GeoEye-1

Instrument/Product Description

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Purpose and Scope

This document describes the GeoEye-1 satellite instrument and product characteristics. It was prepared in accordance with the format of the GMES-CMDA-EOPG-IS-08-03 document. This product description is intended to be considered by GMES for informational purposes only, and is applicable only for GeoEye's GeoEye-1 sensor. Not all descriptions included in this document are considered "standard" measurements or characteristics for the GeoEye-1 sensor and therefore none of these descriptions will be considered as binding "contractual specifications" for the purpose of GeoEye-1 product deliveries. The specifications provided herein are for information purposes only and are subject to change. All specifications and products described herein, and/or products delivered in accordance with the specifications herein, are intended for internal use only and may not be disseminated publicly for a fee or otherwise.

1.1 Infrared and Visible Optical Sensors

When applicable and if available, for each mode of the sensor (e.g. wide swath, different hyperspectral modes), the value of the following parameters and their relative uncertainty/accuracy shall be provided:

Code	IVOS-01
Parameter	**Mission status**
Definition	The status describes whether the satellite still has to be launched [specify future launch date], or the mission is currently in its commissioning phase [specify launch date and end of commissioning phase], or in its operational phase [specify launch date and beginning of operational phase], or it is a past mission [specify launch date and end of mission].
VALUE	Launch Date – September 6, 2008 Full Operational Capacity (FOC) certification – February 20, 2008
Validated	N/A
Monitored	Operated daily since launch.
Uncertainty	N/A

Code	IVOS-02
Parameter	**Orbit elements, general orbit type and satellite altitude**
Definition	Semimajor axis [km], eccentricity, inclination [deg]. For example whether the orbit is sun-synchronous, retrograde etc. The operational altitude [km] (reference mean value) of the satellite above the Earth surface.
VALUE Semimajor axis, eccentricity, inclination, orbit type/ description, altitude, uncertainties	Sun Synchronous 682Km +/- 100m Height 7054.1Km +/- 100m Semimajor Axis 0.0015 +/- .001 Eccentricity 98.114º +/- 0.05 Inclination 10:30am +/- 10min lmst equatorial crossing
Validated	Yes
Monitored	Daily
Uncertainty	See above

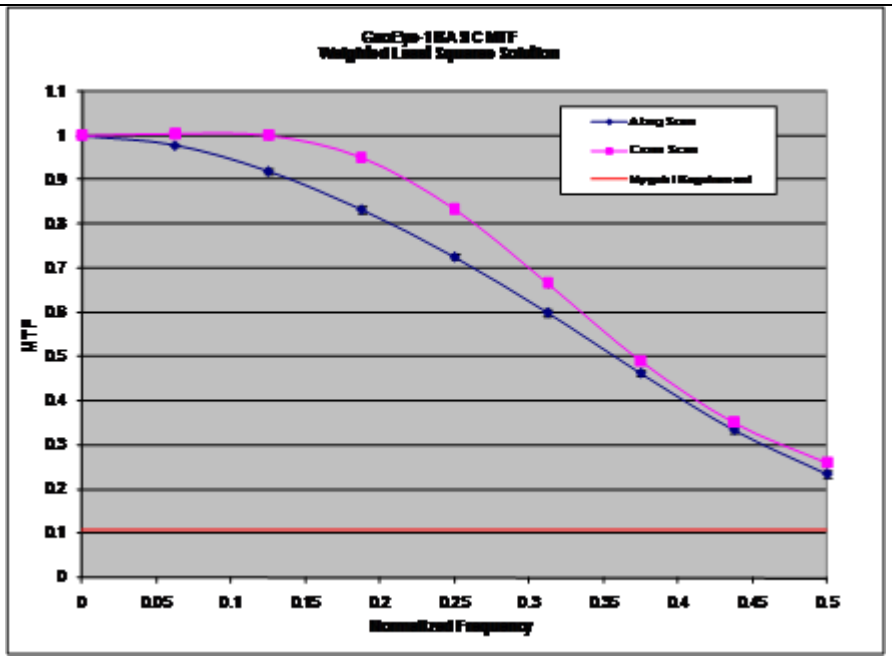
1.1.2 GEOMETRIC CHARACTERISTICS AT NADIR

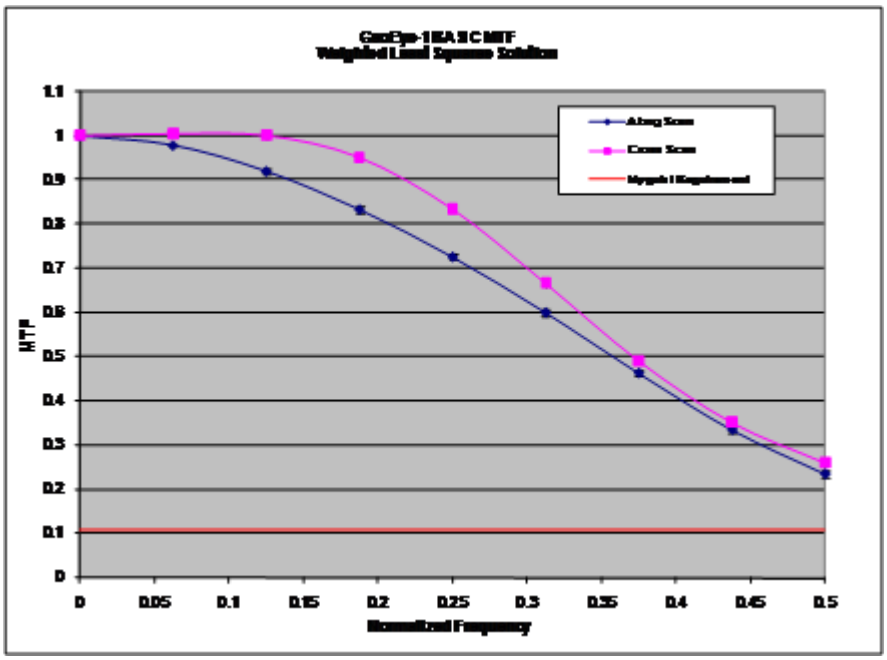
Code	IVOS-03
Parameter	**Instantaneous geometric field of view (IGFOV) [m2 at altitude H in km]**
Definition	The geometric size of the image projected by the detector on the ground through the optical system. When expressed in linear or area units such as meters or hectares, it is an altitude dependent measure of the ground resolution of the instrument. This is also called pixel footprint, and it should not be confused with the Ground Sample/ing Distance. (Ref: Joseph, G. 2004. How well do we understand Earth observation electro optical sensor parameters? Post-Launch Calibration of Satellite Sensors. Taylor and Grancis group: London.) (Note that imagery must be re-sampled to 0.5 meters for non-US Government customers)
VALUE	The IGFOV is 41 cm at nadir for the panchromatic band. The IGFOV is 1.64 cm at nadir for each of the four multi-spectral bands.
Validated	Yes, based on focal plane/CCD design and confirmation of orbital altitude.
Monitored	N/A
Uncertainty	Minimal

Code	IVOS-04
Parameter	**Ground Sampling Distance (GSD) [m]**
Definition	Ground Sample Distance (GSD) refers to the size of the pixels expressed in ground units. The pixel size has not to be confused with the spatial resolution which instead identifies the minimum separation between two objects at which the resulting images of the objects appear distinct and separate.
VALUE	The GSD is 41 cm at nadir for the panchromatic band. The GSD is 1.64 cm at nadir for each of the four multi-spectral bands.
Validated	Yes, based on focal plane/CCD design, confirmation of orbital altitude, and approximate 100% detector fill factor.
Monitored	N/A
Uncertainty	Minimal

Code	IVOS-05
Parameter	**Modulation Transfer Function (MTF) at IGFOV [value at specific frequency]**
Definition	The Modulation Transfer Function describes the response of the imaging sensor as a function of the spatial frequency. It is calculated by performing the normalized Fourier Transform of the Point Spread Function. The point spread function (PSF) describes the response of an imaging system to a point source or point object. A related but more general term for the PSF is a system's impulse response. Another related quantity is the Contrast Transfer Function (CTF). MTF describes the response of an optical system to an image decomposed into sine waves. CTF describes the response of an optical system to an image decomposed into square waves. In other words, the Modulation Transfer Function at IGFOV can be defined as the ratio of the intensity variation of the ground scene to the intensity variation of the image at a spatial frequency equal to the IGFOV.
VALUE	Camera MTF at Nyquist for Pan is .15 based on 08/21/09 measurement.
Validated	Yes, via imaging of ground targets.
Monitored	Semi-annually
Uncertainty	+/- .01 (1σ)

Code	IVOS-06
Parameter	**MTF Calculation Procedure**
Definition	Please provide a description of the MTF calculation procedure used to derive the value specified in IVOS-05.
VALUE	Description of procedure can be found in “Modulation Transfer Function Measurement Method and Results For the Orbview-3 High Resolution Imaging Satellite.” Kevin Kohm.
Validated	By JACIE & CCAP
Monitored	No – procedure is constant.
Uncertainty	N/A

Code	IVOS-07
Parameter	**Effective IFOV (EIFOV) [value at specific frequency]**
Definition	This is defined as the resolution corresponding to a spatial frequency (ground resolution) for which the system MTF is 50%. (Ref: Joseph, G. 2004. How well do we understand Earth observation electro-optical sensor parameters?. *Post-Launch Calibration of Satellite Sensors.* Taylor and Grancis group: London.)
VALUE	
Validated	Yes, via imaging of ground targets.
Monitored	Semi-annually
Uncertainty	Not calculated

Code	IVOS-08
Parameter	**Radiometrically accurate IFOV [value at specific frequency]**
Definition	The resolution for which the MTF is higher than 0.95. (Ref: Joseph, G. 2004. How well do we understand Earth observation electro-optical sensor parameters?. *Post-Launch Calibration of Satellite Sensors.* Taylor and Grancis group: London.)
VALUE	
Validated	Yes, via imaging of ground targets.
Monitored	Semi-annually
Uncertainty	Not calculated

Code	IVOS-09
Parameter	**Band to band registration [pixels at 1 sigma]**
Definition	Distortions and differences between the various instrument's bands due to the detector (e.g. focal plane alignment and stability). The multispectral registration is the maximum distance between the pixel centers of each multispectral band corresponding to a selectable point. This error is measured relatively from a reference band (TBD) to the others bands.
VALUE	Maximum misregistration in a typical strip from any color band to the PAN band is less than 0.2 MS pixels or 1.6 PAN pixels.
Validated	Yes, by performing band to band correlation on multiband images of terrestrial scenes.
Monitored	Yes, as a part of periodic geometric calibration.
Uncertainty	< 20%

Code	IVOS-10
Parameter	**Centering accuracy [m at 1 sigma]**
Definition	Centering accuracy is associated with the programming function and concerns the ability of the system to optimally point a target on ground. This is the difference between a theoretical centre of an image at the programming step and his real position in the acquired image.
VALUE	~100 m
Validated	Yes
Monitored	No
Uncertainty	~100 m

Code	IVOS-11
Parameter	**Direct Geo-location accuracy [m at 1 sigma]**
Definition	The location error stands for the deviation between the real position of any point on an image and its estimated position using the ancillary data of the product without ground control points. The value of this error is expressed for positions on the reference ellipsoid and an altitude given by a DTM.
VALUE	Nominally better than 5.0m LE/CE 90˚ and currently slightly better than 3.5m LE/CE 90˚.
Validated	Yes, via ground control points in imagery.
Monitored	Quarterly.
Uncertainty	Not calculated

Code	IVOS-12
Parameter	**Geo-location accuracy for Orthorectified products [m at 1 sigma]**
Definition	The location error after orthorectification represents the deviation between the estimated coordinates and elevation of any point on an image and its real position and elevation on the ground
VALUE	10 m CE90 for GeoProfessional; 4 m CE90 for GeoProfessional Precision
Validated	By JACIE & CCAP
Monitored	QA inspects all precision products with check points
Uncertainty	Not calculated.

Code	IVOS-13
Parameter	**Orthorectification procedure**
Definition	Description of the applied orthorectification procedure specifying the algorithm, sensor model and used Digital Elevation Model (DEM) or Digital Terrain Model (DTM).
VALUE	Proprietary.
Validated	
Monitored	
Uncertainty	

Code	IVOS-14
Parameter	**Jitter effect analysis**
Definition	The jitter effects in an image concerns very high frequencies which occur during the acquisition and cannot be corrected by calibration (e.g. microvibrations). Please include within this report and relevant information.
VALUE	Proprietary.
Validated	
Monitored	
Uncertainty	

1.1.3 RADIOMETRIC CHARACTERISTICS

Code	IVOS-15
Parameter	**Noise equivalent reflectance (NE2ρ) [no unit] or Noise equivalent Radiance Difference (NE2L) [Wm-2steradian-1μm-1]**
Definition	This can be defined as the minimum change in reflectance (temperature) that can be detected by the sensor. (Ref: Joseph, G. 2004. How well do we understand Earth observation electro-optical sensor parameters?. Post-Launch Calibration of Satellite Sensors. Taylor and Grancis group: London.)
VALUE	Proprietary.
Validated	
Monitored	
Uncertainty	

Code	IVOS-16
Parameter	**Minimum and maximum saturation radiances for each band [maintain units]**
Definition	The maximum value of radiance which can be measured by the detector. Saturation is the condition where energy flux exceeds the sensitivity range of a detector.
VALUE	Saturation by band (W/cm^2-sr-μm) Pan .167 Blue .117 Green .074 Red .109 NIR .040
Validated	Predicted on ground.
Monitored	Annually
Uncertainty	Not calculated

Code	IVOS-17
Parameter	**System signal to noise ratio at two radiance values for the different bands of the instrument [ratio]**
Definition	Self explanatory
VALUE	SNR @ 15% Well Fill Pan 122.5 Blue 204.8 Green 206.4 Red 195.4 NIR 210.2
Validated	Yes, on orbit.
Monitored	Annually
Uncertainty	N/A

Code	IVOS-18
Parameter	**Number of quantization bits [number of bits]**
Definition	The signal measured by the sensor is transformed to digital counts, which are represented by a number of bits called “quantization bits”
VALUE	11 bits in each band.
Validated	Yes, by design
Monitored	No
Uncertainty	None

Code	IVOS-19
Parameter	**Any additional compression (e.g. jpg), compression noise**
Definition	Data size reduction due to compression.
VALUE	On average, 11 bits compressed to 2.4 bits prior to data downlink. After compression, transmission, and decompression image quality remains high.
Validated	Yes
Monitored	Intrinsic in spacecraft hardware
Uncertainty	None

Code	IVOS-20
Parameter	**Absolute calibration**
Definition	Relation between quantity values provided by measurement standards and the corresponding indications of a measuring system, carried out under specified conditions and including evaluation of measurement uncertainty. The absolute calibration is determined by the coefficients needed to transform the acquired data into values obtained via accurate ground reference measurements and taking into account all system's errors. A different set of coefficients is used for each spectral band.
VALUE	Scaling coefficients by band can be found in image metadata and are a function of camera settings for a given acquisition. Look for coefficients with units of mW/(cm^2-str-μm-DN)
Validated	N/A
Monitored	N/A
Uncertainty	N/A

1.1.4 SPECTRAL CHARACTERISTICS

Code	IVOS-21
Parameter	**Spectral response for each band**
Definition	Self explanatory
VALUE	wavelength (nm) Pan 450 – 800 Blue 450 - 510 Green 510 - 580 Red 655 - 690 NIR 780 - 920
Validated	On ground measurements.
Monitored	No
Uncertainty	N/A

1.1.5 ORBIT CONTROL CHARACTERISTICS

Code	IVOS-22
Parameter	**Position and Velocity Orbit accuracy [m and m/s]**
Definition	Horizontal and vertical (radial) orbit position and velocity accuracy.
VALUE	Proprietary.
Validated	
Monitored	
Uncertainty	

1.1.6 COVERAGE AND TEMPORAL CHARACTERISTICS

Code	IVOS-23
Parameter	**Instantaneous field of view (IFOV) [m^2]**
Definition	The instantaneous field of view (IFOV) is the angle over which a measurement is being made by a detector at any instant (i.e. swath).
VALUE	.41 m by 15.2 km for pan and 1.64 m by 15.2 km for MS.
Validated	Yes
Monitored	No
Uncertainty	None

Code	IVOS-24
Parameter	**Instantaneous Access area [m^2]**
Definition	The total area on the ground that could potentially be seen at any moment by turning the spacecraft or instrument.
VALUE	Images are typically taken within 30 deg of nadir, but can be taken anywhere on the earth as seen from 681 km altitude.
Validated	Yes, by normal operations
Monitored	Yes, by normal operations
Uncertainty	N/A

Code	IVOS-25
Parameter	**Duty cycle [percentage]**
Definition	This is the fraction of the total time that the instrument is operating during an orbit.
VALUE	~ 40% duty cycle
Validated	Yes
Monitored	Yes, by normal operations
Uncertainty	N/A

Code	IVOS-26
Parameter	**Temporal resolution with same incidence angle and time of acquisition [time]**
Definition	This temporal resolution is defined as the shortest time separation between two acquisitions of the same location on Earth captured with the same incidence angle and at the same time of the day.
VALUE	11days (205 revs) repeat within 20 km at equator 140 days (2049 revs) exact
Validated	This result follows from the orbit geometry.
Monitored	Orbit is monitored.
Uncertainty	Not Calculated

Code	IVOS-27
Parameter	**Temporal resolution with different incidence angle and time of acquisition [time]**
Definition	This temporal resolution is defined as the shortest time separation between two acquisitions of the same location on Earth captured with a different incidence angle and at a different time of the day.
VALUE	12 seconds
Validated	By demonstration.
Monitored	No
Uncertainty	~ 2 seconds