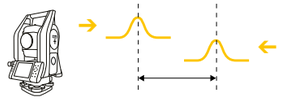
NIKON XF SERIES TOTAL STATIONS

WHITEPAPER

There are two models of Nikon XF Series, the XF and XF HP, which differ mainly in the EDM technology. The Nikon XF model utilizes Time of Flight, whereas the Nikon XF HP utilizes Phase Shift EDM technology. This white paper will detail the technologies and explain the differences between each model and give example applications to help select the best total station model for given applications.

EDM MEASUREMENT PRINCIPLE

Nikon XF

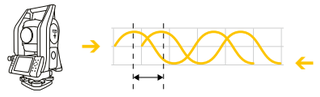


Time of Flight EDM (Electronic Distance Meter)

Principle:
The Time of Flight (TOF) method precisely measures timing information in order to calculate a distance measurement.

Application:
In simple terms, the EDM generates many short infrared or laser light pulses, which are transmitted through the telescope to a target. These pulses reflect off the target and return to the instrument, where electronics determine the round trip time for each light pulse. As the velocity of light through the medium can be accurately estimated, the travel time can be used to compute the distance between the instrument and the target. Typically 20,000 pulsed laser measurements are taken every second, which can be averaged to give accurate distance measurement value.

Nikon XF HP



Phase Shift EDM (Electronic Distance Meter)

Principle:
Measure the phase shift between outgoing and received light for multiple frequencies. The distance is calculated from each phase difference.

Application:
The phase shift method works by modulating a measuring signal onto a continuous carrier wave signal. The method is similar in principle to the way music is modulated onto a carrier wave for radio broadcasts, however for phase shift EDM technology the carrier wave is at light wavelengths. The instrument measures a constant phase offset despite inevitable variations in the emitted and received signal. Only the phase offset is obtained through the phase comparison—initially, a cycle ambiguity prevents the total distance from being directly estimated. This cycle ambiguity is resolved using multiple measurement modulation wavelengths, which provides a unique integer number of cycles. Once the integer number is achieved, the distance to the target can be accurately determined.

LASER CLASS

Nikon XF
Class 1

Nikon XF HP
Prism Measurement: Class 1
Reflectorless: Class 3R

Class 1	Class 1 lasers do not cause direct danger if another surveying instrument is pointed into the source of the Class 1 laser beam. The IEC standard 60825-1 states,"Lasers that are safe under reasonably foreseeable conditions of operation, including the use of optical instruments for intrabeam viewing."
Class 3R	Direct in-beam observation may cause eye damage. The risk of eye damage increases with exposure time, and intentional eye exposure is dangerous. Class 3R visible-light lasers are considered safe for unintentional eye exposure. To deliberately look into or stare into the beam can cause eye damage.

ACCURACY (ISO STANDARD)

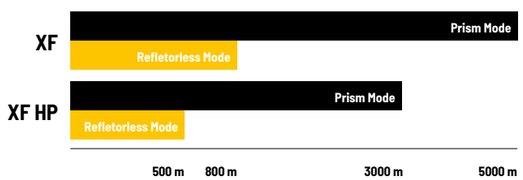
Nikon XF
Prism: 2mm + 2ppm
Reflectorless: 3mm + 2ppm

Nikon XF HP
Prism: 1mm + 1.5ppm
Reflectorless: 2mm + 2ppm

Accuracy by Prism measurement	Nikon XF 2 mm + 2 ppm	Nikon XF HP 1 mm + 1.5 ppm
100 m away	±2.2 mm	±1.15 mm
500 m away	±3 mm	±1.75 mm
1000 m away	±4 mm	±2.5 mm

DISTANCE RANGE

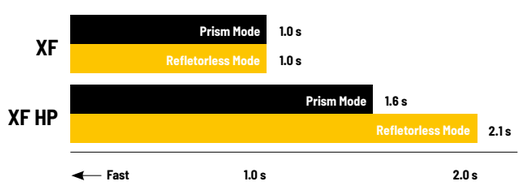
The pulses used for the Nikon XF TOF (Time of flight) method can be many times more powerful than the energy used for the Nikon XF HP phase shift EDM. The Nikon XF can therefore typically measure much longer distances (with or without a prism) than the Nikon XF HP.



MEASUREMENT TIME

The times illustrated below are for standard measurement mode. Faster measurements (with reduced accuracy) can be achieved in tracking measurement mode.

The Nikon XF TOF (Time of flight) method uses light pulses to directly measure distances, while the Nikon XF HP phase shift method uses modulated light to measure a phase shift, which results in different measuring times.



SPOT SIZE

Nikon XF
60 mm diameter @ 30 m

Nikon XF HP
26 mm diameter @ 30 m

The beam of light used for measurement spreads out as it travels from the source.

When measuring edges such as steel frames in reflectorless mode, the spot size affects the measurement accuracy.

Smaller spot sizes are advantageous for usage as in Fig 5.

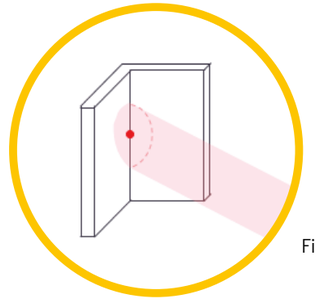


Fig 5

OPERATING TIME

Measuring method	Nikon XF	Nikon XF HP
Continuous angle-only measurement	14 h	19 h
Distance/angle measurement/AF every 30 s	12 h	18 h (no AF)
Continuous distance/angle measurement	7 h	10.5 h

AUTOFOCUS

Nikon XF
Standard on all models

Nikon XF HP
Not available

In the Nikon XF Series, the laser is Class 1. Due to the fast distance measurement speed, it is possible to realize an Autofocus system using distance measurement.

The Autofocus system can improve work efficiency and reduce worker fatigue.

autofocus
powered by Nikon

SUITABLE USER

Road Survey

Boundary

Bridges

Ship Building

Construction

Mining

Landscaping

Steel Work

XF — XF HP

FURTHER NIKON XF HP USE CASES

- There are many instances when the construction supervisor, construction surveyor, or engineering contractor need to check construction progress and ensure the structure is constructed per design.
- As construction progresses, distance measurements are often required to target thin/small targets such as steel frames, reinforcing I-beam steel, etc.
- The target can be located at a high position, and there can be a need to measure many remote points in a short amount of time. In these cases the use of a prism target is not practical, so the instrument is set to non-prism mode and repeated measurements and checks are made.
- The Nikon XF HP is strong in high-accuracy/small spot measurement performance. It specializes in measurements to steel frames, I-beam edges, steel structures, iron bar/frame, and corner measurements.

SPECIFICATIONS

	Nikon XF	Nikon XF HP
Measurement principle	Time of Flight	Phase Shift
Laser class	Class 1	Class 1 / Class 3R
Distance accuracy (ISO Standard)	Prism : ± (2 mm + 2 ppm) Reflectorless : ± (3 mm + 2 ppm)	Prism : ± (1 mm + 1.5 ppm) Reflectorless : ± (2 mm + 2 ppm)
Distance range	Prism : 5000 m Reflectorless : 800 m	Prism : 3000 m Reflectorless : 500 m
Measurement time	Prism : 1.0 s	Prism : 1.6 s
Spot size (at 30 m)	60 mm	26 mm
Angle accuracy	1", 2", 3", 5"	1", 2", 3", 5"
Autofocus	Yes	Not Available
Plummet	Optical / Laser	Optical
Battery Meas. every 30 s	12 h (AF every 30 s)	18 h

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