

MODIS (Terra/ Acqua)

highlight shows info to be input into instrument specs json file

[1] Reference: SMAD 3rd ed, 9.6.2

- Moderate Resolution Imaging Spectrometer
- See Table 9-18
- Is a whiskbroom

[2] <https://modis.gsfc.nasa.gov/about/>

- 36 distinct spectral bands broken into four separate FPAs: Visible (VIS), Near Infrared (NIR), Short- and Mid-Wave Infrared (SWIR/MWIR), and Long-Wave Infrared (LWIR).
- 0.4 μm to 14.4 μm .
- The MODIS viewing path is 10 km along track at nadir, and 25 km along track at ± 55 degrees. This means that there are 10 detector elements along track for each of the 1 km bands, 20 for each of the 500-m bands, and 40 for the 250-m bands. Two of MODIS' bands – 13 and 14 – each have dual arrays of 10 elements along track.
- Two bands are imaged at a nominal resolution of 250 m at nadir, with five bands at 500 m, and the remaining 29 bands at 1 km.
- ± 55 -degree scanning pattern at the EOS orbit of 705 km achieves a 2,330-km swath and provides global coverage every one to two days.
- Two custom PIN photo-voltaic (PV) silicon hybrids cover the VIS and NIR FPAs (0.4 μm to 1.0 μm), an HgCdTe PV detector hybrid is used on the SWIR/MWIR FPA (1.2 μm to 4.5 μm), and another on the LWIR FPA (bands up to 10 μm). The LWIR FPA also includes a six-band photo-conductive (PC) detector for the wavelengths beyond 10 μm .
- Each FPA focuses light onto a certain section of detector pixels, which are relatively large – ranging from 135 μm to 540 μm square.

[3] W. L. Barnes, T. S. Pagano and V. V. Salomonson, "Prelaunch characteristics of the Moderate Resolution Imaging Spectroradiometer (MODIS) on EOS-AM1," in *IEEE*

Transactions on Geoscience and Remote Sensing, vol. 36, no. 4, pp. 1088-1100, July 1998.

- Due to the number of bands and the 2330-km swath, a pushbroom system was considered impractical and cross-track scanning was chosen for the MODIS design.
- Thus, each 1-km band has a ten-element linear detector array with a spectral interference filter in close proximity and each of the 250-m and 500-m bands have 40 and 20 element arrays, respectively.
- 1354 earth view pixels across the 55 swath in 1.477 s (see bottom of Fig. 2).

[4] MODIS Level 1A Earth Location: Algorithm Theoretical Basis Document Version 3.0

Table 3-1. Focal Lengths for Each Focal Plane

Focal Planes	Focal Length (f)
LWIR	282.118 mm
SWIR/MWIR, NIR and VIS	380.859 mm

Table 3-2. Detector Specifications

Bands	Ground Projection	Detector Size	Number of Detectors
1, 2	250 m	135 μm	40
3 to 7	500 m	270 μm	20
8 to 26	1 km	540 μm	10
27 to 30	1 km	400 μm	10
31 to 36 (LWIR)	1 km	400 (track) by 380 (scan) μm	10

- A new frame of data is generated every 333.333 μsec (exactly 3 kHz). The sample time, integration time, and number of samples per frame for each of the bands are given in Table 3-4. The integration time is 10 μsec less than the sample time

to allow for the readout of the detectors. Bands 27 to 30 are over-sampled by 4 times and averaged by the on-board computer into a single sample per frame.

Table 3-4. Detector Sampling

Bands	Sample Time	Integration Time	Number of Sample s per Frame
1, 2	83.333 μ sec	73.333 μ sec	4
3 to 7	166.667 μ sec	156.667 μ sec	2
8 to 26	333.333 μ sec	323.333 μ sec	1
27 to 30	333.333 μ sec	4 x 73.333 μ sec	4 avg. to 1
31 to 36	333.333 μ sec	323.333 μ sec	1

[5]William L. Barnes, Vincent V. Salomonson, "MODIS: a global imaging spectroradiometer for the Earth Observing System," Proc. SPIE 10269, Optical Technologies for Aerospace Sensing: A Critical Review, 102690G (16 November 1992)

Scanning	360° scan, double sided mirror, 20.3 rpm, 2.954 sec period
IFOV	0.354 mr (0.25 km), 0.709 mr (0.50 km), 1.418 mr (1.0 km)
Dwell Time	83.3 μ s (0.25 km), 166.7 μ s (0.50 km), 333.3 μ s (1.0 km)
Telescope	2-mirror off axis afocal Gregorian, 4X magnification, EPD 17.8 cm

- SNR \geq 57 at 22 deg Solar Zenith requirement
- The 17.8 centimeter unobscured aperture provides high throughput
-

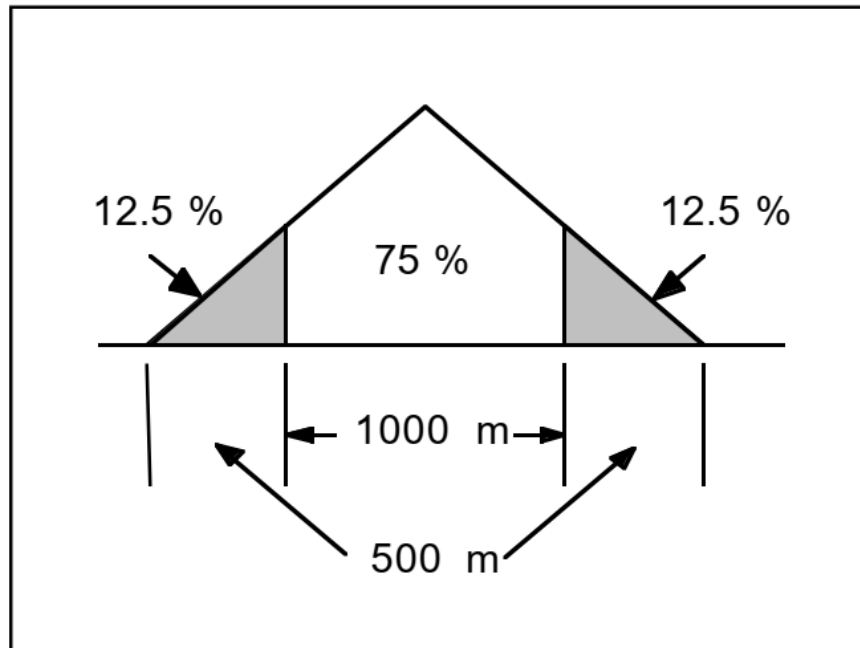


Figure 2-6. 75 % of Signal is Collected from the Nominal Pixel

Determined MODIS specs (highlight are “guessed-values”):

- $\text{IFOV} = d/f = 540\text{e-}6/380.859\text{e-}3 = 0.00141784754988066 \text{ rad} = 0.0812366806011266 \text{ deg}$
- $\text{IFOV} * 705\text{km} \sim 1\text{km}$, thus confirms IFOV calculation
- $\text{AT-FOV} = 10 * \text{IFOV}$ (Since 10 AT detectors), also confirms 10km AT swath at Nadir
- $F\# = f/D = 380.859\text{e-}3 / 0.1778 = 2.1421$

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