

	Trimble R12 i	Tersus Oscar Basic / Ultimate	CHC i90 Pro	South G7	Emlid Reach RX	Emlid Reach RS2+	Topcon Hiper HR	Leica G18 I
Number of channels	672	576	336	1598	184	184	452	555
Channels (GPS, Glonass, Galileo)	GPS: L1C/A, L1C, L2C, L2E, L5 GLONASS: L1C/A, L1P, L2C/A, L2P, L3 Galileo: E1, E5A, E5B, E5 AltBOC, E62	GPS: L1 C/A, L2C, L2P, L5; GLONASS: L1 C/A, L2 C/A, Galileo: E1, E5a, E5b	GPS: L1 C/A, L2E, L2C, L5 GLONASS: L1C/A, L2 C/A, L3 CDMA Galileo: E1, E5a, E5b, E5AltBOC, E6	GPS: L1, L1 C, L2C, L2P, L5 GLONASS: L1C/A, L2 C/A, L1P, L2P, L3 , Galileo: E1, E5a, E5b, AltBOC, E6C	GPS/QZSS L1C/A, L2C, GLONASS L10F, L20F, BeiDou B1I, B2I, Galileo E1-B/C, E5b	GPS/QZSS L1C/A, L2C, GLONASS L10F, L20F, BeiDou B1I, B2I, Galileo E1-B/C, E5b	GPS L1 C/A, L1C, L1P(Y), GLONASS L1 C/A, L1P, L2 C/A, L2P, Galileo E1, E5a, E5b, E5AltBOC, E6 L3C L2P(Y), L2C, L5	GPS L1, L2, L2C, L5 / Glonass L1, L2, L2C, L3 / Galileo E1, E5a, E5b, AltBOC, E6
Update frequencies [Hz}	1-20	1-20	1 - 50	1-20	5	1-10	1-20	1-20
RTK-accuracy with a single base station, lateral	8 mm + 1 ppm	8 mm + 1 ppm	8 mm + 1 ppm	8 mm + 1 ppm	7 mm + 1 ppm	7 mm + 1 ppm		8 mm + 1 ppm
RTK-accuracy with a single base station, vertical	15 mm + 1 ppm	15 mm + 1 ppm	15 mm + 1 ppm	15 mm + 1 ppm	14 mm + 1 ppm	14 mm + 1 ppm		15 mm + 1 ppm
RTK-accuracy with network, lateral	8 mm + 0.5 ppm	8 mm + 0.5 ppm		8 mm + 0.5 ppm			5.0 mm + 0.5 ppm	8 mm + 0.5 ppm
RTK-accuracy with network, vertical	15 mm + 0.5 ppm	15 mm + 0.5 ppm		15 mm + 0.5 ppm			10.0 mm + 0.8 ppm	15 mm + 0.5 ppm
Static (phase) with long observations, lateral	3 mm + 0.1 ppm RMS	2.5 mm + 0.1 ppm RMS	2.5 mm + 0.5 ppm RMS	2.5 mm + 0.5 ppm RMS		4mm+0.5ppm	3 mm + 0.1 ppm RMS	3 mm + 0.1 ppm
Static (phase) with long observations, vertical	3.5 mm + 0.4 ppm RMS	3.5 mm + 0.4 ppm RMS	5 mm + 0.5 ppm RMS	3.5 mm + 0.5 ppm RMS		8mm+1ppm	3.5 mm + 0.4 ppm RMS	3.5 mm + 0.4 ppm
Operating time [hours] total with all batteries with GSM data transfer	13	18,9 (rover/GSM)	18	12 (rover / Bluetooth)	16 (rover / LTE)	16 (rover / LTE)	9	8***
Size of battery / batteries [Wh]	54,8	94,7	50,3	49,0	18,7	41,0	40,1	30,8

Number of batteries (basic package)	2	2	2	1, internal	1, internal	1, internal	2	2 (in RTKrover package)
Vibration test	MIL-STD-810G	MIL-STD-810G	-	MIL-STD 810G	-	-	-	MIL STD 810G 514.6 Cat.24
Drop test to concrete surface	2m	2 m	2m	2m	-	-	2m	2m
Proof against water, sand and dust	IP67	IP68	IP67	IP67	IP68	IP67	IP67	IP66
Operating temperature	-40 C - +65 C	-40 C - +70 C	-40 C - +65 C	-25 C - +65 C	-20 C - +65 C	-20 C - +65 C	-40C - +80C	-40 C - +65 C
Weight with battery [kg]	1,12	1,4	1,26	0,97 / 0,79	0,25	0,95	1,17	1,25
Tilt compensation accuracy at 30 degrees, lateral [mm]	17	20*	31	31	-	-	39**	20
Tilt compensation accuracy at 60 degrees, lateral [mm]	-	20*	-	52 (not specified, calculated from 0-30 deg. range)	-	-	-	-
Tilt compensation maximum angle [degrees]	30	60*	30	60	-	-	15	30
Price according to prices freely available in internet	31 495 USD (Allterracentral, USA)	3600 eur (Basic) / 6175 eur (Ultimate) / Dimense Oy	5447 eur (South Survey, UK)	2195 eur / 2495 eur (without 4G / with 4G) / Dimense Oy	1599 eur (Dimense Oy)	2199 eur (Dimense Oy)	12 700 USD (Geotronics, USA)	22 800 eur (G2survey.com / UK) with controller and 2 batteries
NOTE !		<ul style="list-style-type: none"> Basic-model has no tilt comp. 					**given only for < 10 deg.	***depends on package chosen

Remarks:

- 1) The maximum number of channels does not matter as long as there are enough of them. The table below shows the known channel numbers of different systems. In Finland, the importance of the satellite systems of Japan and India is minor, because either the aforementioned satellites are not visible or they are at such angles (less than 15 degrees) that the measurement accuracy they can achieve is poor. So the most important are GPS, Galileo and Glonass, which have a total of 252 channels. In some regions of Finland also Beidou satellites (105 satellites) may be usable. Channels are sometimes also called correlators, but basically they are two different things. There can be more correlators than channels and they are needed e.g. for the elimination of scattered echoes. It can be said that when there are enough channels and correlators, good accuracy is achieved in demanding environments, such as between buildings and under dense treesⁱⁱⁱ

	L5 / L5OC / E5a / B2a	L2 / L2C / L2OC	E6 / LEX	L1 / L1OC / E1 / B1
GPS	30	30		30
GLONASS	24	24		24
Galileo	30		30	30
BeiDou	35		35	35
QZSS	3	3	3	3
IRNSS	7			
	129			122

← ARNS* Bands →

■ Frequency band used by the system, with N = number of satellites
■ Frequency band not used by the system

Figure 1: GNSS constellations, their associated frequencies and the number of satellites ultimately transmitting these signals. Source: gsa.europa.eu

- 2) As you can see from the table on the previous page, in basic operation (one RTK base station or RTK base stations networked) the accuracy achieved with different devices is very much exactly the same. The RTK (Real Time Kinematic) system is based on the fact that the measuring device constantly receives real-time information from the base station (either directly via a radio link or via the GSM network) about how much and in which direction the location of the stationary base station "throws". It can therefore be said that the accuracy required in practical land surveying is achieved with all devices. The practical accuracy is also affected by the number of channels and, above all, the number of correlators, because with

correlator technology, e.g. scattered echoes can be eliminated. But if the conditions are good enough, i.e. enough satellites are visible and the distance to the base station/base stations is not too long, all devices achieve a sufficiently good accuracy. If one base station is used, the recommended maximum distance to the base station is 40 km.

- 3) The biggest differences between the devices come in the operating time (if the device has external batteries, they can be obtained "enough"), the promised operating temperature range, the device's moisture/dust sealing (IP class), vibration and drop test classification and, above all, the accuracy of the tilt correction. Some devices do not have tilt correction at all, and in those devices with tilt correction, the specified operating range varies between 15 degrees and 60 degrees. Size and weight also differ considerably (weight range 0.25 -1.4 kg), but it depends on how the meter works, how much this matters.
- 4) This table does not compare the differences between controllers and measurement software. If the device can be used as a controller with an ordinary phone or an Android phone or tablet specially designed as a controller for field use, this has several advantages. In this case, you can also use a measurement program other than that of the device manufacturer. Survey programs are available from several manufacturers, e.g. Microsurvey Field Genius and Aplitop TcpGPS. Another advantage is that the controller is often the weakest link in the system, as it may fall or otherwise be damaged. In this case, it is an advantage if a regular phone can be used as an alternative controller.

ⁱ <https://gssc.esa.int/navipedia/index.php/Correlators>

ⁱⁱ https://www.e3s-conferences.org/articles/e3sconf/pdf/2019/20/e3sconf_iscgnss2018_03006.pdf