should be held firmly in place, but be careful not to overtighten the set screws.

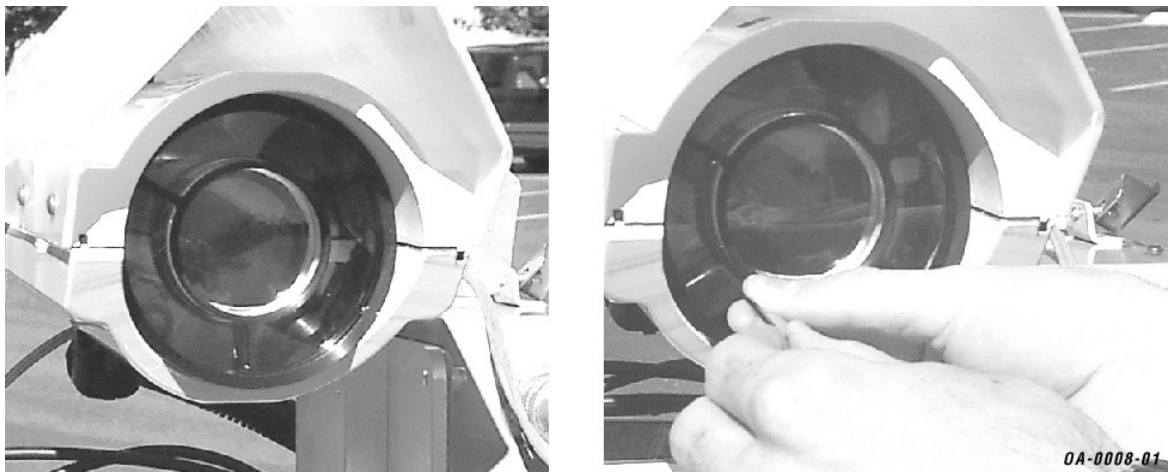


Figure C-4. Left: correct placement of mount. Right: tightening of the set screws. The set screws should be tightened gently, starting with the top set screw. After the initial gentle tightening, tighten the set screws again in the same rotation so there is equal firm pressure holding the mount in place.

STEP 2: Select and Install Neutral Density Filter

The next important step is the selection of the proper neutral density filter (see Table 1). The distance between the TereScope units determines the value of the neutral density filter. Measure the distance between the units. See Table C-1 or C-2 to determine the correct neutral density filter value.

Table C-1. T1000 Proper Neutral Density Filter Selection.

Link Range	Optical Density of Neutral Density Filter	B+W filter Number	Hoya filter number
Less than 60 m	0.9	N/A	1@ND (x8)
Greater than 60 m	No Attenuator needed	No Attenuator needed	No Attenuator needed

Table C-2. T1000X Proper Neutral Density Filter Selection.

Link Range	Optical Density of Neutral Density Filter	B+W filter Number	Hoya filter number
Less than 60 m	3.0	110	ND400
60 to 150 m	1.8	106	2@ND(x8)
Greater than 150 m	No Attenuator needed	No Attenuator needed	No Attenuator needed

NOTE: If Hoya filters are used for the 60 to 150 m range on the TereScope 1000X, two ND(x8) filters need to be used at each end. The filters are threaded so that they can be attached together and then placed into the filter mount.

Once the neutral density filter is selected, screw the filter into the mount. Again, be careful not to get fingerprints on the TereScope front lens or the front of the neutral density filter (see Figure C-5). The completed installation is shown in Figure C-6. The attenuator mount and neutral density filter need to be installed on both ends of the link.

NOTE: If the link is being transmitted through an office window, the window glass will provide some attenuation. This would change Tables C-1 and C-2 slightly, depending on how many windowpanes are in the path and the amount of window tint. Please contact the MRV Communications Technical Services Center for details.

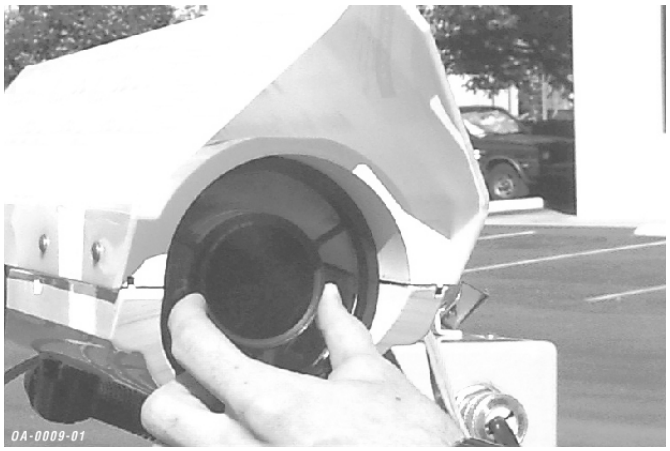


Figure C-5. Threading the neutral density filter into the mount.

Figure C-6. Attenuator mount and neutral density filter correctly installed.

APPENDIX D: TERESCOPE™ 1000 TRANSCEIVER SPECIFICATIONS

Transmitter:	
Laser Type	Single Mode AlGaAs Laser Diode
Laser Classification	Class 1M
Laser Wavelength	785 nm
Transmit Beam Diameter at Aperture	50 mm (2 in)
Transmit Beam Divergence	2.5 mrad
Average Output Power	7 mW (typical)
Maximum Range (clear conditions)	400 m
Transmit Beam Diameter (at max. range)	1 m (typical)
Allowable Mis-pointing Angle	1 mrad
Receiver:	
Detector	PIN
Receiver Field of View	3.5 mrad
Bit Error Rate	$< 10^{-9}$
Receiver Diameter	97 mm (4 in)
Receiver Area	0.005 m^2 (8 in^2)
Minimum Receive Power (average)	5000 nW (over receiver area)
Scintillation Fade Margin (at max. range)	7.5 dB
Allowable Atmospheric Attenuation (at max. range)	1 dB (visibility ≥ 2.5 miles)
Fiber Optic Interface:	
Line Data Rate	10-155 Mbps (full duplex)
Center Wavelength	1310 nm (850 nm option)
Fiber Link Length	2000 m (1.24 miles) (max.)
Input Optical Power	-28 dBm avg. (min.); -14 dBm avg. (max.)
Output Optical Power	
(62.5/125 μm fiber)	-18.5 dBm avg. (min.); -14 dBm avg. (max.)
(50/125 μm fiber)	-22.0 dBm avg. (min.); -14 dBm avg. (max.)
Interface Connectors	ST
Mechanical and Power:	
Operating Temperature	-30°C to 50°C (-22°F to 122°F)
Dimensions	24" long x 13" wide x 15.5" high
Weight	35 lbs
Input Power Requirements	100-240 VAC*, 50-60 Hz, single phase, 3 A *Voltage value set at factory.
Fuses	100-120 VAC F1: T 1.25A, 125 V (min) F2: T 3A, 125 V (min) 220-240 VAC F1: T 1.25A, 250 V F2: T 3A, 250 V
Operating Power (Including Heaters)	170 W
Operational Diagnostics:	
Alignment via CCD Camera	PalmPilot and Windows based monitoring software
Receive and Transmit Data Lights	Monitors receive signal level, laser, and temperature RS-232 based interface

Specifications subject to change without notice

CE

OA-0140-01

MRV Communications, Inc.

SAN DIEGO OPERATIONS
10343 Roselle Street
San Diego, CA 92121