



# False Color to NDVI Conversion Precision NDVI Single Sensor

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# 1 Sensor Properties

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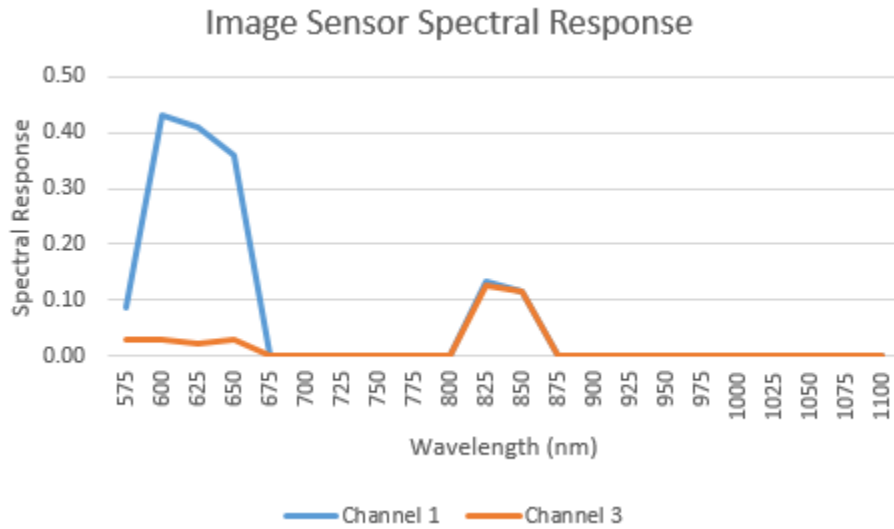


Figure 1: Spectral Response of Sentera Narrow NDVI

The plot above shows the quantum efficiency of Sentera's Precision NDVI Single Sensor. The colors shown in the plot correspond to the colors in the Raw NIR imagery. The "blue" channel contains no blue light, but only NIR light. The "red" channel contains both red and NIR light. The "green" channel is typically unused. Look closely at the plot above and note that Channel 1 is almost exactly aligned with Channel 3 in the 800-875nm range. While Sentera sensors are sometimes referred to as NIR sensors or NDVI sensors, the device is measuring the bands shown above, from which it is possible to derive NIR, NDVI, and other values.

# 2 Isolating Bands

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The most common use of Sentera's "NIR and NDVI" sensors is to compute NDVI. In order to do so, it is necessary to isolate the red and NIR bands. The isolation equations account for the difference in sensitivity between bands, and account for crosstalk between bands. In particular, channel 1 contains both RED and NIR light, so the NIR light must be removed to isolate for red.

Equation 2-1

$$RED = 1.0 * DN_{ch1} - 1.012 * DN_{ch3}$$

Equation 2-2

$$NIR = 6.403 * DN_{ch3} - 0.412 * DN_{ch1}$$

Where  $DN_{ch1}$  is the Digital Number (pixel value) of channel one, typically assumed to be the “red” channel by image software, and  $DN_{ch3}$  is the Digital Number (pixel value) of channel three, typically assumed to be the “blue” channel by image software

### 3 Accounting for Light Composition

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The sun and sky provide unequal irradiance in the RED and NIR bands. In general, at the earth’s surface, the irradiance of RED varies between 1.3x to 1.7x the irradiance of NIR. Using the average value of 1.5x, it is necessary to normalize the NIR band to the power of the RED band by multiplying the NIR band by 1.5.

*Equation 3-1*

$$NIR = 1.5 * (6.403 * DN_{ch3} - 0.412 * DN_{ch1})$$

Which reduces to:

*Equation 3-2*

$$NIR = 9.605 * DN_{ch3} - 0.618 * DN_{ch1}$$

### 4 Calculating NDVI from Original Image Pixel DN

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The standard NDVI equation:

*Equation 4-1*

$$NDVI = \frac{NIR - RED}{NIR + RED}$$

Substitute for RED and NIR, using Equation 2-1 and Equation 3-2:

*Equation 4-2*

$$NDVI = \frac{(9.605 * DN_{ch3} - 0.618 * DN_{ch1}) - (1.0 * DN_{ch1} - 1.012 * DN_{ch3})}{(9.605 * DN_{ch3} - 0.618 * DN_{ch1}) + (1.0 * DN_{ch1} - 1.012 * DN_{ch3})}$$

Group the terms:

*Equation 4-3*

$$NDVI = \frac{(9.605 + 1.012) * DN_{ch3} - (1.0 + 0.618) * DN_{ch1}}{(9.605 - 1.012) * DN_{ch3} + (1.0 - 0.618) * DN_{ch1}}$$

Reduce:

*Equation 4-4*

$$NDVI = \frac{10.617 * DN_{ch3} - 1.618 * DN_{ch1}}{8.593 * DN_{ch3} + 0.382 * DN_{ch1}}$$

Divide through by 8.593 to make equation more intuitive:

*Equation 4-5*

$$NDVI = \frac{\frac{1}{8.593}}{\frac{1}{8.593}} * \frac{10.617 * DN_{ch3} - 1.618 * DN_{ch1}}{8.593 * DN_{ch3} + 0.382 * DN_{ch1}}$$

Which reduces to:

*Equation 4-6*

$$NDVI = \frac{1.236 * DN_{ch3} - 0.188 * DN_{ch1}}{1.000 * DN_{ch3} + 0.044 * DN_{ch1}}$$

The final equation above is the equation used for generating NDVI Data from the Raw NIR images. If original imagery is stitched, the equation above can be applied using any GIS tool's band math calculator to produce NDVI.

## 5 Calculating NDVI from AgVault's Exported Grayscale NDVI Data

AgVault exports three sets of imagery when processing NIR sensor imagery: NIR imagery, NDVI Data, and NDVI Color Mapped. The NDVI value in the NDVI Data files is computed as shown above, but must be converted to an 8 bit integer to be stored as an image for further processing. NDVI values of [-1.0:+1.0] are mapped to [0:255] for storage as an image file, which can be viewed as a grayscale image, but is really intended for quantitative analysis by software.

The equation used to produce the DN is:

$$DN = (127 * NDVI) + 128$$

To compute the NDVI value from pixel DN of NDVI Data files, use the following equation:

$$NDVI = \frac{DN - 128}{127}$$

For example

DN	Equation	NDVI
255	$NDVI = \frac{255 - 128}{127}$	+1.0
128	$NDVI = \frac{128 - 128}{127}$	0.0
0	$NDVI = \frac{0 - 128}{127}$	-1.008 *

\* Note that an NDVI value of -1.008 is impossible, but may be encountered due to rounding error in integer math used to produce the ND when saving the data image. The coefficient of 127 was chosen to ensure that a value of +1.0 could be represented.