

# **TereScope 1000P**

## Gigabit Ethernet Photonic Air Link

### **User Manual**



## Standards Compliance

This equipment is designed to comply with UL 1950; CSA 22.2 No 950; FCC Part 15 Class B; CE-89/336/EEC, 73/23/EEC, IP-66.

### FCC Notice

**WARNING:** This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct for the interference at his own expense.

The user is cautioned that changes and modifications made to the equipment without approval of the manufacturer could void the user's authority to operate this equipment.

It is suggested that the user use only shielded and grounded cables when appropriate to ensure compliance with FCC Rules.

### CE Mark

The CE mark symbolizes compliance with the EMC directive of the European Community. Such marking is indicative that the specified equipment meets or exceeds the following technical standards:

- EN 55022 – Limits and Methods of Measurement of Radio Interference Characteristics of Information Technology Equipment
- EN 50081-1 – Electromagnetic compatibility of Radio Interference Characteristics of Information Technology Equipment – Generic Emission standard Part 1: Residential commercial and light industry environment
- EN 50082-1 – Electromagnetic compatibility – Generic immunity standard Part 1: Residential, commercial and light industry environment
- EN61000-4-2 (previously IEC 1000-4-2) – Electromagnetic compatibility for industrial-process measurement and control equipment – Part 4, Section 2: Electrostatic discharge requirements
- EN61000-4-3 (previously IEC 1000-4-3) – Electromagnetic compatibility for industrial-process measurement and control equipment – Part 4, Section 3: Radiated electromagnetic field requirements
- EN61000-4-4 (previously IEC 1000-4-4) – Electromagnetic compatibility for industrial-process measurement and control equipment – Part 4, Section 4: Electrical fast transient/burst requirements
- EN61000-4-5 – Electromagnetic compatibility for industrial-process measurement and control equipment – Part 4, Section 5: Surge Immunity requirements
- EN61000-4-6 – Electromagnetic compatibility for industrial-process measurement and control equipment – Part 4, Section 6: Immunity to conducted disturbances induced by radio frequency fields
- EN61000-4-8 – Electromagnetic compatibility for industrial-process measurement and control equipment – Part 4, Section 8: Power frequency magnetic field immunity requirements
- EN61000-4-11 – Electromagnetic compatibility for industrial-process measurement and control equipment – Part 4, Section 11: Voltage dips short interruptions and voltage variations immunity requirements
- EN61000-3-2 – Harmonic standard
- EN61000-3-3 – Voltage Fluctuation and Flicker standard
- CISPR 22 – Radiated and Line-conducted Class B
- EN 60950 – ITE Safety

A 'Declaration of Conformity', in accordance with the above standards, has been made and is on file at MRV®.

## MRV® Laser Safety Certification

The TereScope 1000P is designed, built, and tested to be eyesafe, even if the output beams are viewed directly, provided that no magnifying optics are used.

This product is Class 1 according to the American National Standard for Safe Use of Lasers ANSI Z136.1-1993 provided that there is no reasonable probability of accidental viewing with optics in the direct path of the beam where the TereScope 1000P is installed.

This product is Class 1M according to the International Standard of the International Electrotechnical Commission IEC 60825-1, Amendment 2, January 2001 entitled "Safety of laser products." The following explanatory label is applicable to these products:

**LASER RADIATION  
DO NOT VIEW DIRECTLY WITH OPTICAL INSTRUMENTS  
(BINOCULARS OR TELESCOPES)  
CLASS 1M LASER PRODUCT**

This product complies with United States FDA performance standards for laser products except for deviations pursuant to Laser Notice No. 50 as published in June, 2001, which allows for the use of the IEC 60825-1 classification standard. Under this standard, these products are Class 1M.

A 'Declaration of Conformity', in accordance with the above standards, has been made and is on file at MRV.

## Disclaimer

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### Contact Information

For customer support, you can:

- Contact your local MRV representative
- E-mail us at [InternationalSupport@mrv.com](mailto:InternationalSupport@mrv.com)
- Visit our MRV Web site at <http://www.mrv.com>

# Contents

<b>About this Manual .....</b>	<b>8</b>
<b>Purpose.....</b>	<b>8</b>
<b>Audience.....</b>	<b>8</b>
Qualifications .....	8
Training.....	8
Experience.....	8
Authorization.....	8
<b>Latest Revision .....</b>	<b>8</b>
<b>Related Documents .....</b>	<b>8</b>
<b>Acronyms .....</b>	<b>9</b>
<b>Safety Requirements.....</b>	<b>9</b>
<b>When Installing .....</b>	<b>9</b>
<b>During Operation .....</b>	<b>10</b>
<b>Overview .....</b>	<b>11</b>
<b>General.....</b>	<b>11</b>
<b>Features .....</b>	<b>11</b>
<b>Advantages.....</b>	<b>12</b>
<b>Applications .....</b>	<b>12</b>
<b>Layout .....</b>	<b>13</b>
<b>Pre-Installation .....</b>	<b>14</b>
<b>General.....</b>	<b>14</b>
<b>Tools &amp; Equipment .....</b>	<b>14</b>
<b>Site Survey Procedure.....</b>	<b>15</b>
Site Suitability .....	15
Line of Sight.....	15
Range and Location.....	15
Mounting Environment & Stability.....	18
Transmitting through a Window .....	20

---

Routine Checks for Adjustments .....	21
Ordering Equipment .....	21
<b>Installation .....</b>	<b>22</b>
<b>Fiberoptic Cable .....</b>	<b>22</b>
General .....	22
Handling .....	22
Testing .....	22
Laying .....	24
Preparation .....	24
Connection .....	24
<b>Mounting .....</b>	<b>24</b>
Mounting Accessories .....	25
Mounting Procedure .....	25
<b>Special Mounting Techniques .....</b>	<b>26</b>
Mounting on the Floor .....	27
Mounting on a Fragile/Crumbly Wall .....	27
<b>Alignment .....</b>	<b>28</b>
General .....	28
Tools and Equipment .....	28
Procedure .....	28
<b>Connecting the TereScope 1000Ps, Media Converters .....</b>	<b>32</b>
<b>Link Test .....</b>	<b>35</b>
<b>Installation Log .....</b>	<b>35</b>
<b>Troubleshooting .....</b>	<b>36</b>
<b>Appendix A: Product Specification .....</b>	<b>37</b>
<b>Appendix B: Required Materials .....</b>	<b>39</b>
<b>Optic Module .....</b>	<b>39</b>
<b>Installation Tools .....</b>	<b>39</b>
<b>Equipment for Fiber Test and Link Alignment .....</b>	<b>39</b>
<b>Appendix C: Site Survey Form .....</b>	<b>40</b>

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<b>Appendix D: Cleaning Optical Connectors</b> .....	<b>41</b>
General.....	41
Tools and Equipment.....	41
Procedure .....	41
<b>Appendix E: Installation Log</b> .....	<b>42</b>
<b>Appendix F: Received Signal Power vs Distance</b> .....	<b>46</b>
<b>Appendix G: Cabling</b> .....	<b>47</b>
Cabling.....	47
<b>Appendix H: MC102/G/SX/PAL</b> .....	<b>48</b>
General.....	48
Models.....	48
Layout .....	48
Front .....	48
Rear .....	49
Ambient Temperature .....	49
Mounting.....	50
Cabling.....	50
Fiberoptic.....	50
Switch Side .....	50

## Figures

Figure 1: Typical Application of TereScope 1000P .....	12
Figure 2: Front View of TereScope 1000P.....	13
Figure 3: Rear View of TereScope 1000P .....	14
Figure 4: Optimal Mounting.....	16
Figure 5: Acceptable Mounting .....	16
Figure 6: Unrecommended Mounting .....	17
Figure 7: Unacceptable Mounting .....	17
Figure 8: Mounting Locations in Order of Preference .....	18
Figure 9: Parapet/Ledge Mounting (using JMP only).....	19
Figure 10: Wall Mounting (using JMP and JMB).....	19
Figure 11: Floor Pedestal Mounting (using JMP and M015C).....	19
Figure 12: Wall Pedestal Mounting (using JMP and M054C) .....	19
Figure 13: Extended Wall Mounting (using JMP and M062C).....	20
Figure 14: Arrangement for Transmitting through a Window .....	21
Figure 15: Light Source (left) and Optical-Power Meter (right) – Examples .....	23
Figure 16: TereScope 1000P with Mounting Plate and O-Ring .....	26
Figure 17: Drawing of Vertical Mounting Brackets (JMBs) .....	26
Figure 18: Mounting on a Concrete Slab .....	27
Figure 19: Mounting on a Fragile Wall .....	28
Figure 20: Fine Alignment Motion Screws – Rear View.....	29
Figure 21: Connectors for Fiberoptic Cables .....	30
Figure 22: Beam (circle) on Receiver (rectangle) after Horizontal Alignment.....	31
Figure 23: Final Beam after Horizontal and Vertical Alignment .....	31
Figure 24: Flange and Fiberoptic Cable Duct .....	32
Figure 25: Extracting the Terminal Block by the Yellow Wire Loop .....	32
Figure 26: Extracting the Terminal Block by a Pair of Pliers.....	33
Figure 27: Insertion of the Terminal Block and Fiber Strain Relief .....	33
Figure 28: Connection of the Wires from the TereScope 1000P to the Heating Power Supply Connector .....	34
Figure 29: Interconnection of TereScope 1000P, Media Converters, & Switches .....	34
Figure 30: Air Link Distance vs Expected Received Signal Power .....	46
Figure 31: MC102G/P Layout .....	48

## Tables

Table 1: TereScope 1000P Features.....	11
Table 2: Air Link Distance vs Minimum Required Received Signal Power .....	46
Table 3: Front Panel LEDs.....	49

# About this Manual

## Purpose

This manual is intended for the user who wishes to install, operate, manage, and troubleshoot the TereScope 1000P<sup>1</sup> photonic air link.

## Audience

### Qualifications

Users of this manual are expected to have working knowledge of:

- Fiberoptic Cabling
- LAN equipment (Layer 2)

### Training

Installers are required to do a training course on *MRV* TereScopes that includes:

- IR links (site survey, installation equipment, alignment, etc.)
- Indoors and outdoors installation
- On-the-job-training
- Proficiency tests

### Experience

Installers are required to have experience in LAN installation and IR equipment installation.

### Authorization

When all the requirements specified above (namely, Qualifications, Training, and Experience) have been met, the installer is required to receive authorization from *MRV* certifying eligibility.

## Latest Revision

The latest revision of the user manual can be found at:

[ftp.international.mrv.com/support/tech\\_data](ftp.international.mrv.com/support/tech_data)

## Related Documents

- Release Notes for TereScope 1000P – if applicable. (This document contains information not found in the User Manual and/or overriding information.)

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<sup>1</sup> TereScope is a trademark of *MRV*.




- TereScope Installation Guide (Publication No. 46366)
- 

## Acronyms

<b>CATV</b>	Cable Antenna TeleVision
<b>CLI</b>	Command Line Interpreter
<b>GPS</b>	Global Positioning System
<b>IR</b>	Infra-Red
<b>MTBF</b>	Mean Time Between Failures
<b>NA</b>	Numerical Aperture
<b>PVC</b>	PolyVinyl Chloride
<b>RSSI</b>	Receiver Signal Strength Indication
<b>STP</b>	Shielded Twisted-Pair
<b>TELNET</b>	(dial-up) TELEphone NETwork (connection protocol)
<b>UTP</b>	Unshielded Twisted-Pair

## Safety Requirements

	<b>Caution!</b>
	To reduce risk of injury and to maintain proper operation, ensure that the safety requirements stated hereunder are met!

## When Installing

- Ensure, by visual inspection, that no part of the TereScope 1000P is damaged.
- Avoid prolonged eye contact with the laser beam.
- Ensure that the system is installed in accordance with ANSI Z136.1 control measures (engineering, administrative, and procedural controls).
- Ensure that the system is installed in accordance with applicable building and installations codes.
- Install the TereScope 1000P in a restricted location as defined in this manual since it is a Class 1M FSOCS transmitter and receiver. A restricted location is a location where access to the transmission equipment and exposed beam is restricted and not accessible to the general public or casual passerby. Examples of restricted locations are: sides of buildings at sufficient heights, restricted rooftops, and telephone poles. This definition of a restricted location is in accordance with the proposed IEC 60825-1 Part 12 requirements.
- Avoid using controls, adjustments, or procedures other than those specified herein as they may result in hazardous radiation exposure.

## **During Operation**

Avoid prolonged eye contact with the laser beam.

# Overview

## General

TereScope 1000P is a wireless optical communication link for transferring Gigabit Ethernet data over a distance of up to 260 m (842 ft) at 30 dB/km.

The TereScope 1000P is unique in that data transmission and reception is *fully optical*. Most wireless optical links have an interface unit for transferring data between the transmission lines and air transceiver. In the TereScope 1000P, optical data is *directly* transferred between a special fiberoptic cable and the air, using appropriate beam-shaping optics, without any intermediate processing electronics. This technology eliminates all the disadvantages of electrical components (e.g., electric power, RFI/EMI, etc.) while providing all the inherent advantages of optics (e.g., large bandwidth, greater reliability, higher security, etc.).

The TereScope 1000P is used with a special fiberoptic cable and electro-optic module provided by *MRV*. The fiberoptic cable has differing transmit and receive fibers. The TereScope 1000P outdoor unit should interface with the MC102G/P media converter only, via the supplied fiberoptic cable.

The TereScope 1000P has a special proprietary coating on the lenses in order to prevent condensation effects on the lenses. As an additional safety measure against moisture build-up on its lenses, the TereScope 1000P system also includes an optional heating element. This heating element is powered by a power supply (supplied with the TereScope 1000P system) located near the media converter via an *extra-low-voltage* power limiting circuit and two copper conductors integrated into the supplied optical cable.

For convenience, it is recommended that at least the rooftop portion of the heating installation (cabling and connections) be made so that if heating is required, only the indoor power connection needs to be made.

## Features

Table 1: TereScope 1000P Features

Characteristic	Model	
	TS1000/P/DST	
Link Length (max) (Link Length =lengths of two fiberoptic cables + distance between the two TereScope 1000Ps.)	260 m (842 ft) at 30 dB/km	
Receive (at Switch) Fiber Core/Cladding Diameters	200/230 $\mu\text{m}$	
Beam Divergence	2 mrad	
Fiber-coupled power	7 dBm	

## Advantages

- MTBF – over 10 years
- Secure transmission
- No electric power needed
- No need for electrical grounding or lightning protection
- No opto-electronic transducers needed
- No EMI/RFI either to or from the TereScope 1000P.
- Immediate deployment
- Temporary or permanent installation
- Installable in harsh terrain and over obstacles (rivers, highways, etc.)
- License-free

## Applications

- Point-to-Point and Mesh network topologies
- Last-mile connectivity
- Cellular network
- LAN/WAN environments
- Fiber backup
- Disaster recovery backup

Figure 1 shows a typical application of the TereScope 1000P.

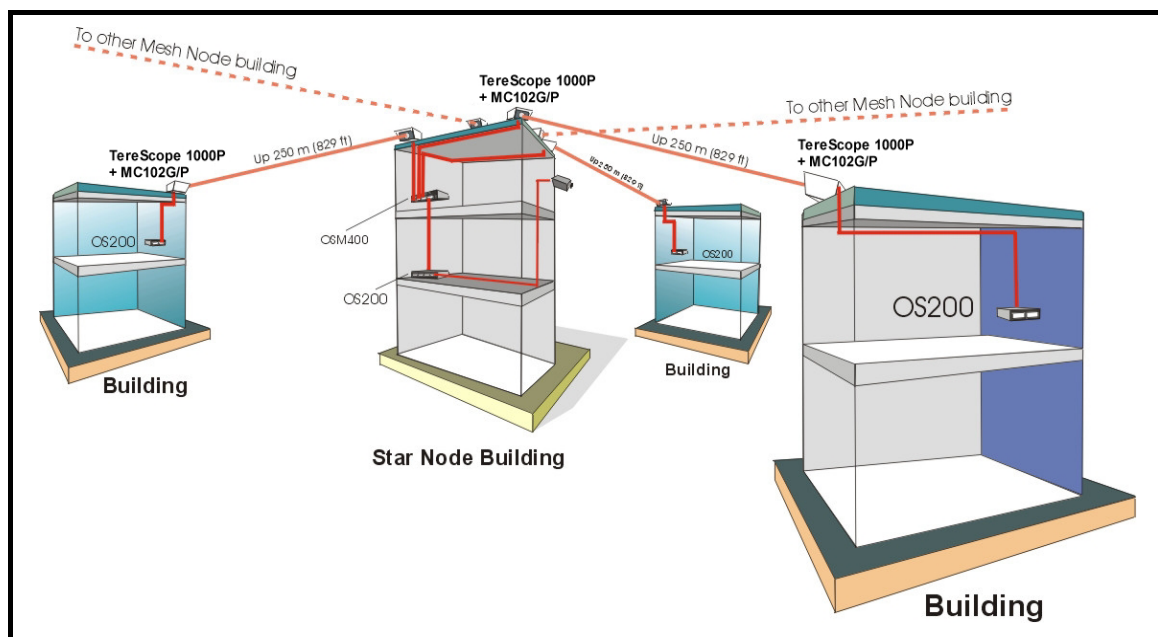


Figure 1: Typical Application of TereScope 1000P

# Layout

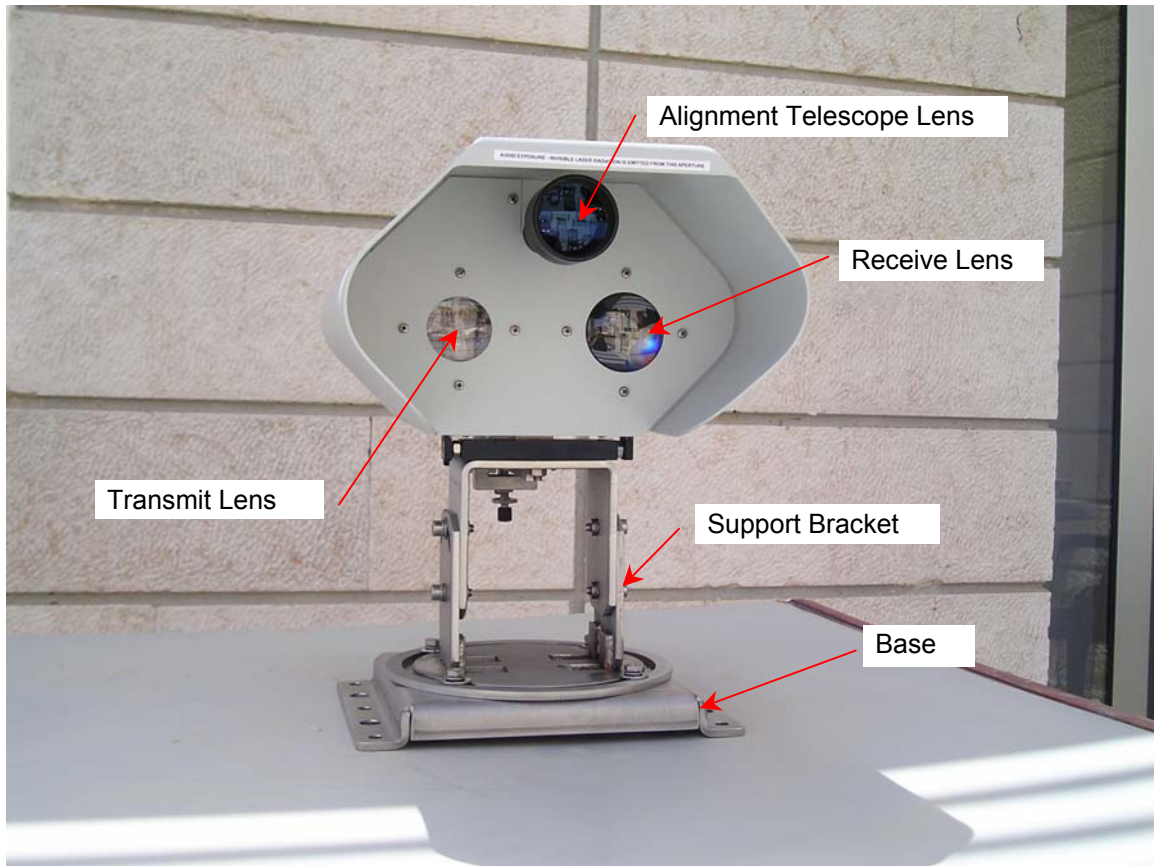


Figure 2: Front View of TereScope 1000P

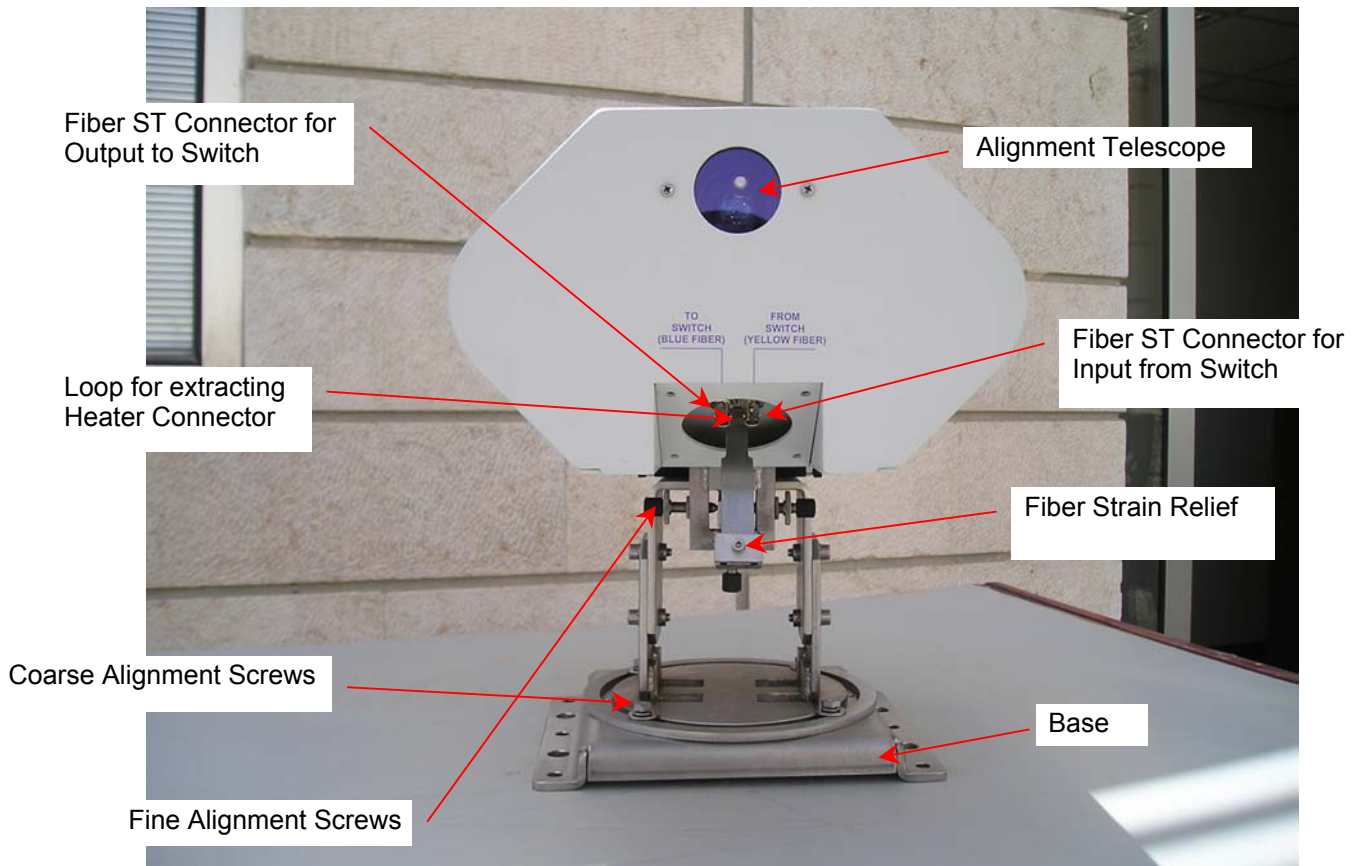


Figure 3: Rear View of TereScope 1000P

## Pre-Installation

### General

Site survey is **key** for finding a suitable geographical area for an optical wireless link. A good site survey, which covers all aspects of the installation requirements, is a pre-requisite for satisfactory link installation and operation. Accordingly, it is important:

- To determine the optimal geographical location for the link elements.
- That customers recognize their responsibilities prior to installation.

On completion of the link design, the *Site Survey Form* (shown in *Appendix C: Site Survey Form*) should be filled out to assure complete coverage of all installation aspects.

### Tools & Equipment

The following equipment are useful in performing a successful and accurate site survey:

- Rangefinder binoculars
- Digital camera

- Compass
- GPS receiver
- 3 m tape measure.
- Site Survey Form (shown in *Appendix C: Site Survey Form*)

## Site Survey Procedure

### Site Suitability

1. Try to avoid East-West directions for links because even if  $0.5^\circ$  of the sun disk overlaps the receiver telescope, errors may occur on a few days in a year for a few minutes each day.
2. Choose buildings of medium height. Avoid tops of skyscrapers because of their large sway. In suburban areas, you should choose the tallest building in the area that is not too tall.

### Line of Sight

1. Make sure that no obstacles cross the line of sight between the two TereScope 1000Ps.  
Examples of obstacles are: Growing trees, New buildings, Crane movement, Bridges over which tall vehicles may pass, Birds nesting, Hot surfaces (such as metal or black roofs), Exhaust gases or dust clouds, Smoke from chimneys.
2. **Photograph** the line of sight view from the rooftops.



#### Note

It is important to photograph the view containing the line of sight from the elevation at which you are going to mount the TereScope 1000Ps. The photograph can be used to: Recheck the location for details that may have been overlooked during the survey, Show it for consultation, etc.

### Range and Location

1. Referring to the data in *Appendix A: Product Specification*, under **Operating Range**, choose and record the distance between the two TereScope 1000Ps of the link. (You can use any of the following equipment to determine the distance: rangefinder laser binoculars, GPS receiver, maps, etc.)
2. Noting that the length of fiberoptic cabling (interconnecting a TereScope 1000P and Media Converter) should not exceed 50 m (164 ft), choose and record the acceptable distance between each TereScope 1000P and the Media Converter.
3. Noting that two TereScope 1000Ps are required per link,
4. Record the bearing to the opposite site by compass.
5. Record the number of links to be installed at the site.
6. Note whether additional sheltering is needed for the TereScope 1000Ps, for e.g., against strong winds (120km/h or more) – see *Appendix C: Site Survey Form* for details.

Figure 4 and Figure 5 show optimal and acceptable locations for the TereScope 1000P links. Notice that in both figures the TereScope 1000Ps are mounted on rooftop edges and high enough above the ground.

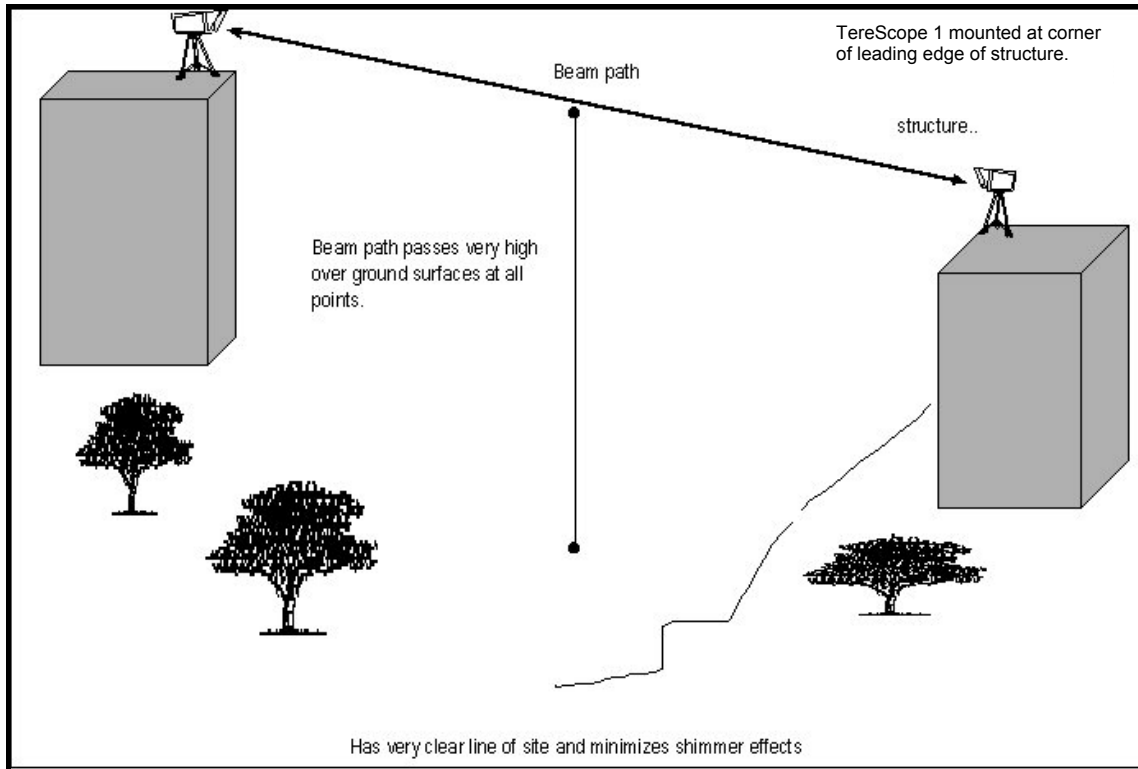


Figure 4: Optimal Mounting

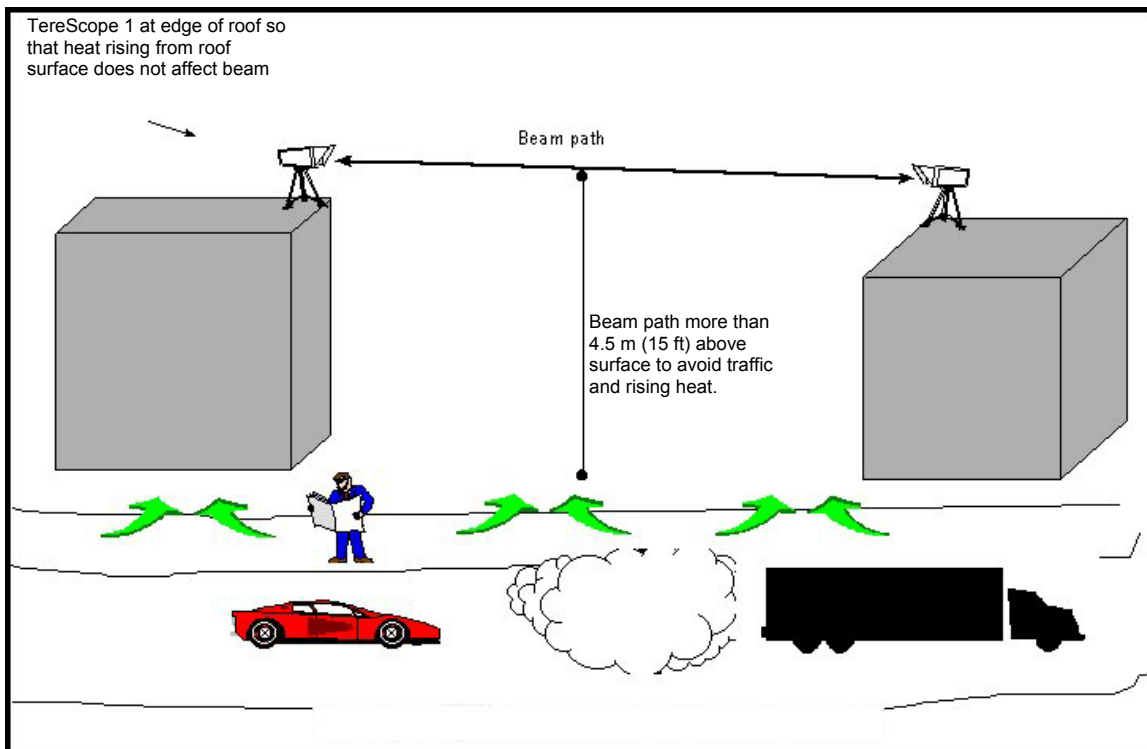


Figure 5: Acceptable Mounting



Figure 6 shows an unrecommended TereScope 1000P link location because of interference by IR. Notice that the TereScope 1000Ps are mounted far from the rooftop edges or are too close to the ground.

Figure 7 shows an *unacceptable* TereScope 1000P link location because of interference by passing vehicles. Notice that the TereScope 1000Ps are mounted far from the rooftop edges and not high enough above the ground.

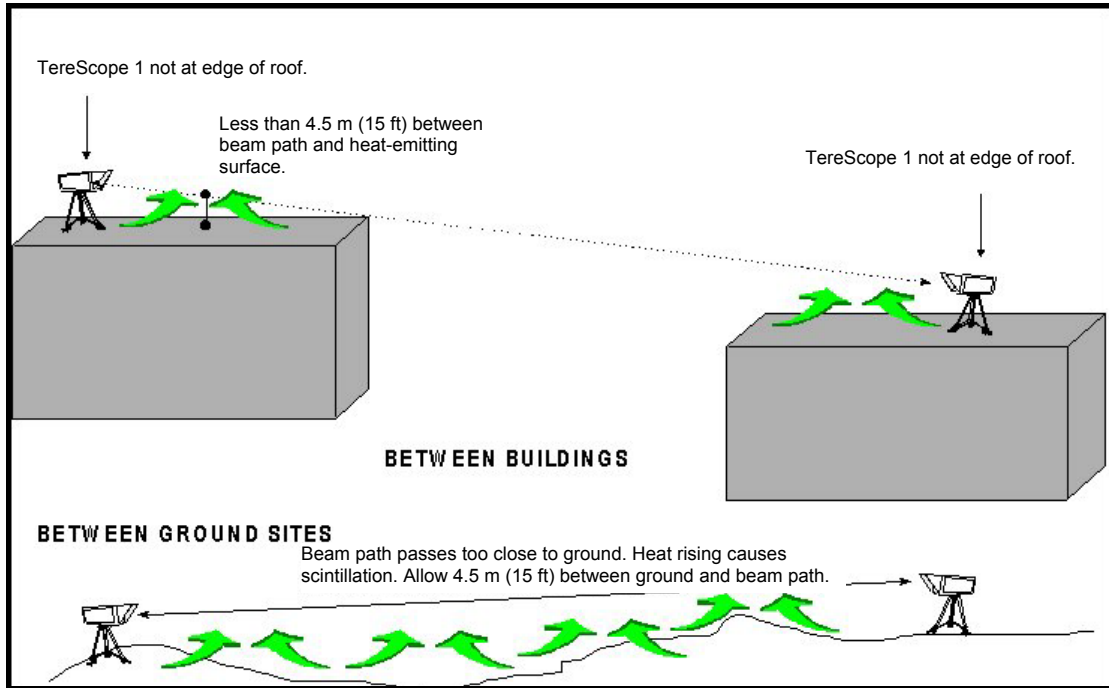


Figure 6: Unrecommended Mounting

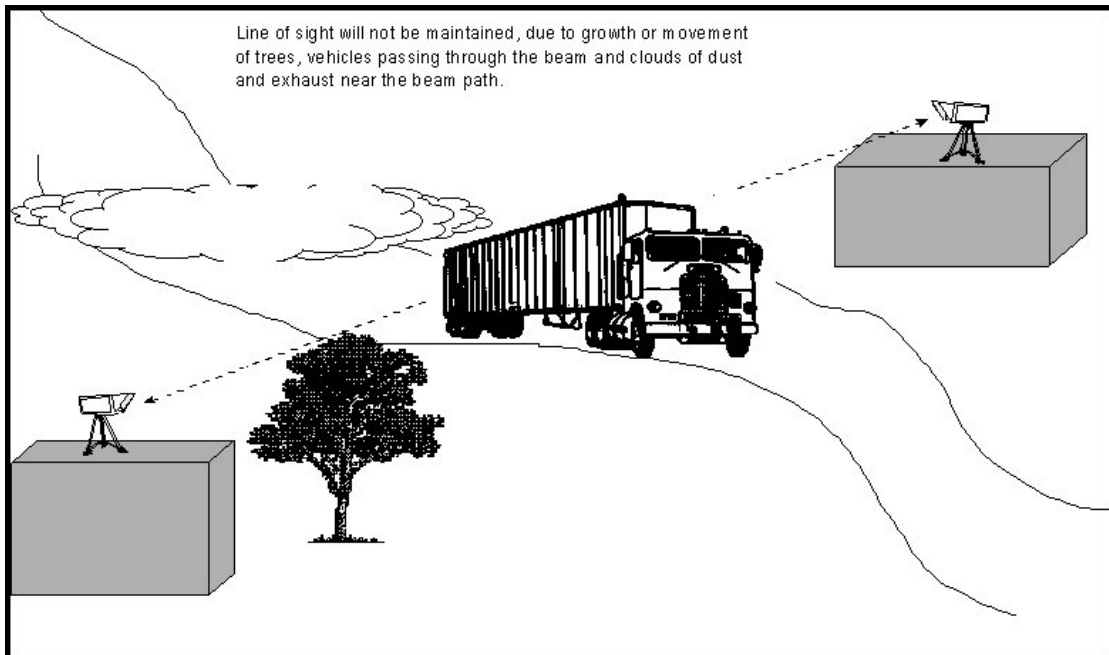
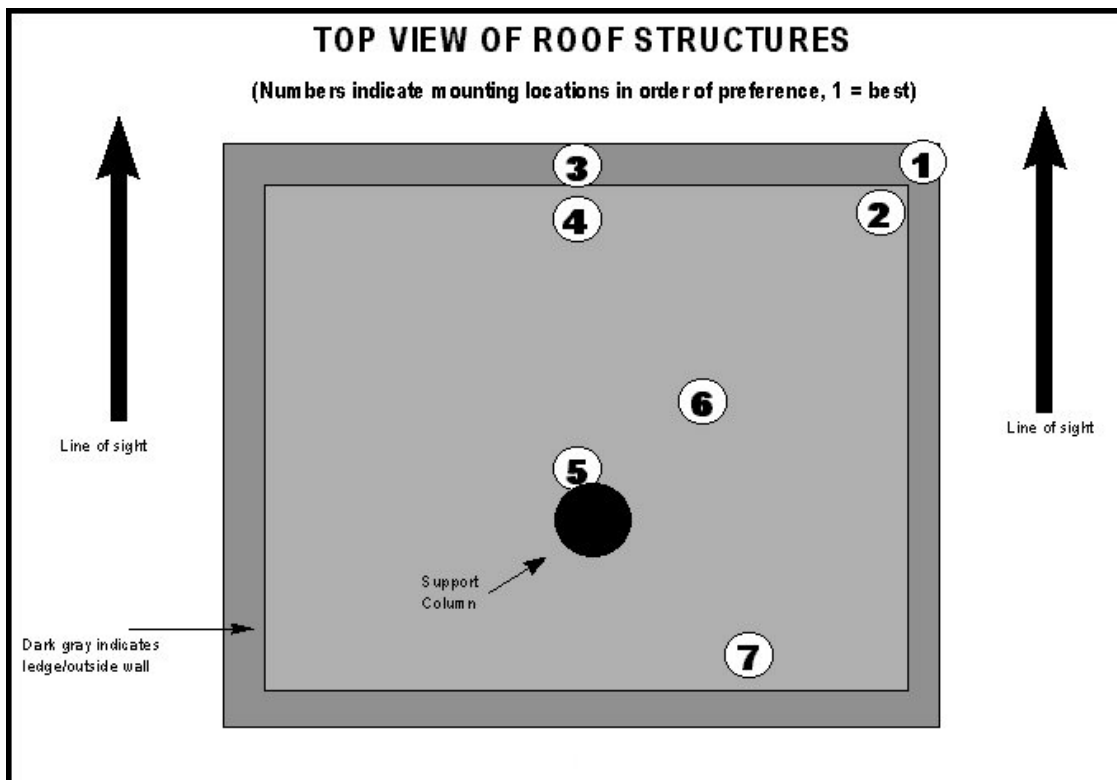


Figure 7: Unacceptable Mounting

## Mounting Environment & Stability

1. When deciding the mounting location, you should look on the rooftop for vibration sources such as compressors, elevators, motors, and try to avoid them.
2. Photograph the mounting location so as to select the best mounting option.

*Figure 8* shows mounting locations on a rooftop in descending order of preference. Location 1 is the best; location 7 is the worst.



**Figure 8: Mounting Locations in Order of Preference**

3. Avoid surfaces with high reflectivity (e.g., white walls) behind the TereScope 1000P so as to reduce interference with the optical signal.
4. Get customer approval for the *exact* positions where the TereScope 1000Ps will be mounted. Using paint, mark these positions.
5. Note the height that each TereScope 1000P will be above or aside the rooftop.
6. Identify the type/quality of the floor or wall and dimensions of the location at which the TereScope 1000P is planned to be mounted.
7. For each TereScope 1000P, select one of the following mounting options<sup>2</sup> and record it.
  - a. **Parapet/Ledge Mounting** (*Figure 9*) – This is a standard mounting option that uses only the Plate (JMP).

<sup>2</sup> For more information on these mounting options, refer to *TereScope Installation Guide* (Publication No. 46366).

- b. **Wall Mounting** (*Figure 10*) – This is a standard mounting option that uses the Plate (JMP) as well as the two Mounting Brackets (JMBs).
- c. **Floor Pedestal Mounting** (*Figure 11*) – This is a non-standard mounting option that uses the Plate (JMP) as well as a Floor Pedestal (e.g., M015C).
- d. **Wall Pedestal Mounting** (*Figure 12*) – This is a non-standard mounting option that uses the Plate (JMP) as well as a Wall Pedestal (e.g., M054C).
- e. **Extended Wall Mounting** (*Figure 13*) – This is a non-standard mounting option that uses the Plate (JMP) as well as an Extended Wall (e.g., M062C).



Figure 9: Parapet/Ledge Mounting  
(using JMP only)



Figure 11: Floor Pedestal Mounting  
(using JMP and M015C)



Figure 10: Wall Mounting  
(using JMP and JMB)



Figure 12: Wall Pedestal Mounting  
(using JMP and M054C)



**Figure 13: Extended Wall Mounting  
(using JMP and M062C)**

## Transmitting through a Window

1. Determine the number of surfaces the beam transits or is reflected from, the reflectivity of each surface, and condensation/precipitation collection areas.
2. Use the data below to determine whether the light beam attenuation is acceptable.
  - 4% attenuation for each surface of light reflection.
  - 15% attenuation for a double pane window.
  - Attenuation due to tint in windowpane must be taken into consideration in choosing the right TereScope 1000P model. (The % attenuation depends on the tint and must be measured.)
3. Ensure that the angle of incidence<sup>3</sup> of the beam striking the windowpane is between 1° and 45°, preferably closer to 1° for greater beam penetration.



### Note

On high buildings, for indoor window installation, the user should consider that occasionally the window-cleaning elevator might block the link beam.

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<sup>3</sup> Angle which the light beam makes with the perpendicular to the windowpane.

Figure 14 shows the arrangement for transmitting through a window.

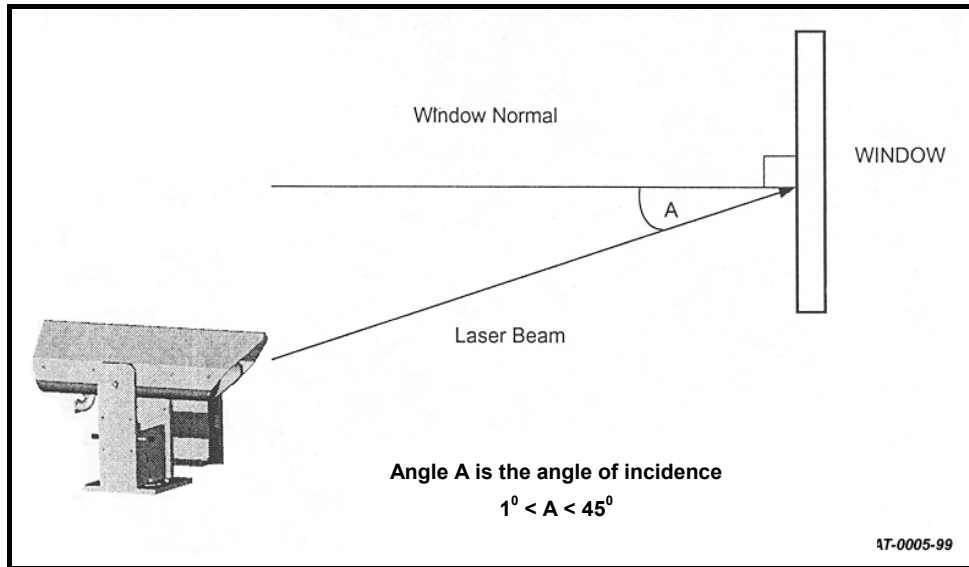



Figure 14: Arrangement for Transmitting through a Window

## Routine Checks for Adjustments

Ensure that all rooftop sites are visited about two or three weeks prior to the installation of the system. Make sure that no changes took place, which may have a direct effect on the planned installation. Note the relevant changes and make sure that timely adjustments are implemented in the system, to accommodate these changes.

## Ordering Equipment

Using the results of the survey, *Appendix A: Product Specification*, *Appendix B: Required Materials*, and *Appendix C: Site Survey Form*, place orders for the required MRV equipment and materials for the installation process.

	<p><b>Note</b></p> <p>For insurance, it is advisable to order a longer fiberoptic cable than that required by measurement.</p>
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# Installation

## Fiberoptic Cable

### General

MRV supplies a special fiberoptic cable for carrying optical data between the Media Converter and the TereScope 1000P. The cable contains both a transmit fiber and a receive fiber, each of different type. The TereScope 1000P has no light source, detector, or amplifier inside. Therefore the cable plays a crucial role in the link, as any loss in the cable translates into an equal loss in the received signal strength.

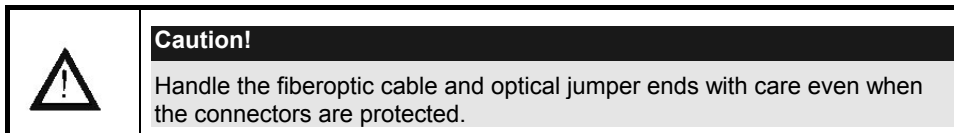
The cable also contains two wires of gauge #20 AWG for connecting an optional indoors heating power supply to a heating circuit in the outdoor unit.

The fiberoptic cable is an outdoor cable having two active fibers, two copper wires of gauge #20 AWG, and one vacant sheath. The vacant sheath (together with the active fibers) is needed to give the cable a cylindrical shape for robustness. The cable has four connectors, two at each end, for interconnecting a TereScope 1000P and Media Converter. Each end of the cable is protected with a heat-shrink sleeve, part of which is shrunk around the cable end and the portion around the connectors is left unshrunk for protection of the connectors until they are safely connected. during the installation process. The cable is available in various lengths. (The specification of the cable is given in *Appendix A: Product Specification*.)

### Handling

The fiberoptic cable should be handled with care since fiberoptic cables, in general, are fragile. In particular,

- Do not bend any part of the fiberoptic cable to a radius that is smaller than the minimum permitted according to the manufacturer's specification (usually 210 mm or 8.25 in).
- Do not apply physical stress that is greater than the maximum permitted according to the manufacturer's specification.



### Testing

#### General

Before laying the fiberoptic cables, the attenuation of each fiber should be measured to determine if it is acceptable.

## Tools and Equipment

The following tools and equipment are required for testing the fiberoptic cables.

- Fiberoptic cables.
- Optical-power meter – shown in *Figure 15*. (If the readings are in dBm, the difference between the input and output power gives the power attenuation of the fiber in dB. )
- 850 nm light source<sup>4</sup> – shown in *Figure 15*.
- 200/230  $\mu\text{m}$  patch jumper fiberoptic cable<sup>5</sup> (supplied by *MRV*<sup>6</sup> on customer order).
- ST-ST adapter.



Figure 15: Light Source (left) and Optical-Power Meter (right) – Examples

## Procedure

1. Connect the optical power meter to the light source with the patch cable. Measure the power (in dBm). Disconnect the patch cable from the power meter but leave its other end connected to the light source.

<sup>4</sup> A Media Converter may be used.

<sup>5</sup> A patch jumper cable is short, has connectors at both ends, and has negligible attenuation.

<sup>6</sup> Instead, the following fiberoptic patch cables may be used: 50/125  $\mu\text{m}$  or 62.5/125  $\mu\text{m}$ .

2. Connect one end of the transmit fiber (yellow-sheathed) of the fiberoptic cable under test to the patch cable with an ST-ST adapter. Connect its other end to the optical power meter. Measure the power (in dBm).
3. Note the difference in the two measurements in Steps 1 and 2. This is the attenuation of the fiber in dB. Stick a label with the attenuation value on the fiber.
4. Repeat Steps 1 to 3 for the receive fiber (blue-sheathed) of the fiberoptic cable.
5. For each fiber, the attenuation needs to be between 0.3 dB and 1 dB, depending on the cable length.
6. Repeat Steps 1 to 5 for all fiberoptic cables.


## Laying

It is strongly recommended to run the fiberoptic cable on roofs and in buildings in cable canals (made of PVC) and not to pull them through ducts because of the risk of applying too much frictional stress.

For each bend of the cable at a corner, use a short piece of flexible plastic tubular duct (the same type supplied with the TereScope 1000P— see *Figure 24*). The duct serves a double purpose. It ensures that no damaging stress will be applied to the cable, and that the cable will be accessible for troubleshooting if needed.

## Preparation

Each end of each cable is fitted with two ST type optical connectors and protected with a heat shrink sleeve. After laying the fiberoptic cable, *carefully* cut off the unshrunk portion of the heat shrink sleeve with scissors or an exactor knife to reveal the cable fibers and their attached connectors and also the two copper wires.

	<p><b>Note</b></p> <p>For TereScope 1000P do not bend the cable fiber to a radius smaller than 60 mm (2<sup>1</sup>/<sub>2</sub> in).</p>
---	---

## Connection

The fiberoptic cables are connected after alignment is completed as described in the section Connecting the TereScope 1000Ps, Media Converters. .

## Mounting

This section shows how to mount the TereScope 1000P and accessories at a site. For required materials, refer to *Appendix B: Required Materials*.



**Note**

Avoid surfaces with high reflectivity (e.g., white walls) behind the TereScope 1000P so as to reduce interference with the optical signal.

## Mounting Accessories

### Standard

The following standard mounting accessories are available for the TereScope 1000P:

1. Mounting Plate (**JMP**) and Mounting Ring – shown in *Figure 16*. These are used for mounting on a horizontal concrete surface, and are supplied with all TereScope 1000Ps. The Mounting Plate is *always* required.
2. Mounting Brackets (**JMBs**) – shown in *Figure 17*. They are used for mounting on a vertical surface, and are supplied on customer order.

### Non-Standard

These are additional accessories required for special mounting options, and are supplied on customer order. The mounting options are shown in *Figure 11*, *Figure 12*, and *Figure 13*.

## Mounting Procedure

1. If you are going to use an *MRV* standard mount, disassemble the mounting plate and mounting ring (shown in *Figure 16*) – if they are joined to each other – from the TereScope 1000P.
2. Secure the mounting plate to a parapet, ledge, or an *MRV* mounting bracket, possibly with additional non-standard accessories. (When mounting the TereScope 1000P on an *MRV* non-standard mount, do not disassemble the mounting plate from the ring – just connect the mounting plate with the supplied 4 x 8 mm bolts).
3. Place the TereScope 1000P on the mounting plate.
4. Secure the TereScope 1000P with bolts and washers, with the mounting ring outside the bolts – see *Figure 16*. Do not tighten the bolts so that the TereScope 1000P can be rotated. Tighten them only after coarse alignment has been performed as described in the section *Coarse Alignment*.

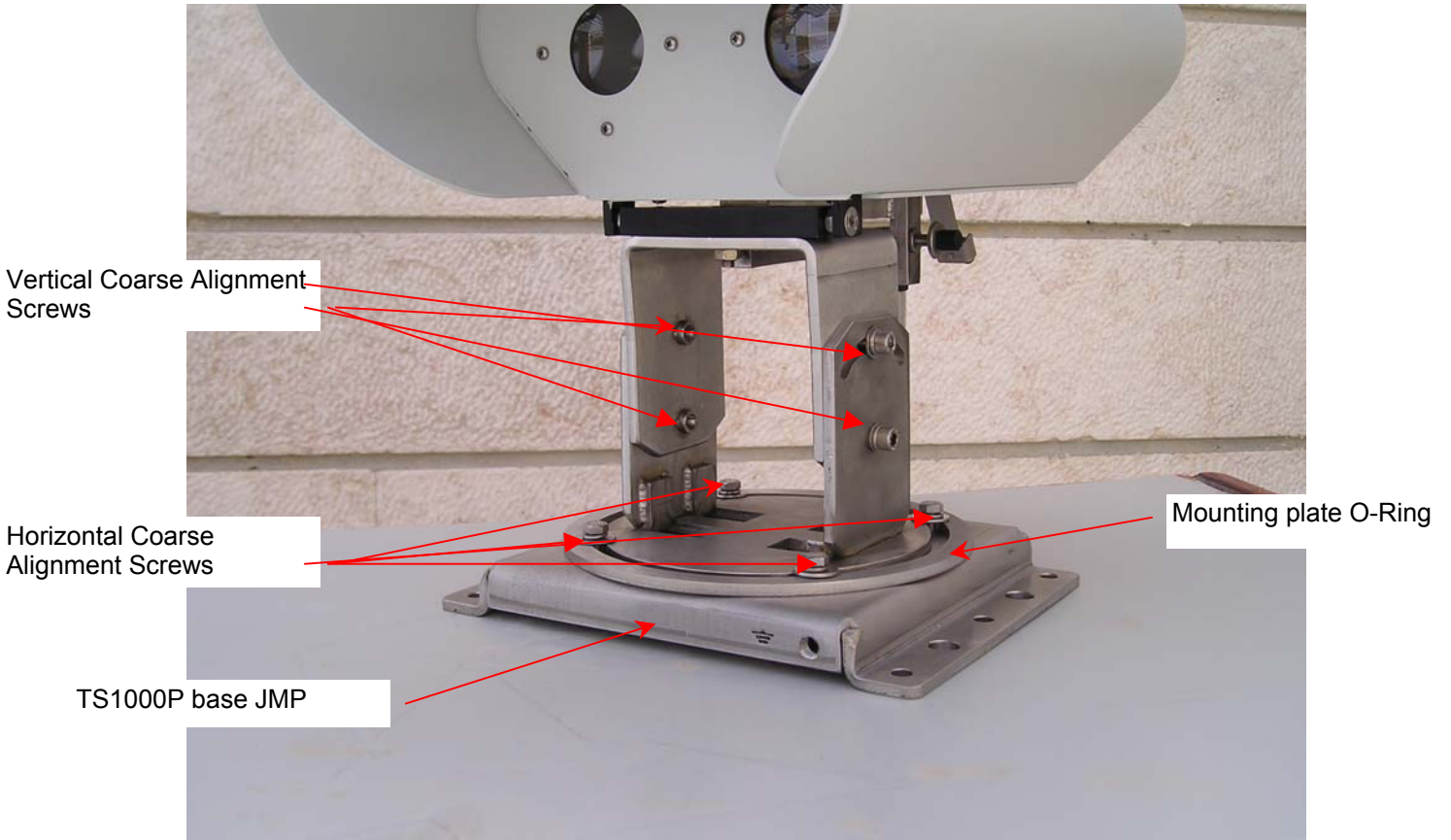


Figure 16: TereScope 1000P with Mounting Plate and O-Ring

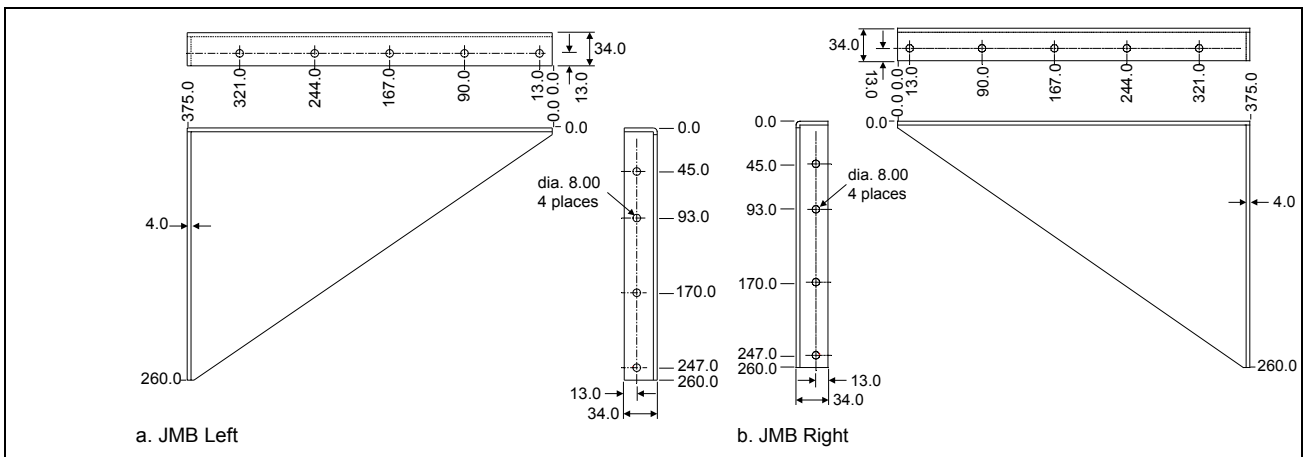


Figure 17: Drawing of Vertical Mounting Brackets (JMBs)

## Special Mounting Techniques

This section describes two widely used mounting options:

- Mounting on the Floor
- Mounting on a Fragile/Crumblly Wall

## Mounting on the Floor

On roofs with a metallic parapet or without a parapet, drilling holes in the roof floor is not recommended. In such cases, the only place where the installation is practicable or authorized is on the floor.

The technique for mounting on such roof floors – illustrated in *Figure 18* – is as follows:

1. Prepare a small concrete slab (60 cm x 60 cm x 15 cm). (This slab will be used to stabilize the pedestal<sup>7</sup> for the TereScope 1000P.)
2. When the slab solidifies, secure the floor pedestal with screws passed through holes drilled into the slab.
3. Remove any intervening extraneous material, such as asphalt, present between the slab/tower base and the floor. After mounting is completed, restore the roof waterproofing around the slab with appropriate sealing material.

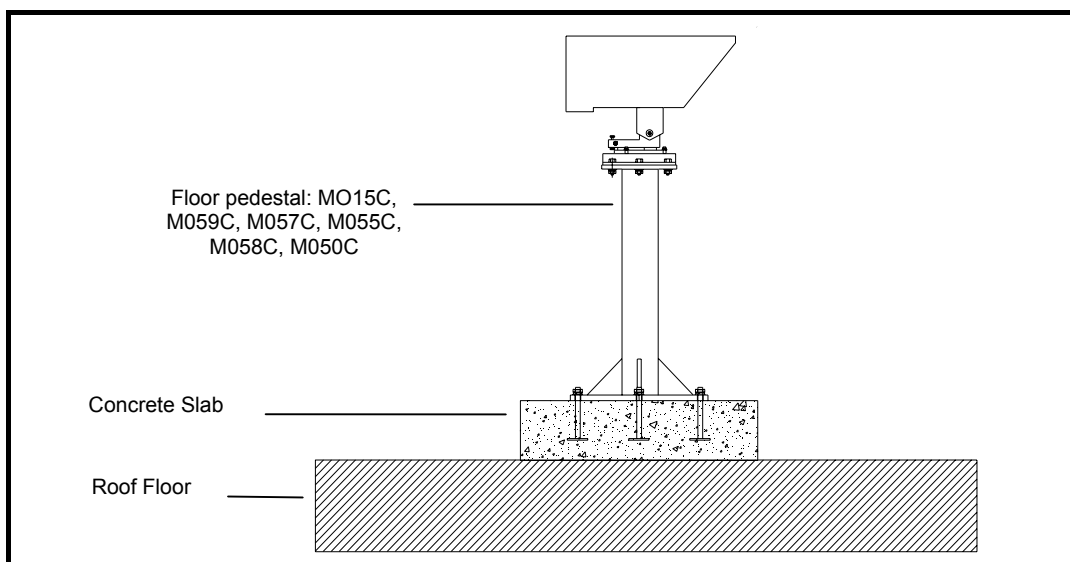


Figure 18: Mounting on a Concrete Slab

## Mounting on a Fragile/Crumbly Wall

At sites where installation on fragile (pre-fab) or crumbly (old or red brick) walls is unavoidable, the best way to securely fix the vertical mounting brackets is to use a metallic clamping plate<sup>8</sup>. The clamping plate provides greater rigidity and stability.

The technique for mounting on such walls is illustrated in *Figure 19*.

<sup>7</sup> The pedestal is supplied by *MRV™* on customer order.

<sup>8</sup> The metallic clamping plate is supplied by *MRV™* on customer order.

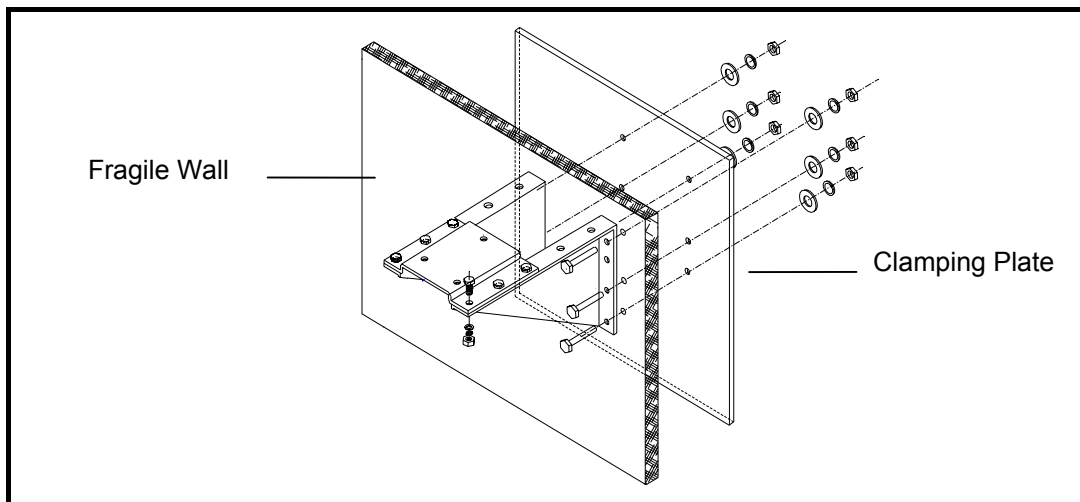



Figure 19: Mounting on a Fragile Wall

## Alignment

### General


Point-to-point connections require face-to-face orientation of both transceiving ends of the link. With wireless optical links, the beam spot should be positioned symmetrically on the remote receiver, as accurately as possible.

### Tools and Equipment

	<p><b>Note</b></p> <p>The customer can order patch cables and high-output portable source from <i>MRV</i>.</p>
---	--

The following tools and equipment are required at each link end:

- A communication device (mobile phone or walkie-talkie)
- Optical-power meter, giving readings in milliwatts/microwatts or dBm. If no power meter is available, a DVM can be connected to the 2-pin **OPTICAL POWER** port of the MC102G/P media converter and the voltage readings can be used for alignment.
- Patch jumper fiberoptic cable 200/230  $\mu\text{m}$  for the power meter.

	<p><b>Caution!</b></p> <p>Cover the fiber output from view or turn off the light source until ready to connect it to the link.</p>
---	--

### Procedure

The alignment procedure is done in two stages:

- Coarse Alignment

- Fine Alignment

### Coarse Alignment

1. Slightly loosen the Horizontal Motion Locking Bolts and the Vertical Motion Locking Bolts (two on each support bracket) – see *Figure 16*.
2. To enable maximum flexibility during the fine alignment stage, rotate the fine alignment screws (*Figure 20*) until the alignment bar is centered.
3. While looking (see note below) through the telescope, rotate and tilt the TereScope 1000P to bring the telescope crosshairs on the telescope lens of the opposite TereScope 1000P.
4. Tighten the four coarse alignment screws and four bolts by applying a torque less than 20 Newton-meter.

### Fine Alignment

#### General

The purpose of fine alignment is to position the center of the transmitted beam spot on the center of the TereScope 1000P receiver – in both directions. This is achieved by adjusting the horizontal and vertical motion screws (shown in *Figure 20*) until maximum power is received at the opposite TereScope 1000P.

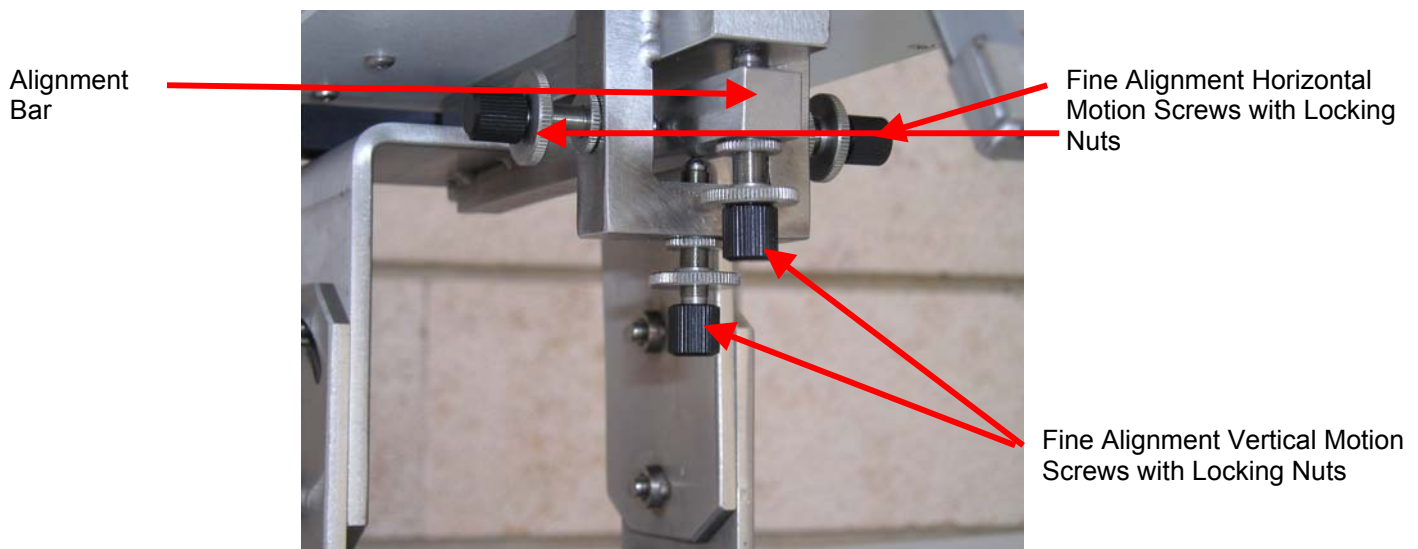



Figure 20: Fine Alignment Motion Screws – Rear View

**Fine Alignment Vertical Motion Screws** – Two screws. Used for fine rotation of the TereScope 1000P in the *vertical* plane. Both screws are required to lock a vertical position.

**Fine Alignment Horizontal Motion Screws** – Two screws. Used for fine rotation of the TereScope 1000P in the *horizontal* plane. Both screws are required to lock a horizontal position.

To use *any* fine alignment screw, its nut must first be released.

## Procedure

	<p><b>Note</b></p> <p>Two installers are required for fine alignment, one at each TereScope 1000P site.</p>
---	---

The fine alignment procedure is as follows:

1. Make certain the power meter is set for 850 nm wavelength.
2. At one TereScope 1000P (Site A), remove the flange and duct (shown in *Figure 24*). Referring to *Figure 21*, do either one of the following:
  - a. Connect one end of the yellow-sheathed cable to the Media Converter and the other end to the TereScope 1000P's **FROM SWITCH** connector, as shown in *Figure 29*.
3. At the other TereScope 1000P (Site B), remove the flange and duct. Referring to *Figure 21*, use the patch cable (200/230  $\mu\text{m}$  to interconnect the optical power meter and the **TO SWITCH** connector.




**TO SWITCH** Connector



**FROM SWITCH** Connector

**Figure 21: Connectors for Fiberoptic Cables**

4. At Site A, turn the horizontal motion screws until the installer at Site B reports maximum received power. (This assures that the beam spot is positioned symmetrically in the left-right direction about the TereScope1000P receiver located behind the telescope lens, as shown in *Figure 22*.)  
Close the screws lightly – do *not* tighten!
5. At Site A, turn the vertical motion screws until the installer at Site B reports maximum received power. (This assures that the beam spot is now positioned at the center of the TereScope1000P receiver located behind the telescope lens, as shown in *Figure 23*. The received power should be *about* the same as the expected power given in *Table 2 of Appendix F: Received Signal Power vs Distance*. *Table 2* shows expected power for various distances.) Record the maximum received power in  $\mu\text{W}$ .

	<p><b>Note</b></p> <p>This power reading is the sum of both signal and background light. On a sunny day, for long air links, the background light may add to the true signal power. The problem is resolved in Steps 8 and 9.</p>
---	---

6. Repeat the horizontal and then the vertical alignment to ensure maximum reading.
7. Tighten all the fine alignment screws and locking nuts.
8. Disconnect or turn off the Media converter, then measure and record the background light power in dBm.
9. Subtract the background reading from the recorded maximum received power in Step 5 to get the signal power. This signal power should be *close* to the expected power given in *Appendix F: Received Signal Power vs Distance*.
10. Repeat Steps 1 to 9 for the opposite direction.

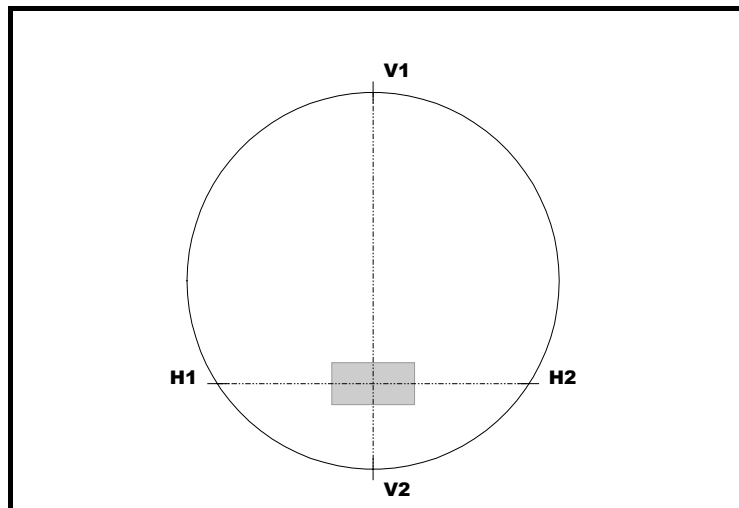


Figure 22: Beam (circle) on Receiver (rectangle) after Horizontal Alignment

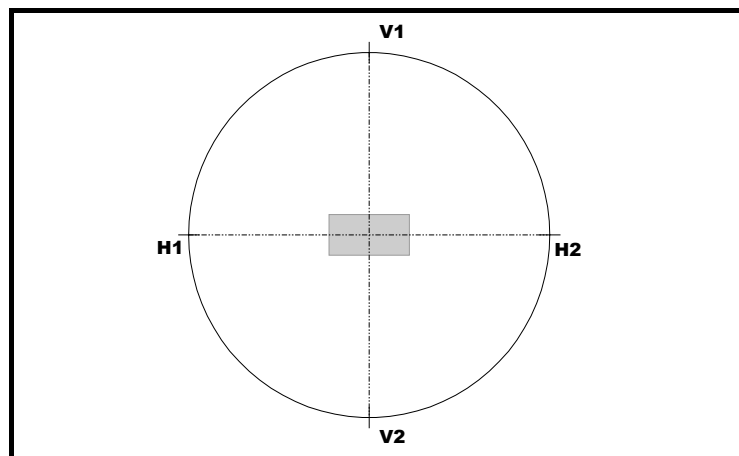


Figure 23: Final Beam after Horizontal and Vertical Alignment

## Connecting the TereScope 1000Ps, Media Converters.

1. At one of the two TereScope 1000Ps of the link, release the flange and duct (shown in *Figure 24*) by unscrewing the flange.



**Figure 24: Flange and Fiberoptic Cable Duct**

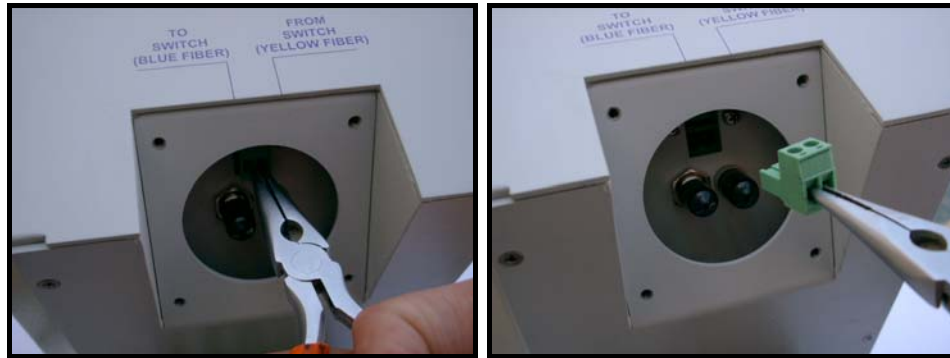
2. After cutting off the unshrunk portion of the sleeve on the fiberoptic cable end, carefully slip the cable through the duct and flange.
3. To connect the heating circuit (recommended option):
  - a. Extract the green pluggable terminal block from the socket in the TereScope 1000P as shown in *Figure 25*.



**Figure 25: Extracting the Terminal Block by the Yellow Wire Loop**

If the yellow wire loop is missing or slips when trying to extract it, use a pair of pliers as shown in *Figure 26*.





**Figure 26: Extracting the Terminal Block by a Pair of Pliers**

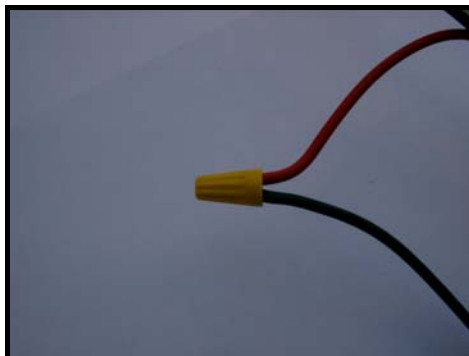
- b. Remove and trash the yellow wire loop attached to the terminal block.
- c. Strip the two copper wires and, using a screwdriver, connect them to the two prongs of the terminal block.
- d. Plug the terminal block back into the green socket in the TereScope 1000P as shown in *Figure 27*.



**Figure 27: Insertion of the Terminal Block and Fiber Strain Relief**

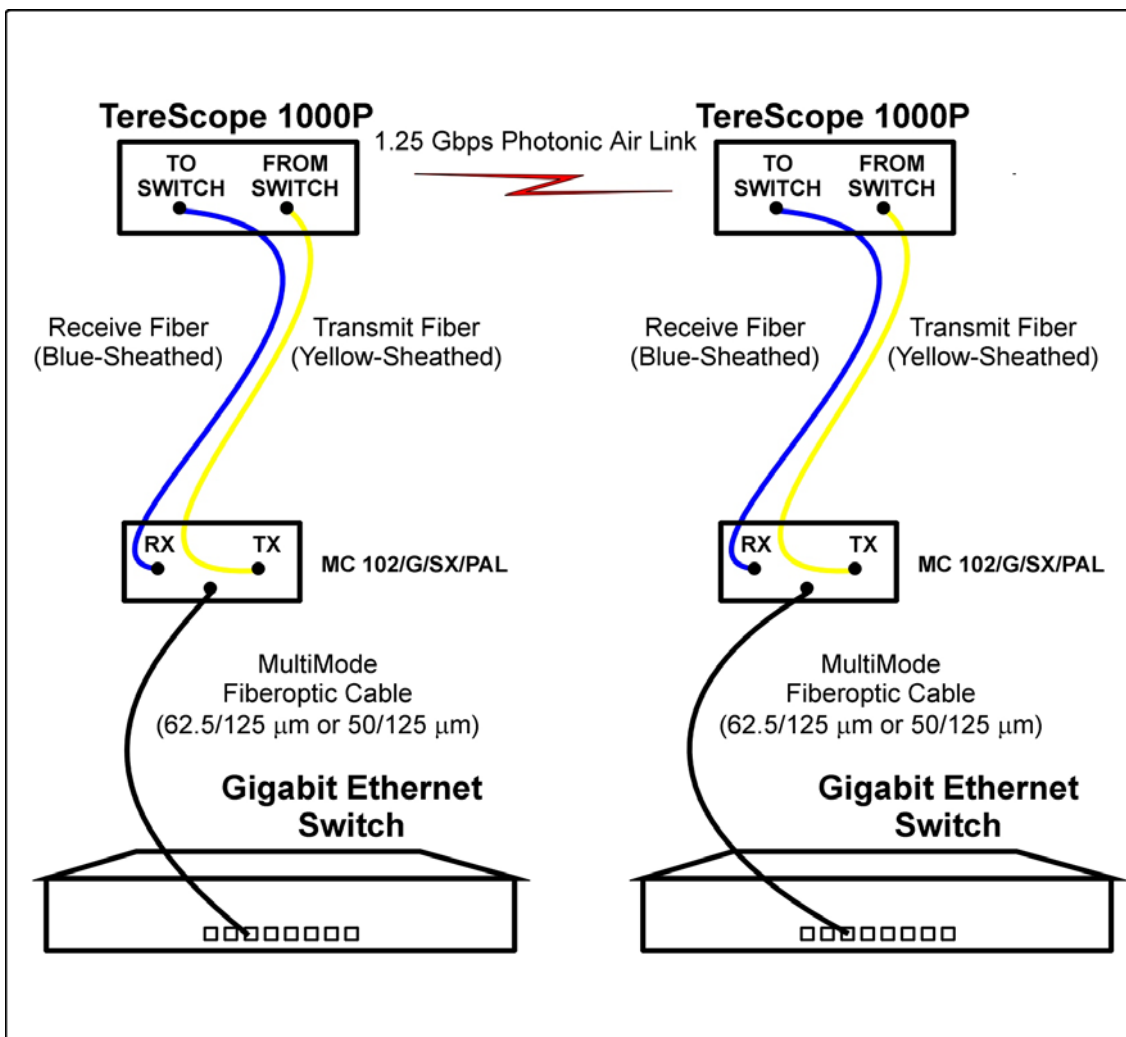
4. Connect the transmit fiber (yellow-sheathed) to the **FROM SWITCH** connector, and the receive fiber (blue-sheathed) to the **TO SWITCH** connector.
5. Remove the screw on the Fiber Strain Relief, open the flange, pass the yellow and blue fibers through the Fiber Strain Relief, verify that the connectors are coupled well, screw the flange back into place, making sure it is firmly tightened, and tighten the removed screw.
6. Repeat Steps 1 to 5 for the other TereScope 1000P of the link.
7. connect the TereScope 1000Ps to switches via MRV MC102/G/SX/PAL as shown in *Figure 29*.
8. If the heater is to be used, do the following at the indoor end of the cable:
  - a. Strip the two copper wires of the cable.
  - b. Strip the two copper wires of the output of the MRV heater power supply (15 V, cat no. 1406700).

- c. Connect each power supply output wire to one cable wire using the wire-nuts provided as shown in *Figure 28*.



**Figure 28: Connection of the Wires from the TereScope 1000P to the Heating Power Supply Connector**

- d. Plug the power supply into a wall socket using a standard IEC 320/C8 (shaver and stereo style) cord (not supplied by MRV).



**Figure 29: Interconnection of TereScope 1000P, Media Converters, & Switches**

## **Link Test**

In the network in Figure 29, perform ping test for the remote switch to check if link connectivity is OK.

## **Installation Log**

In the Installation Log, record all the information about the installation For the MC102/G/SX/PAL, the received power reading appears at the top left hand corner on the front panel as 10 green Led's bar graph. This information will be a valuable reference for future maintenance and troubleshooting.

# Troubleshooting

Since the TereScope 1000P is a passive device, it is unaffected by EMI, RFI, power cuts, etc. Only violent physical disturbances or faulty optical power input from the media converter may cause the device to malfunction.

The following procedure shows how to troubleshoot a faulty optical power input. Follow the steps in the order given until the problem is resolved. If the problem persists, consult your *MRV* representative.

1. Ensure that the fiberoptic cable at the media converter is properly connected.
2. . On the MC102/G/SX/PAL, check the reading on its front panel. If the power is too low, first make sure that there are no interferences with the air link (e.g., fog, smoke, dust, etc.).
3. Ensure that the fiberoptic cable at the TereScope 1000P is properly connected.
4. Ensure that the fiberoptic cable (connectors, etc.) is not physically damaged.
5. Ensure that there are no unnecessary bends or pressure on the optical cable anywhere in the building or on the roof.
6. Ensure that there is no physical damage to the TereScope 1000P.
7. Ensure that the optical link attenuation is less than the power budget of the media converter.
8. Repeat Steps 1 to 7, above, for the other TereScope 1000P of the link.

# Appendix A: Product Specification

Protocol		
Giga Bit Ethernet		
Link Beam		
Transmitted Beam Divergence	2 milliradians	
Receiver Aperture Diameter	50 mm	
Receiver Field-of-View	2.4 milliradians	
Operating Range		
Attenuation	Weather Condition	Maximum Range
30dB/km	Blizzard, cloudburst	260 m
60dB/km	Light to Moderate fog	180 m
Fiberoptic Cable		
Maximum length	Up to 50 meters at each link end	
Attenuation	10 dB/km	
Transmit Fiber:		
Sheath	Yellow	
Core/Cladding Diameters:	100/140 $\mu$ m	
Receive Fiber		
Sheath	Blue	
Core/Cladding Diameters:	200/230 $\mu$ m	
Copper Wires	2 (one black the other red), #20 AWG	
<i>Fiber</i> Bend Radius (min. permitted)	60 mm (2 <sup>1</sup> / <sub>2</sub> in)	
<i>Cable</i> Bend Radius (min. permitted)	210 mm (8.25 in)	
Fiber Connectors	ST <sup>TM</sup>	
Heating System		
Power supply	Use only MRV Cat. No. 1406700 15 V @ 1.0 or 1.2 A Class II double insulated (3000 VAC) Class 2 power limited output UL, cUL, TUV approved 1950 or 60950	
Power supply input connector	IEC 320/C8 (2 prong shaver type)	
Environmental		
Temperature		
Operating:	-40to +60 °C (-40 to 140°F)	
Storage:	-40 to +60 °C (-40 to 140 °F)	
Humidity (non-condensing)	Less than 90%	
Housing	Weatherproof (IP-65)	

<b>Physical</b>	
Dimensions (W x H x D)	410x 244 x 325mm <sup>3</sup>
Weight (including mounting accessories)	5.5 kg (11 lb)
Torque applicable to Coarse Alignment Screws (max)	20 Newton-meter
<b>Standards Compliance</b>	
Media Access	IEEE 802.3z CSMA/CD
Safety	Designed to comply with UL-1950; CSA 22.2 No. 950; FCC Part 15, Class B; CE-89/336/EEC, 73/23/EEC, IEC 1M Laser safety, IP-66
<b>Part Numbers</b>	
Model 1000P	TS1G/B/BDL/25/A

# Appendix B: Required Materials

## Optic Module

The optic modules are designed to send and receive optical data through the link. The following type of -optic module is available:

### Media Converter

The media converter is designed to connect between the TereScope 1000P format and fiberoptic 1000Base-FX format. For more information, please refer to the manuals of the media converter and your network equipment.


## Installation Tools

- Electric drill with impact action for masonry, reversible motion, speed control, and a 0-13 mm adjustment chuck.
- Concrete carbide drill bits: 6 mm, 12 mm, and long (30 cm) 12 mm for penetrating concrete walls.
- Power screwdriver.
- Threading equipment.
- Toolbox containing: "Hex driver (Allen) set; open-ended wrench from 6 mm to 17 mm; hammer (200 g); regular pliers; long-nose pliers; cutter; flat-tip screwdrivers, Philips screwdrivers; exactor knife; Socket wrench for 8 mm, 10 mm, 11 mm, 12 mm, 14 mm, ½-inch, etc.

## Equipment for Fiber Test and Link Alignment

- Fiberoptic power meter for 850 nm (e.g. of EXFO or ACTERNA).
- Fiberoptic multi-mode light source of 850 nm wavelength for multimode fibers (e.g. of EXFO or ACTERNA).
- Visual fault locator.
- Fiberoptic jumper – 1 m, 200/230 µm core/cladding diameters
-

# Appendix C: Site Survey Form

		<b>TereScope®</b> <b>LINK SITE SURVEY FORM</b>		
City		Date	____/____/2004	
Street Address		Company Name		
<b>Line of Sight</b>		<b>NOTES</b>	<b>Mounting Environment &amp; Stability</b>	
<b>Check Path for:</b>	√		<b>Vibration Sources</b>	
Trees			Compressors or Motors	
Growing trees			Elevators	
Birds nesting			Mounting area, wall type	Concrete/ red brick/ block/ Marble Other _____
Power line movement			Expected minimum and maximum temperatures	
Local atmospheric disturbances			Microwave dishes	
Hot surfaces			Electromagnetic interference sources	
Pedestrian or vehicle traffic			Antennas	
Exhaust or dust clouds			Other electronic equipment	
Exhaust vents			Additional shelter requirements	
Photo taken of underlying terrain (Photo of area below line of sight)			Photo taken of mounting location	
Photo taken of "line-of-sight"			<b>Mount Placement</b> (Best available mount placement on building)	
Photo taken of rooftop			Mounting Brackets Part # s	M001, M015C, M022C, M050C M051C, M053C, M054C, M055C M056C, M057C, M058C, M059C M062C, M063C, M064C, PCL3 PCL4, PCL5, PCL6, JMP
<b>Transmission through a Window</b>		Elevation angle	_____°	
Number of window surfaces		Mounting adaptor needed		
Reflective coating on window		Dimensions for adaptor		
Precipitation collection areas		<b>Power</b>		
Beam angle to window		Power Source	Main and/or UPS	
<b>Range &amp; Location Information</b>		Voltage & Frequency (AC)	110Vac/60Hz or 220 Vac/50Hz	
Distance between sites (m)		Voltage (DC)	24 Vdc, 48 Vdc, other _____	
Method used to measure distance: (GPS, laser binoculars, maps, other)		TereScope Lightning Rod (Recommended optional accessory)	Yes / No	
Number of links to be installed at the site		Cable Length for TS 1 PAL	25 m, 50 mother _____	
Bearing to the receiving site (as measured with compass)	E _____° W _____°	<b>Data Interface</b>		
		Data Rate (Mbps)	1Gbps, 622 Mbps, 155 Mbps, 100 Mbps, 34 Mbps, 10 Mbps, E1, T1, 4E1, other _____	
<b>Cabinets for Routers &amp; Switches (if applicable)</b>		Host Network Equipment		
19" rack mount space (in U, 1U = 1 <sup>3</sup> / <sub>4</sub> in)		Fiber Wavelength	850 nm, 1310 nm, MM, SM	
Large cabinet	Yes/No	Optical Connector	SC/PC, ST/PC, other _____	
Small cabinet	Yes/No	Other connectors	RJ45, RJ48, BNC, other _____	
<b>TereScope Model Required</b> _____				



# Appendix D: Cleaning Optical Connectors

## General

Intrusions (e.g., dust, grease, etc.) at the interface of two optical fibers, such as at a pair of coupled connectors, attenuate the signal through the fiber. Consequently, optical connectors must be cleaned before they are coupled with other connectors.

## Tools and Equipment

Following are tools and equipment required for cleaning connectors.

- **Dust caps**  
Caps for protecting the connector from intrusions. A cap is usually made from flexible plastic. When placing a cap over a connector, avoid pressing it against the fiber ferula surface in the connector so as to prevent contamination.
- **Isopropyl alcohol**  
Solvent for contaminants.
- **Tissues**  
Soft multi-layered fabric made from non-recycled cellulose.

## Procedure

The procedure for cleaning connectors is as follows:

1. If no stains are present, using a new clean dry tissue, gently rub, in small circular motions, the exposed fiber surface and surrounding area in the connector to remove dust.
2. If stains are present,
  - A. Moisten a new clean dry tissue with isopropyl alcohol and gently rub, in small circular motions, the exposed fiber surface and surrounding area in the connector to remove the stains.
  - B. Using a new clean *dry* tissue, gently rub, in small circular motions, the exposed fiber surface and surrounding area in the connector to remove the dissolved stains and excess isopropyl alcohol.
  - C. If a connector is *not* to be coupled with another immediately, cover it with a dust cap.

# Appendix E: Installation Log

## E.1. Client/Dealer Information

	Customer	Dealer
Company Name		
Address		
City		
Country		
Contact Person		
Tel		
Fax		
E-mail		

## E.2. Application Information

Type of network	<input type="checkbox"/> T1 , <input type="checkbox"/> E1 , <input type="checkbox"/> Ethernet , <input type="checkbox"/> Gbs ETH <input type="checkbox"/> Fast Ethernet , <input type="checkbox"/> FDDI , <input type="checkbox"/> ATM , <input type="checkbox"/> Other (Specify)
Product	
Evaluated distance by customer	
Address of installation at Site A	
Address of installation at Site B	

## E.3. Area Sketch

--

## E.4. Installation

Done by	
Customer representative	
Date	

		Site A	Site B
System model			
Serial number			
Location: (Should be the same as by site survey, if not provide details)			
Accessories: (Should be the same as by site survey, if not provide details)			
Received Signal Strength	Total Received Power		
	Background Light Power		
	Signal Power		
Telescope calibration : if cannot , sketch the telescope view			
BER test			
BER equipment type			
Loopback location			
Error type (random, burst)			
Brief interruption test			

**E.5. System failure**

Visit made by	
Customer representative	
Date	

	Site A	Site B
Sketch of telescope view		

Received Signal Strength	Total Received Power		
	Background Light Power		
	Signal Power		
Failure detail			
Action items			

Visit made by	
Customer representative	
Date	

	Site A	Site B
Sketch of telescope view		
Digital readout		
Failure detail		

---

Action items		

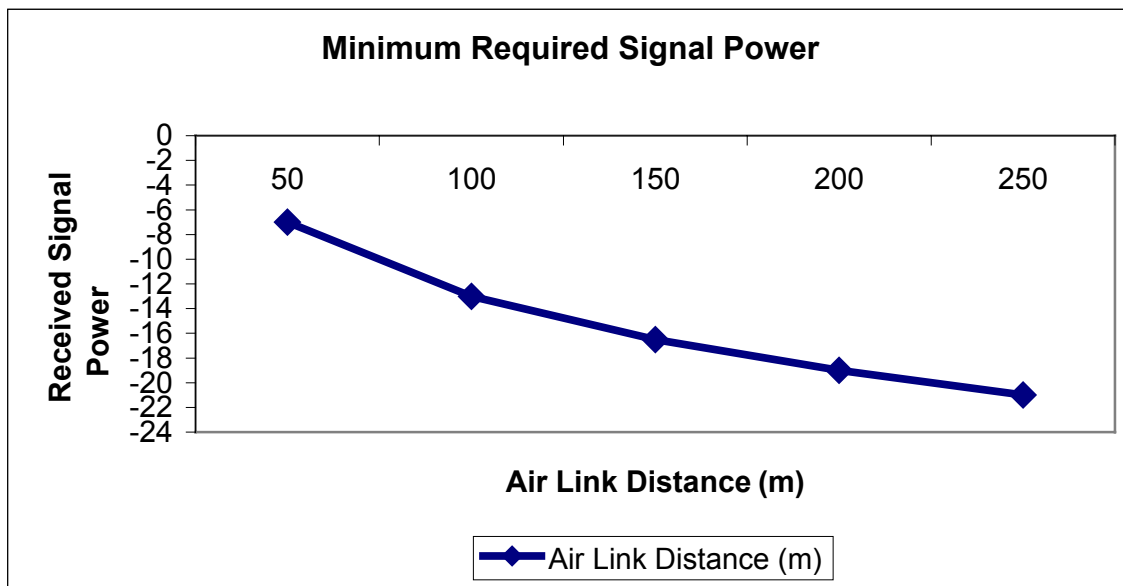
## Appendix F: Received Signal Power vs Distance

This table is provided to give the installer an estimate of the expected received signal power after fine alignment. The values given apply when a Media Converter transceiver module is used as a light source and the patch cables are as specified in the section *Tools and Equipment* under *Alignment*.

**Table 2: Air Link Distance vs Minimum Required Received Signal Power**

Air Link Distance (m)	TS1000P	
	$\mu W$	dBm
50	200	-7
100	50	-13
150	22	-16.5
200	12.5	-19
250	8	-21

Figure 30 shows the relation between the air link distance (in meters) and expected received power (in dBm) graphically. Note that at distances of 60 m and less, optical power at the receiver is too high (above the saturation level). Accordingly, for such small distances, an optical power attenuator must be coupled to the TX (transmitter) port.



**Figure 30: Air Link Distance vs Expected Received Signal Power**

# Appendix G: Cabling

## Cabling

The yellow-sheathed fiber of an MRV special cable is connected to a **TX** connector. The blue-sheathed fiber of an MRV special cable is connected to a **RX** connector. The two copper wires are for connection of the optional MRV power supply #1406700 for heating the outdoor TereScope 1000P. The polarity of the wires may be ignored when connecting the wires.

# Appendix H: MC102/G/SX/PAL

## General

The MC102/G/SXPAL is used to connect a TereScope 1000P link to any Gigabit switch with special fiberoptic cables provided by *MRV™*. These fiberoptic cables are described in *Appendix A: Product Specification*.

The MC102/G/SX/PAL supports ordinary, VLAN, MPLS, and jumbo frames.

## Models

Model MC102-G/SX/PAL2 is used with TereScope 1000P powered by 100-240Vac.

Model MC102-G/SX/PAL3 is used with TereScope 1000P powered by 24-60Vdc

## Layout

### Front



Figure 31: MC102G/P Layout

### 1000Base-SX Port P1

Protocol	1000Base-SX/Full-Duplex
Connector Type	SC
Operating Wavelength	850 nm



**1000Base-SX Port P2**

Protocol	1000Base-SX/Full-Duplex
Connector Type	ST
Operating Wavelength	850 nm
Transmitter Power	TS1000P: 7 dBm
Receiver Sensitivity	-29 dBm

**Optical Power**LEDs

The 10 LEDs marked **OPTICAL POWER** qualitatively indicate the power level of the received optical signal. 4 LEDs in the ON state indicate that the power level is just acceptable (above the receiver sensitivity level). All 10 LEDs in the ON state indicate that the power level may be too high (in the saturation range).

Port

The 2-pin optical power port marked **OPTICAL POWER** can be used to get a qualitative indication of the received optical signal power level if no power meter is available. This can be done by connecting a DVM to the port and using the voltage readings as a guide in alignment.

**Table 3: Front Panel LEDs**

LED	Status	Significance
P1 L	ON	Port P 1 link OK.
	OFF	Port P 1 link <i>absent</i> or <i>faulty</i> .
P2 L	ON	Port P 2 link OK.
	OFF	Port P 2 link <i>absent</i> or <i>faulty</i> .
LED graph Bar	ON	TS link is O.K
	OFF	TS link is absent of faulty

**Rear****Line/Mains Power Port**

3-prong receptacle with universal power supply for 100-240Vac and 60/50Hz line (mains) power input, or 24-60Vdc

**Ambient Temperature**

The required ambient temperature ranges for the MC102/P are as follows:

Operating: 0 to 40 °C

Storage: -40 to +70 °C

## Mounting

The MC102G/P is to be mounted on a wall or desktop (flat, stable, non-conductive static-free surface).

## Cabling

### Fiberoptic

The yellow-sheathed fiber of a special MRV cable is connected to the **TX** connector and the blue-sheathed fiber is connected to the **RX** connector. The two copper wires are for connection of the optional MRV power supply #1406700 for heating the outdoor TereScope 1000P. The polarity of the wires may be ignored when connecting the wires.

### Switch Side

The MC102G/P's P1 fiber side port is connected using a standard MM 62.5/125 $\mu$  optical patch cords

**Connector:** SC