INSIDE THE

Trimble C5 Series Total Stations

TRANSFORMING THE WAY THE WORLD WORKS

Trimble

Introduction

There are two models of Trimble C Series, the C5 and C5 HP, which differ mainly in the EDM technology. The Trimble C5 model utilizes Time of Flight, whereas the Trimble C5 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.

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EDM Measurement Principle

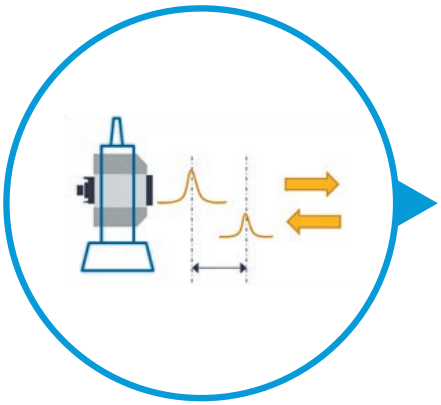


Fig 1

Trimble C5:

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.

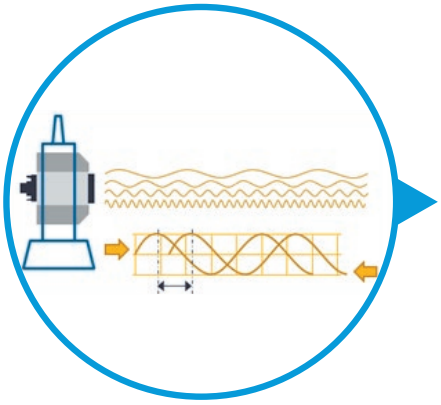


Fig 2

Trimble C5 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

Trimble C5: Class 1
Trimble C5 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)

Trimble C5: Prism: 2mm + 2ppm
Reflectorless: 3mm + 2ppm
Trimble C5 HP: Prism: 1mm + 1.5ppm
Reflectorless: 2mm + 2ppm

Accuracy by Prism measurement	Trimble C5 2 mm + 2 ppm	Trimble C5 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 Trimble C5 TOF (Time of flight) method can be many times more powerful than the energy used for the Trimble C5 HP phase shift EDM.

The Trimble C5 can therefore typically measure much longer distances (with or without a prism) than the Trimble C5 HP.

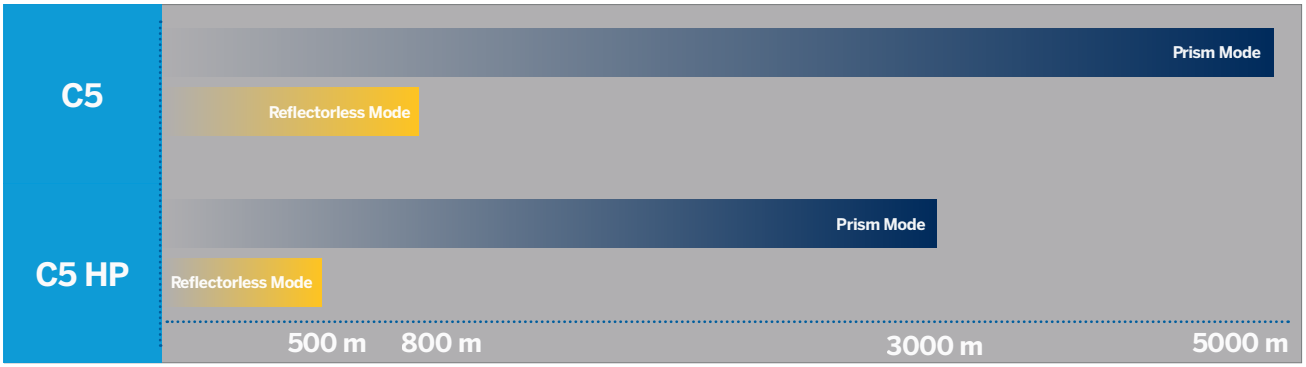


Fig 3

Measurement Time

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

The Trimble C5 TOF (Time of flight) method uses light pulses to directly measure distances, while the Trimble C5 HP phase shift method uses modulated light to measure a phase shift, which results in different measuring times.

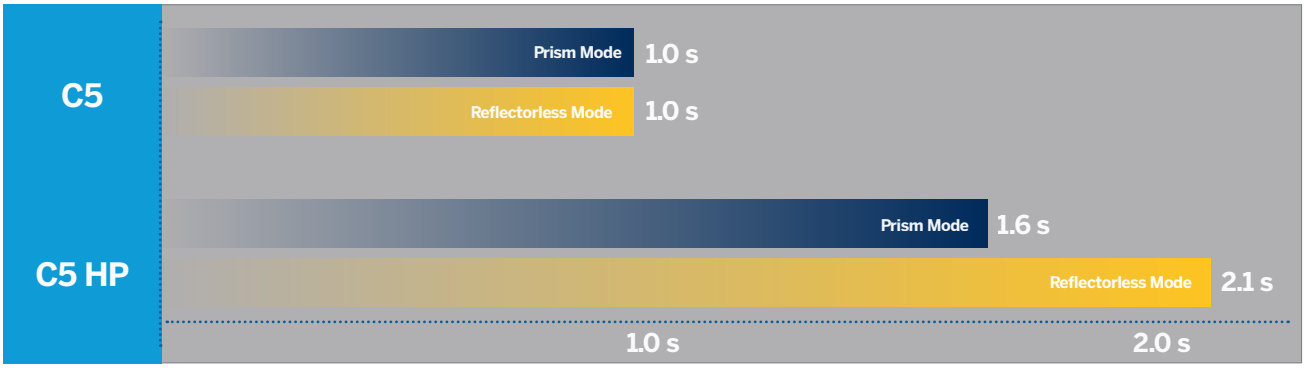


Fig 4

Spot Size

Trimble C5: 58 mm diameter @ 50 m
Trimble C5 HP: 33 mm diameter @ 50 m

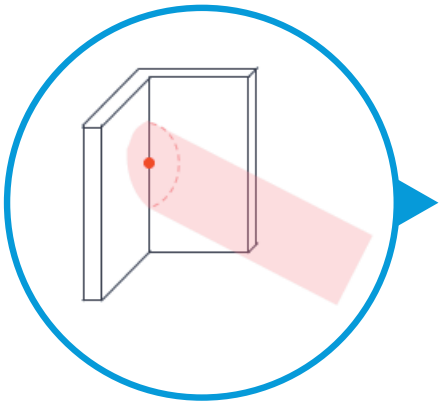


Fig 5

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.

Autofocus

Trimble C5: Standard on all models
Trimble C5 HP: Not available

In the Trimble C5 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.

Operating Time

Measuring method	Trimble C5	Trimble C5 HP
Continuous angle-only measurement	14 h	19 h
Distance/angle measurement/AF every 30 s	12 h	18 h
Continuous distance/angle measurement	7 h	10.5 h

** Battery life specification at 25 °C (77 °F). Operation times may vary depending on the condition and deterioration of the battery.*

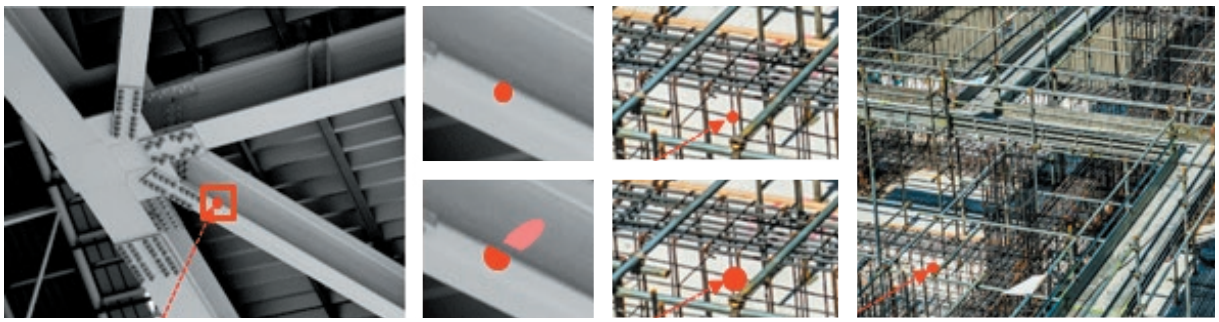
Suitable User

Fig 6

Further C5 HP Use Cases

- There are many instances when the construction supervisor, construction surveyor, or engineering contractor needs 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 Trimble C5 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.




ROAD SURVEY


CONSTRUCTION


MINING


LANDSCAPING


BRIDGES


BOUNDARY


STEEL WORK


VOSS, REPAIR
SHIP BUILDING

Specification

	Trimble C5	Trimble C5 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 50 m)	58 mm	33 mm
Angle accuracy	1", 2", 3", 5"	1", 2", 3", 5"
Autofocus	Yes	Not available
Plummet	Optical / Laser	Optical
Battery Life (meas. every 30s)	12 h	18 h

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