

GNSS Receivers

Last year we replaced the term GPS (Global Positioning System) by GNSS (Global Navigation Satellite System) because of their gradual evolution into real navigation systems. The receivers listed here represent the high-end segment aimed at achieving survey accuracy.

A recent newspaper article headlined "Made in China Rapidly Changing to Made by China" reported a 33% increase in registration of patents of Chinese origin in 2006 compared to 2005. With an annual 170,000 registrations, China now holds third place in the world after the US and Japan (source: World Intellectual Property Organization (WIPO)). So it is surprising that we welcome to our current Product Survey just one new Chinese GNSS receiver manufacturer, China HuaCe, founded in 2002 and based in Shanghai. It is rumoured, other Chinese and Asian manufacturers are ready to launch new instruments at Integeo 2007 (see preview page 29). Although Hemisphere GPS is a new name it was formerly known as CSI wireless Inc. Another newcomer is Altus Positioning Systems.

OEM

Original Equipment Manufacturer (OEM) refers to a company that acquires a product or component from a dedicated manufacturer and incorporates it into a product of its own, bringing it to the market under its own brand name. The use of OEM products has also found its way to GNSS receivers. Trimble, for example, subcontracts the manufacture of pretty well all its GPS subsystems to Solectron Corporation. As OEM boards form the fundament of many GPS receivers, those manufactured by Hemisphere GPS, Novatel and Septentrio are included as examples.

GNSS Trends

The technological trend is towards integration of GNSS with other techniques. Seamless navigation from outdoor to indoor or from gate to gate, for example, can only be achieved by integrating GNSS with other sensors and data. On the consumer market, mobile phones are gradually becoming equipped with a GPS or GNSS chip, and it is true that, as with Lidar, new applications depend not so much on technological constraints as on the limits of human imagination. Galileo input is still limited; the EU and USA recently agreed on collaboration. And how will the Chinese Beidou system develop? See for an answer this month's Pinpoint (page 11).

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Brand	Altus Positioning Systems	China HuaCe
Model name/Type	APS-3	CHC X90 2)
Introduction date		March 2006
Class (GPS, Glonass, Galileo/S, D en T)	GPS DF, Glonass DF	GPS & Glonass Dual-frequency, RTK
Receiver and Antenna		
Dimensions (h*d*w* in cm): base station case/rover set case	8 x 17.5	8.5 x 20
Weight (receiver, rover, antenna, communications, batteries, pole)	1.5kg	Rover receiver: 1.5kg Pole: 1.2kg
Static [mm + ppm]	5mm+0.5ppm	5mm + 1ppm
RTK [mm + ppm]	10mm+1ppm	10mm + 1 ppm (Horizontal)
Signal(s) tracked (types/bands/codes)	GPS L1 L2, Glonass L1 L2	GPS L4 L1 + 14 L2 (L1 C/A code, L2 carrier phase, p-code), GLONASS 12 L1 + 12 L2 (L1 C/A code, L1 P code, L2 P code, L1L2 full carrier phase) SBAS
Single/dual/triple frequency	Dual	Dual
Number of channels/tracking mode	48	54 (2 SBAS + 28 GPS + 24 GLONASS)/parallel
Max. no. of satellites tracked parallel	12 GPS/12 Glonass DF	14 GPS/12 GLONASS/2 SBAS
Time to first fix (C/W/R) [sec/sec/sec]	< 45/<20/<1	60/35/1
Can the receiver perform RTK surveys?	Y	Y
RTK initialisation (s/d) [sec]	7s	Typically <15s
PPS (Puls per second)	Y	Y
Update rate of position (frequency) [Hz]	10Hz standard, 20Hz max	5 Hz, Up to 20Hz
Supported RTCM version	2.3, 3.0	RTCM 3.0
Possible types of messages	V2.3: 1,2,3,9,16,18,19,22,24,59 V3.0: 1003,1004,1005,1006	RTCM, RTCA, CMR
Id. proprietary format	SBF	Y
Antenna (integr. and / or ext.)	Integrated	Integrated
Rover (r/rd/rdm) [V - W/W/W]	7.2 - 4w	8V, 2.5w static/3.3w GPRS RTK/3.4w Radio RTK
Base (b/bm) [V - W/W]	7.2 - 10w	8V, 2.5w static/2.5w RTK Base
Operating time wo/w radio (h) [hrs/hrs]	8w/21wo	8hrs / 4.5hrs
Use of cellular phone for the datalink/ Protocol		GPRS/CDMA
Supported GSM protocols, ISDN, GPRS, UMTS	GPRS	ISDN, GPRS, CDMA
I/O-ports (number and type of plug)	2, Lemo	1 RS232(9 pins)
Remote managing receiver	N	N
Options remote	N	N/A
Special remote software needed?	N	N/A
Integrity warnings (warning at failure datalink, loss of lock i.e. (Y/N)	Y	N
Base antenna phase centre stability I)	<input type="checkbox"/>	<1mm
Rover antenna phase centre stability I)	<input type="checkbox"/>	<1mm
Data Storage and User Interface		
Data storage on receiver	Y	Y
Storage medium (type)/memory [MB]	SD card/1 GB	Flash Card / 64MB
Exchangeable/fixe	Exchangeable	Fixed
Display; size (lines and char./line)	None	240 x 320
Data input (pen/keys/qwerty board)	via Terminal	Y all
Graphical display functions	Via Terminal	Y
Background map support	Y	Y
Suitable for other auxiliary input devices?	Y	Y
Stakeout options (Graphical/ENH)	Y	Both
Support of RTK network solutions based on (VRS, FKP, PRS, RTCM3)	Y	VRS, FKP, RTCM3
Office Software		
Brand/name	Carlson Software	CHC(Huace)/Compass Post-processing Software
Hardware requirements	Windows XP, P4	Pentium min, 150MHz, 32MB RAM, 1GB HD, SVGA colour 800 x 600, keyboard with mouse/track-ball, CD ROM
Network design (reconnaissance)	N	Y
Network adjustment	Carlson SurvNet	Y
Determination of local coordinate system parameters and input of predefined coordinate system parameters	Y	Y
User file output supported, specify	User defined	Y, customisable format files allow most formats to be created
Predefined output format supported DXF, SHP,...	DXF, ASCII	DXF, TXT
Feature code processing	Y	Y
DTM and Volume calculations	Y	N/A
Stakeout preparation	Y	Y
Batteries		
Internal and/or External	Internal	Internal
Number	2	1
Fixed or Exchangeable	Exchangeable	Exchangeable
Free available f.e. penlight/brand bound	N	Brand Bound
Rechargeable with (auto)battery	N	N/A
Direct car connection cable available	Y	Y

N/A = Not Applicable
 = No information received



Brand	China HuaCe	Hemisphere	GPS	Leica Geosystems
Model name/Type	CHC X20	Crescent R100 3)		Leica GX1230 GG 4)
Introduction date	September 2004	January 2007		May 2006
Class (GPS, Glonass, Galileo/S, D en T)	GPS, Single-frequency	GPS		GPS & Glonass, Dual-frequency, RTK (prepared for GPS L5 and Galileo E1 and E5)
Receiver and Antenna				
Dimensions (h ² d ² w ² in cm): base station case/ rover set case	6 x 15	4.5 x 16.0 x 11.4		21.2 x 16.6 x 7.9
Weight (receiver, rover, antenna, communications, batteries, pole)	Receiver: 0.8kg	0.5kg receiver only		All on the pole setup: 4.15kg. Backpack setup: 1.8kg (weight of pole), 2.2kg weight of backpack.
Static [mm + ppm]	5mm + 1ppm	5mm + 1ppm horizontal, 95%		Post-processing (static and rapid static)=5mm+0.5ppm, post-processing kinematic=10+1ppm (horizontal accuracies)
RTK [mm + ppm]	N/A	25mm + 1ppm horizontal, 95%		RTK static=5mm+0.5ppm, RTK kinematic=10+1ppm (horizontal accuracies)
Signal(s) tracked (types/bands/codes)	GPS L2 L1 C/A code	GPS L1 code/carrier		5)
Single/dual/triple frequency	Single	Single		Dual
Number of channels/tracking mode	12 GPS only/parallel	12 parallel		72/SmartTrack+
Max. no. of satellites tracked parallel (GPS/Glonass/Galileo/Other)	12 GPS	12 GPS		28
Time to first fix (C/W/R) [sec/sec/sec]	60/35/1	60/45/20		Typically 60s/30s/1s
Can the receiver perform RTK surveys?	N	Y		Y
RTK initialisation (s/d) [sec]	N/A	300/300		8s (static and kinematic)
PPS (Puls per second)	Y	Y		Y optional
Update rate of position (frequency) [Hz]	1Hz	20Hz		20 Hz
Supported RTCM version	RTCM 2.3	N/A		RTCM 2.x and 3.0 / 3.1
Possible types of messages	RTCM, RTCA, CMR	N/A		2.x with 1,2,3,9,18,19,20,21,22,23,24. 3.x with 1001 to 1012, 1014 to 1016
Id. proprietary format	Y	Y		Leica proprietary, CMR, CMR+
Antenna (integr. and/or ext.)	Integrated	External		External
Rover (r/rd/rdm) [V -W/W/W]	8V, 1w static	N/A		12V nominal, range 10.5-28V - 3.8/ 3.8 / 3.8
Base (b/bm) [V -W/W]	N/A	N/A		12V nominal, range 10.5-28V - 3.8/ 3.8
Operating time wo/w radio (h) [hrs/hrs]	15hrs	N/A		15hrs without radio, 10 hours with radio
Use of cellular phone for the datalink/ Protocol	<input type="checkbox"/>	External		Supported in housing: Siemens MC75, CDMA MultiTech. Supported without housing: any suitable phone
Supported GSM protocols, ISDN, GPRS, UMTS	<input type="checkbox"/>	External		ISDN, GPRS, EDGE, CDMA, TDMA, UMTS
I/O-ports (number and type of plug)	1 RS232(9 pins)	2 x D-sub 9		4 x RS232 (8-pin LEMO)
Remote managing receiver	N	N/A		Y, modem and serial
Options remote	N/A	N/A		Configure, status, download data, update firmware
Special remote software needed?	N/A	N/A		Y, Leica Geo Office or Leica Spider Software.
Integrity warnings (warning at failure datalink, loss of lock i.e. (Y/N))	Y	Via Display		Y, all events trigger message warnings. Icons permanently show most important status information
Base antenna phase centre stability I)	<1.2mm	N/A		Sub mm
Rover antenna phase centre stability I)	N/A	N/A		Sub mm
Data Storage and User Interface				
Data storage on receiver	Y	N/A		Y, removable CF card or fixed internal memory (optional)
Storage medium (type)/memory [MB]	Flash Card/16MB	N/A		CF card 64MB, 256MB or 1 GB (not for internal memory)
Exchangeable/fixed	Fixed	N/A		Removable
Display; size (lines and char. /line)	240 x 320	Y, 4x16		Y, 1/4 VGA screen 11 lines, 32 characters per line
Data input (pen/keys/qwerty board)	Y all	Keys		Touch Screen, Full alpha QWERTY keyboard, function keys and user-definable keys
Graphical display functions	Y	N		Y
Background map support	N	N		Y, converters from dxf, XML and other formats
Suitable for other auxiliary input devices?	Y	Y		Y, laser distance, tilt, meteo, echo sounders, bar code readers etc
Stakeout options (Graphical/E'N'H)	N/A	N		Y, graphically assisted
Support of RTK network solutions based on (VRS, FKP, PRS, RTCM3)	<input type="checkbox"/>	N		Y, VRS, FKP, RTCM3 and LEICA Spider network formats
Office Software				
Brand / name	CHC(Huace) / ANT Post-processing Software	N/A		Leica Geo Office
Hardware requirements	Pentium, 150MHz or faster with min. 32MB RAM and a 1GB HD, SVGA colour 800 x 600, keyboard with mouse or track-ball, CD ROM Drive	N/A		Minimum: Pentium 150MHz/32MB RAM/100MB free hard disk space/Windows98/Explorer 4.0 Recommended: Pentium 300MHz or higher/256MB RAM/300MB free hard disk space/Windows 2000 or XP/Explorer 5.5
Network design (reconnaissance)	N/A	N/A		Y
Network adjustment	N/A	N/A		Y
Determination of local coordinate system parameters and input of predefined coordinate system parameters	Y	N/A		Y
User file output supported, specify	Y, customisable format files allow most formats to be created	N/A		Y, customisable format files allows most formats to be created.
Predefined output format supported DXF, SHP, ..	DXF, TXT	N/A		Dxf, dgn, mif and shape files
Feature code processing	N/A	N/A		Line and area objects directly imported
DTM and Volume calculations	N/A	N/A		Y
Stakeout preparation	N/A	N/A		Y all
Batteries				
Internal and/or External	Internal	N/A		Internal and external
Number	1	N/A		2 internal Li-Ion and 1 external
Fixed or Exchangeable	Exchangeable	N/A		Exchangeable
Free available i.e. penlight/brand bound	Brand Bound	N/A		Brand bound
Rechargeable with (auto)battery	N/A	N/A		N
Direct car connection cable available	Y	Y		Y

N/A = Not Applicable
 = No information received



Leica Geosystems	Leica Geosystems	Magellan Professional	Magellan Professional
Leica ATX1230 GG	Leica GRX1200 GG Pro	ProMark3 RTK	ProMark3
May 2006	May 2006	May 2007	September 2005
GPS & Glonass, Dual-frequency, RTK (prepared for GPS L5 and Galileo E1 and E5)	GPS & Glonass, Dual-frequency, RTK (prepared for GPS L5 and Galileo E1 and E5)	GPS, SBAS/S	GPS/S
18.6 x 8.9	21.2 x 16.6 x 7.9	19.5 x 9 x 4.6 cm (7.7 x 4.6 x 1.8 in)	19.5 x 9 x 4.6 cm
All on the pole setup: 2.79kg	□	0.48kg (1.05 lb) with battery, 0.45kg antenna	0.48kg (1.05 lb) with battery, 0.45kg antenna
Post-processing (static and rapid static)=5mm+0.5ppm, post-processing kinematic=10+1ppm (horizontal accuracies)	Post-processing (static and rapid static)=5mm+0.5ppm, post-processing kinematic=10+1ppm (horizontal accuracies)	5mm + 1ppm (in post processing)	5mm + 1ppm (in post processing)
RTK static=5mm+0.5ppm, RTK kinematic=10+1ppm (horizontal accuracies)	N/A	10mm + 1ppm	N/A
5)	5)	GPS, SBAS / L1 C/A code and carrier	GPS, L1 code and carrier
Dual	Dual	Single	Single
72/SmartTrack+	72/SmartTrack+	14	14
28	28	14	14
Typically 60s/30s/1s	Typically 60s/30s/1s	Depend on initialisation method	Post processing
Y	DGPS (SBAS)	Y	N
8s (static and kinematic)	N/A	Depend on initialisation method	N/A
N	Y optional	□	□
20 Hz	20 Hz	1Hz	1Hz
RTCM 2.x and 3.0 / 3.1	RTCM 2.x and 3.0 / 3.1	RTCM 2.3 (rover); RTCM 3.1 (Rover and base)	RTCM 2.3 (upgrade 2007)
2.x with 1,2,3,9,18,19,20,21,22,23,24. 3.x with 1001 to 1012, 1014 to 1016	2.x with 1,2,3,9,18,19,20,21,22,23,24. 3.x with 1001 to 1012, 1014 to 1016	Rover RTCM-2.3 (1,3,9,18,19,20,21,22,59) and RTCM-3.1 (1001-1008,1014-1016); Base RTCM-3.1 (1002, 1006, 1008)	NMEA
Leica proprietary, CMR, CMR+	Leica proprietary, CMR, CMR+	□	□
External	External	Integrated and external	Integrated and external
12V nominal, range 10.5-28V - 3.8/ 3.8 / 3.8	12V nominal, range 10.5-28V - 3.8/ 3.8 / 3.8	3.7V Li-Ion, 3900 mAh	3.7V Li-Ion, 3900 mAh
12V nominal, range 10.5-28V - 3.8/ 3.8	12V nominal, range 10.5-28V - 3.8/ 3.8		
ATX Receiver antenna 6 hrs, Data collector 11hrs	7.5hrs without radio, 5 hrs with radio	8hrs/6hrs	8hrs
Supported in housing: Siemens MC75, CDMA MultiTech. Supported without housing: any suitable phone	Supported in housing: Siemens MC75, CDMA MultiTech. Supported without housing: Any suitable phone	Y, through Bluetooth link	N
ISDN, GPRS, EDGE, CDMA, TDMA, UMTS	ISDN, GPRS, EDGE, CDMA, TDMA, UMTS	N/A	N/A
1 x RS232 (clip-on), 1 x USB port, Bluetooth	4 x RS232 (8-pin LEMO)	3, RS232, USB, Bluetooth	3, RS232, USB, Bluetooth
Y, modem and serial	Y, modem and serial	N/A	N/A
Configure, status, download data, update firmware	Configure, status, download data, update firmware	N/A	N/A
Y, Leica Geo Office or Leica Spider Software.	Y, Leica Geo Office or Leica Spider Software or Web Interface	N	N/A
Y, all events trigger message warnings. Icons permanently show most important status information	Y, all events trigger message warnings. Icons permanently show most important status information	Y	Y
Sub mm	Sub mm	North: 1.0mm, east : 3.8mm, up: 73.2mm above ARP	North: 1.0mm, east : 3.8mm, up: 73.2mm above ARP
Sub mm	Sub mm	North: 1.0mm, east : 3.8mm, up: 73.2mm above ARP	North: 1.0mm, east : 3.8mm, up: 73.2mm above ARP
Y, removable CF card	Y, removable CF card	Y	Y
CF card 64MB, 256MB or 1GB	CF card 64MB, 256MB or 1GB	Internal 128 MB, external SD card up to 1GB	Internal 128 MB, external SD card
Removable	Removable	Exchangeable (SD card)	Exchangeable (SD card)
Y (data collector) - Colour, 1/4VGA screen 11 lines, 32 characters per line	Y, 1/4VGA screen 11 lines, 32 characters per line	320 x 240 resolution with 262,144 colors	320 x 240 resolution with 262,144 colors
Touch Screen, Full alpha QWERTY keyboard, function keys and user-definable keys	Touch Screen, Full alpha QWERTY keyboard, function keys and user-definable keys	Pen/keys/qwerty board	Pen/keys/qwerty board
Y	Y	Y	Y
Y, converters from dxf, XML and other formats	Y, converters from dxf, XML and other formats	Y	Y
Y, Laser distance, tilt, meteo, echo sounders, bar code readers etc	Y, laser distance, tilt, meteo, echo sounders, bar code readers etc	N	N
Y, graphically assisted	N/A	Y	N
Y, VRS, FKP, RTCM3 and LEICA Spider network formats	Y, VRS, FKP, RTCM3 and LEICA Spider network formats	Y	N
Leica Geo Office	Leica Geo Office	GNSS Solutions	GNSS Solutions
Minimum: Pentium 150MHz/32MB RAM/100MB free hard disk space/VWindows98/Explorer 4.0 Recommended: Pentium 300MHz or higher/256MB RAM/300MB free hard disk space/Windows 2000 or XP/Explorer 5.5	Minimum: Pentium 150MHz/32MB RAM/100MB free hard disk space/VWindows98/Explorer 4.0 Recommended: Pentium 300MHz or higher/256MB RAM/300MB free hard disk space/Windows 2000 or XP/Explorer 5.5	Windows 2000/XP; Pentium 133 or higher; 64MB RAM mini, 128 MB RAM recommended; 200 MB disk space required for installation	Windows 98/NT/2000/XP
Y	Y	Y	Y
Y	Y	Y	Y
Y	Y	Y	Y
Y, customisable format files allow most formats to be created.	Y, customisable format files allow most formats to be created.	DXF, SHP, RW5, LandXML	Customised format
Dxf, dgn, mif and shape files	Dxf, dgn, mif and shape files	Y	Y
Line and area objects directly imported	Line and area objects directly imported	Y	Y
Y	Y	Y	N
Y all	Y all	Y	Points
Internal and external	Internal and external	Internal/external optional	Internal/external optional
1 internal Li-Ion and 1 external	1 internal Li-Ion and 2 external	1	1
Exchangeable	Exchangeable	Exchangeable	Exchangeable
Brand bound	Brand bound	N/A	N/A
N	N	Y	Y
Y	Y	N	N

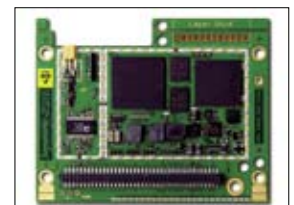
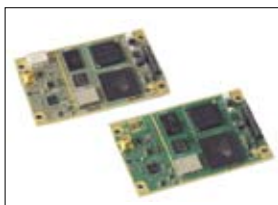


Brand	Magellan Professional	NavCom Technology	NavCom Technology	NavCom Technology
Model name/Type	Z-Max.Net	NCT-2030M	StarFire Receivers SF-2040G/SF-2050G & M & VueStar	RTK Receivers RT-3010S/RT-3020S & RT-3020M
Introduction date	April 2006	October 2003	September 2002/September 2004	September 2002
Class (GPS, Glonass, Galileo/S, D en T)	GPS/D	GPS/D	GPS D	GPS D
Receiver and Antenna				
Dimensions (h*d*w* in cm): base station case/ rover set case	26,9 x 12,5 x 14	20 x 40 x 43/20 x 40 x 43	20 x 40 x 43/20 x 40 x 43	20 x 40 x 43/20 x 40 x 43
Weight (receiver, rover, antenna, communications, batteries, pole)	4.5kg	5.0kg	4.5kg/5.0kg	4.5kg/5.0kg
Static [mm + ppm]	5mm + 0.5ppm	5 + 1 (rms)	5 + 1 (rms)	5 + 1 (rms)
RTK [mm + ppm]	10mm + 1ppm	10 + 1 (rms)	10 + 1 (rms)	10 + 1 (rms)
Signal(s) tracked (types/bands/codes)	L1/L2 code+carrier	L1 & L2 Phase, C/A, P1, P2, SBAS	L1 & L2 Phase, C/A, P1, P2, SBAS, StarFire	L1&L2 Phase, C/A, P1, P2, SBAS
Single/dual/triple frequency	Dual	Dual-frequency	Dual-frequency	Dual-frequency
Number of channels/tracking mode	24 parallel	2 SBAS + 24 GPS Paralell	2 SBAS + 24 GPS Paralell + 1 StarFire	2 SBAS + 24 GPS Paralell
Max. no. of satellites tracked parallel (GPS/Glonass/Galileo/Other)	12	2 SBAS + 12 GPS	2 SBAS + 12 GPS + 1 StarFire	2 SBAS + 12 GPS
Time to first fix (C/W/R) [sec/sec/sec]	105/16/2	60 / 60 / 1	60/60/1	60/60/1
Can the receiver perform RTK surveys?	Y	Y, OTF RTK software upgrade	Y, OTF RTK software upgrade	Y, with OTF RTK
RTK initialisation (s/d) [sec]	2 sec	< 2	< 2	< 2
PPS (Puls per second)	Y, standard	Y, standard	N/Y, standard SF-2050M & VueStar	N/Y, standard RT-3020M
Update rate of position (frequency) [Hz]	10Hz	10Hz Position, 50Hz Raw Data	25Hz Position, 50Hz Raw Data	25Hz Position, 50Hz Raw Data
Supported RTCM version	All versions	3	3	3
Possible types of messages	NMEA, NTRIP	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Id. proprietary format	Y	Y, NCT Ultra Compact, CMR, CMR+	Y, NCT RTK Extend, CMR, CMR+	Y, NCT Ultra Compact, CMR, CMR+
Antenna (integr. and/or ext.)	External	External	Integrated/External	Integrated/External
Rover (r/rd/rdm) [V - W/W/W]	10 - 28VDC - 6.0 W	10-30VDC 4/5/6	10-30VDC 8/9/9	10-30VDC 5/6/7
Base (b/bm) [V - W/W]	10 - 28VDC - 6.0 W	10-30VDC 4/5	10-30VDC 8/8	10-30VDC 5/6
Operating time wo/w radio (h) [hrs/hrs]	14hrs. at 0° C	Battery dependent	10/8	18/15
Use of cellular phone for the datalink/ Protocol	Built-in GSM module	Various external	Various external	Various external
Supported GSM protocols, ISDN, GPRS, UMTS	ISDN, GPRS	External cellular phone specific.	External cellular phone specific.	External cellular phone specific.
I/O-ports (number and type of plug)	4, RS232, RS422, USB, Bluetooth	2 RS232, 1 Power, LEMO	2 RS232, 1 Power (+ 1PPS + 1 Event SF-2050M & VueStar) LEMO	2 RS232, 1 Power (+ 1PPS + 1 Event RT-3020M) LEMO
Remote managing receiver	Y, Modem, GSM	Y, Geo++ Modem, Serial, IP	Y, Geo++ Modem, Serial, IP	Y, Geo++ Modem, Serial, IP
Options remote	Y	Y, StarUtil, Geo++	Y, StarUtil, Geo++	Y, StarUtil, Geo++
Special remote software needed?	Y	Y, StarUtil, Geo++	Y, StarUtil, Geo++	Y, StarUtil, Geo++
Integrity warnings (warning at failure datalink, loss of lock i.e. (Y/N)	Y	Y	Y	Y
Base antenna phase centre stability I)	0.3, 0.8, 0.5	0.5, 0.3, 0.5/94.0%/99.9%	0.5, 0.3, 0.5/94.0%/99.9%	0.5, 0.3, 0.5/94.0%/99.9%
Rover antenna phase centre stability I)	0.3, 0.8, 0.5	0.5, 0.3, 0.5/94.0%/99.9%	0.5, 0.8, 1.1/94.0%/99.9%	0.5, 0.8, 1.1/94.0%/99.9%
Data Storage and User Interface				
Data storage on receiver	Y	Y	Y	Y
Storage medium (type)/memory [MB]	Secure digital , 128 MB available	MMC/64	MMC/64	MMC/64
Exchangeable/fixed	Exchangeable	Fixed	Fixed	Fixed
Display; size (lines and char. /line)	Y, 1 line; 8 Char. Scrolling	See website: www.navcomtech.com	See website: www.navcomtech.com	See website: www.navcomtech.com
Data input (pen/keys/qwerty board)	Y	See website	See website	See website
Graphical display functions	ASCII	See website	See website	See website
Background map support	N	See website	See website	See website
Suitable for other auxiliary input devices?	Y	See website	See website	See website
Stakeout options (Graphical/E'N'H)	Y	See website	See website	See website
Support of RTK network solutions based on (VRS, FKP, PRS, RTCM3)	Y, VRS, FKP , RTCM3	See website	See website	See website
Office Software				
Brand / name	GNSS Solutions	Waypoint Consulting/GrafNav - GrafNet	Waypoint Consulting/GrafNav - GrafNet	Waypoint Consulting/GrafNav - GrafNet
Hardware requirements	Windows 98/NT/2000/XP	Pentium, Windows 95/98/2000/NT/XP, 64MB RAM	Pentium, Windows 95/98/2000/NT/XP, 64MB RAM	Pentium, Windows 95/98/2000/NT/XP, 64MB RAM
Network design (reconnaissance)	Y	Y	Y	Y
Network adjustment	Y	Y	Y	Y
Determination of local coordinate system parameters and input of predefined coordinate system parameters	Y	Y	Y	Y
User file output supported, specify	DXF, SHP, RW5, LandXML	Y	Y	Y
Predefined output format supported DXF, SHP, ..	Y	N	N	N
Feature code processing	Y	N	N	N
DTM and Volume calculations	N	N	N	N
Stakeout preparation	Points	N	N	N
Batteries				
Internal and/or External	Internal/external optional	External	Internal/External	Internal/External
Number	1	User selected	2/User selected	2/User selected
Fixed or Exchangeable	Exchangeable	Exchangeable	Exchangeable	Exchangeable
Free available i.e. penlight/brand bound	N/A	User selected	NavCom/User selected	NavCom/User selected
Rechargeable with (auto)battery	Y	N	N	N
Direct car connection cable available	Y	N	N	N

N/A = Not Applicable
 = No information received



NovAtel OEMV-1/OEMV-IG	NovAtel OEMV-2/OEMV-3	NovAtel ProPak-V3 Receiver Enclosure 6)	Penmap PenmapGPS 7)	Septentrio AsteRx I _OEM - GPS/Galileo Single-frequency OEM Receiver
2006	2006	2006	February 2007	June 2007
GPS, S, RTK/GPS & Glonass, S, RTK	GPS, G, D, RTK/GPS, G, T, RTK	GPS, G, T, RTK	GPS & Glonass	GPS & Galileo, SBAS
0,46 x 0,71 x 0,10	0,60 x 1,00 x 0,13	1,85 x 1,60 x 0,71	GPS: 7.5 x 17 x 11 Case: 55 x 35 x 23	0,9 x 7,6 x 5,6
0,022kg	0,056kg/0,075kg	1.0kg	1.4kg inc pole, antenna, battery, GPS (Rover)	40g
10mm + 1ppm	10mm + 1ppm	10mm + 1ppm	10mm + 1ppm	700mm
10mm + 1ppm	10mm + 1ppm	10mm + 1ppm	10mm + 1ppm	N/A
L1 C/A code and CP, L-Band, SBAS/L1 C/A code and CP, Glonass, SBAS	L1 C/A code and CP, L2 P(Y) code and CP, SBAS, Glonass/L1 C/A code and CP, L2 P(Y) code and CP, L5, SBAS, Glonass, L-Band	L1 C/A code and CP, L2 P(Y) code and CP, L5, SBAS, GLONASS, L-Band	L1 L2	L1 code/carrier GPS and Galileo; SBAS
Single	Dual/ Triple	Triple	Dual	Single
14 L1, 1 L-Band, 2 SBAS/14 L1, 12 Glonass L1, 2 SBAS	14 L1, 14 L2 GPS, 12 L1, 12 L2, Glonass, 2 SBAS/+ 1 L-Band	14 L1, 14 L2 GPS, 12 L1, 12 L2, GLONASS, 2 SBAS, 1 L-Band	72	24, parallel
14 GPS + 1 L-Band + 2 SBAS/14 GPS + 12 Glonass + 2 SBAS	14 GPS + 12 Glonass + 2 SBAS/14 GPS + 12 GLONASS + 6 L5 + 2 SBAS + 1 L-Band	14 GPS + 12 GLONASS + 6 L5 + 2 SBAS + 1 L-Band	14 GPS - 12 Glonass - 2 Sbas - 6 L5	24 GPS or Galileo or SBAS
60/35/1	50/40/1	50/40/1	50/40/30	50/15/0,5
Y	Y	Y	Y	no
< 30 s (short baseline, low multipath conditions)	< 30s (short baseline, low multipath conditions)	< 30s (short baseline, low multipath conditions)	10 sec	N/A
Y, standard	Y, standard	Y, standard	20 nano seconds	Y
20	20	20	20	50Hz
2.3, 3.0	2.3, 3.0	2.3, 3.0	2.1, 1.1, Up to RTCMV3	RTCM v2.2, 2.3 and 3.0
RTCA, RTCM, RTCMV3, CMR, CMR+, NovAtel proprietary	RTCA, RTCM, RTCMV3, CMR, CMR+, NovAtel proprietary	RTCA, RTCM, RTCMV3, CMR, CMR+, NovAtel proprietary	All major messages supported	1,2,3,9,16,18,19,20,21,22,59
Y	Y	Y	Y, but CMR and others supported	Y, CMR; Septentrio Binary Format (SBF)
External	External	External	Integrated	External
N/A	N/A	N/A		5VDC ± 5%; <1W
N/A	N/A	N/A		5VDC ± 5%; <1W
N/A	N/A	N/A	10hrs	N/A
N/A	N/A	N/A	Y, Internal	N/A
N/A	N/A	N/A	GSM, GPRS UMTS, NTRIP	N/A
2 LV-TTL, 2 CAN, 1 USB	1 LV-TTL, 1 CAN, 1 USB/ RS-232 or RS-422, 1 RS-232, 1 LVTT, 1 CAN, 1 USB	2 RS-232 or RS-422, 1 RS-232, 1 USB	3 RS232, USB, TTL	OEM: I/O 2x40 pins (Samtec SFM); (HSG: USB/PWR ODU5 pins female; I/O1 ODU7 pins female; I/O2 ODU7 pins female)
Y, serial	Y, serial	Y, serial	Y	Y, UART (3x) / USB
Configuration, data logging, firmware updates	Configuration, data logging, firmware updates	Configuration, data logging, firmware updates	Y	Configuration, data download, firmware update, perm. Reference stations..
N	N	N	N	N
Y	Y	Y	Y	Y
N/A	N/A	N/A	Maximum 3 mm	N/A
N/A	N/A	N/A	Maximum 3 mm	N/A
N	N	N	Y	N
N/A	N/A	N/A	8GB SD Card	N
N/A	N/A	N/A	Fixed	N/A
N	N	N	640 x 480 Pixel Sunlight readable colour lcd	N/A
N/A	N/A	N/A	Pen Stylus, Touchscreen, Keys	N/A
N/A	N/A	N/A	Y, fully graphical	N/A
N/A	N/A	N/A	Y, raster and vector	N
N/A	N/A	N/A		N
N/A	N/A	N/A		N
N/A	N/A	N/A	Y, VRS + FKP	Y
N/A	N/A	N/A	Penmap Office	N/A
N/A	N/A	N/A	Pentium 3 or above.	N/A
N/A	N/A	N/A	Y	N/A
N/A	N/A	N/A	Y	N/A
N/A	N/A	N/A	Y	N/A
N/A	N/A	N/A	Users can design their own output formats	N/A
N/A	N/A	N/A	DXF, SHP, DGN, ASCII (+ 25 others)	N/A
N/A	N/A	N/A	Y, user defined	N/A
N/A	N/A	N/A	Y	N/A
N/A	N/A	N/A	Y	N/A
N/A	N/A	N/A	Internal	N
N/A	N/A	N/A	I	N/A
N/A	N/A	N/A	Exchangable	N/A
N/A	N/A	N/A	Brand Bound	N/A
N/A	N/A	N/A	Y	N/A
N	N	Y	Y	N/A



Brand	Septentrio	Septentrio	Sokkia	Sokkia
Model name/Type	AsterRx2_OEM - GPS/Glonass Dual-frequency OEM Receiver	PolarRx2e/2eTR/2e_FDL (Field Data Logger)	GSR2700 ISX	GSR2600
Introduction date	September 2007	October 2005	2007	
Class (GPS, Glonass, Galileo/S, D en T)	GPS & Glonass, SBAS	GPS/S, D, EGNOS/WAAS	GPS & Glonass	GPS/D
Receiver and Antenna				
Dimensions (h ^o d ^o w ^o * in cm): base station case/ rover set case	1,1 x 9,5 x 6	3,7 x 28,5 x 14	22.5 (f) x 10.5 (D)	7.0 x 18.3 x 15
Weight (receiver, rover, antenna, communications, batteries, pole)	85g	930g	1.8kg (3.9 lb) with internal radio	1.3kg
Static [mm + ppm]	10mm + 1 ppm	10mm + 1ppm	3mm + 0.5ppm (H) 10mm + 1ppm (V)	3mm + 0.5ppm (H) 10mm + 1ppm (V)
RTK [mm + ppm]	10mm + 1 ppm	10mm + 1ppm	10mm + 1ppm (H) 20mm + 1ppm (V)	10mm + 1ppm (H) 20mm + 1ppm (V)
Signal(s) tracked (types/bands/codes)	L1/L2 code/carrier GPS and Glonass; SBAS	L1 CA+P code+phase, L2P code+phase, SBAS	L1: C/A-Code and Carrier Phase, L2: P(Y)-Code and Carrier Phase	L1: C/A-Code and Carrier Phase, L2: P(Y)-Code and Carrier Phase
Single/dual/triple frequency	Dual	Dual	Triple	Dual
Number of channels/tracking mode	48, parallel	48, parallel	72 Universal Channels	24 Parallel Channels
Max. no. of satellites tracked parallel (GPS/Glonass/Galileo/Other)	24 GPS or Glonass or SBAS	16 GPS DF; 6 SBAS. 8)	14 L1, 14 L2, 6 L5 GPS, 12 L1, 12 L2 GLONASS, 2 SBAS	12 GPS
Time to first fix (C/W/R) [sec/sec/sec]	50/15/0.5	<90/<20/<2	50/40/L1:0.5 and L2: 1.0	50/40/L1:0.5 and L2: 1.0
Can the receiver perform RTK surveys?	Y	Y	Y	Y
RTK initialisation (s/d) [sec]	5 sec	5 sec	<10 sec., varies with bl length	<15 sec., varies with bl length
PPS (Puls per second)	Y	Y	1 PPS (out)	1 PPS (out)
Update rate of position (frequency) [Hz]	10Hz	10Hz	20Hz	20Hz
Supported RTCM version	RTCM v2.2, 2.3 and 3.0	RTCM v2.2, 2.3 and 3.0	v2, v3	v2, v3
Possible types of messages	1,2,3,9,16,18,19,20,21,22,59	1,2,3,9,16,18,19,20,21,22,59	RTCA, RTCM, CMR, CMR+, NTRIP, NMEA, 1 PPS (out), mark in	RTCA, RTCM, CMR, CMR+, NTRIP, NMEA, 1 PPS (out), mark in
Id. proprietary format	Y, CMR; Septentrio Binary Format (SBF)	Y, CMR; Septentrio Binary Format (SBF)	Y	Y
Antenna (integr. and/or ext.)	External	External	Integrated Pinwheel	External Pinwheel
Rover (r/rd/rdm) [V -W/W/W/W]	3,3 VDC ± 5%; 2,5W typ	9-30 VDC; 5W typ		
Base (b/bm) [V -W/W]	3,3 VDC ± 5%; 2,5W typ	9-30 VDC; 5W typ		
Operating time wo/w radio (h) [hrs/hrs]	N/A	N/A	16 hrs/10 hrs	Varies with power option chosen
Use of cellular phone for the datalink/ Protocol	N/A	NA	Y, integrated	External GSM module available
Supported GSM protocols, ISDN, GPRS, UMTS	N/A	N/A	GSM/GPRS	GSM/GPRS
I/O-ports (number and type of plug)	OEM: I/O 2x40 pin (Samtec SFM)	PWR ODU 3 pins female; IN/ COM1&2 ODU 7 pins female; OUT/ COM3&4 ODU 5 pins female; ETH ODU 4pins female	2 x RS232, 1 x USB, 2x Bluetooth, 1 x Internal Radio	2 x RS232, 1 x Power, 1 x Antenna
Remote managing receiver	Y, UART (3x)/USB	Y, serial/ethernet	N	N
Options remote	Configuration, data download, firmware update, perm. Reference stations..	Configuration, data download, firm-ware update, perm. Reference stations.	N	N
Special remote software needed?	N	N	N	N
Integrity warnings (warning at failure datalink, loss of lock i.e. (Y/N))	Y	Y	Y	Y
Base antenna phase centre stability 1)	N/A	N/A	L1 and L2 phase centre in same location with zero offset	L1 and L2 phase centre in same location with zero offset
Rover antenna phase centre stability 1)	N/A	N/A	L1 and L2 phase centre in same location with zero offset	L1 and L2 phase centre in same location with zero offset
Data Storage and User Interface				
Data storage on receiver	N	Y	Y	Y
Storage medium (type)/memory [MB]	SD card, up tot 2GB (SPI)	CF card standard 256MB, other possible	Flash/64 MB Standard. Options up to 2GB	Compact Flash/16MB Standard. Options up to 2GB
Exchangeable/fixd	N/A	Fixed	Fixed	Exchangeable
Display; size (lines and char. /line)	N/A	RxMobile	Y, fuel gauge style	Y, 3 lines, variable length
Data input (pen/keys/qwerty board)	N/A	RxMobile	Single button interface	7 button interface
Graphical display functions	N/A	RxMobile	Y, via data collector	Y, via data collector
Background map support	N	N	Y, via data collector	Y, via data collector
Suitable for other auxiliary input devices?	N	N	Y	Y
Stakeout options (Graphical/E'N'H)	N	N	Y, via data collector	Y, via data collector
Support of RTK network solutions based on (VRS, FKP, PRS, RTCM3)	Y	Y, FKP, RTCM3	Y, VRS, FKP, RTCM3	Y, VRS, FKP, RTCM3
Office Software				
Brand / name	N/A	GrafNav and other	Spectrum Survey Suite	Spectrum Survey Suite
Hardware requirements	N/A	N/A	Windows 95 or later, min 16MB RAM, Pentium or later	Windows 95 or later, min 16MB RAM, Pentium or later
Network design (reconnaissance)	N/A	N/A	N	N
Network adjustment	N/A	N/A	Y	Y
Determination of local coordinate system parameters and input of predefined coordinate system parameters	N/A	N/A	Y	Y
User file output supported, specify	N/A	N/A	Y, definable exports	Y, definable exports
Predefined output format supported DXF, SHP,...	N/A	N/A	PICS, IOB, SDR, IMAP, SGL, ASCII	PICS, IOB, SDR, IMAP, SGL, ASCII
Feature code processing	N/A	N/A	Y	Y
DTM and Volume calculations	N/A	N/A	N	N
Stakeout preparation	N/A	N/A	N	N
Batteries				
Internal and/or External	N	External	Internal and External	External
Number	N/A	N/A	2	N/A
Fixed or Exchangeable	N/A	Exchangeable	Fixed	N/A
Free available i.e. penlight/brand bound	N/A	Free available	Via Sokkia Dealer	N/A
Rechargeable with (auto)battery	N/A	Depends	Charge in reciever	N/A
Direct car connection cable available	N/A	Y	N	N

N/A = Not Applicable
 □ = No information received



Sokkia GSR2650 LB	Sokkia Stratus	Spectra Precision EPOCH 10	Spectra Precision EPOCH 25
GPS/D	GPS/S	GPS	GPS
7.1 x 18 x 15.4	15.5 x 12.5	4.4 x 24.2 x 9.5	GPS receiver: 14.5 x 8.1 x 14.5 EPOCH L1/L2 Antenna: 16.1 dm x 5.8 (h)
1.1kg	0.8kg (with batteries)	With internal batteries: 0.62kg (1.37lb)	Base: 0.93kg (2.0 lb), Rover: 1.18kg (2.6lb) with internal battery, internal radio, UHF antenna
3mm + 0.5ppm (H) 10mm + 1ppm (V)	5mm + 1ppm (H) 10mm + 2ppm (V)	±5mm + 0.5ppm × (baseline length) RMS (H), ±5mm + 1ppm × (baseline length) RMS (V)	±5mm + 0.5ppm RMS (H), ±5mm + 1ppm RMS (V)
10mm + 1ppm (H) 20mm + 1ppm (V)	N/A	N/A	±10mm + 1ppm RMS (H), ±20mm + 1ppm RMS (V)
L1: C/A-Code and Carrier Phase, L2: P(Y)-Code and Carrier Phase	L1 Full code and Carrier	12 Channels L1 C/A Code, L1 Full Cycle Carrier, WAAS/EGNOS	L1 C/A Code, L1/L2 Full Cycle Carrier, WAAS/EGNOS
Dual	Single	Single	Dual
24 Parallel Channels 12 GPS	12 Channels 12 GPS	12 Channels 12	24 channels 12
50 sec/40 sec/L1:0.5 sec and L2: 1.0 sec	120 sec/40 sec/1 sec	N/A	<60/<30/<15
Y	N	N	Y
<15 sec., varies with bl length	N/A	N/A	Typically <30 seconds
1 PPS (out)	N	N	N
20 Hz	1 Hz	1 Hz	5Hz
v2, v3	None	N/A	RTCM 2.1, 2.2, 2.3, 3.0, CMR, CMR+
RTCA, RTCM, CMR, CMR+, NTRIP, NMEA, 1 PPS (out), mark in	None	N/A	NMEA-0183: AVR, GSV, HDT, VGK, VHD, ROT, GGK, GGA, GSA, ZDA, VTG, GSOF
Y	Y	N/A	GST, PJT, and PIK
External L-Band Pinwheel	Integrated	Integrated / Removable	External
8 to 12hrs	30hrs	8 hrs	RTK: 8 hrs, Static/PPK: >10hrs
External GSM module available	N	N/A	Y/ Circuit Switched/ Packet Switched
GSM/GPRS	N	N/A	All
3 x RS232, 1 x Power, 1 x Antenna	Serial and infrared communications link	9)	2 x RS232 serial ports, Bluetooth dongle available as accessory
N	N	N	N
N	N	N/A	N/A
N	N/A	Not needed	N/A
N	Y	Y	Y
L1 and L2 phase centre in same location with zero offset	L1 and L2 phase centre in same location with zero offset	Submm phase centre repeatability	Submm phase centre repeatability
L1 and L2 phase centre in same location with zero offset	L1 and L2 phase centre in same location with zero offset	Submm phase centre repeatability	Submm phase centre repeatability
N	Y	Y	Y
N/A	Flash/4MB Standard. Options up to 2GB	More than 400 hrs L1 logging at 15 sec. with 6 satellites with 64MB Recon data collector memory	2MB: 55 hrs of raw observables based on recording data from 6 satellites at 15 sec. intervals.
N/A	Exchangeable	Fixed	Fixed
N	Y, fuel guage style	240 x 320 pixel (¼ VGA) colour TFT with LED front light	240 x 320 pixel (¼ VGA) colour TFT with LED front light
N/A	Single button interface	Keys	Keys
Y, via data collector	Y, via data collector	Y	Y
Y, via data collector	N	Y	Y
Y	N	N/A	N/A
Y, via data collector	N	N/A	Y, graphical/E'N'H
Y, VRS, FKP, RTCM3	N	N	Y
<input type="checkbox"/>	Spectra Survey Suite	Spectra Precision Survey Office	Spectra Precision Survey Office
<input type="checkbox"/>	Windows 95 or later, min 16MB RAM, Pentium or later	10)	10)
<input type="checkbox"/>	N	Y	Y
<input type="checkbox"/>	Y	Y	Y
<input type="checkbox"/>	Y	Y	Y
<input type="checkbox"/>	Y, definable exports	Y, user configurable CSV file export	Y, user configurable CSV file export
<input type="checkbox"/>	PICS, IOB, SDR, IMAP, SGL, ASCII	Y, DWG/DXF	Y, DWG/DXF
<input type="checkbox"/>	Y	N	N
<input type="checkbox"/>	N	N	N
<input type="checkbox"/>	N	N	N
External	Internal and External	Internal	Internal
N/A	2	1	
N/A	Exchangeable	Exchangeable	Fixed
N/A	Via Sokkia Dealer	N	N
N/A	N	Y	Y
Y	N	Y	N



Brand	South Survey	South Survey	South Survey	Topcon
Model name/Type	S86	S82	S62	GR-3
Introduction date	October 2007	August 2006	October 2007	July 2006
Class (GPS, Glonass, Galileo/S, D en T)	GPS	GPS	GPS	GPS, Glonass & Galileo/T
Receiver and Antenna				
Dimensions (h*d*w* in cm): base station case/ rover set case	14.5 x 14.5 x 7.8	18 x 18 x 9.4	14.5 x 14.5 x 7.8	Rover: 23.5 x 15.7 x 15.7, case: 29 x 35 x 47
Weight (receiver, rover, antenna, communications, batteries, pole)	All on the pole setup: 1.35kg Receiver with battery: 3.25kg	All on the pole setup: 0.8kg Receiver with battery: 2.7kg	All on the pole setup: 1.35kg Receiver with battery: 3.25kg	1.78kg (rvr, ant, comm, batt)
Static [mm + ppm]	3mm+1ppm	5mm+1ppm	5mm+1ppm	3mm + 0.5ppm (H), 5mm+0.5ppm (V)
RTK [mm + ppm]	Horizontal: 10mm+1ppm, Vertical: 20mm+1ppm	Horizontal: 20mm+1ppm, Vertical: 30mm+1ppm	Horizontal: 20mm+1ppm, Vertical: 30mm+1ppm	10mm + 1ppm (H), 15mm + 1ppm (V)
Signal(s) tracked (types/bands/codes)	L1/L2, C/A	L1/L2, C/A	L1, C/A	L1)
Single/dual/triple frequency	Dual	Dual	Single	Triple
Number of channels/tracking mode	24, parallel	24, parallel	12, parallel	72 universal channels (G, GG, GD, GGD)
Max. no. of satellites tracked parallel (GPS/ Glonass/Galileo/Other)	GPS 24	GPS 24	GPS 12	36
Time to first fix (C/W/R) [sec/sec/sec]	Typically 60/30/1s	Typically 60/30/1s	Typically 30s	<60/<10/<1
Can the receiver perform RTK surveys?	Y	Y	Y	Y, on-the-fly
RTK initialisation (s/d) [sec]	8s(static and kinematic)	10s(static and kinematic)	10s(static and kinematic)	Situation dependent ~ seconds
PPS (Puls per second)	N/A	N/A	N/A	N
Update rate of position (frequency) [Hz]	Up to 20Hz	Up to 20Hz	Up to 10Hz	Up to 20Hz
Supported RTCM version	2 X with RTCM 3	2 X with RTCM 3	3 X with RTCM 3	2.1, 2.2, 2.3, 3.0
Possible types of messages	RTCM2.1-3.0, CMR, CRM+, RTCA	RTCM2.1-3.0, CMR, CRM+, RTCA	RTCM2.1-3.0, CMR, CRM+, RTCA	1,2,3,6,9,15,16,18,19,20,21,22,31,32,34,36,59 User selectable (incl. Special GLONASS messages)
Id. proprietary format	RTCA, Novatel proprietary	RTCA, Novatel proprietary	RTCA, Novatel proprietary	Y, TPS, CMR, CMR+
Antenna (integr. and/or ext.)	Integrated	Integrated	Integrated	Integrated
Rover (r/rd/rdm) [V - W/W/W]	N/A	N/A	N/A	7.2 - 3.5/ 4.4
Base (b/bm) [V - W/W]	N/A	N/A	N/A	7.2 - 3.5/ 6
Operating time wo/w radio (h) [hrs/hrs]	15-20hrs without radio, 9hrs with radio	9 hrs without radio, Battery depends	15-20 hrs without radio, 9hrs with radio	16hrs/13hrs
Use of cellular phone for the datalink/ Protocol	GPRS/CDMA	GPRS/CDMA	GPRS/CDMA	Y, GSM, GPRS (NTRIP)
Supported GSM protocols, ISDN, GPRS, UMTS	All	All	All	GSM, GPRS, EDGE, UMTS
I/O-ports (number and type of plug)	Rs232, USB	Rs232, USB	Rs232, USB	1 Bluetooth, 4 RS232, 1 USB, 1 External Power. (ODU type)
Remote managing receiver	N/A	N/A	N/A	Y
Options remote	N/A	N/A	N/A	Y, modem, serial, USB and Ethernet (IP)
Special remote software needed?	N/A	N/A	N/A	Y, PCCDU-MS, TopNet CORS
Integrity warnings (warning at failure datalink, loss of lock i.e. (Y/N))	Y	Y	N/A	Y
Base antenna phase centre stability I)	Sub mm	sub mm	N/A	<1mm phase center stability
Rover antenna phase centre stability I)	Sub mm	sub mm	N/A	<1mm phase center stability
Data Storage and User Interface				
Data storage on receiver	Built-in memory 64M	Built-in memory 32M	Built-in memory 64M	Y
Storage medium (type) / memory [MB]	Built-in memory 64M or removable SD card 512M	Built-in memory 32M	Built-in memory 64M	SD memory card/1024 MB
Exchangeable / fixed	Removable	Removable	Fixed	Exchangeable
Display, size (lines and char. /line)	LCD display 16*8chars	N/A	LCD display 16*8chars	Y, 240 x 320 pixel dimensions (FC100/FC200/GMS-2/FC2000)
Data input (pen/keys/qwerty board)	Qwerty board (via controller)	Qwerty board (via controller)	Key	Y/Y/Y
Graphical display functions	Y, via controller	Y, via controller	Y, via controller	Y
Background map support	N/A	N/A	N/A	Y
Suitable for other auxiliary input devices?	Y, echo-sounder	Y, echo-sounder	Y, echo-sounder	Y, laser distance, tilt, meteo, echo sounder
Stakeout options (Graphical/ENH)	Y, via controller	Y, via controller	Y, via controller	Y, both
Support of RTK network solutions based on (VRS, FKP, PRS, RTCM3)	Y, all	Y, all	Y, all	Y, VRS, FKP, RTCM 3.0
Office Software				
Brand / name	South GPS Processor	South GPS Processor	South GPS Processor	Topcon Link/Topcon Tools/3D Office
Hardware requirements				32 bit, Windows compatible OS, Windows 98 or higher Version
Network design (reconnaissance)	N/A	N/A	N/A	Y
Network adjustment	Y	Y	Y	Y
Determination of local coordinate system parameters and input of predefined coordinate system parameters	Y	Y	Y	Y, localisation, predefined (Global) and user-defined projections
User file output supported, specify	Y	Y	Y	Y, user defines text file format (ASCII)
Predefined output format supported DXF, SHP, ...	DXF	DXF	DXF	Y, all commonly used formats supported
Feature code processing	N/A	N/A	N/A	Y
DTM and Volume calculations	N/A	N/A	N/A	Y
Stakeout preparation	Y	Y	N/A	Y, points, lines, roads, DTM, alignments
Batteries				
Internal and/or External	Internal	Internal	Internal	Internal and External
Number	2 Li-ion Int.	1 Li-ion Int.	2 Li-ion Int.	2 x Internal (Hot-swappable)
Fixed or Exchangeable	Fixed	Exchangeable	Fixed	Exchangeable
Free available i.e. penlight/brand bound	Brand bound	Brand bound	Brand bound	Both, Lithium Ion packs and AA (penlight) batteries
Rechargeable with (auto)battery	N/A	N/A	N/A	Y
Direct car connection cable available	N/A	N/A	N/A	Y

N/A = Not Applicable
□ = No information received



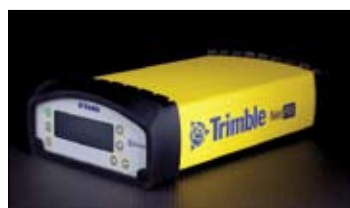
Tocon	Topcon	Topcon	Trimble
HiPer Pro/HiPer+/HiPer GL	GB -1000/GB-500	NET-G3/Odyssey-RS/Legacy-E+	R8 GNSS
May 2003/January 2005/January 2007	February 2004	March 2007/December 2001/2000	
GPS & Glonass/D (a)	GPS & Glonass/D (a)	GPS, Glonass & Galileo/ TJGPS & Glonass/D (a)/ GPS & Glonass/D (a)	GPS & Glonass
15.9 x 8.8 x 17.2	25.7 x 15 x 6.3	9.3 x 27.5 x 16.6/24.2 x 15.9 x 4.9/ 22.5 x 10.5 x 3.3	11.2 x 19
1.65kg (rcvr; ant, comm, batt), 3.44 kg (complete rover set)	1.2kg (rcvr;batt), 0.5kg (ant)	2.4kg (rcvr)/1.8kg (rcvr, batt), 0.5kg (ant)/0.63kg (rcvr)	1.35kg (2.97 lb) with internal battery, internal radio, standard UHF antenna
3mm + 0.5ppm (H), 5mm+0.5ppm (V)	3mm + 0.5ppm (H), 5mm+0.5ppm (V)	3mm + 0.5ppm (H), 5mm+0.5ppm (V)	± 5mm + 0.5ppm RMS (H), ± 5mm + 1 ppm RMS (V)
10mm + 1ppm (H), 15mm + 1ppm (V)	10mm + 1ppm (H), 15mm + 1ppm (V)	10mm + 1ppm (H), 15mm + 1ppm (V)	± 10mm + 1ppm RMS (H), ± 20 mm + 1ppm RMS (V)
12)	12)	13)	15)
Dual (a)	Dual (a)	Triple/Dual (a)/Dual (a)	Triple
40(L1) 20(L1+L2)/parallel (a)	40(L1) 20(L1+L2)/parallel (a)	72 Universal Channels/40(L1) 20(L1+L2)/parallel (a)	72/Trimble R-Track technology
40 (L1) 20(L1+L2) (a)	40 (L1) 20(L1+L2) (a)	36/40 (L1) 20(L1+L2) (a)/40 (L1) 20(L1+L2) (a)	GPS, Glonass "All in View"
<60/<10/<1	<60/<10/<1	<60/<10/<1	<60/<30/<15
Y, on-the-fly	Y, on-the-fly	Y, on-the-fly	Y
Situation dependent ~ seconds	Situation dependent ~ seconds	Situation dependent ~ seconds	typically <10 sec.
Y	Y	Y	N
Up to 20 Hz	Up to 20 Hz	Up to 20 Hz	1 Hz, 2 Hz, 5 Hz, and 10 Hz
2.1, 2.2, 2.3, 3.0	2.1, 2.2, 2.3, 3.0	2.1, 2.2, 2.3, 3.0	CMR+, RTCM 2.1, RTCM 2.3, RTCM 3.0 Input and Output
1,2,3,6,9,15,16,18,19,20,21,22,31,32,34,36,59 User selectable (incl. Special GLONASS messages)	1,2,3,6,9,15,16,18,19,20,21,22,31,32,34,36,59 User selectable (incl. Special GLONASS messages)	1,2,3,6,9,15,16,18,19,20,21,22,31,32,34,36,59 User selectable (incl. Special GLONASS messages)	16 NMEA outputs. GSOFF and RT17 outputs. Supports BINEX and smoothed carrier
Y,TPS, CMR, CMR+	Y,TPS, CMR, CMR+	Y,TPS, CMR, CMR+	CMR+
Integrated and external	External	External	Integrated
7.2 - 4.6	7.4-3.4/-/-	6 to 28 V/4/5/7 4-3.4/-/-/6 to 28V	☐
7.2 - 10 (1Watt Radio)	7.4-3.4/-/-	6 to 28 V/4/5/7 4-3.4/-/-/6 to 28V	☐
16hrs/14 hrs(RX)/10 hrs(TX)	GB-1000: 7hrs/ GB-500: 9hrs	Net-G3: N/A/ GB-1000: 7hrs/GB-500: 9hrs/ Legacy-E+: N/A	450MHz receive only option 10.5hrs with 2 internal batteries, varies with temperature
Y, GSM, GPRS (NTRIP)	Y, GSM, GPRS (NTRIP)	Y, GSM, GPRS (NTRIP)	Y/Circuit Switched/ Packet Switched
GSM, GPRS, EDGE, UMTS	GSM, GPRS, EDGE, UMTS	GSM, GPRS, EDGE, UMTS	All
4 serial, 1 power, USB, PPS, Events, Bluetooth (ODU & BNC type)	GB-1000: 3 serial, 1 power, USB, Ethernet, PPS, Events/GB500: 3 ser, 1pwr, USB, PPS, Events (Lemo, ODU, USB & RJ45 type)	14)	3-wire serial (7-pin Lemo) on Port 1. Full RS-232 serial on Port 2 (Dsub 9 pin)
Y	Y	Y	N
Y, modem, serial, USB and Ethernet (IP)	Y, modem, serial, USB and Ethernet (IP)	Y, modem, serial, USB and Ethernet (IP)	N/A
Y, PCCDU, TopNet, CORS	Y, PCCDU, TopNet, CORS	Y, PCCDU, TopNet, CORS	N/A
Y	Y	Y	Y
<1mm phase centre stability	<1mm phase centre stability	<1mm phase centre stability	Submm phase centre repeatability
<1mm phase centre stability	<1mm phase centre stability	<1mm phase centre stability	Submm phase centre repeatability
Y	Y	Y	Y
Internal 128MB	CF memory card/1024 MB (GB-1000), Internal memory 128 MB (GB-500)	CF memory card/1024MB	Internal memory/11MB: 302 hrs of raw observables based on recording data from 6 satellites at 15 sec. intervals
Fixed	Exchangeable (GB-1000), Fixed (GB-500)	Exchangeable/Service center exchangeable/Service center exchangeable	Fixed
Y, 240 x 320 pixel dimensions (FC100/FC200/GMS-2/FC2000)	Y, 240 x 320 pixel dimensions (FC100/FC200/GMS-2/FC2000)	Y, 240 x 320 pixel dimensions (FC100/FC200/GMS-2/FC2000)	16)
Y	Y	Y	Data collector: 53 key alphanumeric keypad, 8-position spider key
Y	Y	Y	Y
Y	Y	Y	Y
Y, laser distance, tilt, meteo, echo sounder	Y, laser distance, tilt, meteo, echo sounder	Y, laser distance, tilt, meteo, echo sounder	N/A
Y, both	Y, both	Y, both	Y, graphical/ E'N'H
Y, VRS, FKP, RTCM 3.0	Y, VRS, FKP, RTCM 3.0	Y, VRS, FKP, RTCM 3.0	Y
Topcon Link/Topcon Tools/3D Office	Topcon Link/Topcon Tools/3D Office	Topcon Link/Topcon Tools/3D Office	Trimble/TGO, TTC
32 bit, Windows compatible OS, Windows 98 or higher Version	32 bit, Windows compatible OS, Windows 98 or higher Version	32 bit, Windows compatible OS, Windows 98 or higher Version	10)
Y	Y	Y	Y
Y	Y	Y	Y
Y, localisation, predefined (Global) and user-defined projections	Y, localisation, predefined (Global) and user-defined projections	Y, localisation, predefined (Global) and user-defined projections	Y
Y, user defines text file format (ASCII)	Y, user defines text file format (ASCII)	Y, user defines text file format (ASCII)	Y, refer to www.trimble.com
Y, all commonly used formats supported	Y, all commonly used formats supported	Y, all commonly used formats supported	Y
Y	Y	Y	Y
Y	Y	Y	Y
Y, points, lines, roads, DTM, alignments	Y, points, lines, roads, DTM, alignments	Y, points, lines, roads, DTM, alignments	Y
Internal and External	Internal and External	External/Internal and External/External	Internal and External
2 x Internal	2 x Internal (Hot-swappable)	N/A/2 x Internal/N/A	2
Service Center Exchangeable	Exchangeable	N/A/Service Center Exchangeable/N/A	Exchangeable
Brand bound, Lithium Ion	Brand bound, Lithium Ion	Free available/Brand bound, Lithium Ion/Free available	Y
Y	Y	N/A/Y/N/A	N
Y	Y	Y	Y



Brand	Trimble	Trimble
Model name/Type	NetR5	R6
Introduction date		
Class (GPS, Glonass, Galileo/S, D en T)	GPS & Glonass	GPS & Glonass
Receiver and Antenna		
Dimensions (h*d*w ² in cm): base station case/ rover set case	5 x 24 x 12	11.5 x 19
Weight (receiver, rover; antenna, communications, batteries, pole)	1.55kg (3.42 lb) receiver with internal battery	1.35kg (2.97 lb) with internal battery, internal radio, standard UHF antenna.
Static [mm + ppm]	± 5mm + 0.5ppm RMS (H), ± 5mm + 1 ppm RMS (V)	± 5mm + 0.5ppm RMS (H), ± 5mm + 1 ppm RMS (V)
RTK [mm + ppm]	± 10mm + 1ppm RMS (H), ± 20 mm + 1ppm RMS (V)	± 10mm + 1ppm RMS (H), ± 20 mm + 1ppm RMS (V)
Signal(s) tracked (types/bands/codes)	15	17
Single/dual/triple frequency	Triple	Dual
Number of channels/tracking mode	72/Trimble R-Track technology	72/Trimble R-Track technology
Max. no. of satellites tracked parallel (GPS/Glonass/Galileo/Other)	GPS, Glonass "All in View"	GPS, Glonass "All in View"
Time to first fix (C/W/R) [sec/sec/sec]	<60/<30/<15	<60/<30/<15
Can the receiver perform RTK surveys?	Y, only as GPSNet rover integrity monitor typically <10 sec.	Y
RTK initialisation (s/d) [sec]	N	typically <10 sec.
PPS (Puls per second)	N	N
Update rate of position (frequency) [Hz]	1Hz, 2Hz, 5Hz, 10Hz and 20Hz	1Hz, 2Hz, 5Hz, and 10Hz
Supported RTCM version	CMR, CMR+, BINEX and RTCM 2.1, 2.2, 2.3, 3.0 Input and Output	CMR+, RTCM 2.1, RTCM 2.3, RTCM 3.0 Input and Output
Possible types of messages	RT-17/RT-27 outputs	16 NMEA outputs. GSOFF and RT17 outputs. Supports BINEX and smoothed carrier
Id. proprietary format	CMR+	CMR+
Antenna (integr. and/or ext.)	External	Integrated
Rover (r/rd/rdm) [V - W/W/W]	<input type="checkbox"/>	<input type="checkbox"/>
Base (b/bm) [V - W/W]	<input type="checkbox"/>	<input type="checkbox"/>
Operating time wo/w radio (h) [hrs/hrs]	15hrs	450 MHz receive only option 10.5hrs with 2 internal batteries, varies with temperature
Use of cellular phone for the datalink/ Protocol	Y/Circuit Switched/Packet Switched	Y/Circuit Switched/Packet Switched
Supported GSM protocols, ISDN, GPRS, UMTS	All	All
I/O-ports (number and type of plug)	1 LAN port: 1 port with RJ45 connector; 3 x RS232 ports, Bluetooth port, 1 USB port: host and slave	3-wire serial (7-pin Lemo) on Port 1. Full RS-232 serial on Port 2 (Dsub 9 pin)
Remote managing receiver	Y	N
Options remote	<input type="checkbox"/>	N/A
Special remote software needed?	Not needed	N/A
Integrity warnings (warning at failure datalink, loss of lock i.e. (Y/N))	Y	Y
Base antenna phase centre stability 1)	Submm phase centre repeatability	Submm phase centre repeatability
Rover antenna phase centre stability 1)	Submm phase centre repeatability	Submm phase centre repeatability
Data Storage and User Interface		
Data storage on receiver	Y	Y
Storage medium (type) / memory [MB]	59 MB (1620 hrs) of raw data observables based on recording data from 6 satellites at 15sec. epoch intervals	Internal memory/11 MB: 302 hrs of raw observables based on recording data from 6 satellites at 15sec. intervals
Exchangeable / fixed	Fixed. Support for USB memory stick and USB hard drives allowing several hundred GB to be stored for applications requiring more memory	Fixed
Display; size (lines and char. /line)	Y, 2 lines, 16 char./line	Not on Receiver. Data collector: Colour, illuminated TFT, daylight-readable touch screen displayed at 320 x 240 pixels (QVGA), backlight illuminated display.
Data input (pen/keys/qwerty board)	Keys	Data collector: 53 key alphanumeric keypad, 8-position spider key
Graphical display functions	N/A	Y
Background map support	N/A	Y
Suitable for other auxiliary input devices?	N/A	N/A
Stakeout options (Graphical/E'N'H)	N/A	Y, graphical/E'N'H
Support of RTK network solutions based on (VRS, FKP, PRS, RTCM3)	Y, only as GPSNet rover integrity monitor	Y
Office Software		
Brand / name	Trimble/TGO, TTC	Trimble/TGO, TTC
Hardware requirements	Pentium, 150MHz or faster with 32 MB RAM and a 1GB hard drive, SVGA colour 800 x 600, Keyboard with mouse or trackball, CD ROM drive	Pentium, 150MHz or faster with 32 MB RAM and a 1GB hard drive, SVGA colour 800 x 600, Keyboard with mouse or trackball, CD ROM drive
Network design (reconnaissance)	Y	Y
Network adjustment	Y	Y
Determination of local coordinate system parameters and input of predefined coordinate system parameters	Y	Y
User file output supported, specify	Yes, refer to www.trimble.com	Yes, refer to www.trimble.com
Predefined output format supported DXF, SHP, ..	Y	Y
Feature code processing	Y	Y
DTM and Volume calculations	Y	Y
Stakeout preparation	Y	Y
Batteries		
Internal and/or External	Internal, not user replaceable	Internal and External
Number	1	2
Fixed or Exchangeable	Fixed	Exchangeable
Free available i.e. penlight/brand bound	N/A	Y
Rechargeable with (auto)battery	Y	N
Direct car connection cable available	N/A	Y

Notes

- Noise in mm, E, N, H/%epoch 0-10°/epoch 10-90°.
- Specifications of CHC X60 (not listed), introduced May 2005, differ only slightly from specifications of CHC X90.
- Hemisphere GPS delivers also the 20g Crescent OEM board only.
- Specifications of GX1230, introduced March 2004, resembles those of GX1230 GG and is upgradable to Glonass.
- Fully independent L1 and L2 code and phase measurements. GPS: L4 L1 + 14 L2. (L1 Carrier phase full wavelength, C/A narrow code) (L2 Carrier phase full wavelength with C-code and P-Code [AS off] or P-code aided under AS. Equal performance with AS on or off). GLONASS: L2 L1 + 12 L2. (L1 Carrier phase full wavelength, C/A narrow code). SBAS : WAAS/EGNOS/MSAS. Designed to support GPS L5 and Galileo E1 and E5.
- Another receiver enclosure of Novatel, the FlexPak-V2, not listed here, differs slightly in dimensions and is not able to track L5 and L-band.
- The PenmapGPS is also available with external GPS antenna, external cellular phone and external battery as PenmapGPS-MC.
- More satellites can be tracked with Polara2eH: 16 SF (3 ant), 9 DF (3 ant) -24 SF (2 ant), 12 DF (2 ant).
- 1 x external DC power port, 1 x RS232 serial port, Integrated USB for data download speeds in excess of 1 Mb/s, External GPS antenna connector, 2 x CompactFlash removable data storage ports.
- Pentium, 150MHz or faster with 32MB RAM and a 1GB hard drive, SVGA colour 800 x 600, Keyboard with mouse or trackball, CD ROM drive.
- GPS: L1 (C/A &P), L2, L2C, L5; Glonass: L1, L2, L1CA, L2CA, L1 P, L2 P; Galileo: E2-L1-E1, E5a; EGNOS/WAAS
- GPS: L1, L2 carrier, CA, L1 P, L2 P (a); GLONASS: L1, L2, L1CA, L2CA, L1 P, L2 P; Galileo: G3 Upgrade path (a); EGNOS/WAAS
- GPS: L1, L2 carrier, CA, L1 P, L2 P (a); GLONASS: L1, L2, L1CA, L2CA, L1 P, L2 P; EGNOS/WAAS; Galileo: E2-L1-E1, E5a/Galileo: G3 Upgrade path (a); Galileo : G3 Upgrade path (a).
- NET-G3: 4 ser, 1 USB, 1 Ethernet, 2 pwr, 1PPS, Event Marker, Ext. Frequency, GPS antenna / GB-1000: 3 serial, 1 power, USB, Ethernet, PPS, Events/GB500: 3 ser, 1pwr, USB, PPS, Events (Lemo, ODU, USB & RJ45 type)/Legacy E-: 4 serial, 2 power, USB, Ethernet, PPS, Events, GPS antenna.
- GPS L1 C/A Code, L2C, L1/L2/L51 Full Cycle Carrier; Glonass L1 C/A Code, L1 P Code, L2 P Code, L1/L2 Full Cycle Carrier; SBAS WAAS/EGNOS support.
- Not on Receiver. Data collector: Colour, illuminated TFT, daylight-readable touch screen displayed at 320 x 240 pixels (QVGA), backlight illuminated display.
- GPS L1 C/A Code, L2C, L1/L2 Full Cycle Carrier; Glonass L1 C/A Code, L1 P Code, L2 P Code, L1/L2 Full Cycle Carrier; SBAS WAAS/EGNOS support.



N/A = Not Applicable
 = No information received