TereScope

Optical Wireless Link

Installation Guide

Standards Compliance

UL 1950; CSA 22.2 No 950; FCC Part 15 Class A; 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 A 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 instruction 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 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:

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

Disclaimer

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

Optical Access 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.

Although much care has been taken in the preparation of this document, omissions and errors may still exist. Therefore, 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.

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Contents

Figures

Tables

About this Guide

Purpose

This guide provides general installation information for those who wish to install the *Optical Access* TereScopes[1] or give training courses on TereScope installation.

For additional information on TereScopes, such as information specific to a TereScope model, TereScope management, etc., refer to the applicable TereScope Manual.

Audience

Qualifications

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

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

Training

Installers are required to do a training course on *Optical Access'* 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

When all the requirements specified above (namely, Qualifications, Training, and Experience) have been met, the installer must receive authorization from *Optical Access'* certifying eligibility.

Related Documents

- TereScope Manuals
- MegaVision NMS User Guide

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[1] TereScope is a trademark of *Optical Access Ltd.*

Acronyms

CATV	Cable Antenna TeleVision
CLI	Command Line Interpreter
GPS	Global Positioning System
IR	Infra-Red
MM	Multi-Mode
MTBF	Mean Time Between Failures
NA	Numerical Aperture
PVC	PolyVinyl Chloride
RSSI	Receiver Signal Strength Indication
SM	Single-Mode
TELNET	(dial-up) TELephone NETwork (connection protocol)

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

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. The power cord terminations should be a suitably rated earthing-type plug at one end and an IEC appliance inlet coupler at the other end. Both of the power cord terminations must carry the certification label of the cognizant safety organization of the country.

During Operation

Do not connect or disconnect cables and/or power cords during a thunderstorm.

Servicing

All servicing must be carried out only by *qualified* service personnel.

Before servicing, ensure that *all* power to the TereScope is cut off!

Overview

The following will provide a complete description of the system, including both the theoretical and practical considerations. Detailed information on tooling and installation procedures will also be given. The subjects detailed will include:

- **Pre-Installation** – Site survey for wireless link, geographic location, etc.

- **Installation** – Subcontractor equipment, tools & test equipment.
  Optical Access will provide some or all of the necessary equipment such as TereScope, Mounts, Cabinets, Fiberoptic cables, Racks, Switches / Routers, etc.
  Indoor & Outdoor installation Cabinets & Racks, installation procedures, etc.
  TereScope alignment procedure.

Pre-Installation

General

Site survey is ***key*** in a link application. 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.
- Determine the most appropriate TereScope system.
- Inform the customers of their responsibilities prior to the installation.

On completion of the link design, the *Site Survey Form* should be completed to assure complete coverage of all installation aspects.

Test Equipment

To perform a successful and accurate site survey use the following test equipment: Rangefinder binoculars, digital camera, Compass, GPS, 3m' tape measure.

Site Suitability

Finding an advantageous geographical area is a key factor in achieving a sound TereScope system installation. The requirement calls for the most suitable building at the best location so that the most effective link can be established.

The buildings on which the TereScope is to be mounted must be suitable for IR links. The building chosen should be of medium height. Skyscrapers should be avoided because of their large sway, in some cases more than 30 degrees, which can cause sunlight interference. In suburban areas, the tallest building in the area should be chosen which, at the same time, is not too tall.

Site Survey Procedure

Line of Sight

Make sure that no obstacles cross the line of sight between the two TereScopes. 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.

Photograph the 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.

Range and Location

- Record the distance between TereScope locations. (You can use any of the following equipment to determine the distance: rangefinder laser binoculars, GPS receiver, etc.)
- Record the bearing to the opposite site by compass.
- Record the number of links to be installed at the site.
- Note whether additional sheltering is needed for the unit, for e.g., against strong winds (120km/h or more) – see the Site Survey Form for details.

Figure 1 and Figure 2 show acceptable and optimal site locations for the TereScope. Notice that in both figures, the TereScopes are mounted on rooftop edges and high enough above the ground.

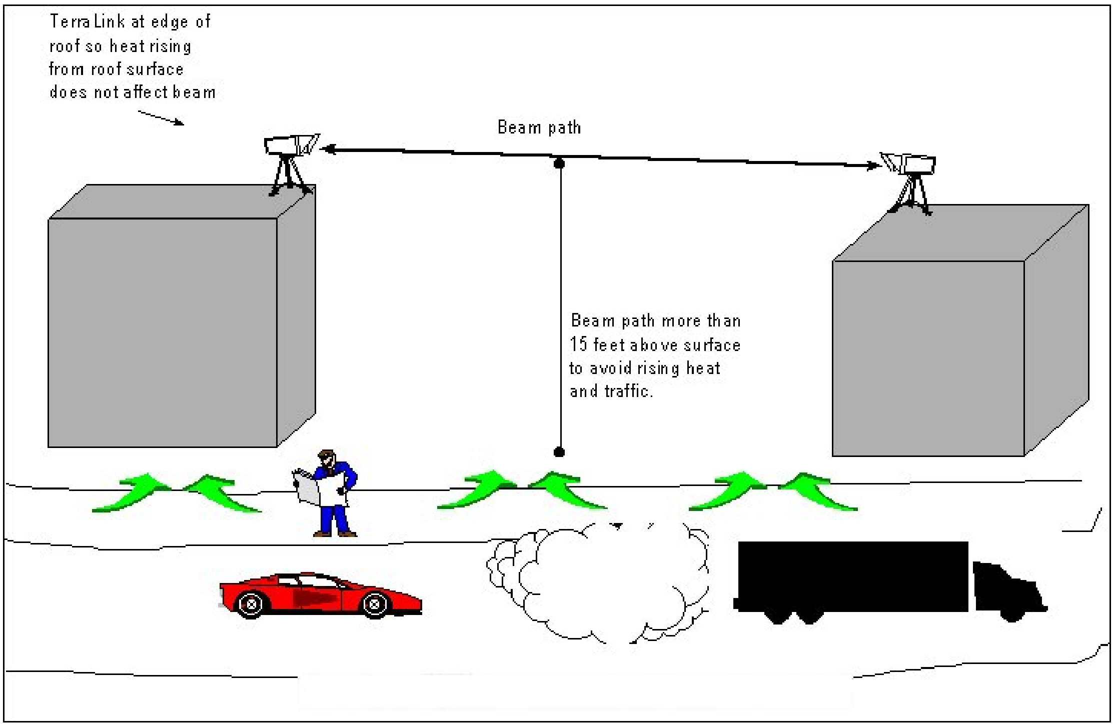


Figure 1: Acceptable Mounting Position

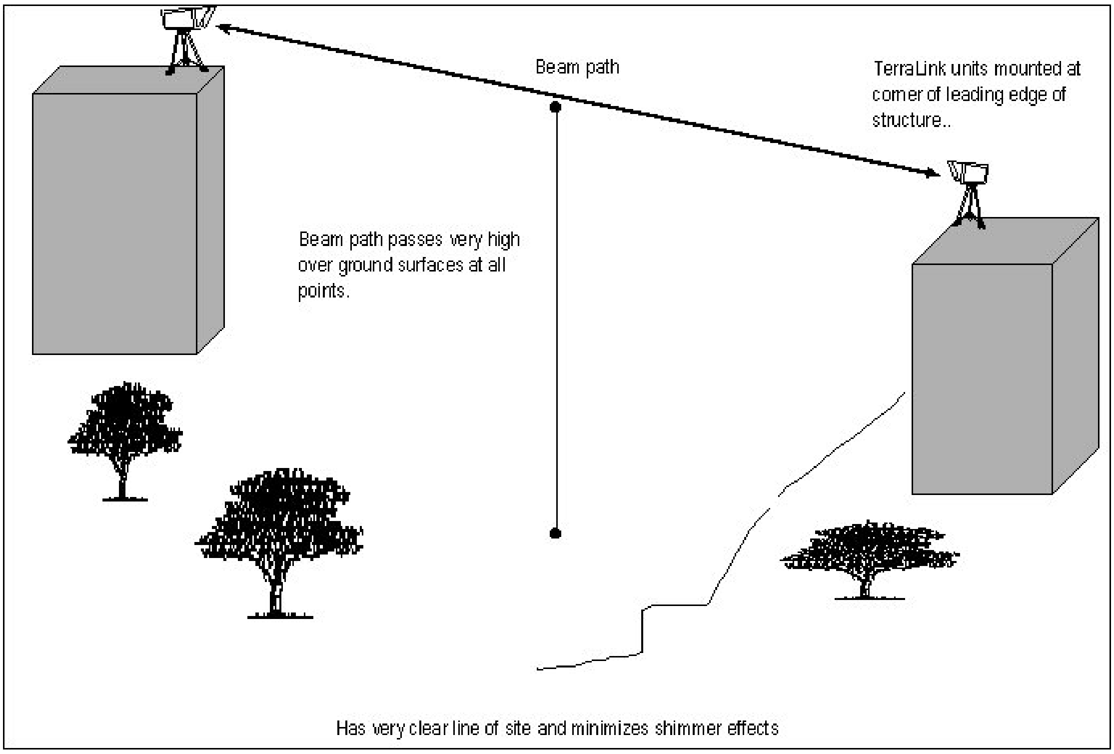


Figure 2: Optimal Mounting Position

Figure 3 and Figure 4 shows an unacceptable and unrecommended TereScope location on rooftop not taking in consideration the underline terrain and the heat from rooftop.

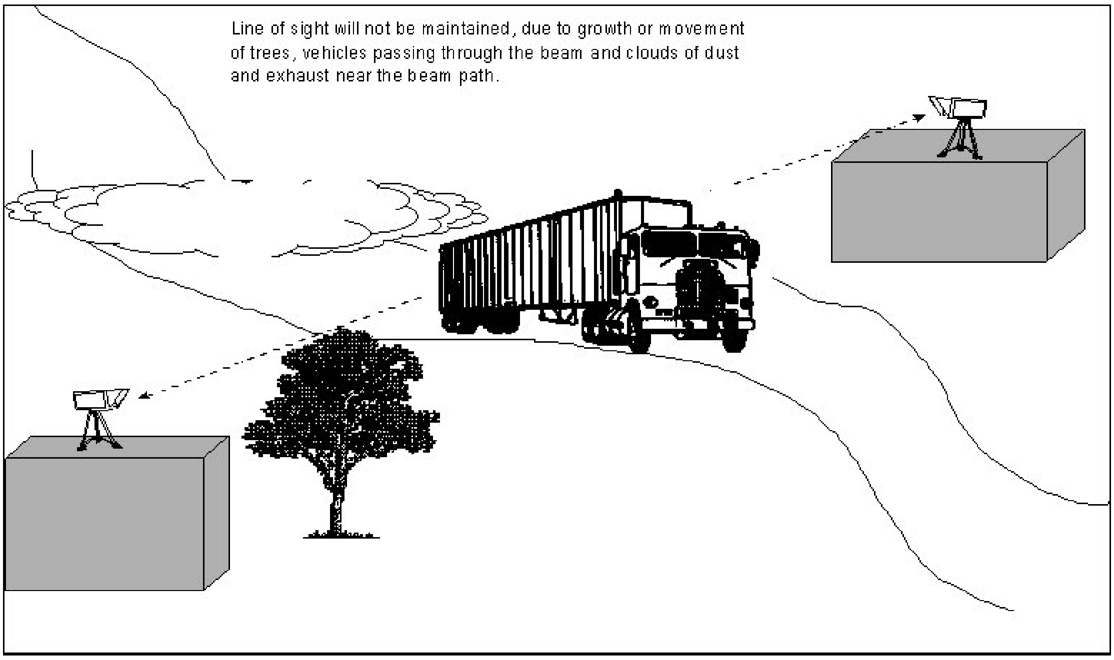


Figure 3: Unacceptable Mounting Position

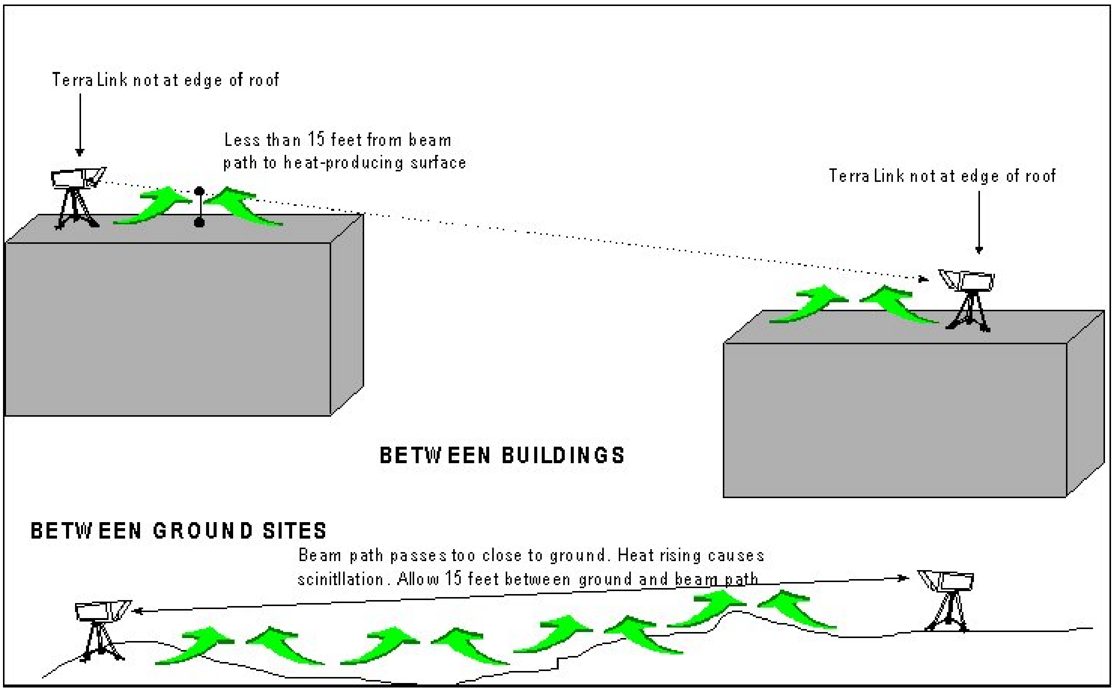


Figure 4: Unrecommended Mounting Positions

Mounting Environment & Stability

When deciding the mounting location, you should look on the rooftop for vibration sources such as compressors, elevators, motors, and try to avoid them. Try to avoid mounting the unit close to microwave dishes, antennas, and other electronics devices that emit or radiate EMI or RFI. Take a picture of the mounting site and write down the mounting model number that you need for the site you are in. Using paint, mark the exact position on the rooftop where each TereScope will be mounted. Also, note the height that the TereScope will be above or aside rooftop. (Pin-pointing the TereScope location will avoid misunderstanding with the customer on the day of installation).

Note

It is crucially important to know the dimensions of the location at which the TereScope is planned to be mounted. In addition, it would be very helpful to take a picture of the mounting location so as to select the best mounting option.

Figure 5 shows the best and worse location on a rooftop. Location **1** is the best; location **7** is the worst.

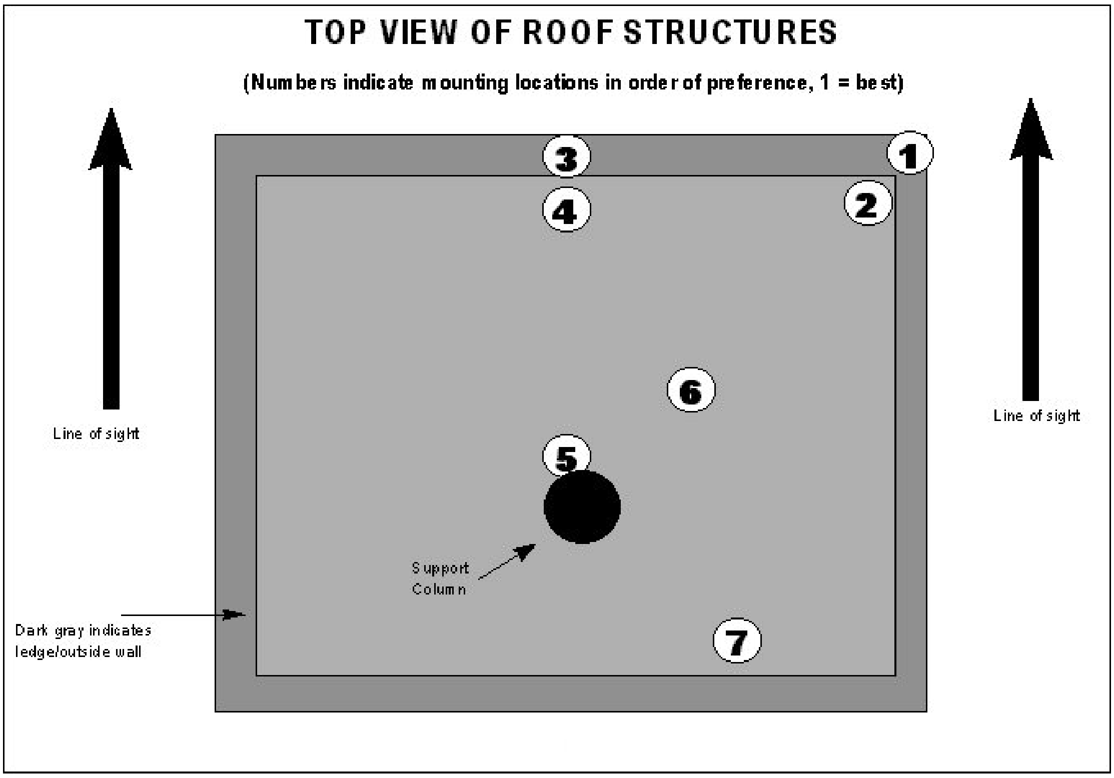


Figure 5: Preferred Mounting Locations

- **Power:** Check whether the line (mains) power is 220Vac/50Hz (or 48Vdc) or 110Vac/60 Hz (or 24Vdc). This information is needed to order TereScopes which can operate at the available line (mains) voltage. Determine if there is a need for a UPS and how long the UPS can supply the requisite dc power when the line (mains) power is cut off. (The UPS is normally selected by the customer). Also find out the power connector type (AC, DC Euro, USE etc.).

- **DATA Interface:** Write down the data rates (Mbps), host network equipment, communication protocol (Ethernet, Fast Ethernet, ATM, E1 T1, Giga, etc.), fiberoptic cable light wavelength (850nm or 1310nm), fiber type (multimode or single mode), Optical connector type (SC or ST), TX transmission power and RX optical receiver sensitivity. This information is needed to accurately match the TereScope to the customer's host equipment.

- **Cabinets:** Determine and write down the fiberoptic cable route, from the rooftop to the installation site of the host equipment cabinet. Choose the cabinet you need; e.g., 19-inch rack-mountable cabinet, large outdoor cabinet, or small outdoor cabinet.

- **Transmitting through window:** Determine the number of surfaces the beam transits or is reflected from, the reflectivity of each surface, and condensation/precipitation collection areas. Use the data below to determine whether the light beam loss is acceptable.

  - 4% light reflection from each surface.

- 15% loss from a double pane window.
- Tinted window increase attenuation.

Ensure that the angle of incidence[2] of the beam striking the window pane is between 1º and 45º.

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

> **Note**
>
> When choosing the link direction try to avoid East-West links.
> (This results because if 0.5º sundisk overlaps the receiver telescope it can cause errors only for a few days a year and only for a few minutes each day.)

The above information will be summarized in a table, in order to enable the user to make the relevant Purchase Orders for acquisition of the Optical Access system, as well as, for the materials required for the installation process.

> **Note**
>
> Ensure that all relevant rooftops are visited about three weeks prior to the installation of the system. Make sure that no changes took place, which may have a direct influence on the planned installation. Note any changes, which are relevant, and make sure that timely adjustments are implemented in the system, to provide for these changes.

[2] Angle which the light beam makes with the perpendicular to the window pane.

Optical Access ™ General Installation Requirements

General

All installations, temporary or permanent, will be treated in the same manner.

All installation accessories will be UV-protected and be of the outdoor-type equipment.

All installation accessories must be approved by the cognizant Standards Organization of the country).

Mounting

All TereScope™ units will be installed on the original mountings provided by *Optical Access*. Mounting units not met by *Optical Access* standards will require a formal approval by the Optical Standard installation group *of Optical Access*.

All mounting units will be grounded to the grounding system of the building using a standard grounding cable.

Junction Box

The *Optical Access* "CCD" TereScopes are equipped with a junction box. The "VS" TereScopes don't have a junction box connected to it. It recommended to use the IB11 junction box that contains the optical jumpers, CAT5 cable and the power cord from the TereScope to the fiberoptic or CAT5 cable leading to the communication equipment.

Rooftop

The fiberoptic cable on the rooftop must be housed in a duct (rigid or flexible) and attached to the roof.

Indoor Installation

Indoor installations should be hidden in shafts, pits, behind acoustic ceilings, etc. If this is not possible, the fiberoptic cable will be housed in a plastic can

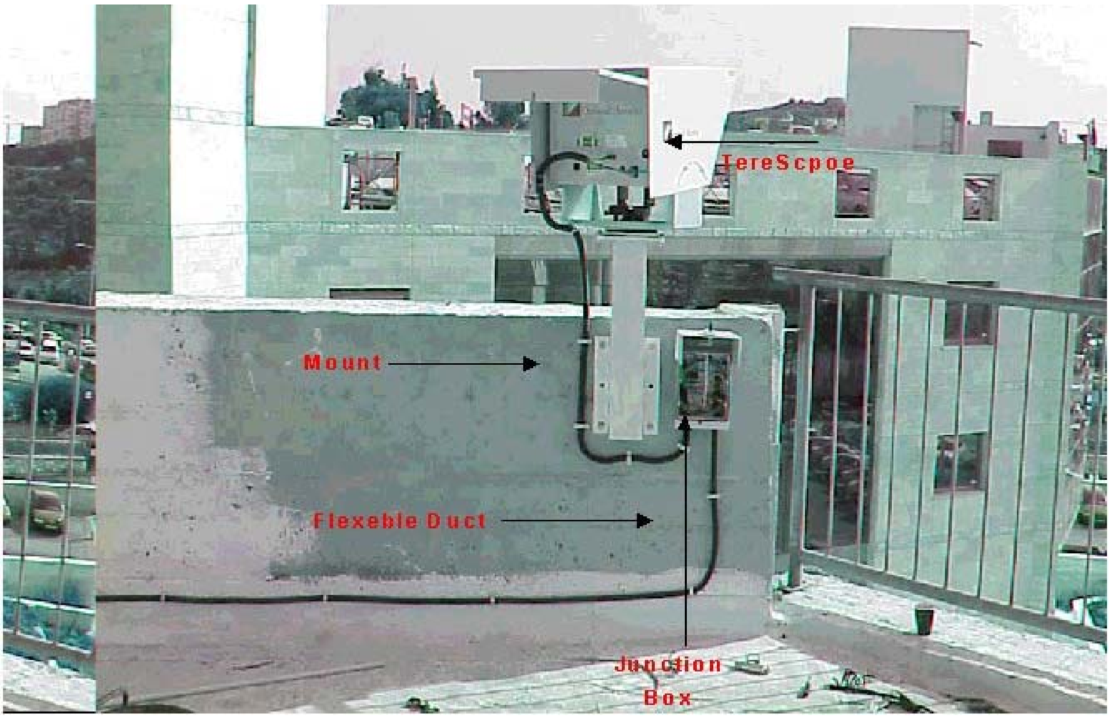


Figure 6: General Installation View

Figure 7: General Junction Box View

Optical Access			**TereScope™ LINK SITE SURVEY FORM**	
City		Date	/ / 01	
Street address		Company Name		
Line of Sight		**NOTES**	**Mounting Environment & Stability**	
Check path for:	√		Vibration Sources	
Trees			Compressors Motors	
Possible tree growth			Elevators	
Possible nesting of birds			Mounting area, wall type	Concrete/ red brick/ block/ marble Other:
Power line movement			Expected Minimum and Max. Temp	
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	
Take photo of underlying terrain (Photo area below line of sight)			**Take photo** of mounting location	
Take "Line of Sight" photo			**Building Mounting Selection**	Choose the best available Mount Placement
Take photo of rooftop			Part # mount bracket	M001 M015C M022C M050C M051C M053C M054C M055C M056C M057C M058C M059C M062C M063C M064C
Transmission through a Window			Elevation angle	°
Number of window surfaces			Mounting adaptor needed	
Reflective coating on window			Dimensions for adaptor	
Precipitation collection areas			**Power**	
Beam angle to window			Power Source	Main and/or UPS
Range & Location Information			Voltage & Frequency (AC)	110VAC 220VAC 50-60HZ
Distance between sites	(m)		Voltage (DC)	24Vdc 48Vdc Other:
Method used to measure distance: GPS, laser binoculars, maps Other:			TereScope Lightening Rod (Recommended optional accessory)	Yes No
Number of links to be installed at the site			Cable type	
Bearing to the receiving site (with compass)			**Data Interface**	
			Data Rate (Mbps)	1Gb/s 155Mb/s 100 Mb/s 10Mb/s E1 T1 others:
Cabinets for Routers & Switches (when applicable)			Host Network Equipment	
19" rack mount	(U)		Fiber Wavelength	850nm 1310nm Other:
Large cabinet			Optical Connector	SC/PC ST/PC Other:
Small cabinet			Other connectors	RJ45 RJ48 BNC Other:

TSSF Version 1.0

Figure 8: Site Survey Form

Beam Width Table

Table 1 shows the beam width as a function of link distance for different TereScope models.

Table 1: Beam Width Table

TERESCOPE BEAM WIDTH CALCULATION TABLE AUG 2001

TERESCOPE Code	TERESCOPE NAME	ENTER Distance LINK Distance [m]	OUTCOME Beam Width [m]
TS1000/A/DST/CCD	TereScope1000G	140	0.35
TS155/B/DST/CCD	TereScope1000X	700	1.75
TS155/E/DST/CCD	TereScope3000	1000	2.50
TS155/B/DSC/VS	TereScope3101	300	0.84
TS155C/DSC/VS	TereScope3103	350	0.98
TS155/D/DSC/VS	TereScope3303	650	1.17
TS155/E/DSC/VS	TereScope4400	850	1.87
TS25/B/DST/VS	TereScope802/ST	350	1.41
TS25/C/DST/VS	TereScope807/ST	450	1.82
TS25/D/DST/VS	TereScope811/ST	700	1.26
TS25/E/DST/VS	TereScope940/ST	900	1.98
TS10/A/ETH/VS	TereScope702/ETH	250	3.40
TS10/C/ETH/VS	TereScope807/ETH	600	2.42
TS10/D/ETH/VS	TereScope811/ETH	820	1.47
TS10/E/ETH/VS	TereScope940/ETH	1100	2.42
TS2/B/E1/VS	TereScope802/E1	320	0.90
TS2/C/E1/VS	TereScope807/E1	550	1.54
TS2/D/E1/VS	TereScope811/E1	780	1.40
TS2/E/E1/VS	TereScope940/E1	1000	2.50
TS2/F/E1/VS	TereScope960/E1	1000	1.80

Digital Readout Vs Distance

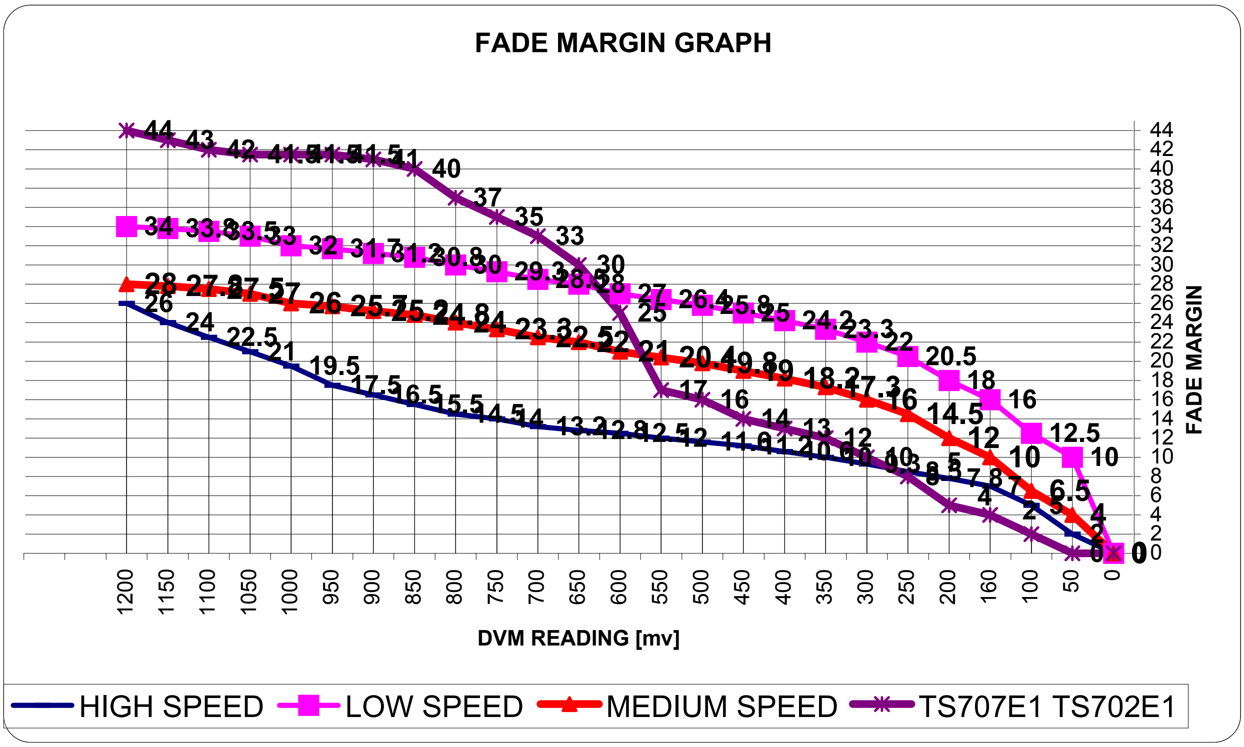
VISUAL ALIGNMENT TERESCOPE

Digital Readout Vs Distance

April 2001	TERESCOPE UNIT												
HIGH SPEED	TereScope3101												
	DISTANCE IN METERS	100	200	300	400	500	600	700	800				
	DVM READING	900	500	200	120	70	50	30	20				
	TereScope3103												
	DISTANCE IN METERS	100	200	300	400	500	600	700	800	900	1000	1400	
	DVM READING	1100	900	650	400	250	170	120	90	65	50	20	
	TereScope3303												
	DISTANCE IN METERS		200	300	400	500	600	700	800	900	1000	1500	2000
	DVM READING		1250	1180	1100	1000	950	900	850	800	750	500	250
	TereScope4400												
	DISTANCE IN METERS	400	600	800	1000	1200	1400	1600	1800	2000	2200	2400	2600
	DVM READING	1250	1230	1170	1110	1060	1010	980	950	920	880	840	800
MEDIUM SPEED	TereScope 802/ST												
	DISTANCE IN METERS	50	100	200	300	400	500	600	700	800			
	DVM READING	1100	600	270	180	140	100	70	50	45			
	TereScope 807/ST												
	DISTANCE IN METERS	100	200	300	400	500	600	700	800	900	1000		
	DVM READING	950	500	350	240	200	160	140	120	100	80		
	TereScope 811/ST												
	DISTANCE IN METERS	400	500	600	700	800	900	1000	1200	1400	1600		
	DVM READING	1300	880	720	650	580	500	430	340	300	260		
	TereScope 940ST												
	DISTANCE IN METERS	800	900	1000	1500	2000	2500	3000	3500	4000			
LOW SPEED	DVM READING	1300	1250	1100	820	630	500	380	320	300			

	TERESCOPE UNIT										
	TereScope807/ETH										
	DISTANCE IN METERS	100	200	300	400	500	600	700	800	900	1000
	DVM READING	950	500	350	240	200	160	140	120	100	80
	TereScope811/ETH										
	DISTANCE IN METERS	400	500	600	700	800	900	1000	1200	1400	1600
	DVM READING	1300	880	720	650	580	500	430	340	300	260
	TereScope940/ETH										
	DISTANCE IN METERS	800	900	1000	1500	2000	2500	3000	3500	4000	
	DVM READING	1300	1250	1100	820	630	500	380	320	300	
	TereScope702/ETH										
	DISTANCE IN METERS	100	150	200	230	250	300	350			
	DVM READING	500	360	300	270	240	150	100			
	TereScope 802 E1										
	DISTANCE IN METERS	50	100	200	300	400	500	600	700		
	DVM READING	1100	600	270	180	140	100	70	50		
	TereScope 807 E1										
	DISTANCE IN METERS	100	200	300	400	500	600	700	800	900	1000
	DVM READING	950	500	350	240	200	160	140	120	100	80
	TereScope 811 E1										
	DISTANCE IN METERS	400	500	600	700	800	900	1000	1200	1400	1600
	DVM READING	1300	880	720	650	580	500	430	340	300	260

Fade Margin Graph



The above graph shows the fade margin (per link) of air attenuation before the link fails after an installation, with regards to the DVM reading on the back panel of the TereScope™.
The above graph refer only to the TereScope™ with the DVM on the back panel:
HIGH SPEED: products are all TereScope™ from 100Mbs up to 155Mbs.
MEDIUM SPEED: product is the Open Protocol 25Mbs.
LOW SPEED: products are all TereScope™ the E1 (2Mbs) and the 10Mbs EHT.

Installation

General

The installation procedure is divided into two main parts. Indoor and Outdoor installations.

Outdoor installation deals with the equipment, which is to be mounted on the rooftops: Terescope mounts, junction boxes, outdoor cabling, and grounding cable.

Indoors installation deals with equipment installed indoors, in stairways and inside the houses: racks, cabinets, UPS, and power lines.

Tools

The following tools and equipment are required for the successful installation of a TereScope system:

- Electric drill with: impact capability for masonry, reversible rotation, speed control, and a 0-13 mm chuck.
- Concrete carbide bit drills: 6, 8, 10,12 and 12 mm, 30cm long – to penetrate through walls.
- Power Screwdriver.
- Threading equipment.
- Toolbox containing: "Hex nutdriver (Allen) set; open-ended wrench having a jaw span of 6mm to 17mm; hammer (200g); regular pliers; long-nose pliers; cutter; flat screwdrivers ' Philips screw drivers; knife blade; Socket wrenches (8 mm, 10 mm, 11mm, 12mm, 14mm, ½", etc).
- Special toolbox to install optical SC & ST multimode (MM) connectors.
- LAN wiring tools for RJ45 connectors.

The following is a list of the Test Equipment required for the TereScope system installation:

- Power meter: MM 780-1310 nm wavelength.
- Light source: MM 780-1310 nm wavelength.
- Visual fault locator.
- Digital VoltMeter (DVM).
- Palm Pilot + Null-modem cable with DB9 to DB25 adapter.

- Monitor or T.V set.
- Rangefinder Binoculars (up to 1000m range).
- Infrared Viewer Binoculars. (Optional).
- Two data switches for testing. (Optical Access' OS200/AC).
- Laptop.
- LAN Test Equipment

Optical Access will issue a list of all the equipment required for a system installation within an internal Purchase Order: TereScopes, Switches, Routers and Mounts. A list of outsourcing equipment will also be issued, for items such as racks, cabinets, fiberoptic cables, etc. – as required in each system installation.

Mounting Brackets

There are 5 families of mounting brackets:

- M001 Angle Bracket Mount.
- Wall pedestal mounts: M054C – 10" wall pedestal mount, MO53C – 22" wall pedestal mount and the M022C – 34" wall pedestal mount.
- Floor pedestal mounts: M055C – 22" floor pedestal mount; M050C-34" floor pedestal mount; M057C – 22" floor pedestal beam mount; M058C – 34" floor pedestal beam mount; M059C – 47" floor pedestal beam mount; M015C – 47" reinforced floor pedestal mount.
- Extended wall mounts: M051C – 22" extended concrete wall mount; M056C – 34" extended concrete wall mount; M062C – 22" extended wall beam mount; M063C – 34" extended wall beam mount, M064C – 12" extended wall beam mount.
- Pole clamp: there are 4 kind of pole clamps – PCL 3" pole clamp for 3" pipe, PCL 4" pole clamp for 4" pipe, PCL 5" pole clamp for 5" pipe, PCL 6" pole clamp for 6" pipe.

Note

Pole clamps are not standalone products. An extended wall beam mount has to be added to attach the TereScope. The most highly recommended is the M064 model.

These mounts will provide the user with a variety of options, which will enable installation of TereScopes of all types on all kinds of rooftops.

All of these mounts will accept all the *Optical Access* TereScope models.

Mounts must be installed on concrete bases only, using the appropriate concrete "Jumbo" Screws. Never install a mount on a wooden platform or on roof tiles. If for some reason the wall is made from red bricks or some other soft bricks, the mount will have to be attached with thru screws (12mm) from side to side.

Ensure that all mounts are properly grounded, using a standard grounding cable to the Earth Ground of the building –see Appendix B.

Figure 9: Extended Wall Mount (M062)

Figure 10: Angle Bracket Mount (M001)

Figure 11: Floor Pedestal Mount (M015)

Figure 12: Wall Pedestal Mount (M054)

Outdoor Installation

Install the mount on the rooftop on a concrete surface, using appropriate “Jumbo Screws". Wooden surfaces or roof tiles must not be used as a base for the mount. TereScopes which are not equipped with a junction box have the option of adding an additional junction box the“IB11 “ type junction box which contains the connection for the cable at the user's end, the fiber optic connector adapaters, RJ45 adaptors, and power cable jumpers which connect to the TereScope.

The fiberoptic jumpers, CAT5 cable, and the power cord to the TereScope from the junction box must beat most 10 meters long. If the distance is greater, use additional cabling of the same type as that which connects between the switch and the TereScope.

The cable between the junction box and the point entering the building will be housed in a duct (UV-protected), with the duct attached firmly to the roof. The mount will be grounded to earth with a standard grounding cable 95# (16AWG). Connect the grounding cable to the building's grounding earth point, or to the grounding cables of poles and/or antennas existing on the roof. If none of the above is found in the building, insert an electrode into the ground and connect the grounding cable to it. For all grounding and lightning protection, refer to Appendix B.

Indoor Installation

The indoor installation begins at the entrance to the building or the staircase, with the fiber optic or copper cable running to the location of the communication equipment cupboard, or a 19" rack. The cupboard or the 19" rack will house the switch/router and the UPS.

It is highly recommended to use UPS's when installing the IR link. The UPS should be connected to the TereScope and the communication equipment. The UPS will insure that if there is a power failure at one end of the link the other end will not be affected by it, and will maintain the input voltage to the TereScope™ stable. The standby time is for the customer to decide.

Cabinet Installation

Optionally, a cabinet can be used to install the communication equipment outdoors or directly on the wall. The equipment is installed upright (vertically) in a cabinet (in a horizontal installation in a 19" rack). A 19" frame in the cabinet opens like a dishwasher door to accept the equipment. The frame is either 2.5U or 4U high. (The 2.5U cabinet has an added height of 1U to enable the addition of an RJ45 connection, in cases where connection of subscribers to the cabinet is required.

Fiberoptic Cable

There are two kinds of fiberoptic cables that can be used – 8 MM fibers and 4 MM fibers.

- Fiber optic cables with 8 MM fibers (62.5/125 µ) plus a 1000W power cord, plus two UTP cables. Such cables will be used for MESH installations and can feed up to 4 TereScopes™.

- Fiber optic cables with 4 MM fibers (62.5/125µ) plus a 300mW power cord, plus two UTP cables. Such cables will be used for drop installations and can feed up to 2 EtherLight's. (The 4 optical fibers in the cable are used when the EtherLights are changed to fiber connection TereScope™)

- Physical Properties: Cables with the 8 MM fibers will have a minimum band radius of 20 x R = 34 cm. Cables with 4 MM fiber will have a minimal band radius 20 x R = 27cm.

- Attenuation:
  For SM cable: 1310 nm → 0.5dB/km, 850nm → 2.75dB/km [Avg.]
  For MM cable: 1310 nm → 3.5dB/km, 850nm → 4.5dB/km [Avg.]

Indoors Installations should be concealed as much as possible, in shafts, wall cabinets, or plastic canals.

Connecting the Equipment

A standard fiberoptic cable contains fibers, a power cord and UTP cords. Such an integrated configuration enables the running of a single cable from the rooftop with the capacity to provide all the power requirements and the ability to feed up to 4 TereScopes™. The technical team connecting the TereScopes™ will hook up all the optic connectors and connect the power cord to the junction box and the TereScopes™. The UTP cords are intended to connect units equipped with SNMP, or TereScopes™ with only an RJ45 connection, in which case the cable can feed only 2 TereScopes™.

Cabling Connection Tests

Installation checks will include checking the fiber optic cable and the connection to the fiberoptic terminations. This can be done with the aid of a power meter and a light source, transmitting from one end, and by checking the power at the other end. The average attenuation for 1310 nm wavelength for MM must be 0.5 dB per 100m of cable plus 0.5 dB per cable connector.

When installing CAT5 cables, it must be tested with an appropriate test tool (e.g., FLUKE for good connectivity.

The power supply to the TereScope™ units, as well as their proper operation, must also be checked.

CCD TereScope™ Link Alignment

TereScopes™ are divided into two types. One type is equipped with an alignment camera. The letters “CCD” next to the model number of the unit indicates this capability. The other type serves as a visual alignment and is identified with the letters “ VS “ next to the model number of the unit.

Equipment

CCD camera alignment equipment needed for installation are:

- Palm Pilot or PC with the alignment software.
- Serial RS-232 cable with DB25→DB9 adapter (male → male).
- T.V. monitor or T.V set + RG59 coax cable with BNC connectors.
- Tools: 3/16” hex nutdriver, 5/16” hex nutdriver, 7/16” open-ended wrench, #2 Philips screwdriver.
- Voice communication device (i.e., 2-way radio or a pair of cellular phones).

Alignment Procedure (T3000)

Make a coarse alignment with the telescope at the opposite end (lasers off). Next, tighten the 5/16 ” hex nut which controls the horizontal alignment and the 7/16” screw (with the open-ended wrench) on the right hand side of the TereScope™ which controls the vertical alignment.

- Make a coarse alignment with the telescope for each TereScope™.
- Connect the T.V. monitor to the BNC port in the junction box. Connect the Palm Pilot or P.C. to the RS- 232 port.
- Choose the External camera mode on the software (in the TS3000 model only) and set Squelch to OFF. Do it at both TereScopes – see Figure 13.
- A white dot on the monitor should now be visible (in the TS3000 model only), indicating laser transmission from the other end. With the fine alignment screws horizontal (on the left hade side) and the vertical on the right hand side bring the dot to the center of the screen.
- Switch ON the Palm Pilot or PC to the internal camera. The monitor will show a larger white dot, showing the light beam striking the detector. With the fine alignment screws. Ensure that the white dot is appears directly at the center of the monitor screen – see Figure 14.
- Using the 3/16” hex nutdriver, tighten and secure all the screws after these fine adjustments have been made..
- Set Squelch to ON.
- Save the settings in the EPROM.
- Verify that the parameter values agree with the values in the table below.

Table 2: TereScope 3000 Characteristics

Parameter	Operational Minimum	Typical	Operational Maximum
RSSI	1.9 V	2.1 to 2.4 V	2.4 V
High Voltage	150 V	200 V	210 to 250 V

Current	0 µA	50 µA	400 µA
MPD	8.0 mW	10 mW	11 mW
Bias	O mA	Above 0 mA	Above 0 mA
Temperature	20 ºC	Depends on weather	50 ºC

RSSI –(**R**eceiver **S**ignal **S**trength **I**ndication) is an indication of the average amount of power received at the detector.

HV –(**H**igh **V**oltage) is an indication of automatic gain control operation.

Current - an instantaneous measure of the light striking the detector.

MPD (**M**onitor **P**hoto **D**iode) indicates the average power output of the laser diode.

Bias is the bias current that the laser diode is operated at and upon which signal current is added.

Temperature is the Temperature reading from the circuit board.

Note

In the TS1000 and TS1000X models, the procedure is the same except that it is done without the External camera mode.

On the T1000G, the laser is always "ON" and there is no need for a palm pilot; only a TV/monitor is required to align the TereScopes. Software control is achieved by hooking a PC to the CLI port of the management. (It is highly recommended to read the installation guide **before** installing the link.)

White Dot Laser Transmitting

Figure 13: External Camera View (TS3000)

Figure 14: Internal Camera View

Visual Alignment TereScope™ Link Alignment

Equipment

The equipment needed for link alignment of Visual Alignment TereScopes are:

- Hex nutdriver 5/16”, open ended wrench (having a jaw span of 8mm, 10mm, 11mm, 14mm, and ½”)
- Screw driver (Philips & flat) # 1,2,3.
- Digital Voltmeter (DVM.
- Voice communication device (i.e., 2-way radio or a pair of cellular phones).

Alignment Process

1. Call one of the teams Team “A” and the other Team “B”.

- Coarse align the TereScope™ with the telescope (with lasers turned off). Tighten the horizontal and vertical coarse alignment bolts.
- Move the Mode Select Dip Switch to the “Alignment” mode, (at both ends for the High Speed Family).
- Team “A” will move the fine adjustment screws horizontal & vertical while Team “B” is reading the DVM readings at its end (without touching the unit) until the maximum reading is obtained.
- Team “B” will move its fine adjustment screw horizontally & vertically while Team “A” is reading the DVM readings, until the maximum reading is obtained.
- Team “B” will confirm that the reading at its end stayed the same.
- If the reading at one end is higher then 1100 mV, the opposite end needs to attenuate with the DIP switch attenuators 5, 6, 7, or 8 to get a lower reading.
- Set the Mode Select DIP Switch to the “NORMAL” mode (on the high-speed family), and the DATA RATE Switch to the needed rate.
- Remember, it is a **CROSS** connection**.**
- **Important:** When doing the fine alignment, it is advised to go all the way to the right and to the left, then up and down in order to find the middle of the “optical bell”. The expected DVM reading levels vs. distances can help you knowing when you are at the pike.
- Insure that for each optical fiber the ends are connected as follows: Tx → Rx; Rx → Tx.

Display

Following successful alignment, the display should be as follows:

- **AIR RX Flag** - Green LED indicating that the Airlink receiver is receiving data. Turns ON at the threshold levels.
- **AIR RX Sync –** Yellow LED, which turns ON if the rate of the received Data Rate matches the Data Rate set on the Data Rate DIP switch.
- **F/O RX Flag -** Green LED indicating that the fiberoptic receiver is receiving Data. Turns ON at the threshold levels.
- **F/O RX Sync -** Yellow LED, which turns ON if the rate of the received Data Rate matches the Data Rate set on the Data Rate DIP switch.

Back Panel Description (for High-speed Family)

Connectors

- **POWER** – power source inlet (main or UPS)
- **FIBER OPTIC** – fiber optic interface for the connection of the communication equipment.
- Remote Monitor – connection to an optical Remote Status Monitor.

Selectors

- **DATA RATE** - Sets the transmission rate of the transceiver (internal clock).
- **MODE SELECT** – Sets the operation 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.

  LOOP BACK = N/A.

  AIR TX Power = Used to attenuate the optical power radiated by the Airlink TX (Normal = no attenuation, -3dB = 3dB).

Appendix A - Recommendation For BERT Testing

Using the WWG™ Equipment

BER TESTING AT THE DOMINOWAN (E1).

To execute BERT testing, the user should do the following:

- Select the Domino Core option. If the DominoNAS is installed, select the Domino icon.
- Select the Monitor option.
- The WAN Monitor Setup Window will appear. Select the HDLC option.
- The Tool Bar will appear. Select the Interface option then go to the Bert option.
- Select the desired pattern.
- Select the Start button to operate the Bert testing option.

EDT-135 Setup For BERT (for E1)

- Select the Setup Menu 1. Adjust the mode to Rx/Tx.
- Adjust the Line Code to HDB3.
- Select Menu 2 (Softkeys).
- To setup Menu 2, select the desired BERT pattern.
- Select the Menu 3 button.
- The user will receive an output known as G.821 (CCITT standard) analysis of the results.
- In Setup Menu 3, press Run button.
- The user should see the “OK” on the left display window. In the right display window the user should see all the results of the Test.

ANT-20 Setup for BERT (for 155Mb/s)

From the ANT-20 Main menu toolbar, select Instruments and verify that the Anomaly/Defect Analyzer and Signal Structure features are selected

Figure 15: ANT 20

In the Signal Structure, map your configuration and pattern to send to BERT.

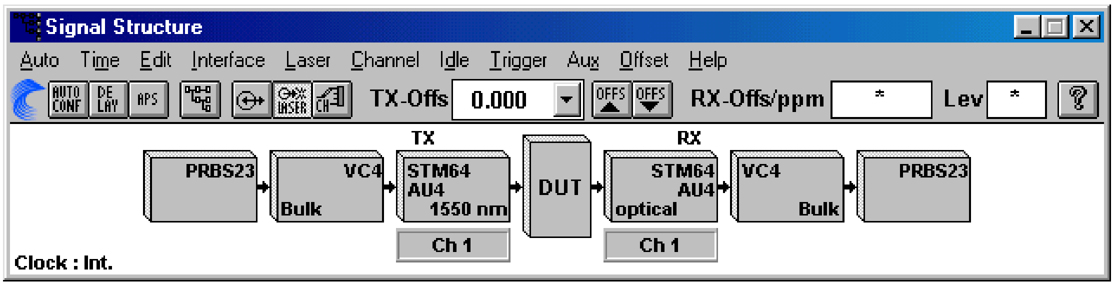


Figure 16: Signal Structure

Figure 17: Edit Signal Structure

If user wants to filter the results for the TSE (BERT), this can be done from the Anomaly/Defects Analyzer window. Select Filter and setup for TSE only.

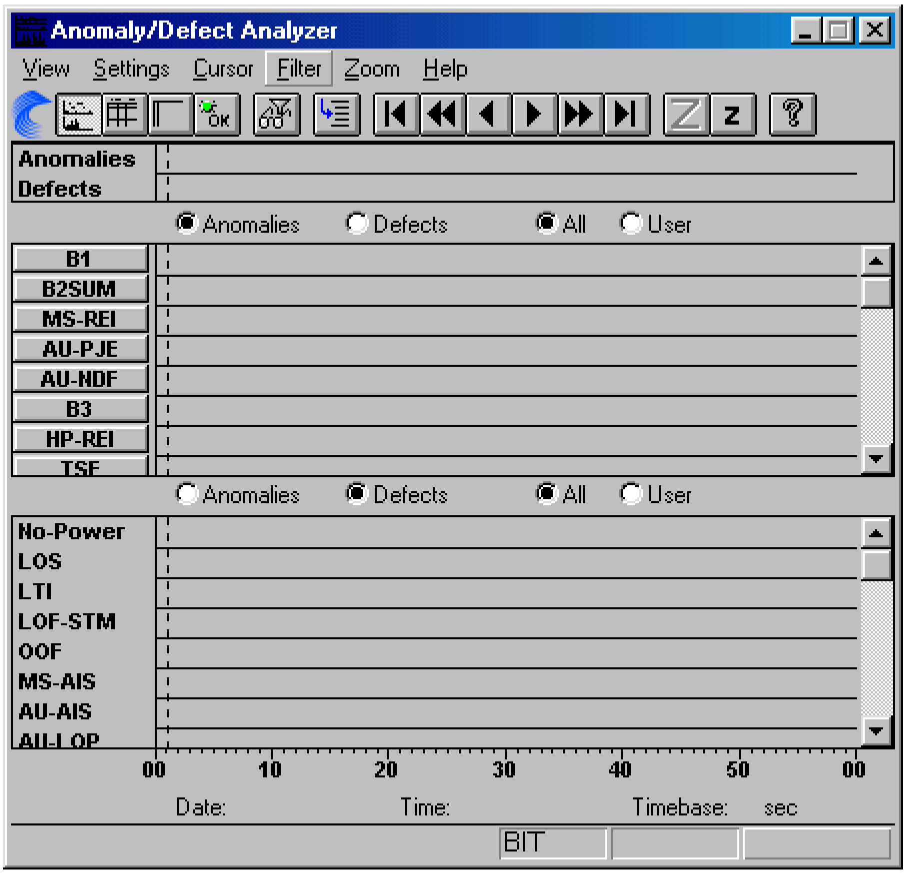


Figure 18: Anomaly/Defect Analyzer

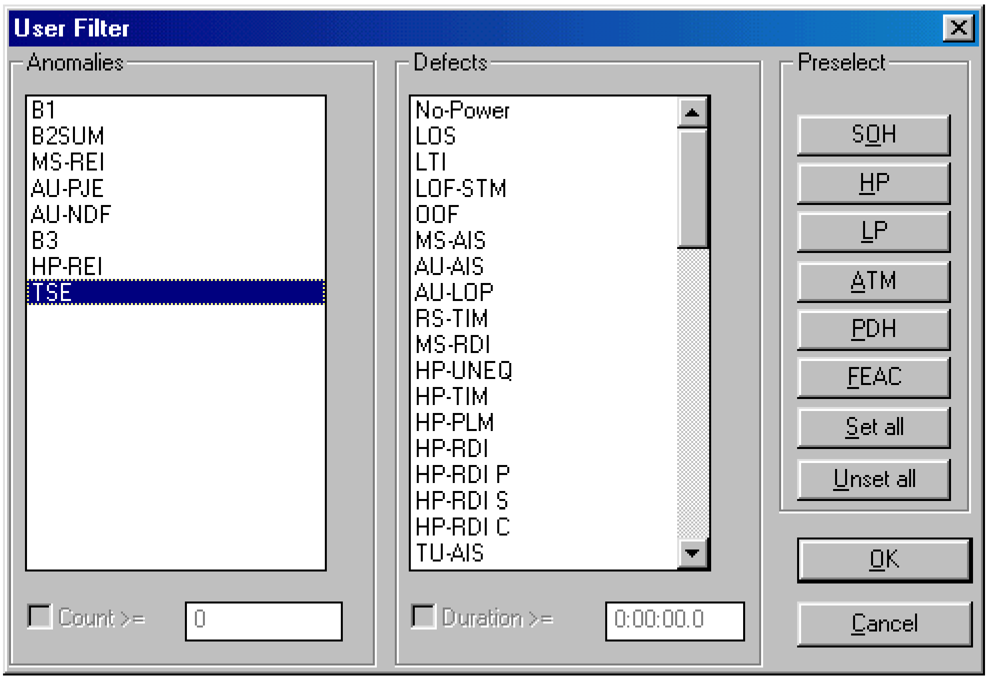


Figure 19: User Filter

Verify physical connections are OK. From the main window, select Measurement and Start.

Using the OC3 Port Plus by FLUKE

- If the user needs to set up SONET parameters, press SONET button and scroll down/up through the relevant parameters.
- Turn laser on, press SONET button, select " laser on " highlight and change it from the selection "OFF" to "ON".
- Press the BERT button, use the up/down arrows in order to select the appropriate BERT pattern. Use the same procedure for defining error injection and then begin the BERT test.
- The unit will load defined BERT pattern and start testing. Use arrows to change monitoring screens.

Figure 20: OC3 Port Plus

Appendix B – Grounding Procedure

Grounding & Over Voltage Prevention Procedure

Version	Revision	Date	Issued By	Signature
1	1	O5.01	Elie Elgressy	
			Advisor: Elie Elgressy E.Engineer – E.M.C. Eng. Senior Member I.E.E.E.	
			Approved By: Ofer Raviv	
			Procedure Approved By:	

Standards and Specifications

This procedure is based on the following Standards and Specifications:

- The relevant Electricity Laws of the Country in which the equipment is being installed.
- I.S 1742 (Grounding Electrodes)
- NFPA 780, with reference to the relevant chapters
- NACE, with reference to the section/s of corrosion prevention
- UL 96A, with reference to the relevant chapters
- IEC 1024-2, with reference to the relevant chapters
- NFC 17-102, with reference to ESE (Early Streamer Emission)

Introduction

Overview

A grounding system constitutes part of the safety network adapted to the electricity laws of the country, the terrain conditions, and the accepted and relevant standards of the country.

In case of conflict between this specification and the standard requirements of the Country in which the equipment is being installed, the more stringent of the standards will apply.

This specification is not concerned with grounding against lightning or grounding of buildings, except with the grounding of the equipment installed.

The Function of a Grounding System is to minimize lightning damages.

Purpose

The purpose of this procedure is:

- To specify standards for the planning of a Grounding System
- Detail the installation procedure of a Grounding System
- Check the quality of the installed system.

Responsibility

- It is the responsibility of the Contractor performing the work to adhere to the details and standards specified in this procedure.
- It is the responsibility of the Contractor performing the work to carry out his task in accordance with the standards and details promulgated in this procedure.
- It is the responsibility of the Contractor performing the work to complete the Grounding System as planned, including the relevant measurements of the installed system and the recording of the measurements obtained.

Definitions

Parts of the definitions listed in this paragraph were specified in accordance with standards accepted in most countries.

Site	The location where Optical Access equipment is being installed.
Permanent Site	The site constructed on the roof or balcony of a building.
Grounding	An intended connection to the Ground Mass.
Safety Grounding (TT)	A safety device to prevent electrocution, characterized by Grounding Leads of the installation to the Mass of the Earth.
Foundation Grounding / Use Ground	The system comprising a Foundation Grounding Electrode, a ridging Ring, a Potential Equalization Bar and a Grounding conductor which connects the Bridging Ring to the Potential Equalization Bar.
System Grounding	Grounding of the " Transformer Star point " to the Ground. (Connecting midpoint to grounding electrode)
Fault Loop Path	The path of the Fault Loop current runs from the supply source, through the supply conductors, the Foundation Grounding, the Ground wires the Earth Mass, the System Grounding of the Power Source, through all these or parts of them (connected in parallel or series), runs the Fault Loop current or the Null current.
PEN (Protective Earth Neutral)	A conductor which serves both as a Ground conductor and a neutral conductor
Grounding System	System comprising grounding electrodes, grounding conductors and accessories connecting between them and the entity, which is being grounded.
Foundation Lead Spike	An outlet from the foundation lead ring, serving as a lightning protection connecting lead, or as an additional electrode to other entities requiring connection to the foundation grounding.
Cable Entrance Ground Bar (CEGB)	A copper bar to which the RF Cables shielding is grounded at the entrance to the building.
Tower Ground Bar (TGB)	A copper bar to which the tower ladders, the RF cables shielding, the tower lights cable shielding as well as other elements installed on the tower, are grounded.
Terescope™ Ground Bar (TS.GB)	A potential Bar installed on insulators at the bottom of the lightning rod / Air terminal. Connected to it are the lightning rod, down conductor, and other services.
Master Ground Bar (MGB)	The main internal copper bar bridging various grounds.

Equipment Ground Bar (EGB)	An Internal copper bar bridging the pedestal grounds.
(TN-C-S, TN-S)	A safety device to prevent electrocution. This is done by connecting the grounding of the equipment to the PEN conductor of the supply to the Building.
Ground Rod	A vertical rod be found in contact with the earth mass, either directly or through the concrete of the building foundation, either as a single rod or as several interconnected rods.
Foundation Grounding Electrodes	An Electrode comprising interconnected steel sections, inserted into the foundation of the structure.
Bridging Ring	A metallic ring bridging the parts of the foundation grounding electrode and constituting a part of it.
Grounding Bar	A grounding strip, which serves to connect or disconnect, grounding wires.
External Ground Loop (EGL)	A grounding ring installed on the roof of the building. It serves as part of the lightning protection system.
Lightning Rod / Air terminal	A system designed to collect the lightning current.
Down Conductor	A conductor connecting the lightning rod system to the foundation grounding system as well as to the electrode or other type of lightning protection system installed on the roof.
Interior Grounding Ring	A copper strip installed around the wall of the room in which communication equipment, Optical Access equipment as well as other electronic devices are installed. The equipment in the room is to be connected to this “Grounding Ring”.

Outdoors Grounding System

Terescope™ Ground Bar (TS. GB)

The Grounding Bar is installed on insulators at the basis of the lightning rod. To the grounding bar are connected the following elements:

- The shielding of the RF cables, using an Andrew Kit or its equivalent, as required.
- Ladders, Piping and all metallic accessories, which serve the equipment. The connection will be accomplished using a 25 sq. mm wire.
- A 95 sq. mm. wire to the base of the lightning rod.
- A down conductor, using an insulated wire 95 sq. mm. NYA, to the grounding system or to the existing lightning protection system on the roof.

Down Conductor Routing

The down conductor will be installed on the exterior of the wall of the building. It can be installed inside the building only under the condition that it will be routed inside a separate shaft, which is free of electrical wiring, communication, water piping or any other system.

In cellular communication or switching equipment sites, do not install the down conductor inside the building.

Cable Entrance Ground Bar (CEGB)

- The CEGB ground bar will be installed, only if required, on the site building, under the RF cable entrance to the building.
- To the CEBG will be bridged the shielding of the RF cables at their entrance point to the building. The CEGB ground bar will be bridged to the Down conductor or to the grounding system, using a 50 sq.mm wire

Outdoor Grounding System Specification

This specification refers to the installation of a Grounding System on sites where no Foundation Grounding System and no Independent Grounding System exists.

System Description

A Grounding System comprises: An external grounding ring attached to the exterior of the building, either in the shape of a horizontal stripe or a vertical electrode. The wire will be of bare copper 50 sq .mm buried in the ground, or of a galvanized strip of 3.5 X 30 mm. Such a ring will be used only if there is no foundation grounding in the building and there is no possibility to install a Vertical Electrode.

Purpose

Maximum utilization of the ground for the construction of a grounding system with a low resistance to the earth mass. The resistance may be per the client's requirement provided it does not exceed **2Ω.**

Vertical Electrode

The Vertical Electrode will be installed at a point, which allows access. It will be constructed of rods of 19 mm diameter and length of 1.5 meters for each rod. The connection between the rods will be done through couplers. The rods will be made of steel, covered with a copper coat at least 0.5 mm thick. The overall length of the rods must be such that the resistance of **2Ω** is not exceeded.

Horizontal Electrode

Digging of an external Horizontal Electrode will be affected at a distance of at least one meter from the building and at a depth of 70 cm. The digging will start at the bottom of the building from the Down conductor.

The connection between the underground wire and the down conductor will be done on the building wall in a Connection Box. Within the dig, a bare copper wire of 50 sq .mm cross-section or a 3.5 X 30 strip will be installed along the entire length of the dig.

Responsibility

The contractor performing the work is responsible for the completion of all stages of the work in accordance with this detailed specification.

The contractor will assign an experienced team manager who will be in charge throughout all stages of the work, and shall be responsible for the performance all the stages of the project until its completion.

Standards and Specifications

The following standards and specifications will be an integral part of this task and will be followed by the contractor in his work.

- The Electricity Laws of the country in which the equipment is installed
- NFPA 780 - with reference to its relevant chapters
- I.S. 1742 – Grounding Electrodes
- NACE – with reference to the sections on corrosion prevention
- UL 96A - with reference to the relevant sections
- IEC 1024-1 – with reference to the relevant sections

- NFC 17-102 – with reference to Lightning rod ESE (Early Streamer Emission)
- KEMA (K 83 C) – grounding Electrodes (Class A)

Method of Performance

Site Familiarization

- The contractor will tour the construction site and familiarize himself with all aspects of the site. He will note existing obstacles such as, water pipes, under ground cable runs and any other object/s, which may hinder or prevent the successful completion of the work detailed in this specification. The contractor will make the necessary efforts to pinpoint existing or suspected obstacles, which may hinder the performance of the task at hand.
- The contractor will carry full responsibility for all damages, which may be caused due to his work at the site.

Covering the Excavation

- On completion of the connections between the conductors in the excavations, the excavations will be covered by local earth without stones. The covering will be done with water and earth packed down tightly.
- Do not use dune, sand, or limestone even if the excavated area consists of limestone or dune sand.
- In rocky earth, dune, sand, and limestone use Back-fill of low resistivity or use EGR Electrolyte to change the specific resistivity of the earth.

Checking the Resistance of the Grounding Field

On completion of the work as detailed in the specifications, the resistance of the grounding field to the earth mass is to be measured. The required resistance must not exceed **2Ω**.

Anti Corrosion Painting

- All connections will be painted with a first layer of Primer Wash.
- Following appropriate drying out of the first layer, as per manufacturer's instructions, a Cold Zinc or Tar Spray layer of paint will be applied.

Installation of Materials and Accessories

All the accessories required for the connections between the conductors will be of approved standard and carry the approval of *Optical Access*.

On completion of the work, the contractor will present to the customer a *detailed* plan of the location of all conductors and electrodes. This will be used for future inspections and repair work.

Approvals

All work items which deviate from the detailed specifications above, will require prior approval of the *Optical Access* Project Department.

Inspection of Grounding Area

General

This section concerns itself with the proper inspection of the grounding area resistance to the general earth mass. The resistance may be specified by the customer provided it does not exceed **2Ω**.

Measuring Equipment

- A number of measuring instruments can be used to measure the resistance of a grounding system. The principle on which these instruments operate, measures the increase of the resistance of the grounding system to the earth mass.
- The type of instrument used must be absolutely reliable and of a manufacturer of recognized authority in the manufacture of such measuring equipment, e.g., " MEGGER ", "CHAUVIN ARNOUX", or their equivalent.

Auxiliary Electrode Placement for Measurement Purposes

The separation/distance between the auxiliary electrode and the electrode being measured is determined by the size of the latter (or according to the instrument manufacturer's values).

For a Vertical Electrode

The separation/distance between the electrode being measured and the next nearest electrode must be at least three times the length of the electrode being measured.

The separation/distance between the electrode being measured and the furthest electrode must be at least 4.5 times the length of the electrode being measured.

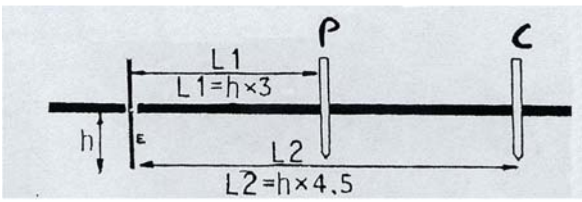


Figure 21: Vertical Electrode

Building Foundation Ground

1. The separation/distance between the foundation electrodes being measured and the nearest reference electrode must be three times the diameter of a circle whose area equals the area of the foundation.

2. The separation/distance between the foundation electrode being measured and the furthest reference electrode must be 4.5 times the diameter calculated in 1, above.

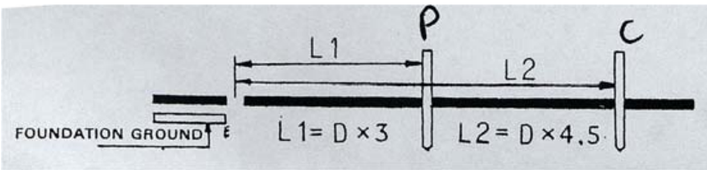


Figure 22: Foundation ground

When:

D = diameter

R = radius D = r x 2 $r = \sqrt{S / \pi}$

<u>Example</u>: Foundation area = 850 sq. meters

$r = \sqrt{850 / 3.14} = 16.4$ D = 16.4 x 2 = 33

Therefore, the separation and/or distance between the foundation and the nearest electrode will be 33 x 3 = 99 meters and 33 x 4.5 = 151 meters from the furthest.

The following are a few practical suggestions for your consideration prior to installing the electrodes.

The resistance of each electrode depends on two factors:

- Specific resistivity of the soil.
- The length of the electrode and the number of electrodes required. The specific resistivity varies over a wide range. The following table shows approximate values of specific resistivity for various types of soil.

Table 3: Soil Resistivity

Environment	Specific Resistivity (ohm-cm)
Sea water	40 – 50
Black agricultural soil	500 – 800
Moist Loess	600 – 800
Dry black soil	1000 – 8000
Light soil – red clay	2000 – 3000
Light agricultural soil	3000 – 4000
Hardpan	7000 – 14000
Dune sand	15000 - 30000

Resistance Calculation for Electrodes Installed in Parallel

When the desired value cannot be achieved with one electrode, additional electrodes must be installed.

N = number of electrodes needed

R1 = value resulting for one electrode $N = \frac{R1}{R} \times 1.2$

R = required value

Sample Calculation: $N = \frac{10}{4} \times 1.2 = 3$

Assume one vertical electrode at a depth of 400 cm yields a value of 10 ohms so that for the required value: R = 4 ohms.

Therefore three electrodes must be installed in parallel at a minimum spacing of 6 meters. If the electrodes are installed in a smaller area, the factor must be increased by 1.2 to 1.4.

Resistance Calculation for Electrodes When Deep Soil Penetration is Not Possible

For hard or rocky soils where deep penetration is not possible let's assume 4 meter penetration and specific resistivity of = 7000 ohm-cm

In this case the resistance will be: $R_{(\Omega)} = \frac{0.85 \times 7000(\Omega \times cm)}{400} = 15\Omega$

$$N = \frac{R1}{R} \times 1.2 = \frac{15}{2} \times 1.2 = 9$$

In the example cited above, nine electrodes should be driven to a depth of 4 meters.

Grounding (Earthing) Improvement

In some cases, following installation the measured resistance value does not satisfy mandated requirements and a question arises as to how many additional electrodes should be installed in parallel.

Sample Calculation:

Let the required value be R=1 ohm and the measured valued be 4 ohms.

$$R2 = \frac{R \times R1}{R1 - R}$$

Where:

R = the value required according to the size of the facility.

R1 = the measured resistance value

R2 = the resistance that must be added in parallel to the electrodes to attain the required value. $R2 = \frac{1 \times 4}{4 - 1} = \frac{4}{3} = 1.3\Omega$

The value that must be added to the grounding to attain the required 1Ω.

Calculating the Value of One Electrode

In the case where the specific resistivity of the site is 4000 ohm-cm .

The resistance value will result from driving an electrode to a depth of 6 meters.

$$R_{(\Omega)} = \frac{0.85x4000}{600} = \frac{4}{3} = 5.6\Omega$$

Quantity of Electrodes Required to Improve the Grounding

N = number of electrodes needed

R1 = resistance of one electrode $N = \frac{R1}{R2} \times 1.2$ $N = \frac{5.6}{1.3} \times 1.2 = 5.16$

R2 = resistance to be added to attain the required value

Five electrodes are therefore to be added. (The electrodes must be installed at a maximum separation from one another).

Lightning Rod Installation

General

System Description

The lightning rod (FRANKLIN type).

Serves as a vertical reception rod. It creates around itself a protection zone in the shape of a cone. The size of the protection zone is a function of the height of the lightning rod. In sites where the height of the lightning rod is limited or other technical reasons apply, FRANKLIN lightning rod will be installed with a mechanism which provides ESE (Early Streamer Emission) factor of at least **"Δt = 10 μ s".** (The ESE Rod can be installed at a distance of up to 10m from the TereScpoe™).

Purpose

The purpose of a Lightning rod is to protect as large an area as possible of the installation site from lightning strikes by receiving the lightning strikes and discharging them via the shortest possible route to the ground.

Responsibility

The contractor undertaking the completion of the work in accordance with the detailed specifications is responsible for all aspects of the work process. He will appoint a work manager who will oversee all phases of the job until the completion of the project.

Standards and Specifications

NFC 17-100 – With the relevant reference to the Franklin Lightning rod

NFC17-102 – Lightning rod ESE.

NFPA 780 – With reference to the relevant chapters.

I.S. 1742 – With reference to the relevant chapters.

NACE – With reference to corrosion prevention.

UL 96A – With reference to the relevant chapters

K83C Kema (Class A).

Method of Performance

FRANKLIN Lightning Rod

- The lightning rod is constructed of Aluminum 22mm diameter with a height of 150 cm. It is installed on the basis of the Terescope™ according to the relevant drawing/s.
- The down conductor to the ground will be attached to the bolt designated for this purpose on the Terescope™ Ground Bar (TS, GB) strip, installed on the Terescope™.

E.S.E Lightning rod (Early Streamer Emission)

This is an additional mechanism installed on the lightning rod. It has an early streamer emission factor of at least "**Δt = 10 μ s**".

This mechanism is installed on the FRANKLIN type lightning rod. (It is an optional accessory).

Functioning Principle

A rod-type lightning conductor works by altering, at its level, the equipotential layers, which match the structure of the construction it protects.

The creation of highly ionized plasma at the tip of a lightning rod, favors the capture of lightning strikes.

This however, can only be achieved if it is possible to produce ions during short periods without permitting the creation of permanent charges, which have a tendency to destroy the point effect by compressing the electrical equipotentials.

The lightning conductor releases a trail of high voltage pulses controlled at each turn of the descending tracer. This results in the emission of high frequencies (more than 100 kHz) by the tracers of electromagnetic waves: These waves propagate toward the ground at the speed of light (300,000 km/second) with a frequency of 1 MHz, while the tracer propagates at a relatively low speed of 100km/second.

Considering the speed differences, radiation reaches the lightning conductor well before the tracer reaches it. In the case of a tracer situated 500m from a lightning conductor, there is a lapse of 5 ms between each arrival. This lapse of time is usually sufficient to transform the electromagnetic radiation into high voltage pulses adapted to develop an ascending tracer.

Each turn of the descending tracer emits an electromagnetic signal, which is detected and used by the lightning conductor to emit a series of pulses of more than 10 kV amplitude at a frequency of around 10 kHz. These emissions get amplified in accordance with the electromagnetic phenomena, which recede and accompany lightning.

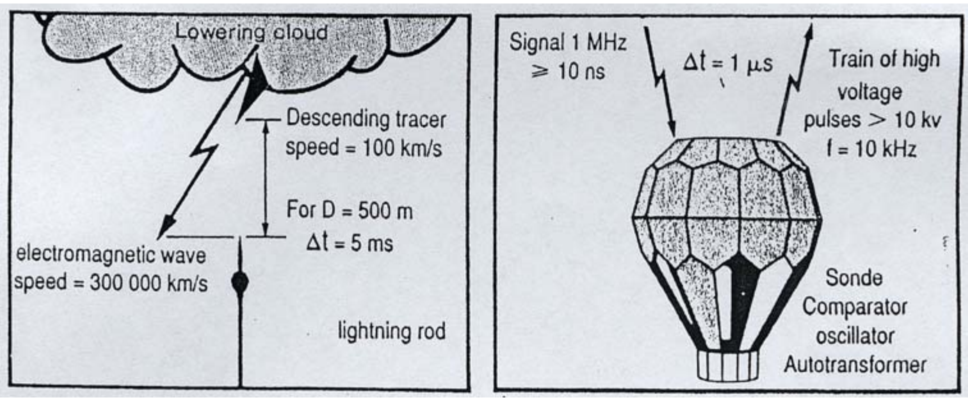


Figure 23: Emissions

Anti Corrosion Painting

- All connections will be painted with a first layer of Primer Wash.
- Following appropriate drying of the first layer, as per manufacturer's instructions, a Cold Zinc or Tar Spray layer of paint will be applied.

Approvals

All work items which deviate from the detailed specifications above, will require prior approval of the *Optical Access* Project Department.

Indoor Grounding System

Grounding System for the Internal Equipment

General

3. The internal grounding system at a Site is based on bridging all pedestals and metallic accessories to the internal grounding ring and through it to the external grounding system.

- The equipment will be connected to the Master Grounding Bar (MGB) of the existing installation, through the power supply line-grounding conductor or through an independent grounding conductor.

Equipment Ground Bar

This grounding conductor is installed in the communication room. If *Optical Access* equipment is installed in this room, the grounding conductor of this equipment will be connected to the Equipment Ground Bar EGB or to the Interior Grounding Ring. The EGB serves to ground pedestals, safety devices, and other equipment.

Interior Grounding Ring

The Interior Grounding Ring serves to ground static charges in the air space of the room. It grounds to it the following accessories:

- Over Voltage protectors of the power supplies, communication pedestals whose grounding connections are situated at the bottom of the units, anti static flooring, and other equipment.
- If Optical Access equipment is installed in this room, the grounding conductor of this equipment will be connected to the EGB.

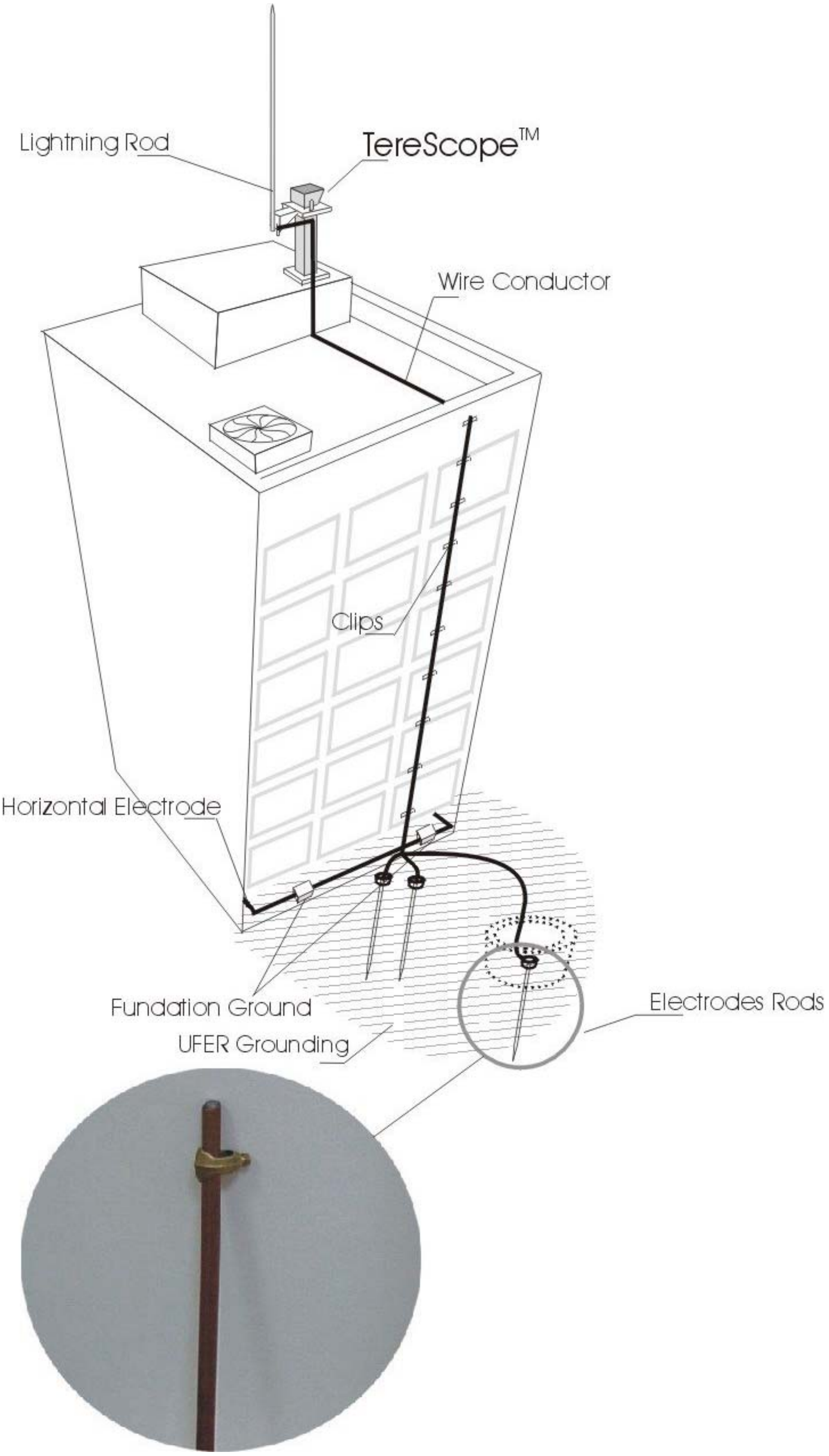


Figure 24: General View of Lightning Rod with TereScope™ Grounding

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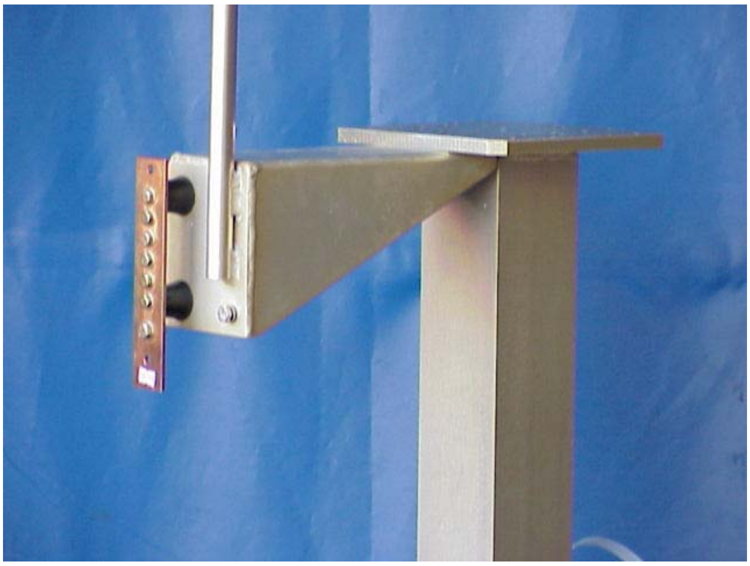

Figure 25: Lightning rod base plate look

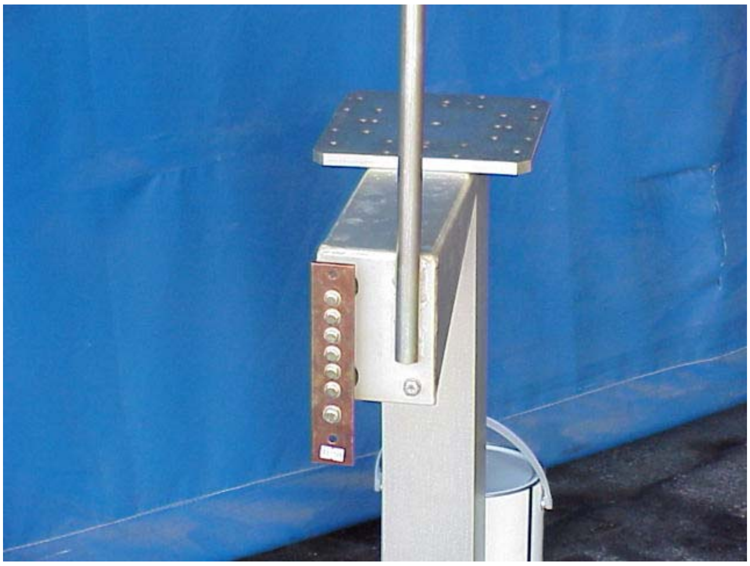

Figure 26: Lightning rod base plate look

Figure 27: Lightning Rod – Typical