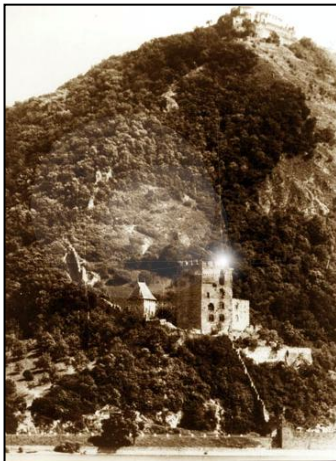


## 1 Introduction

### 1.1 What is FSO?

**FSO** is free space optics provides point-point broadband communications using Laser Light as the transmission medium.

**FSO** is a state of art data communication method which is based on a very old communication solution. Ancient Chinese developed a protection system against the Mongol tribes, building watchtowers within the line of site to other towers. And as soon as the towers saw some hostile sign on the horizon they use they shield to reflect the sun to the remote towers. In this way the area could be prepared against the attack in a very short period of time.



In the ancient times for this communication use the mirror as a transmitter and the sunlight was the light source, and the receiver was the remote guard's eye. This basic signalling method was developed later into up communication device which used „line coding“. This allowed the guards to tell the number of enemy, or the direction they are coming from.

Current **FSO** systems use a laser-diode as a light source, and a receptor diode (photo diode) to receive the signals coming from the laser diode from the transmitter side. But the basic elements are still the same: line of site between the communication nodes, and individual line coding. It is all about performance. **Trimble FSO** offers **FSO** systems with the highest power budget available on the market.

### 1.2 Why is it important?

Because of in the ancient Chinese times, the rain, the fog, or even the cloudy weather, could impact the operation of the whole system.

In the **FSO** units, comprising light source and receiver the cloud problem was solved, but development conditions still can impair performance. To go throw the rain, the fog, or snow you need more and more power to be seen from the remote side. Achievable power levels are limited by a number of factors including eye safety.

In this way there is no other choice to see more than „training the eye“. Making the receiver more and more sensitive to sense delight emitted from the remote side.

**Trimble FSO** offers high transmit power and also very hard receiver sensitivity. These two factors combined to provide one of the best performing **FSO** systems on the market today.



To meet the demands for every higher bandwidth, **Trimble FSO Limited** continues to invest heavily in research and development with the newest product line which offers Gigabit speeds being launched.

This manual describes the **Trimble FSO Next** series of free space laser transmission system.

The **Trimble FSO Next** product range offers cost effective reliable free space laser transmission for two Mbps up to 1000 Mbps data to the air, where a clean line of site is available. It delivers the most effective point-to-point connection between computer networks or telephone exchanges.

No need for installing cables, no rental costs, no licensing requirements.

Ideal for urban areas or city centres, where the use of these lines are expensive. Suitable for factories or industrial environments where high noise level can interfere with the transmitted data. The best choice to make a connection across rivers and other natural or artificial obstacles, where cable is not available.

The transmission technique used in the **Trimble FSO** devices provides transparent and wire-speed data transfer with virtually zero latency. Because they use infrared light as the transmission medium, **Trimble FSO** system do not require frequency licenses and the transmission is not effected by electro-magnetic or radio-frequency interference. Basically the **Trimble FSO** link can be considered as a virtual fibre in the air, which ends in real fibre optic cable at both ends.

Our product is built using high quality components for operation in even the most adverse conditions.

Metal housing gives robust, waterproof environment for the electronics.

The shield protects the device from direct sunlight and provides extra air isolation.

The **Trimble FSO X** systems comprise two laser-heads and the two indoor interconnection units (OIU) - one at each end. The interface connections are housed in the outdoor unit together with the PSU of the system.

Best practises were employed in cost engineering throughout the development of **Trimble FSO**.

## 1.3 Optical Free-space Transmission

The principle used in free space laser transmission is very similar to the one is used for fibre optic transmission. The difference is while fibre optic devices use electronics and optics optimized for transmission to the air. Also one can observe to the similarity in the transmission properties. No galvanic contact, no ground-loops, no need for surge protection, noise immunity, long distances, high bandwidth.

What makes it unique – and difficult to design – is that it does not require any transmission medium like fibre or copper, but it has to cope with the dynamically changing parameters. For instance while the attenuation of an optical fibre is constant, the attenuation of the atmosphere between the laser units can change dramatically (depending on the weather conditions).

The laser-heads are usually placed on top of building, where the clean line of site is guaranteed and the beam cannot be interrupted.

In the head the incoming signal is amplified, encoded, and then drives the laser-diode. The transmitter optics assures the proper beam shape and controls the beam divergence. The receive optics perceives and directs the transmitter signal to the photo diode. The diode converts it back into electrical, than it is decoded, amplified and converted.

There are several things that can influence the quality of transmission. We can classify those factors into three main groups.

System conditions - transmitting power, transmitter's wavelength, beam divergence, receiver optics diameter, receiver sensitivity, parameters of optical system and casing. These parameters determine the system's characteristic at a certain distance and are controlled by system design and factory set up.

Weather conditions - molecular absorption, particle scattering and turbulence. These elements have great effect on the operational conditions of the system. We do not have very much influence on them; proper product selection can eliminate the undesirable effects.

Environmental conditions - building movements, direct sunlight, refractive surfaces. These are also key factors related to the installation sites and can be controlled by appropriate site survey and system installation

## 1.4 Typical applications

Most typically the **Trimble FSO Next** products are used to interconnect LAN-s. The system is protocol transparent, thus other applications also can be taken into consideration. Appropriate interface converters are needed and system bandwidth must be matched for that.

Here we collected some circumstances, where the deployment of the **Trimble FSO** is the most adequate as a cost effective solution.

Those are:

### ***Areas with natural or artificial obstacles***



Where cable is actually not an alternative, like across rivers or railways or in rugged terrain.

### ***Urban areas***

Where only leased lines are available with limited speed, and high rental cost. With Trimble FSO links you can establish on line LAN-to-LAN connections.



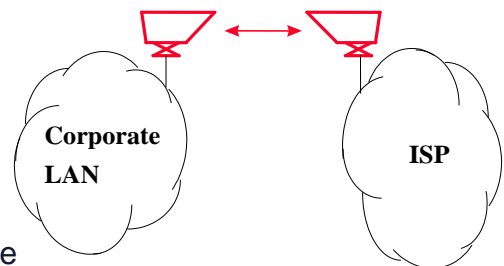
### ***Industrial areas***



Where you have noisy environment with high EMI or RFI. Factory buildings, airport objects can be connected through laser link.

### ***ISP connections***

Where high bandwidth is required. ISP's can offer high-speed links to their customers or trunks can be established between ISP's instead of expensive leased lines.



## 2 Interfaces for the X Series

### 2.1 100Mbps TP interface

The **Trimble FSO X PoE** series products are designed to provide easy-to-use and cost-effective solution for interconnecting Local Area Networks. By utilizing standard Category 5 cable and using standard IEEE802.3af interface the deployment of the system is easier than ever before. The transparent and wire speed data transfer together with virtually zero latency assures the easy integration of the system in all environments.

The **X PoE** systems should be considered as repeaters in the network. So the installation distance between the head and the network device is 100m. The distance on a back to back site is maximum 5 meters, between the heads without signal regeneration.

The **X PoE** systems connecting to the network with an RJ 45 cable which provides the power required for operation and the data. The system requires IEEE 802.3af Power over Ethernet switch or power injector. The power consumption suits to the standards described in the standard. Also provides fast and easy connection for the management system for more details please see the chapters below. The system is certified **Class 1M product**, this way 100% eye safe.

## 3 Sites of installation

### 3.1 Key factors of operation

There are four key issues that the site survey has to shed light on. Proper system operation cannot be guaranteed without satisfying all of the four requirements.

**Clear line of sight** - The entire optical path between the two ends must be free of any obstacles. It not only means that one has to see the other side, but other possible sources of disturbance should also be taken into consideration. For example there might be turbulence above the roofs and other constructions, and this can cause fraction or scattering of the beam or snow accumulation on roofs too close to the beam can influence or even interrupt communication.

**Solid mount surface** - is the key for long-term operation. Since the diameter of the beam is limited, it is extremely important to mount the unit on a stable structure with the possible smallest movement. This way the receiver of the remote unit cannot get out of the beam due to the movement of the opposite head.

**East-West orientation** - although the receiver optics are equipped with optical filters to protect the receiver diode from the effect of undesired light sources, direct sunshine can cause saturation of the diode. This prevents the system from working properly for several minutes a day at certain times of the year. In most cases this effect can be avoided by careful selection of the mounting spot.

In order to comply with the requirements of the successful installation - including the discussed four key factors and other criteria - the following matters should be taken into consideration.

### 3.2 Preferred installation sites

All buildings and constructions have a certain movement of their own. It's determined by the structure and material of the building. Metal structures can shift or twist due to temperature changes. Wooden construction can expand or shrink with any changes in humidity. Give preference to concrete or brick buildings. On the other hand high structures like towers, skyscrapers or poles are always subject to movement. Mount the support frame to walls of the building or near corners, as they are the most stable spots. Use appropriate consoles for wall mounting. If a stand is used on the top of

building, secure it directly to the ceiling or to the concrete cornice wherever is possible. Do not fix stands to insulating materials as they can slowly sink under the weight of the unit and with temperature changes. Big chimneys and smokestacks may look stable, but as their inner temperature varies they can also move. Vibration caused by heavy traffic, trains and elevators etc. may slowly move the system out of its specified direction. Another important consideration is to provide enough space for alignment and to have the potential for future maintenance. Consider that the

support frame is usually heavy, so the selected spot should be easily accessible.

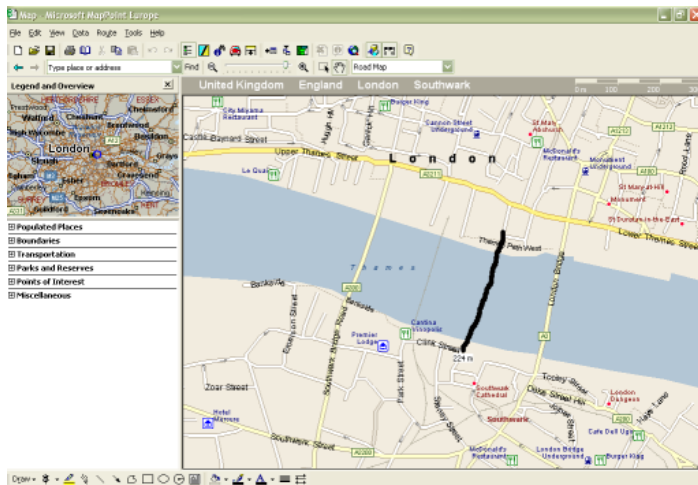
| <b><i>Preferred installation sites</i></b> | <b><i>Pay attention to</i></b> | <b><i>Avoid (*)</i></b>                |
|--|--------------------------------|--|
| Concrete wall                              | Behind window                  | Soft materials                         |
| Brick wall                                 | Old constructs                 | Chimneys                               |
|  | Microwave towers               | Wooden constructs                      |
|  |                                | Metal masts or Frames                  |
|  |                                | Hidden heat isolations, like Styrofoam |

(\*)  
*In cases where installations are listed under "AVOID" cannot be avoided than special mounting accessories to be designed and special installations must be used.*

It is not only the building that has to be solid, but the support structure too. Antenna poles and security camera holders are not suitable for the **Trimble FSO** units.

### 3.3 Distance measurement

Because the units were designed, and calibrated for certain distance operations the higher distance will decrease the availability. Trimble FSO pre-calibrates and pre-tests every unit shipped to the customer. To ensure that the unit you are about to buy fits to the needs, the first step is to measure the distance. The best way to measure it is by GPS (Global Positioning System), these units are accurate enough to determine the distance between two points. For more details please refer to the GPS manufacturer handbook. Also there are several other ways to measure the distance. If you know the exact address you can use mapping software like MapPoint or Auto route.



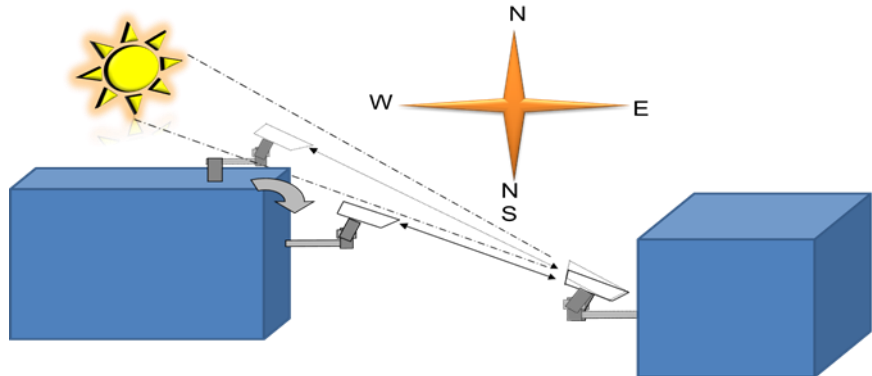
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### 3.4 Direct sunshine

To prevent the sun shining directly into the receiver optics, first one has to determine the orientation of the link. Try to avoid East-West orientation wherever it is possible. Examine both sides of the link at sunset and sunrise and find a position where the sun cannot get behind any of the heads. Be aware that the path of the sun is changing throughout the year.



any of the heads. Be aware that the path of the sun is changing throughout the year.



## 4 Eye safety

There are no two installation spots of the same kind, the buildings or structures, the available space and the accessibility of the place will be different in each case. Nevertheless, as a general rule it is very important to select the installation site so that nobody can look directly into the transmitter. For this reason place the head either so high (on the side wall of the building) or so close to the edge of the building (on a parapet on the rooftop) that no person can approach it accidentally and can get into the beam path. Set up barriers if necessary and put warning signs at prominent places.

The laser heads are provided with all labels and hazard warnings required by the laser standard. There are warning labels on both the left and right side of the protective cover next to the optical window and there is a warning and an informative label on the rear side of the laser head.

