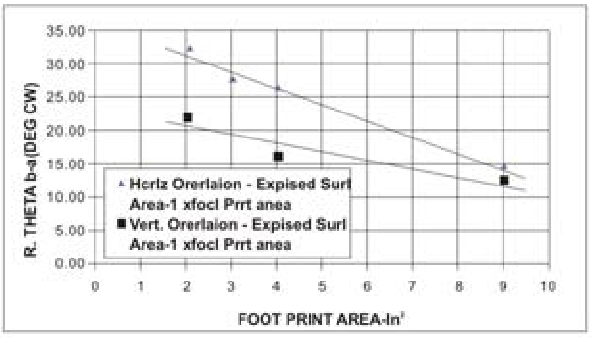

Flat Heat Sink, 009˙(2.3mm) Thick - Hcrz. Sot-up Fig. 3C - Vert Sot-up Fig 3D

Figure 5. RΘ Board-Ambicnt Per Emitter in Free Convection Vs. Foot Print Area

In the vertical orientation, the thermal resistance decreases noticeably as the exposed surface area doubles. The total surface area of the horizontal heat sink equals the foot print area. For the vertical heat sink, the total surface area is double the foot print area.

The vertical heat sink is also more efficient due to the nature of free convection. Warm air moving over a vertical surface is more efficient than air that moves vertically away from a horizontal surface. As the foot print areas approach 9in, the R孝B-A of the two orientations begin to converge. This indicates that as foot print areas approach 9in per emitter, heat sink orientation is not influential. Also, with areas greater than 9in per emitter, there are diminishing reductions in the R孝B-A. The lower limit for R孝B-A with increasing area will approach about 10 to 11 ∼C/W.

4. Range of Efficiency with Flat Heat Sinks

The two conditions shown in Figure 5 represent the most efficient (vertical, 2 convective surfaces) and least efficient (horizontal on low conducting insulating foam) configurations of a flat heat sink. Most applications probably fall some where in between. When selecting a heat sink for your application, you will need to determine the most comparable condition. You will also need to assess other factors that might make the R孝B-A of the larger or smaller than the extremes shown in Figure 5. Mounting the heat sink to a conductive surface or at a 45∼ angle, for example, are both factors that would reduce the R孝B-A compared to the horizontal orientation in Figure 5.

5. Finned (Fig. 3A) vs. Flat Heat Sinks (Fig. 3C) in Free (Natural) Convection

We tested two finned heat sinks with identical 2 in foot print areas, but different exposed surface areas. Increasing the number and length of fins on the heat sink increases the surface area. The fin spacing was about 0.25 in. Figure 6 shows R孝B-A per exposed surface area for finned heat sinks and flat heat sinks. The heat sinks plotted in Figure 6 are horizontal (Set-up Figure 3A for finned, Figure 3C for flat). The finned heat sinks required more xposed surface area for a given R孝B-A compared to the flat heat sinks. This shows that a flat heat sink can be effective in thermally managing WAH WANG Power Light Sources with 25 mm emitter spacing. In order to fully utilize the surface area on the finned heat sinks, the fins must lie in parallel with the convection airflow. The finned heat sinks would probably have a slightly lower R孝B-A if oriented vertically (Set-up Figure 3B).

6. Finned Heat Sinks Reduce Foot Print Size

The Figure 7 shows R孝B-A per foot print area for finned heat sinks and flat heat sinks. Each of the finned heat sinks had 2 in footprints. The flat heat sinks have footprints equal to the exposed area. A flat heat sink needs about 6 in footprint to match the R孝B-A of a 2 in foot print finned heat sink. If foot print size is a major design constraint, a finned heat sink offers an efficient solution.

The lower limit for R孝B-A using a 2 in footprint finned heat sink is about 10 to 11∼C/W. A heat sink typical of this performance is an AAVID heat sink extrusion part # 65245. A 1.6 in length of this heat sink extrusion has 25 in total surface area with a 2 in footprint. R孝B-A for this heat sink is plotted in Figure 7. Looking at Figure 5, a 9 in vertical flat heat heat sink (18 in total surface area) would have about the same R孝B-A.

B. Heat Sinks in Free Convection - Dense Emitter Spacing When WAH WANG Power LED is densely packed, they function as a single heat source. This chart will help you characterize the WAH WANG Power LED as well as custom Level 2 Boards with emitter spacing between 9 and 13 mm. This chart can also be used to characterize heat sinks for clustered Power LED, with spacing up to about 19 mm. For wider spacing, use the charts in Section B. The following chart in Figure 9 shows the Total Array R孝B-A vs. heat sink area required for the total array. It is the total array R孝B-A shown in Figure 2, which is the thermal resistance model for multiple emitter products.

We characterized three types of heat sinks using 12 and 18 WAH WANG power LED Floods. The results are shown in Figure 9.

All heat sinks were vertically orientated with free convection on all sides. We tested both flat plate (see Figure 3D test set- up) and finned heat sinks (see Figure 3B.) Figure 9 should be most useful in sizing heat sinks for custom applications that use ten to twenty Power LED. However, it can

also be used as a rough guide for sizing heat sinks for applications with about 3 to 20 densely spaced Power LED.

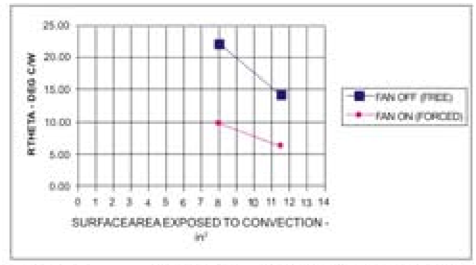

Figure 8. $R\theta_{Board\text{-}Ambient}$ per Emitter - Free Conv. (Test Set-up Fig. 3A) vs. Forced Conv. (Test Set-up Fig. 3E) - 42f/min (12.8m/min)Air Flow with Fan On

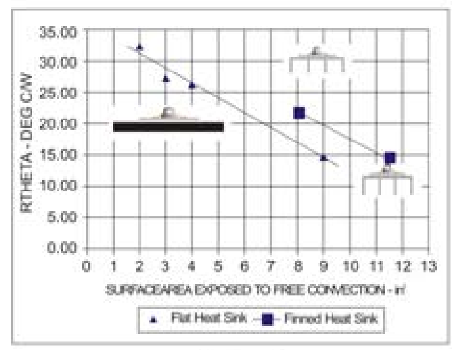

Figure 6.

$R\theta_{Board\text{-}Ambient}$ per Emitter in Free Conv.

Horizontal Flat Heat Sink - Set-up Fig. 3A vs. Horizontal Finned Heat Sink- Set-up Fig. 3C

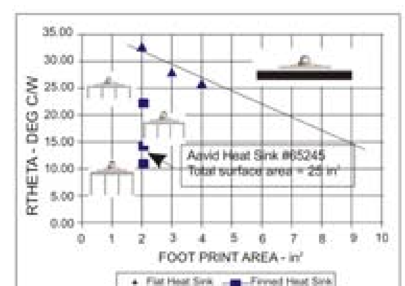

Figure 7.

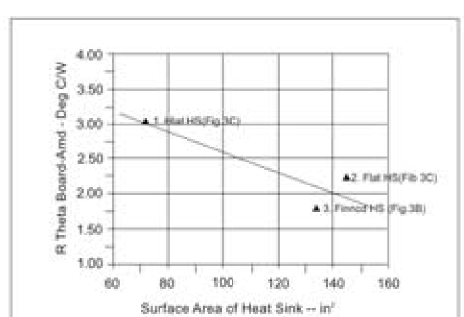

Figure 9. High Density Emitter Hest Sink Total Array Thermal Resistance (Board to Ambient) vs. Surface Area Esposed