Thermal Characteristics of IC Assembly

INTRODUCTION

The purpose of this document is to provide a centralized listing of package thermal characteristics (Junction-to-Ambient and Junction-to-Case). This listing is not specific to individual devices sold by Analog Devices; it is representative of typical values for a given package and pin count. When the data sheet for a specific product lists thermal characteristics, that data is correct for that specific device and reflects any thermal enhancements that have been made in the packaging of that device.

PROCEDURE USED

θ_{JA} test data was taken from either SEMI or JEDEC standard boards. The SEMI boards are vertically mounted and comply with the SEMI standard G42-88; the test method for using this board is specified by the SEMI standard G38-87. These standards are available in the SEMI International Standards book, Volume 4, for packaging.

The JEDEC boards are horizontally mounted. Each board is made of FR4, is 1.57 mm thick, and consists of 2 oz/ft copper traces on one or both of the exposed surfaces. This is a low effect thermal conductivity test board.

The JEDEC 4 layer boards are intended to give a near best-case thermal performance value. The JEDEC 4 layer board is made of FR4, is 1.60 mm thick, and consists of four copper layers. The two internal layers are solid copper (1 oz/ft or 35 um thick). The two surface layers utilize 2 oz/ft copper.

Table I.

Package	Leads	θ_{JA}	θ_{JC}	Board Type	Layers	Comments
BGA	225	58	8.5	JEDEC	2	(19 × 19 mm)
BGA	225	23	1.7	SEMI	2	(23 ×23 mm)
BGA	225	29.9	8.5	JEDEC	4	(19 × 19 mm)
BGA	225	27.5	10.6	JEDEC	4	(19 × 19 mm)
BGA	256		1.2	SEMI	2	(27 × 27 mm)
BGA	256	14.3	0.8	JEDEC	4	(27 × 27 mm)
BGA	260	31.8	12.4	JEDEC	4	(19 × 19 mm)
BGA	304	27		JEDEC	2	(31 × 31 mm)
BGA	313	48.7	5.3	SEMI	2	
BGA	316	30	9.38	JEDEC	4	(23 × 23 mm)
BGA	352	17.2		SEMI	2	(35 × 35 mm)
BGA	352	12.7	2.8	JEDEC	4	(35 × 35 mm)
BGA	400	25	3.6	JEDEC	2	(27 × 27 mm)
BGA	400	15.7		JEDEC	4	(27 × 27 mm)
BGA	484	16.6	6.7	JEDEC	4	(19 × 19 mm)
BGA	500	9.3	2.2	JEDEC	4	(37.5 × 37.5 mm)
BGA	625	13.8	3.1	JEDEC	4	(27 × 27 mm)

Data represents general results for packages. Result for specific devices can be found in their respective data sheets.

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Table I. (continued)

Package	Leads	θ_{JA}	θ_{JC}	Board Type	Layers	Comments
CERDIP	16	75.9		SEMI	2	
CERDIP	18	72.3		SEMI	2	
CERDIP	20	70.4		SEMI	2	
CERDIP	24	66.9		SEMI	2	
CERDIP	28	50.9		SEMI	2	
CERDIP	40	44.5		SEMI	2	
CQFP	240 (32 × 32)	20	0.25	JEDEC	2	Heat sink
CSP	20 (4 × 4)	135.7		JEDEC	2	Paddle soldered to board, no thermal vias in pad
CSP	20 (4 × 4)	30.4		JEDEC	4	Paddle soldered to board, 9 thermal vias in pad
CSP	20 (4 × 4)	70.5		JEDEC	2S2P	Paddle not soldered to board
CSP	32 (5 × 5)	108.2		JEDEC	2	Paddle soldered to board, no thermal vias in pad
CSP	32 (5 × 5)	27.3		JEDEC	4	
CSP	32 (5 × 5)	46	32.7	JEDEC	2S2P	Paddle not soldered to board
CSP	32 (5 × 5)	32.5	32.1	JEDEC	2S2P	Paddle soldered to board, 9 thermal vias in pad
CSP	48 (7 × 7)	25.9		JEDEC	4	
CSP BGA	28	88.8		JEDEC	2	(7 × 7 mm)
CSP BGA	28	47		JEDEC	4	(7 × 7 mm)
CSP BGA	48	100	20	JEDEC	2	(7 × 7 mm)
CSP BGA	52	77.7		JEDEC	4	(5 × 5 mm)
CSP BGA	64	165		JEDEC	2	(9 × 9 mm)
CSP BGA	64	129		JEDEC	4	(9 × 9 mm)
CSP BGA	108	71.7	8.3	JEDEC	2	(10 × 10 mm)
CSP BGA	108	37.3		JEDEC	4	(10 × 10 mm)
CSP BGA	144	70.7	7.4	JEDEC	2	(10 × 10 mm)
CSP BGA	144	67.6		SEMI	2	(13 × 13 mm)
CSP BGA	144	34.4		JEDEC	4	(10 × 10 mm)
CSP BGA	144	32.7		JEDEC	4	(13 × 13 mm)
CSP BGA	160	62.3	5.8	JEDEC	2	(12 × 12 mm)
CSP BGA	196	43.7	5	JEDEC	2	(15 × 15 mm)
CSP BGA	196	38.5		JEDEC	4	(15 × 15 mm)
JLCC	44	53	7		nonstd	
LCC	20	76.1		SEMI	2	
LCC	28	66.1	4.1	SEMI	2	
LCC	44	49	10	SEMI	2	
LCC	44	40	6	SEMI	2	w/heat slug
LGA	16 (9.1 × 11.6)	25.7	25.9	JEDEC	4	

Data represents general results for packages. Result for specific devices can be found in their respective data sheets.

Table I. (continued)

Package	Leads	θ_{JA}	θ_{JC}	Board Type	Layers	Comments
LQFP	34	121	45	SEMI	2	(7 × 7 mm)
LQFP	44	43.3		JEDEC	4	(10 × 10 mm)
LQFP	48	91	19	SEMI	2	(7 × 7 mm)
LQFP	48	50.1		JEDEC	4	(7 × 7 mm)
LQFP	52	29.9	1.5	SEMI	2	(14 × 14 mm) w/heat slug
LQFP	64	65.9	11.1	SEMI	2	(10 × 10 mm)
LQFP	64	53	3	SEMI	2	(10 × 10 mm) w/heat slug
LQFP	64	68	13	SEMI	2	(14 × 14 mm)
LQFP	64	47	11.1	nonstandard	4	(10 × 10 mm)
LQFP	64	37.3	3.1	JEDEC	4	(10 × 10 mm)
LQFP	64	41.3	1.2	JEDEC	4	(7 × 7 mm) w/heat slug
LQFP	80	48		SEMI	2	(12 × 12 mm)
LQFP	80	69	10	SEMI	2	(14 × 14 mm)
LQFP	80	38.7		JEDEC	4	(12 × 12 mm)
LQFP	80	38.1	7.6	nonstandard	4	(14 × 14 mm)
LQFP	100	40		SEMI	2	(14 × 14 mm)
LQFP	100	29.8		nonstandard	4	(14 × 14 mm)
LQFP	120	35	5	SEMI	2	(14 × 14 mm)
LQFP	120	46.4		SEMI	2	(14 × 14 mm) w/heat slug
LQFP	128	47.1		SEMI	2	(14 × 14 mm)
LQFP	128	36.1	3.8	SEMI	2	(14 × 20 mm)
LQFP	144	42.1		SEMI	2	(20 × 20 mm)
LQFP	144	22.5	0.6	SEMI	2	(20 × 20 mm) w/heat slug
LQFP	144	45.3	1	JEDEC Lg Bd	2	(20 × 20 mm) w/exposed pad
LQFP	144	33.8		nonstandard	4	(20 × 20 mm)
LQFP	176	21		JEDEC Lg Bd	2	(24 × 24 mm) w/heat slug
LQFP	176	21		JEDEC	4	(24 × 24 mm)
LQFP	184	30.2		JEDEC	2	(20 × 20 mm)
MSOP	8	214	44	SEMI	2	0.060 × 0.086 die
MSOP	8	141.9	43.7	nonstandard	4	
PDIP (N)	16	116.8	38.9	SEMI	2	
PDIP (N)	20	102	30.6	SEMI	2	
PDIP (N)	24	105	34.7	SEMI	2	
PDIP (W)	28	73.6	23.5	SEMI	2	
PLCC	20	89.4	46	SEMI	2	
PLCC	28	79.3	36.7	SEMI	2	
PLCC	44	47.7	17.5	SEMI	2	
PLCC	44	35.6	19.4	nonstandard	4	
PLCC	68	46.1	14.6	SEMI	2	
PLCC	84	31.7	10.5	SEMI	2	
PLCC (Thermally Enhanced)		44	30.2		SEMI 2	

Data represents general results for packages. Result for specific devices can be found in their respective data sheets.

Table I. (continued)

Package	Leads	θ_{JA}	θ_{JC}	Board Type	Layers	Comments
PSOP	20		0.85	SEMI	2	can handle 5.89 W, body size is 11 × 15.9 × 3.15 mm
PSOP	20	53		SEMI	2	slug up
PSOP	20	23.3		nonstandard	4	slug up
PSOP	28	23.7		nonstandard	4	slug down
QFP	44	93	22	SEMI	2	(10 × 10 mm)
QFP QFP	44 52	72 122	22	nonstandard SEMI	4 2	(10 × 10 mm) (10 × 10 mm)
QFP	64	48		SEMI	2	(10 × 10 × 2.7 mm)
QFP	64	44	24.6	nonstandard	4	(14 × 14 mm)
QFP	80	44.1		SEMI	2	(14 × 14 × 2.7 mm)
QFP	100	50	6	SEMI	2	(14 × 20 mm)
QFP	100	42.1	0.7	SEMI	2	(14 × 20 mm) power quad w/heat slug
QFP	128	36	8.4	SEMI	2	(14 × 20 mm)
QFP	128	37.5		JEDEC	4	(14 × 20 mm)
QFP	160	40.5	6.7	SEMI	2	(28 × 28 mm)
QFP	160	24.2	6	SEMI	2	(28 × 28 mm) heat slug
QFP	208	33.5	13.8	JEDEC	2	(28 × 28 mm)
QFP	208	29.4		nonstandard	4	(28 × 28 mm)
QFP	240	25.9		SEMI	2	(32 × 32 mm)
QFP	240	15.9		SEMI	2	(32 × 32 mm) heat slug
QFP	240	12.4	0.4	JEDEC	4	(32 × 32 mm) heat slug
QFP	304	25.9	8.9	nonstandard	4	(40 × 40 mm)
QSOP	16	150	39	SEMI	2	
QSOP	16	105.4	38.8	nonstandard	4	
QSOP	20	125.8		SEMI	2	
QSOP	20	83.2		nonstandard	4	
QSOP	24	122.3	31.3	SEMI	2	
QSOP	24	82.1	31.3	nonstandard	4	
QSOP	28	115.2	27	SEMI	2	
QSOP	28	78.6	27	nonstandard	4	
QSOP	36	58		SEMI	2	
SC70	3	211.4	177.4	nonstandard	4	
SC70	5	331.4	223.9	nonstandard	4	
SC70	6	340.2	228.9	nonstandard	4	

Data represents general results for packages. Result for specific devices can be found in their respective data sheets.

Table I. (continued)

Package	Leads	θ_{JA}	θ_{JC}	Board Type	Layers	Comments
SOIC	8	157	56	SEMI	2	
SOIC	8	121.3		nonstandard	4	
SOIC	14	104.5		SEMI	2	
SOIC	16	124.9	42.9	SEMI	2	
SOIC	16	80.6	42.9	nonstandard	4	
SOIC (W)	16	89.2	55.6	SEMI	2	
SOIC (W)	16	55.6	29.3	nonstandard	4	
SOIC (W)	20	75.3	38	SEMI	2	
SOIC (W)	20	57.7		nonstandard	4	
SOIC (W)	28	71	23	SEMI	2	
SOIC (W) Batwing	24	61	22	JEDEC	2	
SOIC (W) Batwing	24	44.1		Eval	4	
SOT143	4	368		SEMI	2	
SOT143	4	265		nonstandard	4	
SOT23	3	333	102	SEMI	2	
SOT23	3	270	102	nonstandard	4	
SOT23	5	240		SEMI	2	
SOT23	6	229.6	92	SEMI	2	
SOT23	6	169.5	92	nonstandard	4	
SOT23	8	211.5		SEMI	2	
SSOP	16	139	56	SEMI	2	
SSOP	20	126	46	SEMI	2	
SSOP	24	112	33.8	SEMI	2	
SSOP	28	109	39	SEMI	2	
SSOP	28	63.6		nonstandard	4	
TSSOP	8	208		SEMI	2	
TSSOP	8	140.8		nonstandard	4	
TSSOP	14	136		SEMI	2	
TSSOP	14	89.2		nonstandard	4	
TSSOP	16	150.4	27.6	SEMI	2	
TSSOP	16	112.6		nonstandard	4	
TSSOP	20	143	45	SEMI	2	
TSSOP	24	128	42	SEMI	2	
TSSOP	28	98	14	SEMI	2	
TSSOP	28	41.8		JEDEC	4	
TSSOP	38	109.5	9	SEMI	2	
TSSOP	38	71.1		nonstandard	4	
TSSOP	28 (W)	96		SEMI	2	
TSSOP	28 (W)	68.6		nonstandard	4	
TSSOP	48 (W)	115	32	SEMI	2	
TSSOP	48 (W)	70.5		nonstandard	4	

Data represents general results for packages. Result for specific devices can be found in their respective data sheets.