C P M CORE POSITIONING

MODULE



INTEGRATED GNSS MOBILE HARDWARE

# imaginationware

### [Background]

In the beginning there were GPS receivers and correction service receivers, otherwise known as demodulators. The combination of this mobile precise positioning hardware then evolved appearing in different forms and levels of integration. To understand why the Positioneering CPM is so different and special it helps to understand this evolution, which can be considered in as follows:

Generation-0 - Initial Hardware Combination - This includes the base components of GPS receiver and correction demodulator with either the corrections being injected directly into the receiver or raw data and corrections being fed into eternal QC software for reprocessing.

Generation-1 - Component Integration - This is the first level of integration which includes the base components of GPS receiver and correction demodulator integrated into a single rack housing along with a dedicated processor. This configuration used external software to conduct active Quality Control. The first evolution of this included the integration of the sensor cards rather than separate house products but functionally this was the same.

Generation-2 - Full Integration - This generation saw a move towards greater levels of integration including the embedding of a processor in an attempt to remove the need for an external computer to conduct the QC and reprocessing. To cover different user requirements, mainly relating to mounting scenarios and cost, this evolution led to two types of product; larger rack-mount boxes requiring significant heat management such as fans and subsequent severe challenges to reliability and secondly smaller units with reduced processing power and therefore forfeiting the real-time quality control.

Generation-3 - The latest incarnation. In an attempt to extend functionality and differentiate, products were developed to accept more and more cards, incorporate additional ports and user interface elements. The outcome was larger still hardware, a greater distance from the optimum embedded solution.

The Positioneering Generation - The objective of this exercise was to be the first to create a fully optimal product in the truest sense and following the correct Product Management Process. Nor would be differentiate models on the basis of such trivial aspects as mounting scenarios with the aim of having a lower spec option.

The concept and what we have produced is a single universal unit built to the highest standard and on a truly managed production line, leveraging all of the benefits of low-volume mass production such as product build quality and consistency. Providing all conceivable features and the highest levels of performance and availability, the CPM contains all aspects of the positioning process from observations, to delivery of the final solution, which is a low-latency, highavailability position with fully active Quality Control and without the need for any external processing or computing hardware - the way it should always be. The positioning process and delivery to the user is the core function of the CPM and no other function will interrupt this Core task. Secondary to its real-time operation is total remote access to the CPM, with comprehensive visualisation of every aspect of operation and performance as well as remote control, monitoring and system management, whether locally or back at headquarters at the other side of the globe. The Core function focus of the product philosophy ensures that the right positioning is available always but this does not inhibit in any way the scale of access to all key information and the system itself. This separation of concerns allows optimum implementation of each

### Protected Core Function + Unlimited Secondary Features











### [Operation and User Interface]

Substantial effort has been invested into determining an optimum user experience for the CPM. The ultimate aim for the product was to make it as functionally and operationally transparent for the user as possible but achieving this without compromising the availability of all data and parameters required by the full range of users from operator to scientist. This has been achieved and the CPM requires no configuration whatsoever relating to its main function and will always operate in an optimum manner based upon what is available. The only remaining configuration relates to user-specific settings such as outputs and inputs and for this we have provided multiple methods to satisfy different preferences. The primary method of configuring the unit is through an integrated Web-Management Utility (WMU) that can be accessed from any browser on the same network as the CPM.

The user-interface on the unit is designed to be transparent by the provision of a gesture-based multi-touch solution on the front panel of the unit. Accidental power actuation and protection against failure of typical mechanical switches is achieved by the use of a Capacitive-Touch power switch whilst hardware and general unit status is provided by an illuminated halo. To prevent dazzling a user at night and potentially damaging night-vision as well as maintaining brightness at the optimal level the CPM has an integrated ambient light sensor that continuously adjusts the brightness of all illuminated components.



### [Interfacing]

Often overlooked, the interface between the positioning and customer systems is absolutely critical - what is the point of producing the best position possible and then failing to deliver it reliably to the end application. For real-time operation the position has a finite life of just a second or so. It is therefore imperative that the position data is not only delivered with the lowest latency but also reliably. To ensure this we have implemented the most reliable hardware including fast serial ports able to deliver data reliably via software selectable RS232 or RS422 and to speeds up to 1 Mega-Baud as well as dual fully independent Ethernet networks.

This takes the data to the outside world but for this to provide ultimate performance connectors are equally important. The ubiquitous D-Type and RJ45 connectors are of course low cost and have universal convenience but they are far from fit for purpose in such high-end operations. Although rarely monitored it is quite surprising how much data is actually lost through poor quality connectors and cables. To ensure that the result of our obsession to produce the best position solution is not wasted, we have implemented the highest quality solution based upon the Fischer DEU series connectors. These highly reliable IP67 rated bayonet connectors ensure the best connections not only for output data but also for all connections including RF, power, Ethernet and any utility connections. A comprehensive suite of prefabricated cables are supplied to ensure that the connection is completed correctly maintaining maximum data communication speed and reliability throughout.



### [Reliability and Robustness]

The best form of support is that which helps a user gain value from the use of the products and services. The worst form is that relating to product failures or operating issues. The CPM has been designed to exploit all technologies and techniques to remove any need for ongoing maintenance and remove the need for remedial support. Literally hundreds of items have been considered, a small selection of which follows:

### Sealed Product

A major area of potential hardware issues is a housing open to the elements, especially in a salt air environment. The main necessity for this is to allow active cooling of the electronics and CPU using fans and associated ventilation. The drawback of this is that not only do cooling fans tend to fail leading to potential overheating but when they are working they draw in the salt laden air, which subsequently causes corroding of the electronics and rapid failure. It is possible to resolve this by reducing the electronics content to just the basic GNSS card but this means forfeiting the extended processing required for active quality control and other CPU intensive functionality, UI function etc. but this ultimately reduces the performance of positioning. The answer to this is for the product to be sealed from the environment.

The CPM is fully sealed to IP67 and uses a passive heat management system that we have developed that allows the CPM to conduct full processing whilst remaining cool and without any moving parts. To further underpin product reliability all electronics components and sub-sytems are extended temperature range and either industrial or military specification.

To ensure correct and consistent sealing all connectors, including the front panel USB are rated to IP67. To compensate for the wide range of temperatures that the CPM will experience, potentially changing over a very short time period, a novel means of breathing is employed that allows expanded air to leave the housing but prevents any moisture from entering ensuring that sealing is maintained.

### **Cable-Free Design**

Another potential area of failure is the loss of connection through interconnecting cables that can either chafe or become disconnected over time. The CPM has been designed to be virtually cable-free and all interconnections are made through locked header connections resilient to shock and vibration.

EMI Performance - The CPM has been designed to meet the most stringent EMC certifications and is currently compliant to CE and FCC standards required by the marine EN60945 certification. The minimisation of the use of cabling as well as additional layers of grounding and extensive EMI protection components within the electronics ensures that the CPM is electrically very quiet.

### [Performance]

Whilst focus is usually placed upon position accuracy alone, there are many aspects to the overall performance of a GNSS system. The ultimate objective of Positioneering is to provide precise positioning solutions with maximum availability and this includes every aspect from background system hardware and software and of course user facing product hardware, software algorithms and support. The components specific to the CPM are:

Signal - Everything begins with the signals we are trying to receive, both GNSS and augmentation. We have design optimum antenna solutions that allow reception of all signals in both clear and highly congested environments and then provide enough pre-amplification of the composite signal band to ensure no performance is lost in subsequent cabling connecting to the CPM. Utilising the optimum cabling solution ensures that the received signal is in the best condition upon reaching the CPM which receives the cable via high-performance rear-panel connectors maintaining minimum insertion losses. Once inside the CPM an intelligent coupler (RFDU), which is controlled by software, distributes the signal to the internal sensors with minimal insertion loss.

Measurement - Having supplied the best signal possible to the sensors, we now have the best measurement available by using the latest GNSS hardware that provides not only the best measurements but also performance in situations of high-multipath and even interference. The optimum combination of observations are produced for each solution type.

Position - Once the measurements are formed intelligent adaptive algorithms are used to derived the best position combination possible including Positioneering's P and S solutions to provide the most accurate and robust position combination possible. The position computation is conducted within the embedded software with extreme reliability and availability and with low and consistent latency to ensure the best real-time operation possible.

[Position Latency]

		<150ms* (Average)							
		SV Measurements	Data Transfer	Position Processing	Iterative QC	Results to Output Ports	Communication to User App		
		1	2	3	4	5	6		
1	A epoch includes SV's at different distances so observations not all at same time. Spread is a few a milliseconds so obs period is short. Measurements are aligned in processing.								
2	Fast low-leve	Fast low-level transfer <5ms							
3	Intensive floating point mathematics that varies based upon SV Count but is typically 10's of milliseconds								
4	Isolation and adjustment or removal of erroneous observations Varies based upon number of outliers. Each iteration is almost an entire recalculation each taking several milliseconds								
5	Fast low-leve	Fast low-level transfer <5ms							
6	Fast transfer	dictated by output	t telegram format a	and baud rate CPM runs u	p to 1MBaud	Maxim Toleran Maxim	um operating speed 3Kn ice um Latency	: 1.54m/s : 0.25m : 162 ms	

### [Installation]

Many issues are caused by poor installations. We have designed our hardware and service solutions to make installations as trouble-free and transparent as possible with a plug-and play approach and with all engineering dealt with in the product design. Every aspect has been standardised upon optimum components throughout from antenna, cables and even product mounting.

Element	Solution
Antenna	A rugged combined GNSS / Augmentation cable lengths. Also provided is a rugged mo
Downlink Cable	A range of cable solutions for short, mediun installation on temporary installations. Fully
System Power	A dedicated IP67 DC power-supply certified scenarios to ensure that the system operate
System Mounting	A modular frictionless mounting solution that scenarios
Interconnections	A full set of high-performance sealed cablin

### [Mounting Solutions]

**Desktop / Bulkhead Mounting Plate** Allows interconnection of CPM to any flat surface











Example Installation CPM's installed using the Desktop Mounting plate with two units stacked.

antenna with optimum low-noise pre-amplification for a wide range of ounting bracket to cover all usual antenna mounting scenarios.

m and longer cable runs and with characteristics that enable easier matched with the system.

ed for all intended applications and with power that covers all de-rating tes with spare capacity over the full temperature range of -25C - +55C

at allows secure installation in racks, consoles and free-standing

ng options to ensure reliable, high speed communication



### **Unit Configuration**

oo eivers: Istellations:	1 or 2 GNSS receivers GPS, GLONASS, COMPASS, GALILEO, SBAS
mentation	
ellite Channel 1:	Positioneering SDTS (L-band) Positioneering Service-A1 / Service-A2
ellite Channel 2:	Positioneering SDTS (L-Band)
A:	2 x channels IALA MF
ernal:	RTCM V2 / V3

### **Communications & Data**

pendence:	All communications ports are electrically isolated and independent from each other
al:	4 x RS232/RS422/RS484 (Configurable via User-Interface) Data rates configurable from 300 Baud-921,600 Baud
ernet:	2 x fully independent 100Mbit/s Ethernet 1 x hub connection off 2nd Ethernet
ocols:	TCP/IP UDP - Uni-Cast, Multi-Cast, Broadcast
ty:	1 x utility port with: - 1PPS output 1 x utility port with - Event-in - Alarm-out - Serial RS232/RS422/RS484
3:	1 x USB Ver. 2.0, Type-A reciprocal 1 (Rated IP67)
): 	Service Management Channel connection (Power out / Data I/O)
a outputs EA-0183: A: BT: V: DOA:	Sentences: GGA, GGA High precision, GGA (Converteam) GBS, GLL, GNS, GRS, GSA, GST, GSV, HDG, HDT, ROT, RMC, VTG, ZDA \$DPGGA <b>PO</b> sitioneering <b>S</b> tandard <b>T</b> ransfer (Proprietary) GNSS, Augmentation P2/94
out rate:	1Hz - 5Hz
<b>a Logging</b> rnal Logging	

Onboard automated logging:

POST (Aug, Aux, Position, Statistics, Satellite, Observations) - c. 5-days Raw GNSS data - 48 hours Diagnostics data - 6-months Usage data - Product Life ( > 5 years)

### Certifications:





## BS EN 60945:2002





# [ A Few Features ]



### [Seamless User Interface]

Full gesture-based multi-touch user interface for reviewing system status including intelligent non-mechanical power actuation using state-of the art capacitive touch technologies avoiding openings in the housing such as those required for normal touch screens and power switches, which can lead to moisture or dust ingress and subsequent product damage ]



### [Maintenance Free]

[The CPM has been designed with no moving parts such as fans nor any elements needing maintenance such as batteries. Despite its aesthetics, which has been derived entirely from its function, the product has been designed to withstand use in harshest of environments. With a virtually cable-free design and so nothing to accidentally disconnect, the CPM has even been extensively shock and vibration tested and collision and drop tested and even submerged to prove continuity of operation. ]



### [ Connecting to the World

[A comprehensive range of fully isolated and protected communications hardware and protocols including Serial (RS232/422/485), Ethernet (UDP, TCP/IP)]



### [Stay Cool] [Efficient solid state passive heat management to keep unit cool coupled with use of extended range industrial and military spec components throughout to enhance long-term reliability ]



### [Well Housed]

[ To maintain full control of all physical aspects of the CPM performance a very innovative approached was adopted in relation to the design and production of the product casing. To house the passive heat-management system necessary for the avoidance of troublesome active heat management and preserve good sealing, an aluminium extrusion process was used coupled with very precise 5-axis CNC machining to complete the detail. The result is an optimal product housing that enhances all functional and performance aspects of the product inside and out. ]

[Access all Areas]

onboard logging ]

[ The CPM can be accessed via several means of configuration utility

including an onboard Web-Maintenance Utility and can be monitored

via a dedicated Service-Management Channel that allows the CPM to be

accessed remotely worldwide. Comprehensive visualisation is achieved

with the POSTMAN software and all data is available from continuous



### [Tightly Integrated]

[ To ensure both integrity of data and long product lifespan all electronics and onboard sensor cards are connected directly via the 10-layer motherboard using locked header connectors avoid cable based interconnections that are prone to failure over long periods of time operating in harsh and dynamic environments. ]



### [Mount me Every Way]

[ With its universal mounting system the CPM can be securely mounted in all usual installation scenarios with ease. The mounting solution has been designed to provide a fast, efficient and safe means of installing the CPM and with its very fine tolerances avoids any annoying vibration rattles ]



### [Not too Bright]

[ To ensure that unit does not dazzle or impact a user's night vision and maintain optimum visibility the CPM has a fully automated ambient light sensor and brightness adjustment ]



### [Completely Fresh]

[ Creating a position is easy. Creating the right position, fully checked and guaranteed, in minimal time and delivered every time without variation or failure coupled with the highest reliability of every component with full control and visualisation is not so easy. The CPM provides this with ease and without the need for any special configuration or setup. ]

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