DMC Constellation: User Guide

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DMC Constellation Imagery User Guide

This user guide provides essential information regarding all the Medium-Resolution DMC constellation products and services. It contains the following information:

- Qualitative description of the constellation offering, its performance, and available products
- Technical discussion of product quality and usage
- Product format and naming
- Product ordering and delivery

We would like this document to be as useful as possible. If you feel that information is missing or unclear; or for any other feedback you may have on the content and format, please e-mail us at: UKIntelligence-ImagerySupport@airbus.com

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1 Introduction

The UK DMC constellation consists of four satellites working together to provide scheduled and archive medium resolution imagery to satisfy a range of customer requirements.

UK-DMC2 and DEIMOS-1 were launched together in 2009, enhancing, and eventually replacing the previous generation of 32m DMC constellation satellites. The next generation DMC satellites, ASALT-1B and KazSTSAT, now join them, once again enhancing the existing constellation and providing continuity of coverage for this resolution class.

	UK-DMC2	DEIMOS-1	ALSAT-1B	KazSTSAT
Operator	UK Intelligence	Urthecast collaborating regularly with UK Intelligence on case by case basis	UK Intelligence and ASAL	UK Intelligence and Ghalam LLP
Country	UK	Spain and UK	UK and Algeria	UK and Kazakhstan
Launch	July 2009		Sept 2016	Dec 2018
Swath	640km		147km	275km
Resolution	MUL: 22m		MUL: 24m PAN: 12m	MUL: 21m
Spectral bands	NIR, R, G		PAN, NIR, R, G, B	NIR, R-E, R, G, B, C-B

Table 1-1: The DMC+ Satellite Constellation - Summary

1.1 KazSTSAT

Launched on 3rd December 2018, KazSTSAT is the most recent introduction to the DMC constellation of medium resolution satellite imagers, delivering 6 bands of 21m resolution orthorectified data as standard.

The table outlines the main characteristics of KazSTSAT.

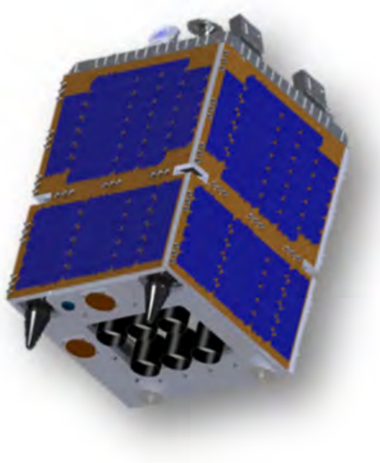

Figure 1-1: Impression of KazSTSAT

Satellite mission name	KazSTSAT	Satellite imagery offer name	DMC Constellation
Launch	3rd December 2018	Viewing angle	Standard: ± 20º Extended: On request
Orbit at launch	Sun-synchronous, 10:30 UTC LTDN, 573km altitude	Revisit capacity	< 14 days, more frequent toward the poles
Period/Inclination	96.2 minutes/97.5º	Targeting accuracy	< 500m for nadir and non-nadir acquisitions
Optical system	6 lens/sensor pairs configured in two banks of three tilted to ensure significant ground overlap. Across-track FoV per bank is 26.6°. Focal length 155.9mm, f/5	Orthorectified product location accuracy at nadir	<1 pixel CE90 with respect to given reference
Spectral bands	Coastal Blue: 433-453 nm Blue: 450-510 nm Green:525-605 nm Red: 630-690 nm Red Edge: 690-740 nm Near Infrared: 775-900 nm	Instrument TM link rate	500Mb/sec
Detectors	SSTL EarthMapper (based on heritage SLIM-6)	Mission lifetime	Design lifetime of 7 years
Ground sampling distance (nadir)	21 m	Main X-band down/uplink station	Ghalam, Kazakhstan
Product resolution	21 m	Programming and production	Airbus Intelligence Guildford (UK)
Swath width	275km at nadir	Satellite control centre	Ghalam, Kazakhstan
Dynamic range at acquisition	12 bits per pixel		

Table 1-2: Main characteristics of KazSTSAT

Figure 1-2: SSTL SLIM6 Imager on KazSTSAT

KazSTSAT data consists of six multispectral bands with a GSD at nadir of 21m. Imagery is provided as scaled radiance multispectral orthorectified products. The imagery payload has an adjustable swath to 275km. The instrument is an improved version of the SSTL SLIM6 model previously used on UK-DMC2.

Table 1-3 provides further specifications on image product quality and sensor performance that are considered relevant to the user. All figures stated here with respect to imager radiometry, MTF and Signal-to-Noise (SNR) are those currently provided after a number of initial on-ground and in-orbit calibration procedures and measurements. Further in-orbit measurements are planned to ensure continued image data quality throughout the lifetime of the satellite.

Geometry and Resolution	
GSD at Nadir	MS: 21m
Satellite MTF per band	Coastal Blue, Blue, Green, Red, Red Edge: >10% NIR: > 5% *MTF quoted at Nyquist and at boresight, verified by on ground testing (AD-2).*
Planimetric accuracy of Orthorectified Product	< 21m CE90 relative to the EOX Sentinel-2 Cloudless layer. Product created by placing GCPs on this 2D reference, combined with height information obtained from the SRTM4 DEM.
MS Band co-registration	< 0.3 MS pixels CE90
Radiometry	
Mean absolute calibration accuracy	All bands: < 5%
Satellite SNR per band, using default gains at the given reference radiance	Coastal Blue: 70.4 @ 133 W $sr^{-1}m^{-2}$ μm^{-1} Blue: 167.0 @ 147 W $sr^{-1}m^{-2}$ μm^{-1} Green: 220.2 @ 130 W $sr^{-1}m^{-2}$ μm^{-1} Red: 198.2 @ 113 W $sr^{-1}m^{-2}$ μm^{-1} Red Edge : 143.7 @ 84 W $sr^{-1}m^{-2}$ μm^{-1} NIR : 184.2 @ 75 W $sr^{-1}m^{-2}$ μm^{-1}

Table 1-3: Product and sensor image quality performance indicators for KazSTSAT

1.2 ALSAT-1B

Launched on 26th September 2016, ALSAT-1B provides orthorectified products with resolution up to 12m as standard.

The ALITE instrument aboard ALSAT-1B allows near-simultaneous acquisition of panchromatic and multispectral data. This means that imagery can be provided either singly (MS or PAN), or as a bundle (MS + PAN) delivered together in a single product.

The table outlines the main characteristics of ALSAT-1B

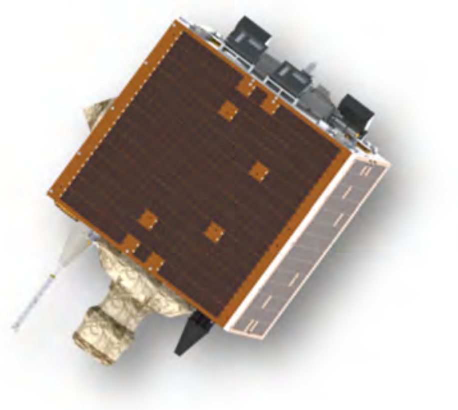

Figure 1-3: Impression of ALSAT-1B

Satellite mission name	ALSAT-1B	Satellite imagery offer name	DMC Constellation
Launch	26th September 2016	Viewing angle	Standard: ± 20º Extended: On request
Orbit at launch	Sun-synchronous, 10:30 UTC LTDN, 670km altitude	Revisit capacity	8 days

Period/Inclination	98.4 minutes/98º	Targeting accuracy	< 1000m for nadir and non-nadir acquisitions
Optical system	Newtonian telescope with five linear detectors in the along-track direction in the common focal plane of the sensor. Each channel has 12,288 active pixel elements of 8µm x 8µm with a separation of 6.8mm.	Orthorectified product location accuracy at nadir	<1 pixel CE90 with respect to given reference
Spectral bands	PAN: 480-720 nm Blue: 450-530 nm Green:535-615 nm Red: 620-700 nm Near Infrared: 760-890 nm	Instrument TM link rate	500Mb/sec
Detectors	ALITE	Mission lifetime	Design lifetime of 7 years
Ground sampling distance (nadir)	Panchromatic: 12m Multispectral: 24 m	Main X-band down/uplink station	ASAL, Algeria
Product resolution	Panchromatic: 12 m Multispectral: 24 m	Programming and production	Airbus Intelligence Guildford (UK)
Swath width	~150km at nadir	Satellite control centre	ASAL, Algeria
Dynamic range at acquisition	10 bits per pixel		

Table 1-4: Main characteristics of ALSAT-1B

ALSAT-1B data consists of four 24m multispectral bands and a 12m panchromatic channel. Imagery is provided as scaled radiance multispectral orthorectified products. The imaging payload has an approximately 150km ground swath coverage, depending on the imaging angle.

The CCD layout for band data collection is illustrated in the Figure below.

Figure 1-4: ALSAT-1B sensor band arrangement on one CCD

Table 1-5 provides further specifications on image product quality and sensor performance that are considered relevant to the user. All figures stated here with respect to imager radiometry, MTF and Signal-to-Noise (SNR) are those currently provided after a number of initial on-ground and in-orbit calibration procedures and measurements. Further in-orbit measurements are planned to ensure continued image data quality throughout the lifetime of ALSAT-1B.

Geometry and Resolution	
GSD at Nadir	MS: 24m; PAN 12m
Satellite MTF per band	MS: > 20%; PAN: > 10%
Planimetric accuracy of Orthorectified Product	< 12m CE90 relative to the EOX Sentinel-2 Cloudless layer. Product created by placing GCPs on this 2D reference, combined with height information obtained from the SRTM4 DEM.
MS Band co-registration	< 0.3 MS pixels CE90
MS-PAN Band co-registration	< 0.3 MS pixels CE90
Radiometry	
Mean absolute calibration accuracy	MS: <5% PAN: < 4.00% *NB: These figures are after first in-orbit calibration. Subsequent update planned 2020*
Satellite SNR per band, using default gains at the given reference radiance	Blue: 115 @ 1974.972 W $sr^{-1}m^{-2}$ μm^{-1} Green: 148 @ 1802.042 W $sr^{-1}m^{-2}$ μm^{-1} Red: 158 @ 1559.490 W $sr^{-1}m^{-2}$ μm^{-1} NIR: 280 @ 1067.449 W $sr^{-1}m^{-2}$ μm^{-1} PAN: 170 @ 1678.559 W $sr^{-1}m^{-2}$ μm^{-1}

Table 1-5: Expected product and sensor image quality performance indicators for ALSAT-1B

1.3 UK-DMC2 and DEIMOS-1

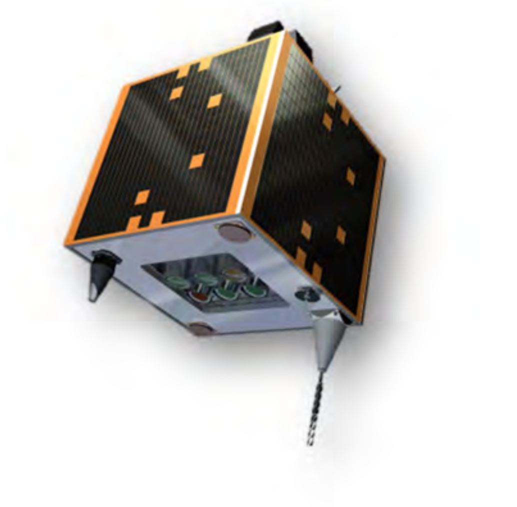

Figure 1-5: Impression of U-KDMC2 and DEIMOS-1

UK-DMC2 and DEIMOS-1 were launched together on the 29th July 2009, providing continuity to the previous generation of DMC medium-constellation satellites and delivering 22m resolution orthorectified products as standard. Archive data for both satellites is available to order via the catalogue. Scheduled DEIMOS-1 data is also available to request on enquiry.

Both nadir pointing satellites contain the SLIM-6-22 imaging payload built by SSTL UK, which is an evolution of the multi-spectral imagers flown on previous SSTL missions.

The SLIM-6-22 instrument is a dual bank linear CCD push broom imager, providing 3 spectral bands to capture radiation reflected from the Earth's surface within a 640km swath.

Table 1-6 outlines the main characteristics of these missions.

Satellite mission name	UK-DMC2 and DEIMOS-1	Satellite imagery offer name	DMC Constellation
Launch	29th July 2009	Viewing angle	NADIR only
Orbit at launch	UK-DMC2: Sun-synchronous, LTAN 10:45 UTC, 659km altitude DEIMOS-1: Sun-synchronous, LTAN 11:10 UTC, 667km altitude	Revisit capacity	DEIMOS-1: 10 days UK-DMC2: Archive only
Period/Inclination	UK-DMC2: 97.9 mins/98.06° DEIMOS-1: 98.1 mins/98.1°	Targeting accuracy	< 1000m for nadir
Optical system	Custom design double Gaussian derivative lens with Focal length 155.9mm, corrected across-track FoV of ± 25.97°, and an f-number of f/53	Orthorectified product location accuracy at nadir	<1 pixel CE90 with respect to given reference
Spectral bands	Green:520-600nm Red: 630-690 nm Near Infrared: 770-900 nm	Instrument TM link rate	<80Mb/sec
Detectors	SLIM-6-22	Mission lifetime	Operating beyond design lifetime of 5 years
Ground sampling distance (nadir)	Multispectral: 22 m	Main X-band down/uplink station	Guildford (UK)
Product resolution	Multispectral: 22 m	Programming and production	Airbus Intelligence Guildford (UK)
Swath width	640km	Satellite control centre	SSTL, Guildford (UK)
Dynamic range at acquisition	11 bits per pixel, 8 bits transmitted to ground		

Table 1-6: Main characteristics of UK-DMC2 and DEIMOS-1

The SLIM-6-22 imager (Figure 1-6) is composed of two imaging camera banks, each bank consisting of 3 channels corresponding to the NIR, Red and Green spectral bands according to a filter placed over each lens. Each bank is mounted at an angle to provide a total imaging swath of over 600km, which includes a small overlap between the simultaneously acquired images.

Table 1-7 provides a set of specifications relevant to image product quality and sensor performance.

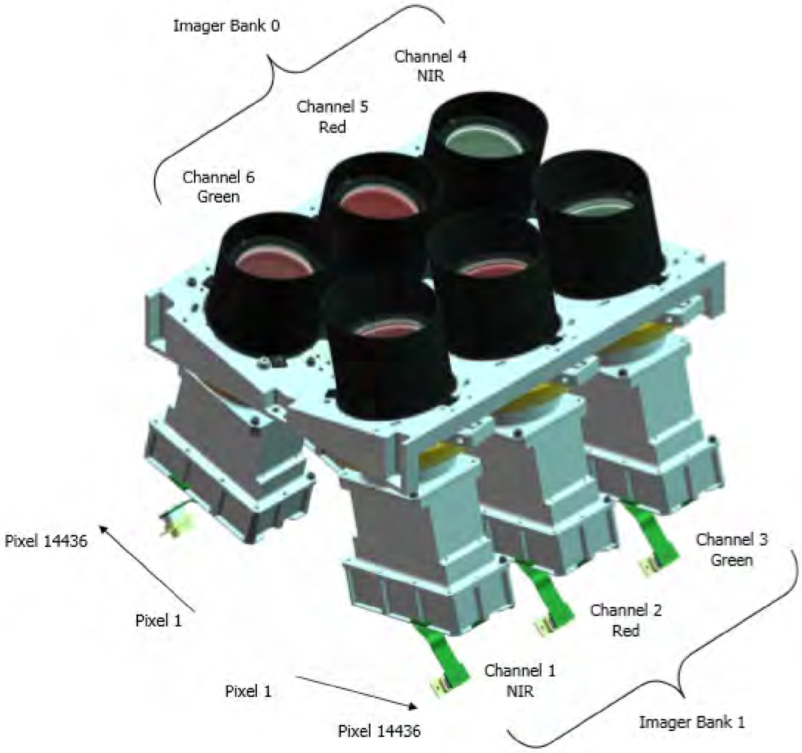

Figure 1-6: Detector and channel layout of the SLIM-6-22 imager

Geometry and Resolution	
GSD at Nadir	MS: 22m
Satellite MTF per band	MS: > 20%
Planimetric accuracy of Orthorectified Product	< 22m CE90 relative to a given reference layer (e.g. Landsat GLS or Sentinel-2 EOX). Product created by placing GCPs on this 2D reference, combined with height information obtained from the SRTM4 DEM.
MS Band co-registration	< 0.3 MS pixels CE90
MS-PAN Band co-registration	< 0.3 MS pixels CE90
Radiometry	
Mean absolute calibration accuracy	Green/Red/NIR: <5%
Satellite SNR per band, using default gains at the given reference radiance	For a nominal vegetated scene at mid-latitude summer, the SNRs for all three bands approach 100:1, with the green spectral band having the highest SNR.

Table 1-7: Expected product and sensor image quality performance indicators for UK-DMC2 and DEIMOS-1

1.4 Acquisition Mode

All DMC+ satellite images are acquired in push-broom fashion, with the acceptable range of roll angle determined by the platform:

- KazSTSAT and ALSAT-1B routinely acquire at roll angles of up to 20°, although greater roll angles can be accommodated on request, according to feasibility
- UK-DMC2 and DEIMOS-1 are both nadir-only imagers

In each case, acquired strips of variable length are divided into individual scenes according to the imager.

Satellite	MS resolution	Swath Width (at nadir)	Scene Length (at nadir)
KazSTSAT	21m	275km	378km
ALSAT-1B	24m	150km	170km
DEIMOS-1	22m	640km	341km
UK-DMC2	22m	640km	341km

Table 1-8: Swath width and scene length for each satellite at nadir

Acquisitions are typically delivered as single scenes although it is possible to provide longer strips upon request.

2 Image Processing

For each satellite in the constellation the theory and principles of radiometric processing are the same. The general method is outlined here, followed by a definition of the Solar Spectral Irradiance Values per band for each satellite.

2.1 Radiometric Processing

2.1.1 Radiometric Processing Levels

There are three levels of radiometric processing that may be applied to satellite data, according to the level preferred by any given application.

- The initial raw measurement performed by the satellite is converted to a radiance value (via the sensor calibration). This value is then scaled appropriately for delivery. This is the radiometric processing level at which all constellation products are supplied.
- Radiance data can then be converted to a 'Top-Of-Atmosphere' (TOA) reflectance as measured from space, thus considering the reflectance measurement as filtered by the atmosphere.
- TOA reflectance may be further corrected to consider the transfer of reflected light through the atmosphere to obtain direct spectral information at the ground level. This is known as ‘Bottom-Of-Atmosphere’ (BOA) or ‘Top-Of-Canopy’ (TOC) reflectance.

Radiance

Different radiometric artefacts may affect the raw acquisition data as it is collected. The main issues are high frequency noise due to the differential sensitivities between detectors (pixel equalisation) and low frequency variations in the field of view (vignetting, etc.). After correction for this detector PRNU (Photo Response Non-Uniformity), the dark signal and relative gain of each detector are characterised and monitored at regular intervals throughout the satellite’s life to maintain good equalisation according to the nominal TDI level or electronic gain.

After the above corrections, the measured DN value still does not truly account for the light power incident on the imaging telescope at the time of image acquisition. Losses occur during transmission at different stages of the acquisition chain (optics, filters, etc.). These losses are considered to be the same for each band with some evolution during the satellite lifetime. The related correction is thus modelled by a simple linear function on each band. This 'absolute' sensor calibration provides offset and gain corrections for each band, allowing the final transformation of values to fully represent the TOA radiance incident on the sensor. Absolute calibration coefficients are updated at regular intervals throughout the satellite lifetime.

In general, to convert DN values to (TOA) spectral radiance (L), the following linear formula is applied per band (b):

$$L_b = DN_b * GAIN_b + BIAS_b$$

KazSTSAT and ALSAT-1B data products are supplied as 16-bit encoded scaled radiance products, with a common gain for each band of 0.01 and a common bias value of zero.

UK-DMC2 and DEIMOS-1 data products are supplied as 8-bit encoded scaled radiance products. These products have gain and bias values that vary per image, with specific values provided within the DIMAP metadata (PHYSICAL_GAIN and PHYSICAL_BIAS).

It should be noted that, for UK-DMC2 and DEIMOS-1, it is the *reciprocal* of the PHYSICAL_GAIN parameter provided in the metadata that must be used in the above formula for spectral radiance.

The physical unit of TOA spectral radiance (L) is $W.st^{-1}.m^{-2}.\mu m^{-1}$

Under clear sky conditions (assuming few dynamic factors affecting the lower atmosphere), the radiance value may be considered to be comparable to the ground surface radiance at the given acquisition angle.

TOA Reflectance

The reflectance (ρ) for a given spectral band (ρ_b) is the fraction of the incident solar illumination (or irradiance) reflected by the Earth to the sensor. A value 0 represents full absorption (black), and a value of 1 represents complete reflection (perfect white). Note that, in reality, apparent reflectance may exceed a value of 1 when considering specular targets or on slopes facing towards the Sun.

The measured Top of Atmosphere (TOA) radiance is first calculated from the delivered data via the calibration coefficients described above. This can then be transformed to a TOA reflectance measurement.

The TOA radiance of the acquired scene varies as a function of the incident solar illumination – i.e. the local elevation of the Sun at the time of image acquisition. Converting to TOA reflectance minimises this dependency and makes cross-comparison of different products possible.

The TOA spectral radiance (L_b) can be converted to TOA spectral reflectance (ρ_b) by applying the following formula:

$$\rho_b = \frac{\pi\, L_b\, d^2}{E_{0b}\, \cos\theta_s}$$

Where:

E_{0b} = solar spectral irradiance (ESUN) at the imager for band b
θ_s = solar zenith angle at the time/location of acquisition = (90 – solar elevation) °
d = Sun-Earth distance at the time of acquisition in units of AU

The value for the solar elevation at acquisition is provided in the image metadata (SUN_ELEVATION) and this can be converted to solar zenith angle by subtraction from 90°.

The Sun-Earth distance at the time of acquisition (*d*) can be calculated using commonly available data online. 1AU is described as the mean distance of the Earth from the Sun in metres. In reality, the value for *d* varies only very slightly during the year.

DMC Constellation Solar spectral irradiance values (ESUN)

Solar spectral irradiance, E_{0b}, (commonly known as ESUN) is a constant value specific to each band of each imager. It is determined by using well know models of Solar Irradiance with the measured spectral transmission of the imager for each incident wavelength. It has units of $Wm^{-2}\mu m^{-1}$.

The applicable values are provided in the following tables.

KAZSTSAT

Band	COASTAL BLUE	BLUE	GREEN	RED	RED EDGE	NIR
ESUN, E_0 ($Wm^{-2}\mu m^{-1}$)	1886.305	2013.767	1807.938	1536.439	1383.847	1035.411

Table 2-1: Solar spectral irradiance for each KazSTSAT band

ALSAT-1B

Band	PAN	BLUE	GREEN	RED	NIR
ESUN, E_0 ($Wm^{-2}\mu m^{-1}$)	1678.559	1974.972	1802.042	1559.490	1067.449

Table 2-2: Solar spectral irradiance for each ALSAT-1B band

UK-DMC2 and DEIMOS-1

Both the UK-DMC2 and DEIMOS-1 feature the SLIM-6-22 imager and have the same exo-atmospheric solar irradiance values.

Band	GREEN	RED	NIR
ESUN, E_0 ($Wm^{-2}\mu m^{-1}$)	1811	1841	1811

Table 2-3: Solar spectral irradiance for each of the UK-DMC2 and DEIMOS-1 bands

TOC Reflectance – atmospheric correction

In order to calculate TOC reflectance, some modelling of the Earth's atmosphere at the time of image acquisition is required. In general, in-situ measurements of the atmosphere are unavailable and determining the best atmospheric correction to use is a complex matter.

In short, atmospheric correction can be considered two-fold:

1. Correction of the systematic contribution of the atmosphere

   This corresponds to the effect of the atmosphere when viewing on a perfectly clear day. It corrects for the known effects of the gaseous nature of the different layers of atmosphere due to molecular (Rayleigh) scattering and the corresponding loss of relevant illumination (particularly in the longer wavelengths) responsible for the bluish tinge noted in TOA imagery. Spatially, this contribution is nearly uniform across the whole of the image and it can be computed per image using various standard atmospheric models (e.g. the LOWTRAN family – MODTRAN, ATCOR etc. or 5S-6S – SMAC etc.).

2. Correction of a number of dynamic factors affecting the lower atmosphere

   There are a number of far more unstable atmospheric phenomena that exist in the lower atmosphere (fog, haze, thin cloud etc.). Their contribution to the atmospheric absorption/scattering of incident solar radiation is never homogenous across any image scene and this type of atmospheric correction is generally investigated on the pixel level.

At present, no atmospheric correction is offered for any of the DMC constellation missions, although, some relevant parameters are provided within the DIMAP metadata for input to a chosen model (e.g. Solar Azimuth, Solar Elevation and View and Incidence Angles).

2.1.2 Spectral Bands and Spectral Response

KazSTSAT

KazSTSAT acquires images using five spectral bands as indicated in the table.

Band Name	Min Wavelength, λ_{min} (nm)	Max Wavelength, λ_{max} (nm)	Centre Wavelength, λ_{Centre} (nm)	Spectral Bandwidth (nm)
Coastal Blue	433	453	443	20
Blue	450	510	480	60
Green	525	605	565	80
Red	630	690	660	60
Red Edge	690	740	715	50
NIR	775	900	837.5	125

Table 2-4: KazSTSAT spectral bands

The spectral response at any wavelength is defined as the ratio of light power measured at the sensor to that input at the telescope entrance. The relative spectral response of the instrument is shown in the figure.

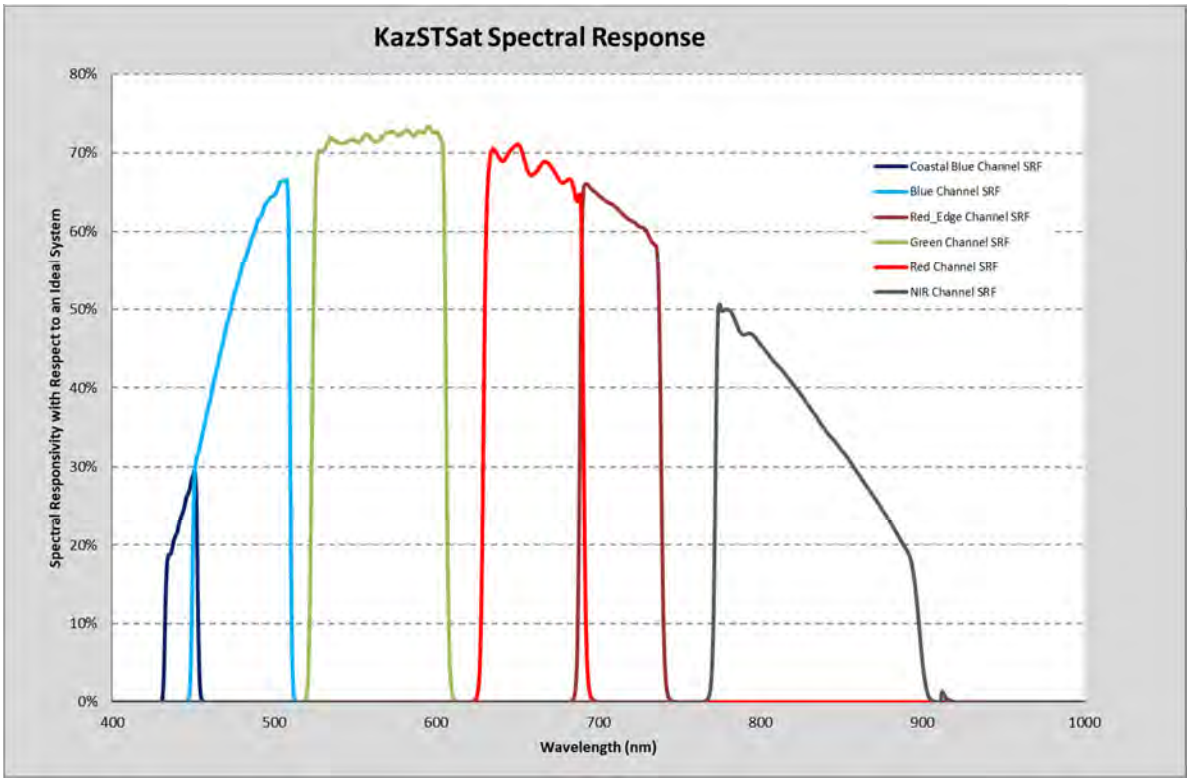

Figure 2-1: KazSTSAT relative spectral band response

ALSAT-1B

ALSAT-1B acquires images using five spectral bands as indicated in the table.

Band Name	Min Wavelength, λ_{min} (nm)	Max Wavelength, λ_{max} (nm)	Centre Wavelength, λ_{Centre} (nm)	Spectral Bandwidth (nm)
Panchromatic	480	720	600	240
Blue	450	530	490	80
Green	535	615	575	80
Red	620	700	660	70
NIR	760	910	825	150

Table 2-5: ALSAT-1B spectral bands

The spectral response of the instrument is shown in the figure below.

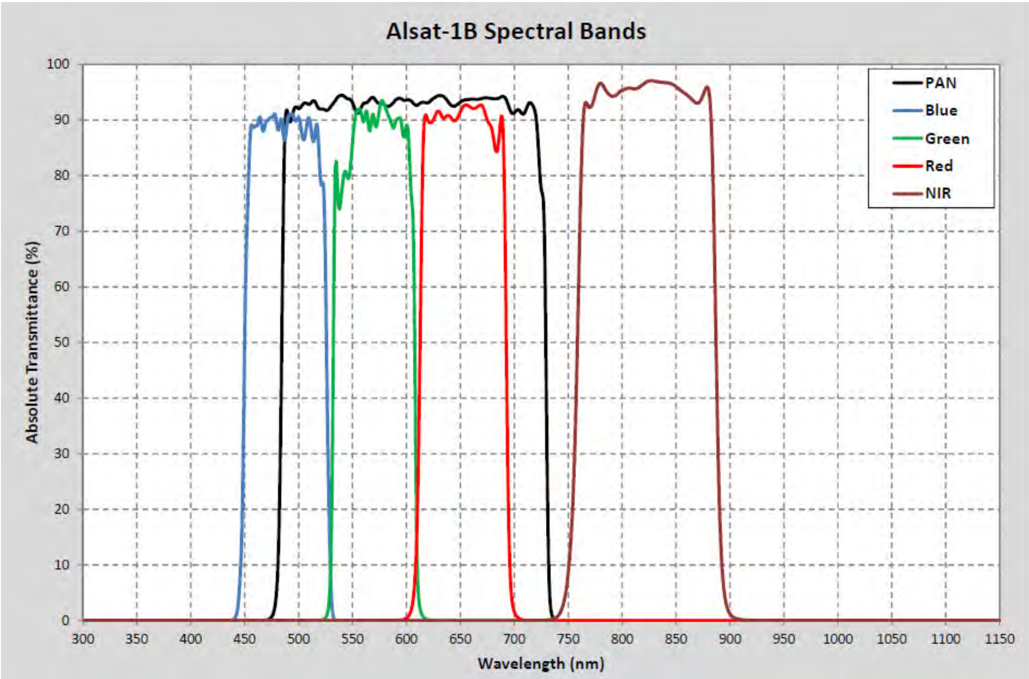

Figure 2-2: ALSAT-1B spectral band response

UK-DMC2 and DEIMOS-1

UK-DMC2 and DEIMOS-1 acquires images in 3 bands as indicated in the table.

The spectral response of each band of the SLIM-6 imager relevant to these missions is illustrated in the sequence of figures below.

Band Name	Min Wavelength, λ_{min} (nm)	Max Wavelength, λ_{max} (nm)	Centre Wavelength, λ_{Centre} (nm)	Spectral Bandwidth (nm)
Green	520	600	560	80
Red	630	690	660	60
NIR	770	900	835	130

Table 2-6: UK-DMC2 and DEIMOS-1 spectral bands

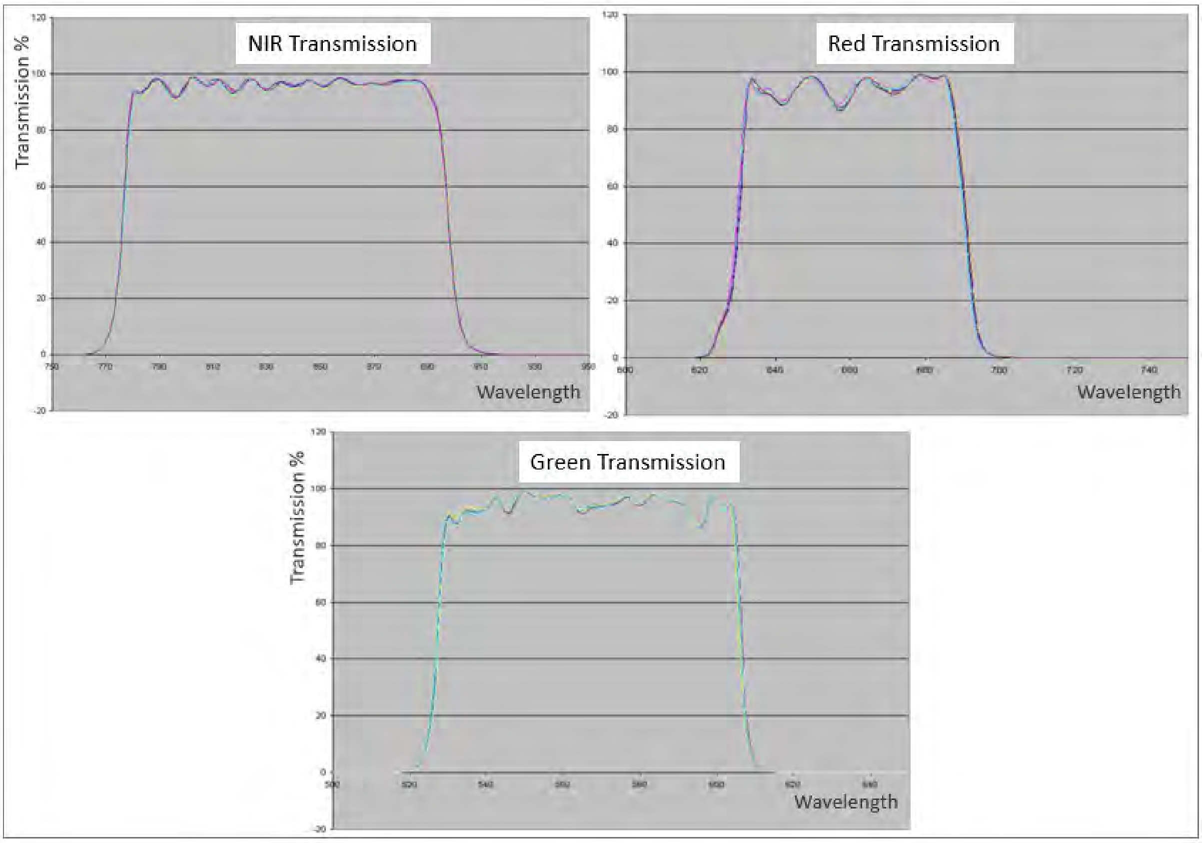

Figure 2-3: UK-DMC2 and DEIMOS-1 spectral bands

2.2 Geometric Processing

Initial geometric corrections are applied for each mission using attitude and ephemeris measurements at the time of imaging, in combination with the bespoke geometric sensor models. The main corrections applied are:

- Combination of all sub-swaths across the field of view
- Application of the geometric sensor model
- Bank mosaicking (if required for UK-DMC2 and DEIMOS-1 only)
- Co-registration of all spectral bands (multispectral and panchromatic where appropriate)
- Projection using WGS84/UTM

- Orthorectification using GCP collection against a standard reference data set and DEM. A mix of automated and manual GCP collection is used according to the mission and associated quality requirements of the required coverage.

The geometric corrections described above remove the following sources of geometric distortion from the image:

- Sensor Geometry
- Lens Distortion
- Curvature of the Earth
- Rotation of the Earth
- Spacecraft Attitude
- Spacecraft Motion

Full orthorectification is an optional process for data provided by ALSAT-1B and KazSTSAT, and this data can be provided with a simple projection onto the ellipsoid, if required. These data products are also provided with a rational polynomial coefficients (RPC) file.

Detailed information describing the use of RPCs, related metadata, and terminology related to image projection and orthorectification is provided in Appendix A at the end of this document.

3 Available Products

The DMC constellation currently offers the geometrically and radiometrically processed data products outlined below. KazSTSAT, ALSAT-1B and DEIMOS-1 are available for imaging upon request; UK-DMC2 supplies archive data only.

Products	KazSTSAT	ALSAT-1B	UK-DMC2	DEIMOS-1
Projected	✓	✓		
Standard Orthorectified	✓	✓	✓	✓
Tailored Orthorectified	✓	✓	✓	✓
Multispectral	✓	✓	✓	✓
Panchromatic		✓		
Bundle		✓		

Table 3-1: Overview of the available products for each satellite

3.1 Geometric Product Variations

Geometrically, the following options are available. Please refer to Table 3-1 for the products available for each satellite:

1. ***Projected***

   The projected product is created by the application of a mapping process to project the image onto an Earth cartographic system at a fixed altitude. The image is georeferenced without the application of a Digital Elevation Model (DEM) and supplied with the RPC model file, which is supported by many existing software products, from standard GIS to expert photogrammetry.

   This means that image products are directly compatible with GIS environments and can be easily orthorectified using the customer's own reference data.

   The projected product is mapped onto the Earth using a standard reference datum and projection system at a constant terrestrial altitude, relative to the reference ellipsoid. By default, the map projection system used is WGS84/UTM. Other projection systems are also available for the creation of customised products.

2. Standard Orthorectified

The standard orthorectified product (sometimes called the Precision Ortho, or L1T for UK-DMC2 and DEIMOS-1) is a georeferenced image in Earth geometry, whose generation includes the application of a DEM and GCPs. It is created via a mix of fully- and semi-automated procedures according to the mission and associated quality requirements of the required coverage.

The orthorectification procedure eliminates the perspective effect on the ground (excluding buildings) to restore the geometry of a vertical shot. The Standard Ortho product is intended for those users who wish to use the data directly for their given application. As such, it can be ingested directly into a Geographic Information System and used immediately. This processing level facilitates the management of several layers of products, from several different sensors, while reducing localisation gaps that can be caused by different viewing angles or relief between the various layers.

The Standard Ortho product is created using our accurate sensor model, with height information provided via the SRTMv4 DEM[1]. Precision is improved via GCPs applied using a cloudless Sentinel-2 layer as reference.

3. Tailored Orthorectified

In addition to the standard orthorectified product described above, when different specifications are needed, Airbus Intelligence can also provide on-demand, custom orthorectification, using projection, height and/or reference information provided by the client as required. Each Tailored Ortho product is subject to a feasibility study and specific delivery timeframes.

3.2 Radiometric product variations

The DMC constellation products are considered as ready-to-use. They are easily integrated in GIS and/or transformed into thematic information when combined with other satellite, airborne or ground information.

The following spectral configurations are available; please refer to Table 3-1 for an overview of available products per satellite:

1. 6-Band Multispectral, MS6

This single multispectral product includes six multispectral (colour) bands provided by KazSTSAT: Coastal Blue, Blue, Green, Red, Red Edge and Near Infrared.

The product pixel size is 21m.

2. 4-Band Multispectral, MS4

This single multispectral product includes four multispectral (colour) bands provided by ALSAT-1B: Blue, Green, Red and Near Infrared.

The product pixel size is 24m.

[1] The STRM DEM V4 only covers the Earth's land mass between ±60° latitude. Where the acquired image exceeds this, orthorectification will be performed using the 1km GLOBE DEM supplied by NGDC

3. 3-Band Multispectral, MUL

This single multispectral product includes three multispectral (colour) bands provided by UK-DMC2 and DEIMOS-1: Green, Red and Near Infrared.

The product pixel size is 22m.

4. Single Band Panchromatic, PAN

The ALSAT-1B panchromatic product includes data contained within a single high-resolution band. It covers wavelengths between 480 and 720nm within the visible spectrum.

The product pixel size is 12m.

5. Bundle, BUN

ALSAT-1B Bundle products provide both the 4-band multispectral, and the panchromatic data from the same acquisition in a single product package.

Data is provided with pixel sizes of 24m and 12m for MS and PAN data respectively.

4 Product Format and Naming

4.1 Product Format

DMC Constellation imagery is provided in DIMAP version 1.1 format.

- Data is provided as GeoTIFF raster with LZW compression, and
- Rational Polynomial Coefficients (RPCs) are provided with projected products for simple orthorectification and other geometric processing.

A KMZ quicklook file is also included to allow rapid user-friendly display of the main metadata in the Google Earth environment.

4.2 Band Orders

Band Number	KazSTSAT	ALSAT-1B	UK-DMC2/ DEIMOS-1
B1	Coastal Blue	Blue	Green
B2	Blue	Green	Red
B3	Green	Red	NIR
B4	Red	NIR	
B5	Red Edge		
B6	NIR		

Table 4-1: Band order for each of the satellites in the DMC Constellation

4.3 DIMAP Metadata File Description

Products are delivered with two main metadata files containing information pertinent to the delivered imagery – a DIMAP xml metadata file for automated product ingestion, and an html metadata file for easy human viewing. The main content and format of the DIMAP xml metadata file is described in the following table and it is detailed on-line here:

https://www.intelligence-airbusds.com/dimap/spec/dimap.htm

Section	Description	Useful Information
Metadata_Id	Description of metadata format and version	Currently DIMAP version 1.1
Dataset_Id	Contains the core dataset name and thumbnail path	e.g. AB_BUN_20201029210321_ORTP_S103867_0cd7

Production	Dataset production information	Currently contains the production date.
Dataset_Use	Intended to provide information about permitted use of the data	Right now, this information is contained only in the licence provided separately, and this section of metadata remains blank.
Data_Processing	Basic information about the product processing.	Contains the software version, DEM used and interpolation type used in the delivered product.
Quality_Assessment	Describes the geometric quality of the delivered product.	Contains the number of GCPs applied and various measures of geometric accuracy, including RMS_x, RMS_y and *CE90* values. This section is only relevant for orthorectified products.
Coordinate_Reference_System	Details of the CRS applied in the product generation.	Contains EPSG codes, projection information etc.
Geoposition	Details of the upper left corner	Upper left corner position in metres and the x and y dimensions per pixel – i.e. product pixel sizes in x and y (within the XDIM and YDIM fields)
Raster_CS	Defines the sub-pixel position of the upper left map coordinates stated in ULXMAP and ULYMAP	This can be type POINT or CELL. Usually type: *POINT*
Dataset_Frame	The position of each corner of the dataset, starting at the upper right corner and moving anti-clockwise around the image	Provided in metres, degrees long/lat and image row/column
Raster_Encoding	Tiff raster encoding	Contains product bit depth, data type, byte order and tiff tile size
Data_Access	Provides the file type and relative file path to the image data file	File type is always GEOTIFF and the file path is relative to the location of the metadata file.
Raster_Dimensions	Basic dimensions of the delivered image file raster	NCOLS, NROWS, NBANDS
Image_Interpretation	Contains information on the band order and gain/bias values to apply, with units	Band order is as stated in Table 4-1: Band order for each of the satellites in the DMC Constellation . Physical gain/bias values are image specific for UK-DMC2 and DEIMOS-1; gain is set to 0.01 for KazSTSAT and ALSAT-1B, with bias 0.0. Units are standard reflectance $W.m^{-2}st^{-1}m^{-6}$.
Image_Display	Provides the correct band order to allow display of an RGB image, with relevant statistics for display stretching.	Provides values per band for: • Min/max value • Standard deviation • Mean

		• Linear min/Max value for mapping to a linear stretch on a monitor (0 to 255). These are derived as: LIN_MIN = MEAN – 2.5 * STDV LIN_MAX = MEAN + 2.5 * STDV
Dataset_Sources	Various information on the source acquisition data used in the product derivation.	Includes: • source acquisition ID • a basic source bounding box • Acquisition information - Imaging start/stop date & time - Incidence and viewing angles - Sun azimuth and elevation angles • Sensor location at time of imaging - Sensor altitude (m) - Sensor azimuth and elevation (°)

Table 4-2: DIMAP metadata file description

4.4 Product Naming

4.4.1 KazSTSAT and ALSAT-1B

The naming convention and product package format for KazSTSAT and ALSAT-1B retains some compatibility with previous UK-DMC2 MR products whilst remaining in line with newer missions. Products are delivered as a zip file with structure:

<PRODUCT_ID>.zip

<FOLDER_ID>

Product Files

The <PRODUCT_ID> and <FOLDER_ID> take the general form as follows:

<PRODUCT_ID>

<NAME_ABBREVIATION>_<SPECTRAL_PROCESSING>_<IMAGING_START_TIME>_<PROCESS_LEVEL>_<JOB_ID>_<NUM_PRODUCT>

<FOLDER_ID>

<NAME_ABBREVIATION>_<SPECTRAL_PROCESSING>_<ORDER_ID>_<SCENE_ID>_<PRODUCT_VERSION>

E.g.

AB_BUN_20200604171607_ORTP_S105201_0b03.zip

AB_MS4_Test_01-1

<ALSAT-1B Product Files>

Name Section	Description	Format/Example/Options
<NAME_ABBREVIATION>	Abbreviation of given satellite name (KazSTSAT /ALSAT-1B)	KAZ or AB
<SPECTRAL_PROCESSING>	3-letter abbreviation to indicate the band configuration provided (MS4, MS6, PAN or BUN)	E.g. MS6
<IMAGING_START_TIME>	UTC start time of the originating image acquisition	Format: YYYYMMDDHHMMSS E.g.20190801103021
<PROCESS_LEVEL>	This is the processing level of the given product, either projected or orthorectified	Projected (not ortho): PRJ Orthorectified: ORTP
<JOB_ID>	Internal Airbus processing ID. This is unique to every version of every product	Format: SNNNNNN E.g. S123456
<NUM_PRODUCT>	4 digit hex identifier associated with the original acquisition ID	Format: XXXX E.g. 1A2B
ORDER_ID	alphanumeric string	Format: Free format according to the original customer order E.g. UKOrder1234
SCENE_ID	2-digit number representing the position of the delivered scene in an acquired strip. A value of 00 means that the delivered product is representative of the entire acquisition strip.	02
PRODUCT_VERSION	Version number of the product in delivery, starting at 1. This allows the customer to keep track of any re-delivered orders.	Format: N E.g. 1

Table 4-3: <PRODUCT_ID> and <FOLDER_ID> detailed description

The folder contains a number of individual product files. Each file has a <ROOT_NAME> and an optional prefix/suffix (depending upon file type) according to the following naming structure, and further described in the table below:

<ROOT_NAME>

<NAME_ABBREVIATION>_<SPECTRAL_PROCESSING>_<IMAGING_START_TIME>_<PROCESS_LEVEL>_<JOB_ID>_<NUM_PRODUCT>

File Name	File Type	Comment
DIM_<ROOT_NAME>_Meta	.xml	Dimap metadata file
<ROOT_NAME>_Meta	.html	Html version of the dimap metadata
<ROOT_NAME>	.sip	Sip file supplied to provide continuity with UK-DMC2

<ROOT_NAME>	.rpc	RPC file provided with projected products to allow customer orthorectification using a chosen DEM/DTM
<ROOT_NAME>	.tfw	Tiff World File
<ROOT_NAME>	.tif	Tiff file containing the delivered imagery
<ROOT_NAME>_Icon	.jpg	Jpeg thumbnail/icon file
<ROOT_NAME>_Preview	.kmz	Kmz quicklook
<ROOT_NAME>_Preview	.jpg	Jpeg quicklook

Table 4-4: KazSTSAT and ALSAT-1B product files

4.4.2 UK-DMC2 and DEIMOS-1

UK-DMC2 and DEIMOS-1 orthorectified products (L1T) are delivered as a zip file with structure:

<PRODUCT_ID>.zip

Product Files

The <PRODUCT_ID> takes the general form as follows:

<PRODUCT_ID>

<PROCESS_LEVEL>-<SATELLITE_NAME><EVENT_ID>_<SCENE_START_LINE_NUMBER>_<SCENE_END_LINE_NUMBER>_<IMAGER_BANK>_<PRODUCT_LEVEL>_<PROCESS_DATE>-<PROCESS-TIME>

E.g.

ORTHO-U200688d_015000_030499_s_L1T-20170711-150039.zip

<UK-DMC2 Product Files>

Parameter	Description	Value
<PROCESS_LEVEL>	Short name describing product processing level	ORTHO
<SATELLITE_NAME>	Satellite name	DE = DEIMOS-1 U2 = UK-DMC2
<EVENT_ID >	Acquisition ID Number	Unique 6 digit hexadecimal value
<SCENE_START_LINE_NUMBER>	Starting line number of delivered scene from the originally acquired strip	6 digit start line number
<SCENE_END_LINE_NUMBER>	Final line number of delivered scene from the originally acquired strip	6 digit scene end number

<IMAGER_BANK>	Imager bank used to acquire the delivered scene	P – *Port* imager bank S – *Starboard* imager bank T – Both imager banks mosaicked
<PRODUCT_LEVEL>	Product Level	L1T
<PROCESS_DATE>	UTC date of product creation	Format: YYYYMMDD E.g.20170711
<PROCESS_TIME>	UTC time of product creation	Format: HHMMSS E.g. 150039

Table 4-5: <PRODUCT_ID> detailed description

The folder contains a number of individual product files. Each file has a <ROOT_NAME> and an optional prefix/suffix (depending upon file type) according to the following naming structure, and further described in the table below:

<ROOT_NAME>

<SATELLITE_NAME><EVENT_ID>_<SCENE_START_LINE_NUMBER>_ <SCENE_END_LINE_NUMBER>_<IMAGER_BANK>_<PRODUCT_LEVEL>

File Name	File Type	Comment
<ROOT_NAME>	.dim	Dimap metadata file
<ROOT_NAME>	.html	Html version of the dimap metadata
<ROOT_NAME>_meta	.sip	Sip file supplied to provide continuity with UK-DMC2
<ROOT_NAME>	.tfw	Tiff World File
<ROOT_NAME>	.tif	Tiff file containing the delivered imagery
<ROOT_NAME>_browse	.jpg	Jpeg thumbnail/icon file
<ROOT_NAME>_thumb	.jpg	Jpeg thumbnail/icon file

Table 4-6: UK-DMC2 and DEIMOS-1 Product file description

5 Products, Services and Options

The DMC Constellation offers an extensive worldwide archive of imagery, as well as new acquisitions from the latest missions.

Mission	Archive	New Acquisitions (One Tasking)
ALSAT-1B	2019-Present	✓
KazSTSAT	2019-Present	✓
UK-DMC2	2009-2019	
DEIMOS-1	2009-Present	✓

Table 5-1: Archive and New Acquisitions

5.1 Archive Data

Archive data for the missions in the above table is available to order via the catalogue with a minimum order size of 5000km^2. Archive data from previous generation missions, between 2004 and 2011, are also available on request.

5.2 One Tasking

Commissioning a satellite and obtaining the imagery you requested – exactly when you need it – is now risk-free, fast, and incredibly easy. 30 years ago, Airbus Intelligence was the first to offer satellite-tasking services, revolutionising the satellite imagery market. Today, with One Tasking, the company sets the bar again, with an unprecedented commitment to deliver new imagery collections when and where its customers need them.

In a context of information overload, with One Tasking, Airbus Intelligence provides a unique offer to the market. It takes full advantage of the resource availability and revisit capabilities of its satellite constellations in order to collect and deliver – with unrivalled reliability – the image or coverage you requested, exactly when you need it. Airbus Intelligence's programming offer, redesigned from the ground up, is committed to delivering the very best results, with a tasking service designed entirely around the customer's needs.

A team of world-class tasking experts ensures that your area is covered on time and on spec. Airbus Intelligence's team carefully conducts feasibility studies and closely follows up open tasking requests, constantly adjusting priorities. All of that fine-tuning is at Airbus Intelligence's core and, more than any technical feature, is the secret of One Tasking's reliability.

One Tasking provides you with answers and support in any situation: from the most basic map update through to emergency response, land-use analysis, mission planning, and frequent insights through reliable monitoring.

Key Benefits

- Exceptional tailored customer service.
- Financial compensation if (ever) we do not make it on time
- Flexible sensor availability
- Streamlined offer, to lighten the ordering process alongside all Airbus and partner satellites and sales channels

One Tasking offers **four** tasking options:

ONE DAY	ONE NOW	ONE PLAN	ONE SERIES
Choose your acquisition day Imagery acquisition for a specific day is now risk-free. Three working days before your acquisition date, you receive a weather forecast to let you confirm, postpone or cancel your request at no cost.	**Access useful information in an instant** When immediate imagery is required, our satellites can be tasked to deliver valuable insights in the shortest possible timeframe. Don't panic if it's cloudy – we keep collecting images of your area until we are successful.	**Obtain qualified coverage within an agreed timeframe** You select your timeframes, dates and preferred sensor – we ensure you receive the right qualified coverage, perfectly matching your project milestones.	**Get coverage on a regular basis** Whether you are dealing with long-term changes or highly dynamic situations, One Series brings you the required intelligence at the frequency you choose. For highest frequencies, our cloud cover commitment ensures you pay only for the most useful results.

Table 5-2: One Tasking Summary

	ONE DAY	ONE NOW	ONE PLAN	ONE SERIES	
				Routine	Critical
Timeframe	1 day	The smallest period needed to secure three acquisitions – additional acquisitions are made until cloud cover rate reaches 20% or the customer decides to end the tasking	Customer selected	Customer Selected, including frequency	
Cloud Cover	≤ 100%. Weather forecast provided three working days ahead of acquisition, and updates can be made to the tasking plan up to 10:00 (GMT/BST) two working days before acquisition. It may be possible to reduce this timeframe, subject to feasibility.	≤ 20%. All acquisitions are delivered. A validated acquisition ends the tasking.	• OnePlan and OneSeries Routine: ≤20% or ≤10% with uplift • OneSeries Critical: ≤20%, or ≤100% in the case of daily acquisitions. For daily acquisitions, images are invoiced when reaching ≤60% cloud cover.		
Min AOI	5,000km^2		10,000km^2 5,000 km^2 if five revisits or more		
Max AOI	140 km EW x 140 km NS Larger areas are subject to feasibility study		Subject to feasibility study		
Acquisition Mode	Mono				
Incidence Angle	0-20° as standard, or custom on request, subject to feasibility (UK-DMC2 and DEIMOS-1 nadir only)				
Level	Premium		Regular	Regular	Premium

Table 5-3: Overview of One Tasking options

5.2.1 OneDay

Choose your acquisition date

OneDay tasking allows you to task the satellite on a specific day, subject to feasibility assessment. The satellite resource will be booked for your requested date and the satellite will then cover your area with the highest priority. The collected image will be delivered to you regardless of the cloud cover.

The OneDay tasking option for a specific chosen day is now risk-free: three working days before your acquisition date, you will receive a weather forecast to let you confirm, postpone or cancel your request at no cost. Updates can be made to the tasking plan up to 10:00 (GMT/BST) two working UK days before acquisition. It may be possible to reduce this timeframe, subject to feasibility. This option is especially useful when you need an image for a specific event on a particular day.

The success/failure criterion of a OneDay tasking is whether the acquisition happens on the planned day.

All successful images collected are delivered and invoiced as specified in the acknowledgement of tasking order receipt.

Timeframe	One day
Number of acquisitions	1
Start Date	Any day during the upcoming year
Minimum Order Size	5,000km^2
Max Bounding Box	140 km East–West , 140 km North- South Larger areas are subject to a feasibility study
Cloud Cover	Up to 100%
Acquisition Notification	You are notified of all images acquired.
Acquisition Mode	Mono
Incidence Angle	0-20° as standard, or custom on request, subject to feasibility
Service Level	Premium
Delivery Lead Time	Rush, subject to feasibility

Table 5-4: OneDay Parameters

Tasking parameters

The tasking parameters when selecting the OneDay option include:

- The acquisition date.
- The acquisition mode: Mono.
- The incidence angle is 0-20° as standard, or custom on request, subject to feasibility. Accepting extended angles allows you to increase the available number of acquisition dates, but could impact the geometric performance of your product. Please note that DEIMOS-1 acquires only at nadir.

5.2.2 OneNow

Access useful information in an instant

When immediate imagery is required, our satellites can be tasked to deliver valuable insights in the shortest possible timeframe. This option is mainly dedicated to answer emergency needs when up-to-date information on what is happening on the ground is requested.

OneNow uses the highest satellite tasking priority, and is subject to feasibility assessment. The tasking ends as soon as a validated image is acquired. If a validated image is not acquired within the window, it is possible to extend the survey period and continue to collect imagery until a successful coverage is achieved (i.e. within your requested validation criteria). Note there is an additional fee for extending the survey window.

Timeframe	The smallest period required to attempt three image acquisitions; additional acquisitions are made until either the cloud cover reaches ≤ 20%, or the customer decides to end the tasking
Number of acquisitions	Only one good acquisition
Start Date	Any day during the upcoming year, subject to feasibility.
Minimum Order Size	5,000km^2
Max Bounding Box	140 km East–West , 140 km North–South Larger areas are subject to a feasibility study
Cloud Cover	≤ 20% by default or any other selected cloud cover depending on the location of the area or specific requirements A validated acquisition ends the tasking.
Acquisition Notification	You are notified of all images acquired.
Acquisition Mode	Mono
Incidence Angle	0-20° as standard, or custom on request, subject to feasibility
Service Level	Premium
Delivery Lead Time	Rush, subject to feasibility

Table 5-5: OneNow Parameters

OneNow tasking service acquires the area of interest until an image with 20% or less cloud cover (or any other specific cloud cover or validation criteria requested or accepted by the customer) is acquired.

If the AOI is not collected in full and on specification within the acquisition window, the customer is given the choice to:

- Extend the acquisition period by directly emailing the Imagery Support Team.
- Close the request and receive delivery of everything that has been collected on specification (if applicable). In this particular case, all acquisitions shall be invoiced as per delivery.
- If several images are necessary to fully cover the area but one acquisition is missing, all the images acquired that do cover the area will be invoiced.

If an AOI is more than one scene, in the limit of the maximum bounding box, then the commercial commitment is to successfully collect the complete AOI during the initial tasking timeframe agreed with the customer. This implies including some days where the AOI can only be partially covered. These partial coverage days may still be attempted in order to make the coverage progress in between. They do not count in the failure rating and are considered as an add-on.

The success/failure criterion of an acquisition is technically based on the tasking performance to successfully collect the area in full and on specification within the agreed acquisition window.

With our commitment to delivering useful results, larger areas are subject to a feasibility study before the acquisition of imagery. In this instance, the main objective is to successfully collect the area as soon as possible.

Tasking parameters

The tasking parameters when selecting the OneNow option include:

- The start date.
- The acquisition mode: Mono
- The maximum cloud cover accepted
- The incidence angle is 0-20° as standard, or custom on request, subject to feasibility. Accepting extended angles allows you to increase the available number of acquisition dates, but could impact the geometric performance of your product.

5.2.3 OnePlan

Obtain qualified coverage within an agreed timeframe

Whether for a map update, infrastructure planning or any other specific project, OnePlan will provide you with the imagery you need. You select timeframes and dates, and we ensure you receive the right qualified coverage, perfectly matching your project milestones. Your requirements are assessed through a feasibility assessment, and will be defined as either Achievable or Challenging.

Timeframe	From 7–365 days
Start Date	Any day during the upcoming year.
Minimum Order Size	10,000km^2
Max Bounding Box	Subject to feasibility study
Cloud Cover	≤20% as standard; ≤10% with uplift. Subject to feasibility study
Acquisition Notification	You are notified of all images acquired.
Acquisition Mode	Mono
Incidence Angle	0-20° as standard, or custom on request, subject to feasibility
Feasibility	Diagnosis on the probability of collecting the AOI in full complying with the specifications: Achievable, Challenging
Service Level	Regular
Delivery Lead Time	Standard

Table 5-6: OnePlan Parameters

If the AOI is not collected in full and on specification within the acquisition window, the customer is given the choice to:

- Extend the acquisition period, or
- Close the request and receive delivery of all that has been collected on spec (if applicable). In this instance, all acquisitions shall be invoiced as per delivery.

The success/failure criterion of an acquisition is technically based on the tasking performance of the initial tasking timeframe agreed with the customer.

Tasking parameters

The tasking parameters when selecting the OnePlan option include:

- The acquisition period. For a single acquisition, you may indicate your preferred collection period, with start and end dates. For instance, if you indicate 01/01/2020 – 31/03/2020, it means that you want the image to be acquired during the first three months of 2020.
- The acquisition mode: Mono
- The incidence angle is 0-20° as standard, or custom on request, subject to feasibility. Accepting extended angles allows you to increase the available number of acquisition dates, but could impact the geometric performance of your product.
- The maximum cloud cover accepted: the standard value is 20%. If you need a lower cloud cover commitment, please select another cloud cover threshold or specify your requirement.
- You can also request other specific requirements, for example by providing limitations on snow, haze or sand in the acquired imagery.

5.2.4 OneSeries

Get Routine or Critical coverage on a regular basis

Whether you are dealing with long-term changes or highly dynamic situations, OneSeries brings you the required intelligence at a time frequency of your choosing. For urgent acquisitions, our cloud cover commitment ensures that you pay only for the most useful results. OneSeries offers two options – **Routine** or **Critical** – dependent on customer requirements and subject to feasibility assessment.

OneSeries Routine

OneSeries Routine corresponds to standard monitoring of the same area of interest, with the aim to provide regular information on a specific area. This is the perfect solution for fortnightly, monthly and quarterly monitoring. Your requirements will undergo a feasibility assessment, and will be defined as either Achievable or Challenging.

Timeframe	From 7–365 days
Start Date	Any day during the upcoming year.
Minimum Order Size	10,000km^2
Max Bounding Box	Subject to feasibility study
Cloud Cover	≤20% as standard; ≤10% with uplift. Subject to feasibility study
Acquisition Notification	You are notified of all images acquired.
Acquisition Mode	Mono
Incidence Angle	0-20° as standard, or custom on request, subject to feasibility
Feasibility	Diagnosis on the probability of collecting the AOI in full complying with the specifications: Achievable, Challenging
Service Level	Regular
Delivery Lead Time	Standard

Table 5-7: OneSeries Routine Parameters

If the AOI is not collected in full and on specification within the acquisition window, the customer can choose between:

- Extending the acquisition period of the missed observation, or
- Closing the ongoing period and taking delivery of everything that has been collected on specification (if applicable). In this particular case, all acquisitions shall be invoiced as per delivery.

The success/failure criterion of an acquisition is technically based on the tasking performance of the initial tasking period agreed with the customer.

OneSeries Critical

OneSeries Critical has been specially designed for the most demanding monitoring with intensive acquisitions and deliveries with very short observation periods up to daily. All data is delivered promptly to provide the most up-to-date information on what is happening on the ground. OneSeries Critical is subject to feasibility assessment.

Timeframe	From 7–365 days
Start Date	Any day during the upcoming year.
Minimum Order Size	10,000km^2
Max Bounding Box	Subject to feasibility study
Cloud Cover	≤20%, or 100% in case of daily acquisitions
Acquisition Notification	You are notified of all images acquired.
Acquisition Mode	Mono

Incidence Angle	0-20° as standard, or custom on request, subject to feasibility
Feasibility	Diagnosis on the probability of collecting the AOI in full complying with the specifications
Service Level	Premium
Delivery Lead Time	Rush

Table 5-8: OneSeries Critical Parameters

Any successful images collected are delivered and invoiced as specified in the acknowledgment of order receipt.

If several images are necessary to fully cover the area but one acquisition is missing, the images acquired that do cover the area will be invoiced.

In case of cloud cover validation, the success/failure criterion of an acquisition is technically based on the tasking performance of the initial tasking period or acquisition frequency agreed with the customer.

For daily acquisitions, the success/failure criteria of an acquisition is technically based on the tasking performance (i.e. if the acquisition happened on the planned day).

OneSeries Window Options

Acquisition windows for OneSeries Routine and OneSeries Critical can be defined as either Multi-Period or Regular depending upon the requirement, and in accordance with the feasibility assessment.

Multi-Period Monitoring

You can plan several acquisitions over the same AOI with your own custom periods. When acquisitions are validated for one period, the tasking request is stopped until the next period starts.

For example:

- Duration of a construction project: Three months from 1st September to 30th November
- Monitoring request: Three acquisitions
- Observation periods: 1st – 30th September, 1st – 31st October, and 1st – 30th November. They will receive one image per period, a total of three images.

The customer will need to provide the following details:

Number of Observations	2–50 upon customer selection.
Observation Periods	Start and end dates – upon customer selection.
Criticality	Criticality is subject to feasibility, depending on the observation period and the AOI size.

Table 5-9: Details required for multi-period monitoring

Regular Monitoring

If regularly monitored, the AOI will be covered several times at regular intervals. A dead period in between two acquisitions needs to be specified.

For example:

- Duration of a construction project: Three months from 1st September to 30th November

- Monitoring request: Three acquisitions
- Dead period: 15 days. In this example we can assume that a total number of three new acquisitions collected from 1st September until 30th November are required, with a minimum of 15 days between two consecutive acquisitions.

The customer will need to provide the necessary details as outlined below:

Number of Observations	Indicates the number of desired observations: 2–50 upon customer selection.
Start and End Dates	Dates on which the monitoring project starts and ends – on customer selection.
Dead Period	Minimum number of days between two validated images: upon customer selection.
Criticality	Criticality is subject to feasibility, depending on the observation period, dead period and the AOI size.

Table 5-10: Details required for regular monitoring

How to order a series of images over your AOI

First, define the observation periods for your monitoring. Once you have chosen your OneSeries type, Routine or Critical, you select one of two monitoring options: Multi-Period or Regular.

Tasking parameters

The tasking parameters when selecting the OneSeries option include:

- The acquisition mode: Mono
- Any other requirements you might have, such as:
  - A specific cloud cover percentage.
  - Specifications for snow, haze, sand or any other weather condition.
- The incidence angle is 0-20° as standard, or custom on request, subject to feasibility. Accepting extended angles allows you to increase the available number of acquisition dates, but could impact the geometric performance of your product.
- The maximum cloud cover accepted:
  - For OneSeries Routine, like the OnePlan option, the standard value is 20%, but other cloud cover values can be selected depending on your needs or Area of Interest (AOI) location.
  - OneSeries Critical offers cloud cover validation – upon feasibility study – even though observation periods are usually short. If daily acquisitions are required then no cloud cover restriction can be selected.

5.3 Cloud Cover Warranty

Optimising DMC Constellation satellite tasking in accordance with weather forecasts ensures that resources are used as efficiently as possible. We propose image tasking with cloud cover less than 20% over the Area of Interest (AOI) of the order. Cloud cover does not include cloud shadow or semi-transparent haze.

5.4 Acquisition Assurance

If you are not entirely satisfied with your acquisition, please contact the Imagery Support Team to discuss options. Please note that OneTasking vouchers for DMC Constellation are not available at this time.

5.5 Feasibility Study

The feasibility study is a diagnosis performed by tasking experts in order to organise the acquisition plan and estimate the confidence in covering the area of interest within the defined acquisition period and parameters. To assess feasibility analysis, we ask the customer where, by when, and for which application. With this information, the Tasking Team issues a tasking proposal that includes advice and recommendations that clearly indicate:

- The feasibility study diagnosis: Achievable/Challenging/Unachievable
- The estimated area coverage: %
- New proposed parameters when relevant.

The feasibility study proposes the best programming parameters in order to successfully collect the area on time and on specification.

The OneNow feasibility study mainly focuses on the first three possible days when the area can be entirely collected after the desired start date.

For OneNow, it is possible to request access for acquisitions with an incidence angle of 20º or less. No choice is given on the acquisition days.

The OnePlan and OneSeries feasibility studies mainly focus on the desired timeframe compared to the location, the size, the angle, and cloud constraints. Depending on all requested programming parameters, the Tasking Manager issues a diagnosis (Achievable/Challenging/Unachievable) to the customer and proposes alternatives if the feasibility results are challenging or unachievable.

- If the request is judged to be Challenging, the Tasking Team sends two feasibility studies, each with the relevant quotation: one with Challenging parameters to match the customer's request, and another with different parameters that will make the tasking Achievable.
- If the request is judged Unachievable, the Tasking Team sends two proposals, each with the relevant quotation: one for it to become Challenging, one for it to become Achievable.

In these cases, the customer will always have the choice between the two tasking proposals.

The tasking is activated once the customer confirms their order.

5.6 Multi-AOI

Multi-polygon orders are possible. However, each AOI creates an order: a shape file featuring four polygons will be treated as four separate orders. Each order has its own service level agreement (SLA) and acquisition failure terms (i.e. if one acquisition for one polygon has failed, it has no impact on the success or failure of the other three). The polygons are also independent for the access study and the feasibility study, as well as any tracking progress service.

5.7 Regular and Premium Services

Two service levels are offered in the event of a new acquisition order.

	Premium Service Included in OneDay, OneNow and OneSeries Critical	Regular Service for OnePlan and OneSeries Routine
Ordering	Monday-Friday 09:30-16:00 (GMT/BST) through Imagery Support Team.	Monday-Friday 09:30-16:00 (GMT/BST) through Imagery Support Team.
Response	Acknowledgement issued within 3 hours of receipt of customer request (within normal working hours). This will include an indication of when the customer can expect to receive the feasibility study.	Acknowledgement issued within 24 hours of receipt of customer request (within normal working hours). This will include an indication of when the customer can expect to receive the feasibility study.
Customer Modification/ Cancellation after Order Confirmation	Modifications and cancellations are possible free of charge up to 10:00 (GMT/BST) two working days before image acquisition. It may be possible to reduce this timeframe, subject to feasibility. After this time, 100% cancellation fee applies.	Modifications and cancellations are possible. All qualified images are invoiced. Upon acceptance of tasking proposal, cancellation or modification shall be sent to the Imagery Support Team at least three working days before the image acquisition.
Tracked	Notification sent at each step of the tasking order - see Table 7-1 for details.	
Delivery	**Rush** 1 UK working day from reception at Airbus, subject to feasibility study.	**Standard** 2 UK working days from reception at Airbus, i.e. Monday-Friday from 09:30-16:00 (GMT/BST), subject to feasibility study. Standard delivery default (rush delivery optional).

Table 5-11: One Tasking specifications

5.8 Licensing

Airbus Intelligence offers flexible licensing options to meet your needs:

- **The Standard End User Licence Agreement (EULA)** permits the end user to share the DMC Constellation product with affiliated end users identified to Airbus, in the frame of a joint project. The standard price of the DMC Constellation product allows for up to five affiliated end users; for six or more end users, the 'Multi' option should be selected (available at an increased price).

  Under the **Standard Licence**, the end user can:

  - Use the DMC Constellation product for their own internal needs.
  - Create value added products (VAP) containing imagery data and use them for their own internal needs.

- Create derivative works (DW) that do not contain imagery data from the initial DMC Constellation product and are irreversible and decoupled from the source imagery data of the DMC Constellation product. DW can be freely used and distributed.
- Share the DMC Constellation product with their consultant and contractor for use on behalf of the end user and/or affiliated end users.
- Print an extract of the DMC Constellation product for promotional activities.

- **The Academic Licence** is focused on research and educational purposes. It permits the use of the product by one educational entity for academic research or training. An extract of the DMC Constellation product may be reproduced in certain training tools and publications related to the results of a research.
- **The Technical Evaluation Licence** permits the end user to use the DMC Constellation product for technical evaluation only. The end user shall not transfer the DMC Constellation product to any third party but may make the product available to a consultant or contractor for use on behalf of the end user. The end user shall inform Airbus Intelligence of the results of the performed evaluation.
- **The Demonstration Licence** allows the end user to use the product, the value added product, and/ or derivative works, for demonstration and display at events such as a trade fair, trade show, conference or exhibition, and to selected clients and prospects.
- **The Web Licence** permits the end user to convert the product into an image and post it on a website for public access or subscription-based access, allowing any internet user to see the image.
- **The Media Licence** allows the end user to use the product for communication purposes and post the DMC Constellation image on any means of communication, which can be either digital (e.g. displayed on the Internet, TV, advertising, banners) or print medium (e.g. magazine, newspaper, flyer, promotional brochure, etc.).
- **Other needs** – for specific commercial needs, we may propose tailored licence conditions (such as a governmental licence, visual simulation licence, etc.) on a case-by-case basis. For such a requirement, please contact your Sales Manager or the Imagery Support Team.

6 Product Ordering

6.1 Access to DMC Constellation Data

DMC Constellation data can be ordered by contacting our UK Imagery Support Team or another Customer Care representative:

- Telephone: +44 (0)1483 44 6960
- Email: ukintelligence-imagerysupport@airbus.com

An imagery order form is available and can be provided by our Imagery Support Team upon request.

6.2 How to Order

It is not possible to access DMC Constellation through our GeoStore web portal. Please follow the instructions below to access DMC Constellation imagery.

You can place an order:

- directly with our Imagery Support Team;
- directly with a local partner; or
- by completing a DMC Constellation Data Request Form and returning it to the Imagery Support Team.

This includes providing information on the following steps:

- **Step 1:** Contact Information and Delivery Method
- **Step 2:** End User Information
- **Step 3:** Area of Interest
- **Step 4A:** Product Type – Archive Imagery
- **Step 4B:** Product Type – New Collections with One Tasking
- **Step 5:** Processing Options
- **Step 6:** Feasibility Study and Order Confirmation

Once you have submitted your order, you will be contacted by a member of our Imagery Support Team. When new tasking is requested, our tasking experts will study the feasibility of your request and propose the best tasking parameters that will allow the DMC Constellation to collect your area on time and within the requested specifications.

For further details on tasking feasibility studies, please refer to section 5.5 Feasibility Study.

6.3 Order Cancellation, Order Modification, Terms and Conditions

Please refer to our General Supply Conditions of Satellite Imagery Products on our website.

7 Product Delivery

7.1 Order Completion and Delivery

Once an order is confirmed, users can begin requesting information about the progress of their requests through our Imagery Support Team. Notifications will be sent at the stages identified in the table below.

<table>
<tr><th colspan="2">Notification Name</th><th>Notification Summary</th></tr>
<tr><td colspan="2">Archive Order Confirmation</td><td>Confirmation that a DMC Constellation Archive order has been registered successfully.</td></tr>
<tr><td colspan="2">OneTasking Order Confirmation</td><td>Confirmation that a DMC Constellation OneTasking order has been registered successfully.</td></tr>
<tr><td colspan="2">Tasking Cancellation Confirmed</td><td>Confirmation that a OneTasking order has been cancelled.</td></tr>
<tr><td colspan="2">Tasking End Notification</td><td>Notification that the end of a OneTasking order is approaching and option of extension of imaging period.</td></tr>
<tr><td rowspan="4">Acquisition Notifications for OneTasking orders:</td><td>Being Analysed</td><td>Notification that image has been acquired and cloud cover of this new acquisition is being analysed.</td></tr>
<tr><td>Rejected</td><td>Notification that image has been acquired and has been rejected by Airbus.</td></tr>
<tr><td>Proposed</td><td>Notification that image has been acquired and although it may not exactly meet the initial specifications, may meet user needs. Requires validation or rejection from the user.</td></tr>
<tr><td>Validated</td><td>Notification that image has been acquired and validated as meeting the agreed criteria of the order.</td></tr>
<tr><td colspan="2">Delivery Notification</td><td>Summary of delivery of DMC Constellation product with access instructions.</td></tr>
</table>

Table 7-1: Order Notifications

After Airbus has successfully collected all of the appropriate data, we will process and deliver orders. The table below describes the estimated processing timelines based on the combination of the product and order parameters chosen.

Description	Standard	Rush
Standard Ortho or Projected	2 UK working days from reception at Airbus, subject to feasibility study.	1 UK working day from reception at Airbus, subject to feasibility study. FTP delivery only
Tailored Ortho	Ad hoc estimate provided with the quotation	N.A.

Table 7-2: Delivery times according to processing levels

Processing timelines for all Tailored Ortho products do not begin until all imagery is collected and all the necessary support data (e.g. DEMs, Reference data, GCPs) are received. The timeframe to obtain DEMs and GCPs depends on the geographic location of the area of interest. Large orders may require additional processing time.

Depending on the delivery method selected, the order will either be posted to an FTP site or shipped.

Image data products will be provided according to the format described in section 4.1.

Please contact our Imagery Support Team at any time during the order process for further information, or to check on the status of your order.

7.2 How to Open Your Product

GIS or other image processing software may be used to open a DMC Constellation product and access the image coordinates and metadata. Most commercial off-the-shelf software is able to read, georeference and process (orthorectify, etc.) DMC Constellation products. Be aware that the various software packages may use different methods to georeference DMC Constellation products.

Georeferencing is achieved by reading the GeoTIFF header, TFW worldfile, or XML metadata file for products in GeoTIFF.

Airbus is working with major image processing software providers to ease the ingestion of DMC Constellation data into their systems.

7.3 Technical Support and Claims

Whether you are looking for specific metadata, have questions about the format you need, think your image does not look right, cannot open a file, or anything else, we are here to help. For any question, advice or problem, please contact the Imagery Support Team.

Appendix A: Image Projection and Geo-referencing

A.1 Image Projection

A geographic projection is a simple mapping projection based on a geodetic datum and ellipsoid model of the Earth to convert the coordinates to a planar system as angular coordinates. Geographic projections are related to WGS84 geodetic datum/ellipsoid in decimal degree angular unit, with pixels regularly posted in latitude/longitude.

A mapping projection is based on a geodetic Coordinate Reference System (CRS) and uses a map projection model to convert the coordinates to a horizontal plane as Cartesian linear coordinates. Mapping projections are related to National Mapping Agencies or International Authorities. The default parameter values are those registered in EPSG. The linear unit is the metre.

A number of CRS mapping projections are available for orthorectified image products. Please contact us to confirm availability of any specific orthorectification requirements.

A.2 Image Geo-referencing

A geographic projection is a simple mapping projection based on a geodetic datum and ellipsoid model of the Earth to convert the coordinates to a planar system as angular coordinates. Geographic projections are related to WGS84 geodetic datum/ellipsoid in decimal degree angular unit, with pixels regularly posted in latitude/longitude.

A.2.1 Metadata relating to Geo-referencing

For good image geolocation, information pertaining to image geo-referencing is provided in the DIMAP metadata, the Tiff World File and the RPC file (for projected products). Some useful information within the DIMAP metadata is presented in the following table.

DIMAP Metadata fieldname	Description	Also Present in Tiff World File
NCOLS	Number of image columns	
NROWS	Number of image rows/lines	
NBITS	Bit depth of provided image file	
NBANDS	Number of spectral bands	
XDIM/YDIM	Product pixel dimensions in the X and Y directions (metres)	Yes
ULXMAP/ULYMAP	X and Y position of the upper left corner (metres)	Yes
PROJECTION_CT_NAME	e.g. Transverse Mercator	
PROJECTION_CT_CODE	e.g. EPSG: 9807	
HORIZONTAL_CS_NAME	Horizontal co-ordinate system name (e.g. WGS 84 / UTM zone 52N”)	
HORIZONTAL_CS_CODE	Horizontal co-ordinate system code (e.g. EPSG: 32652)	

Table A-1: Metadata fields pertaining to image geo-referencing

Tiff World Files are provided with Projected and Orthorectified KazSTSAT products. The Tiff World File describes the geo-referencing through an affine transformation with six parameters in the form:

$$x' = A_x + B_y + C$$
$$y' = D_x + E_y + F$$

Where:

x'/y'	- calculated x/y co-ordinate of the pixel on the ground
x/y	- pixel column/row number
A	- pixel size in the x-direction (XDIM in the DIMAP metadata)
B/D	- rotation about the y and x axes respectively
C	- x co-ordinate of the upper left corner of the image (ULXMAP in the DIMAP metadata)
F	- y co-ordinate of the upper left corner of the image (ULYMAP in the DIMAP metadata)
E	- the negative of the pixel size in the y-direction (YDIM in the DIMAP metadata)

The above-described value for E is negative due to a difference in the position of the origin between the image and the ground co-ordinate system. In the image, the origin for the y position is the upper left corner and y increases as we move down and away from this origin; but for the map, y co-ordinate values increase as we move upwards.

Values for the rotation terms, B and D are always set to zero, as no rotation is needed.

Values for C and F are taken as the centre of the upper left image pixel.

The Tiff World File itself is a short ASCII file containing six lines, giving the six parameters in the following order (one per line).

Parameter	Example
A	3.5
D	0.0
B	0.0
E	-3.5
C	269290.0
F	3249365.0

Table A-2: Content description and example of the Tiff World File

The Rational Polynomial Co-efficient (RPC) file is provided with projected image products to allow orthorectification by the customer, using COTS (or other) software. The RPC model is an analytical model which provides a per-pixel relationship between the ground and the image via a set of 20 term cubic polynomial functions that relate given geographic co-ordinates on the ground (lat, long, alt) to image co-ordinates (column, line), all of which have been normalised to the centre of the image via:

$$lat_{CN} = (lat - LAT\_OFF) / LAT\_SCALE$$
$$lon_{CN} = (lon - LONG\_OFF) / LONG\_SCALE$$

alt_{CN} = (alt - HEIGHT_OFF) / HEIGHT_SCALE

For any given (lat, long, alt) position on the ground, the translation RPC equations are defined as:

$$col_{CN} = \frac{\sum_{i=1}^{20} SAMP\_NUM\_COEFF_i \cdot \rho_i(lat_{CN}, lon_{CN}, alt_{CN})}{\sum_{i=1}^{20} SAMP\_DEN\_COEFF_i \cdot \rho_i(lat_{CN}, lon_{CN}, alt_{CN})}$$

$$lin_{CN} = \frac{\sum_{i=1}^{20} LINE\_NUM\_COEFF_i \cdot \rho_i(lat_{CN}, lon_{CN}, alt_{CN})}{\sum_{i=1}^{20} LINE\_DEN\_COEFF_i \cdot \rho_i(lat_{CN}, lon_{CN}, alt_{CN})}$$

Where CN refers to centre normalised co-ordinates and the numerators and denominators are each 20-term cubic polynomial functions of the form:

$$\sum_{i=1}^{20} C_i \cdot \rho_i(lat_{CN}, lon_{CN}, alt_{CN}) =$$

$$\begin{aligned}
&C_1 \ldots\ldots\ldots. + C_6 \cdot lon_{CN} \cdot alt_{CN} + C_{11} \cdot lat_{CN} \cdot lon_{CN} \cdot alt_{CN} + C_{16} \cdot lat_{CN}^3 \\
&+C_2 \cdot lon_{CN} \ldots\ldots\ldots. + C_7 \cdot lat_{CN} \cdot alt_{CN} + C_{12} \cdot lon_{CN}^3 \ldots\ldots\ldots. + C_{17} \cdot lat_{CN} \cdot alt_{CN}^2 \\
&+C_3 \cdot lat_{CN} \ldots\ldots\ldots. + C_8 \cdot lon_{CN}^2 \ldots\ldots\ldots. + C_{13} \cdot lon_{CN} \cdot lat_{CN}^2 \ldots\ldots\ldots. + C_{18} \cdot lon_{CN}^2 \cdot alt_{CN} \\
&+C_4 \cdot alt_{CN} \ldots\ldots\ldots. + C_9 \cdot lat_{CN}^2 \ldots\ldots\ldots. + C_{14} \cdot lon_{CN} \cdot alt_{CN}^2 \ldots\ldots\ldots. + C_{19} \cdot lat_{CN}^2 \cdot alt_{CN} \\
&+C_5 \cdot lon_{CN} \cdot lat_{CN} + C_{10} \cdot alt_{CN}^2 \ldots\ldots\ldots. + C_{15} \cdot lon_{CN}^2 \cdot lat_{CN} \ldots\ldots\ldots. + C_{20} \cdot alt_{CN}^3
\end{aligned}$$

These co-efficients are represented in the RPC file as follows (where n = an integer between 1 and 20):

LINE_NUM_COEFF_n
LINE_DEN_COEFF_n
SAMP_NUM_COEFF_n
SAMP_DEN_COEFF_n

The new centre normalised (column, line) co-ordinates and then transformed back to standard image co-ordinates, beginning at (1, 1) in the upper left corner, via:

*col = col_{CN} * SAMP_SCALE + SAMP_OFF*
*lin = lin_{CN} * LINE_SCALE + LINE_OFF*

A.3 Acquisition Angles

A.3.1 Incidence and viewing angles

Figure A-1 illustrates the difference between ground incidence and satellite view angle for any DMC constellation image acquisition.

The incidence angle (β in the figure) is the angle between the ground normal and satellite look direction. As the angle is measured with respect to the ground normal (regardless of satellite roll direction), this angle will always be positive.

The view angle (α in the figure) is the angle measured between the satellite look direction and nadir. In its purest form as a complement to the ground incidence angle but measured with respect to the satellite nadir line, this angle will also always be positive.

These angles are given in the product metadata as INCIDENCE_ANGLE and VIEWING_ANGLE with units of degrees.

Each of these angles may be projected onto two planes normal to the ground and in the along and across-track directions. The viewing angle projected in this way is also provided as:

- VIEWING_ANGLE_ACROSS_TRACK (degrees)

  The across-track contribution to the viewing angle (from satellite roll)

- VIEWING_ANGLE_ALONG_TRACK (degrees)

  The along-track contribution to the viewing angle (from satellite pitch)

These angles may be either positive or negative as they are each measured with respect to a plane. A left-looking image (with respect to the satellite direction of travel) will have a negative across-track viewing angle. A rearward looking image will have a negative along-track viewing angle.

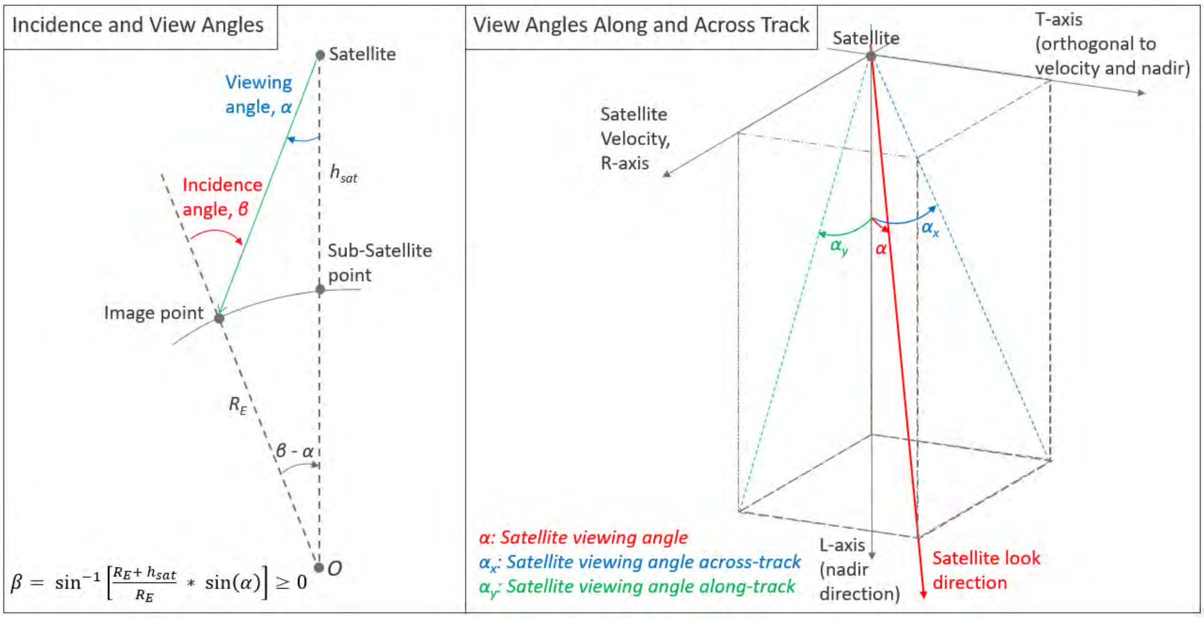

Figure A-1: Definitions of incidence and view angles in general (left); and projected along and across track (right)

A.3.2 Sensor azimuth angle

The sensor azimuth angle Az_{sat} is the angle between the meridian indicating the north passing through an image point and the line joining the same image point with the satellite nadir point. The sensor azimuth angle is given for the point at the centre of the imaged scene and is given in degrees. The potential range for this angle is 0 - 360° in the clockwise direction. It is illustrated in the figure below.

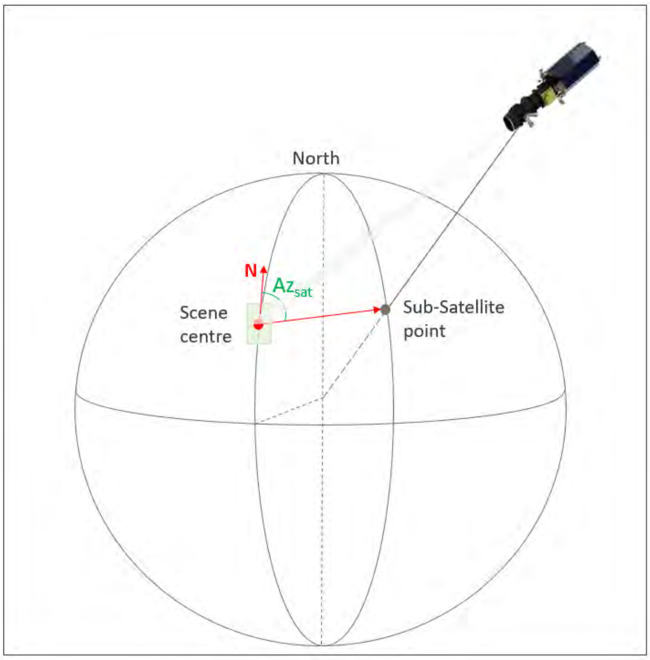

Figure A-2: Definition of the sensor azimuth angle

A.3.3 Solar Angles

The solar azimuth and elevation angles (Az_{sun} and El_{sun}) are calculated in the local Earth frame, which uses orthogonal axes defined by the local North, local East and local normal to the ellipsoid. They are defined in the product metadata by the fields SUN_AZIMUTH and SUN_ELEVATION.

Additionally, the solar zenith angle (θ_{sun}) is the complement of the solar elevation.

$$\theta_{sun} = 90° - El_{sun}$$

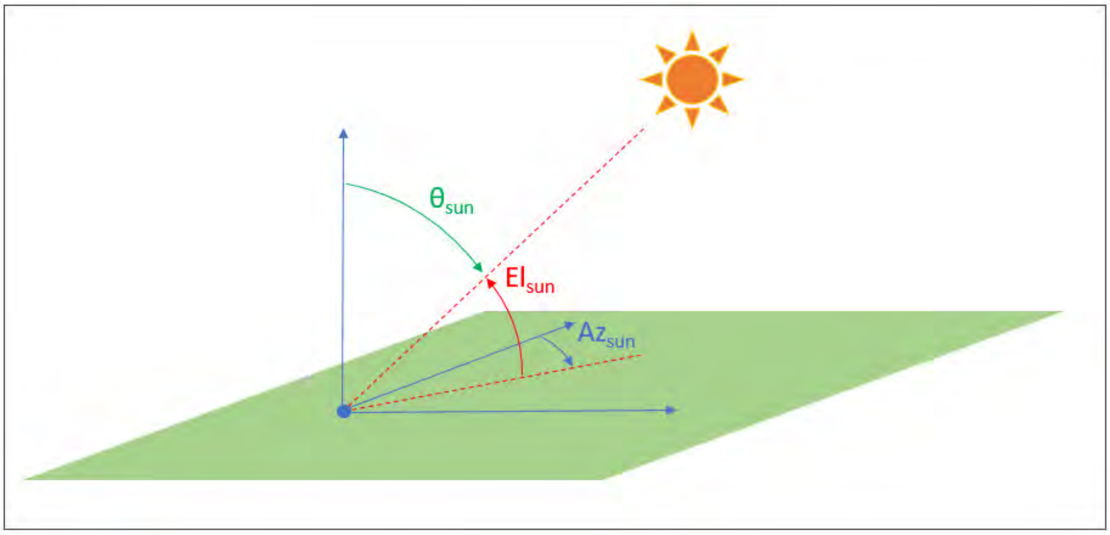

Figure A-3: Solar incidence angles

Appendix B: List of Abbreviations, Acronyms and Terms

Term	Description
AOI	Area of Interest.
Attitude	The angular orientation of a spacecraft as determined by the relationship between its axes and a reference line or plane or a fixed system of axes. Usually, 'Y' is used for the axis that defines the direction of flight, 'X' for the 'cross-track' axis perpendicular to the direction of flight, and 'Z' for the vertical axis. Roll is the deviation from the vertical axis (the angle between the Z-axis of the vehicle and the vertical axis, or angular rotation around the Y-axis). Pitch is the angular rotation around the X-axis. Yaw is rotation around the Z-axis.
ASCII	American Standard Code for Information Interchange. A commonly used coding for text files.
Azimuth	An angle describing the arc of the horizon measured clockwise from the north point to the point referenced, expressed in degrees. Azimuth indicates direction, and not location
BOA	Bottom of Atmosphere. A lesser used term for TOC.
CCD	Charged Coupled Device used to capture the charge deposited
CE90	Circular Error of geographically corrected (Projected or orthorectified) image products, with a confidence level of 90% (considering positioning accuracy on both x and y-axes). It indicates that the actual location of an object is represented on the image within the standard accuracy for 90% of the points.
CN	Centre Normalised. The central pixel of the image becomes the “origin” or central point to which all other points are referenced.
COTS	Commercial Off The Shelf
CRS	Co-ordinate Reference System
DEM	Digital Elevation Model. A 3D model that includes the maximum altitude at each point. Includes canopy and other ground structures.
DN	Digital Number.
EPSG	A list of geodetic parameters used for performing geometric transformations on EO data.
GCP	Ground Control Point. Used in the positional refinement of orthorectified data products.
TIFF/GeoTIFF	Geographic Tagged Image File Format. A public domain metadata standard allowing georeferencing information to be embedded within the image TIFF file
GIS	Geographic Information System. A system designed to capture, store, manipulate, analyse, edit, manage and present all types of geographic data.
GSD	Ground Sample Distance. The distance on the ground between two neighbouring pixels at acquisition
EO	Earth Observation
ESUN	Solar Spectral Irradiance calculated for a specific waveband on a sensor with a specific measured spectral transmission. Provided in units of $Wm^{-2}\mu m^{-1}$
EULA	End User Licence Agreement. Describes the permitted use of purchased DMC constellation imagery.
Incidence Angle	Angle between the ground normal at the observed point on the ground and the line of sight of the imaging sensor. It is different from the view angle.
KML	Keyhole Markup Language. An XML notation for expressing geographic annotation and visualisation within internet-based, two-dimensional maps and three- dimensional Earth browsers. KML was developed for use with Google Earth, which was originally named

	Keyhole Earth Viewer. It was created by Keyhole Inc., which was acquired by Google in 2004. KML is an international standard of the Open Geospatial Consortium.
KMZ	A compressed KML file. It will open directly with Google Earth and some other GIS software.
MS	Multispectral. Indicates remote sensing using between 2 and 20 spectral bands.
MS4	Four band multispectral image data
MTF	Modulation Transfer Function. A measure of image sharpness provided to an image by the imaging sensor.
Nadir	The point on the ground vertically beneath the sensor
NIR	Near Infra-Red. A region of the electromagnetic spectrum spanning wavelengths in the range 700 – 3000nm approx.
NIIRS	National Image Interpretability Rating Scale. A subjective scale used to rate the quality of VHR imagery (satellite or otherwise). It defines 10 levels of image quality/interpretability based on the types of ground cover that can be correctly identified by an operator.
Ortho/Orthorectified	An orthorectified image product (an ortho product) has been corrected for geographic position (including height) and may be directly overlaid upon a map.
PAN	Short for Panchromatic. Covering a wide range of visible optical spectra.
Pan-sharpening	The practice of using the highest resolution Panchromatic band in conjunction with the other lower resolution multispectral bands to increase the apparent spatial resolution of a multispectral image product
Planimetric Accuracy	The positional accuracy of the image projected on an Earth mapping system and reset with a DEM (vertical reset) and, optionally, GCPs (horizontal reset). Planimetric Accuracy depends on the intrinsic accuracy of the external data (DEM and GCP) and is used to describe georeferenced image products
PRNU	Photo Response Non-Uniformity. A measure of the differing pixel responses across a CCD detector array.
Quicklook	A subsampled version of the original image product to allow efficient browsing of the image data (for example within a catalogue)
Radiance	A measure of radiant intensity per unit of a projected source area in a specified direction. The unit is the rate of transfer of energy (Watt, W) at sensor input, per square metre on the ground, for one steradian (solid angle from a point on Earth's surface to the sensor), per unit wavelength being measured
Reflectance	Reflected radiance expressed as a fraction of incident radiance. Reflectance provides a standardised measure, which is directly comparable between images. Reflectance has no unit and thus is measured on a scale from 0 to 1 (or 0–100%). Top-of-Atmosphere (TOA) reflectance does not attempt to account for atmospheric effects
Resolution (Spatial Resolution)	A measure of the smallest angular or linear separation between two objects that can be resolved by the sensor. Not the same as spectral resolution.
Resolution (Spectral Resolution)	A measure of the smallest difference in wavelengths that can be resolved by the sensor. Not the same as spatial resolution.
RMSEP	Root Mean Squared Error of Planimetry. Describes the square root of the mean horizontal distance between all photo-identifiable GCPs and their respective twin counterparts acquired in an independent geodetic survey (reference dataset)
ROI	Region of Interest. See AOI.
RPC	Rational Polynomial Coefficients. An RPC file is provided to assist in the correct geolocation of projected products
Sensor Model	A mathematical representation of sensor state/position at the time of image collection. The algorithm accounts for refraction, position, orientation, velocity, and viewing directions along the sensor array through the camera. It calculates the transformation

	between 3-D ground space and image line and sample coordinate points, and vice versa. Every image has unique sensor model parameters that reflect the location and orientation of the sensor at the time the image was collected.
SLA	Service Level Agreement.
SNR	Signal to Noise ratio. Measures the radiometric accuracy of an image.
Spectral Band	An interval in the electromagnetic spectrum defined by two wavelengths, frequencies, or wave numbers. E.g., the KazSTSAT BLUE band ranges between 440 and 510nm.
SRTM	Shuttle Radar Topography Mission. A DEM for use in the production of orthorectified data products.
Swath	The width of an image on the ground, which will increase with view angle.
TDI	Time Delay Integration. A time delay integration charge-coupled device (CCD) is widely used for observation of high-speed moving objects undetectable by classic CCD. This technique senses charge patterns and shifts them across the charge-coupled device (CCD) array in sync with the movement of the image, to integrate more light from the scene
TOA	Top of Atmosphere
TOC	Top of Canopy
UTC	Universal Time Co-ordinated. A universal timing standard; never adjusted for daylight savings.
UTM	Universal Transverse Mercator. A projection system that divides the Earth into 60 zones (UTM zones), each 6 degrees of longitude wide. A secant transverse Mercator projection is used in each zone.
VAP	Value Added Product. Often known as level 4 processing. Product data may become unrecognisable in comparison with the original data source.
VHR	Very High Resolution imagery below 1m
Viewing Angle	Angle between the satellite nadir line and the line of sight of the imaging sensor. It is different from the incidence angle. If pitch and roll are independently controlled for imaging, the view angle will take both of these into account.
WD4O	World DEM for Ortho. The Airbus compiled DEM product used to orthorectify DMC constellation products as standard.
Zenith	The point in the celestial sphere that is exactly overhead. The opposite of nadir.