Simplified thermal management is one of the benefits of using Vicor converters. High operating efficiency minimizes heat loss, and the low-profile package features an easily accessible, electrically isolated thermal interface surface.

Proper thermal management pays dividends in terms of improved converter and system MTBFs, smaller size, and lower product life-cycle costs. The following pages provide guidelines for achieving effective thermal management of Vicor converters.

Consideration should be given to the module baseplate temperature during operation. The maximum baseplate temperature specification for Maxi, Mini, and Micro is 100°C.

Enhanced module cooling can be achieved with free or forced convection by using the appropriate heat sink. The available Vicor heat sinks and thermal interface options are available on the Vicor website.

The relevant nomenclature for the tabulated thermal information supplied in this section for the Maxi, Mini and Micro modules is defined as follows:

T_B = baseplate temperature

T_A = ambient temperature

P_{OUT} = module output power

P_{IN} = module input power

η = module efficiency = P_{OUT} / P_{IN}

P_{DISS} = module power dissipation = $P_{IN} – P_{OUT} = (1/\eta – 1) \bullet P_{OUT}$

Supplied thermal resistance values:

θ_{BS} = baseplate-to-heatsink thermal resistance

θ_{BA} = baseplate-to-ambient thermal resistance

Basis of output power versus ambient temperature derating curves:

$$T_{A_{MAX}} = T_{B_{MAX}} – \theta_{BA} \bullet P_{DISS} = T_{B_{MAX}} – \theta_{BA} \bullet (1/\eta – 1) \bullet P_{OUT}$$

Additional Thermal Data
The following pages contain temperature derating curves. For additional thermal data, see the following link: http://asp.vicorpower.com/calculators/calculators.asp?calc=5

Thermal Performance Curves (Maxi)

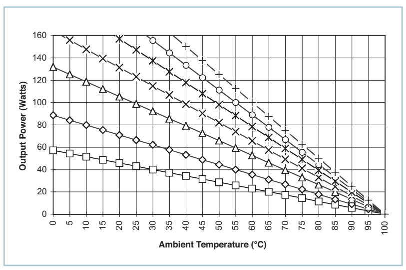
Table Usage: The forced convection thermal impedance data shown in the tables on pages 27 – 29 assumes airflow through the heat sink fins. Actual airflow through the fins should be verified. For purposes of heat sink calculation, assume efficiencies listed on Maxi data sheets. Use as a design guide only. Verify final design by actual temperature measurement.

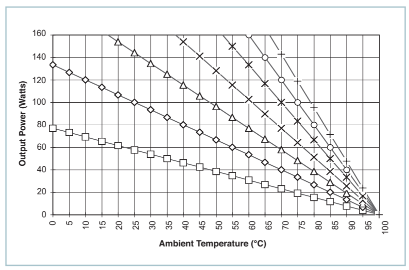
Maxi θ_{BA} (Baseplate-to-Ambient Thermal Resistance Values) vs. Airflow					
θ_{BS} = 0.07°C/W	Baseplate	0.9in Longitudinal Fins	0.9in Transverse Fins	0.4in Longitudinal Fins	0.4in Transverse Fins
Free Air	4.98	2.89	2.24	3.72	3.49
200LFM	3.23	1.30	1.02	2.14	1.53
400LFM	2.17	0.90	0.72	1.48	1.08
600LFM	1.73	0.72	0.60	1.10	0.87
800LFM	1.46	0.59	0.51	0.86	0.70
1,000LFM	1.27	0.51	0.44	0.71	0.60
1,200LFM	1.14	0.46	0.41	0.61	0.55

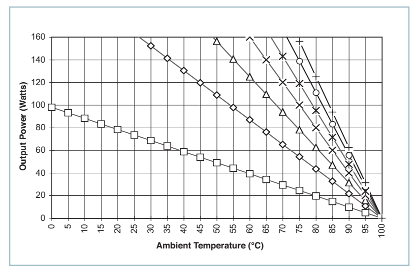
Maxi Output Power vs. Ambient Temperature De-rating Curves

Baseplate (No Heat Sink) | **0.4in [10,1mm] Heat Sink** | **0.9in [22,8 mm] Heat Sink**

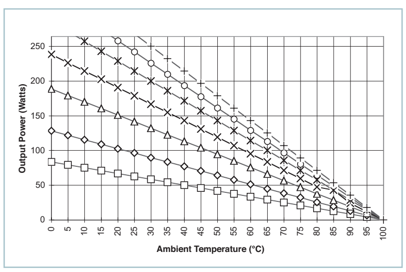
2V

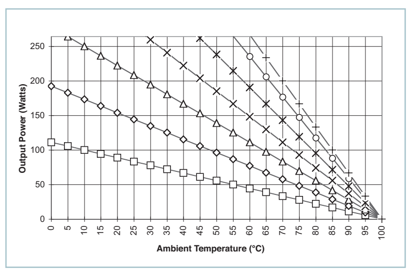


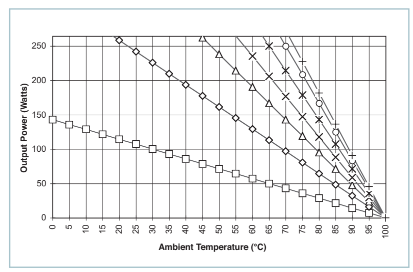




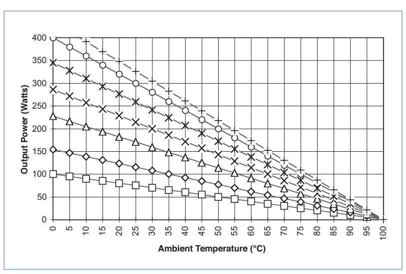
3.3V

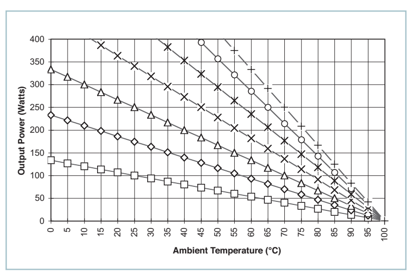


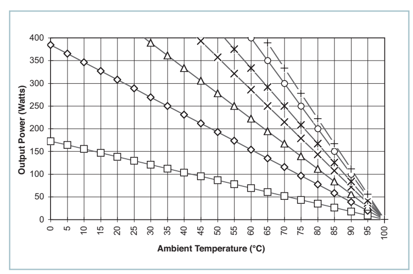




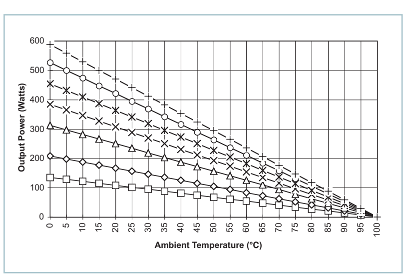
5V

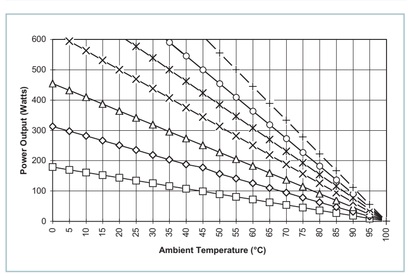


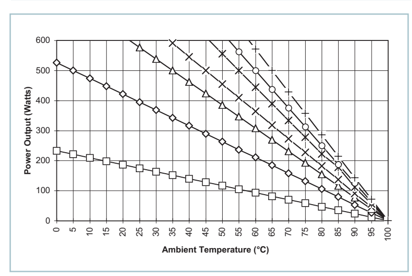




12 – 54V







Free Air | 200LFM | 400LFM | 600LFM | 800LFM | 1000LFM | 1200LFM

Thermal Performance Curves (Mini)

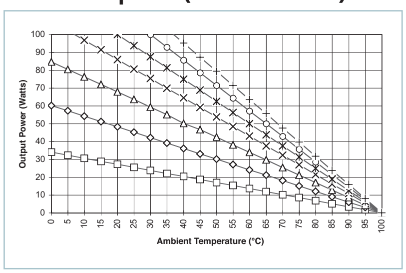
Table Usage: The forced convection thermal impedance data shown in the tables on pages 27 – 29 assumes airflow through the heat sink fins. Actual airflow through the fins should be verified. For purposes of heat sink calculation, assume efficiencies listed on Mini data sheets. Use as a design guide only. Verify final design by actual temperature measurement.

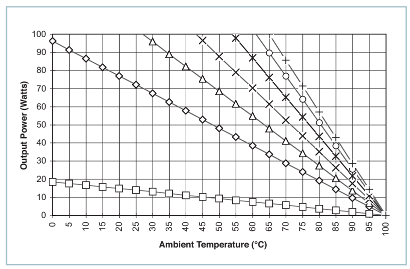
Mini θ_{BA} (Baseplate-to-Ambient Thermal Resistance Values) vs. Airflow					
θ_{BS} = 0.14°C/W	Baseplate	0.9in Longitudinal Fins	0.9in Transverse Fins	0.4in Longitudinal Fins	0.4in Transverse Fins
Free Air	7.94	4.10	3.93	6.28	6.34
200LFM	4.50	1.72	1.93	2.81	3.00
400LFM	3.20	1.26	1.38	1.98	2.09
600LFM	2.52	1.02	1.06	1.55	1.59
800LFM	2.15	0.86	0.89	1.24	1.31
1,000LFM	1.89	0.75	0.77	1.05	1.11
1,200LFM	1.69	0.68	0.70	0.94	0.99

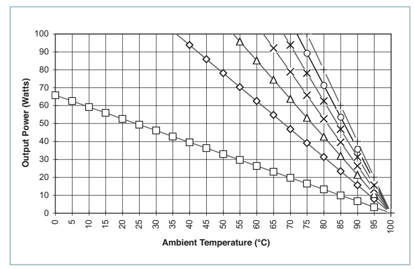
Mini Output Power vs. Ambient Temperature De-rating Curves

Baseplate (No Heat Sink) | **0.4in [10,1mm] Heat Sink** | **0.9in [22,8 mm] Heat Sink**

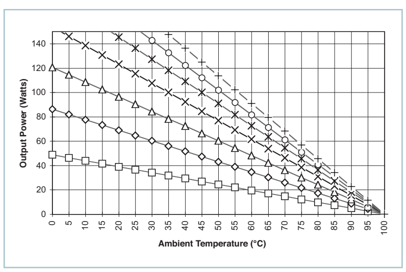
2V

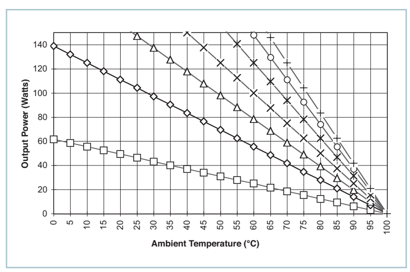


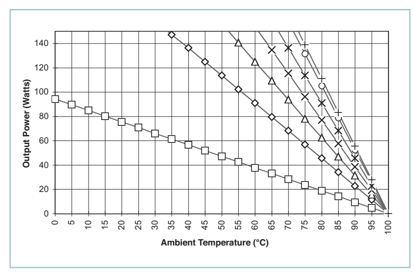




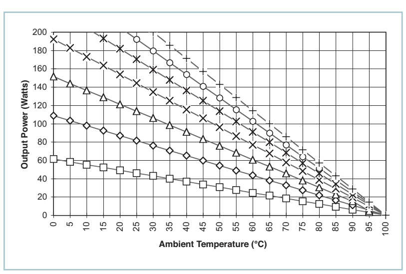
3.3V

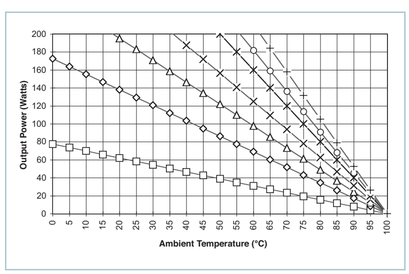


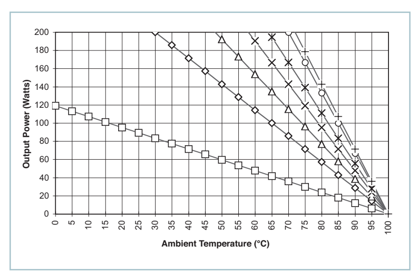




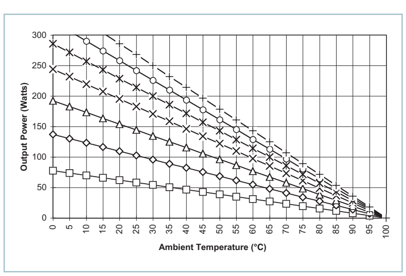
5V

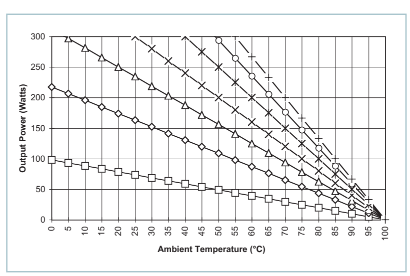


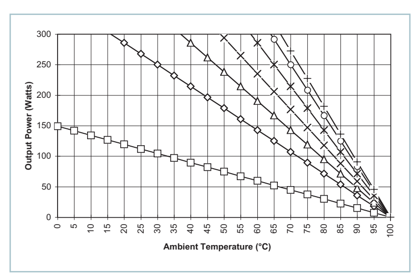




12 – 54V







Free Air | 200LFM | 400LFM | 600LFM | 800LFM | 1000LFM | 1200LFM

Thermal Performance Curves (Micro)

Table Usage: The forced convection thermal impedance data shown in the tables on pages 27 – 29 assumes airflow through the heat sink fins. Actual airflow through the fins should be verified. For purposes of heat sink calculation, assume efficiencies listed on Micro data sheets. Use as a design guide only. Verify final design by actual temperature measurement.

Micro θ_{BA} (Baseplate-to-Ambient Thermal Resistance Values) vs. Airflow					
θ_{BS} = 0.21°C/W	Baseplate	0.9in Longitudinal Fins	0.9in Transverse Fins	0.4in Longitudinal Fins	0.4in Transverse Fins
Free Air	10.90	5.37	5.04	7.77	7.76
200LFM	6.90	2.51	2.31	3.87	3.58
400LFM	4.78	1.79	1.68	2.68	2.52
600LFM	3.74	1.42	1.31	2.13	2.01
800LFM	3.15	1.20	1.10	1.78	1.67
1,000LFM	2.79	1.06	0.97	1.48	1.45
1,200LFM	2.49	0.93	0.88	1.32	1.29

Micro Output Power vs. Ambient Temperature De-rating Curves

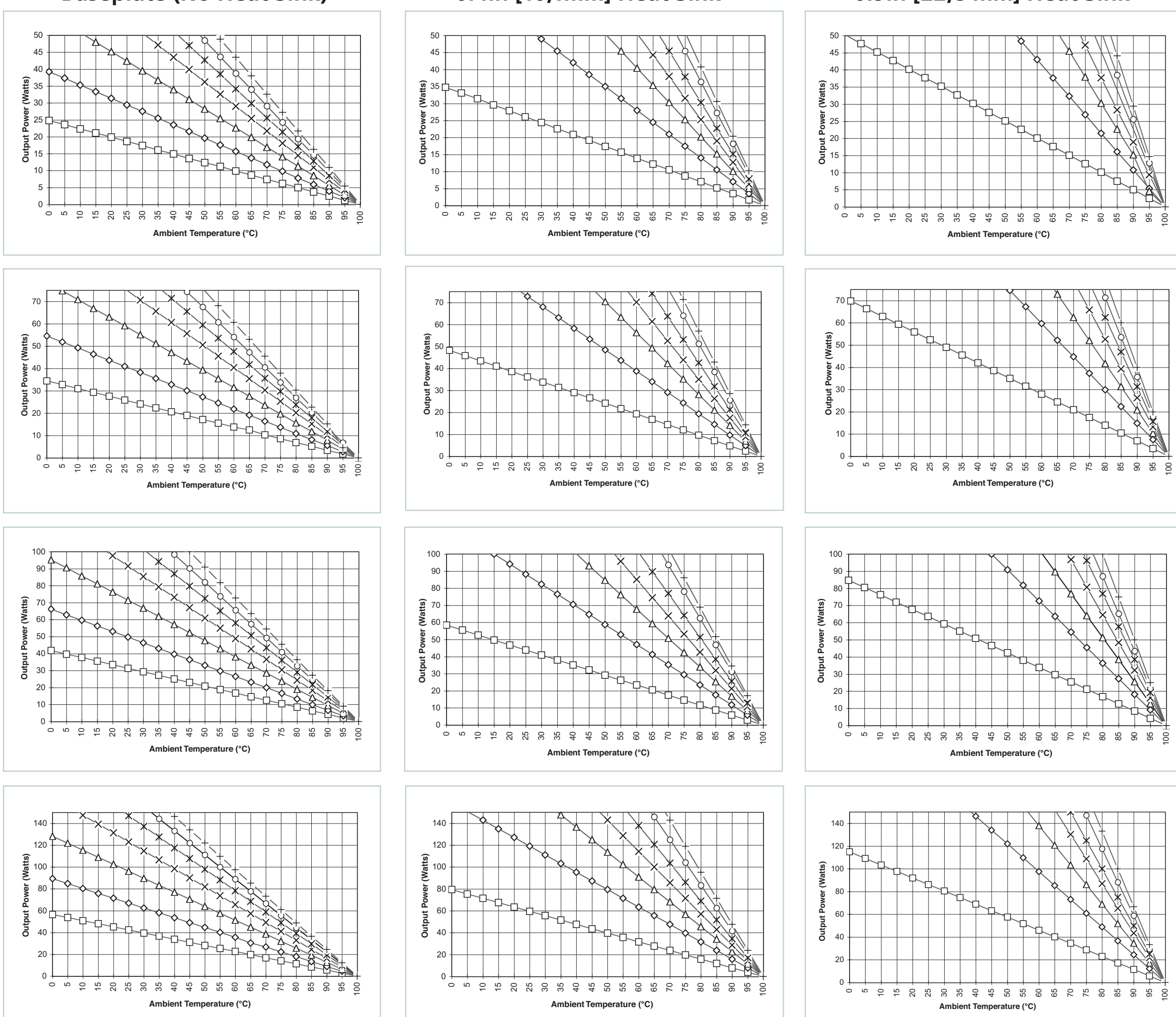
Baseplate (No Heat Sink) | **0.4in [10,1mm] Heat Sink** | **0.9in [22,8 mm] Heat Sink**

2V

3.3V

5V

12 – 54V



Free Air — 200LFM — 400LFM — 600LFM — 800LFM — 1000LFM — 1200LFM

Typical Examples — Thermal Equations (Maxi, Mini, Micro)

Example 1

Determine the maximum output power for a Maxi module without a heat sink delivering 5V in 400LFM airflow at a maximum ambient temperature of 40°C.

Maximum output power = $\left(T_{B_{MAX}} - T_{A_{MAX}}\right) / \left[\theta_{BA} \cdot (1/\eta - 1)\right]$

$T_{B_{MAX}}$ = 100°C

$T_{A_{MAX}}$ = 40°C

For Maxi module without a heat sink @ 400LFM, θ_{BA} = 2.17°C/W

For the 5V Maxi module the typical value for η = 0.83

Maximum output power = $(100 - 40) / [2.17\ (1/0.83 - 1)] \sim 135W$

Or, the same answer could be obtained by using the output power versus ambient temperature de-rating curves for the Maxi modules.

For the case with no heat sink the baseplate chart for the 5V module would be used. At a 40°C ambient and 400LFM airflow this chart indicates a maximum output power of approximately 135W.

For full output power of 400W the required thermal resistance is;

$\theta_{BA} = (100 - 40) / [400\ (1/0.83 - 1)] = 0.73°C/W$

What size heat sink would be necessary to operate at full output power (400W) under the same conditions?

From the θba versus airflow charts for the Maxi, the thermal resistance at 400LFM airflow requires the use of a 0.9in [22,8mm] transverse fin heat sink.

Example 2

Determine the maximum ambient for a Mini module with a 0.9in [22,8mm] heat sink in 400LFM of airflow delivering 200W at 5V.

From the output power versus ambient temperature chart for the $5V_{OUT}$ Mini with a 0.9in [22,8mm] heat sink, the 200W at 400LFM data point results in a $T_{A_{MAX}}$ of approximately 48°C.

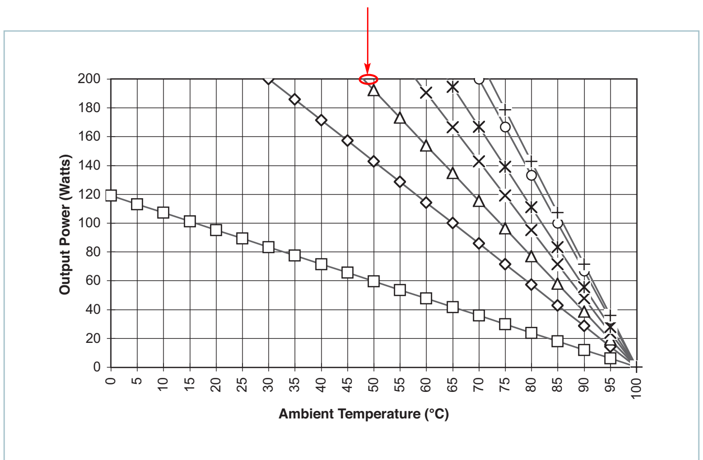
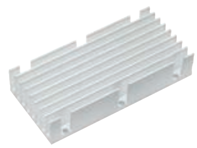
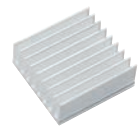
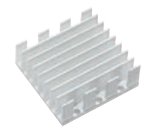
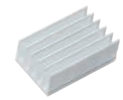
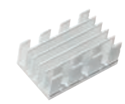
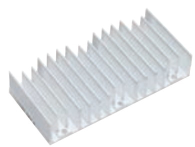
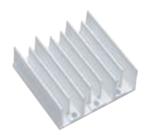
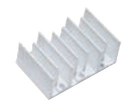


***Figure 6.1** — 5V Mini with 0.9in [22,8mm] heat sink*

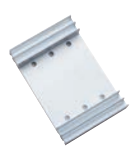
Thermal Management Accessories

All parts are RoHS compliant unless otherwise noted.

	Maxi Heat Sinks		Mini Heat Sinks		Micro Heat Sinks	
	Threaded	Through Hole	Threaded	Through Hole	Threaded	Through Hole
Longitudinal Fins	 0.4in [10,1mm] Fin P/N 30482 0.9in [22,8mm] Fin P/N 30188	 0.4in [10,1mm] Fin P/N 30718 0.9in [22,8mm] Fin P/N 30181	 0.4in [10,1mm] Fin P/N 32188 0.9in [22,8mm] Fin P/N 30189	 0.4in [10,1mm] Fin P/N 30195 0.9in [22,8mm] Fin P/N 30182	 0.4in [10,1mm] Fin P/N 32174 0.9in [22,8mm] Fin P/N 30190	 0.4in [10,1mm] Fin P/N 30719 0.9in [22,8mm] Fin P/N 30183
Transverse Fins	 0.4in [10,1mm] Fin P/N 30778 0.9in [22,8mm] Fin P/N 30196	 0.4in [10,1mm] Fin P/N 30720 0.9in [22,8mm] Fin P/N 30723	 0.4in [10,1mm] Fin P/N 30184 0.9in [22,8mm] Fin P/N 30269	 0.4in [10,1mm] Fin P/N 30721 0.9in [22,8mm] Fin P/N 30724	 0.4in [10,1mm] Fin P/N 32173 0.9in [22,8mm] Fin P/N 30270	 0.4in [10,1mm] Fin P/N 30722 0.9in [22,8mm] Fin P/N 30725

Low-profile Side-fin Heat Sinks

Height only 0.125in [3,17mm] above module baseplate [a]

		
0.55in [13,97mm] Side Fins P/N 30096	0.55in [13,97mm] Side Fins P/N 32190	0.55in [13,97mm] Side Fins P/N 30095

Standoffs and Screws

Bulk and single-module kits compatible with all standard mounting configurations.

See the specific products on the Vicor website for more information.

ThermMate Thermal Pads

20263

20265

20264

For use with Vicor modules, ThermMate thermal pads are a "dry" alternative to thermal compound and are pre-cut to the outline dimensions of the module.

Thermal pad	Part Number	Thickness
Maxi (10pc. pkg.)	20263	0.007" [0,177mm]
Mini (10pc. pkg.)	20264	0.007" [0,177mm]
Micro (10pc. pkg.)	20265	0.007" [0,177mm]

[a] For thermal curves of low-profile side-fin heat sinks and on-line capability for thermal curve calculations, see the following link: http://asp.vicorpower.com/calculators/calculators.asp?calc=5