INFORME PLAN DE VUELO

INFORME DE DISEÑO DE PLAN DE VUELO PARA CAPTURA Y PROCESAMIENTO DE FOTOGRAFÍAS AÉREAS E INFORMACIÓN LIDAR CONTRATO 018 DE 2021

REALIZADO POR:
ISATECH CORPORATION

ABRIL DE 2021

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1 INTRODUCCION

El presente documento describe las características de plan de vuelo diseñado para cumplir las tareas definidas para la captura y procesamiento de fotografías aéreas e información LIDAR contrato 018 de 2021. Lo anterior, en aras de garantizar la correcta toma de datos, considerando, las condiciones topográficas de la zona además de las condiciones meteorológicas complicadas que se presentan actualmente en el país, y en especial dentro del área de interés, tal y como se reporta en los informes semanales del pronóstico del tiempo, surgen dos alternativas de plan de vuelo, ambas cumpliendo a cabalidad en calidad y precisión de acuerdo con lo dispuesto en el anexo técnico del proyecto.

2 ZONA DE INTERES

Las tareas de captura involucradas en este proyecto fueron planeadas para un área de estudio ubicada en el departamento de Risaralda y que cuenta con una extensión aproximada de 57.998 Ha. se presenta a continuación:

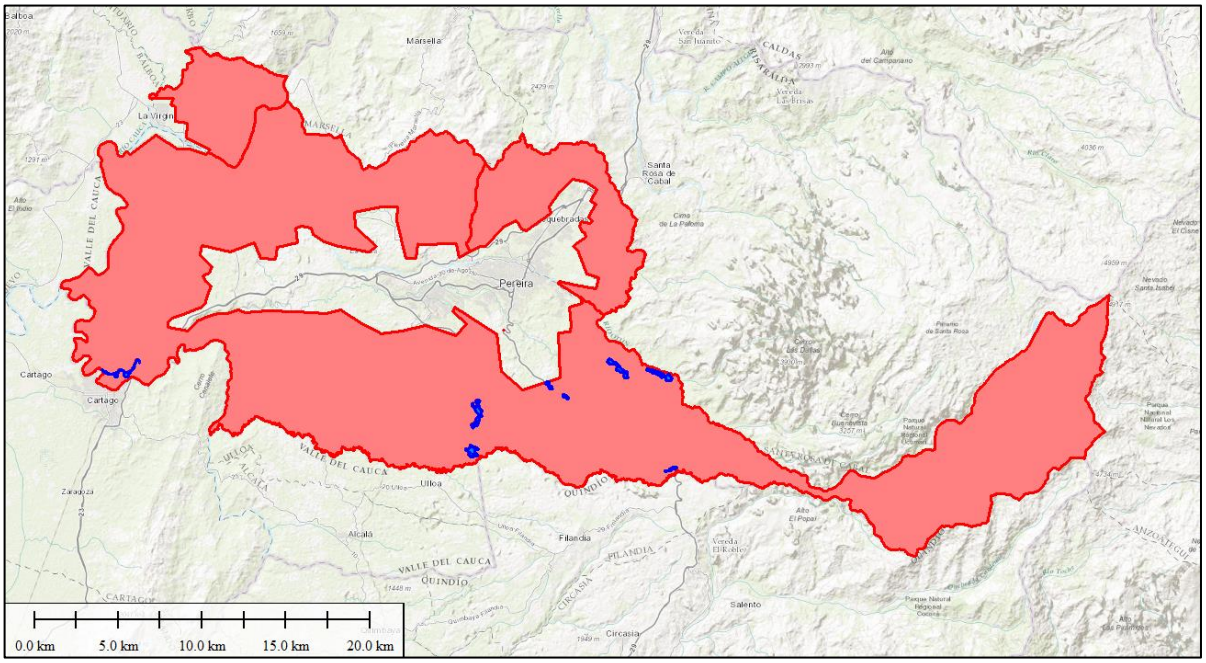


Figura 1 Ubicación del área de interés.

3 DISEÑO DEL PLAN DE VUELO

El plan de vuelo para la toma de fotografías aéreas e información LiDAR del polígono que conforma el producto 2 y producto 3 ubicado en el departamento de Risaralda se realizó implementando la herramienta TrackAir, el plan de vuelo fue generado contemplando las zonas correspondientes a los productos 2 y 3 como una sola área de trabajo. Es de considerar que, ambas alternativas aseguran la calidad y precisión requerida para la ejecución efectiva del proyecto.

3.1 ALTERNATIVA 1.

Los parámetros con los cuales se hizo el diseño se muestran en la siguiente tabla:

PEREIRA DOS QUEBRADAS LA VIRGINIA		
ALTURA PROMEDIO	mts	ft
	800	2624
VELOCIDAD	50mts/s-180km/h	
FOV	60	
PRR	240	
CANTIDAD DE FOTOS PROYECTO TOTAL	6200	
NUMERO DE FAJAS	163	
RECUBRIMIENTO LONGITUDINAL	70%	
RECUBRIMIENTO TRANSVERSAL	30%	
GSD (m)	0.1	
DENSIDAD (PT/M2)	3.4	

Tabla 1 Características del plan de vuelo diseñado para la alternativa 1. Fuente: Autor, 2021.

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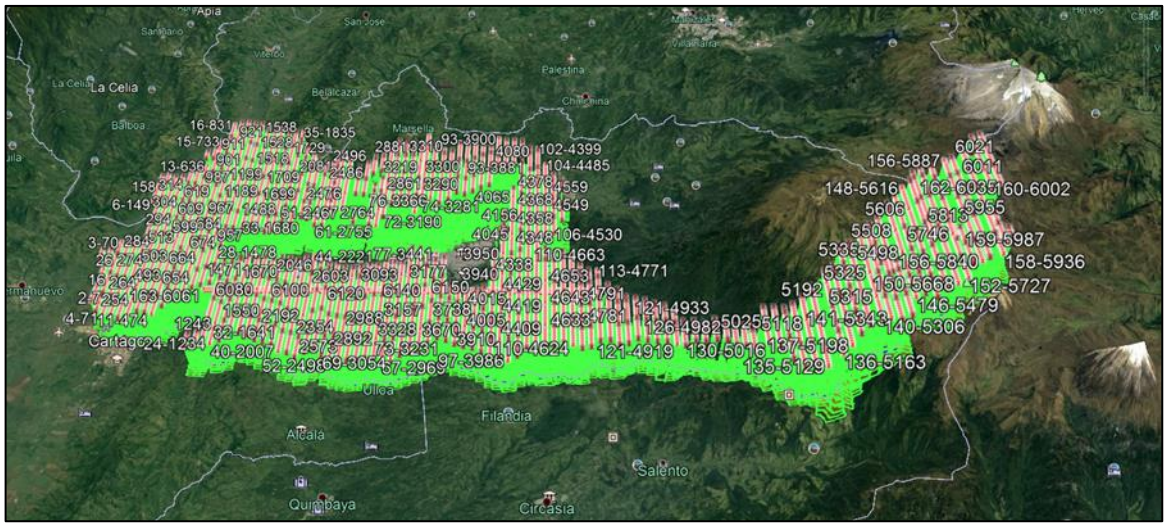


Figura 2. Visualización oblicua del plan de vuelo diseñado

3.2 ALTERNATIVA 2.

Los parámetros con los cuales se hizo el diseño para la alternativa 2, se muestran en la siguiente tabla:

PEREIRA DOS QUEBRADAS LA VIRGINIA		
ALTURA PROMEDIO	mts	ft
	800	2624
VELOCIDAD	50mts/s-180 km/h	
FOV	60	
PRR	240	
CANTIDAD DE FOTOS PROYECTO TOTAL	5717	
NUMERO DE FAJAS	157	
RECUBRIMIENTO LONGITUDINAL	70%	
RECUBRIMIENTO TRANSVERSAL	30%	
GSD (m)	0.1	
DENSIDAD (PT/M2)	3.4	

Tabla 2 Características del plan de vuelo diseñado. Fuente: Autor, 2021.

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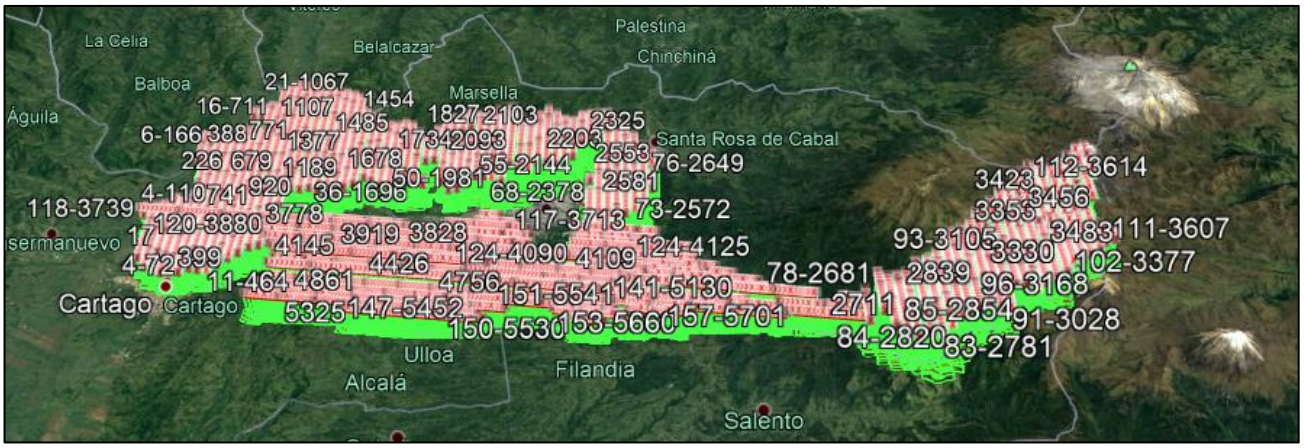


Figura 3. Visualización oblicua del plan de vuelo alternativo diseñado para la correcta toma de los datos.

Se confirma que con los equipos y plan de vuelo propuesto se obtendrá información que permita cumplir con las especificaciones contractuales del proyecto.

Considerando las condiciones propias del polígono de interés, referentes a topografía y condiciones atmosféricas, el plan de vuelo se diseñó con una altura promedio de 800 m sobre el terreno. La topografía de la zona facilita y permite la operación aérea entre las 8:00 a.m. y 4:00 p.m. siempre y cuando las condiciones atmosféricas permitan realizar la captura de forma adecuada.

El vuelo se ejecutará usando en simultaneo los sensores RGB y LiDAR en un mismo vuelo de captura.

4 TOMA DE IMÁGENES DIGITALES

Se realizó el planeamiento de vuelo para ejecutar la adquisición de imágenes digitales a color (RGB) con tamaño de píxel de 10 centímetros para la zona de producto 2 y 25 centímetros para la zona productos 3. Así mismo confirmamos que se obtendrán los permisos de operación aeronáutica exigidos por las autoridades colombianas a saber:

- Registro de operaciones otorgado por la Aeronáutica Civil, para trabajos de toma de fotografía para la aeronave HK4870. Dichas aeronaves de propiedad de la empresa ISATECH CORPORATION SAS.

- Permiso de la Fuerza Aérea Colombiana para la misma labor.

Los demás exigidos por la Dirección Antinarcóticos, la Policía Nacional y la DIAN. Los cuales podrán ser aportados a Unidad Administrativa Especial de Catastro Distrital - UAECD si desea verificarlos.

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El diseño Geométrico del Vuelo, estuvo conformado únicamente por tramos rectos con las siguientes características:

a. Superficie de Trabajo y zona a recubrir: Se cubrió el 100% del área de interés requerida por Unidad Administrativa Especial de Catastro Distrital - UAECD.

b. Proyección Cartográfica: La ejecución del vuelo digital asistido con el sistema Airborne GPS, estará basado en el Sistema WGS-84.

c. Tamaño de Píxel: El tamaño de píxel a obtener, será de 10 centímetros para la zona de producto 2 y 25 centímetros para la zona productos 3.

5 EQUIPOS QUE SE EMPLEARAN EN LA CAPTURA DE INFORMACIÓN AÉREA

- AERONAVE HK4870

EQUIPO FOTOGRAMETRICO AEREO

- Sensor lidar Trimble Harrier 68i (400khz).
- Cámara fotogramétrica digital Phase One ixu-r 1000 (100_megapixeles), con lente RGB Rodenstock.
- IMU y GPS Applanix Pos/Av. combinado con tecnología GNSS para proveer precisión posicional 3D, velocidad y altitud.
- Receptor GNSS Trimble bd960 GNSS Receiver module.
- Receptor de trabajo pesado GNSS/INS Span-se provee solución de posición 3d, velocidad y altitud del vuelo.
- IMU-CPT combinado con tecnología GNSS para proveer solución de posición 3d, velocidad y altitud del vuelo.

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5.1 AERONAVE HK4870

Aeronave Tipo Cessna 182T matricula HK4870. Con todos los requisitos exigidos por la Aeronáutica Civil de Colombia y modificaciones para el montaje de Sensores Remotos hechas en USA y debidamente aprobadas por la Federal Aviation Administration de U.S.A

5.1.1 CARACTERÍSTICAS

Longitud: 8,8 m (29 ft)
Envergadura: 11 m (36 ft)
Altura: 2,8 m (9,3 ft)
Techo de servicio: 5.517 m (18.100 ft)
Velocidad máxima operativa: 370 km/h
Velocidad crucero: 268,5 km/h (167 MPH; 145 nudos) a 2.100m (6.890 ft).
Velocidad de entrada en pérdida: 100 km/h (62 MPH; 54 nudos)



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6 EQUIPO FOTOGRAMETRICO AEREO

6.1 SENSOR LIDAR TRIMBLE HARRIER 68I (400KHz)

DATASHEET

Trimble Harrier 68i Corridor Mapping System

KEY FEATURES

- Up to 400 kHz laser pulse rate
- Scan speed up to 200 Hz
- Full waveform digitization
- 45 – 60 degree field of view
- Roll compensation (software based)
- LiDAR operating altitude up to 1600 m AGL
- Integrated flight management system
- Portable storage system
- Integrated medium-format digital frame camera with fully integrated forward motion compensation (FMC)
- Image resolution up to 3 cm (with medium-format frame camera)

BENEFITS

- Integrated software workflow for laser and imagery data
- Compact, complete system
- High-quality data capture
- Flexible deployment scenarios
- Pilot only operation



PERFECTLY INTEGRATED SOLUTION PRODUCING VERY DENSE POINT CLOUDS AND GEOREFERENCED ORTHO IMAGES FOR YOUR MOST CHALLENGING AERIAL MISSIONS

The Trimble® Harrier 68i is an advanced corridor mapping system with a 400 kHz blasting pulse repetition rate to generate extremely dense point clouds in combination with high-quality, georeferenced ortho images.

The perfect integration of wide-angle full waveform digitization laser equipment, medium-format digital frame camera, direct georeferencing and flight management make the Harrier 68i the ideal solution for wide area mapping, powerline mapping, pipeline monitoring, corridor mapping, aerial survey and other demanding remote sensing operations. The built-in full waveform digitization features of the Harrier 68i enable comprehensive vertical information to be extracted from the acquired echo signals.

The integrated digital medium-format frame camera has been designed to generate geometrically and radiometrically consistent high-quality RGB digital imagery.

The Harrier 68i Multiple-Time-Around Technology allows multiple laser pulses and echoes in the air, thus increasing the point density of the mission.

Trimble

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INFORME PLAN DE VUELO

Trimble Harrier 68i Corridor Mapping System

SPECIFICATIONS

Sensor Head Specifications

Beam deflection	Rotating polygon
Pulse repetition rate	80 kHz–400 kHz
Field of view	45 degrees to 60 degrees (max)
Measurement rate	266 kHz @ 60 degree 200 kHz @ 40 degree
Operating altitude	30 m AGL–1 600 m AGL
Beam divergence	≤ 0.5 mrad
Range capture	Full waveform digitization
Intensity capture	16 bit dynamic range for each echo
Scan frequency	10 Hz to 200 Hz
Eye safety class	Class 3R
Swath width	83% of op. altitude (45 degrees)
Range resolution	0.020 m
Vertical accuracy	<0.15 m (absolute)
Horizontal accuracy	<0.25 m (absolute)
Scan pattern	Parallel lines
Temperature	0 °C to +40 °C (operation) –10 °C to +50 °C (storage)
Humidity	0% to 85% non-condensing
Weight	42 kg
Dimensions	30 W × 64 L × 48 H cm

Available options ... Integrated medium-format digital frame camera
Portable storage system

Digital Camera Specifications (Option)

Model	Trimble AC P65+
Operating altitude	0 to 10,000 ft AGL
Field of view	Different lenses can be selected for this camera
Array size	60 MP
Channels	Three (RGB)
FMC	Fully integrated
Max. Exp. rate	Down to 2.8 sec.
Image pixel size	Down to 0.03 m
Image scales	1:250 to 1:10,000
Calibration	Geometrical and Radiometrical

Computer Rack Specifications

Log time	>8 h
Power	28 V DC, 22 A max.
Temperature	0 °C to +40 °C (operation) –10 °C to +50 °C (storage)
Humidity	0% – 90% Non-condensing
Positioning system	Applanix POS/AV
Weight	43 kg
Dimensions computer	44 W × 54 L × 40 H cm

Vibration isolated case mounts directly on the aircraft floor

Operations and Applications

- Corridor mapping and wide area mapping, aerial survey and remote sensing
- High-resolution ortho images, rapid response, pipeline monitoring, power line mapping, corridor mapping, city models, common LIDAR projects, detailed analysis and studies, target classification
- Helicopter and aeroplane operation
- Uninterruptible power supply provides the system with consistent power even through aircraft power glitches.

Data Processing

- Trimble TopPIT software package for pre- and post- processing of LIDAR data and true-ortho images generation
- Trimble TopPIT has a robust dataflow and workflow for both LIDAR and aerial imagery data.

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6.2 CÁMARAS FOTOGRAMÉTRICA DIGITAL PHASE ONE IXU-R 1000 (100_MEGAPIXELES), CON LENTES RGB/INFRARROJO RODENSTOCK

Phase One iXU-R/iXU

The Phase One iXU-R/iXU aerial cameras are the world's smallest and lightest integrated digital medium format aerial cameras. All iXU-R/iXU cameras are equipped with internal electronically controlled central leaf shutters to provide the image quality expected from a dedicated aerial photography camera.

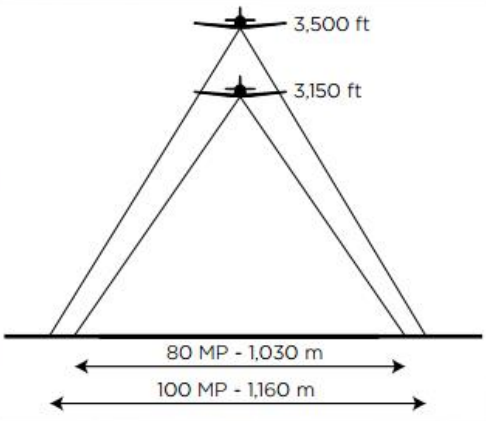
100 Megapixel sensors

Both the iXU-R 1000 and iXU 1000 are equipped with 100 MP CMOS sensors, offering large format coverage in a medium format body. The cameras deliver 11,608 pixels cross-track coverage, which is 12 percent greater than previously available medium format aerial camera systems.

Flying with an iXU-R 1000 or iXU 1000 enables users more coverage during a flight, while maintaining the same ground sample distance (GSD), or a lower GSD, while flying at the same height.

Widening Operational Hours

The CMOS technology of the iXU-R 1000, iXU 1000 and iXU 150 enables you to move from ISO 100 all the way up to 6400 providing quality images all across the ISO range. As weather conditions deteriorate or on days when you previously were unable to capture, the CMOS-based cameras provide the high sensitivities that can make a difference.



Phase One iXU-R series

The Phase One iXU-R cameras offer a small-bodied medium format camera with high performance Rodenstock optics. The small form factor make it an ideal camera for use as a standalone camera for photogrammetric work or as part of an array of multiple cameras, either to cover a larger swath or as part of an oblique camera system.

The iXU-R cameras are built with one of three Rodenstock lenses — 40 mm, 50 mm and 70 mm. The interchangeable lenses are individually inspected and factory calibrated for infinity focus.

Phase One iXU series

The Phase One iXU cameras are so small that their body is barely wider than their lens barrels. With camera weights starting at 1.3 kg with an 80 mm lens, they are well suited for users requiring a small, light camera with a broad range of focal lengths. The iXU cameras use removable Schneider-Kreuznach fast sync lenses, which are available in focal lengths from 28 mm to 240 mm.

UAV ready

Their light weight and small footprint make the iXU cameras perfectly suited for small aircraft and UAV integration. Using iX Link's RS-232 connectivity and internal CF storage, iXU cameras are able to capture thousands of images on a single mission. The iXU-R 1000, iXU 1000 and iXU 150, equipped with full HDMI output, can be guided to photograph specific objects seen by the operator on the ground.



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Technical Specifications
iXU-R/iXU

	iXU-R 1000 iXU 1000	iXU-R 180 iXU 180	iXU-R 160 iXU 160	iXU-R 160 Achromatic iXU 160 Achromatic	iXU 150
Resolution	**100 MP** 11608 x 8708	**80 MP** 10328 x 7760	**60.5 MP** 8984 x 6732	**60 MP** 8964 x 6716	**50 MP** 8280 x 6208
Dynamic range	>84 db	>72 db			>84 db
Aspect ratio	4:3				
Pixel size	4.6 micron	5.2 micron	6.0 micron		5.3 micron
CCD size effective	53.4 x 40.0 mm	53.7 x 40.4 mm	53.9 x 40.4 mm	53.8 x 40.3 mm	43.8 x 32.9 mm
Lens factor	1.0				1.3
Light sensitivity (ISO)	50-6400	35-800	50-800	200-3200	100-6400
Camera type	Medium format camera for aerial photography				
Lens mount	- Phase One R dedicated mount — for iXU-R cameras - Phase One SK dedicated mount — for iXU cameras				
Shutter speed	Leaf shutter: up to 1/1600 second*				
Shutter control	1/3 f-stop increments				
Interfaces	- USB 3.0 - Secured power input (LEMO) - Camera trigger - Mid-exposure pulse - Camera status - iX Link				
Live View/HDMI	iXU 1000 - 1920 x 1080 25p/30p - 1280 x 720 50p/60p				- 1920 x 1080 25p/30p - 1280 x 720 50p/60p
GPS/IMU support	Applanix, NovAtel, IGI, NMEA Devices				
Forward Motion Compensation	N/A	TDI controlled			N/A
Data storage	- 1 TB SSD storage (optional iX Controller) - CompactFlash card Type I/II including UDMA 6 and 7				
Syncronization speed in multiple camera configuration	100 microseconds with factory calibrated (FS) lenses				

Capture rate — full resolution frame	**iXU-R**	**iXU**	**iXU-R**	**iXU**	**iXU-R**	**iXU**	**iXU-R**	**iXU**	**iXU**
	0.85 s	0.95 s	1.25 sec	1.6 sec	1.1 sec	1.45 sec	1.1 sec	1.45 sec	0.85 sec
RAW File compression	IIQ large: 100 MB IIQ small: 65 MB		IIQ large: 80 MB IIQ small: 54 MB		IIQ large: 60 MB IIQ small: 40 MB				IIQ large: 50 MB IIQ small: 33 MB

INFORME PLAN DE VUELO

Technical Specifications
iXU-R/iXU

	iXU-R 1000 iXU 1000	iXU-R 180 iXU 180	iXU-R 160 iXU 160	iXU-R 160 Achromatic iXU 160 Achromatic	iXU 150
Lens + technology optimizes	- Color cast - Light falloff - Chromatic aberration - Fringing - Sharpness falloff - Lens distortion				
Output format	Phase One Raw, TIF and JPG				
Post processing	- iX Capture - Capture One Pro - Capture One Processing Engine				
IR cut-off filter	Camera system available either with or without IR filter				
Connection to pod	Four M4 bolts				
Tripod sockets	N/A				
Power input	12 – 30 V DC				
Maximum power consumption	10 W	12 W			10 W
Dimensions iXU (excluding lens)**	97.4 x 93 x 110 mm (w x h x l)				
Dimensions iXU-R (including lens 40)**	97.4 x 93 x 170.5 mm (w x h x l)				
Dimensions iXU-R (including lens 50)**	97.4 x 93 x 177 mm (w x h x l)				
Dimensions iXU-R (including lens 70)**	97.4 x 93 x 175.3 mm (w x h x l)				
Weight iXU (excluding lens)	.930 kg/2.05 lb — for iXU-R				.750 kg/1.7 lb
Weight iXU (with 80 mm lens)	1.430 kg/3.15 lb				1.25 kg/2.8 lb
Weight iXU-R	iXU-R 40 1.600 kg/3.5 lb iXU-R 50 1.700 kg/3.7 lb iXU-R 70 1.450 kg/3.2 lb				
Approvals	FCC (Class A), CE, RoHS				
Operating Conditions					
Temperature	-10° to 40°C (14° to 104°F)				
Humidity	15 to 80% (non-condensing)				

* 240 mm leaf shutter speed is 1/1000s.

** 2D and 3D drawings for integration of cameras are available from http://industrial.phaseone.com/downloads

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RODENSTOCK

Rodenstock Lenses

Phase One iXU-R and iXA-R cameras are equipped with Rodenstock lenses. Each lens/shutter combination is adapted for aerial photography and offers low distortion, high MTF and excellent contrast. The opening angles shown below are for the iXU-R 1000 cameras.

Lenses	Weight	Opening angle (short side)	Opening angle (long side)
Rodenstock 40 mm f/4.0	730 g	53.2°	67.4°
Rodenstock 50 mm f/4.0	800 g	43.7°	56.2°
Rodenstock 70 mm f/5.6	580 g	31.9°	41.8°

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6.3 IMU Y GPS APPLANIX POS/AV. COMBINADO CON TECNOLOGÍA GNSS PARA PROVEER PRECISIÓN POSICIONAL 3D, VELOCIDAD Y ALTITUD



Top: *Geocorrected CASI-1500 image mosaic (60 cm resolution) processed using precision attitude (roll, pitch, heading) inputs from a POS AV, and orthocorrected using Lidar data.* **Bottom:** *Closeup of identified subset showing excellent seam alignment of multiple north-trending CASI flight lines.*

Data provided by the Joint Airborne Lidar Bathymetry Technical Center of Expertise and collected with the US Naval Oceanographic Office's CHARTS system equipped with a CASI 1500. Toronto, Canada, January 2006.

itres
www.itres.com

GPS/IMU Option: ApplAnix POS AV

The following third party specifications are provided as a courtesy to ITRES sensor clients. They are based on information available at the time of writing from the manufacturer's website at www.applanix.com which should be consulted as the primary source of this information.

POS AV Absolute Accuracy (RMS)

		C/A GPS	DGPS	RTK	Post Processed
Model 310	Position (m)	4.0 6.0	0.5 2	0.1 0.3	0.05 0.3
	Velocity (m/s)	0.05	0.05	0.01	0.075
	Roll & Pitch (deg)	0.03	0.03	0.03	0.015
	True Heading[2] (deg)	0.10	0.08	0.07	0.035
Model 410	Position (m)	4.0 6.0	0.5 2	0.1 0.3	0.05 0.3
	Velocity (m/s)	0.05	0.05	0.01	0.005
	Roll & Pitch (deg)	0.015	0.015	0.015	0.008
	True Heading[2] (deg)	0.08	0.05	0.04	0.015
Model 510	Position (m)	4.0 6.0	0.5 2	0.1 0.3	0.05 0.3
	Velocity (m/s)	0.05	0.05	0.01	0.005
	Roll & Pitch (deg)	0.008	0.008	0.008	0.005
	True Heading[2] (deg)	0.07	0.05	0.04	0.008

[1] *Typical mission profile, max RMS error*

POS AV Relative Accuracy

	Model 310	Model 410	Model 510
Noise (deg/sqrt(hr))	0.15	0.07	0.02
Drift (deg/hr)[2]	0.5	0.5	0.1

[2] *Attitude will drift at this rate up to a max error defined by absolute accuracy shown in the table above*

Temp. Range:	IMU	-54 deg C to +85 deg C
	PCS	-20 deg C to +60 deg C
Size:	IMU	97 D x 86 H mm (3.8 D x 3.4 H inches)
	PCS	239 L x 158 W x 82 H mm (9.4 L x 6.2 W x 3.2 H inches)
Weight:	IMU	0.750 kg
	PCS	2.54 kg
Power:	20 32	Volts DC
	IMU	20 W, Max (supplied by PCS)
	PCS	30 W, Max (not including IMU)

General Specifications

IMU	GPS
200 Hz High Performance FOG Gyros, silicon accelerometers	12 channel dual frequency (L1/L2), low noise, DGPS ready, 10 Hz raw data

I/O

Ethernet (100 base-T)

Parameters	Time tag, status, position, attitude, velocity, track and speed, dynamics, performance Metrics, raw IMU data (200 Hz), raw GPS data (10 Hz)
Display Port	Low rate (1 Hz) UDP protocol output
Control Port	TCP/IP input for system commands
Primary Port	Real time (up to 200 Hz) TCP/IP protocol output
Secondary Port	Buffered TCP/IP protocol output for data logging to external device

Logging

Parameters	Time tag, status, position, attitude, velocity, track and speed, dynamics, performance metrics, raw IMU data (200 Hz), raw GPS data (10 Hz)
Media	External: Removable 1 Gbyte Flash Disk (2 supplied), Internal: Embedded 1 Gbyte Flash Disk for redundant logging

NMEA RS232 ASCII Output

Parameters	NMEA Standard ASCII messages: Position ($INGGA), Heading ($INHDT), Track and Speed ($INVTG), Statistics ($INGST)
Rate	Up to 50 HZ (user selectable)

RS232 High Rate Binary Output

Parameters	User selectable binary messages: Time, position, attitude, speed, track, PAV30 output, Yaw Drift Correction
Rate	Up to 200 Hz (user selectable)

RS232 Input Interfaces

Parameters	Gimbal encoder input, AUX GPS Input (RTK, NavCom Starfire, OmniStar HP), RTCM104 DGPS Corrections Input
Rate	1 to 200 Hz

Other I/O

1 PPS	1 pulse per second Time Sync output, normally high, active low pulse
Event Input (2)	Time mark of external events. TTL pulses > 1 msec width, max rate 100 Hz.

User Supplied Equipment

PC for POS Controller (Required for configuration)	*PC for POSPac Post-Processing Software*
▪☐ Pentium 90 processor (minimum) ▪☐ 16 MB RAM, 1 MB free disk space ▪☐ Ethernet adapter (RJ54 100 base T) ▪☐ Windows 98/2000/NT/XP	▪☐ Pentium 90 processor (minimum) ▪☐ 16 MB RAM, 1 MB free disk space ▪☐ Windows 2000/NT/XP

Third party product specifications are provided based on information available from the manufacturer's website at the time of writing. Specifications subject to change without notice. POS AV is trademark of ApplAnix Corporation. Document #U10053-00 ©March 2007 ITRES Research Limited.



INFORME PLAN DE VUELO

6.4 RECEPTOR GNSS TRIMBLE BD960 GNSS RECEIVER MODULE



KEY FEATURES

- Proven GNSS technology from Trimble
- Centimeter level position accuracy
- OmniSTAR XP/HP support
- Convenience of Ethernet connectivity
- Easy-to-integrate form factor and software commands



EMBEDDED GNSS RECEIVER SPEEDS DEVELOPMENT OF ADVANCED POSITIONING APPLICATIONS

THE GNSS (GLOBAL NAVIGATION SATELLITE SYSTEM) INDUSTRY IS GROWING AND EVOLVING TO ADOPT NEW SIGNAL TECHNOLOGIES. BY ADOPTING MODERNIZED GPS AND GLONASS SIGNAL POSITIONING, APPLICATIONS REACH NEW LEVELS OF PERFORMANCE AND PRODUCTIVITY.

The Trimble® BD960 GNSS system is a multi-channel, multi-frequency, OEM GNSS receiver, in a compact Eurocard form factor. The latest, Trimble centimeter-level positioning technology is now available in an easy-to-integrate module. With the Trimble BD960, OEMs and integrators can easily harness both the modernized GPS L2C and L5 signals and GLONASS L1/L2 signals. This GNSS support is available now, with the confidence of working with proven technology.

DEMONSTRATED PERFORMANCE

Industry professionals trust Trimble embedded positioning technologies as the core of their precision applications. With the latest Trimble-precise Maxwell™ technology, the BD960 provides assurance of long-term future-proofing and trouble-free operation.

Moving the industry forward, the Trimble BD960 redefines high-performance positioning:

- On-board multipath mitigation
- Proven low-elevation tracking technology
- Dramatically improved RTK initialization times

OMNISTAR SUPPORT

For land and air applications where decimeter-precision is required, onboard OmniSTAR satellite service is a convenient option. OmniSTAR satellite-based services are available in specific geographic regions worldwide and require a subscription from the service provider (check with OmniSTAR for availability and operating constraints in your area). The Trimble BD960 supports the three levels of Differential GPS Service provided by OmniSTAR: VBS, HP, and XP.

PROVEN DESIGN

The Trimble BD960 was designed for easy integration and rugged dependability. Customers benefit from the Ethernet connectivity available on the board, allowing high speed data transfer and configuration via standard web browsers. The compact, Eurocard form-factor is suitable for many of the most ambitious designs. Just like other Trimble embedded technologies, easy to use software commands simplify integration and reduce development times. All software features are password-upgradeable, allowing functionality to be upgraded as your requirements change. The BD960 is rigorously tested to perform in harsh environmental conditions with the reliability you expect from Trimble.

Trimble

INFORME PLAN DE VUELO

TRIMBLE BD960 GNSS RECEIVER MODULE

TECHNICAL SPECIFICATIONS

- Advanced Trimble Maxwell Custom Survey GNSS technology
- High precision multiple correlator for GNSS pseudorange measurements
- Unfiltered, unsmoothed pseudorange measurements data for low noise, low multipath error, low time domain correlation and high dynamic response
- Very low receiver noise GNSS carrier phase measurements with <1 mm precision in a 1 Hz bandwidth
- Signal-to-Noise ratios reported in dB-Hz
- 72 Channels:
  - GPS L1 C/A Code, L2C, L1/L2/L5[1] Full Cycle Carrier
  - GLONASS L1 C/A Code, L1 P Code,L2 C/A[2], L2 P Code, L1/L2 Full Cycle Carrier
- 4 additional channels for SBAS WAAS/EGNOS/MSAS support
- L-Band OmniSTAR VBS,HP & XP
- 1 LAN port:
  - supports links to 10BaseT/100BaseT networks
  - all functions are performed through a single IP address simultaneously—including web GUI access and data streaming
- 3 x RS232 ports:
  - Baud rates up to 115,200
- 1 Hz, 2 Hz, 5 Hz, 10 Hz and 20 Hz positioning and data streaming outputs
- Reference outputs CMR, CMR+, RTCM 2.1, 2.2, 2.3, 3.0
- Control Software:
  - HTML web browser. Internet Explorer 7.0 or later,
  - Firefox 2.0 or later
  - PC Utilities including Configuration Toolbox
- 1 Pulse Per Second Output
- Event Marker Input Support

Initialization time[3] . . . . . typically <10 seconds
Initialization reliability[3] . . . . . >99.9%
Navigation outputs . . . . . ASCII: NMEA-0183 GSV, AVR, RMC, HDT, VGK, VHD, ROT, GGK, GGA, GSA, ZDA, VTG, GST, PJT, PJK and Binary: Trimble GSOF
LED drive support. . . . . 3 (indicating Power, Satellite Tracking, and Differential Data)

POSITIONING SPECIFICATIONS

Mode	Accuracy[4]	Latency[5]	Maximum Rate
Synchronized RTK	1 cm + 1 ppm Horizontal 2 cm + 1 ppm Vertical	300 ms[6]	10 Hz
Low Latency RTK	2 cm + 2 ppm Horizontal[7] 3 cm + 2 ppm Vertical	<20 ms	20 Hz
DGPS	<1 m 3D	<20 ms	20 Hz
SBAS[8]	<5 m 3D	<20 ms	20 Hz

PHYSICAL CHARACTERISTICS

Size. . . . . 100 mm x 106.7 mm x 12.7 mm
Power. . . . . 4.9 V DC to 28 V DC
Typical 2.1 W at 5 V DC (L1/L2 GPS)
Connectors
I/O . . . . . 34-pin header
Antenna . . . . . MMCX receptacle

ENVIRONMENTAL CHARACTERISTICS

Temperature
Operating . . . . . –40 °C to +75 °C
Storage. . . . . –55 °C to +85 °C
Vibration. . . . . MIL810F, tailored
Random 6.2 gRMS operating
Random 8 gRMS survival
Mechanical shock MIL810D
±40 g operating
±75 g survival

ORDERING INFORMATION

Module . . . . . Trimble BD960 GNSS available in a variety of configurations from L1 DGPS upwards
Starter Kit . . . . . Includes BD960 receiver, I/O board, Power Supply, Configuration Software and reference manual

1 *The availability of the L5 signal is dependent on the US Government.*
2 *L2 C/A on GLONASS-M satellites.*
3 *May be affected by atmospheric conditions, signal multipath, and satellite geometry. Initialization reliability is continuously monitored to ensure highest quality.*
4 *1 sigma level.*
5 *At maximum output rate.*
6 *Dependent on data link throughput.*
7 *Assumes 1 second data link delay.*
8 *Depends on SBAS system performance.*

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6.5 RECEPTOR DE TRABAJO PESADO GNSS/INS SPAN-SE PROVEE SOLUCION DE POSICIÓN 3D, VELOCIDAD Y ALTITUD DEL VUELO.

SPAN™ | SPAN-SE™



Rugged GNSS/INS Receiver Delivers 3D Position, Velocity and Attitude Solution

Benefits

Continuous, stable navigation

Supports IMUs from a variety of suppliers

Available as fully enclosed product or as board stack

Proven OEMV® technology

Features

SD card data logging

GPS or GPS+GLONASS options

Single antenna and dual antenna support

Wheel sensor input for ground systems

If you require more information about our SPAN products, visit novatel.com/products/span-gnss-inertial-systems

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SPAN: World-Leading GNSS+INS Technology

SPAN (Synchronous Position, Attitude and Navigation) technology brings together two different, but complementary technologies: GNSS positioning and inertial navigation. The absolute accuracy of GNSS positioning and the stability of IMU gyro and accelerometer measurements are tightly coupled to provide an exceptional 3D navigation solution that is stable and continuously available, even through periods when satellite signals are blocked.

SPAN-SE Overview

The SPAN-SE receiver enclosure provides the user interface to SPAN. It outputs raw measurement data or solution data over several communication protocols or to a removable SD card. Multiple GPS-synchronous strobes and event input lines offer easy integration into a larger system. Combining SPAN-SE with a SPAN-supported IMU creates a complete GNSS/INS system. For applications requiring an external heading reference, a dual antenna version of SPAN-SE is available.

SPAN-SE Advantages

Tight coupling of the GPS and IMU measurements provides more satellite observations and the most accurate, continuous solution possible. Utilizes NovAtel's world-class GNSS receiver technology, the SPAN-SE delivers many powerful features including GPS+GLONASS capability and AdVance® RTK performance. A dedicated CPU for real-time GNSS/INS processing results in fast data rates and low raw data and solution latency for highly dynamic or time-critical applications.

Improve SPAN-SE Accuracy

Take advantage of our Advance RTK as well as support for satellite-based augmentation systems such as OmniSTAR® or SBAS to improve real-time performance and accuracy. For more demanding applications Inertial Explorer® (IE) post processing software from our Waypoint® product group can be used to post process SPAN-SE data and offers the highest level of accuracy with the system.

Dual Antenna option provides users with faster initial alignments in difficult low dynamics applications such as marine survey.

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INFORME PLAN DE VUELO

SPAN | SPAN-SE

SPAN System Performance[1]

Horizontal Position Accuracy (RMS)

Single Point L1	1.5 m
Single Point L1/L2	1.2 m
SBAS	0.6 m
CDGPS	0.6 m
DGPS	0.4 m
OmniSTAR	
VBS	0.6 m
XP	0.15 m
HP	0.1 m
RT-20®	0.2 m
RT-2™	1 cm+1 ppm

Measurement Precision

L1 C/A Code	4 cm RMS
L1 Carrier Phase	0.5 mm RMS (differential channel)
L2 P(Y) Code	8 cm RMS
L2 Carrier Phase	1 mm RMS (differential channel)

Data Rates

GPS Measurement	50 Hz
GPS Position	20 Hz
IMU Measurement	Up to 200 Hz
INS Solution	Up to 200 Hz
Time Accuracy[2]	50 ns RMS
Maximum Velocity[3]	**515 m/s**

Physical and Electrical

Dimensions	200 x 248 x 76 mm
Weight	3.4 kg

Power

Power Consumption (single antenna)	10 W (typical)
Power Consumption (dual antenna)	12 W (typical)
Input Voltage	+9 to +28 VDC

Antenna Port(s) Power Output

Output Voltage	+5 VDC
Maximum Current	100 mA

COM Port Output Power

Output Voltage	+9 to +30 VDC
Maximum Current	1.5 A

Connectors

Power	ODU Mini Snap, Series K, 4 pin
I/O 1	ODU Mini Snap, Series K, 30 pin
I/O 2	ODU Mini Snap, Series K, 30 pin
Ethernet	RJ-45
Primary RF	TNC Female
Secondary RF	TNC Female
USB Device	Type B
USB Host	Type A

Communication Ports

RS232/RS422 software configurable UART COM Ports	4
IMU Connection	1
RTK correction Input UART COM Port	1
USB 2.0 Host	1
USB 2.0 Device	1
Ethernet	1
Removable SD Card	1
Event Input Triggers	4
Configurable Output Strobes	3

Environmental

Temperature

Operating	-40°C to +65°C
Storage	-50°C to +80°C
Humidity	95% non-condensing
Waterproof	IEC 60529 IPX7
Dust	IEC 60529 IP6X

Vibration (operating)

Random	RTCA DO-160D, curve C
Sinusoidal	IEC 68-2-6
Shock (operating)	IEC 68-2-27, 25 g

Compliance

Emissions	FCC Part 15, Class B EN 55022, Class B
Immunity	EN 55024
Safety	EN 609050-1
MTBF	269 000 hrs

Features

- Field-upgradable firmware
- Supports RTCM SC-104 version 3.0, CMR version 3.0, CMR+, NMEA 0183 version 3.01, and RTCA DO-217 message types

Included Accessories

- VDC power cable
- Two serial cables
- SD card
- Mounting brackets
- CD
- USB 2.0 cable

Optional Accessories

- GPS-700 series antennas
- ANT series antennas
- RF cables – 5, 10 and 30 m lengths
- Easy post-processing using Inertial Explorer

Optional Dual Antenna

ALIGN® Heading Accuracy[4]	
0.5 m Baseline	0.40°
1.0 m Baseline	0.20°
2.0 m Baseline	0.10°

Supported SPAN IMUs

- UIMU-LCI
- UIMU-LN200
- UIMU-HG58/62
- IMU-FSAS
- IMU-CPT

Version 4 -Specifications subject to change without notice.
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SPAN-SE April 2011

For the most recent details of this product:
novatel.com/assets/Documents/Papers/SPAN-SE.pdf

[1] GNSS/INS performance is dictated by the IMU integrated with SPAN.
[2] Time accuracy does not include biases due to RF or antenna delay.
[3] Export licensing restricts operation to a maximum of 515 metres per second.
[4] A second receiver (Z-model) is required to enable ALIGN functionality.

Statements related to the export of products are based solely on NovAtel's experience in Canada, are not binding in any way and exportability may be different with respect to the export regulations in effect in another country. The responsibility for re-export of product from a Customer's facility is solely the responsibility of the Customer.

INFORME PLAN DE VUELO

6.6 IMU-CPT COMBINADO CON TECNOLOGÍA GNSS PARA PROVEER SOLUCION DE POSICIÓN 3D, VELOCIDAD Y ALTITUD DEL VUELO.

SPAN™ | IMU-CPT™



IMU-CPT Combined with NovAtel's GNSS Technology to Provide 3D Position, Velocity and Attitude Solution

Benefits

Continuous, stable positioning

Minimizes import/export issues

Withstands harsh environments

Easy integration with NovAtel's SPAN-SE™ GNSS/INS receiver

Features

Fiber optic gyros and MEMS accelerometers

Wheel sensor input for ground applications

SPAN: World-Leading GPS+INS Technology

SPAN (Synchronous Position, Attitude and Navigation) technology brings together two different, but complementary technologies: GPS positioning and inertial navigation. The absolute accuracy of GPS positioning and the stability of inertial measurement unit (IMU) gyro and accelerometer measurements are tightly coupled to provide an exceptional 3D navigation solution that is stable and continuously available, even through periods when satellite signals are blocked.

IMU-CPT Overview

The IMU-CPT is designed to be paired with NovAtel's SPAN-SE line of receivers. It is comprised of fiber optic gyros (FOG) and micro electrical mechanical systems (MEMS) accelerometers. FOGs offer exceptionally long life and stable performance compared with other similar gyro technologies. The IMU-CPT provides the best price/performance available on NovAtel's SPAN platform.

Improve IMU-CPT Accuracy

Paired with NovAtel's SPAN-SE receiver platform the IMU-CPT allows customers to benefit from a feature rich and ruggedized enclosure offering excellent price to performance value. This pairing offers a fully integrated tightly coupled GNSS and IMU system delivering the most satellite observations and the most accurate, continuous position, velocity and attitude solution possible. Further, the IMU-CPT is comprised entirely of commercial components, which means cross-border difficulties involved with traditional GPS/INS systems are greatly minimized. Additionally for more demanding applications Inertial Explorer® (IE) post processing software from our Waypoint® products group can be used to post process IMU-CPT data and offers the highest level of accuracy with the system.

If you require more information about our SPAN products, visit novatel.com/products/span-gnss-inertial-systems

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