Solar SnowMax Shade Angle Analysis

Contents

1.0 Scope

1.1 This document outlines the steps taken to determine how much shade, in inches, is present outside the footprint of the Solar SnowMax during daylight hours in 30 minute increments. The shade length is only calculated for the Up-Slope side of the snow guard because this system is used along Solar Panel Eave edges. This information will show that there is minimal shading of the solar array during the peak operating hours throughout the year for various latitudes. Please note that the shade length given in this analysis does not take the sun's azimuth into consideration. *Please note that all dimensions are in inches*

2.0 Terminology

2.1 Sun Elevation Angle (SEA): The peak Angle (in degrees) between the sun and horizon.

2.3 Roof Pitch (RP): The angle of a given roof (in degrees)

2.5 "Shade" from charts: Length of the shaded portion of the solar array on the Up-Slope side of the Solar SnowMax *Outside of the SnowMax Footprint.* The SnowMax bar should be located entirely on the panel frame and suspended off the eave edge.

2.6 In the diagrams showing the SnowMax Bar, the Solar SnowMax Bracket has been removed for clarity. The SnowMax Bar is shown in the following diagrams at the recommended mounting distance from the Panel Frame.

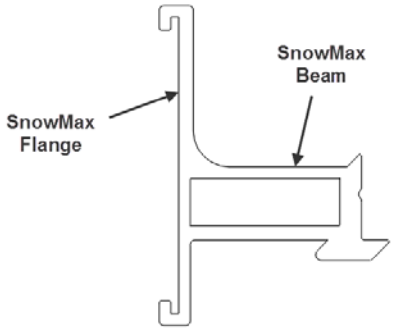


Fig 2.6.a SnowMax Bar Flange is what stops the snow, the Beam is the feature that gives the SnowMax Bar its strength

3.0 Shade Length Calculations

3.1 The following formulas solve for the Solar Snow Pad Up-Slope Shaded Distance if applicable. **Please note that the calculations in the following pages may not be accurate examples of solar elevation angles or roof pitch situations, the numbers are given for explanation purposes only.**

3.2 Figure 3.2.a below shows the geometry that determines the lowest point the sun may be before casting a shadow on the up-slope side of the Solar SnowMax Bar. Fig 3.2.a shows the initial shading caused by the SnowMax Bar Beam. (SnowMax Angle – Roof Pitch) is the lowest maximum elevation angle the sun can be before initial shading occurs. Figure 3.2.b below shows the geometry that determines the lowest point the sun may be before the Solar SnowMax Bar Flange begins to shade the panels.

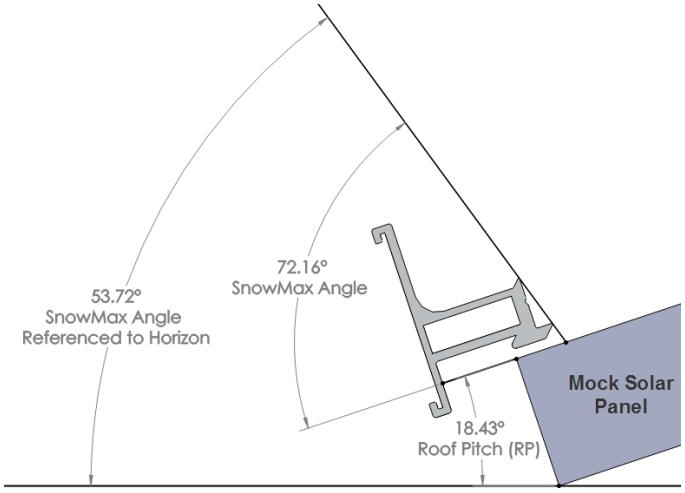


Fig. 3.2.a

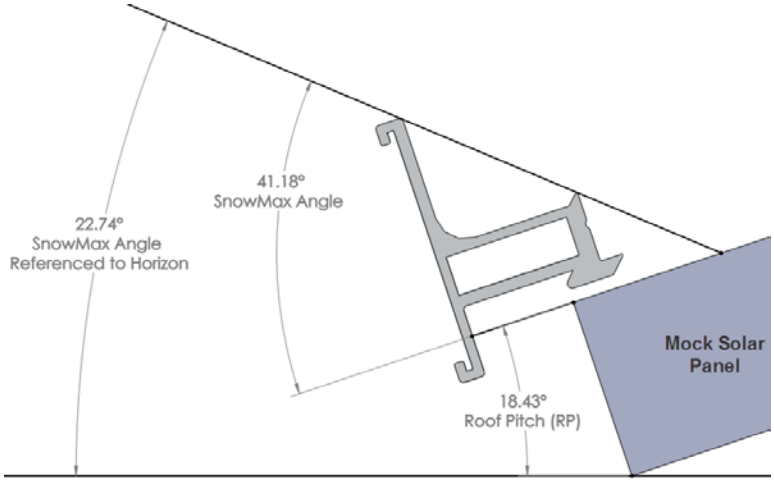
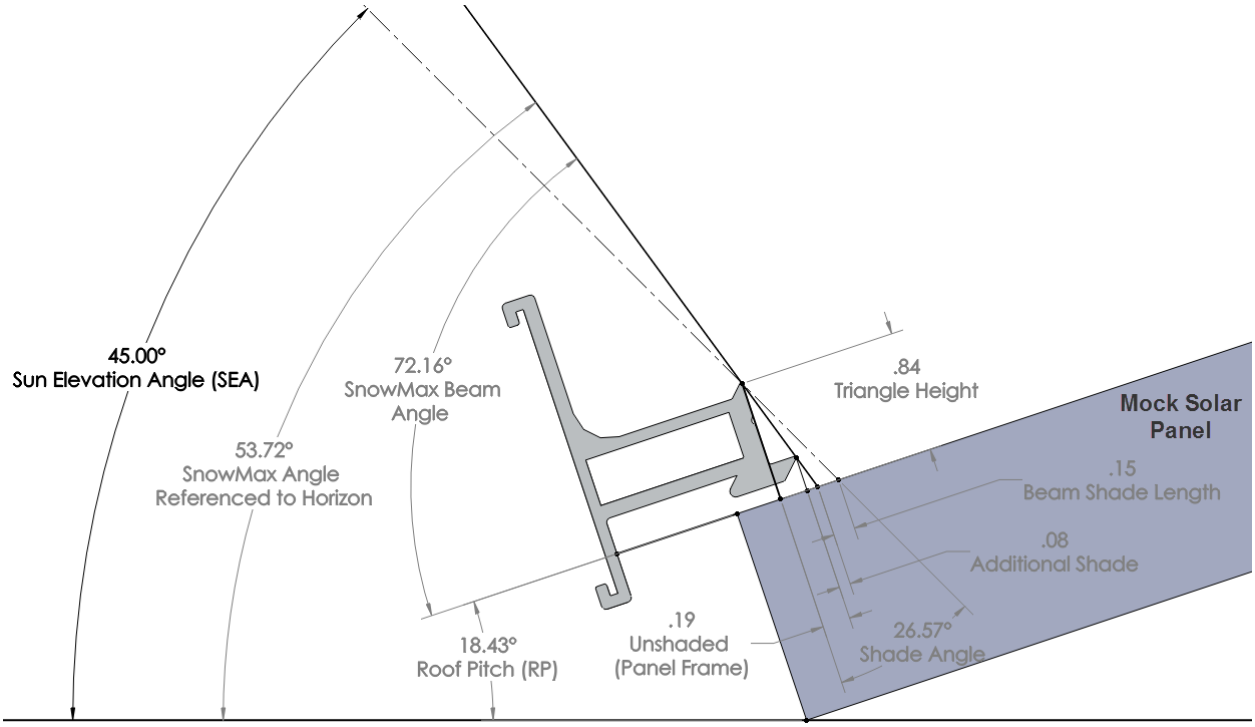


Fig 3.2.b

3.3 Figure 3.3.a shows the geometry that determines the Sun Elevation Angle relationship to the Roof Pitch and SnowMax Bar Beam Angle. This accounts for the initial shading that occurs in off peak hours. The angle we solve for is the shade angle. By solving for this angle, we can now find the Beam Shade Length. The calculations are shown below:

Shade Angle = 90° - (Sun Elevation Angle (SEA) + Roof Pitch (RP))

Shade Angle = 90° - (45° + 18.43°) = 26.57°



The Calculation for finding the Shade Length is listed below:

Shaded Length = (Tan(Shade Angle) x Triangle Height) - .19”(Shaded Panel Frame Length)

Shaded Length = (Tan(26.57) x .84”) - .19

Shaded Length = .23”

Figure 3.3.b shows the geometry that determines the Sun Elevation Angle relationship to the Roof Pitch and SnowMax Bar Flange Angle. The Flange shading will be significant than the bar angle once it is present. Therefore, once the Flange shade occurs, Beam shade is no longer present in the charts. The formula for Flange Shade Length is shown below:

Shade Angle = 90°-(Sun Elevation Angle + Roof Pitch)

The following calculation shows how the 56.57° shade angle was determined in Fig.3.3.a :

Shade Angle = 56.57° = 90°- (15.00°+18.43°)

Please note that due to radii on part corners length and angle tolerance is +/- .1" or 1.0° resp.

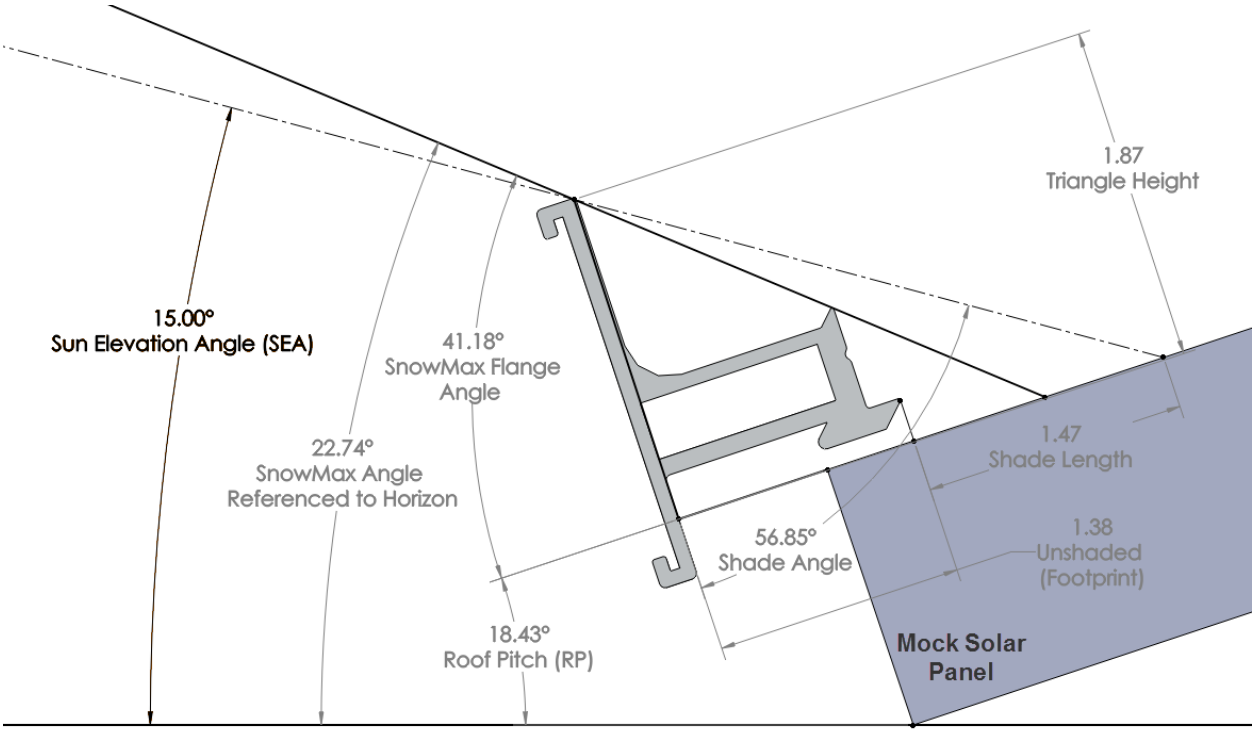


Fig. 3.3.b

3.4 The formula for total shade length is listed below (1.87" is triangle height):

TAN(Shade Angle) = Total Shaded Length / 1.87"

Therefore:

Total Shaded Length = 1.87" X TAN(56.57°) – 1.38"(Part footprint considered "Unshaded")

Total Shade Length = 1.45" (1.47" shown in Fig 3.3.b due to rounding and tolerance)

4.0 Additional Notes

4.1 Most solar panels do not generate electricity along their outer edges. This means the shade length listed in the charts is actually less by the amount of space on the panel edges not generating electricity.

4.2 The Solar SnowMax System was designed to cause minimal shading during the peak power production hours. The bottom edge (eave edge) of the lowest solar panels is all that will be shaded by this system.