TereScope700 and TereScope800

Wireless Optical Communication Links

Models TS700/155, TS700/100, TS800/155

User Manual

WIRELESS OPTICAL COMMUNICATIONS

User Manual

Document Number ML48237, Rev. 01

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Standards

Standards Compliance

UL 1950; CSA 22.2 No 950; FCC Part 15 Class B; CE-89/336/EEC, 73/23/EEC

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 instructions in 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 the user's 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 induces 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

Other Standards

1. CISPR 22: 1993
AS/NZS 3548: 1995, Class B
Joint Amendment No. 1: 1997, Joint Amendment No. 2: 1997

2. EN 60950+A1+A2+A3+A4+A11
ACA TS001-1997
AS/NZS 3260: 1993 A4: 1997

3. ITU G.703, G.704, G.706,G.736, G.737, G.738, G739, G740, G.775, G.823.

MRV ™ Laser Safety Certification

The TereScope 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 1M according to the American National Standard for Safe Use of Lasers, ANSI Z136.1-1993, provided that there is not a reasonable probability of accidental viewing with optics in the direct path of the beam where the TereScope is installed.
This product is Class 1M according to the International Standard of the International Electrotechnical Commision 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

MRV reserves the right to modify the equipment at any time and in any way it sees fit in order to improve it.

MRV provides this document without any warranty of any kind, either expressed or implied, including, but not limited to, the implied warranties of merchantability or fitness for a particular purpose.

The customer is advised to exercise due discretion in the use of the contents of this document since the customer bears sole responsibility.

Trademarks

All trademarks are the property of their respective holders.

About this User Manual

Audience

This manual is intended for the user who wishes to install, operate, manage and troubleshoot the TereScope700 and TereScope800.

Qualifications

Users of this guide are expected to have:

- Working knowledge of Electro-optical equipment
- Working knowledge of LAN equipment (Layer 2 and 3)
- A License to install equipment on buildings/elevated structures
- A License to work with power line (mains) voltages 110/230 Vac

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 coax cable TV home pass installation, PTT home pass installation, LAN installation, IR equipment installation, and home electrical wiring.

Authorization

After all the requirements specified above (namely, Qualifications, Training, and Experience) have been met, the installer must receive authorization from MRV certifying eligibility.

Safety Requirements

All requirements stipulated in the safety laws of the country of installation must be abided by when installing the TereScopes.

⚠	**Caution!** In addition, ensure that the requirements noted in this chapter are met in order to reduce risk of electrical shock and fire and to maintain proper operation.

Before Installing

Power: Ensure that *all* power to the TereScope is cut off. Specifically, disconnect all TereScope power cords from the power line (mains).
Inspection: Ensure by inspection that no part is damaged.

Before Powering On

Figure A: 3 terminal cord forks

Line Power: Ensure that the power from the line (mains) is as specified on the TereScope.
Power Cord: The power cord of The TereScope must have the following specifications:
Flexible 3-conductor power cord approved by the cognizant safety organization of the country. The power cord must be Type HAR (harmonized), with individual conductor wire having cross-sectional area 0.75 sq. mm. min. The power cord terminations should be a suitably rated earthling-type plug at one end and 3 terminal cord forks for M3 screws (1 for each wire) at the other end. Both of the power cord terminations must carry the certification label of the cognizant safety organization of the country.

When Installing

- Ensure, by visual inspection, that no part of the TereScope is damaged.
- Avoid eye contact with the laser beam at all times.
- 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 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 passersby. 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-I Part 12 requirements.

- Avoid using controls, adjustments, or procedures other than those specified herein as they may result in hazardous radiation exposure.
- Avoid prolonged eye contact with the laser beam (maximum 10 sec.).

Servicing

All servicing must be carried out only by qualified service personnel. Before servicing, ensure that all power to the TereScope is cut off!

Introduction

CAREFULLY READ THE ENTIRE MANUAL BEFORE INSTALLING

An InfraRed (IR) link allows connection without any cable between two distant sites. For that, two identical transceivers, each installed on one site and aligned to face each other, provide point-to-point connectivity. This configuration makes possible data transfer from one terminal to the other through the air over an optical wavelength carrier, the IR link – see picture in Figure B, below.

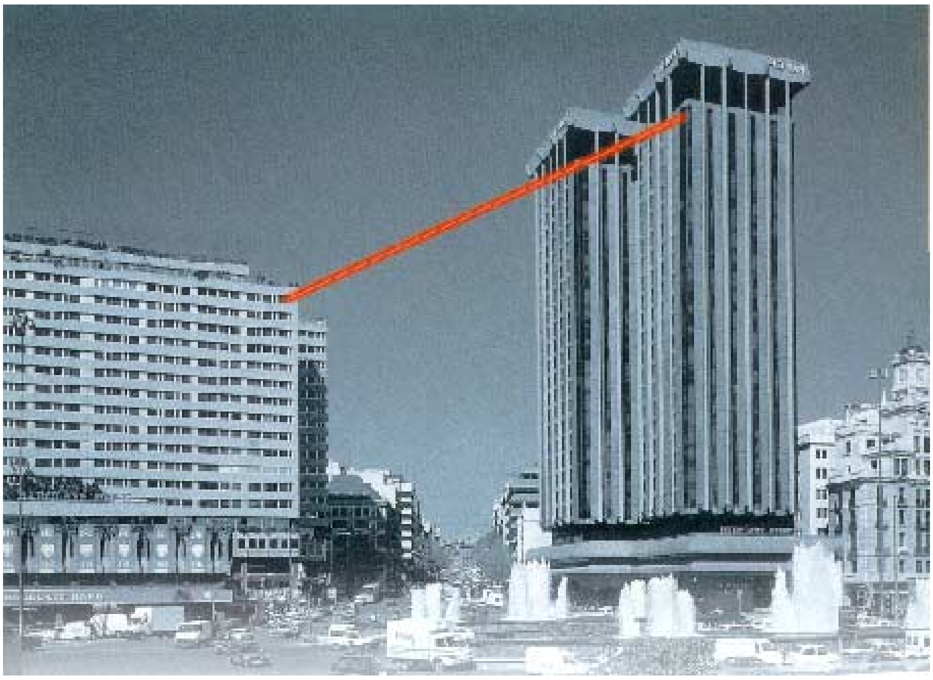


Figure B: IR Link

The installation of such a link can be summarized as 4 stages:

- Site survey
- Installation of the infrastructure
- Mounting of the equipment
- Aiming (alignment) procedure

Always use appropriate safety equipment and procedures when working with electrical equipment and when working on roofs.

Chapter
1

The Product

⚠	**Caution!** When handling the TereScope, take special care not to damage the polycarbonate window!

Models

Table 1: Models of the TereScope[1]

Models	Part Number	Description
TS700/155	TS155/A/YUW/VS	TereScope700 for 1-155 Mbps connectivity up to a distance of 320 m.
TS800/155*	TS155/C2/YUW/VS	TereScope800 for 1-155 Mbps connectivity up to a distance of 800 m + Fusion option.
TS700/100*	TS100/A/TX/VS	TereScope700 for Fast Ethernet 100Base-TX connectivity up to a distance of 320 m + Power-over-Ethernet option.

* Future release.

<u>Using the Part Number for Ordering</u>

To place an order for a TereScope model having a specific configuration, use the Part Number format shown in *Table 1*, noting the following:

'155' represents link operation speed in the range 1 to 155 Mbps.
'A' represents TereScope700.
'C2' represents TereScope800.
'Y' represents Optical Fiber Mode.
Instead of Y use one of the following:
M (for MultiMode)
S (for SingleMode)
'U' represents operating wavelength.
Instead of U use one of the following:
8 (for 850 nm)

[1] TereScope700 or TereScope800.

3 (for 1310 nm)
5 (for 1550 nm)

'W' represents connector type.
Instead of W use one of the following:
C (for SC)
T (for ST)

'TX' represents 100Base-TX with RJ45 connector

'V' represents existence/absence of Fusion.
Instead of V use one of the following:
V designates no built-in Fusion option.
F designates built-in Fusion option (only in TS800).

'S' represents power supply type.
Instead of S use one of the following:
S (for input to the power supply in the range 100-240 VAC)
3 (for input to the power supply in the range 24-60 VDC)

Examples

1 - TS155/A/M3C/VS means TS700/155 :1-155Mbps link, Multimode, 1310 nm, SC interface, 100-240 VAC power supply.

2 - TS155/C2/S3T/F3 : TS800/155 :1-155Mbps link, Singlemode, 1310 nm, ST interface, built-in Fusion option, 24-60 VDC power supply.

General Description

1. Front

Each TereScope head comprises a receiver, 3 transmitters and an interface on the rear panel for connection to the peripheral equipment see Figure 1.1.

Front view
Showing the receiver side, the transmitters and the telescope

CAUTION!
AVOID EXPOSURE – INVISIBLE LASER RADIATION IS EMITTED FROM THIS APERTURE

Figure 1.1: Front View

2. Back

All models of the TereScope are SNMP manageable. SNMP monitoring can be performed using MRV's MegaVision SNMP management application.

A. TS700/155 (Standard Model)

The TS700 supports Fast Ethernet, OC3, STM1, E3, and T3 protocols in the 34-155 Mbps range. A special type of TS700 can be ordered that **can be used for Open Protocol applications** which ensures complete transparency **(including all data in the range of 1-155 Mbps.)** In this type, less than 2 dB of the budget is lost.

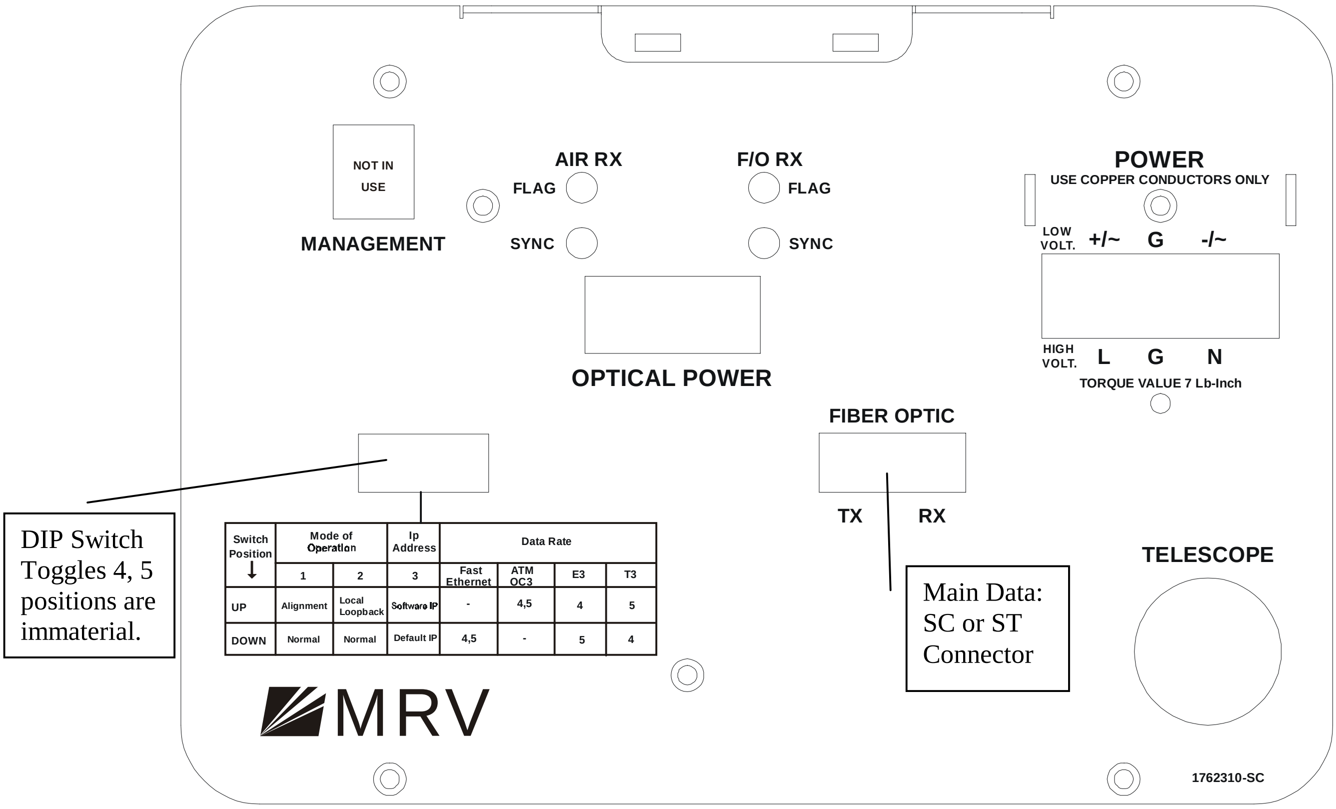


Figure 1.2a: TS700 / 155 Standard Model Panel Schematic

Figure 1.2b: Rear View of TS700/155

Back Panel Description

Table 2: TS700/155 Standard Model Back Panel Controls, Interfaces, and Indicators

Connectors	Power	Power source Terminal Block (Main or UPS)
	Fiber optic	Fiber Optic interface for connection to the peripheral equipment.
	Management (Optional)	Connection to 10base-T SNMP management interface.
Selectors (DIP Switch Toggles) -- *shown in Figure 1.3*	Mode of Operation	Set the Operating Mode ALIGNMENT = Idle transmitted automatically NORMAL = Signal received through the F/O port is transmitted through the Airlink TX. Signal received through the Airlink RX is transmitted through the F/O TX. LOOPBACK=The Data received by the F/O RX is directly returned through the F/O TX.
	IP address set up (for Mgt. option)	Used only with the management option. When the Switch toggle is moved to ON position, the system's IP address changes to default (shown on the back panel label) after the TereScope is powered off and on.
	Data Rate	Set the transmission rate of the transceiver (internal clock). - Fast Ethernet: 4,5 OFF - ATM/OC3/STM1:155 Mbps: 4,5 ON - E3: 34.368 Mbps: 5 OFF, 4 ON - T3: 44.736 Mbps: 4 OFF, 5 ON

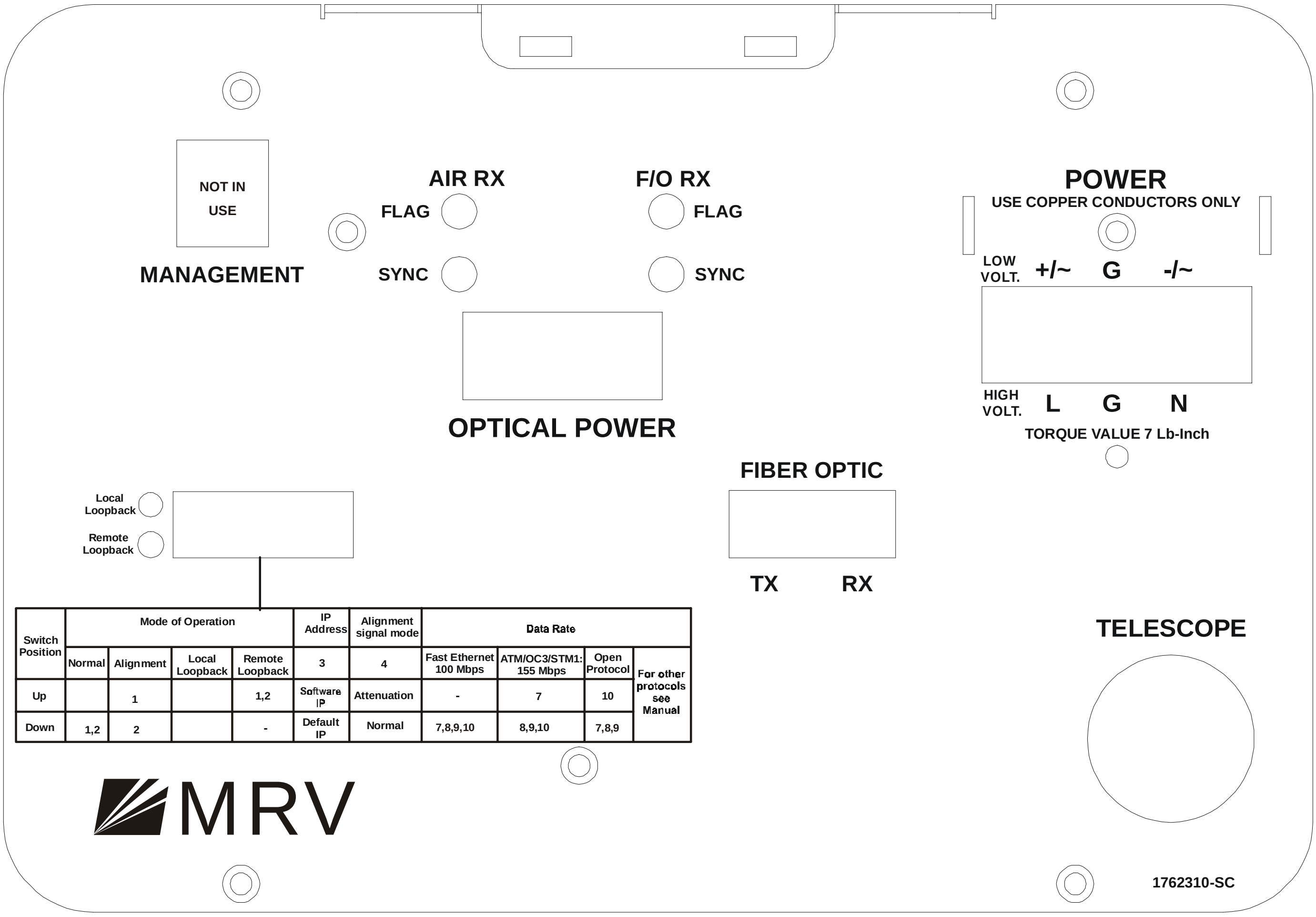
Indicators (7-segment display, LEDs)	Air RX Flag LED	Green LED indicates data received by the Airlink receiver. Turns ON at the threshold level.
	Air RX Sync LED	Yellow LED. Turns ON if the rate of the received Data matches the Data Rate set on the Data Rate DIP switch.
	F/O RX Flag LED	Green LED indicates Data received by the Fiber Optic receiver. Turns ON at the threshold level.
	F/O RX Sync LED	Yellow LED. Turns ON if the rate of the received Data matches the Data Rate set on the Data Rate DIP switch.
	Optical Power 7-segment display	Digital readout indicates the Optical Power level received by the Airlink receiver.

Alignment	***Telescope***	For fine alignment.

Power	***Power Supply***	AC power supply (100 to 240 Vac) or DC power supply (24 to 60 Vdc)

B. TS800/155 Standard Model

The TS800/155 supports most of the prevalent protocols in the 34-155 Mbps range. Support for a special protocol, which is not on the list, can be ordered after coordination with the factory. **This model can be used for Open Protocol applications** which ensures complete transparency **(including all data in the range of 1-155 Mbps.)** In this case, a maximum 2 dB of the power budget is lost.



Switch Position	Mode of Operation				IP Address	Alignment signal mode	Data Rate			
	Normal	Alignment	Local Loopback	Remote Loopback	3	4	Fast Ethernet 100 Mbps	ATM/OC3/STM1: 155 Mbps	Open Protocol	For other protocols see Manual
Up		1		1,2	Software IP	Attenuation	-	7	10	
Down	1,2	2		-	Default IP	Normal	7,8,9,10	8,9,10	7,8,9	

Figure 1.3: TS800/155 Standard Model Panel Schematic

Back Panel Description

Table 3: TS800/155 Standard Model Back Panel Controls, Interfaces, and Indicators

Connectors	Power	Power source Terminal Block (Main or UPS)
	Fiber optic	Fiber Optic interface for connection to the peripheral equipment. In model TS800/155-F with the fusion option, there are two fiberoptic interface ports for connection to the Fusion system; one primary and the other redundant.
	Management (Optional)	Connection to 10Base-T SNMP management interface.
Selectors (DIP Switch Toggles) -- *shown in Figure 1.3*	Mode of Operation	Set the Operating Mode ALIGNMENT = Idle transmitted automatically NORMAL = Signal received via the F/O port is transmitted through the Airlink TX. Signal received via the Airlink RX is transmitted through the F/O TX. LOOPBACK= Data received by the F/O RX is directly returned through the F/O TX. REMOTE LOOP = Loops the electrical RX to the electrical TX and optical RX to the optical TX of the remote unit.
	IP address set up (for Mgt. option)	Used only with the management option. When the DIP switch toggle is moved to ON position, the system's IP address changes to default (shown on the back panel label) after the TereScope is powered off and on.
	Alignment Signal Mode	If the distance between two heads is too short (the received signal is too high), set switch toggle No 4 to "ON" position, which will lower the signal for 20 dB.
	Fusion (Only in TS800-F)	This switch toggle enables working with MRV's Fusion system. For additional information, see page 7. Switch toggle 5 OFF: Fusion not Active (Enabled) Switch toggle 5 ON: Fusion active (Disabled).
	Data Rate	Set the transmission rate of the transceiver (internal clock). - Fast Ethernet: 7,8,9,10 OFF - ATM/OC3/STM1:155 Mbps: 8,9,10 OFF, 7 ON - SMPTE 143 Mbps: 9,10 OFF, 7,8 ON - E3: 34.368 Mbps: 7,8,10 OFF, 9 ON - T3: 44.736 Mbps: 8,10 OFF, 7,9 ON - OC1/STM0: 51.840 Mbps: 7,10 OFF, 8,9 ON - Customized 1 : 10 OFF, 7,8,9 ON - Customized 2 : 7,9,10 OFF, 8 ON - Open Protocol: 7,8,9 OFF, 10 ON.

Note: Pins (4,5) and (7,8) of the management RJ45 connector can be used for dry contact purposes, for Airlink flag and F/O flag alarms respectively.

Indicators (7-segment display, LEDs)	Air RX Flag LED	Green LED indicates data received by the Airlink receiver. Turns ON at the threshold level.
	Air RX Sync LED	Yellow LED. Turns ON if the rate of the received Data matches the Data Rate set on the Data Rate DIP switch.
	F/O RX Flag LED	Green LED indicates Data received by the Fiber Optic receiver. Turns ON at the threshold level.
	F/O RX Sync LED	Yellow LED. Turns ON if the rate of the received Data matches the Data Rate set on the Data Rate DIP switch.

	Optical Power 7-segment display	Digital readout indicates the Optical Power level received by the Airlink receiver.
	Remote Loop LED	Yellow LED. Turns ON as the REMOTE LOOP Operating Mode is selected.
	Loopback LED	Yellow LED. Turns ON as the LOOPBACK Operating Mode is selected.

Alignment	***Telescope***	For fine alignment.

Power	***Power Supply***	AC power supply (100 to 240 Vac) or DC power supply (24 to 60 Vdc)

C. TS800/155-F (Standard Model including Fusion option)

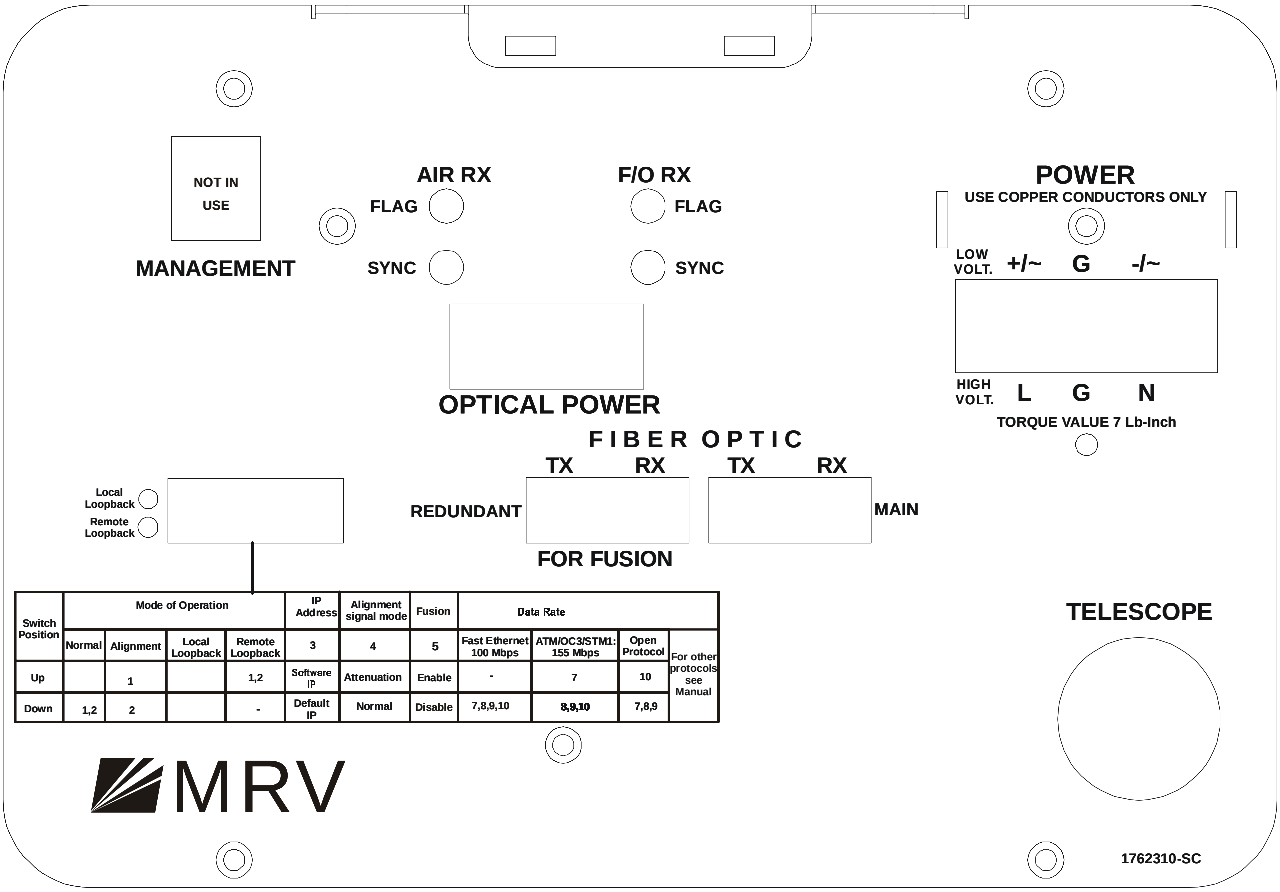


Figure 1.4: TS800/155-F Standard Model Panel Schematic

This special TS800/155-F model can be connected to the back-up radio system without a special MRV switch and card supporting Fusion. This TereScope can be connected to any switch (supporting 10/100 Mbps data rate) via a standard converter that should be connected to the optical port of the TereScope labeled “Redundant”, while the back-up radio system is connected to the same Switch.

As an alternative, the TereScope can be directly connected to a Media Converter of type 10/100 TX-100 FX (for example, MRV’s media converter MC102F). When the TereScope stops operating, the connectivity from the main optical module to the air channel stops and starts flowing into the second optical module designated for radio.

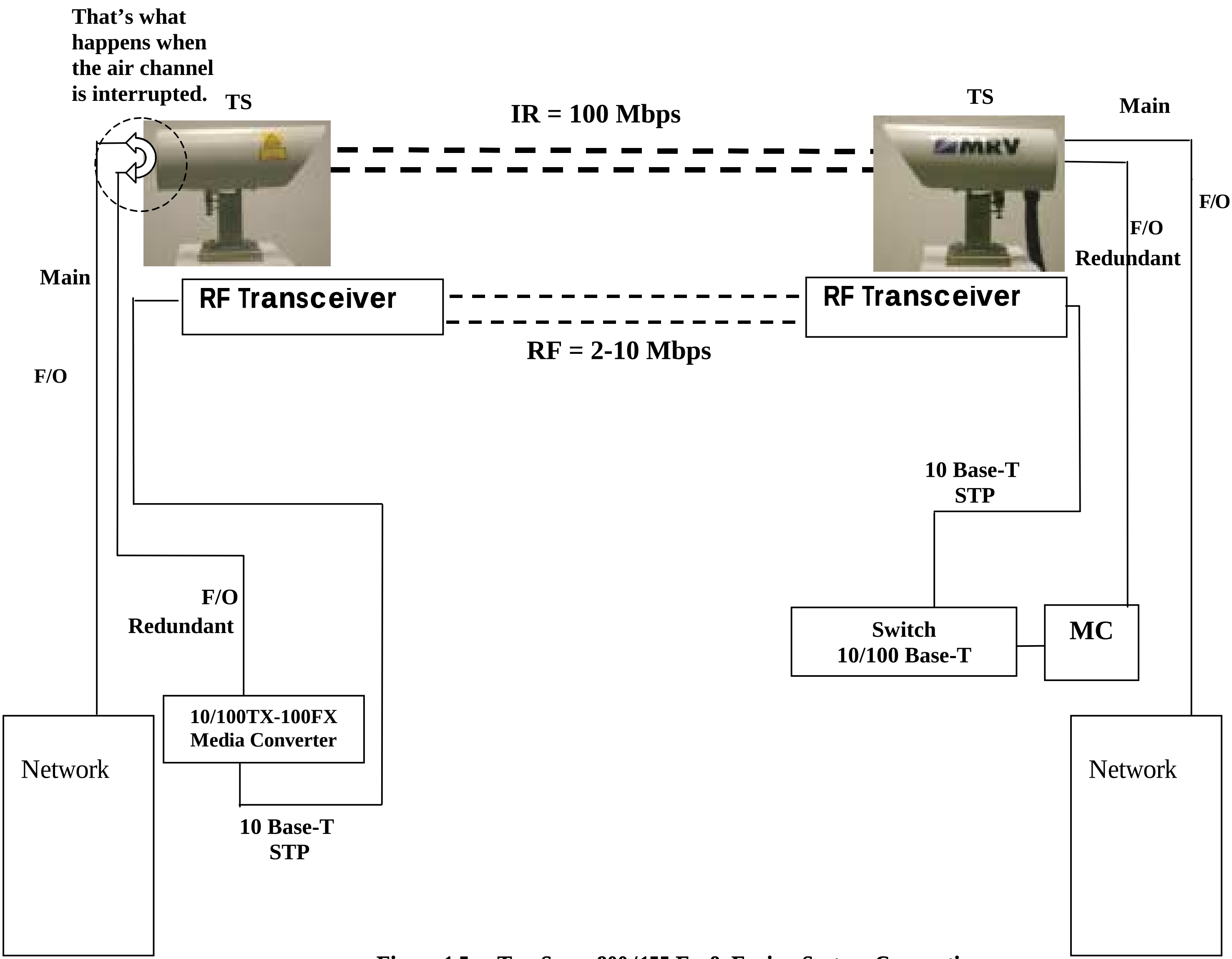


Figure 1.5a: TereScope800/155 F - & Fusion System Connection

For a description of the Back Panel and all the functions, see Paragraph B table 3, and Paragraph C Figure 1.4 – TS800 with Fusion model, page 7.

Fusion Operation Mode

When at least one of the air channels (IR) is cut for more than one second or drops to approximately 60 mV at the display readout:

1. TereScope switches to Fusion mode
2. Data is transmitted from Main module to Redundant module without passing through the air channel
3. The signal is converted to 10Base-T by the Switch and the data Rate decreases to 2-10 Mbps

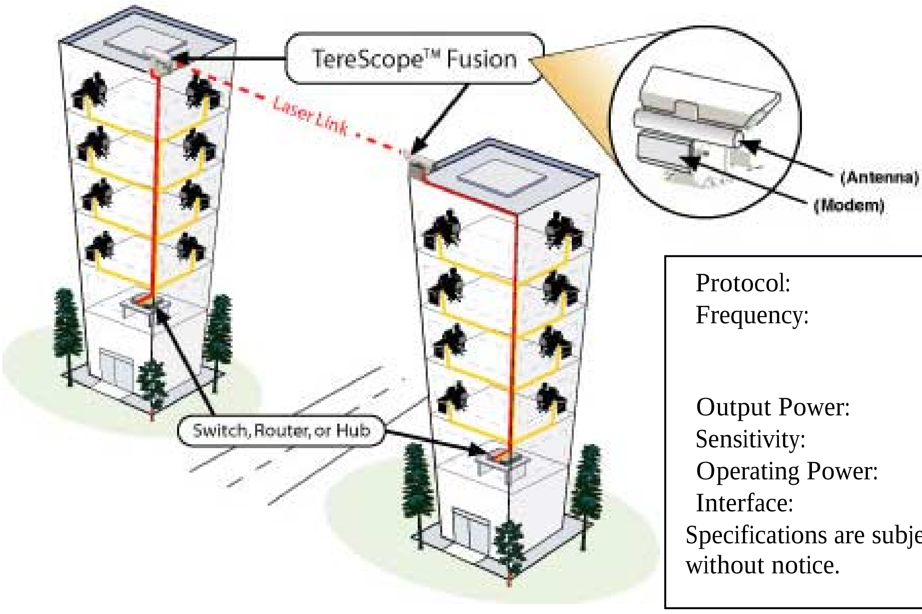
The system switches back to IR channel (TereScope) only when the display readout on both sides increases to approximately 150 mV.

<u>Note</u>: To activate the Fusion option, set DIP Switch toggle 5 to the ON position.

Fusion

Maximizing Link Availability in All Weather Conditions.

The TereScope Fusion was designed to combine the best features of two transport mediums, laser light and radio waves, to form a single, seamless, wireless communication link between network devices. By leveraging both technologies, we can provide the 99.999% availability that your network requires.



Protocol:	10Base-T (IEEE 802.1 1 b)
Frequency:	2.4 - 2.4835 GHz ISM band (ETSI, FCC 2.4 – 2.497 GHz (Japan)
Output Power:	-4 to 24 dBm
Sensitivity:	-85 dBm
Operating Power:	110/220 VAC, 500/250 mA
Interface:	Shielded RJ45

Specifications are subject to change at any time without notice.

Figure 1.5b: TS & Fusion

The TereScope Fusion has been specifically constructed to maximize link availability between network nodes. These systems use the internationally unlicensed, 2.4 GHz ISM band and are used as a backup for a number of TereScope systems.

TereScope Fusion systems have an optical wireless link that provides Fast Ethernet connectivity as the primary link and Ethernet RF as the backup link. These systems operate in most weather conditions, including heavy rain, snow, and fog with nearly 100% link availability. Ease of installation and freedom from licensing make these systems very simple to deploy.

D. TS700/100 - Fast-Ethernet System

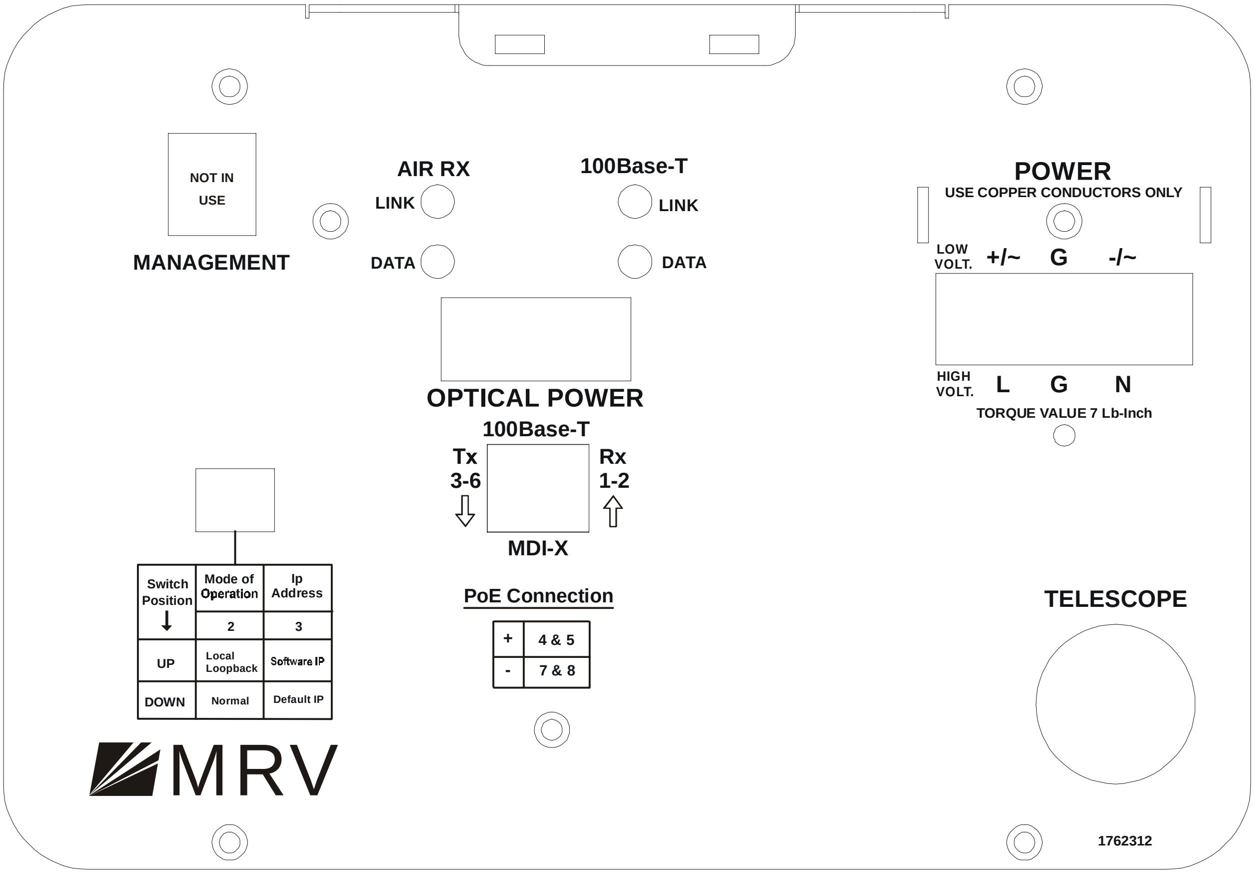


Figure 1.6: TS700/100 Model Back Panel

Back Panel Description

Table 4: TS700/100 Back Panel Controls, Interfaces, and Indicators

Connectors	Power	Power source Terminal Block (Main or UPS)
	100Base-TX	Copper interface (RJ45) for STP cables. MDI-X connection. Connection to the peripheral equipment. This connector can be used for Power-over-Ethernet (PoE). The standard power for PoE is 36-57 Vdc. However, the TS700/100 can operate with 20-60 Vdc. See appendix I.
	Management (Optional)	Connection to 10Base-T SNMP management interface.
Selectors (DIP Switch Toggles) -- *shown in Figure 1.6*	Mode of Operation	Set the Operating Mode NORMAL = Signal received through the F/O port is transmitted through the Airlink TX. Signal received through the Airlink RX is transmitted through the F/O TX In the TS700/100 model, if data is not connected the TereScope automatically transmits an idle signal. LOOPBACK= Data received by the F/O RX is directly returned through the F/O TX
	IP address set up (for Mgt. option)	Used only with management option. When the DIP switch toggle is moved to the ON position the system's IP address changes to default (shown on the back panel label) after the TereScope is powered off and on.

Indicators (7-segment display, LEDs)	Air RX Link LED	Green LED indicates data received by the Airlink receiver. Turns ON at the threshold level.
	Air RX, Data LED	Yellow LED blinking indicates Data transfer via the Airlink receiver to the interface.
	100Base-T Link LED	Green LED indicates Data received by the 100Base-T receiver. Turns ON when connected to peripheral equipment.
	100Base-T Data LED	Yellow LED blinking indicates Data transfer via the 100Base-TX interface.
	Optical Power 7-segment display	Digital readout indicates the Optical Power level received by the Airlink receiver.

Alignment	***Telescope***	For fine alignment.

Power	***Power Supply***	AC power supply (100 to 240 Vac) or DC power supply (24 to 60 Vdc).

Monitoring and Management Options

RJ45 Connection for SNMP Interface

The TereScope is manageable using the SNMP option. SNMP monitoring can be performed via MegaVision, MRV's SNMP management application.

Figure 1.7: SNMP + TereScope

Typical Connection

1 - Fiber Connection

In order to implement a connection, each transceiver must be connected to the peripheral/testing equipment through fiber optic cables. A correct connection is indicated by the display on the back panel of the transceiver (see the section Display and Results pages 28 and 29).

IT IS A CROSS CONNECTION:

TX ➔RX AND RX ➔ TX

Scheme of the Connection to peripheral equipment

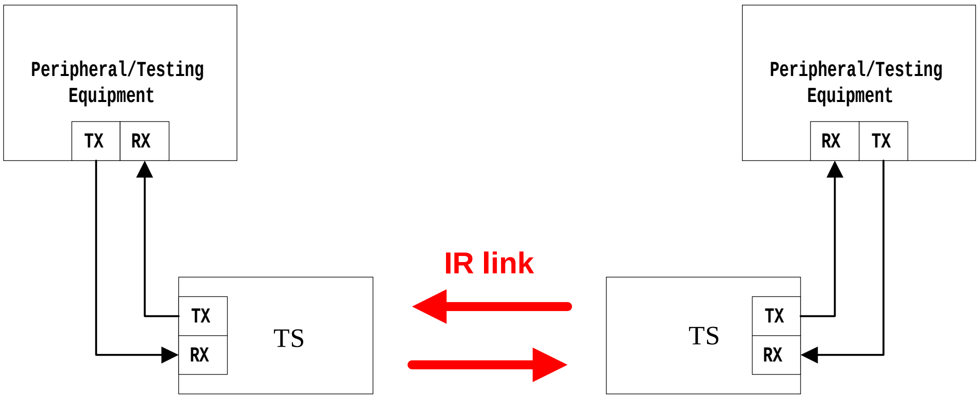


Figure 1.8: Typical Connection for Models 155 and 155-F

2 - Copper Connection

In order to implement a connection, each transceiver must be connected to the peripheral/testing equipment with an STP cable. A correct connection is indicated by the display on the back panel of the transceiver (see the section Display and Results pages 25).

Scheme of the Connection to the peripheral equipment

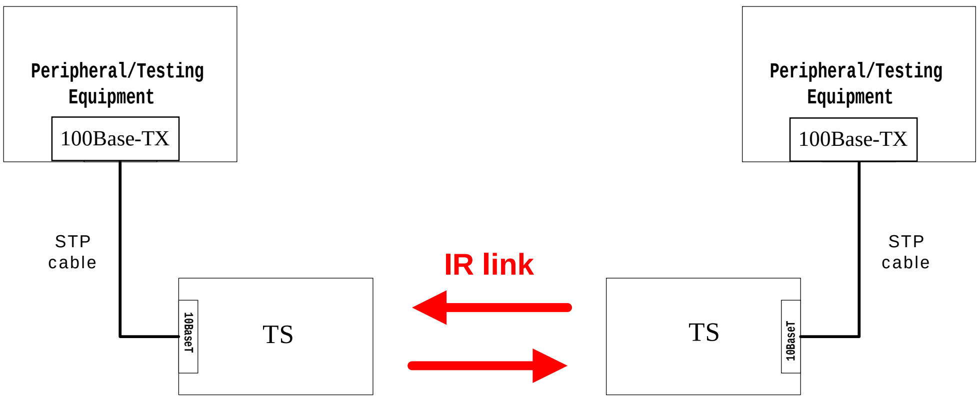


Figure 1.9: Typical Connection for Model TS700/100

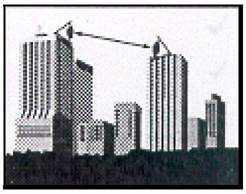
Chapter

2

Site Survey

The first step before every installation is to visit the sites to be linked. in order to make sure that the connection is feasible, to find out potential obstacles or difficulties and to decide on the location and mounting points of the transceivers.

Line of Sight



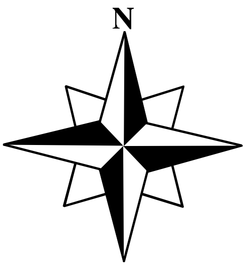
A necessary condition for linking two distant buildings is that the two mounting sites must be within clear sight of each other.

Pay attention to:

- Growing vegetation and increasing foliage during spring
- Building sites (cranes movements, etc.)
- Chimneys (intervening smoke can interrupt the beam from time to time).

Orientation

Direct sunlight can overload the airlink receiver to saturation level. Avoid, as far as possible, the East-West direction for the link.



> **Note**
>
> In case this is not possible, the surrounding buildings could shield the transceiver from the direct sunlight otherwise outages lasting several minutes (depending on the time of the year and the angle of the sun) could occur. The system will fully recover once the sun is out of the receiver field-of-view.

Location & Range

1. The mounting of the transceiver must be very rigid (preventing the installation from twists of even as little as 1 mrad). The key to the required rigidity is to attach the mounting accessories on strong mounting points such as:
   - Stiff building structures
   - Concrete or reinforced concrete surfaces

(1) In case such situations cannot be avoided, special mounting accessories and techniques must be designed and considered (see section Particular Figure Cases\Techniques page 35)

Prefer	Avoid	Pay attention to
Concrete Parapet Structural wall or column	Old constructions Soft material (asphalt, etc.) Non-uniform surfaces Wooden and metal structures	Colored windows Double glazing The proximity of power radio antennas

For reasons of convenience, it is always preferable to install the units indoors as long as all the required conditions previously described are met and the customer/building owner allows it. However, when windows are present in the beam path, the attenuating factor of the glass must be considered regarding the distance and the required fade margin.

2. Referring to the data in Appendix A: Product Specifications, set and record the distance between the two TereScopes of the link. (You can use any of the following equipment to determine the distance: rangefinder laser binoculars, GPS receiver, maps, etc.)
3. Noting that two TereScope units are required per link, record the quantity of each model of the TereScope required.
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, for e.g., against strong winds (120km/h or more)

CONSULT FACTORY IN CASE OF DOUBT !

Figure 2.1 and Figure 2.2 show optimal and acceptable locations for the TereScope links. Notice that in both figures the TereScopes are mounted on rooftop edges and high enough above the ground.

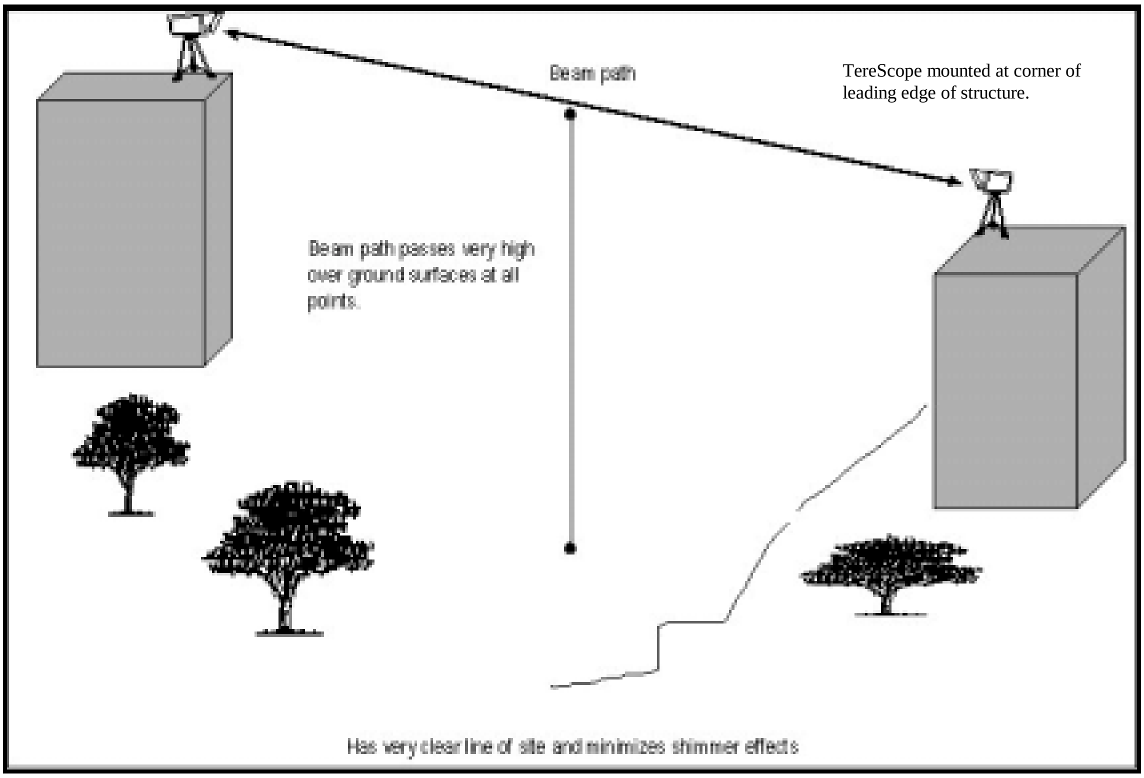


Figure 2.1: Optimal Mounting

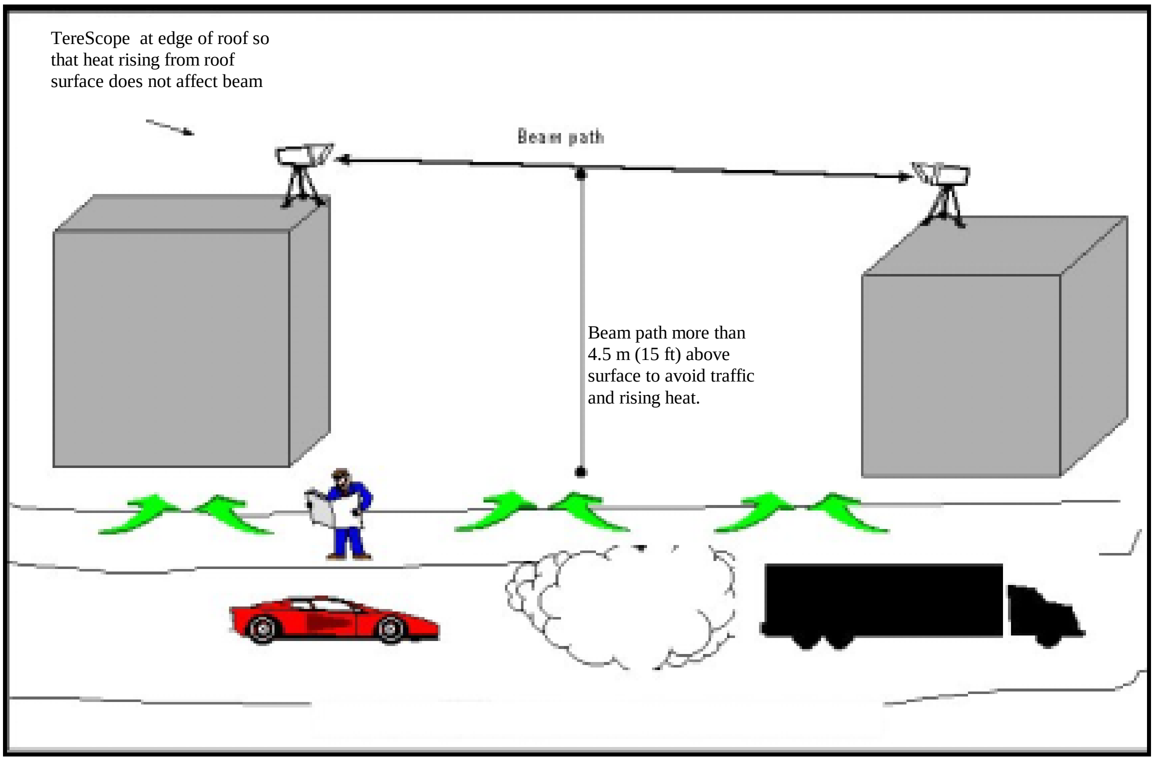


Figure 2.2: Acceptable Mounting

Figure 2.3 shows an unrecommended TereScope link location because of interference by IR. Notice that the TereScopes are mounted far from the rooftop edges or are too close to the ground.

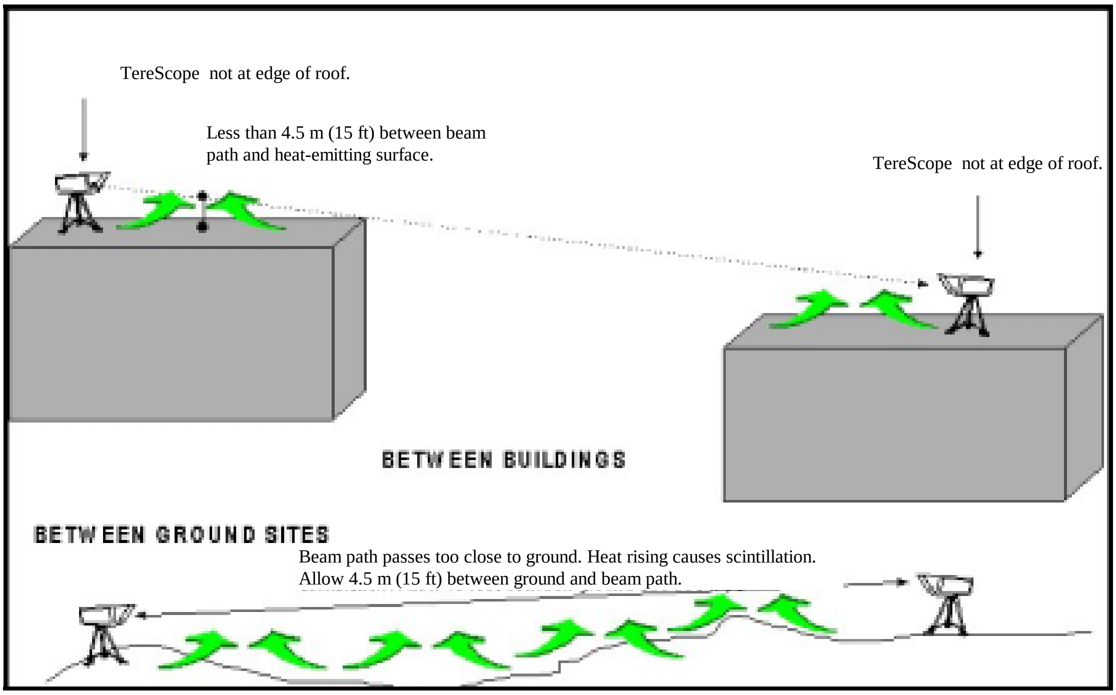


Figure 2.3: Unrecommended Mounting

Figure 2.4 shows an *unacceptable* TereScope link location because of interference by passing vehicles. Notice that the TereScopes are mounted far from the rooftop edges and not high enough above the ground.

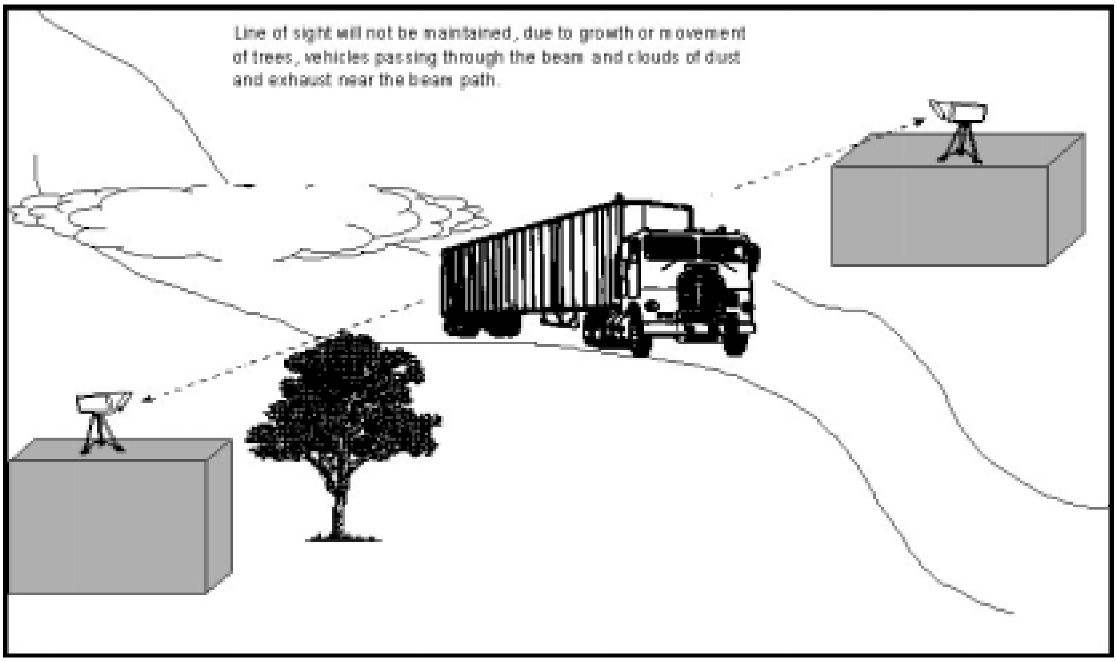


Figure 2.4: Unacceptable Mounting

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

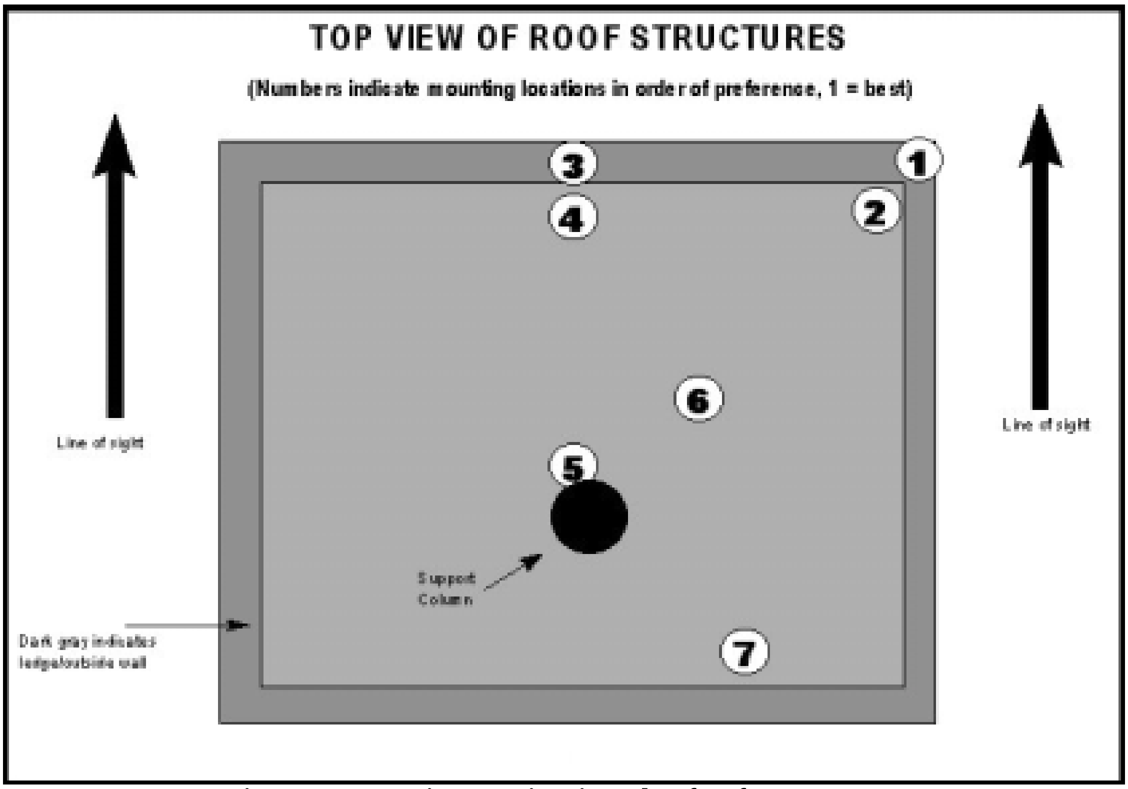


Figure 2.5: Mounting Locations in Order of Preference

Note: If the only option to mount the TereScope is at points 5, 6 or 7, it has to be mounted at least 2 m above the rooftop to avoid roof scintillations and people crossing the link beam (If possible, avoid placing the TereScope on a mast).

3. Avoid surfaces with high reflectivity (e.g., white walls) behind the TereScope so as to reduce interference with the optical signal.
4. Get customer approval for the *exact* positions where the TereScopes will be mounted. Using paint, mark these positions.
5. Note the height that each TereScope will be above or aside the rooftop.
6. Identify the floor or wall type and dimensions of the location at which it is planned to mount the TereScope.
7. For each TereScope head, select one of the following mounting options[2] and record it.
   a. **Parapet/Ledge Mounting** (Figure 2.6) – This is a standard mounting option that uses only the Plate (JMP-L).
   b. **Wall Mounting** (Fig. 2.8) – This is a standard mounting option that uses the Plate (JMP-L) as well as the two Brackets (JMB).
   c. **Floor Pedestal Mounting** (Figure 2.7) – This is a non-standard mounting option that uses the Plate (JMP-L) as well as a Floor Pedestal (e.g., M015C).
   d. **Wall Pedestal Mounting** (Figure 2.9) – This is a non-standard mounting option that uses the Plate (JMP-L) as well as a Wall Pedestal (e.g., M054C).
   e. **Extended Wall Mounting** (Figure 2.10) – This is a non-standard mounting option that uses the Plate (JMP-L) as well as an Extended Wall (e.g., M062C).
   f. **Angle Bracket Mounting** (Figure 2.11) – This is a non-standard mounting option that uses the Plate (JMP-L) as well as an Angle Bracket (e.g., M001).

Figure 2.6: Parapet/Ledge Mounting (using JMP-L only)

Figure 2.7: Floor Pedestal Mounting (using JMP-L and MO15C)

Figure 2.8: Wall Mounting (using JMP-L and JMB)

Figure 2.9: Wall Pedestal Mounting (using JMP-L and MO54C)

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

Figure 2.10: Extended Wall Mounting (using JMP-L and MO62C)

Figure 2.11: Angle Bracket Mounting (using JMP-L and M001)

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 model. (The % attenuation depends on the tint and must be measured.)
3. Ensure that the angle of incidence[3] of the beam striking the windowpane is between 1° and 45°.

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

Figure 2.12 shows the arrangement for transmitting through a window

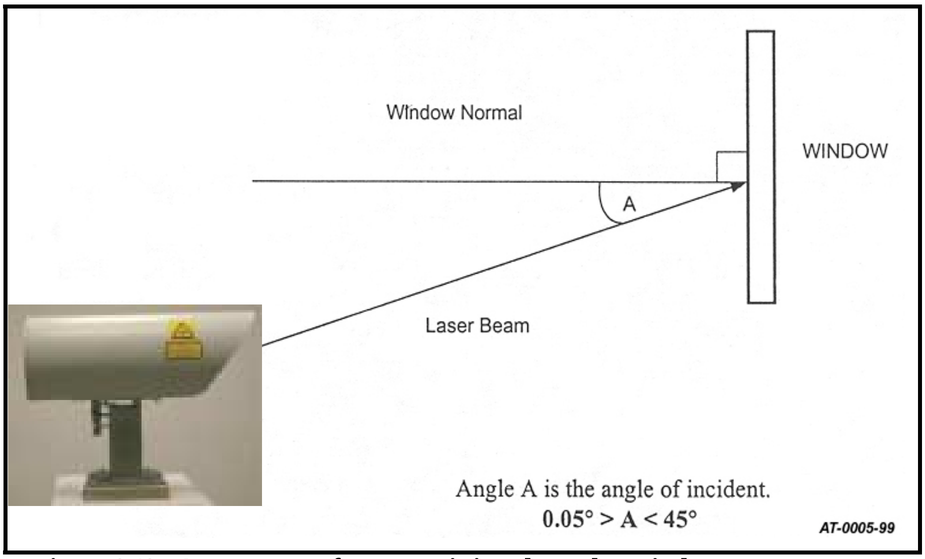


Figure 2.12: Arrangement for transmitting through a window.

[2]Angle which the light beam makes with the perpendicular to the windowpane

Chapter 3

Infrastructure

The only infrastructure required for operating the transceiver and linking the sites is Power and Data/Signal connection to the peripheral networking equipment. This must be ready prior to the airlink installation.

IN OUTDOOR INSTALLATIONS, USE SHIELDED AND WEATHERPROOF MATERIALS (CABLES, INLETS, CONNECTORS) COMPLIANT TO THE SAFETY STANDARD IN FORCE.

Power

Source

The power requirement for standard units is 100-240VAC @ 50/60Hz - 10W.

Note: Units requiring low Voltage : 24-60 VDC - 10W can be factory set upon request.

It is recommended to use a Surge Suppression System to avoid damage to the equipment when power supply is unstable. Protection should be at least 25,000A.

Cabling

Standard 3-conductor power cords are required. (See Safety requirements, Page iv)

Data/Signal Cabling

1. For TS700/155, TS800/155 & TS800/155-F

Type

For connecting the Transceiver to the peripheral equipment, a dual-fiber cable is required (one fiber for transmission, the other for reception). The standard recommended cable is MM 62.5/125 µm fiber or SM 9/125 µm for fiber.

Connectors

Each fiber should be terminated with the ordered type of connector on the transceiver end (SC, ST).

Optical Fiber Testing

The cabling installer must specify the attenuation of each fiber installed.

A simple power loss test can inform us about the condition of the fibers. This test consists in measuring (with an optical power meter) the output power at one end of the tested fiber when a fiber source is connected at the other end. If the values are in dBm, the difference between the input power and the output power gives the power attenuation of the fiber (in dB).

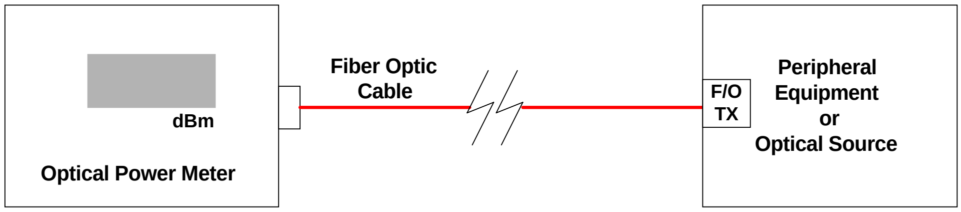


Figure 3.1: F/O cable test.

In case the above equipment is not available, a simple visual test may be performed to locate and reject badly damaged fibers. Place a light source at one end of the fiber and intermittently block it and observe the light coming out of the other end. (This procedure does not guarantee that a fiber is acceptable)

A standard 62.5µm fiber opticcable is characterized by an attenuation factor of about 3 to 5 dB/km. A loss value of more than 3 dB for runs up to 200m indicates that the fiber may be faulty.

Note

The fiberoptic cables must be installed by a qualified person.

HANDLE THE FIBERS VERY CAREFULLY.

2. For TS700/100

Type

For connecting the Transceiver to the peripheral equipment, 2-pair STP Category 5 cable is required (one pair for transmission, the other for reception). This cable must be a **straight** one when the peripheral has an MDI-X 100Base-TX interface and a **Gross** one otherwise.

Connectors

The cable should be terminated with an RJ-45 connector at the Transceiver end.

Chapter

4

Bench Test

It is always easier and more convenient to locate a failure and solve a problem in a lab on a bench than on a roof under bad conditions. Accordingly, it is strongly recommended to perform a bench test with all the modules prior to installation in order to check the equipment compatibility and to validate the configuration.

See Unpacking Instructions in Appendix C.

1 – TS700/155, TS800/155, and TS800/155-F

Compatibility

Peripheral equipment

Check the operation of the peripheral equipment connected with cables (see Configuration 1 below).

Interfaces

Check the specifications compatibility (type, wavelength, receiver range, output power, data rate) between the TereScope and the peripheral equipment interfaces.

Test equipment

Chose an appropriate Bit Error Rate (BER) tester for checking the physical link quality. A portable one is preferable since it is more convenient for use in the field.

For example: the OC3 port plus SONET and ATM analyser manufactured by Fluke.

A ping test or a file transfer between two workstations - connected to the networking equipment - is useful and easy to do for testing the performance of the whole configuration.

Setup

Data Rate DIP Switch Toggle

According to the application in use, set the switch toggles as indicated in the following table:

Table 5: DIP Switch Setting for TereScope

Function	TS700/155		TS800/155	
	OFF	*ON*	*OFF*	*ON*
Fast Ethernet	4,5	–	7,8,9,10	–
ATM/OC3/STM1: 155 Mbps	–	4,5	8,9,10	7
SMPTE 143 Mbps	–		9,10	7,8
E3:34.368 Mbps	5	4	7,8,10	9
T3:44.736	4	5	8,10	7,9
OC1/STMO:51.840 Mbps	–		7,10	8,9
Customized 1	–		10	7,8,9
Customized 2	–		7,9,10	8
Open Protocol	–		7,8,9	10

Mode Select DIP switch toggle
Set DIP switch toggles 1 and 2 to the OFF position for normal operation.

2 – TS700/100

Compatibility

Peripheral equipment

Check the operation of the peripheral equipment connected with cables (see Configuration 1 below).

Interfaces

Check the specifications compatibility (type, data rate) between the TereScope and the peripheral equipment interfaces.

Test equipment

Chose an appropriate Bit Error Rate (BER) tester for checking the physical link quality. A portable one is preferable since it is more convenient for use in the field.

A ping test or a file transfer between two workstations - connected to the networking equipment - is useful and easy to implement for testing the performance of the whole configuration.

Setup

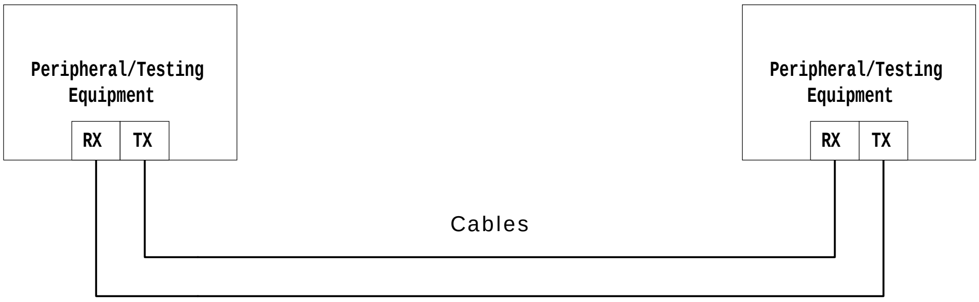
DIP Switch
Set DIP switch toggles 1 and 2 to the OFF position for normal operation.

Bench test

To learn more about TereScope Bench Test, please refer to Appendix E.

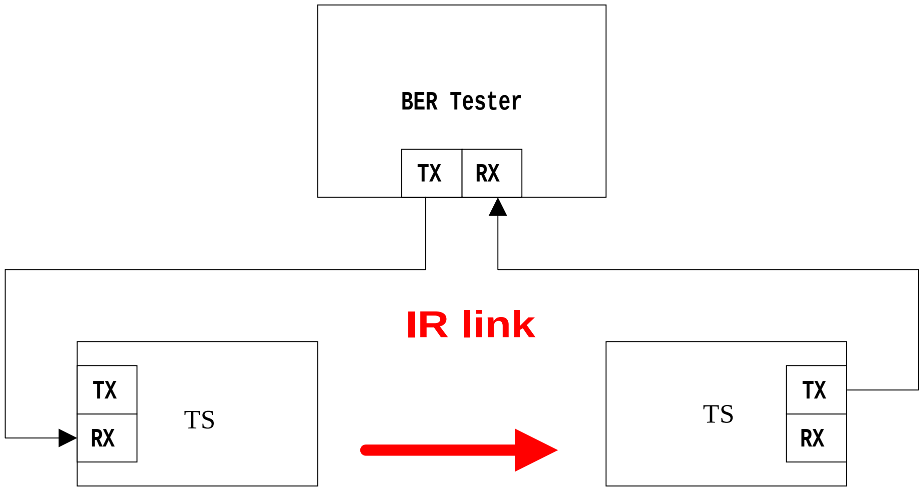
Configuration 1: (Applicable to all models)

Peripheral equipment and cable testing



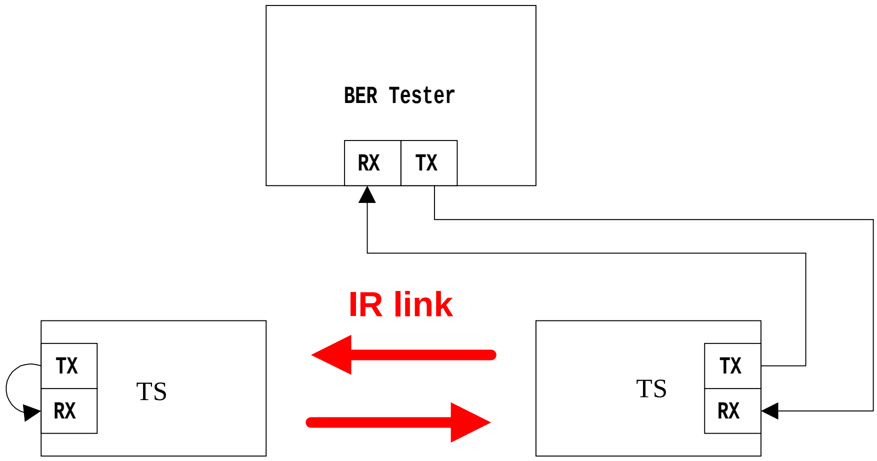
Configuration 2: (Applicable to all models)

1-way Airlink BER test



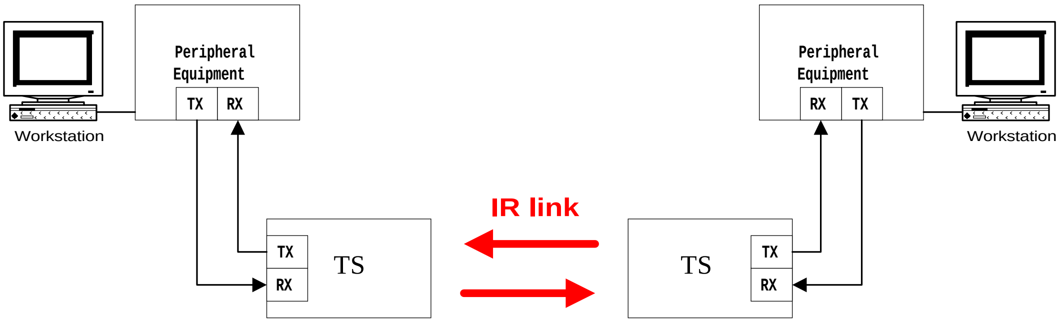
Configuration 3: (Applicable to all models)

Loop-back Airlink BER test



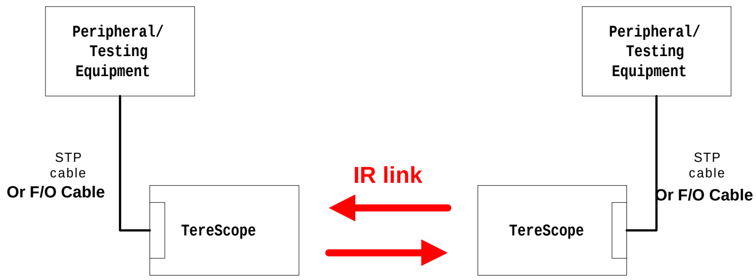
Configuration 4: (Applicable to all models)

Whole configuration operating test (Ping test or File transfer) for Ethernet or Fast Ethernet systems



Configuration 5: (Applicable to all models)

Whole configuration operating test for all models



Display and Results

1. TS700/155, TS800/155 & TS800/155-F

Proper Display

1. **Indicators**

Indicator → Position ↓	AIR RX		F/O RX		Alignment	Loopback
	Flag	Sync	Flag	Sync		
ON	x	x	x	x		
OFF					x	x

Table 7: Indicators

2. **Received power**

100 < OPTICAL POWER < 1000

Expected Results

The BER must be less than 10E-12 (10^{-12}) for on-going tests and error-free for short tests.

2. TS700/100

Proper Display

2. **Indicators**

Indicator → Position ↓	AIR RX		Electrical		Loopback
	Flag	TX	Flag	RX	
ON	x	x	x	x	
OFF					x

Table 8: Indicators

3. **Received power**

100 < OPTICAL POWER < 1000

Expected Results

The BER must be less than 10E-12 (10^{-12}) for on-going tests and error-free for short tests.

The PING test and file transfer procedure should not post any *TIME OUT alarm* or last too long time so long as the cabling connection is OK.

Chapter 5

Installation

This chapter shows how to mount the TereScope and and accessories at the site (see Appendix D for the required material).

See Unpacking Instructions in Appendix C.

CAUTION: TereScope must be mounted in the horizontal position only; max angle 45º

Accessories

The standard mounting accessories are supplied with the transceivers (TereScope heads) in the kit. They are designed for typical mounting on horizontal and vertical surfaces.

Description

The accessories kit (supplied by MRV) consists of:

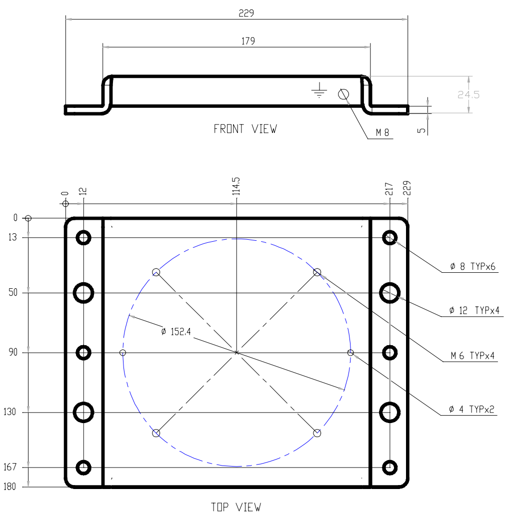
- The Mounting Plate (JMP)
- The Aiming Head
- The Installer Tool Kit (JITK-L)

The JMP is used for mounting the transceiver on the support surface, i.e., a horizontal concrete surface/plate only.

JMP
Mounting Plate
(dimensions in mm)

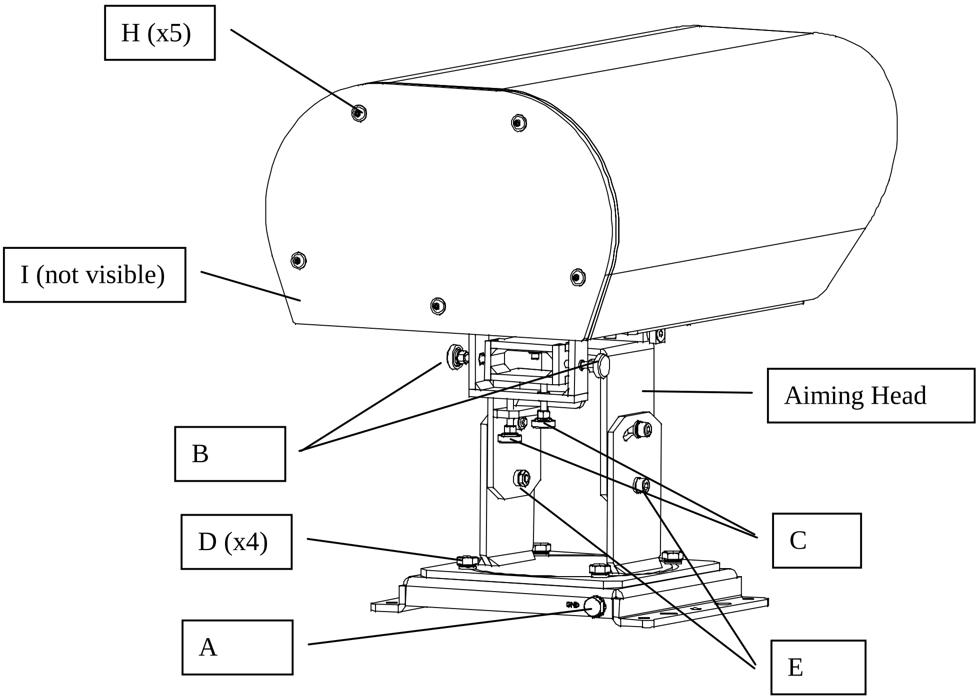
Screw for grounding

Figure 5.1a: JMP



Dimensions in mm

Figure 5.1b: JMP scheme



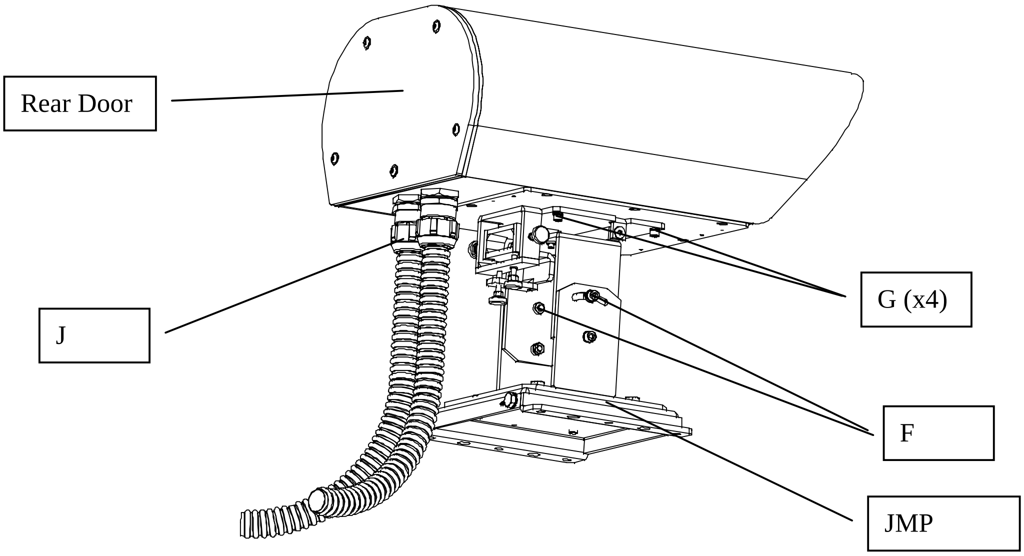


Figure 5.2: TereScope Parts

Table 6: TereScope Parts

Part	Description	Part	Description
A	Screw for Grounding	F	Screws for Vertical coarse Aiming and locking Vertical motion
B	Right-Left Fine Alignment Screws	G(x4)	Four Screws for locking Aiming Head to TereScope Head
C	Up-Down Fine Alignment Screws	H(x5)	Door lock Captive Screws
D	Screws for locking Aiming Head to JMP, Horizontal coarse Aiming and locking Horizontal motion	I	Door Axis
E	Vertical Aiming Axis	J	Cable Duct

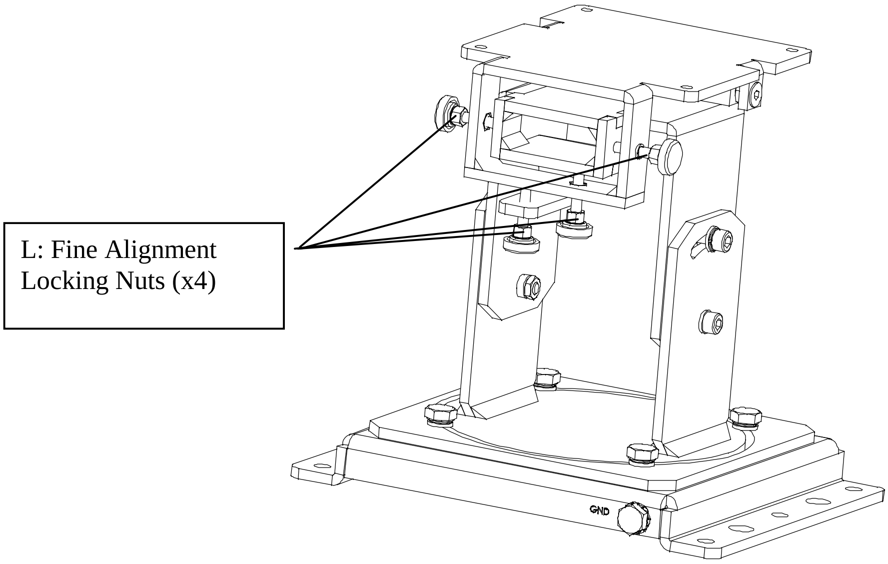


Fig. 5.3: Aiming Head + JMP

Fig. 5.4: Mounting kit

Fig. 5.5: Grounding Screw

Fig. 5.6: Alignment Screws and locking nuts

Fig. 5.7: Alignment Screws – Left View

The Installer Tool Kit (JITK-L)

JITK: Installer Tool Kit

The JITK-L tool kit includes the work tools required for opening and closing nuts and screws of the TereScope for optimal installation. It is recommended that these tools be used. MRV supplies this tool kit with each TereScope head. In addition to the tool kit, screws are supplied for mounting the JMP on a pedestal that is supplied by MRV as an option.

Fig. 5.8: JITK: Installer Tool Kit

Mounting

1- Attachment of the Transceiver (TereScope Head)

The TereScope Head, Aiming Head, and JMP are shipped connected to one another. Before mounting, the JMP must first be detached and connected to the fixation surface. Next, the TereScope Head and Aiming Head can be mounted.
If the TereScope head is to be detached (e.g., for servicing), remove the four 'G' screws (Fig 5.10).

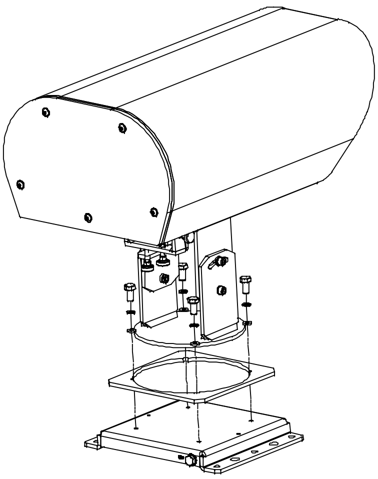


Figure 5.9: Mounting TS on JMP

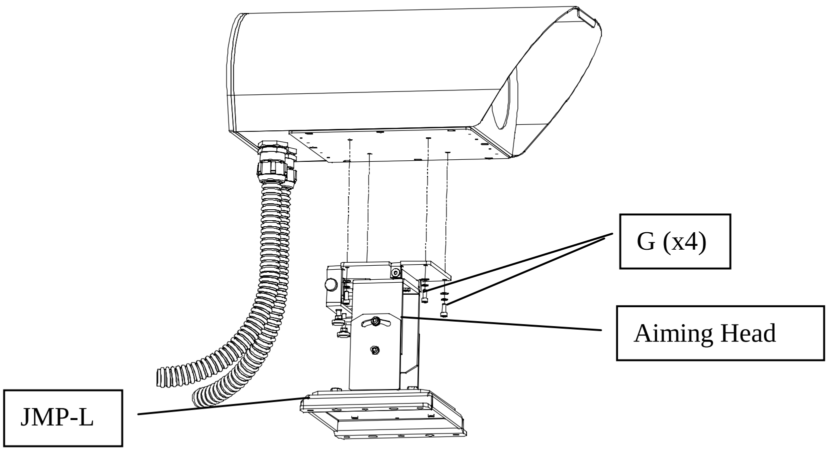


Figure 5.10: TereScope Detached from the Aiming Head

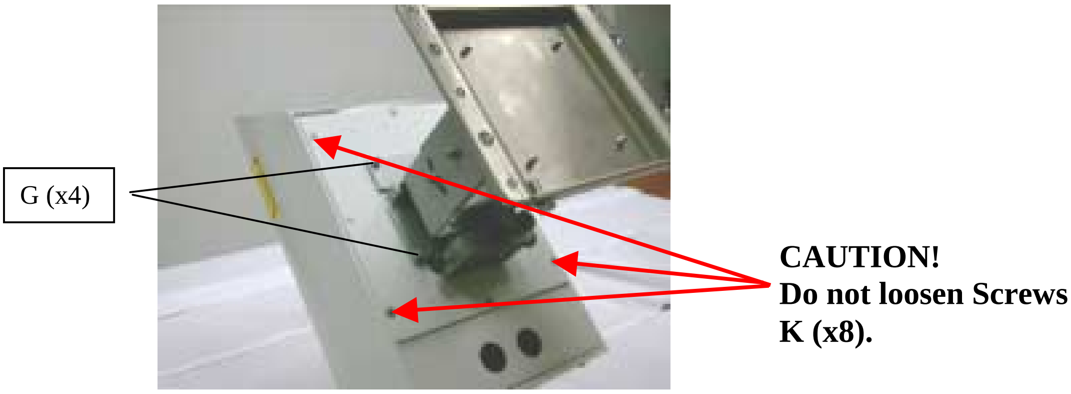


Figure 5.11: Aiming Head Cradle for TereScope Head

2- Accessories

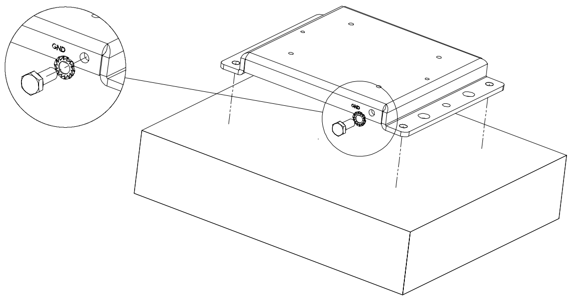


Figure 5.12: JMP on the fixation surface

THE JMP SHOULD BE ORIENTED IN SUCH A WAY THAT THE GROUNDING SCREW IS LOCATED ON THE BACK (CLOSE TO THE INSTALLER) AND THE FRONT FACING THE OPPOSITE SITE.

Special Mounting

Mounting on the floor

In some cases the only place where the installation is acceptable, possible, or authorized is on the floor. **Avoid** installation on roofs with a metallic parapet or without a parapet by drilling holes in the roof floor.

To use the floor, a very stable tower standing on the floor is required. The transceiver will be fixed on the top of the tower.

Two techniques using a small concrete block are suggested for stabilizing the tower on the floor.

- The concrete slab material is poured directly on the base of the tower
- Four bolts are inserted in the concrete slab placed on the floor. The tower mount is fixed on the slab with the inserted bolts using nuts.

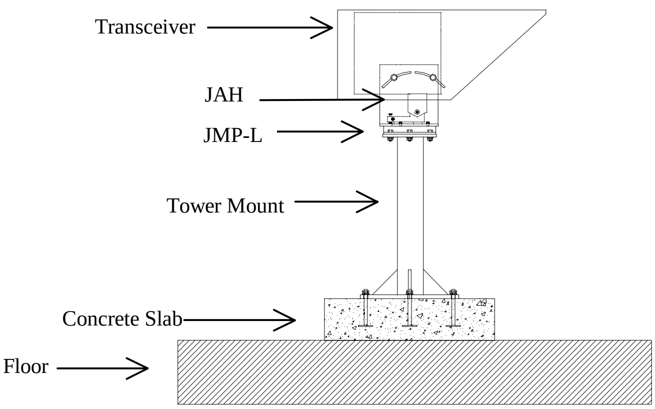


Figure 5.13: Mounting on a concrete slab

TAKE CARE TO REMOVE ANY INTERVENING SOFT MATERIAL, SUCH AS ASPHALT, BETWEEN THE SLAB/TOWER BASE AND THE FLOOR. ONCE THE INSTALLATION IS COMPLETED, RESTORE THE ROOF WATER-TIGHTNESS WITH SEALING MATERIAL AROUND THE SLAB.

Chapter

6

Aiming Procedure

Point to point connections require the orientation face to face of both “transceiving” ends of the link. Concerning wireless optical links, this should be done as accurately as possible in order to position the beam symmetrically all around the remote receiver.

Powering on the TereScope

1 – Make sure that the power cable is disconnected from the electrical power source.
2 – Undo the five screws H -- see Figure 6.1. Holding the Back Door, Pull the door +, and let the Back Door rotate down around the axis (I).

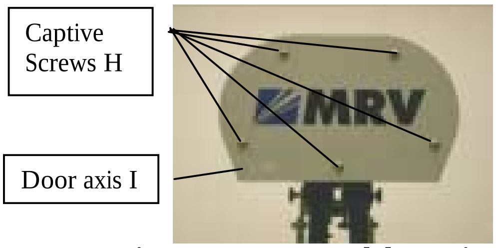


Fig. 6.1: Screws H and door axis

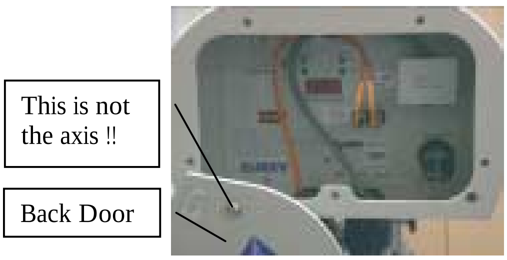


Fig. 6.2: Back Door Rotated down

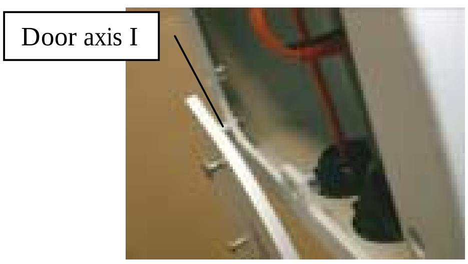


Fig. 6.3: View on Door axis

3 – Connect the wires of the power cable (see Figure 6.4) to the Terminal Block (see Figure 6.5) paying attention to L=Line, G=Ground & N=Neutral.

4 – After connecting the power cables to corresponding sockets, tightly close the screws of the Terminal block – see Figure 6.5. Gently jerk the cable to check that it stays connected. Cover the Terminal Block with a plastic cover (if available).

Fig. 6.4: Power cable & Terminal block

Fig. 6.5: Power Terminal Block Locked

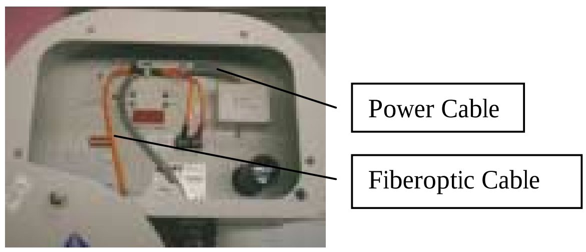


Fig. 6.6: Power Cable and Fiberoptic Cable

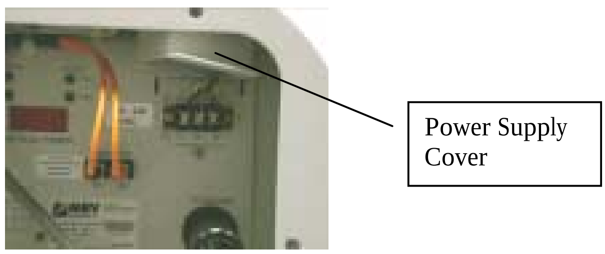


Fig. 6.7: Power Supply Cover

5 – Cover the Terminal Block with the power supply cover.
6 – Rotate and push the Back Door up, and tighten the five H screws.
7 – Connect the power cable to the electrical power source to power on the TereScope.

Transceiver 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.

Successful installation of the TereScope depends primarily on precise and accurate optical alignment. Carefully follow the instructions below!!!

Tools and Equipment

> **Note**
>
> The customer can order patch cables and high-output portable source from *MRV*.

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. (The Optical power meter is convenient though not necessary.)
- JITK-L.

Procedure

Turn on the power to the TereScope heads from the power source.
<u>Models TS700/155 and TS800/155:</u> Set DIP switch toggles 1,2 to the "Alignment" position (indicated on the back panel).
<u>Model **TS700/100**:</u> Even if the data port is left unconnected, the TereScope transmits an Idle Signal which can be used to perform alignment.
The transceiver alignment procedure is implemented in two stages:

- Coarse Alignment
- Fine Alignment

Coarse Alignment

1. Slightly loosen the four Horizontal Motion Locking Screws (screws D) and the two Vertical Motion Locking Screws (screws F) – see Fig 6.8.

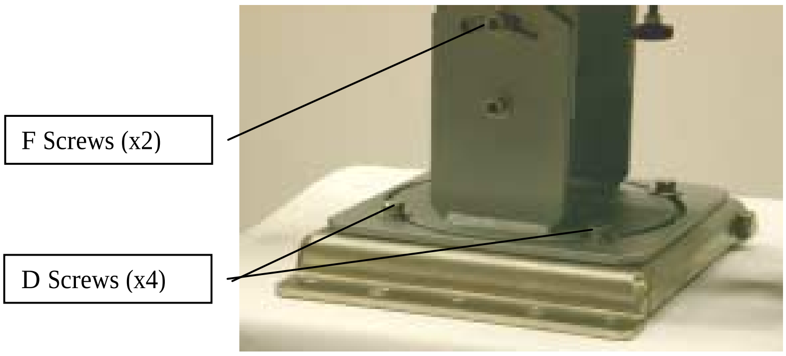


Fig. 6.8: Coarse Alignment Screws

2. To enable maximum flexibility during the fine alignment stage, rotate the fine alignment screws (Figure 6.11) until the alignment block is centered.

3. While looking (see note below) through the telescope, rotate and tilt the TereScope to bring the telescope crosshairs on the left side (your right side) of the opposite TereScope.

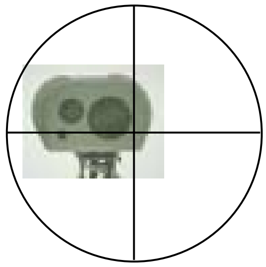


Fig. 6.9: Telescope crosshair on the opposite TereScope

4. Tighten the four horizontal coarse aiming screws (screws D) and 2 vertical coarse aiming screws (screws F) by applying a torque less than 20 Newton-meter.

Fine Alignment

The purpose of fine alignment is to position the center of the transmitted beam spot on the center of the TereScope receiver – in both directions (Fig 6.10). This is achieved by adjusting the horizontal and vertical motion screws (shown in Figure 6.11) until maximum power is received at the opposite TereScope.

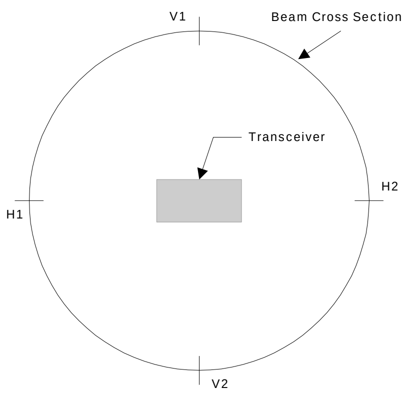


Figure 6.10: Front view – Transceiver at the middle of the beam cross section

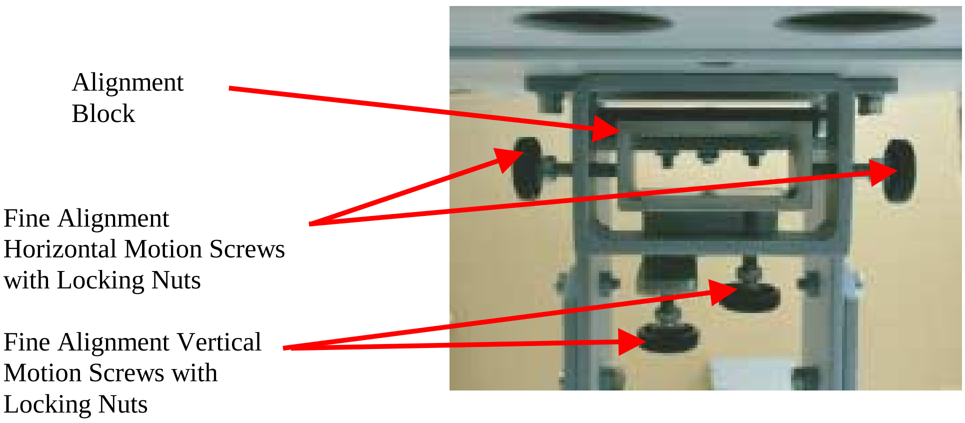


Figure 6.11: Fine Alignment Motion Screws – Rear View

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

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

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

Note

- Two installers are required for *fine alignment*, one at each TereScope site.
- The installers should each have a walkie-talkie, a mobile phone or any other equipment to enable each to talk to the other working at the opposite site.

The fine alignment procedure is as follows:

1. Find the horizontal and vertical Beam edges (H1, H2, V1, V2) by obtaining a reading between 50 and 80 on the 7-segment display.
2. Set successively the remote transceiver in the middle of the two segments [H1,H2] and [V1,V2].

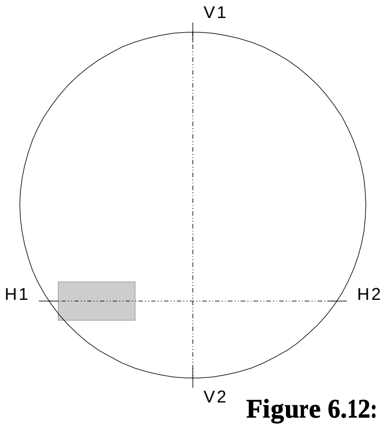


Figure 6.12: Position at the beginning (after the coarse alignment)

Important: Do **not** in any case select the head position for which the DVM reading is maximum! The best position of alignment is the beam center.

To determine the horizontal beam edges H1 and H2, move the local transceiver slowly left and right until the digital readout on the remote transceiver becomes 50. Identify these two points relative to reference points on the opposite site by looking through the telescope. By moving the local transceiver, set the remote transceiver at the middle of these two reference points.

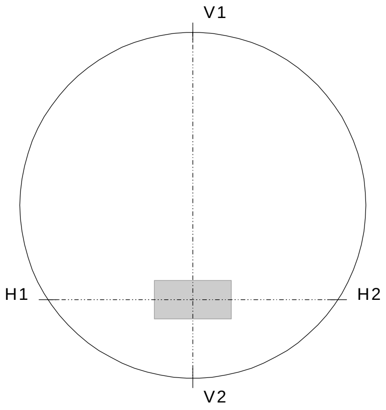


Figure 6.13: Position after the horizontal aiming

Repeat this process for the vertical positioning (middle of segment [V1,V2]).

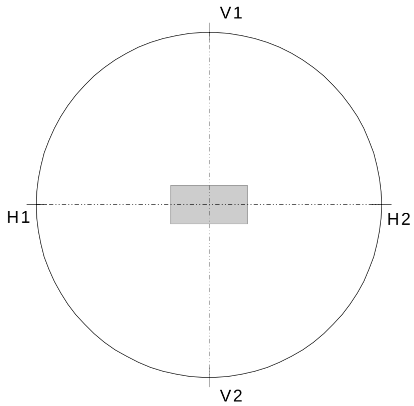


Figure 6.14: Final position after the vertical aiming

Once the central position is reached, firmly tighten the 4 Fine Alignment Locking Nuts (Nuts L).

Repeat this procedure interchanging roles with the second installer at the opposite site, i.e., the second installer will move the remote transceiver while the first installer will report the digital readout at his end).

At the end of the procedure, the digital readout should be approximately the same on both transceivers (see Appendix B page 41 for expected readings).

Link Operating Test

Set back the Mode Select Dip-Switch on the Normal position (the Alignment indicator should switch OFF (if exists depending on the model)).

At both sites, connect with fiberoptic or STP cables coming from the peripheral equipment to the fiberoptic or copper port of the transceiver.

IT IS A CROSS CONNECTION:

TX ➔RX AND RX ➔ TX

The F/O RX Flag and Sync. (Electrical flag and Rx on TS700/100) indicators should turn ON as soon as the peripheral equipment is powered ON.

A BER test is recommended. In case this is not possible at least check with the customer/user the performance of the whole link (see the chapter Bench Test).

Installation Log

Write down all the information about the installation (including digital readout and the setup of the transceivers) in an installation log. This information is a valuable reference for future maintenance or troubleshooting visits.

An example of an installation form is shown in Appendix H.

Before Closing the Rear Door

1. Ensure that the Power Supply Cover is fastened in place.
2. All cables are properly held in position.

Visual Inspection

Visually check that all parts and cables are connected.

Installation Completion

Check that the heads appear as shown in the photographs below.

Fig. 6.15: Mounted TereScope – Right View

Fig. 6.16: Mounted TereScope – Left View

Fig. 6.17: Mounted TereScope – Back View

Fig. 6.18: Mounted TereScope – Front View

Chapter 7

Maintenance

Periodic Visits

Periodic visits (every three/six months, depending on the installation environment) should be planned for:

- Checking the display
- Checking the mounting
- Cleaning the optical aperture of the transceivers
- Cleaning the building windows for indoors installations.

At cleaning time, the reading of the digital readout should be noted in a service log book. If after the optical aperture is cleaned the reading is substantially lower than that noted at installation time, the aiming accuracy should be examined and restored if necessary.

Note

Aiming accuracy should be checked looking through the telescope and comparing the present scene sighting to the one sketched in the Installation Log at installation time.

APPENDIX A Product Specifications

TS700/155 (high speed Light)

Part Number Model		TS155/A/YUW/VS TS700/155
Application / Data Protocol		T3, E3, Fast Ethernet and ATM
Performance	Rate	1-155 Mbps
	Range (1) @ 3dB/km	750 m
	@ 5dB/km	670 m
	@ 10dB/km	530 m
	@ 17dB/km	430 m
	@ 30dB/km	320 m
	Minimum Range	10 m
	Bit Error Rate	Less than 1E-12 (unfaded)
	MTBF	10 years
Transmitter	Light source	1 VCSEL
	Wavelength	830-860 nm
	Total Output power	5 mW
	Beam divergence	3-4 mrad
Receiver	Detector	Silicon Photodiode
	Field of view	14 mrad
	Sensitivity	-32 dBm
Interface	Type	Fiber Optic Transceiver - Multimode (Singlemode available upon request)
	Connectors	SC (other connectors available)
	Wavelength	1300 nm (other wavelength available)
	Output power	-17 ± 3 dBm
	Receiver Operating range	-14 to –30 dBm
Power Supply		Factory set: 100-240 VAC @ 50/60 Hz or 24-60 VDC (10 W)
Environmental Information	Operating Temp.	-50 °C to +60 °C
	Storage Temp.	-50 °C to +70 °C
	Humidity	95% non-condensing
	Housing	Weatherproof – IP 66
	Eye safety Class	1M
Mechanical Design	Dimensions [mm]	470 X 282 X 390
	Weight – Unit	5 kg
	Weight – Accessories	3.5 kg
Diagnostics Indicators / Selectors	Indicators	Airlink: Flag, Sync. Fiber Optic: Flag, Sync.
		Receive Signal Strength (Digital Display)
	Selectors	Data Rate, Alignment, Loopback (local)
	Management	SNMP Protocol – Optional

TS700/100 (Fast-Ethernet Light)

Part Number Model		TS100/A/TX/VS TS700/100
Application / Data Protocol		Fast Ethernet
Performance	Rate	100 Mbps
	Range (1) @ 3dB/km	750 m
	@ 5dB/km	670 m
	@ 10dB/km	530 m
	@ 17dB/km	430 m
	@ 30dB/km	320 m
	Minimum Range	10 m
	Bit Error Rate	Less than 1E-12 (unfaded)
	MTBF	10 years
Transmitter	Light source	1 VCSEL
	Wavelength	830-860 nm
	Total Output power	5 mW
	Beam divergence	3-4 mrad
Receiver	Detector	Silicon Photodiode
	Field of view	14 mrad
	Sensitivity	-32 dBm
Interface	Type	Electrical – 100Base Tx
	Connectors	RJ45
	Cable	STP
Power Supply		Factory set: 100-240 VAC @ 50/60 Hz or 24-60 VDC (10 W) PoE (Power over Ethernet) in dc models (V3)
Environmental Information	Operating Temp	-50 °C to +60 °C
	Storage Temp	-50 °C to +70 °C
	Humidity	95% non-condensing
	Housing	Weatherproof – IP 66
	Eye safety Class	1M
Mechanical Design	Dimensions [mm]	470 X 282 X 390
	Weight – Unit	5 kg
	Weight – Accessories	3.5 kg
Diagnostics Indicators / Selectors	Indicators	Airlink: Link Flag, Data, 100Base-T: Link Flag, Data
		Receive Signal Strength (Digital Display)
	Selectors	Loopback (local), Ip address
	Management	SNMP Protocol – Optional

Priliminary

TS800/155 (high speed Light) Product Specifications

Part Number Model		TS155/C2/YUW/VS or TS155/C2/YUW/FS TS800/155 or TS800/155-F
Application / Data Protocol		Fast Ethernet, ATM, OC3,STM1, SMPTE, E3, T3, OC1/STM0 & Open Protocol
Performance	Rate	1-155 Mbps
	Range (1) @ 3dB/km	1570 m
	@ 5dB/km	1300 m
	@ 10dB/km	970 m
	@ 17dB/km	730 m
	@ 30dB/km	530 m
	Minimum Range	50 m
	Bit Error Rate	Less than 1E-12 (unfaded)
	MTBF	10 years
Transmitter	Light source	1 Laser
	Wavelength	830-860 nm
	Total Output power	22 mW
	Beam divergence	3.5 mrad
Receiver	Detector	Silicon Photodiode
	Field of view	14 mrad
	Sensitivity	-36 dBm
Interface	Type	Fiber Optic Transceiver - Multimode (Singlemode available upon request)
	Connectors	SC (other connectors available)
	Wavelength	1300 nm (other wavelength available)
	Output power	-17 ± 3 dBm
	Receiver Operating range	-14 to –30 dBm
Power Supply		Factory set: 100-240 VAC @ 50/60 Hz or 24-60 VDC (10 W)
Environmental Information	Operating Temp.	-50 °C to +60 °C
	Storage Temp.	-50 °C to +70 °C
	Humidity	95% non-condensing
	Housing	Weatherproof – IP 66
	Eye safety Class	1M
Mechanical Design	Dimensions [mm]	470 X 282 X 390
	Weight – Unit	5 kg
	Weight – Accessories	3.5 kg
Diagnostics Indicators /	Indicators	Airlink: Flag, Sync. Fiber Optic: Flag, Sync.
		Alignment, Loopback, Remote LoopBack, Receive Signal Strength (Digital Display)
Selectors	Selectors	Data Rate, Alignment, Loopback (local), Remote LoopBack, Fusion, Ip address
	Management	SNMP Protocol – Optional

APPENDIX B Digital Readout vs. Distance

These tables are only intended to give you an idea of what digital readout you could expect according to the distance to link.

D= Distance [m]

R= Reading (Digital readout)

TS700/155

D	50	100	150	200	250	300	350	400	450	500	550	600	650	700
R	560	520	420	360	300	240	180	140	120	100	80	60	40	30

Actual reading may be greater or up to 15% lower.

APPENDIX C Unpacking Instructions for TereScope

The TereScope is shipped pre-assembled. See fig.C2

Fig C.1: TereScope as is

1. Unpack all the accessories.
2. Remove the JMP by undoing the four 'D' screws shown in Fig: C2.

The packing box contains:

- 2 x TereScope Transceivers mounted
- JITK-L : Installer tools kit and screws
- CD manuals
- Flexible ducts x 2
- Flange x 2

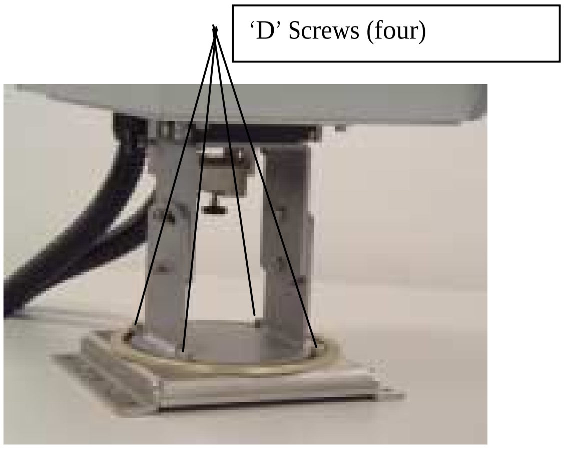


Fig C2: The Four 'D' Screws

KEEP IN SECURE PLACE ALL THE BOLTS AND SCREWS. YOU WILL NEED THEM FOR THE INSTALLATION.

APPENDIX D Tool Kit, Equipment, and Materials

TOOLS

1. Electric drill (impact for masonry), reversible, with speed control and 0-13mm chuck
2. Drills set High Speed Steel (HSS) 3-13mm.
3. Concrete carbide .bit drills 6,8,9 and 10mm (regular and long shank).
4. Adjustable (crescent) wrench 6", 10".
5. Open-ring wrenches (spanners), standard and metric.
6. Vice grip pliers 10-12"
7. Cutter, long nose pliers, electrician's pliers (insulated).
8. Pen, Pencil, Permanent markers.
9. Lens cleaning clothes.
10. Screwdrivers (flat and Philips), sizes 1, 2, 3 + power screwdriver bits.
11. 50m extension cable + 3 outlet multiple electrical tap
12. 200g hammer.
13. Blade knife.
14. Ratchet handle driver.
15. Socket wrenches 8mm, 10mm, 11mm, 13mm, 14mm, ½" .
16. Allen 8mm and Allen 2.5mm.

MATERIALS

1. Anchors (wall plugs) "UPAT" 13mm diameter
2. Hex-head screws to fit wall plugs 40, 60, 75mm length.
3. Assortment of screws, nuts, washers, spring washers.
4. Electric insulation tape.
5. Super glue, tie wraps (Panduit™).
6. 20 mm fuse SB, 125mA, 160mA, 250mA, 500mA, 1A

ELECTRONIC &

GENERAL EQUIPMENT

1. Digital voltmeter (DVM)
2. 2 Walkie Talkies or cellular phones.
3. Binoculars
4. Four STP cables (two cross and two straight) terminated with RJ-45 connectors each end.

OPTICAL EQUIPMENT

(if relevant)

1. Optical Power Meter (Fotec, Noyes, Acterna…) with fiber sockets.
2. 2 sets of multimode (62.5 µm) and Singlemode (15µm) optical fibers with SC terminations.

LAB EQUIPMENT

E1/ETH/ATM/Fast Ethernet BER Test equipment- depending on TS model.

A LIST OF THE TOOLS SUPPLIED BY MRV COMMUNICATIONS WITH EVERY TereScope HEAD

	Description	**Qty**	**Where to use**
a.	WRENCH #8 for Aiming Head, (M5 nut)	1	**L:** Aiming Head , Fine Alignment locking nuts
b.	WRENCH #10 (M5 Hexa. Screws)	1	**D:** Screws for locking Aiming Head to JMP
c.	BALLDRIVER L, WRENCH 5mm for Allen Screw M6	1	**F:** Screws for Vertical coarse Aiming and locking Vertical motion
d.	BALLDRIVER L, WRENCH 3mm for Allen Screw M5	1	**H:** Rear Door lock captive screws
e.	WRENCH #13 (M8 Hexa. Screws)	1	**A:** JMP - Grounding screw Screws between JMP and JMB (if needed) Screws between JMP and pedestals (if needed)
f.	BALLDRIVER L, WRENCH 4mm for Allen Screw M5	1	**G:** Screws for locking Aiming Head to TereScope Head (if necessary)
g	M8 SCREWS, WASHERS, SPRINGS, NUTS	4 of each	Optional. To mount JMP on standard pedestal
h	INSTALLATION TOOL CASE	1	Tool case

Wrenches Kit for TS Installation

APPENDIX E TereScopes Bench Test Procedure

Introduction

All TS Products are bench tested indoors prior to outdoor installation to ensure that the system is fully functional.
The bench test is a simple procedure whereby a link pair is aligned on the table and activated to simulate a channel of communication (see fig.1).

2 Points to Remember

1. Since the link distance during the bench test is very short (i.e. the devices activated are very close), the receivers will go into saturation unless the signal is attenuated.
To avert entering saturation, the transmit signal must be physically attenuated.
We recommend the simple procedure of inserting a piece of paper or the like into the beam path, or concealing a portion of the beam with an opaque (non-transparent) material. This will reduce the signal power entering the receiver.
Make sure to attenuate the signal enough so that the receiver's optical power meter value falls below the saturation estimate of the device. See table below for saturation estimate.

2. An additional derivative of the short link distance is the presence of reflections.
The signal will reflect off the front window of the receiver back at the transmitting device and may be mistaken as part of the opposite transmission.
This interference is commonly called "cross talk".
To avoid cross talk during the bench test, it is advisable to check whether interfering reflections exist by shutting off power to one device and verifying that the optical power meter reading in the other (active) device is zero.
This should be repeated for the opposite device.
Alternatively, a practical setup for bench testing the 4" series (models B, C and D) and Light series (models A and C2) is presented in Figure 1; the bench test setup for the 10" series (models E and F) is presented in Figures 2a,2b.
In the 4"/Light setup, a thin physical barrier, such as a piece of cardboard, is used as a wall to divide between the beam paths, thus ensuring that no cross talk occurs.
In the 10" setup, the two devices are not centrally aligned; instead, only one corner of each device faces the opposite device. This allows for testing each transmitter separately. By rotating the devices 45 degrees, the next pair of transmitters is tested. Hence, testing all 8 transmitters in the link pair requires only 4 rotations.

In the 8” setup, the two devices are not centrally aligned; instead, only one corner of each device faces the opposite device. This allows for testing each transmitter separately. By rotating the devices 45 degrees, the next pair of transmitters is tested. Hence, testing all 6 transmitters in the link pair requires only 3 rotations. With opaque masking tape, cover all transmitters that are not under test.

Table 1: Bench Test Information for TS Products

Product name	Opt. Power M. “Sub-Saturation” value	Potential for Interference
TSxxxx	1100	Low
TSxxx/ETH	1200	Med
TSxxx/E1	1200	High
TSxxxx/ST	1200	Med
TS2000/XXX	1100	High
TS4000/XXX	1200	High
TSx00/XXX	1000	High

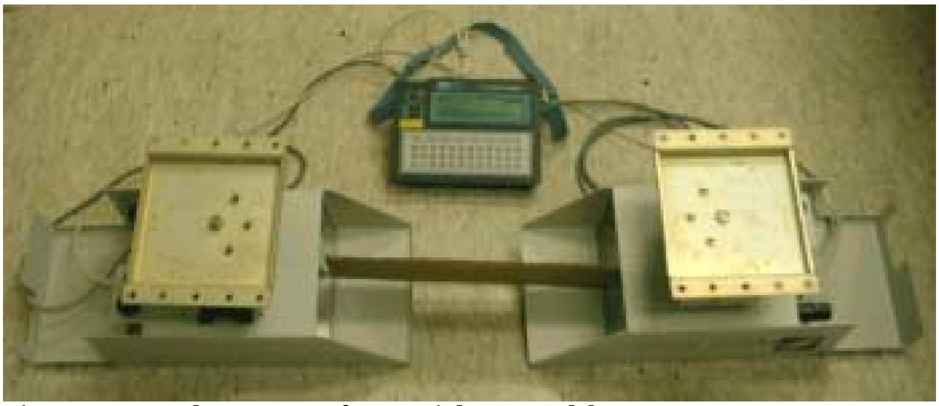


Figure E.1: Bench Test setup for 4”/Light TS models.

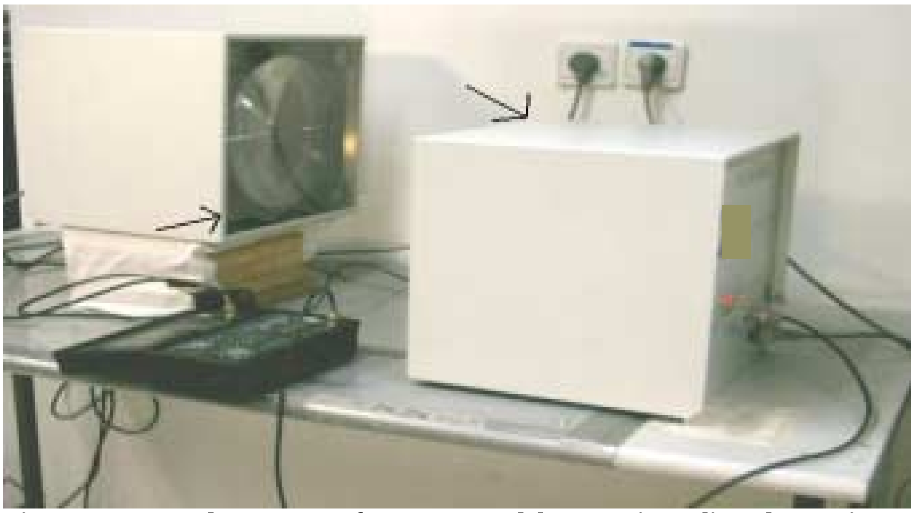


Figure E.2a: Bench Test setup for 10” TS model; transmitter aligned opposite receiver marked with arrows.

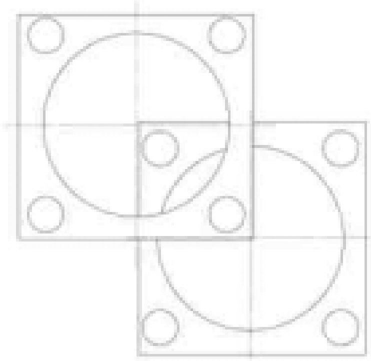


Figure E.2b: Bench Test setup drawing for 10" TS model.

Note that one device is higher than the other and shifted over to the side so that only one transmitter from each device is facing opposite the other device's receiver.

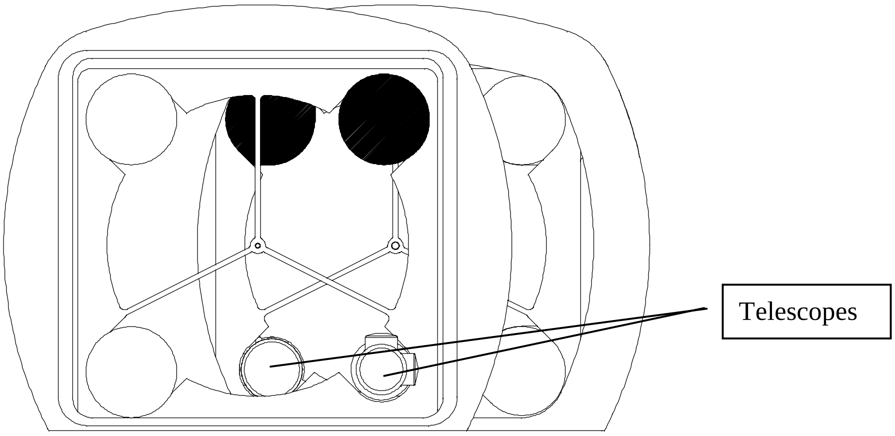


Figure E.3: Active Transmitters (Shown Darkened).

APPENDIX F Effect of Wind on Terescopes

<u>Introduction</u>

The outdoor environment in which our devices are normally placed exposes the link to wind pressures that may affect the accuracy of the link's alignment.
Several factors play a role in the determination of the extent to which the directionality of a TS device may be affected by the wind:
Wind speed
Wind direction
Surface area of device perpendicular to wind
Mechanical stability of aiming head – device system.

For example, the mechanical stability is greatest along the side-side axis of the device. Although the surface area along the side of the device is greatest, the resultant wind force – even at very high wind speeds – will barely have an impact on the beam's direction, due to the rigid mechanics along the side-side axis.

<u>Wind Limits for TS Devices</u>

All TS devices have been tested in "worst-case" scenario of the above four factors.
The force necessary to deviate beam was measured from different direction.
From here[1], the minimum wind speed with maximum effect on beam deviation was determined.
The following table lists the minimum wind speeds for different TS products that may cause:
A momentary lapse in the communication.
An extended lapse requiring mechanical repair.

TS Device	Momentary	Extended
• 10" (E&F models)	110 km/hr	200 km/hr
• 10" with Windproof-L Accessory	Over 180 km/hr	Over 250 km/hr
• 4" (B,C, D models)	150 km/hr	Over 250 km/hr
• 4" with Windproof-S	220 km/hr	Over 300 km/hr
• Light (A&C2 models)	150 km/hr	Over 250 km/hr
• PAL (TS1)	180 km/hr	Over 250 km/hr
• 8" (Models D2, E2, G)	200 km/hr	

[1] We include here the formula for calculating the effective wind force on a flat surface, given a known wind speed:

$$\textbf{Wind Force} = 0.79 \times (\text{Wind Speed})^2 \times (\text{Area of Surface})$$

For instance, assuming a wind speed of 27.78 m/s (equal to 100Km/hr) on a surface area of $0.04m^2$ ($400cm^2$), the force is equal to 24.4 Newtons.

Appendix G FSO Chaining

What is Chaining?

The Chaining of FSO is required when the two sites are connected by more than one link using at least one additional building as a mid-point.

When is the Chaining required?

The Chaining of FSO links is required in the following cases:

a) When there is no direct line of sight between the sites;
b) When the distance between the sites is too long;
c) When the distance between the sites is reachable with one link but the customer wants much more Power Budget for higher reliability.

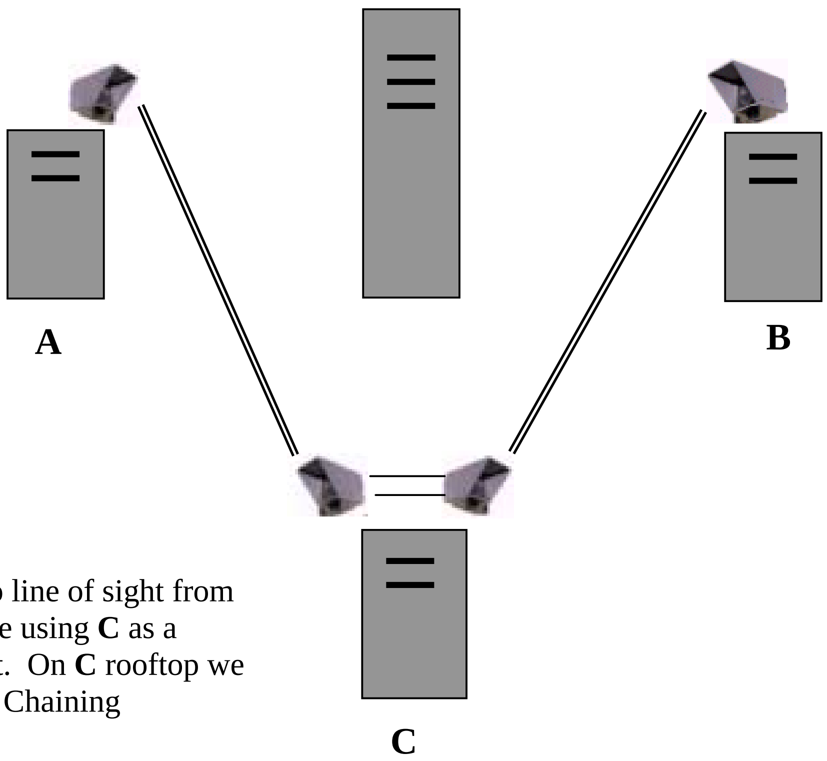


Fig G.1:
As there is no line of sight from **A** to **B**, we are using **C** as a repeater point. On **C** rooftop we used “Direct Chaining connectivity

Indirect Chaining

Indirect Chaining is required for connecting FSO units not including clock recovery circuits. In cases of indirect connectivity, the connection between the two FSO units on the same roof must be done through the Switch or Router or another means of connection that is located inside the building. For example, in Fig. 2, we use the indoor switch in building C for the chaining.

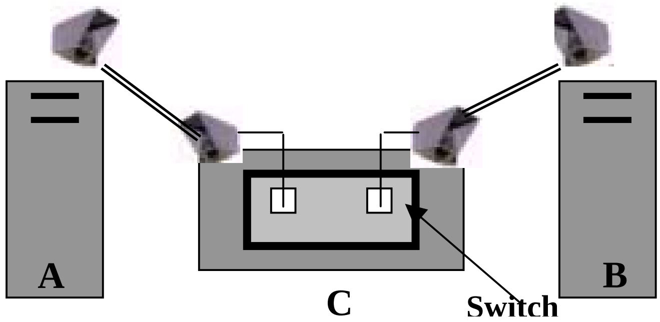


Fig. G.2
Indirect chaining

Direct Chaining

Direct Chaining is the capability to directly connect two FSO units on the same roof (used as repeaters) i.e.. direct crossing between Rx and TX of the two units. For example, in Fig. 3 connection is achieved on rooftop of building **C** without the need to enter the building.

Direct connection is possible for FSO that include clock recovery circuits. The clock recovery regenerates the signal and enables smooth direct chaining.

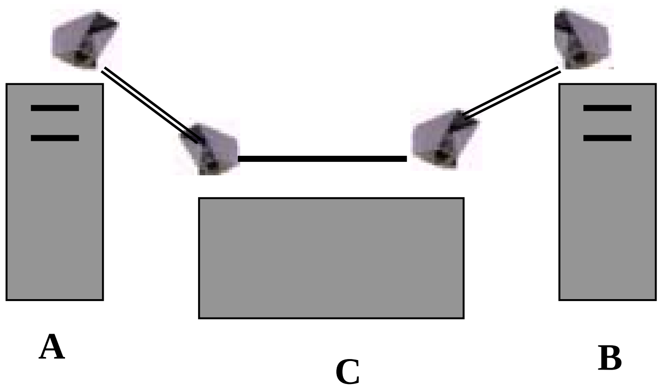


Fig. G.3
Direct chaining

Chaining Limits

The number of links that can be chained is limited due to the Jitter parameter. Sensitivity to jitter is different for every protocol and can vary with different manufacturers. The typical number is 3-4 chained links. If more chains are required, please consult your MRV representative.

FSO products & Chaining

Product series	Chaining	No of chained links
TS3000G (1Gbps) TS1000G (1 Gbps) TS 622 (622 Mbps)	Indirect	3-4
TS155-PI (10-155 Mbps)	Indirect	3-4
TS155-PS (34-155 Mbps)	Direct	3-4
TS 34 (Open Protocol, 1-34 Mbps)	Indirect	3-4
TS 10 (Ethernet)	Direct	3-4
TS Mux (Mux 4E1, 4T1)	Direct	No Limits*
TS 2 (E1, T1)	Direct	No Limits*

**No Limits – it refers to Networking extentions. If the extentions are of TDM type (E1,E3,STM-1, STM-3), after some chains we might face some "jitter"problems. Therefore,in such cases, chaining should be considered on a case by case basis.*

APPENDIX H Installation Log

D.1. Client / Dealer details

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

D.2. Application details

Type of network	☐ E1 , ☐ Ethernet , ☐ Token Ring , ☐ Fast Ethernet , ☐ FDDI , ☐ ATM , ☐ Other (Specify)
Product	
Evaluated distance by customer	
Address of installation (site A)	
Address of installation (site B)	

D.3. Sketch of the area

D.4. Site survey

Done by	
Customer representative	
Distance	
Date	

	Site A	Site B
Location		
Floor		
Orientation (NSEW)		
Installation site scheme		
Indoor / Outdoor		
Plate JMP-L / Bracket JMB		
Window attenuation		
On-line UPS		
Voltage required (110V / 230V)		
Ground earthing		
Radio antenna field		

Associated interface equipment	Site A	Site B
Manufacturer		
Type		
Model number		
Interface type		

D.5. Installation

Done by	
Customer representative	
Date	

	Site A	Site B
System model		
Serial number		
Location : Same as site survey, if not provide details		
Accessories : Same as site survey, if not provide details		
Digital readout		
Telescope calibration : if cannot , sketch the telescope view		

BER test	
BER equipment type	
Loopback location	
Error type (random, burst)	
Brief interruption test	

D.6. System failure

Visit made by	
Customer representative	
Date	

	Site A	Site B
Sketch of telescope view		
Digital readout		
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 I Power over Ethernet

The Power-over-Ethernet (PoE) option is available only for TereScope model 700/100. PoE eliminates an AC outlet at each Access Point (AP) location, i.e., it allows for a single Ethernet cable to be run to each AP instead of two separate cables, one for power and the other for data. There are two types of PoE connections. One type utilizes only four out of the 8 wires of the Ethernet cable. These wires connect to pins 1, 2, 3, and 6 and carry both power as well as data. The other type utilizes the four wires that connect to pins 1, 2, 3, and 6 for carrying data, and the four wires that connect to pins 4, 5, 7, and 8 for carrying power. Pin 4 is shorted to pin 5 and these are connected to the (+) terminal of the power supply. Pin 7 is shorted to pin 8 and these are connected to the (-) terminal of the power supply. TereScope model 700/100 with PoE option supports this second option only (as required per IEEE 802.3af standard) so proper connection to this pins should be provided. The TereScope model 700/100 is available in any of the following three PoE options:

1. TereScope model 700/100 with PoE option is connected directly to *PoE-enabled* equipment – The only needed part is a straight (non-cross) Category 5 cable, which will also supply power to the AP.
2. TereScope model 700/100 with PoE option connected to *non-PoE-enabled* equipment through an external PoE adapter. The PoE adapter couples an Ethernet Line and DC Power (usually 48 VDC – see low voltage power requirement in Appendix A: specifications) onto an 8-wire straight (non-cross) Category 5 cable, as shown in Figure I.1. The other end of the PoE cable is connected directly to the TereScope model 700/100 with the PoE option. Adapters to be used with the TereScope are required to meet the IEEE 802.3af standard. Examples of brands of such adapters are: *HyperLink Technologies BT-CAT5-P1*, *PowerDsine 6001*. These two types of adapters are commercially available. This connection is illustrated on Figure I.1.
3. TereScope model 700/100 with PoE option connected to *non-PoE-enabled* equipment. In this case 8-wire straight (non-cross) Category 5 cable at the equipment side should be split on two cables. One with standard pins 1, 2, 3, and 6 and carrying data to non-PoE enabled equipment. The other should be with four wires that connect to pins 4, 5, 7, and 8 for carrying power using external 48V power supply. Pin 4 is shorted to pin 5 and these are connected to the (**+**) terminal of the power supply. Pin 7 is shorted to pin 8 and these are connected to the (-) terminal of the power supply and grounded if required.

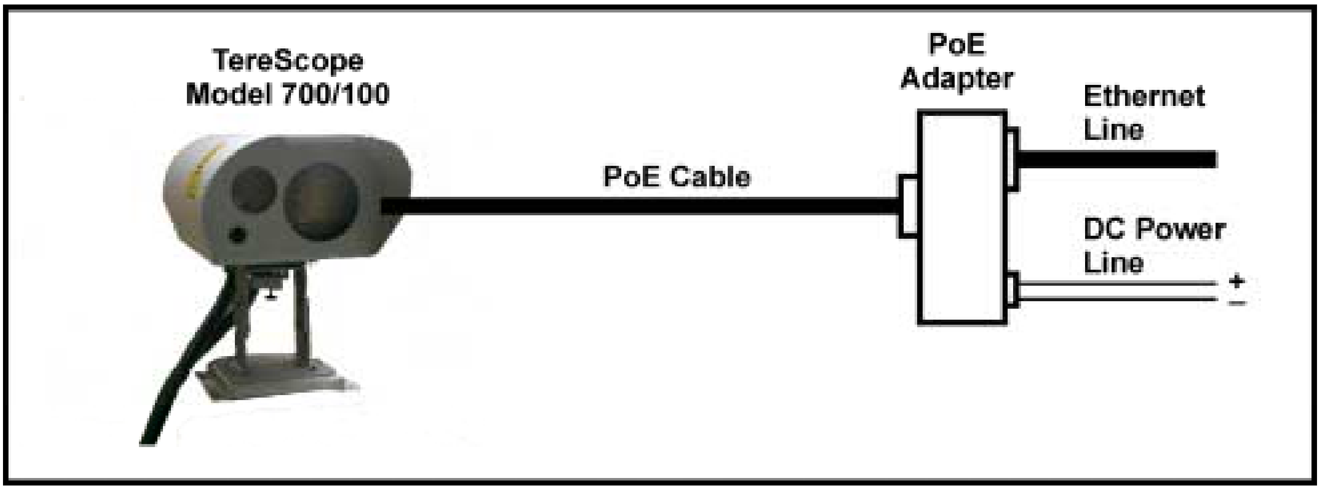


Figure I.1: Power-over-Ethernet Interconnection with external PoE adapter