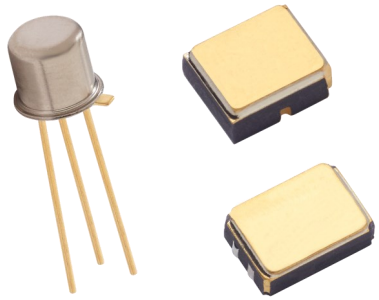
2N2369A, 2N3227, 2N4449

NPN Silicon, High-Speed Switching Transistors

Rev. V1

Features

- JAN, JANTX, JANTXV, JANS and JANSR Qualified to MIL-PRF-19500/317
- For Use in Military and High Reliability Applications
- TO-18 (TO-206AA), TO-46 (TO-206AB) and Surface Mount U, UA, and UB and Package Styles (See Mechanical Outlines for Specific Part/Package Availability)



Electrical Characteristics (+25°C unless otherwise specified)

Parameter	Test Conditions	Symbol	Units	Min.	Max.
Collector - Base Cutoff Current	V_{CB} = 40 V dc	I_{CBO1}	µA dc	—	10
Emitter - Base Cutoff Current	V_{EB} = 4.5 V dc 2N2369A, 2N4449 V_{EB} = 6.0 V dc 2N3227	I_{EBO1}	µA dc	—	10
Breakdown Voltage Collector - Emitter	I_C = 10 mA dc 2N2369A, 2N4449 2N3227	$V_{(BR)CEO}$	V dc	—	 15 20
Collector - Emitter Cutoff Current	V_{CE} = 20 Vdc	I_{CES}	µA dc	—	0.4
Collector - Base Cutoff Current	V_{CB} = 32 V dc	I_{CBO2}	µA dc	—	0.2
Emitter - Base Cutoff Current	V_{EB} = 4 V dc	I_{EBO2}	µA dc	—	0.25
Forward Current Transfer Ratio	V_{CE} = 0.35 V dc; I_C = 10 mA dc 2N2369A, 2N4449 2N3227	h_{FE1}	-	 40 70	 120 250
Forward Current Transfer Ratio	V_{CE} = 0.4 V dc; I_C = 30 mA dc 2N2369A, 2N4449 2N3227	h_{FE2}	-	 30 40	 120 250
Forward Current Transfer Ratio	V_{CE} = 1.0 V dc; I_C = 10 mA dc 2N2369A, 2N4449 2N3227	h_{FE3}	-	 40 75	 120 300
Forward Current Transfer Ratio	V_{CE} = 1.0 V dc; I_C = 100 mA dc 2N2369A, 2N4449 2N3227	h_{FE4}	-	 20 30	 120 150

Electrical Characteristics (+25°C unless otherwise specified)

Parameter	Test Conditions	Symbol	Units	Min.	Max.
Collector - Emitter Saturation Voltage	I_C = 10 mA dc; I_B = 1.0 mA dc	$V_{CE(sat)1}$	V dc	—	0.20
Collector - Emitter Saturation Voltage	I_C = 30 mA dc; I_B = 3.0 mA dc	$V_{CE(sat)2}$	V dc	—	0.25
Collector - Emitter Saturation Voltage	I_C = 100 mA dc; I_B = 10 mA dc	$V_{CE(sat)3}$	V dc	—	0.45
Base - Emitter Saturation Voltage	I_C = 10 mA dc; I_B = 1.0 mA dc	$V_{BE(sat)1}$	V dc	0.70	0.85
Base - Emitter Saturation Voltage	I_C = 30 mA dc; I_B = 3.0 mA dc	$V_{BE(sat)2}$	V dc	—	0.90
Base - Emitter Saturation Voltage	I_C = 100 mA dc; I_B = 10 mA dc	$V_{BE(sat)3}$	V dc	0.8	1.20
Collector - Base Cutoff Current	T_A = +150°C; V_{CB} = 20 V dc	I_{CBO2}	µA dc	—	30
Collector - Emitter Cutoff Current	T_A = +125°C V_{CE} = 10 V dc; V_{BE} = 0.25 V dc	I_{CEX2}	µA dc	—	30
Collector - Emitter Voltage Saturated	T_A = +125°C I_C = 10 mA dc; I_B = 1.0 mA dc	$V_{CE(sat)4}$	V dc	—	0.3
Base - Emitter Saturated Voltage	T_A = +125°C I_C = 10 mA dc; I_B = 1.0 mA dc 2N2369A, 2N4449 2N3227	$V_{BE(sat)4}$	V dc	 0.59 0.50	—
Forward Current Transfer Ratio	T_A = -55°C V_{CE} = 1.0 V dc; I_C = 10 mA dc 2N2369A, 2N4449 2N3227	h_{FE5}	-	 20 40	
Base - Emitter Saturated Voltage	T_A = -55°C I_C = 10 mA dc; I_B = 1.0 mA dc	$V_{BE(sat)5}$	V dc	—	1.02

Electrical Characteristics (+25°C unless otherwise specified)

Parameter	Test Conditions	Symbol	Units	Min.	Max.
Magnitude of Small-Signal Short-Circuit Forward Current Transfer Ratio	V_{CE} = 10 V dc; I_C = 10 mA dc; f = 100 MHz	$\lvert h_{FE} \rvert$		5.0	10
Open Circuit Output Capacitance	V_{CB} = 5 V dc; I_E = 0; 100 kHz≤f≤1 Mhz	C_{obo}	pF	—	4.0
Input Capacitance (Output Open-Circuited)	V_{EB} = 0.5 V dc; I_C = 0; 100 kHz≤f≤1 Mhz 2N2369A, 2N4449 2N3227	C_{ibo}	pF	—	5.0 4.0
Charge Storage Time	I_C = 10 mA dc; I_{B1} = 10 mA dc; I_{B2} = 10 mA dc 2N2369A, 2N4449 2N3227	t_s	ns	—	13 18
Turn-On Time	I_C = 10 mA dc; I_{B1} = 3.0 mA dc; I_{B2} = -1.5 mA dc	t_{on}	ns	—	12
Turn-Off Time	I_C = 10 mA dc; I_{B1} = 3.0 mA dc; I_{B2} = -1.5 mA dc 2N2369A, 2N4449 2N3227	t_{off}	ns	—	18 25

Absolute Maximum Ratings (+25°C unless otherwise specified)

Ratings	Symbol	Value
Collector - Emitter Voltage 2N2369A, UA, UB 2N4449, UA, UB 2N3227, UA, UB 2N2369AU 2N4449U 2N3227U	V_{CEO}	 15 V dc 15 V dc 20 V dc 15 V dc 15 V dc 20 V dc
Collector - Base Voltage (All types)	V_{CBO}	40 Vdc
Emitter - Base Voltage 2N2369A, UA, UB 2N4449, UA, UB 2N3227, UA, UB 2N2369AU 2N4449U 2N3227U	V_{EBO}	 4.5 V dc 4.5 V dc 6.0 V dc 4.5 V dc 4.5 V dc 6.0 V dc
Collector - Emitter Voltage (All types)	V_{CES}	40 Vdc
Operating & Storage Temperature Range	T_J, T_{STG}	-65°C to +200°C

Thermal Characteristics

Types	Symbol	Max. Value
Thermal Resistance, Junction to Case 2N2369A 2N4449 2N3227	$R_{\theta JC}$	 150°C/W 150°C/W 150°C/W
Thermal Resistance, Junction to Solder Pad 2N2369AUA, UB 2N4449UA, UB 2N3227UA, UB 2N2369AU 2N4449U 2N3227U	$R_{\theta JSP}$	 210°C/W 210°C/W 210°C/W 290°C/W (7) 290°C/W (7) 290°C/W (7)
Thermal Resistance, Junction to Ambient 2N2369A 2N4449 2N3227 2N2369AUA, UB 2N4449UA, UB 2N3227UA, UB 2N2369AU 2N4449U 2N3227U	$R_{\theta JA}$	 400°C/W 400°C/W 400°C/W 486°C/W 486°C/W 486°C/W 350°C/W (6) 350°C/W (6) 350°C/W (6)

NPN Silicon, High-Speed Switching Transistors

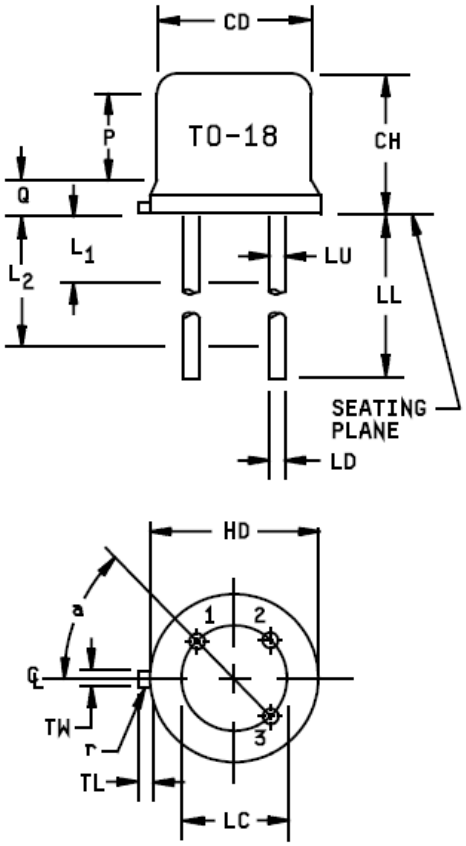
Rev. V1

Types	Symbol	Max. Value
Power Dissipation T_A = +25°C		
2N2369AUA, UB	P_T	0.36 W (2)
2N4449UA, UB		0.36 W (2
2N3227UA, UB		0.36 W (2
2N2369AU		0.5 W (5)
2N4449U		0.5 W (5)
2N3227U		0.5 W (5)
Power Dissipation T_C = +125°C		
2N2369AUA, UB	P_T	0.36 W (3) (4)
2N4449UA, UB		0.36 W (3) (4)
2N3227UA, UB		0.36 W (3) (4)
Power Dissipation T_{SP} = +125°C (1)		
2N2369AUA, UB	P_T	0.36 W (3)
2N4449UA, UB		0.36 W (3)
2N3227UA, UB		0.36 W (3)

(1) Applicable for UA, UB, and U packages.
(2) For TO-18 and TO-46 packages derate linearly 2.06 mW/°C above T_A = +25°C.
(3) Derate linearly 4.8 mW/°C above T_C = +125°C. See figures 8, 9, 10, 11 and 12 of MIL-PRF-19500/317
(4) Power dissipation limited to 360 mW per chip regardless of thermal resistance.
(5) For UA and UB, packages mounted on FR-4 PCB (1 Oz. Cu) with contacts 20 mils larger than package pads. See figure 13 of MIL=PRF-19500/317.
(6) One side only, derate linearly 2.857 mW/°C above T_{SP} = +25°C.
(7) Derate linearly 3.44 mW/°C above T_A = +54.5°C. See figure 13 of MIL-PRF-19500/317.

Outline Drawing (TO-18)

Ltr.	Dimensions				Notes
	Inches		Millimeters		
	Min	Max	Min	Max	
CD	.178	.195	4.52	4.95	
CH	.170	.210	4.32	5.33	
HD	.209	.230	5.31	5.84	
LC	.100 TP		2.54 TP		6
LD	.016	.021	0.41	0.53	7,8
LL	.500	.750	12.70	19.05	7,8,13
LU	.016	.019	0.41	0.48	7,8
L_1		.050		1.27	7,8
L_2	.250		6.35		7,8
P	.100		2.54		5
Q		.030		0.76	5
TL	.028	.048	0.71	1.22	3,4
TW	.036	.046	0.91	1.17	3
r		.010		0.25	10
α	45° TP		45° TP		6



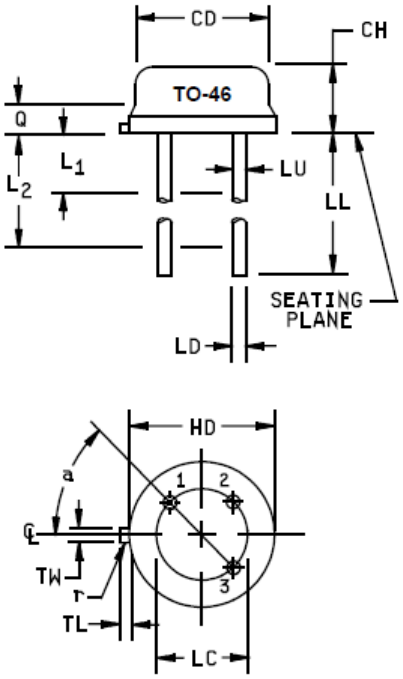
NOTES:

1. Dimension are in inches.
2. Millimeters are given for general information only.
3. Beyond r (radius) maximum, TH shall be held for a minimum length of .011 (0.28 mm).
4. Dimension TL measured from maximum HD.
5. Body contour optional within zone defined by HD, CD, and Q.
6. Leads at gauge plane .054 +.001 -.000 inch (1.37 +0.03 -0.00 mm) below seating plane shall be within .007 inch (0.18 mm) radius of true position (TP) at maximum material condition (MMC) relative to tab at MMC.
7. Dimension LU applies between L_1 and L_2. Dimension LD applies between L_2 and LL minimum. Diameter is uncontrolled in L_1 and beyond LL minimum.
8. All three leads.
9. The collector shall be internally connected to the case.
10. Dimension r (radius) applies to both inside corners of tab.
11. In accordance with ASME Y14.5M, diameters are equivalent to ϕx symbology.
12. Lead 1 = emitter, lead 2 = base, lead 3 = collector.

FIGURE 1. Physical dimensions TO-18 (2N2369A and 2N3227).

Outline Drawing (TO-46)

Ltr.	Dimensions				Notes
	Inches		Millimeters		
	Min	Max	Min	Max	
CD	.178	.195	4.52	4.95	
CH	.065	.085	1.65	2.16	
HD	.209	.230	5.31	5.84	
LC	.100 TP		2.54 TP		5
LD	.016	.021	0.41	0.53	
LL	.500	1.750	12.70	44.45	6
LU	.016	.019	0.41	0.48	6
L_1		.050		1.27	6
L_2	.250		6.35		6
Q		.040		1.02	3
TL	.028	.048	0.71	1.22	8
TW	.036	.046	0.91	1.17	4
r		.010		0.25	9
α	45° TP		45° TP		5

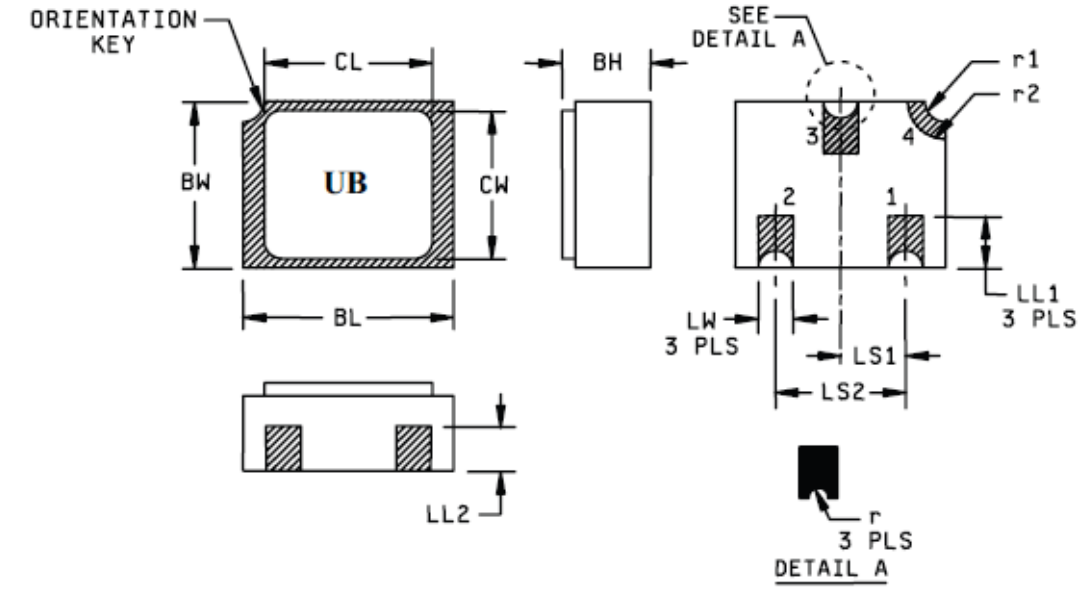


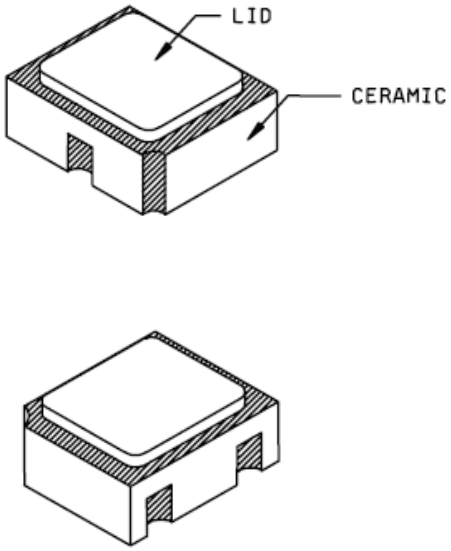
NOTES:

1. Dimensions are in inches.
2. Millimeters are given for general information only.
3. Symbol TL is measured from HD maximum.
4. Details of outline in this zone are optional.
5. Leads at gauge plane .054 inch (1.37 mm) +.001 inch (0.03 mm) -.000 inch (0.00 mm) below seating plane shall be within .007 inch (0.18 mm) radius of TP relative to tab. Device may be measured by direct methods or by gauge.
6. Symbol LU applies between L_1 and L_2. Dimension LD applies between L_2 and LL minimum.
7. Lead number three is electrically connected to case.
8. Beyond r maximum, TW shall be held for a minimum length of .011 inch (0.28 mm).
9. Symbol r applied to both inside corners of tab.
10. In accordance with ASME Y14.5M, diameters are equivalent to ϕx symbology.
11. Lead 1 is emitter, lead 2 is base, and lead 3 is collector.

FIGURE 2. Physical dimensions - TO-46 (2N4449).

Outline Drawing (UB)

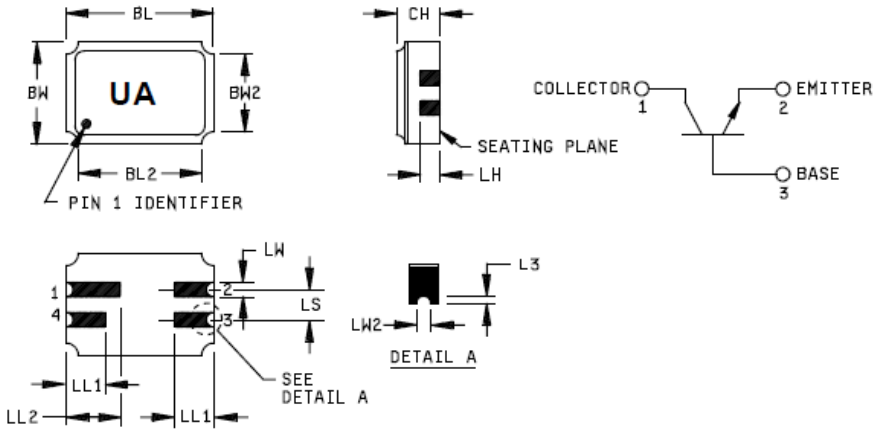




Symbol	Dimensions			
	Inches		Millimeters	
	Min.	Max.	Min.	Max.
BH	0.046	0.056	1.17	1.42
BL	0.115	0.128	2.92	3.25
BW	0.085	0.108	2.16	2.74
CL	—	0.128		3.25
CW		0.108		2.74
LL1	0.022	0.038	0.56	0.96
LL2	0.017	0.035	0.43	0.89
LS1	0.036	0.040	0.91	1.02
LS2	0.071	0.079	1.81	2.01
LW	0.016	0.024	0.41	0.61
r	—	0.008	—	0.203
r1	—	0.012	—	0.305
r2	—	0.022	—	0.559

Figure 3. Physical dimensions, surface mount (UB) for 2N2369A, 2N3227 and 2N2449

Outline Drawing (UA Surface Mount)



Ltr.	Dimensions			
	Inches		Millimeters	
	Min	Max	Min	Max
BL	.215	.225	5.46	5.71
BL2		.225		5.71
BW	.145	.155	3.68	3.93
BW_2		.155		3.93
CH	.061	.075	1.55	1.90
* L3	.003		0.08	
LH	.029	.042	0.74	1.07
LL_1	.032	.048	0.81	1.22
LL_2	.072	.088	1.83	2.23
LS	.045	.055	1.14	1.39
LW	.022	.028	0.56	0.71
LW2	.006	.022	0.15	0.56

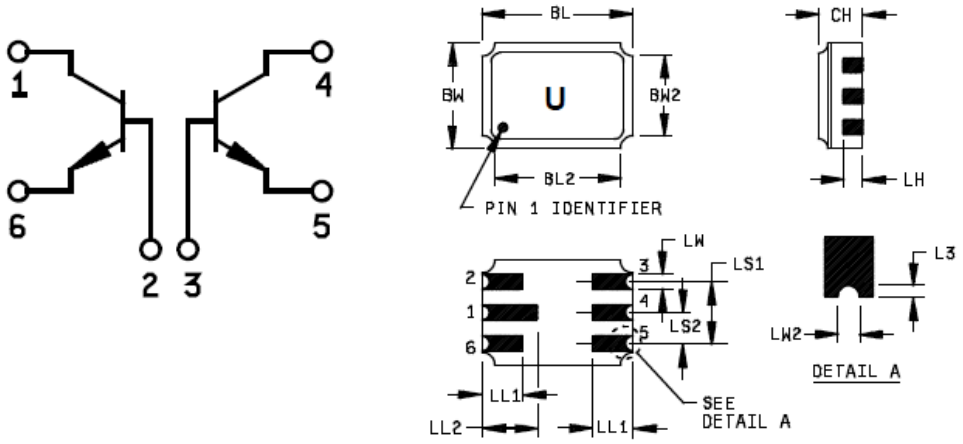
Pin number.	1	2	3	4
Transistor	Collector	Emitter	Base	N/C

NOTES:

1. Dimensions are in inches.
2. Millimeters are given for general information only.
3. Dimension CH controls the overall package thickness. When a window lid is used, dimension CH must increase by a minimum of .010 inch (0.254 mm) and a maximum of .040 inch (1.020 mm).
4. The corner shape (square, notch, radius) may vary at the manufacturer's option, from that shown on the drawing.
5. Dimensions LW2 minimum and L3 minimum and the appropriate castellation length define an unobstructed three-dimensional space traversing all of the ceramic layers in which a castellation was designed. (Castellations are required on the bottom two layers, optional on the top ceramic layer.) Dimension LW2 maximum define the maximum width of the castellation at any point on its surface. Measurement of these dimensions may be made prior to solder dipping.
6. The co-planarity deviation of all terminal contact points, as defined by the device seating plane, shall not exceed .006 inch (0.15mm) for solder dipped leadless chip carriers.
7. In accordance with ASME Y14.5M, diameters are equivalent to ϕx symbology.

* FIGURE 4. Physical dimensions - surface mount (UA version, 2N2369AUA, 2N3227UA, and 2N4449UA).

Outline Drawing (U)



Ltr.	Dimensions			
	Inches		Millimeters	
	Min	Max	Min	Max
BL	.240	.250	6.10	6.35
BL_2		.250		6.35
BW	.165	.175	4.19	4.44
BW_2		.175		4.44
CH	.066	.080	1.68	2.03
L_3	.003	.007	0.08	0.18
LH	.026	.039	0.66	0.99
LL_1	.060	.070	1.52	1.78
LL_2	.082	.098	2.08	2.49
LS_1	.095	.105	2.41	2.67
LS_2	.045	.055	1.14	1.39
LW	.022	.028	0.56	0.71
LW_2	.006	.022	0.15	0.56

Pin number	1	2	3	4	5	6
Transistor	Collector no. 1	Base no. 1	Base no. 2	Collector no. 2	Emitter no. 2	Emitter no. 1

NOTES:

1. Dimensions are in inches.
2. Millimeters are given for general information only.
3. Dimension CH controls the overall package thickness. When a window lid is used, dimension CH must increase by a minimum of .010 inch (0.254 mm) and a maximum of .040 inch (1.020 mm).
4. The corner shape (square, notch, radius) may vary at the manufacturer's option, from that shown on the drawing.
5. Dimensions LW2 minimum and L3 minimum and the appropriate castellation length define an unobstructed three-dimensional space traversing all of the ceramic layers in which a castellation was designed. (Castellations are required on the bottom two layers, optional on the top ceramic layer.) Dimension LW2 maximum and L3 maximum define the maximum width and depth of the castellation at any point on its surface. Measurement of these dimensions may be made prior to solder dipping.
6. The co-planarity deviation of all terminal contact points, as defined by the device seating plane, shall not exceed .006 inch (0.15mm) for solder dipped leadless chip carriers.
7. In accordance with ASME Y14.5M, diameters are equivalent to ϕx symbology.

* FIGURE 5. Physical dimensions - surface mount (dual transistors, U version only, 2N2369AU, 2N3227U, and 2N4449U).

Thermal Impedance Curves

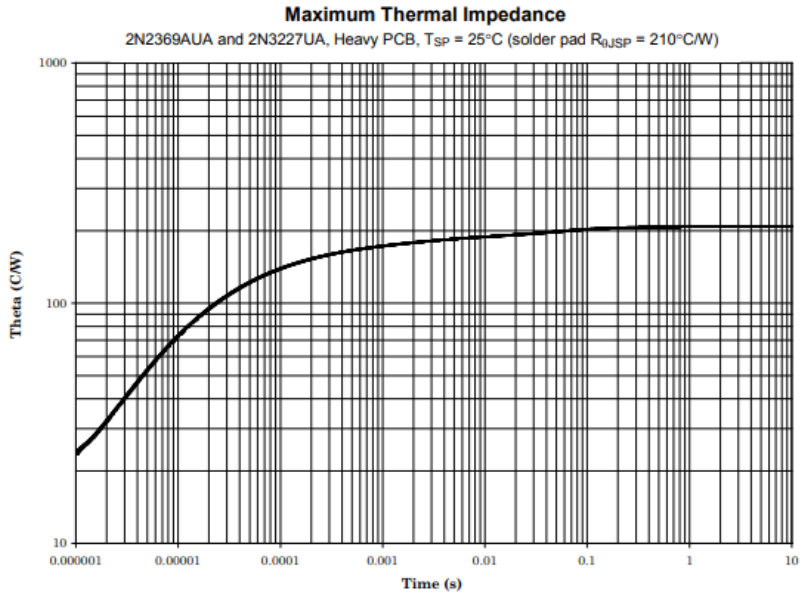


FIGURE 8. Thermal impedance graph ($R_{\theta JSP}$) for 2N2369AUA and 2N3227UA.

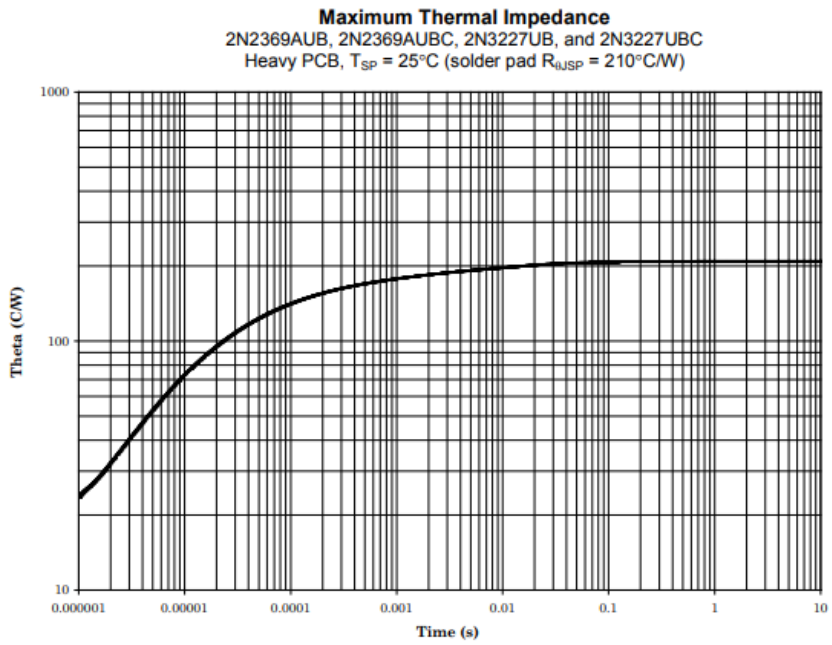


FIGURE 9. Thermal impedance graph ($R_{\theta JSP}$) for 2N2369AUB, 2N2369AUBC, 2N3227UB, and 2N3227UBC.

Thermal Impedance Curves

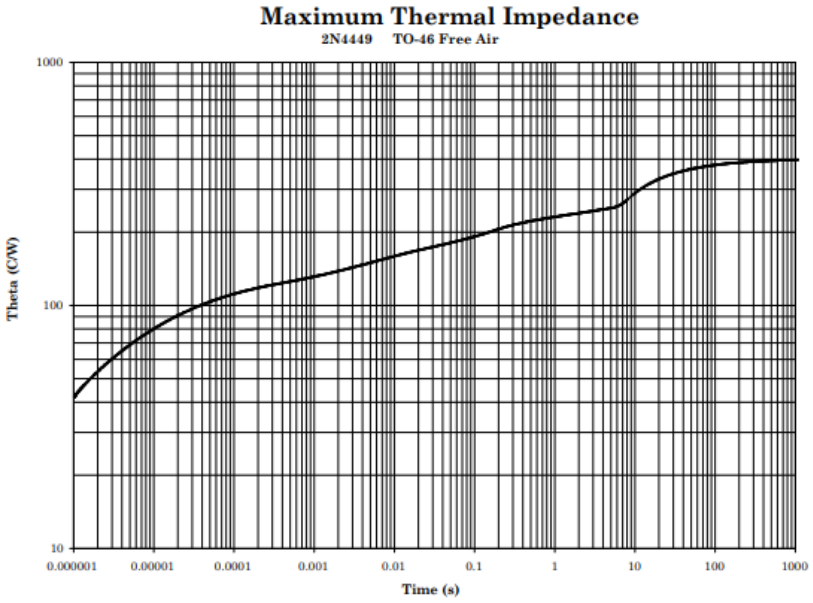


FIGURE 10. Thermal impedance graph TO-46 ($R_{\theta JA}$) for 2N4449.

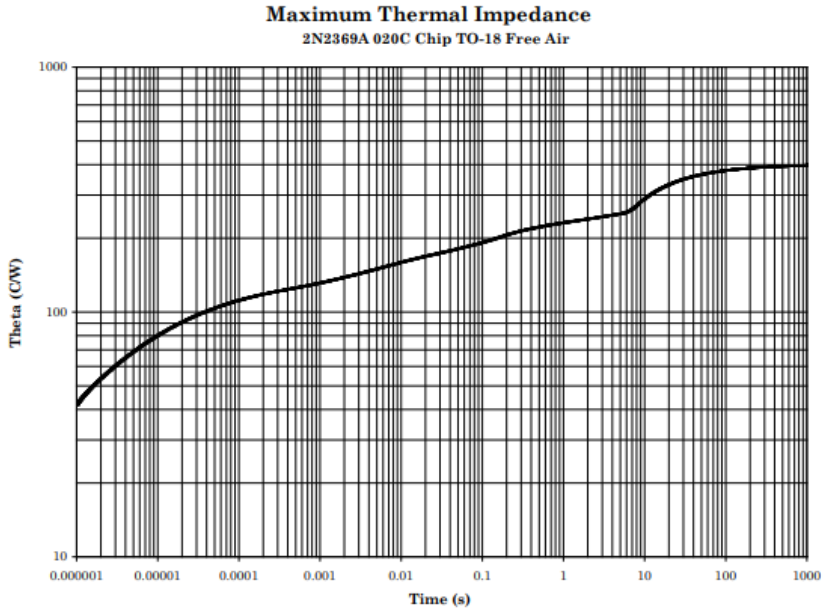


FIGURE 11. Thermal impedance graph (TO-18) ($R_{\theta JA}$) for 2N2369A and 2N3227.

Thermal Impedance Curves

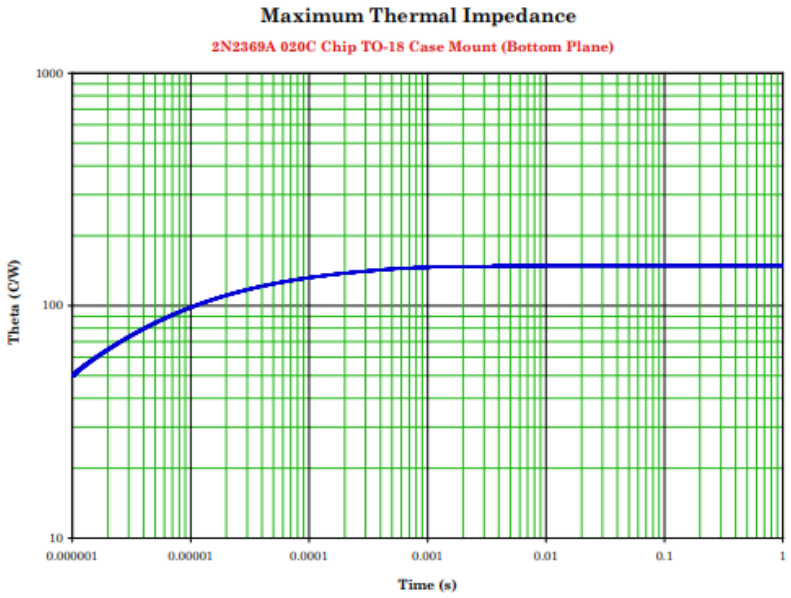


FIGURE 12. Thermal impedance graph (TO-18 TO-46) ($R_{\theta JC}$) for 2N2369A.

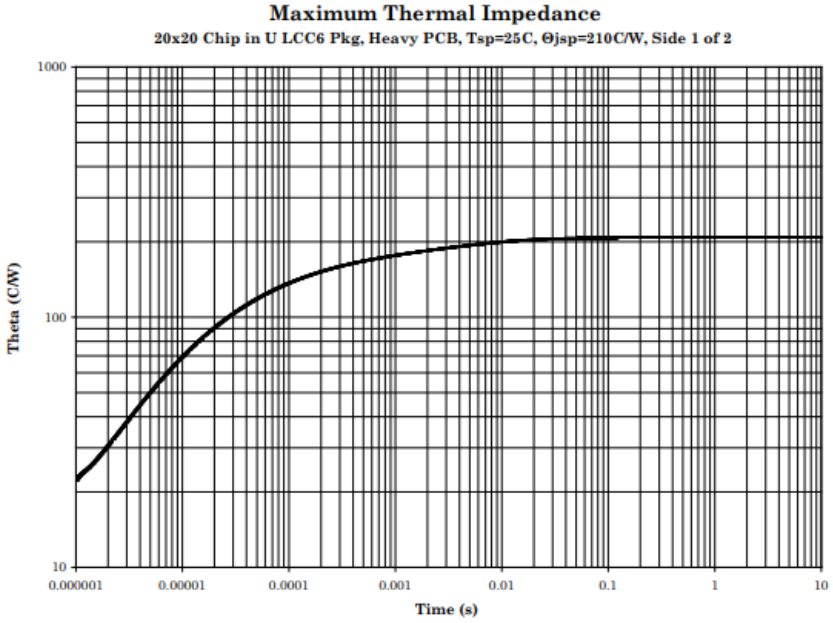


FIGURE 13. Thermal impedance graph ($R_{\theta JSP}$) for 2N2369AU and 2N3227U.