FAQ

SPOT system

Q1 - How can we assign the band B1, B2 and B3 of XS to the Red Green Blue colour so that the natural green colour can be reproduced?

The transformation formulas used for natural green colours are much more complex. The process is not automatic. First of all, one does a special radiometric enhancement. Then, the process is a polynomial transformation from bands B1, B2, B3 to new R, G, B bands. The coefficients of this transformation depend on the original radiometry fand landscape. The final step is manual adaptation.

Q2 - How can I get the irradiance values measured by the instruments?

The conversion of the Spot count values to irradiances is performed as follows:
L = (X/A) + B
where: L = the equivalent irradiance at the input of the instrument
(W * m-2 * sr-1 * micrometer-1)
X = the count (0 to 255),
A = absolute calibration gain, for the considered spectral band
B = absolute calibration offset, for the considered spectral band.
A and B can be found in the Header Record of the Leader File (Format CAP) . On a CD-ROM the first byte of the Header Record is the byte number 3961 in the Leader File. Then, within this Header Record A and B are encoded as follow:(in the following the numbers are bytes numbers within the Header Record)

A: bytes 1765 to 1772 (AA.AAAAA) in panchromatic,
bytes 1765 to 1772 (AA.AAAAA) in multispectral (band 1),
bytes 1773 to 1780 (AA.AAAAA) in multispectral (band 2),
bytes 1781 to 1788 (AA.AAAAA) in multispectral (band 3),
bytes 1789 to 1796 (AA.AAAAA) in multispectral (band 4, for Spot 4),

B: bytes 2277 to 2284 (BB.BBBBB) in panchromatic,
bytes 2277 to 2284 (BB.BBBBB) in multispectral (band 1),
bytes 2285 to 2292 (BB.BBBBB) in multispectral (band 2),
bytes 2293 to 2300 (BB.BBBBB) in multispectral (band 3),
bytes 2301 to 2308 (BB.BBBBB) in multispectral (band 4, Spot 4),

In the DIMAP SPOT Scene format, A is the parameter "PHYSICAL GAIN" and B is the parameter "PHYSICAL BIAS". There are in the "Image Interpretation Spectral Band Info" group.

Q3 - What are the spectral characteristics of the instruments?

You will find a table about Normal Solar Equivalent Irradiance and Spectral profiles in the section "Technical Information/The SPOT satellites".

Q4 - What is the sampling frequency used by the instruments of Spot to capture the images?

The time elapsed between the capture of two consecutive lines (called "line period") is:

- 3.008 milliseconds in multispectral mode,
- 1.504 milliseconds in panchromatic (or monospectral) mode.

This information is posted in the ancillary data of the SPOT Scene products (see, in section "The CAP format", the document "The SPOT Standard Digital Product Format" p 46, 7.7: Ancillary "ephemeris/attitude, bytes 947-958).
or in the DIMAP format (group "Sensor configuration", parameter "LINE PERIOD".

Q5 - The ephemeris data, giving the position of the satellite every minute, are encoded with a 0.1 m resolution. Is it indicative of the actual accuracy of the knowledge of the satellite position?

On Spot 1, 2 and 3, the encoding of the ephemeris data posted in the Ancillary files of the SPOT Scene products does not reflect the actual accuracy of these data which is a few hundred metres (rms).
However, with Spot 4, the use of data coming from the DORIS passenger allows to get an accuracy better than 1 m. Just note that this applies only to the position of the satellite on its orbit; one has to realise that the final location accuracy of the images on the ground depends also on the pointing accuracy of the spacecraft and its instruments (attitude of the spacecraft, mirror pointing angle, etc). This lead to a final location accuracy between 300 and 500 metres (rms).

Q6 - In several papers, the focal length of Spot HRV is 2,087.4 mm. However, it is referred as 1,082 mm in Spot User's Handbook. What is correct?

The focal length is 1,082 mm.

Q7 - What are the differences in the Dimap format between SPOT 1 - 4 data and SPOT 5 data?

The main differences in the Dimap format between SPOT 1 - 4 data and SPOT 5 data concern essentially five points:

- Time of acquisition
- Data attitudes
- Angles
- Mirror Position
- 1B Models

Satellite_time: (Data_Strip/Satellite_Time)
In this group, SPOT 1 - 4 data are described by four keywords:

- UT_DATE
- CLOCK_VALUE
- CLOCK_PERIOD
- BOARD_TIME

On SPOT 5, a supplementary keyword, TAI_TUC, describes data which allow **international atomic time** to be calculated.

Satellite_attitudes: (Data_Strip/Satellite_Attitudes)
The attitude data are described by a block keyword on SPOT 1 - 4, and by two block keywords on SPOT 5.

- On SPOT 1 - 4: Row_attitudes,
- On SPOT 5: Row_attitudes and Corrected_Attitudes.

It is recommended, on SPOT 5, to use the information from the block Corrected_Attitudes which integrate the measures from the star tracker.

Instrument_Look_Angles_List:
(Data_Strip/Sensor_Configuration/Instrument_Look_Angles_List/Instrument_Look_Angles/Look_Angles_List)
The keyword is identical on SPOT 1 - 4 and SPOT 5, while the number of values is greater on SPOT 5:

- For SPOT 1 - 4, only the look directions of the first and the last detector of the CCD array are supplied,
- For SPOT 5 a look direction is supplied for each 6,000 (or 12,000) elementary detectors.

Mirror_Position: (Data_Strip/Sensor_Configuration/Mirror_Position)
In this group, SPOT 1 - 4 data are described by a single keyword: STEP_COUNT.
For SPOT 5, three supplementary keywords describe the data:

- AVERAGE_ENCODER_COUNT
- Encoder_Counts
- MCV_Matrix

Models: (Data_Strip/Models)
The information described by this keyword block allow to convert the geometry of a level 1B SPOT 1 – 4 into the level 1A geometry.
This keyword group does not exist on SPOT 5.

Q8 - Which image processing software on the market are compatible with the Dimap format used for the SPOT 1 to 4 SPOT Scene products?

The image processing software editors received a test data set in September 2004.
At present the latest versions of the following software have been validated as compatible:

- Erdas Imagine(Leica LPS)
- Geomatica (PCI
- ER Mapper
- Envi
- ZI Imaging (Solution photogrammétrie Intergraph)
- Geoimage

If your software does not recognize the Dimap format used for the SPOT 1 to 4 SPOT Scene products, and if it is not in the list above, please contact us or contact the software editor directly.

Q9 - In what order are the spectral bands in SPOT products displayed?

> SPOT spectral bands: The spectral bands in SPOT imagery are:
XS1 = green
XS2 = red
XS3 = near-infrared
XS4 = short-wave infrared (SWIR) for SPOT 4 & 5

> RGB display: The RGB display scheme is:
1st band (1) in the extracted raster file displayed in the red channel
2nd band (2) in the green channel
3rd band (3) in the blue channel

> TIFF file: To conform to the RGB display scheme, spectral bands in TIFF files are extracted in the following order:
1: XS3
2: XS2
3: XS1
To obtain the following display scheme for SPOT products:
- XS3 displayed in red, since it is the 1st spectral band extracted (1)
- XS2 in green (2)
- XS1 in blue (3)
The DIMAP file describes how spectral bands are assigned to channels to obtain this display scheme:
<RED_CHANNEL>1</RED_CHANNEL>
<GREEN_CHANNEL>2</GREEN_CHANNEL>
<BLUE_CHANNEL>3</BLUE_CHANNEL>

> BIL files: In BIL files, spectral bands are extracted in the following order:
1: XS1
2: XS2
3: XS3
The DIMAP file describes how spectral bands are assigned to channels to obtain the SPOT product display scheme:
<RED_CHANNEL>3</RED_CHANNEL>
<GREEN_CHANNEL>2</GREEN_CHANNEL>
<BLUE_CHANNEL>1</BLUE_CHANNEL>

> SWIR band: As only 3 channels can be displayed in colour at once, the SWIR band is not displayed. To display the SWIR band, you can assign XS4 to the green channel, XS3 to red and XS2 to blue.

Be careful not to confuse the names of SPOT spectral bands (XS3, XS2 and XS1) with the order of display channels (RGB).

SPOT 2.5 m and 5 m Colour

Q1 - What are the production options for the merged products?

The merged 1A and 2A products are available as full scenes, in a bicubic resampled GeoTIFF image format.
There are many other options available (concerning size, radiometric enhancement, among others) available in the SPOTView Precision (level 2B) or Ortho (level 3) ranges.

Q2 - Which viewing configurations are acceptable for the merged 1A and 2A products?

To guarantee the best possible quality, the merged product only uses Spot 5 1A panchromatic and colour (XS) scenes acquired simultaneously by the same instrument.

Q3 - How are the B&W and colour scenes merged for level 1A given that, even though simultaneously acquired, they are not registered?

The B&W and colour scenes are acquired with a slight difference in viewing angle, with the B&W sensor pointed a little to the front and the colour sensor pointed a little towards the rear; the difference between the two is about 1.058 degrees which corresponds to about 15 km on the ground.
This difference leads to local geometric offsets as well as a slight time difference (There is a delay of 2.25 seconds between the acquisition of a landscape line by the B&W sensor and the acquisition of the same line by the colour sensor).

The merger process fixes the geometric deviations between the two level 1A scenes in the following way:

- First the colour scene is geometrically adjusted to fit the B&W scene, using only the instruments' data, the satellite attitude data and the ephemeris data. This stage restores the colour image to fit the focal plane of the B&W image.
- Secondly the 2 previously adjusted scenes undergo thorough correlation processing. This calculation is done to correct parallax errors due to the relief observed, with an accuracy of about 1/100th of a pixel. The results of

each of these stages are filtered and combined to produce a final geometrical correction grid matching the colour image to the B&W image.

This level 1A processing is possible due to our thorough knowledge of image acquisition conditions on the Spot 5 satellite as well as the very low residual offsets of simultaneously acquired images.
Processing with this configuration does not require the use of external data (ground control points or digital terrain model). Such external data are still necessary for all other cases (scenes which are not taken at the same time.).

Q4 - What is the geometry of the merged 1A and 2A product?

The merged product keeps the geometry of its B&W source product.
The values of the additional geometric data are exactly the same for both products. Physical modelling of the data thus gives identical results.

Q5 - What are the radiometric characteristics of the merged 1A and 2A product?

The merged product is produced with the same radiometric range as the 10 m colour source product.
The values of the additional radiometric data (PHYSICAL_GAIN, PHYSICAL_BIAS) are the same as those for the 10 m colour source product. All information which is no longer relevant has been removed (Pixel_Parameters, Dead_Detectors, Bad_Lines).
However, since the objects were not observed using the same scale for both products, the spectral content may not be exactly the same (whence the slight differences in the histograms).

Q6 - Which spectral bands are supplied with a merged 1A and 2A product?

The merged product supplies the spectral bands which are correlated with the panchromatic spectral band (0.48 mm-0.71 mm) : principally XS1 (B1), XS2 (B2) and XS3 (B3) for colour rendering.
This is why the SWIR band is not provided. Another reason is to limit the volume of the product.
SPOT Image also offers the 10 m colour source product with the SWIR band for a very reasonable cost. This band can be used once it has been adjusted to fit the merged product.

Q7 - The edges of the image of the merged 1A and 2A scenes are crenellated, is this normal?

Yes. It is due to the correction grid used to adjust the colour source scene to fit the B&W scene. The grid is of course not homogenous for the entire scene.
A given pixel is only assigned a value if it exists on both 1A source scenes after correction, otherwise the value assigned to the image is 0.

Q8 - I already have a B&W SPOT Scene and a colour SPOT Scene. How can I merge them easily?

Merging at the 1A level is a very tricky operation which cannot be done by any of the software available on the market. We suggest that the two scenes first be orthorectified using external data (ground control points, tie points, digital terrain models , etc.) so that they can be perfectly registered point by point. The next step is the radiometry merger which can be done by most off-the-shelf software.

Q9 - What is the format of the merged 1A and 2A products?

The merged 1A products (2.5 m colour and 5 m colour) come in the Dimap format.
The meta-data for these products are described in the 'SPOT Scene profile'.
The merged 2A products (2.5 m colour and 5 m colour) come in the Dimap format and their meta-data are described in a 'SPOTView profile'.
The two profiles for the DIMAP format are described at the following address:**www.spotimage.fr/dimap/spec/dimap.htm**

SPOT 3D

Q1 - Can I buy HRS stereopairs?

The basic offer to access HRS data is a 3-layer database named Reference3D : one DEM layer, one orthoimage layer and one extensive quality meta-data layer. From our studies, very few applications really require the use of the stereopairs. Please contact us for any specific need.

Q2 - What is the orthoimage layer of Reference3D made of? What is its use?

Reference3D orthoimage layer (1/6 arcsec sampling, ie 5m resolution on the Equator) is made by rectifying and mosaicking Panchromatic HRS images onto the HRS DEM. It should prove unrivalled for automatic location of optical imagery, due to its excellent absolute accuracy.
Reference3D orthoimage can be used to extract the main networks (main roads, rivers,…) but is not really designed to perform cartographic works : SPOT HRV and HRG are far best choices for this purpose.

Q3 - Does Reference3D include a DEM or a DTM? By the way, what is exactly the difference between a DEM and a DTM?

Usually, the acronym DTM refers to the altitude of the ground itself : a DTM would consider the soil under the buildings, and around the feet of the trees. On the contrary, a DEM includes the maximum altitude everywhere : roofs of the buildings, top of the trees (often known as “top of the canopy”). The processing of stereoscopic images (space or aerial) naturally produces a DEM, because neither the operator nor the matching software can see the ground itself through the roofs and leaves. If a DTM is really requested, a very heavy correction process has to be undergone, to rub out the trees and buildings, and by no way one can guaranty the accuracy of the result without field checking.
For these economical and accuracy reasons, and also because the elevation information has its own value (eg for airplanes), Reference3D includes a DEM, not a DTM.

Q4 - What is the circular horizontal accuracy of Reference3D?

The horizontal accuracy of Reference3D without GCP is 15 m @ 90%. Sophisticated processing tools are necessary to meet this goal. The above specification is fulfilled over large areas processed into a single block. Small areas will be processed through specific methods. For further information about Reference3D accuracy requirement, please refer to the “Reference3D Product Description”.

Q5 - Before HRS, the posting of the DEMs extracted from SPOT 1 to SPOT 4 Panchromatic was 20 m. Why was it changed to 1 arc second for Reference3D? Does that mean a loss in quality?

Certainly not. HRS DEMs show far better accuracy than any other DEM extracted from medium resolution space data.
The move to 1 arc second was made to comply with the DTED2 standard.
Note that 1 arc second represents 30 m by 30 m on the Equator, but only 30 m by 21 m at a 45° latitude.

Q6 - Can I place an emergency order to task HRS?

A long-term collection plans have been established to achieve the maximum coverage within HRS theoretical lifetime (5 years). Of course, the collection plan is always under revision, to cope with the needs of Reference3D customers.
As of April 2004, the qualified HRS image archive already counts with more than 60 millions km² available for DEM extraction and Reference3D production. This amount should continue to grow with time. However, since HRS has no side-looking mirror, the revisit time is 26 days. This means that HRS cannot be tasked to address extremely urgent crisis needs. Please check the SPOT 3D page of the Technical Information area of our web site in order to find the **HRS worldwide coverage map** available for DEM extraction and Reference3D production.

Q7 - Is Reference3D 100% produced from HRS data?

Reference3D is mostly derived from HRS, but not necessarily 100%. Since HRS revisit capability is only 26 days, we envision that the collection of absolutely cloud-free data over every acre of land could be very long in some areas. That is the reason why it is planned to complement Reference3D with external data : SPOT stereopairs, ASTER, SRTM (DEM layer only),…
The quality layer will register the corresponding mentions.

Q8 - I am interested in Reference3D, but I need only HRS derived data, not the whole thing with external data complementation, …(eg because I will fill the gaps by myself).

No problem. Our Reference3D contracts are flexible and fully customised. That is why we will need some time to consider all the technical solutions to address your exact needs (in the feasibility study step) before proposing you a commercial deal.

Q9 - About Reference3D delivery unit and price?

Reference3D is delivered through a DTED frame (1° x 1° tile). The price of Reference3D is depending upon the type of licencing, and also the global extent of your area.

Q10 - DEM papers often refer to DTED. What does this mean exactly ?

In support of military applications, the U. S. National Geospatial-Intelligence Agency (NGA) has developed DTED standard digital datasets (Digital Terrain Elevation Data). It is a uniform matrix of terrain elevation values, which provides basic quantitative data for systems and applications that require terrain elevation, slope, or surface roughness information. You can find some documentation about DTED on NGA's Web site.
DTED standards encompass several levels of accuracy, from DTED level 0 to DTED level 5. Level 0 content is equivalent to the elevation information of a 1,000,000-scale map (more or less equivalent to DCW, or GTOPO30, or GLOBE). DTED 1 has mainly been extracted from 250,000-scale maps. DTED 2 content is equivalent to the contour information represented on a 1: 50,000 map.
Some DTED figures :

	LEVEL 0	LEVEL 1	LEVEL 2	LEVEL 3
POSTING	30 arc sec.	3 arc sec.	1 arc sec.	0.4 arc sec.
at Equator	± 900 m	± 90 m	± 30 m	± 12 m
at 45° latitude	± 630 m	± 63 m	± 21 m	± 9 m

Posting values decrease near the polar areas to cope with meridian convergence.
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ACCURACIES (@ 90%).			
Absolute horizontal	50 m	23 m	10 m
Absolute vertical	30 m	18 m	10 m
Relative horizontal	--	--	3-10 m
Relative vertical	20 m	12-15 m	1-3 m

Q11 - Is Reference3D the only 3D offer from Spot Image?

Certainly not. Our offer is based on 3 different products:

- **Reference3D**, a 3-layer product (DEM, orthoimage, quality /traceability),
- **SPOT DEM Precision**, a 2-layer product (DEM, quality /traceability) under development,
- **SPOT DEM**, a single layer product (DEM).

End 2004, 8 million sq. km of Reference3D will be available off-the-shelf. The production rate of these products is of 7 M sq. km per year.
Please check the SPOT 3D page in order to find the **SPOT DEM worldwide coverage map** (More than 70 M sq. km as of today).

Q12 - About SPOT DEMs delivery unit and price?

SPOT DEM and SPOT DEM Precision are delivered through a tailored framing (per sq. km offer). The minimum order size is of 3,000 sq. km. The price of these products is detailed in our price list to be found on our web site.
Should you need smaller AOIs, please contact us as we most certainly have a solution to your problem.

Q13 - Why did you choose EGM96 as Reference3D elevation system ?

EGM96 was chosen for its reliability (produced by NASA and NGA) , its accuracy (defined in relation with WGS84), and its compatibility with SRTM and with DTED products. Furthermore, the EGM96 model is very commonly used among the GIS -and Earth Observation- user community.
EGM96 posting is 15' x 15' (approx. 25km on the Equator). Please note that interpolation method within EGM96 is not really a key issue in this case, because the variations of the geoid values are smooth, as compared to the vertical accuracy required for Reference3D.

Q14 - How do you cope with different sea levels (tide effects) on adjacent images ?

The tie points between adjacent HRS pairs are chosen on the ground. This gives a perfect coherency of the elevation values over the landmasses. Over the water areas (sea) the matching process is completely inefficient, and no elevation value can be computed. The sea is flattened to a 0 value within an interactive process. Therefore, when very different sea levels are involved, the effect can sometimes appear on the orthoimage along the seashore, as a sudden "break" of the shoreline. In this case, we try to manually choose a new connecting line for the adjacent orthoimages, to eliminate the discrepancy. Regarding the accuracy of the DEM in these areas, it should be noted that the maximum amplitude of sea tide is commonly far less than 10m (ie +/- 5m around the average) ; therefore, the Reference3D requirement can be met.