

SOLDER PAD RECOMMENDATIONS FOR SURFACE-MOUNT DEVICES

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Cost and performance requirements continue to push the packaging of electronic systems into smaller and smaller spaces. At one time, the standard center-to-center pin spacing was 100 mils (0.1") on through-hole parts (DIPs). The advent of surface-mount devices (SMD) has brought pin spacings that differ from one package series to the next. The solder joint of pin-foot to printed circuit board (PCB) must provide the strength to hold the device in place. The close lead spacings make lead-to-lead solder bridges more prevalent. These factors increase the importance of an optimized PCB design.

The criteria for a well-designed solder joint is based on both empirical data and reliability testing. Solder-joint strength is directly related to the total solder volume. An observable solder fillet is evidence of proper wetting. Therefore, a positive solder fillet is usually specified. A joint can be described by the solder fillets formed between the device pins and the PCB pads. Figure 1 shows the three fillets: toe, heel, and side.

A properly designed solder pad minimizes solder bridging while affording a strong and easily inspected joint. These goals have conflicting dimensional requirements.

Factors to consider when determining the dimensions of the solder pads include part dimension tolerances, PCB production tolerances, and accuracy-of-placement tolerances. Figure 2 shows how placement accuracy can affect solder bridge formation. The designer should also consider the limitations of the soldering process. Boards designed for wave soldering usually have slightly wider pads than those designed for reflow techniques.

Two trade organizations provide industry standards. The Electronic Industries Association (EIA)¹ represents manufacturers in all areas of the electronics industry. The EIA's Joint Electron Device Engineering Council (JEDEC)² establishes standard package dimensions. The Institute for Interconnecting and Packaging Electronic Circuits (IPC)³ has established standards for PCB design. The Surface Mount Land Pattern Subcommittee of the Printed Board Design Committee of IPC has developed standard pad dimensions for the packages defined by the JEDEC committee. The IPC document Surface-Mount Design and Land Pattern Standard is designated IPC-SM-782.

To further assist the designer, the mathematical relationships in the standard have been programmed in a spreadsheet calculator. Access to this program is available at the IPC

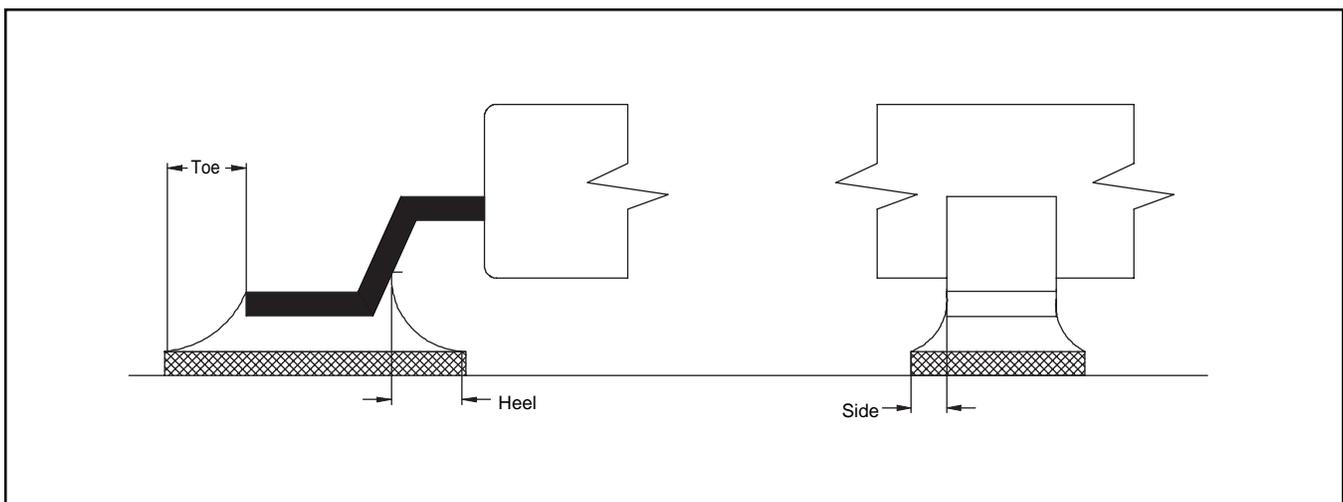


FIGURE 1. Solder Joint Fillets.

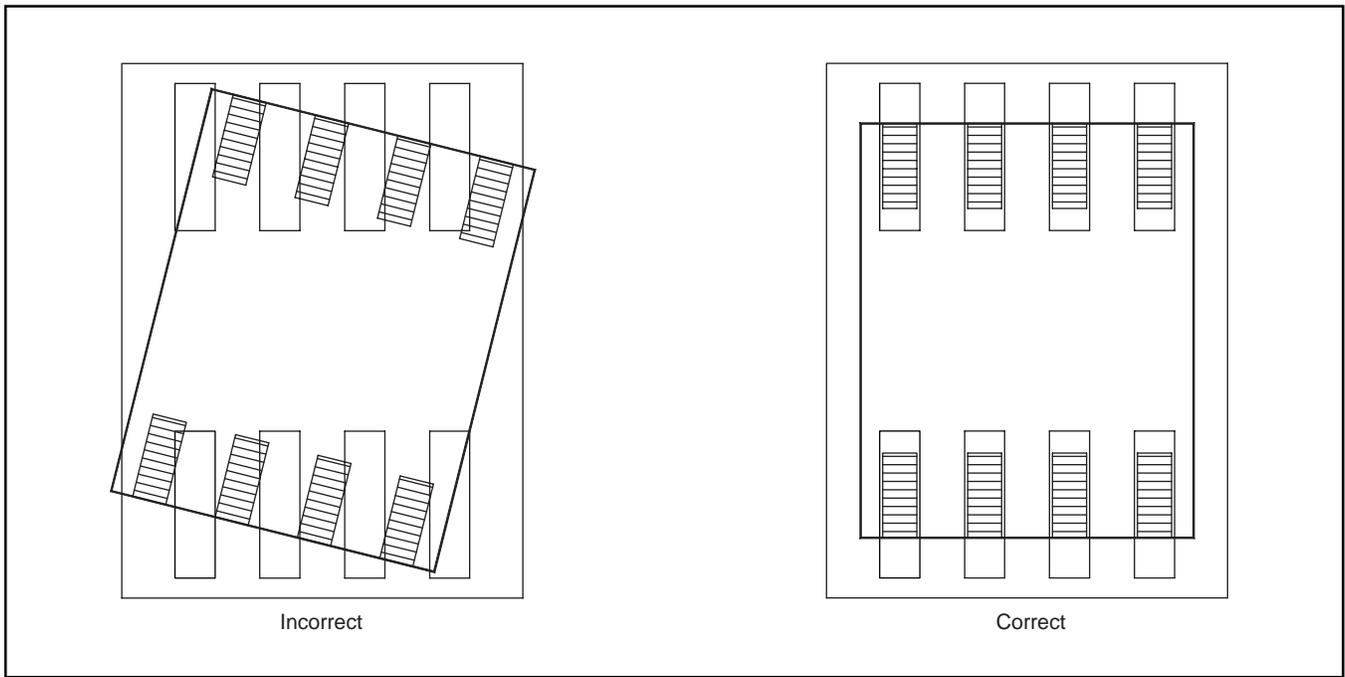


FIGURE 2. Device Placements.

internet web site³. Surface-mount land patterns are given for many JEDEC standard packages. Capability to customize the patterns for special designs is also provided. The results of this program are tabulated in the appendices of this paper for some of the more popular packages currently supplied by Texas Instruments.

The values listed in the following tables are based on the assumptions shown in Table I. Performance will also depend on process variables. While an effort has been made to select nominal values for these variables, the design engineer should determine the optimum value through experimentation.

Fabrication Tolerance	0.1mm
Placement Tolerance	0.1mm
Toe Joint Minimum	0.4mm
Heel Joint Minimum	0.5mm
Side Joint Minimum	0.0mm

TABLE I. Assumed Basic Dimensions.

- NOTES: (1) Electronic Industries Association (EIA)
 2500 Wilson Boulevard
 Arlington, VA 22201
<http://www.eia.org/>
- (2) Joint Electron Device Engineering Council (JEDEC)
<http://www.jedec.org>
- (3) The Institute for Interconnecting and Packaging
 Electronic Circuits (IPC)
 2215 Sanders Road
 Northbrook, IL 60062-6135
 Phone: 847-509-9700 Fax: 847-509-9798
<http://www.ipc.org/index.html>

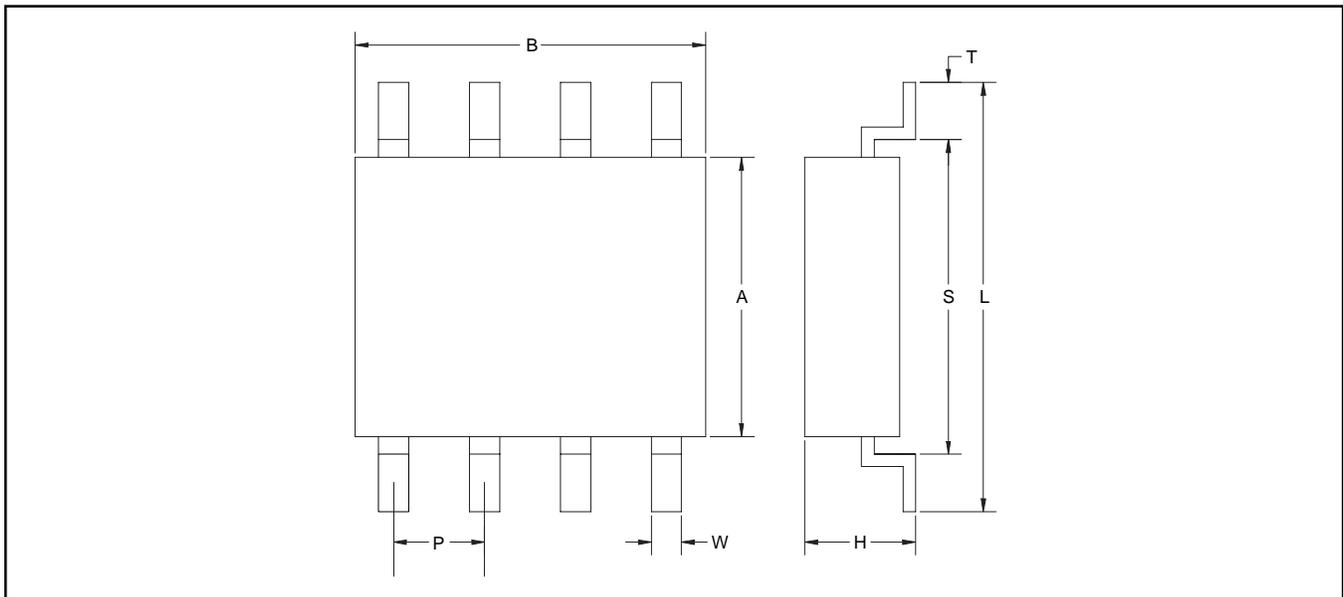


FIGURE 3. Package Dimensions.

PACKAGE	PKG #	L MIN	L MAX	W MIN	W MAX	T MIN	T MAX	A MIN	A MAX	B MIN	B MAX	H MIN	H MAX	P NOM	LEAD COUNT
SO-8	182	0.228	0.244	0.013	0.020	0.016	0.050	0.150	0.157	0.189	0.196	0.053	0.069	0.0500	8
SO-14	235	0.228	0.244	0.013	0.020	0.016	0.050	0.150	0.157	0.337	0.344	0.053	0.069	0.0500	14
SO-16	265	0.228	0.244	0.013	0.020	0.016	0.050	0.150	0.157	0.386	0.394	0.053	0.069	0.0500	16
SO-16W	211	0.394	0.419	0.013	0.020	0.016	0.050	0.291	0.299	0.398	0.413	0.093	0.104	0.0500	16
SO-18	219	0.394	0.419	0.013	0.020	0.016	0.050	0.291	0.299	0.447	0.463	0.093	0.104	0.0500	18
SO-20	221	0.394	0.419	0.013	0.020	0.016	0.050	0.291	0.299	0.496	0.512	0.093	0.104	0.0500	20
SO-24	239	0.394	0.419	0.013	0.020	0.016	0.050	0.291	0.299	0.598	0.614	0.093	0.104	0.0500	24
SO-28	217	0.398	0.419	0.013	0.020	0.020	0.040	0.291	0.299	0.697	0.713	0.093	0.104	0.0500	28
SOT-23-5	331	0.102	0.118	0.010	0.020	0.014	0.022	0.059	0.069	0.110	0.118	0.035	0.057	0.0374	5
SOT-23-6	332	0.102	0.118	0.010	0.020	0.014	0.022	0.059	0.069	0.110	0.118	0.035	0.057	0.0374	6
SOT-23-8	348	0.102	0.118	0.011	0.018	0.004	0.024	0.059	0.069	0.110	0.118	0.035	0.057	0.0256	8
MSOP-8	337	0.189	0.197	0.011	0.015	0.018	0.026	0.114	0.122	0.114	0.122	0.032	0.048	0.0256	8
SSOP-20	334	0.291	0.323	0.009	0.015	0.022	0.037	0.197	0.220	0.272	0.295	0.077	0.079	0.0256	20
SSOP-24	338	0.291	0.323	0.009	0.015	0.022	0.037	0.197	0.220	0.311	0.335	0.077	0.079	0.0256	24
SSOP-28	324	0.291	0.323	0.009	0.015	0.022	0.037	0.197	0.220	0.390	0.413	0.077	0.079	0.0256	28
SSOP-16	322	0.228	0.244	0.008	0.012	0.016	0.050	0.149	0.157	0.188	0.197	0.053	0.069	0.0250	16
SSOP-48	333	0.395	0.420	0.008	0.013	0.020	0.040	0.291	0.299	0.613	0.630	0.053	0.069	0.0250	48
SSOP-56	346	0.395	0.420	0.008	0.013	0.020	0.040	0.291	0.299	0.720	0.730	0.095	0.110	0.0250	56

TABLE II . Package Dimensions—Inches.

PACKAGE	PKG #	L MIN	L MAX	W MIN	W MAX	T MIN	T MAX	A MIN	A MAX	B MIN	B MAX	H MIN	H MAX	P NOM	LEAD COUNT
SO-8	182	5.79	6.20	0.33	0.51	0.41	1.27	3.81	3.99	4.80	4.98	1.35	1.75	1.270	8
SO-14	235	5.79	6.20	0.33	0.51	0.41	1.27	3.81	3.99	8.56	8.74	1.35	1.75	1.270	14
SO-16	265	5.79	6.20	0.33	0.51	0.41	1.27	3.81	3.99	9.80	10.01	1.35	1.75	1.270	16
SO-16W	211	10.01	10.64	0.33	0.51	0.41	1.27	7.39	7.59	10.11	10.49	2.36	2.64	1.270	16
SO-18	219	10.01	10.64	0.33	0.51	0.41	1.27	7.39	7.59	11.35	11.76	2.36	2.64	1.270	18
SO-20	221	10.01	10.64	0.33	0.51	0.41	1.27	7.39	7.59	12.60	13.00	2.36	2.64	1.270	20
SO-24	239	10.01	10.64	0.33	0.51	0.41	1.27	7.39	7.59	15.19	15.60	2.36	2.64	1.270	24
SO-28	217	10.11	10.64	0.33	0.51	0.51	1.02	7.39	7.59	17.70	18.11	2.36	2.64	1.270	28
SOT-23-5	331	2.59	3.00	0.25	0.51	0.36	0.56	1.50	1.75	2.79	3.00	0.89	1.45	0.950	5
SOT-23-6	332	2.59	3.00	0.25	0.51	0.36	0.56	1.50	1.75	2.79	3.00	0.89	1.45	0.950	6
SOT-23-8	348	2.60	3.00	0.28	0.46	0.10	0.61	1.50	1.75	2.80	3.00	0.90	1.45	0.650	8
MSOP-8	337	4.80	5.00	0.28	0.38	0.46	0.66	2.90	3.10	2.90	3.10	0.81	1.22	0.650	8
SSOP-20	334	7.39	8.20	0.23	0.38	0.56	0.94	5.00	5.59	6.91	7.49	1.96	2.01	0.650	20
SSOP-24	338	7.39	8.20	0.23	0.38	0.56	0.94	5.00	5.59	7.90	8.51	1.96	2.01	0.650	24
SSOP-28	324	7.39	8.20	0.23	0.38	0.56	0.94	5.00	5.59	9.91	10.49	1.96	2.01	0.650	28
SSOP-16	322	5.79	6.20	0.20	0.30	0.41	1.27	3.78	3.99	4.78	5.00	1.35	1.75	0.635	16
SSOP-48	333	10.03	10.67	0.20	0.33	0.51	1.02	7.39	7.59	15.57	16.00	1.35	1.75	0.635	48
SSOP-56	346	10.03	10.67	0.20	0.33	0.51	1.02	7.39	7.59	18.29	18.54	2.41	2.79	0.635	56

TABLE III. Package Dimensions—Millimeters.

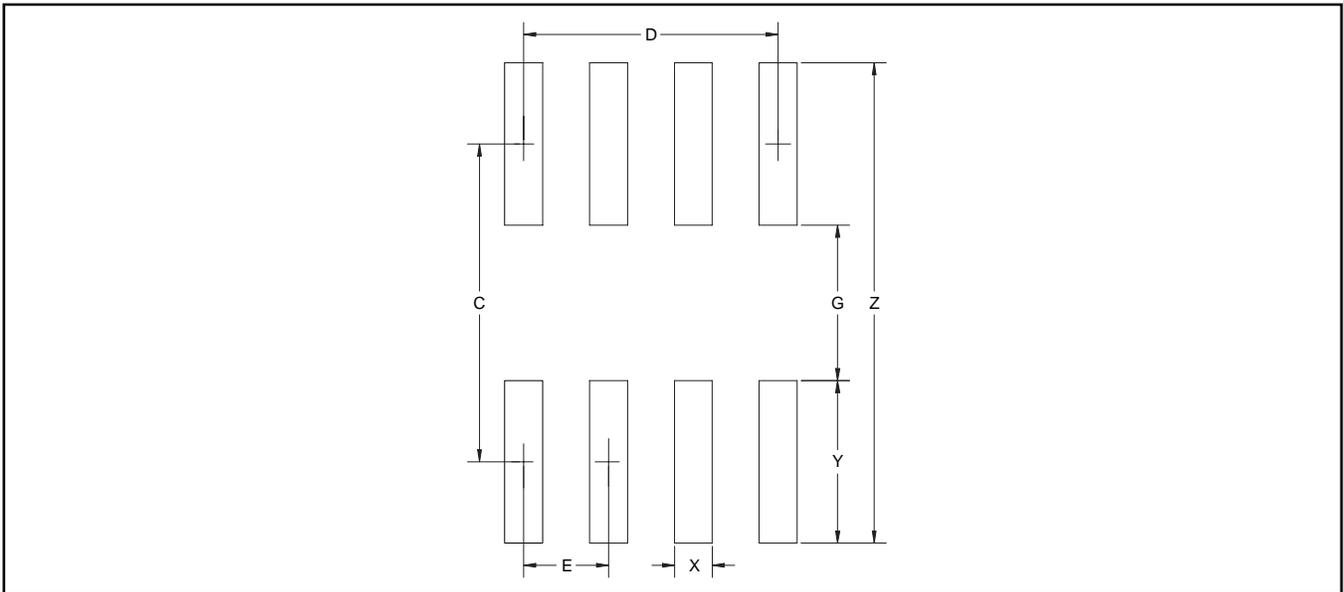


FIGURE 4. Pad Dimensions.

PACKAGE	PKG #	Z MIN	Z MAX	G MIN	G MAX	X MIN	X MAX	Y REF	C/C REF	D REF	E NOM
SO-8	182	0.273	0.277	0.089	0.093	0.018	0.022	0.094	0.183	0.150	0.0500
SO-14	235	0.273	0.277	0.089	0.093	0.018	0.022	0.094	0.183	0.300	0.0500
SO-16	265	0.273	0.277	0.089	0.093	0.018	0.022	0.094	0.183	0.350	0.0500
SO-16W	211	0.447	0.451	0.254	0.258	0.018	0.022	0.099	0.353	0.350	0.0500
SO-18W	219	0.447	0.451	0.254	0.258	0.018	0.022	0.099	0.353	0.400	0.0500
SO-20W	221	0.447	0.451	0.254	0.258	0.018	0.022	0.099	0.353	0.450	0.0500
SO-24W	239	0.447	0.451	0.254	0.258	0.018	0.022	0.099	0.353	0.550	0.0500
SO-28W	217	0.448	0.451	0.278	0.282	0.018	0.022	0.099	0.365	0.650	0.0500
SOT-23-5	331	0.147	0.151	0.034	0.038	0.017	0.021	0.058	0.093	0.075	0.0374
SOT-23-6	332	0.147	0.151	0.034	0.038	0.017	0.021	0.058	0.093	0.075	0.0374
SOT-23-8	348	0.147	0.151	0.015	0.019	0.016	0.020	0.068	0.083	0.077	0.0256
MSOP-8	337	0.226	0.230	0.097	0.101	0.014	0.018	0.066	0.164	0.077	0.0256
SSOP-20	334	0.351	0.355	0.177	0.181	0.013	0.017	0.089	0.266	0.230	0.0256
SSOP-24	338	0.351	0.355	0.177	0.181	0.013	0.017	0.089	0.266	0.281	0.0256
SSOP-28	324	0.351	0.355	0.177	0.181	0.013	0.017	0.089	0.266	0.333	0.0256
SSOP-16	322	0.273	0.277	0.089	0.093	0.011	0.015	0.094	0.183	0.175	0.0250
SSOP-48	333	0.448	0.452	0.275	0.279	0.012	0.016	0.089	0.364	0.575	0.0250
SSOP-56	346	0.448	0.452	0.275	0.279	0.012	0.016	0.089	0.364	0.675	0.0250

TABLE IV. Pad Dimensions—Inches.

PACKAGE	PKG #	Z MIN	Z MAX	G MIN	G MAX	X MIN	X MAX	Y REF	C/C REF	D REF	E NOM
SO-8	182	6.934	7.036	2.261	2.362	0.457	0.559	2.388	4.648	3.810	1.270
SO-14	235	6.934	7.036	2.261	2.362	0.457	0.559	2.388	4.648	7.620	1.270
SO-16	265	6.934	7.036	2.261	2.362	0.457	0.559	2.388	4.648	8.890	1.270
SO-16W	211	11.354	11.455	6.452	6.553	0.457	0.559	2.515	8.966	8.890	1.270
SO-18W	219	11.354	11.455	6.452	6.553	0.457	0.559	2.515	8.966	10.160	1.270
SO-20W	221	11.354	11.455	6.452	6.553	0.457	0.559	2.515	8.966	11.430	1.270
SO-24W	239	11.354	11.455	6.452	6.553	0.457	0.559	2.515	8.966	13.970	1.270
SO-28W	217	11.379	11.468	7.061	7.163	0.457	0.559	2.515	9.271	16.510	1.270
SOT-23-5	331	3.734	3.835	0.864	0.965	0.432	0.533	1.473	2.362	1.905	0.950
SOT-23-6	332	3.734	3.835	0.864	0.965	0.432	0.533	1.473	2.362	1.905	0.950
SOT-23-8	348	3.734	3.835	0.381	0.483	0.406	0.508	1.727	2.108	1.950	0.650
MSOP-8	337	5.740	5.842	2.464	2.565	0.356	0.457	1.676	4.166	1.950	0.650
SSOP-20	334	8.915	9.017	4.496	4.597	0.330	0.432	2.261	6.756	5.842	0.650
SSOP-24	338	8.915	9.017	4.496	4.597	0.330	0.432	2.261	6.756	7.137	0.650
SSOP-28	324	8.915	9.017	4.496	4.597	0.330	0.432	2.261	6.756	8.458	0.650
SSOP-16	322	6.934	7.036	2.261	2.362	0.279	0.373	2.388	4.648	4.445	0.635
SSOP-48	333	11.379	11.481	6.985	7.087	0.305	0.406	2.261	9.246	14.605	0.635
SSOP-56	346	11.379	11.481	6.985	7.087	0.305	0.406	2.261	9.246	17.145	0.635

TABLE V . Pad Dimensions—Millimeters.

SOT223

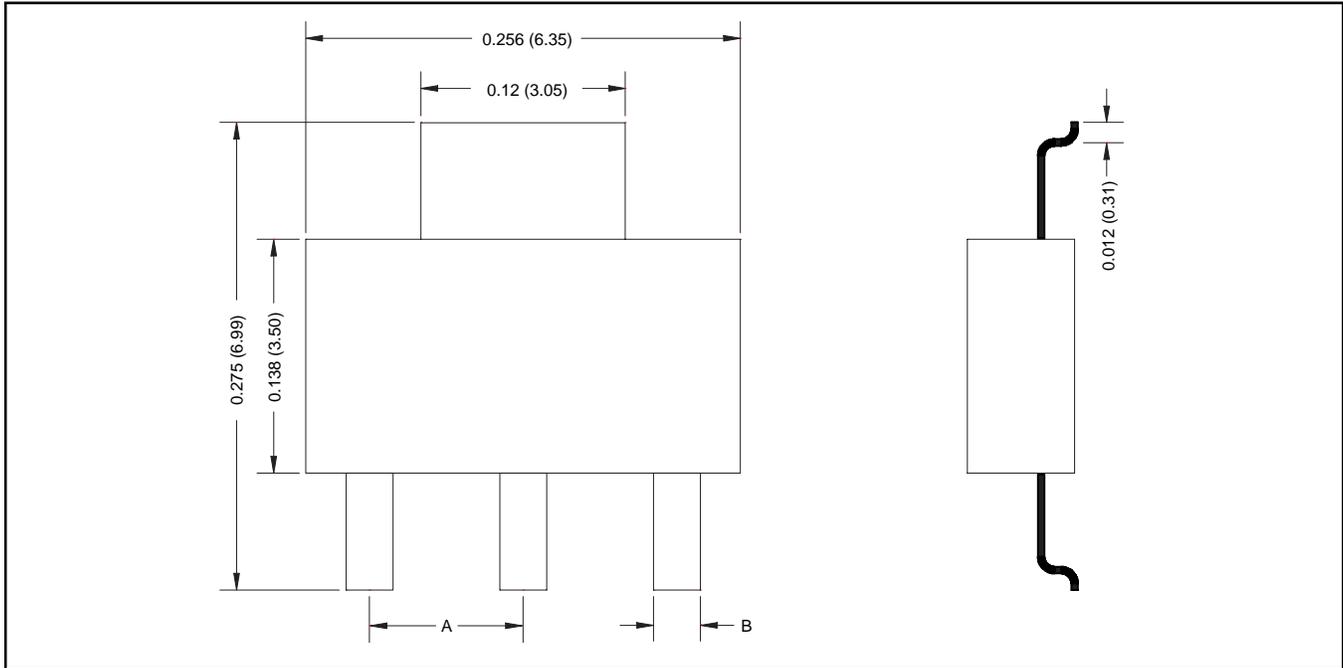


FIGURE 5. SOT223 Package Dimensions—Inches (mm).

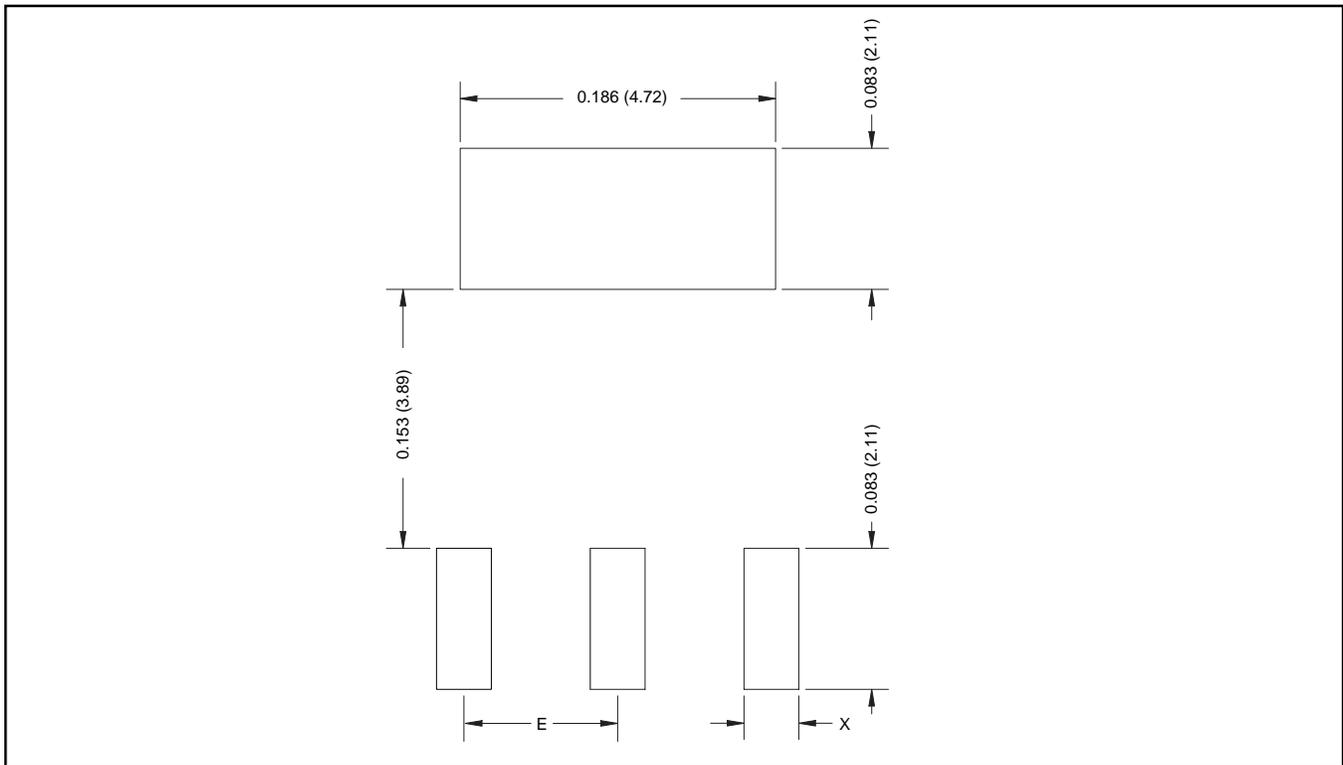


FIGURE 6. PCB Pad Dimensions for SOT223—Inches (mm).

# OF LEADS	PKG DESIGNATOR	A AND E FIGURES 5 AND 6	B FIGURE 5	X FIGURE 6
3	DCY	0.0905 (2.30)	0.03 (0.76)	0.032 (0.81)
5	DCQ	0.05 (1.27)	0.017 (0.43)	0.020 (0.51)

NOTE: Pad sizes are the minimum recommended and may be increased for improved heat dissipation.

TABLE VI. Dimensions for SOT-223—Inches (mm).

DDPAK DEVICES

The three DDPAK surface-mount power package types all have the same body dimensions. They differ only in the

number of leads and their associated lead dimensions. These values are given in Table VIII.

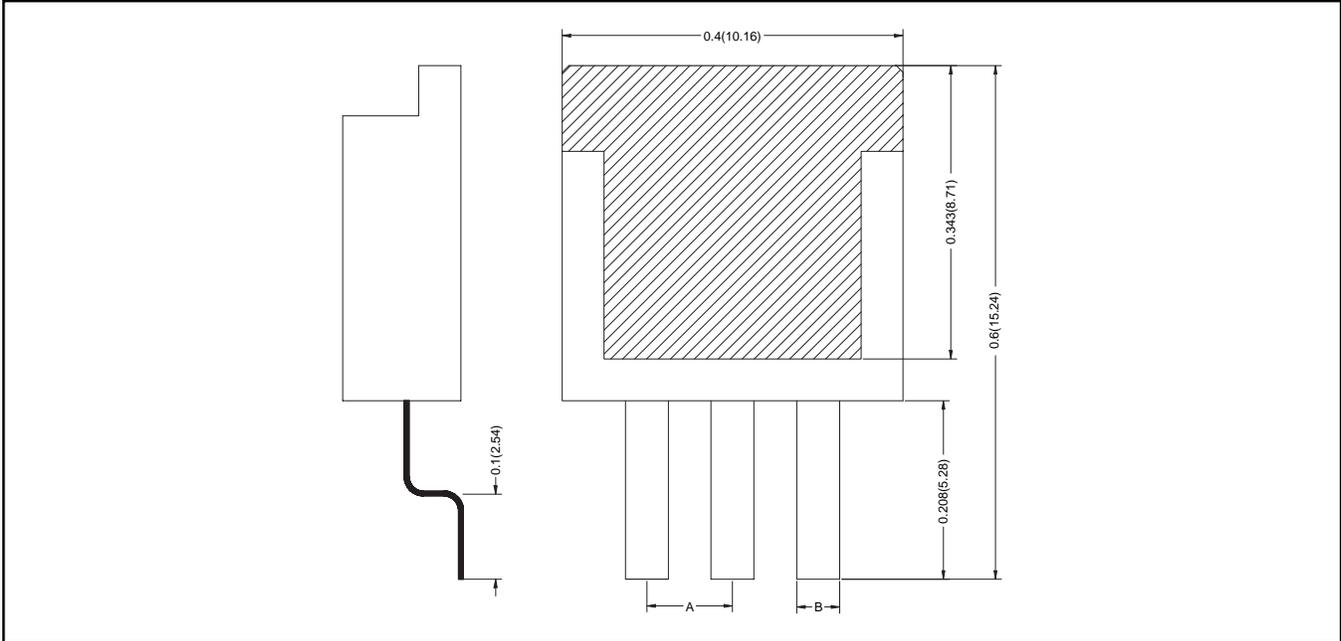


FIGURE 7. DDPAK Package Dimensions—Inches (mm).

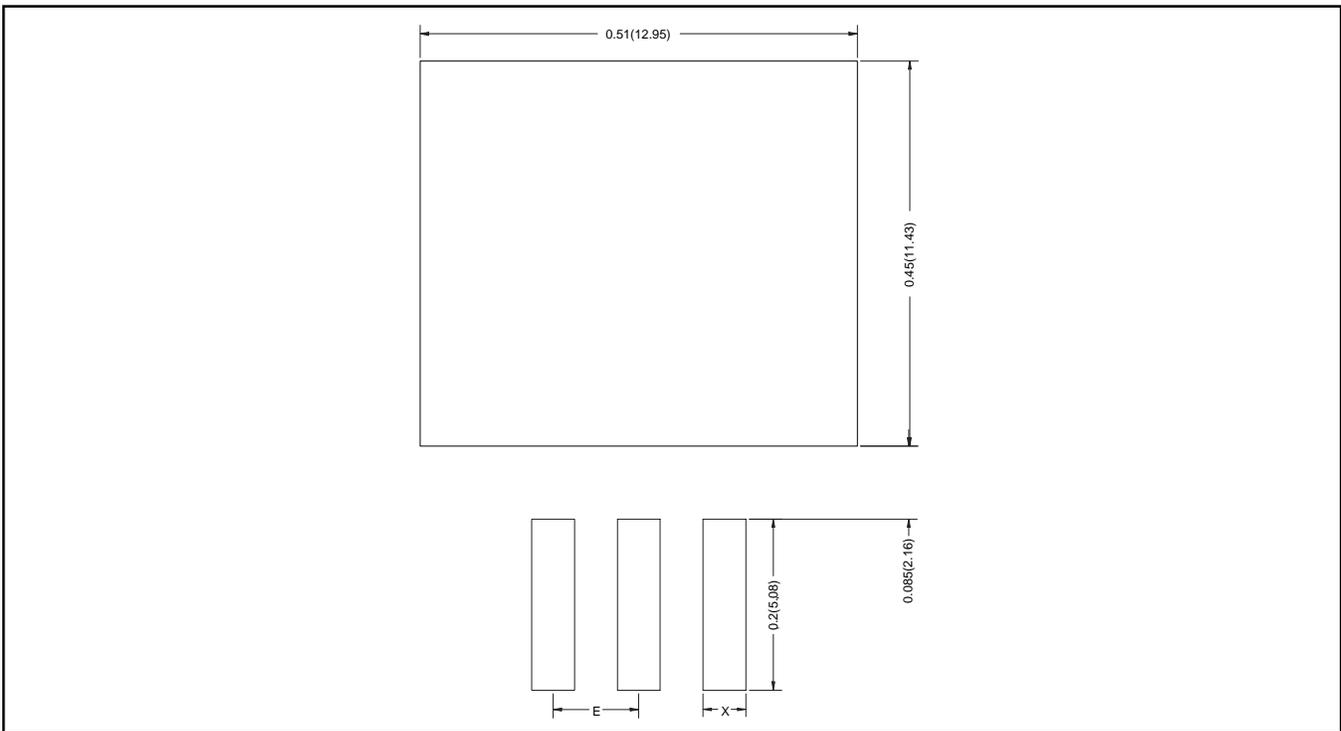


FIGURE 8. PCB Pad Dimensions for DDPAK—inches (mm).

# OF LEADS	PKG DESIGNATOR	A AND E FIGURES 5 AND 6	B FIGURE 5	X FIGURE 6
3	KTT	0.10 (2.54)	0.05 (1.27)	0.055 (1.35)
5	KTT	0.067 (1.70)	0.032 (0.81)	0.038 (0.97)
7	KTT	0.05 (1.27)	0.028 (0.71)	0.035 (0.89)

NOTE: Pad sizes are the minimum recommended and may be increased for improved heat dissipation.

TABLE VII. Dimensions for DDPAK—Inches (mm).

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