

APPENDIX

Appendix A: Thermal conductivity of Selected Materials for Electronics Cooling

Material	Thermal conductivity (W m⁻¹ K⁻¹)	Temperature (K)
Air	0.024	293
Aluminum	250	293
Copper	390	293
Thermal grease	4–6	293
Phase change material	0.5–2	293
Gap pad	0.5–3	293
Silicon	149	293
Silicon dioxide	0.9–1.2	293

Appendix B: Thermal Interface Material Properties

Material	Thermal conductivity (W m⁻¹ K⁻¹)	Temperature (K)
Shin-Etsu 7783D	3.50	293
Bergquist GF3500S35	3.60	293
Loctite epoxy 3874	1.25	293
Honeywell PCM45F SP	2.35	293
Honeywell PCM45F	2.35	293
Laird T-flex 740	5.00	293
Indium	86	358
Soft metal alloy	86	358

Appendix C: Excerpt from a DRAM Datasheet [1]

Table 10: Absolute Maximum Ratings

Parameter	Symbol	Min	Max	Units	Notes	
VDD supply voltage relative to VSS	VDD	-1.0	+4.6	V		
VDDQ supply voltage relative to VSS	VDDQ	-1.0	+4.6	V		
Voltage on any pin relative to VSS	V _{IN} , V _{OUT} , NC	-1.0	+4.6	V		
SDRAM device temperatures	T _A	Commercial	0	+70	°C	1
		Industrial	-40	+85	°C	1
		Storage (plastic)	-55	+155	°C	1
Power dissipation	-	-	+1	W		

Table 11: Temperature Limits

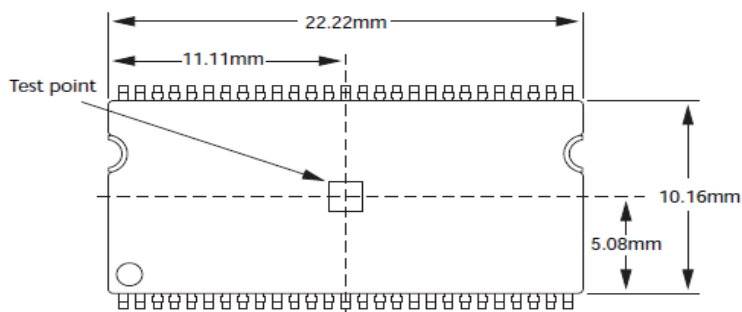
Parameter	Symbol	Min	Max	Units	Notes	
Operating case temperature:	T _C	Commercial	0	80	°C	1, 2, 3, 4
		Industrial	-40	90		
Junction temperature:	T _J	Commercial	0	85	°C	3
		Industrial	-40	95		
Ambient temperature:	T _A	Commercial	0	70	°C	3, 5
		Industrial	-40	85		
Peak reflow temperature	T _{PEAK}	-	260	°C		

- Notes:
1. MAX operating case temperature, T_C, is measured in the center of the package on the top side of the device, as shown on page 47.
 2. Device functionality is not guaranteed if the device exceeds maximum T_C during operation.
 3. Both temperature specifications must be satisfied.
 4. The case temperature should be measured by gluing a thermocouple to the top center of the component. This should be done with a 1mm bead of conductive epoxy, as defined by the JEDEC EIA/JESD51 standards. Care should be taken to ensure the thermocouple bead is touching the case.
 5. Operating ambient temperature surrounding the package.

Table 12: Summary of Thermal Impedance

Die Size (mm ²)	Package	Number of Leads	Test Board	θ _{JA} (°C/W) 0m/s	θ _{JMA} (°C/W) 1m/s	θ _{JMA} (°C/W) 2m/s	θ _{JB} (°C/W)	θ _{JC} (°C/W)
94	TSOP	54	2-layer	62.6	48.4	44.2	19.2	6.7
			4-layer	39.2	32.3	30.6	19.3	

Figure 32: Example Temperature Test Point Location, 54-Pin TSOP: Top View



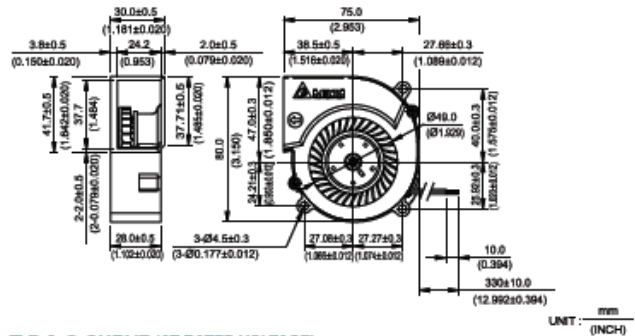
[1] Micron, 2000, "Synchronous DRAM: 512MbSDRAMfront.fm - Rev. L 10/07 EN."

Appendix D: Blower Datasheet - Delta Electronics, Inc. [2]



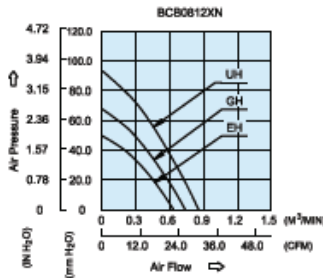
BCB[®] 75 x 80 x 30 MM SERIES

■ DIMENSIONS DRAWING



- Bearing Type
Ball Bearings
- Material
Impeller & Frame : Plastic (UL 94V-0)
- Lead Wires :
UL 1007 AWG #24 OR Equivalent
Red Wire Positive(+)
Black Wire Negative(-)
- Weight : 140g (4.94 oz)

■ P & Q CURVE (AT RATED VOLTAGE)



MODEL		Rated Voltage	Operating Voltage Range	Input Current	Input Power	Speed	Maximum Air Flow		Maximum Air Pressure		Noise
PART NO.	FUNCTION	VDC	VDC	Amp	Watt	R.P.M.	m ³ /min	CFM	mmH ₂ O	IN H ₂ O	dB-A
BCB0812EHN	-R00 / -F00	12	6.0 to 13.2	1.00	12.00	8200	0.632	22.32	49.54	1.950	64.0
BCB0812GHN	-R00 / -F00	12	6.0 to 13.2	1.45	17.40	9500	0.736	25.99	67.64	2.663	67.8
BCB0812UHN	-R00 / -F00	12	6.0 to 13.2	2.30	27.80	10800	0.854	30.16	93.35	3.675	69.3

* Function type is optional.
 * The max. air flow and the speed are measured in free air ; max. air pressure is measured at zero air flow.
 * Noise is measured in anechoic chamber in free air, one meter from intake side.
 * All readings are typical values at rated voltage.
 * Specifications are subject to change without notice.

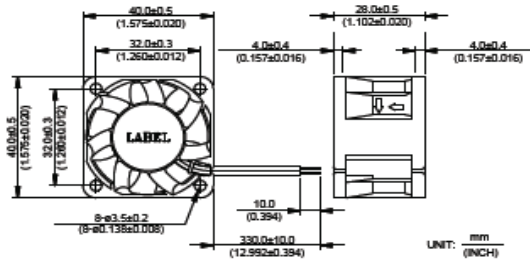
[2] “DC Brushless Fans & Blowers – Centrifugal Blower,” 2012, <http://www.delta.com.tw/product/cp/dc-fans/download/pdf/BCB/BCB75x80x30mm.pdf>.

Appendix E: Vane Axial Fan Datasheet – Delta Electronics, Inc. [3]



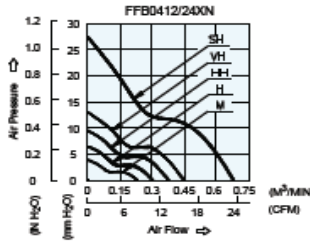
FFB 40 x 40 x 28 MM SERIES

DIMENSIONS DRAWING

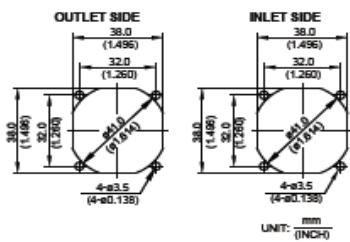


- Bearing Type: Ball Bearings
- Material: Impeller & Pillow : Plastic (UL 94V-0)
- Lead Wires : UL 1007 AWG #24 OR Equivalent
Red Wire Positive(+)
Black Wire Negative(-)
- Weight : 32g (1.13 oz)

P & Q CURVE (AT RATED VOLTAGE)



MOUNTING PANEL CUTOUT



MODEL		Rated Voltage	Operating Voltage Range	Input Current	Input Power	Speed	Maximum Air Flow		Maximum Air Pressure		Noise
PART NO.	FUNCTION	VDC	VDC	Amp	Watt	R.P.M.	m ³ /min	CFM	mmH ₂ O	IN H ₂ O	dB-A
FFB0412MN	-R00/-F00	12	4.5 to 13.8	0.05	0.60	5000	0.228	8.05	3.77	0.148	30.0
FFB0424MN	-R00/-F00	24	14.0 to 27.8	0.04	0.96	5000	0.228	8.05	3.77	0.148	30.0
FFB0412HN	-R00/-F00	12	4.5 to 13.8	0.07	0.84	6500	0.300	10.59	6.30	0.248	36.0
FFB0424HN	-R00/-F00	24	14.0 to 27.8	0.06	1.44	6500	0.300	10.59	6.30	0.248	36.0
FFB0412HHN	-R00/-F00	12	4.5 to 13.8	0.11	1.32	8000	0.375	13.24	9.39	0.370	41.0
FFB0424HHN	-R00/-F00	24	14.0 to 27.8	0.08	1.92	8000	0.375	13.24	9.39	0.370	41.0
FFB0412VHN	-R00/-F00	12	4.5 to 13.8	0.16	1.92	9500	0.447	15.79	12.94	0.509	45.0
FFB0424VHN	-R00/-F00	24	14.0 to 28.4	0.10	2.40	9500	0.447	15.79	12.94	0.509	45.0
FFB0412SHN	-R00/-F00	12	4.5 to 13.8	0.50	6.00	13000	0.680	24.00	27.30	1.075	54.5

* Function type is optional.
 * The max. air flow and the speed are measured in free air; max. air pressure is measured at zero air flow.
 * Noise is measured in anechoic chamber in free air, one meter from intake side.
 * All readings are typical values at rated voltage.
 * Specifications are subject to change without notice.

[3] “DC Brushless Fans & Blowers – Vane Axial Fan,” 2012, <http://www.delta.com.tw/product/cp/dcfans/download/pdf/FFB/FFB40x40x28mm.pdf>.