NovAtel's OEMV-1DF™ L1/L2 Receiver Provides RTK Positioning for Space-Constrained Applications

White Paper

Summary

This paper demonstrates that for applications where performance, size, power consumption, interference mitigation and ease of integration are key considerations, NovAtel's OEMV-1DF receiver is an ideal solution. As the industry's smallest dual frequency GPS receiver, the OEMV-1DF provides reliable positioning performance with no incorrect fixes. This white paper provides an overview of NovAtel's OEMV-1DF receiver and presents test results on its RTK positioning performance in typical conditions and with the presence of interference.

Introduction

The OEMV-1DF receiver offers dual frequency GPS measurements and positioning including NovAtel's AdVance® RTK for high performance centimetre accurate real-time positioning. The OEMV-1DF also offers increased interference rejection and rugged design for continuous and reliable GNSS positioning in harsh, unfavourable conditions. Additional NovAtel firmware features, such as ALIGN® for precise heading and GL1DE® for consistent pass-to-pass accuracy, are also available on the compact OEMV-1DF card.

This paper includes size comparisons and competitive tests comparing RTK positioning performance and interference rejection to industry competitors. It also discusses the advantages related to the environmental conditions the OEMV-1DF can tolerate and its ease of integration.

Size and Weight

Measuring only 46 x 71 mm and weighing just 21.5 grams, the OEMV-1DF allows accurate RTK positioning to be integrated into compact applications where RTK positioning has never been used before. Figure 1 compares the relative size of the OEMV-1DF and four other competitor GNSS receivers to a typical personal digital assistant (PDA) used in the survey industry. The comparison illustrates that the compact form factor of the OEMV-1DF is the most optimal for integration into this device.

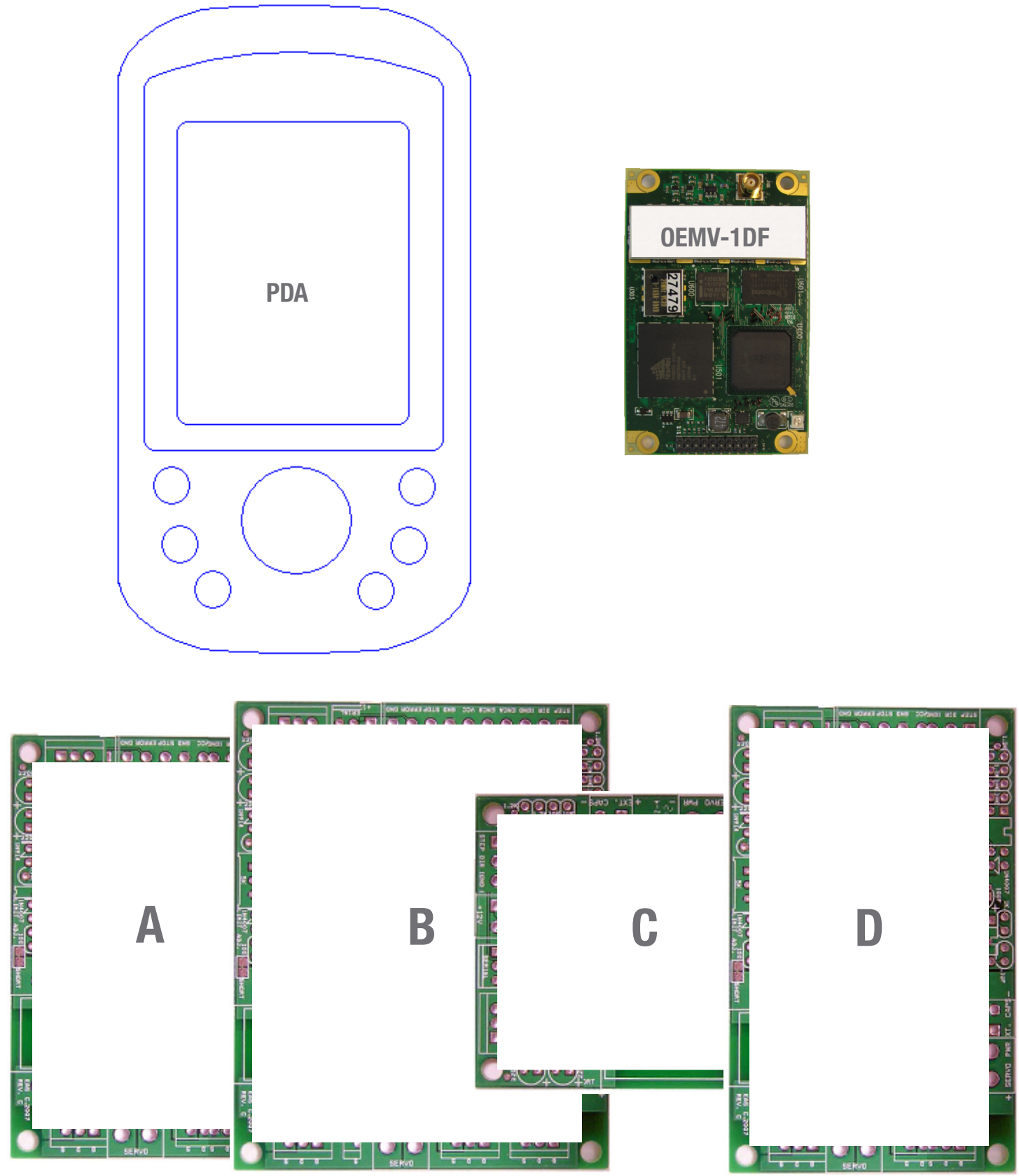
The OEMV-1DF is also suitable for small-payload applications such as those deployed in unmanned aerial vehicles (UAV). The use of a smaller, high-performance GPS receiver provides more room in the payload for application-specific components.

Positioning Performance

OEMV-1DF RTK performance was measured using a test set up designed to eliminate test biases and isolate RTK performance. Refer to NovAtel's AdVance RTK white paper, available on our Web site at www.novatel.com, for details about the set up.

The OEMV-1DF RTK receiver was tested against several GPS+GLONASS RTK receivers, including four industry competitor products and NovAtel's OEMV-3™ receiver. The test results are shown in Figures 2 -11 and Tables 1-3 for short, medium and long baselines.

Figure 1 Size of compact OEM GNSS receivers relative to a typically used PDA



Test Results: Short Baselines (3 km)

In the short baseline (3 km) test, the OEMV-1DF receiver had the best position accuracy. While the OEMV-3™ differed by only a few millimetres, the other competitors could not achieve the same degree of accuracy as the OEMV-1DF and experienced wrong fixes. The OEMV-1DF had a slightly lengthier initialization time, on average, than the OEMV-3 and competitors A and D, but was faster than competitors B and C.

Table 1 RTK Performance – 3 km Baseline

Receiver	2D Error RMS (m)	Ht Error RMS (m)	Mean Fix Time (s)
OEMV-1DF	0.006	0.009	14.4
OEMV-3	0.008	0.010	13.7
A	0.007	0.024	9.4
B	0.014	0.018	23.5
C	0.030	0.033	16.8
D	0.012	0.014	11.9

Figure 2 Horizontal Position Error Scatter Plot - 3 km Baseline

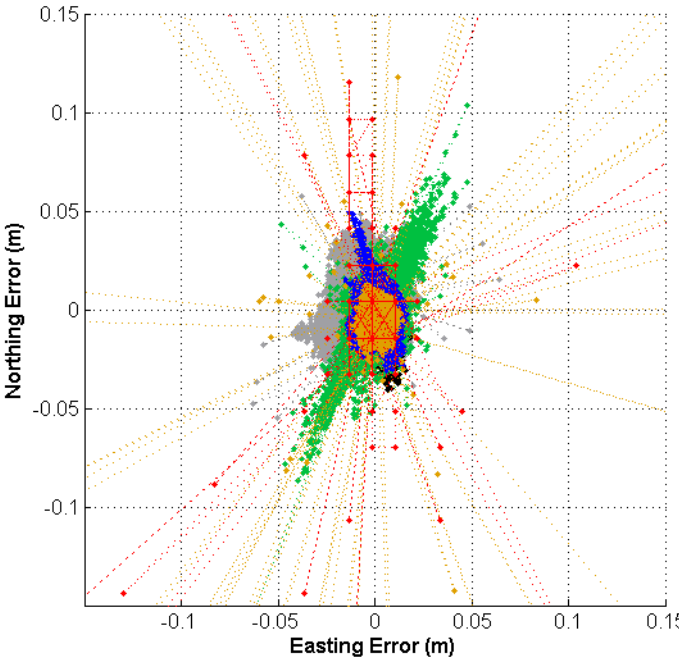


Figure 3 Time to Fix Percentage - 3 km Baseline

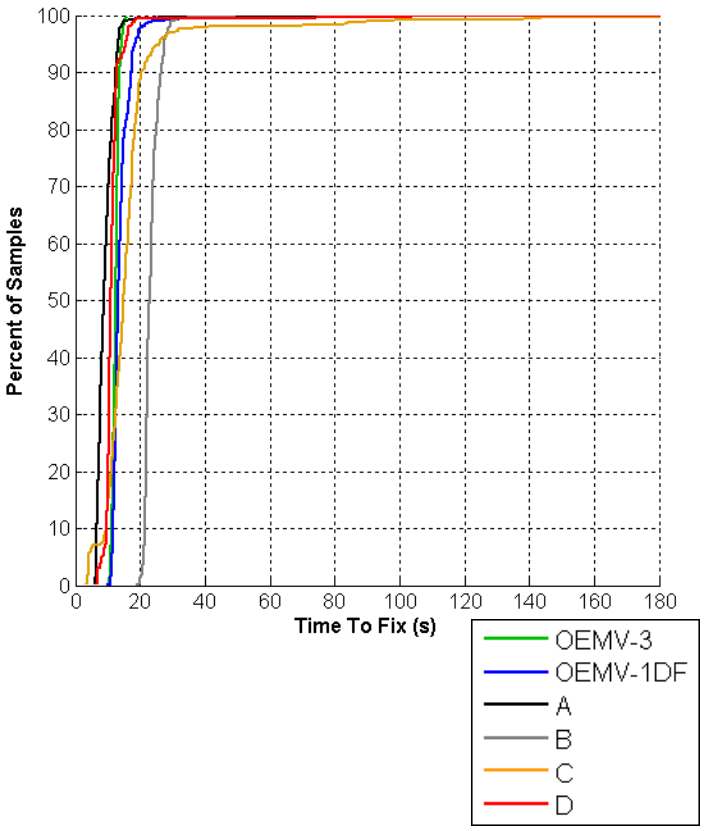
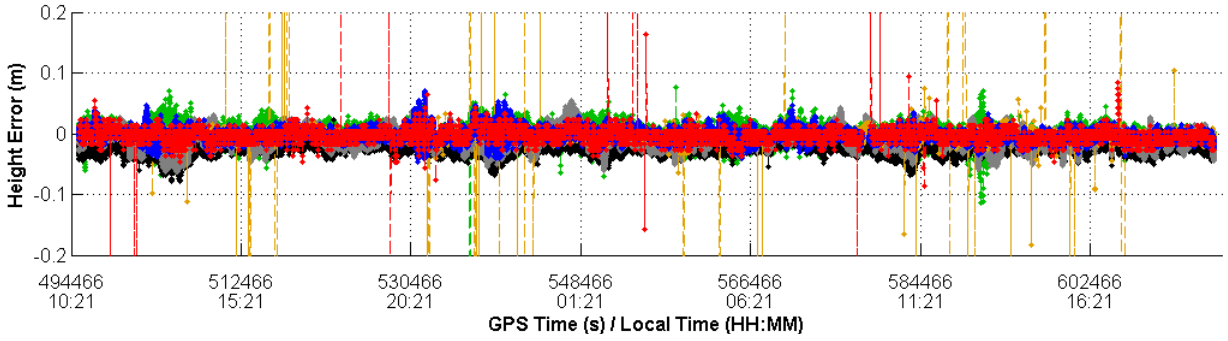


Figure 2 Vertical Position Error – 3 km Baseline – Open Sky



Test Results: Medium Baselines (12 km)

In the medium baseline (12 km) test , the OEMV-1DF maintained its high accuracy outperforming most industry competitors. It was, however, outperformed by the OEMV-3 by a few millimetres. The OEMV-1DF was also able to maintain a consistent initialization time of 15 seconds, on average. Only competitor A and the OEMV-3 were slightly faster.

Table 2 RTK Performance – 12 km Baseline

Receiver	2D Error RMS (m)	Ht Error RMS (m)	Mean Fix Time (s)
OEMV-1DF	0.012	0.019	15.4
OEMV-3	0.011	0.017	14.2
A	0.012	0.020	12.0
B	0.016	0.029	30.7
C	0.024	0.047	24.4
D	0.014	0.024	20.8

Figure 5 Horizontal Position Error Scatter Plot - 12 km Baseline

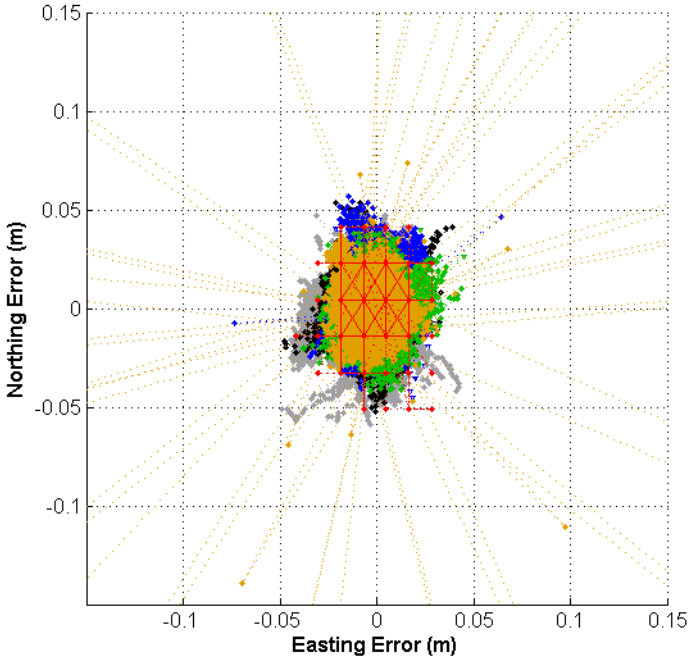


Figure 6 Time to Fix Percentage - 12 km Baseline

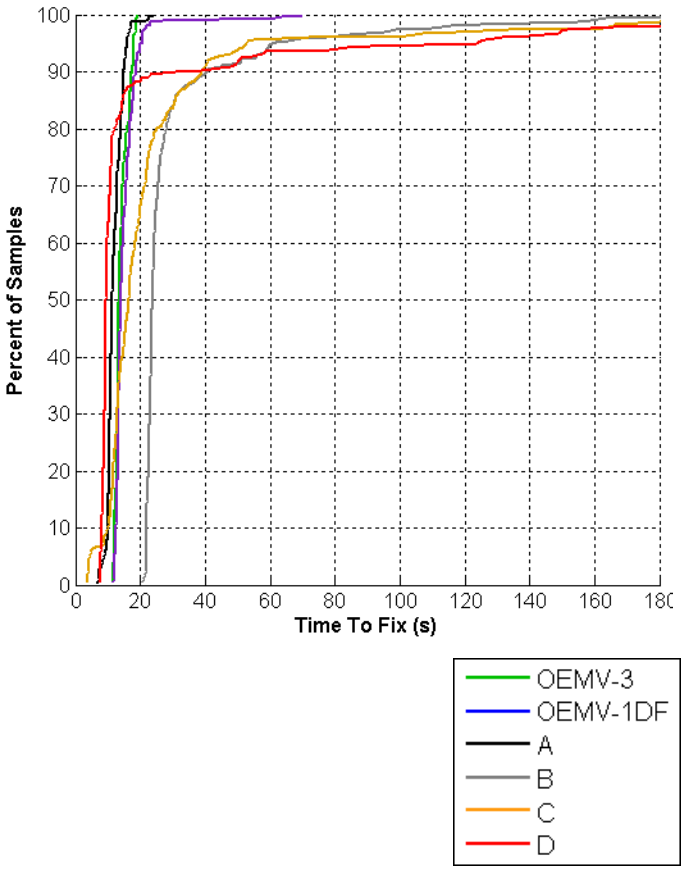
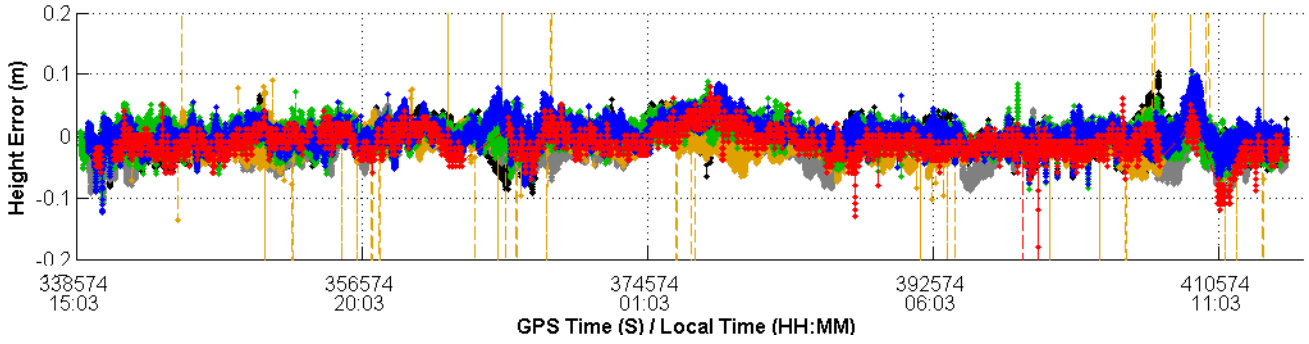


Figure 7 Vertical Position Error – 12 km Baseline



Test Results: Long Baselines (33 km)

In the long baseline (33 km) test, the OEMV-3 had the highest accuracy, with the OEMV-1DF and competitor A differing by millimetres in both horizontal and vertical accuracy. The OEMV-1DF once again produced similar initialization times as the OEMV-3 and competitor A, with competitors B, C and D having on average, much lengthier RTK initialization.

Table 3 RTK Performance – 33 km Baseline

Receiver	2D Error RMS (m)	Ht Error RMS (m)	Mean Fix Time (s)
OEMV-1DF	0.018	0.026	14.3
OEMV-3	0.011	0.019	14.8
A	0.017	0.029	9.7
B	0.017	0.026	34.9
C	0.031	0.045	34.2
D	0.016	0.024	31.4

Figure 8 Horizontal Position Error Scatter Plot - 33 km Baseline

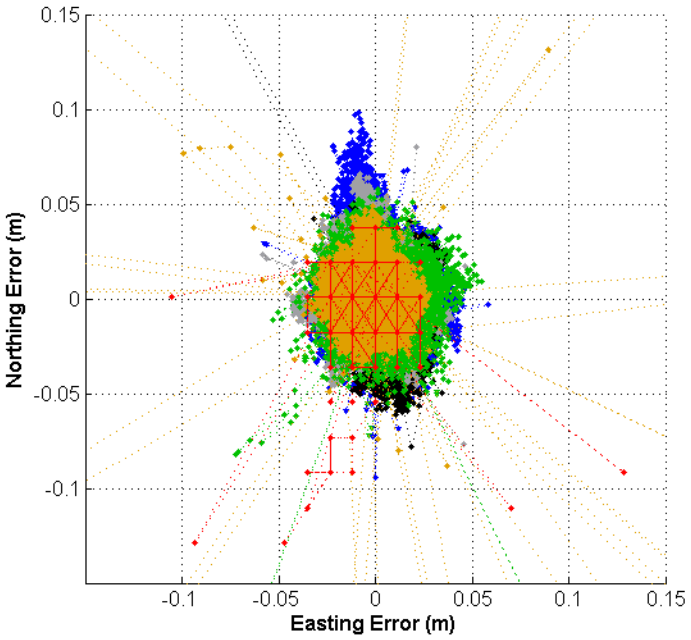


Figure 9 Time to Fix Percentage - 33 km Baseline

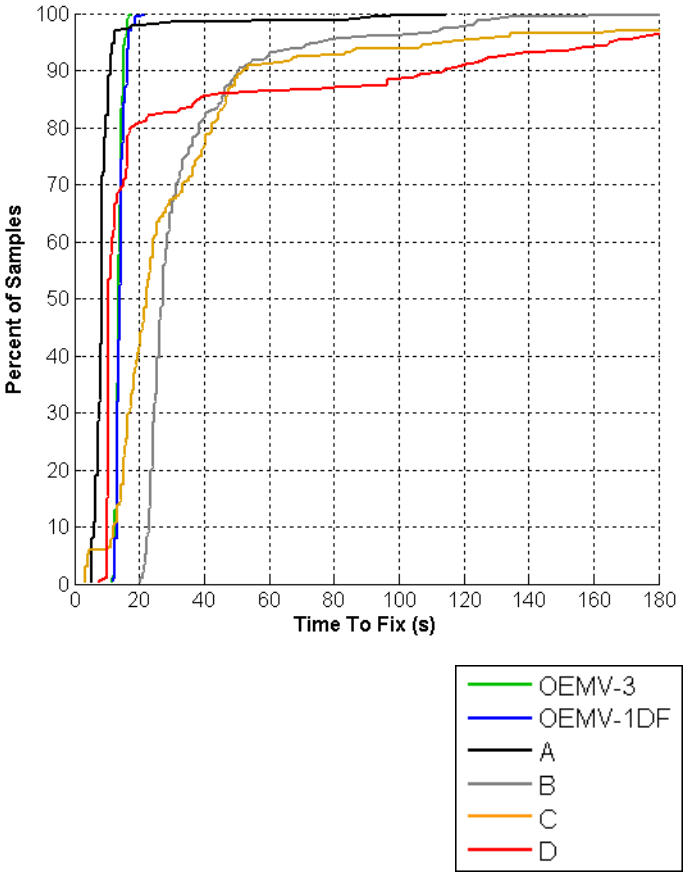
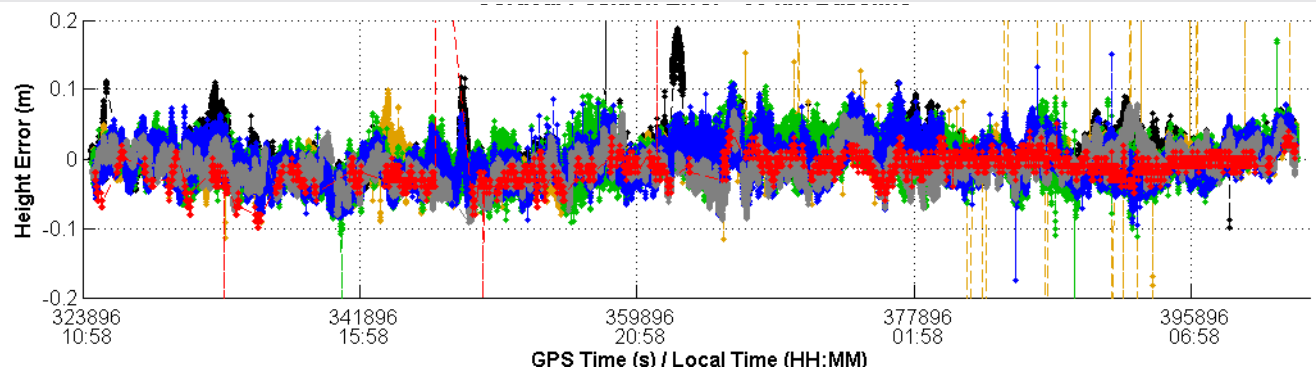


Figure 10 Vertical Position Error – 33 km Baseline



Interference Rejection

Interference occurs when signals near the GNSS operating frequencies are transmitted in the vicinity of GNSS receivers, negatively impacting the reception and processing of GNSS signals. Many users may be unaware that interference is occurring. Their receiver may be working properly for some time then, inexplicably, measurements and positioning performance are degraded by the sudden presence of interference.

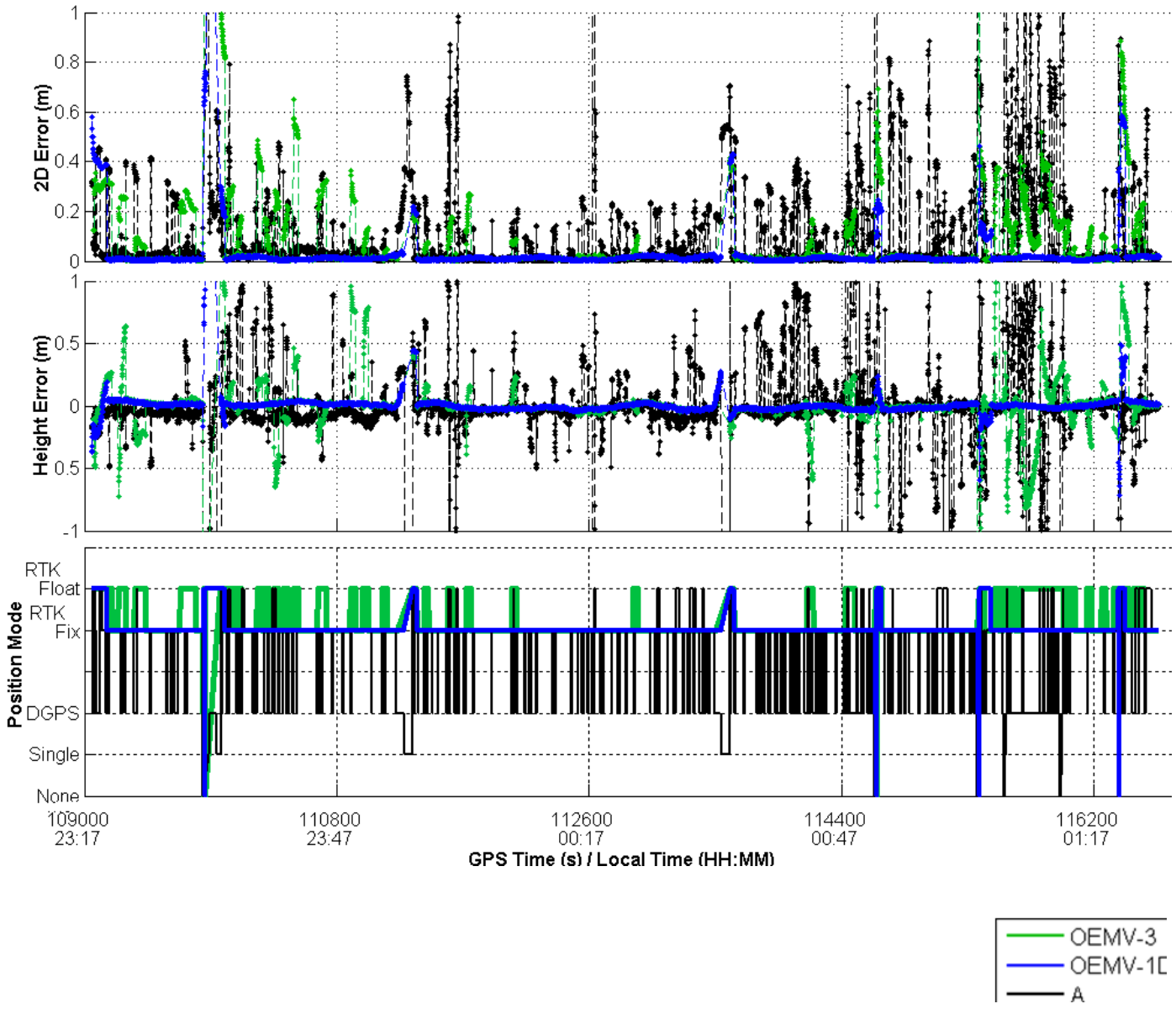
NovAtel carried out tests to demonstrate the interference resilience of the OEMV-1DF compared to both the OEMV-3 and an industry competitor that supports wide band tracking of GPS and GLONASS signals. Each receiver was set up to perform continuous RTK positioning using identical conditions; an interference source was then introduced.

As shown in Figure 11, the interference source degraded the competitor product's carrier-phase measurements to the point where RTK positioning was often not possible and the solution type switched between RTK-fixed and DGPS. This happened throughout the test. Even while the solution was fixed, the competitor product's position solution was noisy, unreliable and unusable in high precision applications.

OEMV-3 carrier-phase measurements were also affected, but to a lesser degree than the competitor, leading to cleaner positioning. The OEMV-3 position type periodically switched from RTK-fixed to RTK-float, but these switches occurred less often than the competitor's product switching between RTK-fixed and DGPS.

Under interference conditions, the OEMV-1DF performed the best, with minimal interruptions in RTK positioning, and consistent, reliable position accuracy.

Figure 11 Interference Rejection Test Results



Environmental

From a design perspective, temperatures inside of an enclosure housing electronics typically rise well above ambient temperatures. As a result, cards that only operate up to +70ºC may fail to operate reliably in hot environments and climates. The OEMV-1DF operates over a temperature range of -40 to +85ºC, and in humidity up to 95% (non-condensing) allowing reliable performance in harsh conditions.

The OEMV-1DF also meets IEC 68-2-27 [30g] (shock), and MIL-STD-810F [7.7 g] and SAEJ1211 [4g] (vibration), which allows the receiver to operate reliably in applications prone to vibration and shock.

Integration Flexibility

All OEMV-1 series variants are pin-for-pin compatible and share common interface commands. With a single integration effort, you can take advantage of the satellite tracking and positioning options of NovAtel's OEMV-1DF, OEMV-1™, OEMV-1G™, and OEMStar™ receivers. This allows, where necessary, a simple receiver upgrade path to address positioning needs of any application.

Table 4 NovAtel OEMV Family Features

	Feature	OEMV-1DF	OEMV-1G	OEMV-1	OEMStar
Positioning	RT-2	1 cm + 1 PPM Unlimited Baseline	1 cm + 1 PPM 3 km Basline		
	RT-20	0.2 m	0.2 m	0.2 m	
	DGPS	0.4 m	0.4 m	0.4 m	0.6 m
	OmniSTAR VBS			0.6 m	
	CDGPS			0.6 m	
	SBAS	0.6 m	0.6 m	0.6 m	0.8 m
	Single Point L1/L2	1.2 m			
	Single Point L1	1.5 m	1.5 m	1.5 m	1.5 m
Signals	GPS L1	X	X	X	X
	GPS L2	X			
	GLONASS L1		X		X
	L-band			X	

Summary

The OEMV-1DF receiver offers a high degree of flexibility in a small form-factor. Its small size and low power consumption allow the OEMV-1DF to fit into compact applications where RTK has never been accessible due to space constraints, such as survey data collectors and UAVs. A series of controlled tests were performed to compare the GPS-only RTK performance of the OEMV-1DF to the GPS+GLONASS RTK performance of NovAtel's OEMV-3 and other GNSS industry competitors. The tests show that even with slightly longer RTK initialization, the OEMV-1DF meets the positioning accuracy of the OEMV-3 and other leading GPS+GLONASS RTK receivers.

Initialization tests demonstrate that the OEMV-1DF receiver is unaffected by signal interference. Under the same interference conditions, it was able to provide consistent and reliable centimetre-level RTK positioning where the other tested products were not.

Designed to the highest environmental specifications, the OEMV-1DF is tough enough to handle any application. It is also pin-for-pin compatible and shares common interface commands with NovAtel's other OEMV-1 series variants offering drop in access to the functionality of three GNSS receivers with one integration effort.

novatel.com

sales@novatel.com

1-800-NOVATEL (U.S. and Canada)
or 403-295-4900

Europe 44-1993-85-24-36

SE Asia and Australia 61-400-833-601

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