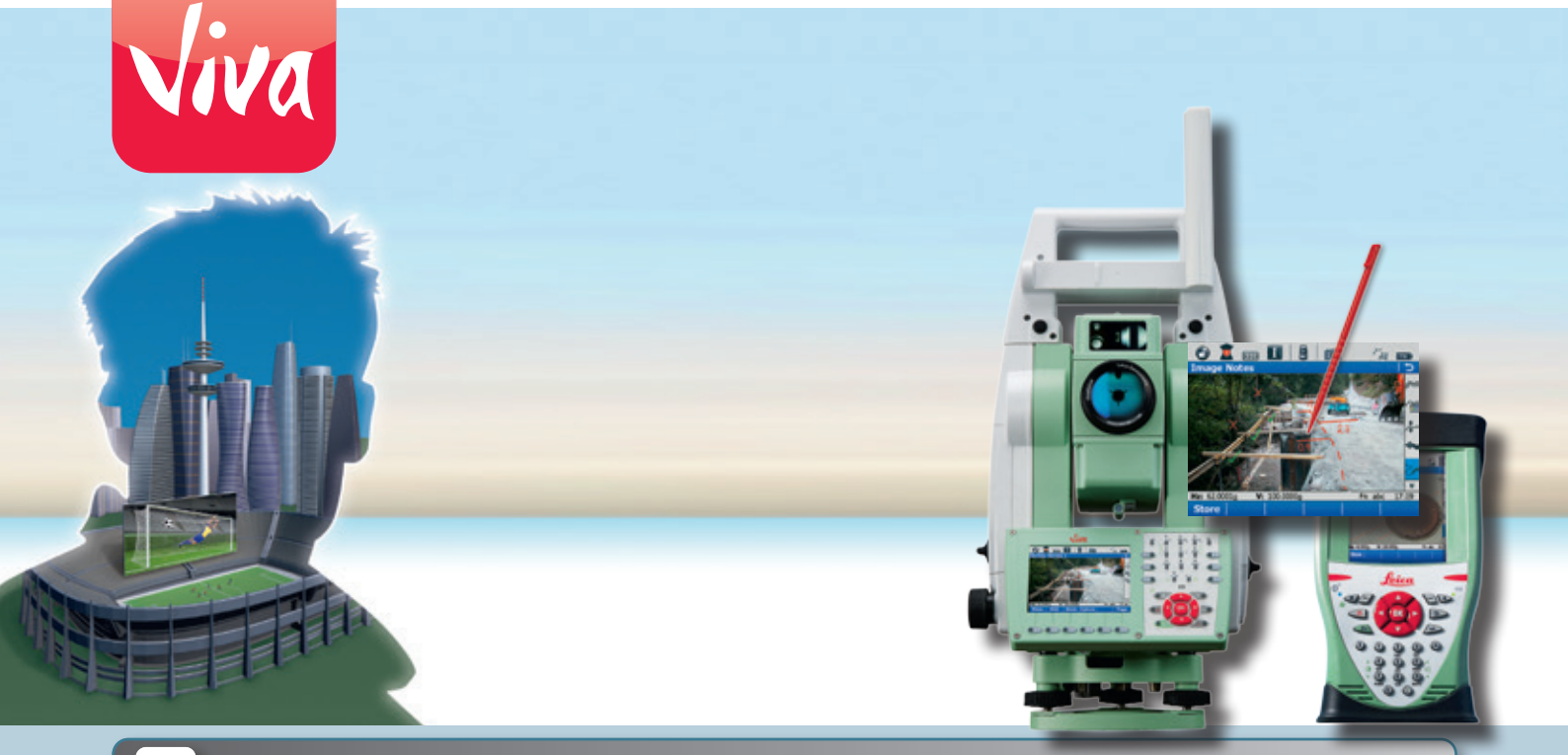
Leica Viva TS15
Datasheet



Best-in-class Imaging

Optimize your productivity with exact photo documentation of site conditions. With live streaming of the total station view, you always know what the total station sees. Measure all points without returning to the total station.

- **Image Notes** – Capture an image, screenshot or template, sketch on it and link it to any object in the database.
- **Image Assisted Surveying** – Simply tap on the display and the total station will turn and measure the desired target.

Best-in-class One-Person-Surveying

Viva TS15 uses years of experience to optimally combine the world's best total station sensors: angles, distances, drives and the patented PowerSearch target recognition camera.

- **Search** – the unique PowerSearch finds your prism within seconds
- **Lock** – Viva TS15 stays locked onto your prism in the most demanding environments
- **Measure** – PinPoint EDM seamlessly harmonizes with precise angle sensors to complete the measurement process

Leica Viva GNSS Add-on

Add full GNSS functionality to your Viva TS15 whenever you want and combine TPS and GNSS in the most efficient way.

- Use SmartStation for TPS setup without the need of control points, traverses and resections
- Use SmartPole to save time with setup 'On-the-fly' and measure parallel with TPS and GNSS for double productivity

- when it has to be **right**

Leica Geosystems

Technical Specifications TS15

Leica Viva TS15	TS15 M	TS15 A	TS15 G	TS15 P	TS15 I
Angle measurement	●	●	●	●	●
Distance measurement to prism	●	●	●	●	●
Distance measurement to any surface (reflectorless)	●	●	●	●	●
Motorized	●	●	●	●	●
Automatic Target Aiming	–	●	●	●	●
PowerSearch (PS)	–	–	–	●	●
Overview Camera	–	–	–	–	●
RS232, USB and SD card interface	●	●	●	●	●
Bluetooth	●	●	●	●	●
Internal Flash Memory (1GB)	●	●	●	●	●
Hotshoe interface for radiohandle	●	●	●	●	●
Guide Light (EGL)	●	●	–	●	●
Laser Guide	–	–	●	–	–
SmartStation/SmartPole GS15 GNSS receiver	o	o	o	o	o
SmartStation/SmartPole GS14 GNSS receiver	o	o	o	o	o
SmartStation/SmartPole GS12 GNSS receiver	o	o	o	o	o
Radio field controller CS10/CS15	o	o	o	o	o
	● = Standard	o = Optional	– = Not available		

Angular Measurement	Accuracy Hz, V[1]	1'' (0.3 mgon), 2'' (0.6 mgon), 3'' (1 mgon), 5'' (1.5 mgon)
	Display resolution	0.1'' (0.1 mgon)
	Method	absolute, continuous, diametrical
	Compensation	Quadruple axis compensation
	Compensator setting accuracy	0.5'' (0.2 mgon), 0.5'' (0.2 mgon), 1.0'' (0.3 mgon), 1.5'' (0.5 mgon)
Distance Measurement	**Distance Measurement (Prism)**	
	Range[2]	
	Round prism (GPR1)	3500 m (12000 ft)
	3 Round prisms (GPR1)	5400 m (17700 ft)
	360° prism (GRZ4, GRZ122)	2000 m (7000 ft)
	360° mini prism (GRZ101)	1000 m (3300 ft)
	Mini prism (GMP101)	2000 m (7000 ft)
	Reflective tape (60 mm x 60 mm)	250 m (800 ft)
	Accuracy[3,4] / Measurement Time	
	Standard	1 mm + 1.5 ppm / typ. 2.4 s
	Fast	2 mm + 1.5 ppm / typ. 0.8 s
	Continuous	3 mm + 1.5 ppm / typ. <0.15 s
	Distance Measurement (Any Surface)	
	Range[6]	
	PinPoint R30 / R400 / R1000	30 m (98 ft) / 400 m (1310 ft) / 1000 m (3280 ft)
	Accuracy[3,7] / Measurement Time	
	PinPoint R30 / R400 / R1000	2 mm + 2 ppm / typ. 3 s
	Distance Measurement (Long-range)	
	Long-range[2,4]	>10000 m (>32800 ft)
	Accuracy[3,6] / Measurement Time	
	Long-range	5 mm + 2 ppm / typ. 2.5 s
	General	
	Display resolution	0.1 mm
	Shortest measurable distance	1.5 m
	Method	System analyzer based on phase shift measurement (coaxial, visible red laser)
	Laser dot size (Non-Prism)	At 30 m: 7 mm x 10 mm, at 50 m: 8 mm x 20 mm
General	**Operating system & Processor**	
	Operating System	Windows CE 6.0
	Processor	Freescale i.MX31 533 MHz ARM Core
	Telescope	
	Magnification	30 x
	Free objective aperture	40 mm
	Field of view	1° 30' (1.66 gon) / 2.7 m at 100 m
	Focusing range	1.7 m to infinity
	Keyboard and Display	
	Display	640 x 480 pixel (VGA) color TFT with LED backlight and touch screen
	Keyboard	36 keys (12 function keys, 12 alphanumeric keys), illumination
	Position	face I standard / face II optional
	Memory, Ports & Communication	
	Internal memory / Memory devices	1 GB (nonvolatile NAND Flash) / SD card, USB stick
	Interfaces	RS232, *Bluetooth®* Wireless-Technology, USB mini AB OTG
	Operation	
	Sensitivity of Circular level	6' / 2 mm
	Centering accuracy of Laser plummet	1.5 mm at 1.5 m
	Number of drives	1 horizontal / 1 vertical
	Power Management	
	Internal Battery	Lithium Ion
	Operating Time	5 – 8 h (GEB221)
	Voltage / Capacity	7.4 V / 4.4 Ah
	Weight and Dimensions	
	Weight of Total Station / Battery GEB221 / Tribrach GDF121	4.9 – 5.5 kg / 0.2 kg / 0.8 kg
	Height / Width / Length	345 mm / 226 mm / 203 mm
	Environmental specifications	
	Working / Storage temperature range	-20° C to +50° C / -40° C to +70° C
	Dust / water (IEC 60529) / Humidity	IP55 / 95%, non-condensing
Guide Light (EGL)	Working Range	5 – 150 m
	Positioning accuracy	5 cm at 100 m

Leica Viva One-Person-Surveying

Motorization	Rotation speed	45° (50 gon) / s	
Automatic Target Aiming (ATR)	**Range**	**ATR Mode**	**Lock Mode**
	Round prism (GPR1)	1000 m (3300 ft)	800 m (2600 ft)
	360° prism (GRZ4, GRZ122)	800 m (2600 ft)	600 m (2000 ft)
	360° mini prism (GRZ101)	350 m (1150 ft)	200 m (660 ft)
	Mini prism (GMP101)	500 m (1600 ft)	400 m (1300 ft)
	Reflective tape (60 mm x 60 mm)	45 m (150 ft)	–
	Shortest distance to 360° prism	1.5 m	5 m
	Accuracy[1] / Measurement Time		
	ATR angle accuracy Hz, V	1" (0.3 mgon)	
	Base positioning accuracy	±1 mm	
	Measurement Time for GPR1	3 – 4 s	
	Maximum speed (Lock Mode)		
	Tangential (standard mode)	5 m / s at 20 m, 25 m / s at 100 m	
	Radial (tracking mode)	4 m / s	
	Searching		
	Search time in field of view	Typ. 1.5 s	
	Field of view	1° 30' (1.66 gon)	
	Definable search windows	Yes	
	Method	Digital Image processing	
Power Search (PS)	**Range**		
	Round prism (GPR1)	300 m (1000 ft)	
	360° reflector[8] (GRZ4, GRZ122)	300 m (1000 ft)	
	Mini prism (GMP101)	100 m (330 ft)	
	Shortest distance	1.5 m	
	Searching		
	Typical search time	5 – 10 s	
	Default search area	Hz: 360° (400 gon), V: 36° (40 gon)	
	Definable search windows	Yes	
	Method	Digital Image processing (rotating laser fan)	

Leica Viva Imaging

Overview Camera	Sensor	5 Mpixel CMOS sensor
	Focal Length	21 mm
	Field of view	15.5° x 11.7° (19.4° diagonal)
	Frame rate	20 frames per second
	Focus	2 m (6.5 feet) to infinity
	Image storage	JPEG up to 5 Mpixel (2560 x 1920)
	Zoom	3-step (1x, 2x, 4x)
	Whitebalance	User configurable
	Brightness	User configurable

Leica Viva SmartStation

Add-on GS15/GS14/GS12	**Position accuracy[9,10]**	Horizontal: 10 mm + 1 ppm, Vertical: 20 mm + 1 ppm	
	RTK Initialization		
	Reliability	>99.99%	
	Time of initialization[11]	GS15/GS14/GS12 4 s, GS08plus 6 s	
	Range	Up to 50 km, assuming reliable data-link is available	
	RTK Data formats for data reception	Leica proprietary formats (Leica, Leica 4G), GPS and GNSS real-time data formats, CMR, CMR+, RTCM v2.1 / 2.2 / 2.3 / 3.x	
	GNSS Antenna		
	Number of channels	GS15/GS14/GS12/GS08plus: 120	
	Dimensions (diameter x height)	GS15: 196 mm x 198 mm GS12: 186 mm x 89 mm	GS14: 190 mm x 90 mm GS08plus: 186 mm x 71 mm
	Weight	GS15: 1.34 kg GS12: 1.05 kg	GS14: 0.93 kg GS08plus: 0.75 kg

[1] Standard deviation ISO 17123-3
[2] Overcast, no haze, visibility about 40 km; no heat shimmer
[3] Standard deviation ISO 17123-4
[4] To Round Prism GPR1
[5] Fast Mode
[6] Object in shade, sky overcast, Kodak Grey Card (90% reflective)
[7] Distance >500 m 4 mm + 2 ppm
[8] Target perfectly aligned to the instrument
[9] Measurement precision, accuracy and reliability are dependent upon various factors including number of satellites, geometry, obstructions, observation time, ephemeris accuracy, ionospheric conditions, multipath etc. Figures quoted assume normal to favorable conditions. Times can also not be quoted exactly. Times required are dependent upon various factors including number of satellites, geometry, ionospheric conditions, multipath etc. The following accuracies, given as root mean square, are based on real-time measurements.
[10] When used within reference station networks the position accuracy is in accordance with the accuracy specifications provided by the reference station network.
[11] Might vary due to atmospheric conditions, signal multipath, obstructions, signal geometry and number of tracked signals.

Whether you want to stake-out an object on a construction site or you need accurate measurements of a tunnel or a bridge; whether you want to determine the area of a parcel of land or need the position of a power pole or to capture objects for as-built maps – you need reliable and precise data.

Leica Viva combines a wide range of innovative products designed to meet the daily challenges for all positioning tasks. The simple yet powerful and versatile Leica Viva hardware and software innovations are redefining state-of-the-art technology to deliver maximum performance and productivity. Leica Viva gives you the inspiration to make your ambitious visions come true.

When it has to be right.

Swiss Technology
by Leica Geosystems

Distance meter (Prism), ATR and PowerSearch:
Laser class 1 in accordance with IEC 60825-1 resp. EN 60825-1

Laser plummet:
Laser class 2 in accordance with IEC 60825-1 resp. EN 60825-1

Distance meter (Non-Prism):
Laser class 3R in accordance with IEC 60825-1 resp. EN 60825-1

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Leica Viva
Overview brochure

Leica Viva GNSS
Product brochure

Leica SmartWorx Viva
Product brochure

Leica Viva LGO
Product brochure

Leica Zeno
Product brochure

Leica Geosystems AG
Heerbrugg, Switzerland

www.leica-geosystems.com

- when it has to be **right**

Leica Geosystems

1 mgon = 0.009 d.g

7 Technical Data

7.1 Angle Measurement

Accuracy

Available angular accuracies	Standard deviation Hz, V, ISO 17123-3	Display resolution			
["]	[mgon]	["]	[°]	[mgon]	[mil]
1	0.3 0.0648"	0.1	0.0001	0.1	0.01
2	0.6 0.1296	1	0.0001	0.1	0.01
3	1.0 0.216"	1	0.0001	0.1	0.01
5	1.5 0.324"	1	0.0001	0.1	0.01

Characteristics Absolute, continuous, diametric.

7.2 Distance Measurement with Reflectors

Range

Reflector	Range A		Range B		Range C	
	[m]	[ft]	[m]	[ft]	[m]	[ft]
Standard prism (GPR1)	1800	6000	3000	10000	3500	12000
Three standard prisms (GPR1)	2300	7500	4500	14700	5400	17700
360° prism (GRZ4, GRZ122)	800	2600	1500	5000	2000	7000
360° Mini prism (GRZ101)	450	1500	800	2600	1000	3300
Mini prism (GMP101)	800	2600	1200	4000	2000	7000
Reflector tape (GZM31) 60 mm x 60 mm	150	500	250	800	250	800
Machine Automation power prism (MPR122) ☞ For Machine Control purposes only!	800	2600	1500	5000	2000	7000

Shortest measuring distance: 1.5 m

Atmospheric conditions

Range A: Strong haze, visibility 5 km; or strong sunlight, severe heat shimmer
Range B: Light haze, visibility about 20 km; or moderate sunlight, slight heat shimmer
Range C: Overcast, no haze, visibility about 40 km; no heat shimmer

☞ Measurements can be made to reflector tapes over the entire range without external ancillary optics.

Accuracy

Accuracy refers to measurements to standard prisms.

EDM measuring mode	std. dev. ISO 17123-4, standard prism	std. dev. ISO 17123-4, tape	Measurement time, typical [s]
Standard	1 mm + 1.5 ppm	3 mm + 2 ppm	2.4
Single (fast)	2 mm + 1.5 ppm	3 mm + 2 ppm	0.8
Continuous	3 mm + 1.5 ppm	3 mm + 2 ppm	< 0.15

Beam interruptions, severe heat shimmer and moving objects within the beam path can result in deviations of the specified accuracy.
The display resolution is 0.1 mm.

Characteristics

Principle:	Phase measurement
Type:	Coaxial, visible red laser
Carrier wave:	658 nm
Measuring system:	System analyser basis 100 MHz - 150 MHz

7.3 Distance Measurement without Reflectors

Range

Type	Kodak Gray Card	Range D		Range E		Range F	
		[m]	[ft]	[m]	[ft]	[m]	[ft]
R400	White side, 90 % reflective	200	660	300	990	>400	>1310
R400	Grey side, 18 % reflective	150	490	200	660	>200	>660
R1000	White side, 90 % reflective	800	2630	1000	3280	>1000	>3280
R1000	Grey side, 18 % reflective	400	1320	500	1640	>500	>1640

☞ R30 is able to achieve a range of 30 m/100 ft under all atmospheric conditions (D, E, F).

Range of Measurement:	1.5 m - 1200 m
Display unambiguous:	up to 1200 m

Atmospheric conditions

D: Object in strong sunlight, severe heat shimmer
E: Object in shade, sky overcast
F: Underground, night and twilight

Accuracy

Standard measuring	std. dev. ISO 17123-4	Measure time, typical [s]	Measure time, maximum [s]
0 m - 500 m	2 mm + 2 ppm	3 - 6	12
>500 m	4 mm + 2 ppm	3 - 6	12

Object in shade, sky overcast. Beam interruptions, severe heat shimmer and moving objects within the beam path can result in deviations of the specified accuracy. The display resolution is 0.1 mm.

Characteristics

Type:	Coaxial, visible red laser
Carrier wave:	658 nm
Measuring system:	System analyser basis 100 MHz - 150 MHz

Laser dot size

Distance [m]	Laser dot size, approximately [mm]
at 30	7 x 10
at 50	8 x 20
at 100	16 x 25

7.4 Distance Measurement - Long Range (LO mode)

Range

The range of the long range measurements is the same for R400 and R1000.

Reflector	Range A		Range B		Range C	
	[m]	[ft]	[m]	[ft]	[m]	[ft]
Standard prism (GPR1)	2200	7300	7500	24600	>10000	>33000

Range of measurement: 1000 m to 12000 m
Display unambiguous: up to 12000 m

Atmospheric conditions

Range A: Strong haze, visibility 5 km; or strong sunlight, severe heat shimmer
Range B: Light haze, visibility about 20 km; or moderate sunlight, slight heat shimmer
Range C: Overcast, no haze, visibility about 40 km; no heat shimmer

Accuracy

Standard measuring	std. dev. ISO 17123-4	Measure time, typical [s]	Measure time, maximum [s]
Long Range	5 mm + 2 ppm	2.5	12

Beam interruptions, severe heat shimmer and moving objects within the beam path can result in deviations of the specified accuracy. The display resolution is 0.1 mm.

Characteristics

Principle: Phase measurement
Type: Coaxial, visible red laser
Carrier wave: 658 nm
Measuring system: System analyser basis 100 MHz - 150 MHz

7.5 Automatic Target Aiming ATR

Range ATR/LOCK

Reflector	Range ATR mode		Range Lock mode	
	[m]	[ft]	[m]	[ft]
Standard prism (GPR1)	1000	3300	800	2600
360° prism (GRZ4, GRZ122)	800	2600	600	2000
360° Mini prism (GRZ101)	350	1150	200	660
Mini prism (GMP101)	500	1600	400	1300
Reflector tape 60 mm x 60 mm	45	150	not qualified	
Machine Automation power prism (MPR122) ☞ For Machine Control purposes only!	600	2000	500	1600
☞ The maximum range can be restricted by poorer conditions, for example rain.				

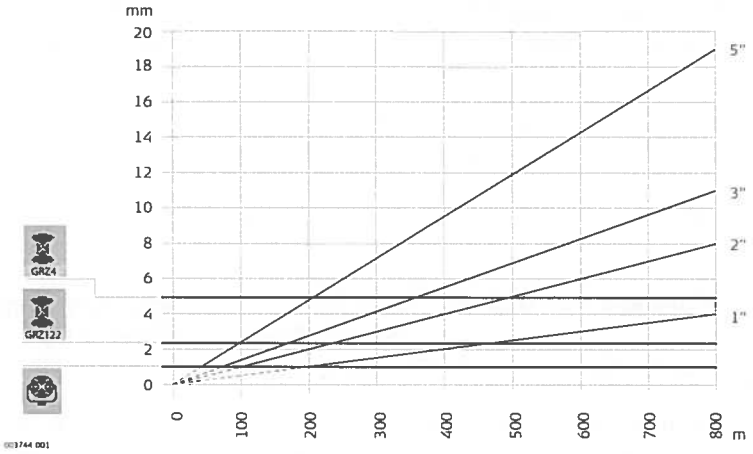
Shortest measuring distance: 360° prism ATR: 1.5 m
Shortest measuring distance: 360° prism LOCK: 5 m

ATR accuracy with the GPR1 prism

ATR angle accuracy Hz, V (std. dev. ISO 17123-3): 1 " (0.3 mgon)
Base Positioning accuracy (std.dev.): ± 1 mm

System accuracy with ATR

- The accuracy with which the position of a prism can be determined with Automatic Target Aiming (ATR) depends on several factors such as internal ATR accuracy, instrument angle accuracy, prism type, selected EDM measuring program and the external measuring conditions. The ATR has a basic standard deviation level of ± 1 mm. Above a certain distance, the instrument angle accuracy predominates and takes over the standard deviation of the ATR.
- The following graph shows the ATR standard deviation based on three different prism types, distances and instrument accuracies.



Leica GRZ4 prism (360°)

Leica GRZ122 prism (360°)

Leica circular prisms and Leica circular Mini prisms

mm ATR accuracy [mm]

m Distance measurement [m]

" Instrument angle accuracy ["]

Maximum speed in lock mode	Maximum tangential speed: Maximum radial speed with **Measure mode: Continuous**	5 m/s at 20 m; 25 m/s at 100 m 5 m/s
Searching	Typical search time in field of view: Field of view: Definable search windows:	1.5 s 1°25'/1.55 gon Yes
Characteristics	Principle: Type:	Digital image processing Infrared laser

7.6 PowerSearch PS

Range

Reflector	Range PS	
	[m]	[ft]
Standard prism (GPR1)	300	1000
360° prism (GRZ4, GRZ122)	300*	1000*
Mini prism (GMP101)	100	330

Reflector	Range PS	
	[m]	[ft]
Machine Automation power prism (MPR122) ☞ For Machine Control purposes only!	300*	1000*

Measurements at the vertical limits of the fan or under unfavourable atmospheric conditions may reduce the maximum range. (*optimally aligned to the instrument)

Shortest measuring distance: 1.5 m

Searching

Typical search time:	< 10 s
Default search area:	Hz: 400 gon, V: 40 gon
Definable search windows:	Yes

Characteristics

Principle:	Digital signal processing
Type:	Infrared laser

7.7 Overview Camera

Overview camera

Sensor:	5 Mpixel CMOS sensor
Focal length:	21 mm
Field of view:	15.5° x 11.7° (19.4° diagonal)
Frame rate:	≤20 frames per second
Focus:	2 m (6.6 ft) to infinity at zoom level 1 x 7.5 m (24.6 ft) to infinity at zoom level 4 x
Image storage:	JPEG up to 5 Mpixel (2560 x 1920)
Zoom:	4-step (1x, 2x, 4x, 8x)
Whitebalance:	Automatic and user configurable
Brightness:	Automatic and user configurable

7.8 SmartStation

7.8.1 SmartStation Accuracy

☞ Measurement precision and accuracy in position and accuracy in height are dependent upon various factors including the number of satellites tracked, constellation geometry, observation time, ephemeris accuracy, ionospheric disturbance, multipath and resolved ambiguities. Figures quoted assume normal to favourable conditions.

Accuracy

Position accuracy:	Horizontal: 5 mm + 0.5 ppm Vertical: 10 mm + 0.5 ppm When used within reference station networks the position accuracy is in accordance with the accuracy specifications provided by the reference station network.

Initialisation

Method:	Leica SmartCheck+ technology
Reliability of initialisation:	Better than 99.99 %
Time of initialisation:	Typically 8 s*
Range:	Up to 50 km*

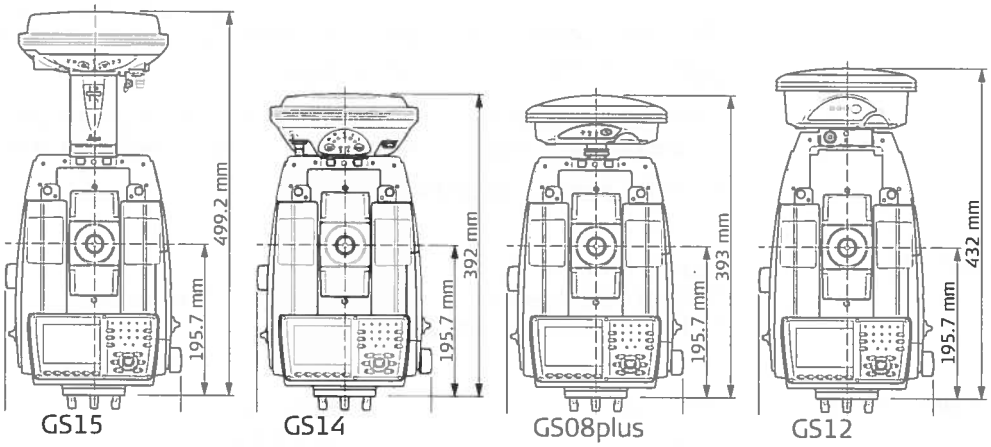
* Might vary due to atmospheric conditions, signal multipath, obstructions, signal geometry and number of tracked signals.

RTK data formats

Formats for data reception:	Leica proprietary GPS and GNSS real-time data formats, CMR, CMR+, RTCM V2.1 / 2.2 / 2.3 / 3.1

7.8.2 SmartStation Dimensions

SmartStation Dimensions



7.8.3 SmartAntenna Technical Data

Description and use

The SmartAntenna is selected for use based upon the application. The table gives a description and the intended use of the SmartAntenna.

Type	Description	Use
GS08plus	L1, L2 GPS, GLONASS SmartTrack+ antenna.	With CS10 field controller or Leica Viva TPS instruments.
GS12	L1, L2, L5 GPS, GLONASS, Galileo SmartTrack+ antenna.	With CS10/CS15 field controller or Leica Viva TPS instruments.
GS14	GPS, GLONASS, Galileo, BeiDou SmartTrack+ antenna with built in groundplane.	With CS10/CS15 field controller or Leica Viva TPS instruments.
GS15	GPS, GLONASS, Galileo, BeiDou SmartTrack+ antenna with built in groundplane.	With CS10/CS15 field controller or Leica Viva TPS instruments.

Dimensions

Type	Height [m]	Diameter [m]
GS08plus	0.071	0.186
GS12	0.089	0.186
GS14	0.090	0.190
GS15	0.198	0.196

Mounting

5/8" Whitworth

Weight

Instrument weights without battery and radio:

Type	Weight [kg]/[lbs]
GS08plus	0.70/1.54
GS12	0.94/2.07
GS14	0.93/2.04
GS15	1.34/2.95

Power

Power consumption:	• GS08plus: 2.0 W typically • GS12: 1.8 W typically • GS14, radio excluded: 2.0 W typically, 166 mA with external battery, 270 mA with internal battery • GS15, radio excluded: 3.2 W typically
External supply voltage:	Nominal 12 V DC (⎓, GEV71 car battery cable to a 12 V car battery), voltage range 10.5 V-28 V DC

Battery internal

Type:	Li-Ion
Voltage:	7.4 V
Capacity:	GEB211: 2.2 Ah / GEB212: 2.6 Ah
Typical operating time:	GEB211: 5.7 h / GEB212: 6.5 h

Electrical data

Type	GS08plus	GS12	GS14	GS15
Frequency				
GPS L1 1575.42 MHz	✓	✓	✓	✓
GPS L2 1227.60 MHz	✓	✓	✓	✓
GPS L5 1176.45 MHz	-	✓	-	✓
GLONASS L1 1602.5625-1611.5 MHz	✓	✓	✓	✓
GLONASS L2 1246.4375-1254.3 MHz	✓	✓	✓	✓
Galileo E1 1575.42 MHz	-	✓	-	✓
Galileo E5a 1176.45 MHz	-	✓	-	✓
Galileo E5b 1207.14 MHz	-	✓	-	✓
Galileo Alt-BOC 1191.795 MHz	-	✓	-	✓
Gain	37 dBi	Typically 27 dBi	27 dBi	Typically 27 dBi
Noise Figure	< 3 dBi	Typically < 2 dBi	< 2 dBi	Typically < 2 dBi

☞ Galileo Alt-BOC covers bandwidth of Galileo E5a and E5b.

Environmental specifications

Temperature

Operating temperature [°C]	Storage temperature [°C]
-40 to +65 Bluetooth: -30 to +65	-40 to +80

Protection against water, dust and sand

Protection	
GS08plus/GS12/GS15	**GS14**
IP67 (IEC 60529)	IP68 (IEC 60529)
Dusttight	Dusttight
Protected against water jets	Protected against continuous immersion in water
Waterproof to 1 m temporary immersion	Tested for 2 hours in 1.40 m depth

Humidity

Protection
Up to 100 %

Protection
The effects of condensation are to be effectively counteracted by periodically drying out the antenna.

7.9 Laser Guide Technical Data

Concept

- Telescope for dual face measurement
- User adjustment for laser beam

Laser

Type:	Visible, red, laser class 3R
Carrier wave:	657 nm

Optics

Line of sight offset:	52.20 mm
Focussing distance:	22.76 mm
Beam angle:	0.09 mrad

Power

Power supply:	From instrument
Power consumption:	ca. 0.2 W

Environmental specifications

Temperature

Operating temperature [°C]	Storage temperature [°C]
-20 to +50	-40 to +70

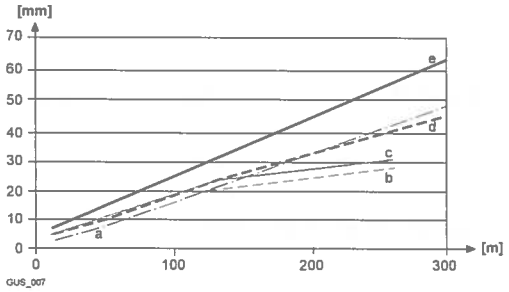
Range

Daylight:	250 m
Darkness:	500 m

Beam diameter

The laser beam diameter is influenced by the intensity of the laser guide, by the application distance, by the characteristics of the surface and by the ambient light.

Typical laser beam diameter on white, smooth surfaces with intensity 50% and 100%



a) Theoretical $1/e^2$
b) Daylight, intensity 50%
c) Daylight, intensity 100%
d) Darkness, intensity 50%
e) Darkness, intensity 100%

7.10 Conformity to National Regulations

7.10.1 TS15

Conformity to national regulations

- FCC Part 15 (applicable in US)
- Hereby, Leica Geosystems AG, declares that the product TS15 is in compliance with the essential requirements and other relevant provisions of Directive 1999/5/EC and other applicable European Directives. The declaration of conformity may be consulted at http://www.leica-geosystems.com/ce.

CE Class 1 equipment according European Directive 1999/5/EC (R&TTE) can be placed on the market and be put into service without restrictions in any EU Member state.

- The conformity for countries with other national regulations not covered by the FCC part 15 or European directive 1999/5/EC has to be approved prior to use and operation.

Frequency band	2402 - 2480 MHz	
Output power	Bluetooth:	5 mW
Antenna	Type: Gain:	Internal Microstrip antenna 1.5 dBi

7.10.2 RadioHandle

Conformity to national regulations

- FCC Part 15 (applicable in US)
- Hereby, Leica Geosystems AG, declares that the RadioHandle is in compliance with the essential requirements and other relevant provisions of Directive 1999/5/EC and other applicable European Directives. The declaration of conformity may be consulted at http://www.leica-geosystems.com/ce.

CE Class 1 equipment according European Directive 1999/5/EC (R&TTE) can be placed on the market and be put into service without restrictions in any EEA Member state.

- The conformity for countries with other national regulations not covered by the FCC part 15 or European directive 1999/5/EC has to be approved prior to use and operation.

Frequency band	RH15 RH16	Limited to 2402 - 2452 MHz Limited to 2402 - 2480 MHz
Output power	< 100 mW (e. i. r. p.)	
Antenna	Type: Gain: Connector:	λ/2 dipole antenna 2 dBi Special customized SMB

7.10.3 GS08plus

Conformity to national regulations

- FCC Part 15, 22 and 24 (applicable in US)
- Hereby, Leica Geosystems AG, declares that the product GS08plus is in compliance with the essential requirements and other relevant provisions of Directive 1999/5/EC and other applicable European Directives. The declaration of conformity can be consulted at http://www.leica-geosystems.com/ce.

CE Class 1 equipment according European Directive 1999/5/EC (R&TTE) can be placed on the market and be put into service without restrictions in any EEA member state.

- The conformity for countries with other national regulations not covered by the FCC part 15, 22 and 24 or European directive 1999/5/EC has to be approved prior to use and operation.

Frequency band

Type	Frequency band [MHz]
GS08plus	1227.60 1575.42 1246.4375 - 1254.3 1602.4375 - 1611.5
Bluetooth	2402 - 2480

Output power

Type	Output power [mW]
GNSS	Receive only
Bluetooth	5 (Class 1)

Antenna

GNSS
Bluetooth

Internal GNSS antenna element (receive only)
Type: Internal Microstrip antenna
Gain: 1.0 dBi

7.10.4 GS12

Conformity to national regulations

- FCC Part 15, 22 and 24 (applicable in US)
- Hereby, Leica Geosystems AG, declares that the product GS12 is in compliance with the essential requirements and other relevant provisions of Directive 1999/5/EC. The declaration of conformity can be consulted at http://www.leica-geosystems.com/ce.

CE Class 1 equipment according European Directive 1999/5/EC (R&TTE) can be placed on the market and be put into service without restrictions in any EEA member state.

- The conformity for countries with other national regulations not covered by the FCC part 15, 22 and 24 or European directive 1999/5/EC has to be approved prior to use and operation.

Frequency band

Type	Frequency band [MHz]
GS12	1176.45 1191.795 1207.14 1227.60 1246.4375 - 1254.3 1575.42 1602.4375 - 1611.5
Bluetooth	2402 - 2480

Output power

Type	Output power [mW]
GNSS	Receive only
Bluetooth	5 (Class 1)

Antenna

GNSS
Bluetooth

Internal GNSS antenna element (receive only)
Type: Internal Microstrip antenna
Gain: 1.5 dBi

Conformity to national regulations

- FCC Part 15 (applicable in US)
- Hereby, Leica Geosystems AG, declares that the product GS14 is in compliance with the essential requirements and other relevant provisions of Directive 1999/5/EC and other applicable European Directives. The declaration of conformity can be consulted at http://www.leica-geosystems.com/ce.
- This Class 2 equipment may be operated in: AT, BE, CY, CZ, DK, EE, FI, FR, DE, GR, HU, IE, IT, LV, LT, LU, MT, NL, PL, PT, SK, SI, ES, SE, GB, IS, LI, NO, CH, BG, RO and TR.

Class 2 equipment according European Directive 1999/5/EC (R&TTE) for which following EEA Member States apply restrictions on the placing on the market or on the putting into service or require authorisation for use:
  - France
  - Italy
  - Norway (if used in the geographical area within a radius of 20km from the centre of Ny-Ålesund)
- The conformity for countries with other national regulations not covered by the FCC part 15 or European directive 1999/5/EC has to be approved prior to use and operation.
- Japanese Radio Law and Japanese Telecommunications Business Law Compliance (applicable for Japan).
  - This device is granted pursuant to the Japanese Radio Law and the Japanese Telecommunications Business Law.
  - This device should not be modified (otherwise the granted designation number will become invalid).

Frequency band

Type	Frequency band [MHz]
GS14	1227.60 1246.4375 - 1254.3 1575.42 1602.5625 - 1611.5
GS14, Bluetooth	2402 - 2480
GS14, Radio	403 - 473
GS14, 2G GSM	Quad-Band EGSM 850 / 900 / 1800 / 1900 GPRS multi-slot class 10

Output power

Type	Output power [mW]
GNSS	Receive only
Bluetooth	5
Radio	Receive only
2G GSM EGSM850/900	2000
2G GSM GSM1800/1900	1000

Antenna

Type	Antenna	Gain [dBi]
GNSS	Internal GNSS antenna element (receive only)	-
Bluetooth	Internal Microstrip antenna	2 max.
UHF	External antenna	-
2G GSM	Integrated antenna	1 max. @ 850 / 900 (preliminary) 4 max. @ 1800 / 1900 (preliminary)

7.10.6 GS15

Conformity to national regulations

- FCC Part 15, 22 and 24 (applicable in US)
- Hereby, Leica Geosystems AG, declares that the product GS15 is in compliance with the essential requirements and other relevant provisions of Directive 1999/5/EC. The declaration of conformity can be consulted at http://www.leica-geosystems.com/ce.

CE Class 1 equipment according European Directive 1999/5/EC (R&TTE) can be placed on the market and be put into service without restrictions in any EEA member state.

- The conformity for countries with other national regulations not covered by the FCC part 15, 22 and 24 or European directive 1999/5/EC has to be approved prior to use and operation.
- Japanese Radio Law and Japanese Telecommunications Business Law Compliance (applicable for Japan).
  - This device is granted pursuant to the Japanese Radio Law and the Japanese Telecommunications Business Law.
  - This device should not be modified (otherwise the granted designation number will become invalid).

Frequency band

Type	Frequency band [MHz]
GS15	1176.45 1191.795 1207.14 1227.60 1246.4375 - 1254.3 1575.42 1602.4375 - 1611.5
Bluetooth	2402 - 2480

Output power

Type	Output power [mW]
GNSS	Receive only
Bluetooth	5 (Class 1)

Antenna

Type	Antenna	Gain [dBi]	Connector	Frequency band [MHz]
GNSS	Internal GNSS antenna element (receive only)	-	-	-
Bluetooth	Internal Microstrip antenna	1.5	-	-

7.10.7 SLR1, SLR2, SATEL SATELLINE-3AS

Conformity to national regulations

- FCC Part 15 (applicable in US)
- Hereby, Leica Geosystems AG, declares that the product SLR1, SLR2 is in compliance with the essential requirements and other relevant provisions of Directive 1999/5/EC and other applicable European Directives. The declaration of conformity can be consulted at http://www.leica-geosystems.com/ce.
- This Class 2 equipment may be operated in: AT, BE, CY, CZ, DK, EE, FI, FR, DE, GR, HU, IE, IT, LV, LT, LU, MT, NL, PL, PT, SK, SI, ES, SE, GB, IS, LI, NO, CH, BG, RO and TR.

Class 2 equipment according European Directive 1999/5/EC (R&TTE) for which following EEA Member States apply restrictions on the placing on the market or on the putting into service or require authorisation for use:

- France
- Italy
- Norway (if used in the geographical area within a radius of 20km from the centre of Ny-Ålesund)

- The conformity for countries with other national regulations not covered by the FCC part 15 or European directive 1999/5/EC has to be approved prior to use and operation.

Frequency band

403 MHz - 470 MHz

Output power

SLR1: 0.5 W-1.0 W
SLR2: Receive only

Antenna

Type	Internal	GAT1	GAT2
Frequency band [MHz]	400 - 470	400 - 435	435 - 470
Type	Internal	Detachable λ/2 antenna	Detachable λ/2 antenna
Connector	-	TNC	TNC

Specific Absorption Rate (SAR)

The product meets the limits for the maximum permissible exposure of the guide-lines and standards which are force in this respect. The product must be used with the recommended antenna. A separation distance of at least 20 centimetres should be kept between the antenna and the body of the user or nearby person within the intended application.

7.10.8 SLR5, SATEL SATELLINE M3-TR1

Conformity to national regulations

- FCC Part 15 (applicable in US)
- Hereby, Leica Geosystems AG, declares that the product SLR5 is in compliance with the essential requirements and other relevant provisions of Directive 1999/5/EC and other applicable European Directives. The declaration of conformity can be consulted at http://www.leica-geosystems.com/ce.
- This Class 2 equipment may be operated in: AT, BE, CY, CZ, DK, EE, FI, FR, DE, GR, HU, IE, IT, LV, LT, LU, MT, NL, PL, PT, SK, SI, ES, SE, GB, IS, LI, NO, CH, BG, RO and TR.

Class 2 equipment according European Directive 1999/5/EC (R&TTE) for which following EEA Member States apply restrictions on the placing on the market or on the putting into service or require authorisation for use:

- France
- Italy
- Norway (if used in the geographical area within a radius of 20km from the centre of Ny-Ålesund)

- The conformity for countries with other national regulations not covered by the FCC part 15 or European directive 1999/5/EC has to be approved prior to use and operation.

Frequency band

403 MHz - 470 MHz

Output power

SLR5: 0.5 W-1.0 W

Antenna

Type	Internal	GAT1	GAT2
Frequency band [MHz]	400 - 470	400 - 435	435 - 470
Type	Internal	Detachable λ/2 antenna	Detachable λ/2 antenna
Connector	-	TNC	TNC

Specific Absorption Rate (SAR)

The product meets the limits for the maximum permissible exposure of the guide-lines and standards which are force in this respect. The product must be used with the recommended antenna. A separation distance of at least 20 centimetres should be kept between the antenna and the body of the user or nearby person within the intended application.

7.10.9 SLR3-1, SLR3-2, Pacific Crest ADL

Conformity to national regulations

- FCC Part 15 (applicable in US)
- Hereby, Leica Geosystems AG, declares that the product SLR3-1, SLR3-2 is in compliance with the essential requirements and other relevant provisions of Directive 1999/5/EC and other applicable European Directives. The declaration of conformity can be consulted at http://www.leica-geosystems.com/ce.
- This Class 2 equipment may be operated in: AT, BE, CY, CZ, DK, EE, FI, FR, DE, GR, HU, IE, IT, LV, LT, LU, MT, NL, PL, PT, SK, SI, ES, SE, GB, IS, LI, NO, CH, BG, RO and TR.

Class 2 equipment according European Directive 1999/5/EC (R&TTE) for which following EEA Member States apply restrictions on the placing on the market or on the putting into service or require authorisation for use:
  - France
  - Italy
  - Norway (if used in the geographical area within a radius of 20km from the centre of Ny-Ålesund)
- The conformity for countries with other national regulations not covered by the FCC part 15 or European directive 1999/5/EC has to be approved prior to use and operation.

Frequency band

SLR3-1: 390 MHz - 430 MHz
SLR3-2: 430 MHz - 470 MHz

Output power

SLR3-1: 0.5 W-1 W
SLR3-2: 0.5 W-1 W

Antenna

Type	Internal	GAT1	GAT2
Frequency band [MHz]	400 - 470	400 - 435	435 - 470
Type	Internal	Detachable λ/2 antenna	Detachable λ/2 antenna
Connector	-	TNC	TNC

Specific Absorption Rate (SAR)

The product meets the limits for the maximum permissible exposure of the guide-lines and standards which are force in this respect. The product must be used with the recommended antenna. A separation distance of at least 20 centimetres should be kept between the antenna and the body of the user or nearby person within the intended application.

7.10.10 SLG1, Telit UC864-G

Conformity to national regulations

- FCC Part 15, 22 and 24 (applicable in US)
- Hereby, Leica Geosystems AG, declares that the SLG1 is in compliance with the essential requirements and other relevant provisions of Directive 1999/5/EC and other applicable European Directives. The declaration of conformity may be consulted at http://www.leica-geosystems.com/ce.

CE Class 1 equipment according European Directive 1999/5/EC (R&TTE) can be placed on the market and be put into service without restrictions in any EEA Member state.

- The conformity for countries with other national regulations not covered by the FCC part 15, 22 and 24 or European directive 1999/5/EC has to be approved prior to use and operation.

Frequency band

UMTS/HSDPA (WCDMA/FDD) 850 MHz/ 1900 MHz/ 2100 MHz
Quad-Band EGSM 850 MHz/ 900 MHz/ 1800 MHz/ 1900 MHz
GPRS multi-slot class 12
EDGE multi-slot class 12

Output power

EGSM850/900:	2 W
GSM1800/1900:	1 W
UMTS2100:	0.25 W
EDGE850/900:	0.5 W
EDGE1800/1900:	0.4 W

Antenna

Type	GS15 Internal	GAT3	GAT5	GAT18
Frequency band [MHz]	824 - 894 / 890 - 960 / 1710 - 1880 / 1850 - 1990 / 1920 - 2170	890 - 960 / 1710 - 1880 / 1920 - 2170	824 - 894 / 1850 - 1990	824 - 894 / 890 - 960 / 1710 - 1880 / 1850 - 1990 / 1920 - 2170
Type	Internal	Detachable λ/2 antenna	Detachable λ/2 antenna	Detachable λ/2 antenna
Connector	-	TNC	TNC	TNC

Specific Absorption Rate (SAR)

The product meets the limits for the maximum permissible exposure of the guide-lines and standards which are force in this respect. The product must be used with the recommended antenna. A separation distance of at least 20 centimetres should be kept between the antenna and the body of the user or nearby person within the intended application.

7.10.11 SLG2, CINTERION MC75i

Conformity to national regulations

- FCC Part 15, 22 and 24 (applicable in US)
- Hereby, Leica Geosystems AG, declares that the SLG2 is in compliance with the essential requirements and other relevant provisions of Directive 1999/5/EC and other applicable European Directives. The declaration of conformity may be consulted at http://www.leica-geosystems.com/ce.

CE Class 1 equipment according European Directive 1999/5/EC (R&TTE) can be placed on the market and be put into service without restrictions in any EEA Member state.

- The conformity for countries with other national regulations not covered by the FCC part 15, 22 and 24 or European directive 1999/5/EC has to be approved prior to use and operation.

Frequency band

Quad-Band EGSM850 MHz/ EGSM900 MHz/ GSM1800 MHz/ GSM1900 MHz

Output power

EGSM850/900: 2 W
GSM1800/1900: 1 W

Antenna

Type	GS15 Internal	GAT3	GAT5	GAT18
Frequency band [MHz]	824 - 894 / 890 - 960 / 1710 - 1880 / 1850 - 1990 / 1920 - 2170	890 - 960 / 1710 - 1880 / 1920 - 2170	824 - 894 / 1850 - 1990	824 - 894 / 890 - 960 / 1710 - 1880 / 1850 - 1990 / 1920 - 2170
Type	Internal	Detachable λ/2 antenna	Detachable λ/2 antenna	Detachable λ/2 antenna
Connector	-	TNC	TNC	TNC

Specific Absorption Rate (SAR)

The product meets the limits for the maximum permissible exposure of the guide-lines and standards which are force in this respect. The product must be used with the recommended antenna. A separation distance of at least 20 centimetres should be kept between the antenna and the body of the user or nearby person within the intended application.

7.10.12 SLC1 (US), SLC2 (US) CDMA Telit CC864-DUAL

Conformity to national regulations

- FCC Part 15, 22 and 24 (applicable in US)
- The conformity for countries with other national regulations not covered by the FCC part 15, 22 and 24 has to be approved prior to use and operation.

Frequency band

Dual-Band CDMA800 MHz/CDMA1900 MHz

Output power

CDMA800: 0.27 W
CDMA1900: 0.4 W

Antenna

Type	Internal	GAT5	GAT18
Frequency band [MHz]	824 - 894 / 890 - 960 / 1710 - 1880 / 1850 - 1990 / 1920 - 2170	824 - 894 / 1850 - 1990	824 - 894 / 890 - 960 / 1710 - 1880 / 1850 - 1990 / 1920 - 2170
Type	Internal	Detachable λ/2 antenna	Detachable λ/2 antenna
Connector	-	TNC	TNC

Specific Absorption Rate (SAR)

The product meets the limits for the maximum permissible exposure of the guide-lines and standards which are force in this respect. The product must be used with the recommended antenna. A separation distance of at least 20 centimetres should be kept between the antenna and the body of the user or nearby person within the intended application.

Telescope

Magnification:	30 x
Free Objective aperture:	40 mm
Focusing:	1.7 m/5.6 ft to infinity
Field of view:	1°30'/1.66 gon. 2.7 m at 100 m

Compensator

Angular accuracy instrument ["]	Setting accuracy		Setting range	
	["]	[mgon]	[']	[gon]
1	0.5	0.2	4	0.07
2	0.5	0.2	4	0.07
3	1.0	0.3	4	0.07
5	1.5	0.5	4	0.07

Level

Circular level sensitivity:	6'/2 mm
Electronic level resolution:	2"

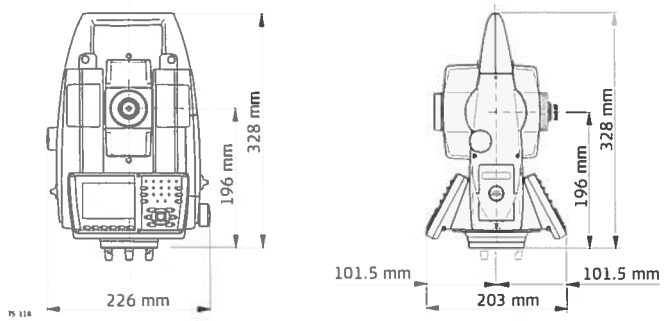
Control unit

Display:	VGA (640 x 480 pixels), color TFT, LED backlight, touch screen
Keyboard:	36 keys including 12 function keys and 12 alphanumeric keys, illumination
Angle Display:	360°'", 360° decimal, 400 gon, 6400 mil, V %
Distance Display:	m, ft int, ft us, ft int inch, ft us inch
Position:	In both faces, face two is optional
Touch screen:	Toughened film on glass

Instrument Ports

Port	Name	Description
Port 1	Port 1	• 5 pin LEMO-0 for power, communication, data transfer. • This port is located at the base of the instrument.
Port 2	Handle	• Hotshoe connection for RadioHandle and SmartAntenna Adapter with SmartStation. • This port is located on top of Communication side cover.
Port 3	BT	• Bluetooth module for communication. • This port is housed within Communication side cover.
USB	USB host port	• USB memory stick port for data transfer.
	USB device port	• Cable connections from USB devices for communication and data transfer.

Instrument Dimensions



Weight

Instrument:	4.8 - 5.5 kg
Tribrach:	0.8 kg
Internal battery:	0.2 kg

Recording

Data can be recorded onto an SD card or into internal memory.

Type	Capacity [MB]	Number of measurements per MB
SD card	• 1024 • 8192	1750
Internal memory	• 1000	1750

Laser plummet

Type:	Visible red laser class 2
Location:	In standing axis of instrument
Accuracy:	Deviation from plumb line: 1.5 mm (2 sigma) at 1.5 m instrument height
Diameter of laser point:	2.5 mm at 1.5 m instrument height

Drives

Type:	Endless horizontal and vertical drives

Motorisation

Maximum rotating speed:	50 gon/s

Power

External supply voltage:	Nominal voltage 12.8 V DC, Range 11.5 V-13.5 V

Internal battery

Type:	Li-Ion
Voltage:	7.4 V
Capacity:	GEB221: 4.4 Ah GEB222: 6.0 Ah

External battery

Type:	NiMH
Voltage:	12 V
Capacity:	GEB171: 9.0 Ah

Environmental specifications

Temperature

Type	Operating temperature [°C]	Storage temperature [°C]
All instruments	-20 to +50	-40 to +70
Leica SD cards	-40 to +80	-40 to +80
Battery internal	-20 to +55	-40 to +70
Bluetooth	-30 to +60	-40 to +80

Protection against water, dust and sand

Type	Protection
All instruments	IP55 (IEC 60529)

Humidity

Type	Protection
All instruments	Max 95 % non condensing The effects of condensation are to be effectively counteracted by periodically drying out the instrument.

Reflectors

Type	Additive Constant [mm]	ATR	PS
Standard prism, GPR1	0.0	yes	yes
Mini prism, GMP101	+17.5	yes	yes

Type	Additive Constant [mm]	ATR	PS
360° prism, GRZ4 / GRZ122	+23.1	yes	yes
360° Mini prism, GRZ101	+30.0	yes	not recommended
Reflector tape S, M, L	+34.4	yes	no
Reflectorless	+34.4	no	no
Machine Automation power prism, MPR122 ☞ For Machine Control purposes only!	+28.1	yes	yes

There are no special prisms required for ATR or for PS.

Electronic Guide Light EGL

Working range: 5 m to 150 m (15 ft to 500 ft)
Position accuracy: 5 cm at 100 m (1.97" at 330 ft)

Automatic corrections

The following automatic corrections are made:

- Line of sight error
- Tilting axis error
- Earth curvature
- Circle eccentricity
- Compensator index error
- Vertical index error
- Standing axis tilt
- Refraction
- ATR zero point error

7.12 Scale Correction

Use of scale correction

By entering a scale correction, reductions proportional to distance can be taken into account.

- Atmospheric correction.
- Reduction to mean sea level.
- Projection distortion.

Atmospheric correction ΔD1

The slope distance displayed is correct if the scale correction in ppm, mm/km, which has been entered corresponds to the atmospheric conditions prevailing at the time of the measurement.
The atmospheric correction includes:

- Adjustments for air pressure
- Air temperature
- Relative humidity

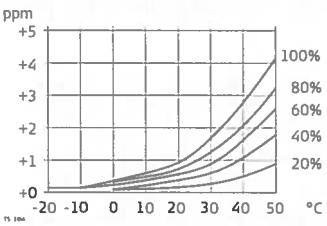
For highest precision distance measurements, the atmospheric correction should be determined with an accuracy of 1 ppm. The following parameters must be redetermined:

- Air temperature to 1 °C
- Air pressure to 3 mbar
- Relative humidity to 20 %

Air humidity

The air humidity influences the distance measurement if the climate is extremely hot and damp.
For high precision measurements, the relative humidity must be measured and entered along with the air pressure and the temperature.

Air humidity correction



ppmAir humidity correction [mm/km]
% Relative humidity [%]
C° Air temperature [°C]

Index n

Type	Index n	carrier wave [nm]
combined EDM	1.0002863	658

The index n is calculated from the formula of Barrel and Sears, and is valid for:

Air pressure p: 1013.25 mbar
Air temperature t: 12 °C
Relative air humidity h: 60 %

Formulas

Formula for visible red laser

$$\Delta D_1 = 286.34 - \left[\frac{0.29525 \cdot p}{(1 + \alpha \cdot t)} - \frac{4.126 \cdot 10^{-4} \cdot h}{(1 + \alpha \cdot t)} \cdot 10^{x}\right]$$

ΔD_1 Atmospheric correction [ppm]
p Air pressure [mbar]
t Air temperature [°C]
h Relative humidity [%]
α $\frac{1}{273.15}$
x (7.5 * t/(237.3 + t)) + 0.7857

If the basic value of 60 % relative humidity as used by the EDM is retained, the maximum possible error in the calculated atmospheric correction is 2 ppm, 2 mm/km.

Reduction to mean sea level ΔD_2

The values for ΔD_2 are always negative and are derived from the following formula:

$$\Delta D_2 = -\frac{H}{R} \cdot 10^6$$

ΔD_2 Reduction to mean sea level [ppm]
H Height of EDM above sea level [m]
R 6.378 * 10^6 m

Projection distortion ΔD_3

The magnitude of the projection distortion is in accordance with the projection system used in a particular country, for which official tables are generally available. The following formula is valid for cylindrical projections such as that of Gauss-Krüger:

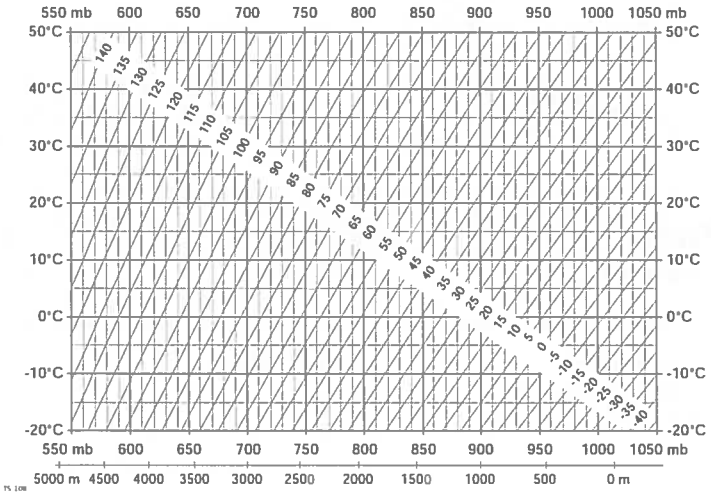
$$\Delta D_3 = \frac{X^2}{2R^2} \cdot 10^6$$

ΔD_3 Projection distortion [ppm]
X Easting, distance from projection zero line with the scale factor 1 [km]
R 6.378 * 10^6 m

In countries where the scale factor is not unity, this formula cannot be directly applied.

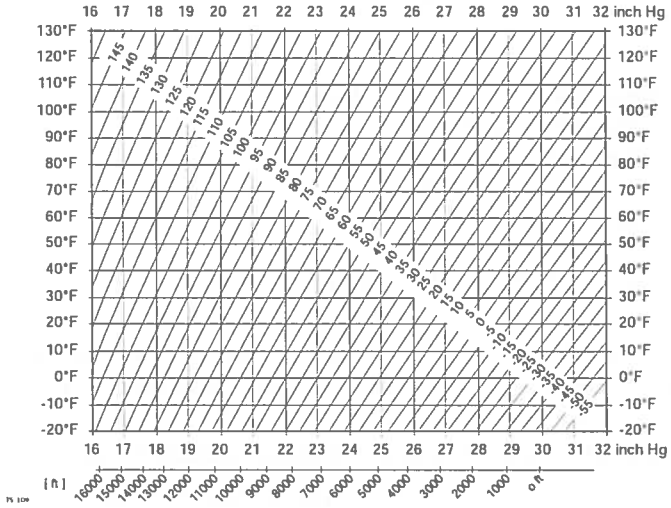
Atmospheric corrections °C

Atmospheric corrections in ppm with temperature [°C], air pressure [mb] and height [m] at 60 % relative humidity.



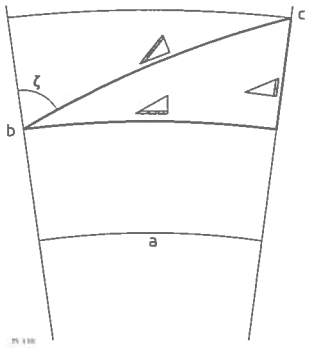
Atmospheric correction °F

Atmospheric corrections in ppm with temperature [°F], air pressure [inch Hg] and height [ft] at 60 % relative humidity.



7.13 Reduction Formulas

Measurements



a) Mean Sea Level
b) Instrument
c) Reflector
◿ Slope distance
◿ Horizontal distance
◿ Height difference

Reflector types

The reduction formulas are valid for measurements to all reflector types:

- measurements to prisms, to reflector tape and reflectorless measurements.

Formulas

The instrument calculates the slope distance, horizontal distance, height difference in accordance with the following formulas:

$$\measuredangle = D_0 \cdot (1 + ppm \cdot 10^{-6}) + mm$$

$\measuredangle$ Displayed slope distance [m]
D_0 Uncorrected distance [m]
ppmAtmospheric scale correction [mm/km]
mm Additive constant of the reflector [mm]

$$\measuredangle = Y - A \cdot X \cdot Y$$

$$\measuredangle = X + B \cdot Y^2$$

$\measuredangle$ Horizontal distance [m]
$\measuredangle$ Height difference [m]
Y $\measuredangle * |\sin\zeta|$
X $\measuredangle * \cos\zeta$
ζ Vertical circle reading
A $(1 - k/2)/R = 1.47 * 10^{-7}$ [m^{-1}]
B $(1 - k)/2R = 6.83 * 10^{-8}$ [m^{-1}]
k 0.13 (mean refraction coefficient)
R $6.378 * 10^6$ m (radius of the earth)

Earth curvature (1/R) and mean refraction coefficient (k) (if enabled on the Refraction page in Main Menu: Config...\Instrument Settings...\TPS Corrections) are automatically taken into account when calculating the horizontal distance and height difference. The calculated horizontal distance relates to the station height and not to the reflector height.

Distance measuring program Averaging

In the distance measuring program Averaging, the following values are displayed:

D Slope distance as arithmetic mean of all measurements
s Standard deviation of a single measurement
n Number of measurements

These values are calculated as follows:

$$\bar{D} = \frac{1}{n} \cdot \sum_{i=1}^{n} D_i$$

$\bar{D}$ Slope distance as arithmetic mean of all measurements
$\sum$ Sum
D_i Single slope distance measurement
n Number of measurements

$$s = \sqrt{\frac{\sum_{i=1}^{n} (D_i - \bar{D})^2}{n-1}} = \sqrt{\frac{\sum_{i=1}^{n} D_i^2 - \frac{1}{n} \left(\sum_{i=1}^{n} D_i\right)^2}{n-1}}$$

s Standard deviation of a single slope distance measurement
$\sum$ Sum
$\bar{D}$ Slope distance as arithmetic mean of all measurements
D_i Single slope distance measurement
n Number of distance measurements

The standard deviation $s_{\bar{D}}$ of the arithmetic mean of the distance can be calculated as follows:

$$s_{\bar{D}} = \frac{s}{\sqrt{n}}$$

$s_{\bar{D}}$ Standard deviation of the arithmetic mean of the distance
s Standard deviation of a single measurement
n Number of measurements