

# HS10D, HS20D, HS50D

## General

The GPS receiver *HSxD* (= *HS10D*, *HS20D* or *HS50D*) processes the NMEA sentences VTG and GGA of the integrated GPS receiver unit. Beside the serial NMEA output (with 115200 baud), it additionally provides the horizontal speed, driving direction, height, position, longitudinal acceleration, angular speed, traverse acceleration, slope angle, curve radius, total acceleration and quality of the GPS measurement data via a three-line display, via a voltage output, via a frequency output and via a CAN bus, where interpolated values are used to put out the corrected speed, the acquired acceleration and the driven distance every 10 ms. Furthermore, driving performance measurements can be made directly.



Figure 1: GPS receiver HS50D with antenna.

## Scope of Delivery

The scope of delivery of a *HSxD* contains:

- *HSxD* box
- Connection cable with open ends for power supply and CAN bus
- GPS antenna
- USB connection cable (virtual COM port)
- Adapter cable *GPS-NMEA* for USB connection cable to connect with the NMEA output
- Adapter cable *GPS-Prog* for USB connection cable to program and configure the GPS receiver unit (which is usually not necessary)

## Accessory

Not within the scope of delivery are:

- external display *ED13* (see appendix 1)
- vacuum cup for *ED13* or *HSxD* (see appendix 2)
- power adapter *PA*
- low speed CAN adapter *LCC719*

## Device Variants

Beside the *HSxD* box, there is also the *HSxD-L* box with a backlit display. The *HSxD-L* box is 3 mm higher, has an additional weight of 11 g, and its current consumption is 50 mA higher than that of the *HSxD* box.

## Voltage Output

The voltage consists of a 12-bit D/A converter which can put out voltages within the range from 0 V to 5 V. It has an internal resistance  $R_i$  of 1 k $\Omega$ . The linearity and offset error are max. 20 mV. At the moment, the current total acceleration is put out as a linear voltage signal: 0 m/s<sup>2</sup>  $\mapsto$  2.5 V and 15 m/s<sup>2</sup>  $\mapsto$  5 V.

The voltage signal is at the LCD page *longitudinal acceleration* the magnitude of signal *GS2\_Acceleration*, at the LCD page *traverse acceleration* the magnitude of signal *GS4\_TraverseAcceleration*, and at the other LCD pages the signal *GS4\_TotalAcceleration*, with the following typical signal delay:

Device Type	acceleration signal delay
HS10D	400 ms (with $T_{acc} = 400$ ms)
HS20D	425 ms (with $T_{acc} = 400$ ms)
HS50D	440 ms (with $T_{acc} = 400$ ms)

## Frequency Output

The frequency output provides a square-wave signal with 0 V or 5 V levels and a 50 % duty cycle. It has an internal resistance  $R_i$  of 1 k $\Omega$ . At the moment, the current speed is put out as a linear frequency signal with 10 Hz per km/h and with an offset of 100 Hz: 0 km/h  $\mapsto$  100 Hz and 100 km/h  $\mapsto$  1100 Hz.

The frequency signal is the signal *GS3\_SpeedInt*, which is updated every 10 ms, and which has the following typical signal delay:

Device Type	GS3_SpeedInt delay
HS10D	150 ms
HS20D	100 ms
HS50D	70 ms

## Operating Modes

The **PAGE** button is used to switch the pages of the LCD display. With releasing the button after holding it down for a longer period of time, sometimes a corresponding action (usually a reset) is triggered.

After turning on, the display page *Driving dynamics* is automatically selected as soon as the GPS signals are valid.

### Info:

HS50D V1.1.0    ascertained device type / firmware version  
 Bat: 12.0 V    measured power supply  
 23:59:59    local time

### Driving dynamics:

100 kph 240m    speed / height  
 B 9.8 R 0.1    longitudinal acc. / traverse acceleration  
 200m 1° 8    curve radius / slope angle / num. of satellites

### GPS status:

100.00 km/h    speed  
 240 m 359°    height / direction  
 Q9 S8 H1.0    quality / number of satellites / HDOP

### Longitudinal acceleration:

100.00 km/h    speed  
 -9.81 m/s<sup>2</sup>    acceleration  
 70 m    distance

### Traverse acceleration:

100.00 km/h    speed  
 0.14 m/s<sup>2</sup>    traverse acceleration  
 200 m 1°T    curve radius / slope angle

### Position:

50.00000 °N    latitude  
 10.00000 °E    longitude  
 240.0 m    height

### Acceleration measurement (A: 0...100 km/h):

#### Waiting for satellite signals:

43.85 km/h    current speed  
 Waiting for  
 sat    A    measurement A

#### Preparing measurement:

43.85 km/h    current speed  
 Waiting for  
 < 3 km/h A    measurement A

#### Waiting for start of measurement:

0.00 km/h    current speed  
 Waiting for  
 ≥ 3 km/h A    measurement A

#### Measurement in progress:

51.71 km/h    current speed  
 30.58 m    progressing distance  
 4.07 s A    progressing time / measurement A

#### Result:

2.97 m/s<sup>2</sup>    average acceleration  
 146.11 m    required distance  
 9.34 s A    required time / measurement A

### Braking measurement (B: 100...0 km/h):

#### Waiting for satellite signals:

43.85 km/h    current speed  
 Waiting for  
 sat    B    measurement B

#### Preparing measurement:

43.85 km/h    current speed  
 Waiting for  
 >100km/h B    measurement B

#### Waiting for start of measurement:

123.51 km/h    current speed  
 Waiting for  
 ≤100km/h B    measurement B

#### Measurement in progress:

48.95 km/h    current speed  
 33.57 m    progressing distance  
 1.62 s B    progressing time / measurement B

#### Result:

-8.52 m/s<sup>2</sup>    average acceleration  
 43.89 m    required distance  
 3.26 s B    required time / measurement B

### 400 m measurement (D: 0...400 m):

#### Waiting for satellite signals:

43.85 km/h    current speed  
 Waiting for  
 sat    D    measurement D

#### Preparing measurement:

43.85 km/h    current speed  
 Waiting for  
 < 3 km/h D    measurement D

#### Waiting for start of measurement:

0.00 km/h    current speed  
 Waiting for  
 ≥ 3 km/h D    measurement D

#### Measurement in progress:

50.21 km/h    current speed  
 13.14 m    progressing distance  
 1.95 s D    progressing time / measurement D

#### Result:

4.68 m/s<sup>2</sup>    average acceleration  
 197.40 km/h    speed after 400 m  
 11.71 s D    required time / measurement D

### NMEA sentences:

Tv: 20 ms    ascertained gap between VTG sentences  
 Tp: 100 ms    ascertained gap between GGA sentences  
 Cv01 Cp01    sentence counters (VTG / GGA)

## Driving Performance Meas.

The different measurements are constantly running in the background, and can be reset at any time by pressing the button longly (at the corresponding measurement page). The acceleration and 400 m measurement are reset together. Whereas the braking measurement is also automatically reset (when driving with more than 100 km/h). The measurements start (or end) at 3 km/h, where the time and distance difference (within the velocity-time graph) to 6 km/h is used for linear extrapolation to 0 km/h:

$$\Delta t_{0...3 \text{ km/h}} = | t_{6 \text{ km/h}} - t_{3 \text{ km/h}} |$$

$$\Delta s_{0...3 \text{ km/h}} = (3 \text{ km/h} \cdot \Delta t_{0...3 \text{ km/h}}) / 2$$

## Display (HDOP)

The HDOP value is displayed on each page in the lower right as a level meter:

Bar	HDOP	( $\Delta$ HDOP)	Comment
7	0,0 ... 1,3	( +1,3 )	best signal
6	1,4 ... 1,8	( +0,4 )	1,4 $\approx$ 1,3875 <sup>1</sup>
5	1,9 ... 2,6	( +0,7 )	1,9 $\approx$ 1,3875 <sup>2</sup>
4	2,7 ... 3,6	( +0,9 )	2,7 $\approx$ 1,3875 <sup>3</sup>
3	3,7 ... 5,0	( +1,3 )	3,7 $\approx$ 1,3875 <sup>4</sup>
2	5,1 ... 7,0	( +1,9 )	5,1 $\approx$ 1,3875 <sup>5</sup>
1	7,1 ... 9,8	( +2,7 )	7,1 $\approx$ 1,3875 <sup>6</sup>
0	9,9 ... 9,9	( +0,0 )	no satellites

## Display (Direction)

The driving direction of the GPS antenna is display directly left to the HDOP level meter as an arrow:

Arrow	Direction	Comment
↑	337,5° ... 22,49° N	
↗	22,5° ... 67,49° NE	
→	67,5° ... 112,49° E	
↘	112,5° ... 157,49° SE	
↓	157,5° ... 202,49° S	
↙	202,5° ... 247,49° SW	
←	247,5° ... 292,49° W	
↖	292,5° ... 337,49° NW	
	( 360° )	no direction

## CAN

### CAN default settings

CAN library	HSxD 1.2
CAN baud rate	500 kbps
CAN sample point	80 %
Message basis ID	600h (11-bit std ID)
Message IDs	600h ... 607h

### Bit numbering

Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
7...0	15...8	23...16	31...24	39...32	47...40	55...48	63...56

A HSxD CAN signal allocates the bit range (within the CAN message) from its start bit to start bit + bit length - 1. The bit numbering corresponds to the weight of the bits of an unsigned 64-bit number (with Intel byte order).

**Message GS1** (ID: basis ID + 0 = 600h / Length: 8 bytes / Repetition rate: after each correctly received VTG sentence)

S'	D L	Description
0	u8	<b>GS1_Counter:</b> This counter is incremented with each new GS1 message. The counter restarts after 255 with 0.
8	u8	<b>GS1_Flags:</b> Bit mask with following assignment: 1: GS1_SpeedRaw not updated 2: GS1_TrackRaw not updated 4: GS4_SpeedAvg not updated 8: GS2_Acceleration not updated 16: Waiting for synchronization for signals GS2_Acceleration, GS3_..., and GS4_SpeedAvg. 32: VTG sentence received too early or too late.
16	u16	<b>GS1_SpeedRaw:</b> Raw (= untreated) speed signal ( $= v_R$ ), directly taken from VTG sentence with a resolution of 0.01 km/h per bit.
32	u16	<b>GS1_TrackRaw:</b> Raw driving direction (= track made good) with a resolution of 0.01° per bit.
48	u16	<b>GS1_Track:</b> Driving direction after acceptance check ( $v_R \geq v_{T,min}$ where $v_{T,min} = 2$ km/h) with a resolution of 0.01° per bit.

**Message GS2** (ID: basis ID + 1 = 601h / Length: 8 bytes / Repetition rate: after each correctly received VTG sentence)

S	D L	Description
0	u16	<b>GS2_Speed:</b> Speed signal ( $= v$ ) after acceptance check, standing detection ( $v_R \geq v_{min}$ with $v_{min} = 0,5$ km/h) and limited acceleration ( $ a  \leq a_{max}$ where $a_{max} = 13,89$ m/s <sup>2</sup> ) with a resolution of 0,01 km/h per bit.
16	s16	<b>GS2_Acceleration:</b> Acceleration of the speed signal $v$ with a resolution of 0.01 m/s <sup>2</sup> per bit.
32	u32	<b>GS2_Distance:</b> Absolute distance counter since HSxD reset with a resolution of 0,01 m per bit.

**Message GS3** (ID: basis ID + 2 = 602h / Length: 8 bytes / Repetition rate: 10 ms)

S	D L	Description
0	u16	<b>GS3_SpeedInt:</b> Interpolated speed signal with a resolution of 0.01 km/h per bit. This signal is linear interpolated from the last two values of signal GS2_Speed.
16	s16	<b>GS3_AccelerationInt:</b> Interpolated acceleration signal with a resolution of 0,01 m/s <sup>2</sup> per bit. This signal is linear interpolated from the last two values of signal GS2_Acceleration.
32	u32	<b>GS3_DistanceInt:</b> Interpolated distance with a resolution of 0.01 m per bit. This signal is linear interpolated from the last two values of signal GS2_Distance.

**Message GS4** (ID: basis ID + 3 = 603h / Length: 8 bytes / Repetition rate: after each correctly received VTG sentence)

S	D L	Description
0	s16	<b>GS4_AngularSpeed:</b> Angular speed with a resolution of 0.001 Hz per bit.
16	s16	<b>GS4_TraverseAcceleration:</b> Traverse acceleration $a_T$ with a resolution of 0.01 m/s <sup>2</sup> per bit.
32	u16	<b>GS4_Radius:</b> Curve radius with a resolution of 0.1 m per bit.
48	u8	<b>GS4_SlopeAngle:</b> Slope angle with a resolution of 0.25° per bit.
56	u8	<b>GS4_TotalAcceleration:</b> Total acceleration, calculated from $\sqrt{a^2 + a_T^2}$ , with a resolution of 0.1 m/s <sup>2</sup> per bit.

1 S: start bit  
 D: data type (u – unsigned Intel / s – signed Intel)  
 L: bit length

**Message GP1** (ID: basis ID + 4 = 604h / Length: 8 bytes / Repetition rate: after each correctly received GGA sentence)

S	DL	Description
0	u8	<b>GP1_Counter:</b> This counter is incremented with each GP1 message. The counter restarts after 255 with 0.
8	u4	<b>GP1_Qual:</b> GPS quality indicator (additional specification for HS20D/HS50D): 0: GPS data not available (or invalid) 1: GPS fix 2: C/A differential GPS, OmniSTAR HP, OmniSTAR XP, OmniSTAR VBS oder CDGPS 4: RTK fixed ambiguity solution (RT2), see also table 90 on page 530 of <a href="#">OEMV family firmware reference manual rev 8</a> 5: RTK floating ambiguity solution (RT20), OmniSTAR HP or OmniSTAR XP 6: Dead reckoning mode 7: Manual input mode (fixed position) 8: Simulator mode 9: WAAS (= Wide Area Augmentation System)
12	u4	<b>GP1_Flags:</b> Bit mask with following assignment: 1: <i>GP1_Sat</i> not updated 2: <i>GP1_HDOP</i> not updated 4: <i>GP1_Synch</i> not updated 8: <i>GP1_HeightRaw</i> not updated
16	u6	<b>GP1_Sat:</b> Number of satellites in use. May be different to the number in view.
22	u2	<b>GP1_Flags2:</b> Bit mask with following assignment: 1: <i>GP2_LatitudeRaw</i> not updated 2: <i>GP2_LongitudeRaw</i> not updated
24	u8	<b>GP1_HDOP:</b> Horizontal dilution of precision with a resolution of 0.1 per bit.
32	u16	<b>GP1_Synch:</b> Part of the UTC time of the GGA sentence. Note, that only the backmost part m:ss.ss from the UTC time hh:mm:ss.ss is used with a resolution of 0.01 s per bit.
48	u16	<b>GP1_HeightRaw:</b> Raw antenna altitude above mean sea level with a resolution of 0,1 m per bit, and with an offset of -500 m.

**Message GP2** (ID: basis ID + 5 = 605h / Length: 8 bytes / Repetition rate: at the earliest after each correctly received GGA sentence)

S	DL	Description
0	s32	<b>GP2_LatitudeRaw:</b> Raw latitude with a resolution of 1/600000 °N per bit.
32	s32	<b>GP2_LongitudeRaw:</b> Raw longitude with a resolution of 1/600000 °E per bit.

**Message GP3** (ID: basis ID + 6= 606h / Lenth: 8 bytes / Repetition rate: at the earliest after each correctly received GGA sentence)

S	DL	Description
0	s32	<b>GP3_Latitude:</b> Latitude with a resolution of 1/600000 °N per bit. This signal is not updated when no satellites are available.
32	s32	<b>GP3_Longitude:</b> Longitude with a resolution of 1/600000 °E per bit. This signal is not updated when no satellites are available.

**Message GP4** (ID: basis ID + 7= 607h / Length: 8 bytes / Repetition rate: after each correctly received GGA sentence)

S	DL	Description
0	u8	<b>GP4_VBat:</b> Measured supplying voltage of the <i>HSxD</i> with a resolution of 0.2 V per bit (and internally measured up to 35 V).
8	u8	<b>GP4_Sec:</b> Local time with a resolution of 1 s per bit in the range of 0..59 s.
16	u8	<b>GP4_Min:</b> Local time with a resolution of 1 minute per bit in the range of 0..59 minutes.
24	u8	<b>GP4_Hours:</b> Local time with a resolution of 1 hour per bit in the range of 0..23 hours.
32	u8	<b>GP4_UTCMin:</b> UTC time with a resolution of 1 minute per bit in the range of 0..59 minutes.
40	u8	<b>GP4_UTCHours:</b> UTC time with a resolution of 1 hour per bit in the range of 0..23 hours.
48	u16	<b>GP4_UTC:</b> UTC time with a resolution of 2 s per bit in the range of 0..23 hours.

## Signal Delays

Symbol	Description
$T_{10}$	Repetition rate for HS10D (= 100 ms)
$T_{20}$	Repetition rate for HS20D (= 50 ms)
$T_{50}$	Repetition rate for HS50D (= 20 ms)
$T_{acc}$	Time window setting for acceleration calculation (= 400 ms).
$T_{acc,x}$	Time windows for acceleration calculation: $T_{acc,x} = \min(i \cdot T_x \mid i \cdot T_x \geq T_{acc})$ mit beliebiger Ganzzahl $i$ von 1 bis 51 für den GPS-Empfänger HSxD mit $x \in \{ 10, 20, 50 \}$
$T_{avg,x}$	Time window for moving average signal: $T_{avg,x} = T_{acc,x} - T_x$ mit $x \in \{ 10, 20, 50 \}$
$T_{d,acc,x}$	Delay of acceleration signal: $T_{d,acc,x} = T_{acc,x} - T_x/2$ mit $x \in \{ 10, 20, 50 \}$
$T_{d,avg,x}$	Delay of moving average signal: $T_{d,avg,x} = (T_{acc,x} - T_x)/2$ mit $x \in \{ 10, 20, 50 \}$
$T_{GPS,x}$	General delay of the GPS signals from GPS receiver HSxD with $x \in \{ 10, 20, 50 \}$ .

## Signal Delays for HS50D

Signal	Typical signal delay	
GS2_Acceleration	440 ms	$T_{GPS,50} + T_{d,acc,50}$
GS3_AccelerationInt	460 ms	$T_{GPS,50} + T_{d,acc,50} + T_{50}$
GS3_DistanceInt	70 ms	$T_{GPS,50} + T_{50}$
GS3_SpeedInt	70 ms	$T_{GPS,50} + T_{50}$
GS4_...	440 ms	$T_{GPS,50} + T_{d,acc,50}$
All further GPS signals	50 ms	$T_{GPS,50}$
$T_{50} \mid T_{GPS,50} \mid T_{acc}$	20 ms   50 ms   400 ms	
$T_{acc,50} \mid T_{d,acc,50}$	400 ms   390 ms	
$T_{avg,50} \mid T_{d,avg,50}$	380 ms   190 ms	

## Signal Delays for HS10D

Signal	Typical signal delay	
GS2_Acceleration	400 ms	$T_{GPS,10} + T_{d,acc,10}$
GS3_AccelerationInt	500 ms	$T_{GPS,10} + T_{d,acc,10} + T_{10}$
GS3_DistanceInt	150 ms	$T_{GPS,10} + T_{10}$
GS3_SpeedInt	150 ms	$T_{GPS,10} + T_{10}$
GS4_...	400 ms	$T_{GPS,10} + T_{d,acc,10}$
All further GPS signals	50 ms	$T_{GPS,10}$
$T_{10} \mid T_{GPS,10} \mid T_{acc}$	100 ms   50 ms   400 ms	
$T_{acc,10} \mid T_{d,acc,10}$	400 ms   350 ms	
$T_{avg,10} \mid T_{d,avg,10}$	300 ms   150 ms	

## Signal Delays for HS20D

Signal	Typical signal delay	
GS2_Acceleration	425 ms	$T_{GPS,20} + T_{d,acc,20}$
GS3_AccelerationInt	475 ms	$T_{GPS,20} + T_{d,acc,20} + T_{20}$
GS3_DistanceInt	100 ms	$T_{GPS,20} + T_{20}$
GS3_SpeedInt	100 ms	$T_{GPS,20} + T_{20}$
GS4_...	425 ms	$T_{GPS,20} + T_{d,acc,20}$
All further GPS signals	50 ms	$T_{GPS,20}$
$T_{20} \mid T_{GPS,20} \mid T_{acc}$	50 ms   50 ms   400 ms	
$T_{acc,20} \mid T_{d,acc,20}$	400 ms   375 ms	
$T_{avg,20} \mid T_{d,avg,20}$	350 ms   175 ms	

## Connectors

The socket and plugs of the *HSxD* are from the [Binder Series 719](#). The socket pins are (in frontal view) numbered clockwise, starting with the first pin after the notch. The plug pins are correspondingly numbered anti-clockwise.



Figure 2: Connectors of the GPS receiver HS50D.

**LNA:** The LNA connector is of type SMA, and connects the *HSxD* with an active GPS antenna. It is temporarily short-circuit proof due to its internal resistance of  $R_i = 50 \Omega$ . The active GPS antenna is supplied with 5 V DC.

**POWER/CAN:** This plug provides the *HSxD* with power and connects it with the CAN bus.

Pin	Assignment
1	Power supply (from 8 V DC to 30 V DC; inverse-polarity and voltage spike protected) (Wire color: brown)
2	Ground (Wire color: white)
3	CAN_L (Wire color: blue)
4	CAN_H (Wire color: black)

Note: The *HSxD* does not possess a CAN bus termination resistor. Therefore, it must be made sure that the CAN bus is properly ended, twice with a  $120 \Omega$  resistor (, or once with a  $60 \Omega$  resistor,) between CAN\_L and CAN\_H.

**RS232/PROG:** This plug connects the *HSxD* with two serial ports.

Pin	Assignment
1	Serial transmit wire TX1 to program the <i>HSxD</i>
2	Ground (internally connected with pin 2 of POWER/CAN)
3	Serial receive wire RX1 to program the <i>HSxD</i>
4	Serial transmit wire TX2 to program and to configure the GPS receiver unit
5	Serial receive wire RX2 to program and to configure the GPS receiver unit

**POWER/VOLTAGE/FREQUENCY/TX RS232:** This socket is optionally used to supply power to the *HSxD*, and it also provides the analog, digital, and NMEA output.

Pin	Assignment
1	Power supply (from 8 V DC to 30 V DC; inverse-polarity and voltage spike protected; internally connected with pin 1 of POWER/CAN)
2	Ground (internally connected with pin 2 of POWER/CAN)
3	Voltage output (0...5 V; internal resistance $R_i = 1 \text{ k}\Omega$ ; 12-bit D/A converter; linearity and offset error: max. 20 mV)
4	Digital output (0 V / 5 V; 50 % duty cycle; internal resistance $R_i = 1 \text{ k}\Omega$ )
5	Serial transmit wire TX3 (Output of the NMEA sentences at 115200 bps)

### Technical Data (HSxD Box)

Property	Description
Dimensions:	84 mm × 52 mm × 22 mm (+ 6 mm for connectors) (+ 3 mm for button/burling)
Typical weight:	119 g for HS10D 123 g for HS20D/HS50D
Power supply:	From 8 V DC to 30 V DC
Typical current consumption of HS20D/HS50D (HS10D):	230 mA (140 mA) at 8 V DC 180 mA (110 mA) at 12 V DC 150 mA (100 mA) at 16 V DC 120 mA (90 mA) at 24 V DC 115 mA (90 mA) at 30 V DC
Typical power consumption of HS20D/HS50D (HS10D):	1,8 W (1,1 W) at 8 V DC 2,2 W (1,3 W) at 12 V DC 2,4 W (1,6 W) at 16 V DC 2,9 W (2,2 W) at 24 V DC 3,5 W (2,7 W) at 30 V DC
Update rate of speed / position:	10 Hz / 10 Hz (for HS10D) 20 Hz / 20 Hz (for HS20D) 50 Hz / 10 Hz (for HS50D)
Display:	3-line LCD display with 12 characters per line
NMEA output:	VTG and GGA sentences with 115200 bps.
CAN:	1 high speed CAN channel (CAN 2.0B) with a max. baud rate of 1 Mbps
Analog output signal::	0...5 V 12-bit D/A converter Internal resistance $R_i = 1 \text{ k}\Omega$ (Linearity and offset error: max. 20 mV)
Digital output signal:	Frequency signal (square wave with 0 V / 5 V, and with a 50 % duty cycle) Internal resistance $R_i = 1 \text{ k}\Omega$
GPS receiver unit:	For HS10D: <a href="#">OEMStar-PVT-10Hz</a> (from NovAtel)  For HS20D and HS50D: <a href="#">OEMV-1-L1</a> (from NovAtel)
LED (Status):	<b>Green:</b> GPS receiver unit delivers valid values. <b>Red:</b> GPS receiver unit not yet ready.
Button (Page):	Button to switch the LCD pages, and when pressed longer, to trigger an action (usually a reset).

### Technical Data (GPS)

GPS receiver unit for HS10D (according to NovAtel):

Property	Description
First sample:	After 45 s (and in worst case after 75 s)
Speed accuracy:	< 0,05 m/s RMS
Position accuracy:	1,5 m RMS (for Single Point L1) 0,7 m RMS (for SBAS) 0,5 m RMS (for DGPS)

See also

<http://novatel.com/Documents/Papers/OEMStar.pdf>

GPS receiver unit for HS20D/HS50D (according to NovAtel):

Property	Description
First sample:	After 35 s (and in worst case after 60 s)
Speed accuracy:	0,03 m/s RMS
Position accuracy:	1,5 m RMS (for Single Point L1) 0,6 m RMS (for SBAS) 0,6 m RMS (for CDGPS) 0,4 m RMS (for DGPS) 0,6 m RMS (for OmniSTAR VBS) 0,2 m RMS (for RT-20)

See also

<http://novatel.com/Documents/Papers/OEMV1.pdf>

### Internet

Most recent HSxD firmware and HSxD data sheet:

<http://tellert.de/?product=hsxd>

Most recent device driver and installation guides for the USB connection cable *USBSE/B719K5*:

<http://tellert.de/?product=usbser>

Information about GPS receiver units used by HSxD:

<http://tellert.de/?product=hsxd-gps>

Information about Binder connectors:

<http://tellert.de/?product=b719>

## Appendix 1: External Display

The external Display *ED13* is backlit and has a contrasty 3.5 digit display with a digit height of 12.7 mm. The output text has the following meaning:

- no communication with *HSxD* box
- invalid GPS signal
- GPS signal out of representable range
- 19.9| (accelerating) longitudinal acceleration
- 19.9| (decelerating) longitudinal acceleration
- 19.9\_ (rightward) traverse acceleration
- 19.9\_ (leftward) traverse acceleration
- 19.9\_| total acceleration



Figure 3: External display ED13.

### Average Rate Switch

The average rate switch is used to define the width of the time window for averaging from 0 s to 1 s in 10 steps.

### Signal Select Switch

Position	Function
a_total	Total acceleration with a resolution of 0.1 m/s <sup>2</sup> from 0 m/s <sup>2</sup> to 19.9 m/s <sup>2</sup> .
a	Longitudinal acceleration with a resolution of 0.1 m/s <sup>2</sup> from -19.9 m/s <sup>2</sup> to 19.9 m/s <sup>2</sup> .
a_T	Traverse acceleration with a resolution of 0.1 m/s <sup>2</sup> from -19.9 m/s <sup>2</sup> to 19.9 m/s <sup>2</sup> .
max(a;a_T)	Dominant acceleration (= acceleration with higher magnitude of longitudinal and traverse acceleration) with a resolution of 0.1 m/s <sup>2</sup> from -19.9 m/s <sup>2</sup> to 19.9 m/s <sup>2</sup> .
v	Speed with a resolution of 0.1 km/h from 0 km/h to 199.9 km/h, or with a resolution of 1 km/h from 200 km/h to 655 km/h.
height	Height with a resolution of 1 m from -500 m to 1999 m.
radius	Curve radius with a resolution of 0.1 m from 0 m to 99.9 m, or with a resolution of 1 m from 100 m to 999 m.
angle	Slope angle with a resolution of 1° from 0° to 63°.
sat	Number of satellites in use.

Position	Function
test	<b>Average Rate 0 ... 0.8 s:</b> LCD test with a single floating segment.  <b>Average Rate 1 s:</b> Max. HDOP value for a valid GPS signal. This value is adjustable via a hole in the rear panel of the ED13.

### Pin Assignment

The 5 pin plug is optionally mountable in the empty bore of the rear panel.

Pin	Assignment
1	Power supply (from 8 V DC to 30 V DC; inverse-polarity protected)
2	Ground
3	Input voltage (0 V to 5 V; currently not used)
4	Serial transmit wire TX for communication with the <i>HSxD</i> box
5	Serial receive wire RX for communication with the <i>HSxD</i> box

### Technical Data (ED13)

Property	Description
Dimensions:	95 mm × 50 mm × 20 mm (+ 6 mm for connector) (+ 13 mm for switches/burling)
Cable length:	1.5 m
Typical weight:	122 g
Power supply:	8 V DC to 30 V DC via the <i>HSxD</i> box; the backlit requires at least 10 V DC.
Typical current consumption:	60 mA
Typical power consumption:	0.5 W at 8 V DC 0.7 W at 12 V DC 1.0 W at 16 V DC 1.4 W at 24 V DC 1.8 W at 30 V DC

## Appendix 2: Vacuum Cup

The vacuum cup *ED13VC* can be used to mount an *ED13* or a *HSxD* on a smooth and flat surface (e. g. glass pane). The fixation is done with a provided piece of hook-and-loop tape.



**Figure 4:** Vacuum cup ED13VC for ED13 or HSxD.