

Absolute Maximum Ratings

Absolute maximum ratings indicate sustained limits beyond which damage to the device may occur. All voltage parameters are referenced to Ground lead. (Tambient=25°C unless otherwise specified).

Symbol	Parameter	Min.	Max.	Units
Vds	Maximum drain to source voltage	-0.3	36	V
Vds cont.	Maximum continuous drain to source voltage	-	28	V
Vin	Maximum input voltage	-0.3	6	V
Isd cont.	Max. diode continuous current (limited by thermal dissipation)	—	4.5	A
Pd	Maximum power dissipation (internally limited by thermal protection)			
	Rth=5°C/W IPS1021	—	25	W
	Rth=40°C/W IPS1021S 1" sqr. footprint	—	3.1	
	Rth=50°C/W IPS1021R 1" sqr. footprint	—	2.5	
ESD	Electrostatic discharge voltage (Human body) C=100pF, R=1500Ω			
	Between drain and source	—	4	
	Other combinations	—	3	
	Electrostatic discharge voltage (Machine Model) C=200pF, R=0Ω			
	Between drain and source	—	0.5	
	Other combinations	—	0.3	
Tj max.	Max. storage & operating temperature junction temperature	-40	150	°C
Tsoldering	Lead soldering temperature (10 seconds)	—	300	°C

Thermal Characteristics

Symbol	Parameter	Typ.	Max.	Units
Rth1	Thermal resistance junction to ambient IPS1021 TO-220 free air	50	—	
Rth2	Thermal resistance junction to case IPS1021 TO-220	2.6	—	
Rth1	Thermal resistance junction to ambient IPS1021S D²Pak std. footprint	60	—	
Rth2	Thermal resistance junction to ambient IPS1021S D²Pak 1" sqr. footprint	40	—	
Rth3	Thermal resistance junction to case IPS1021S D²Pak	2.6	—	
Rth1	Thermal resistance junction to ambient IPS1021R D-Pak std. footprint	70	—	
Rth2	Thermal resistance junction to ambient IPS1021R D-Pak 1" sqr. footprint	50	—	
Rth3	Thermal resistance junction to case IPS1021R D-Pak	2.6	—	

Recommended Operating Conditions

These values are given for a quick design. For operation outside these conditions, please consult the application notes.

Symbol	Parameter	Min.	Max.	Units
VIH	High level input voltage	4.5	5.5	
VIL	Low level input voltage	0	0.5	
Ids	Continuous drain current, Tambient=85°C, Tj=125°C, Vin=5V			
	Rth=5°C/W IPS1021	—	13.5	A
	Rth=40°C/W IPS1021S 1" sqr. footprint	—	4.8	
	Rth=50°C/W IPS1021R 1" sqr. footprint	—	4.3	
Rin	Recommended resistor in series with IN pin to generate a diagnostic	0.5	10	kΩ
Max L	Max. recommended load inductance (including line inductance) (1)	—	20	μH
Max F	Max. frequency (switching losses = conduction losses)	—	500	Hz
Max t rise	Max. input rising time	—	1	μs

(1) Higher inductance is possible if maximum load current is limited - see figure 11

Static Electrical Characteristics

$T_j=25^{\circ}\text{C}$, $V_{cc}=14\text{V}$ (unless otherwise specified)

Symbol	Parameter	Min.	Typ.	Max.	Units	Test Conditions
Rds(on)	ON state resistance $T_j=25^{\circ}\text{C}$	—	20	25	m Ω	$V_{in}=5\text{V}$, $I_{ds}=8\text{A}$
	ON state resistance $T_j=150^{\circ}\text{C}$ (2)	—	38	48		
Idss1	Drain to source leakage current	—	0.1	10	μA	$V_{cc}=14\text{V}$, $T_j=25^{\circ}\text{C}$
Idss2	Drain to source leakage current	—	0.2	20		$V_{cc}=28\text{V}$, $T_j=25^{\circ}\text{C}$
V clamp1	Drain to source clamp voltage 1	36	39	—	V	$I_d=20\text{mA}$
V clamp2	Drain to source clamp voltage 2	—	40	42		$I_d=2\text{A}$
Vin clamp	IN to source pin clamp voltage	5.5	6.5	7.5		$I_{in}=1\text{mA}$
Vth	Input threshold voltage	—	1.7	—		$I_d=10\text{mA}$

Switching Electrical Characteristics

$V_{cc}=14\text{V}$, Resistive load= 1.5Ω , $R_{input}=0\Omega$, $V_{in}=5\text{V}$, $T_j=25^{\circ}\text{C}$

Symbol	Parameter	Min.	Typ.	Max.	Units	Test Conditions
Tdon	Turn-on delay time to 20%	10	30	100	μs	See figure 2
Tr	Rise time 20% to 80%	10	30	60		
Tdoff	Turn-off delay time to 80%	40	150	400		
Tf	Fall time 80% to 20%	15	30	60		
Eon + Eoff	Turn on and off energy	—	2	—	mJ	

Protection Characteristics

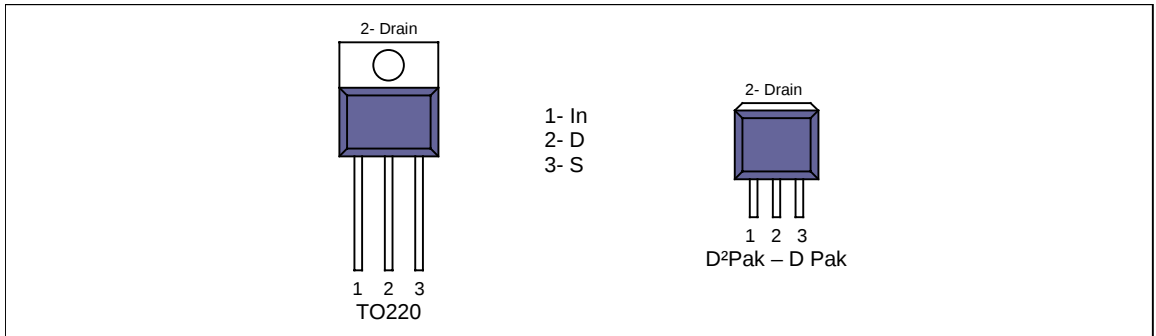
Symbol	Parameter	Min.	Typ.	Max.	Units	Test Conditions
Tsd	Over temperature threshold	150(2)	165	—	$^{\circ}\text{C}$	See figure 1
Isd	Over current threshold	32	45	58	A	See figure 1
OV	Over voltage protection (not active when the device is ON)	34	37	—	V	
Vreset	IN protection reset threshold	—	1.7	—	V	
Treset	Time to reset protection	15(2)	50	200	μs	$V_{in}=0\text{V}$

Diagnostic

Symbol	Parameter	Min.	Typ.	Max.	Units	Test Conditions
Iin, on	ON state IN positive current	15	32	70	μA	$V_{in}=5\text{V}$
Iin, off	OFF state IN positive current (after protection latched)	150	230	350		$V_{in}=5\text{V}$

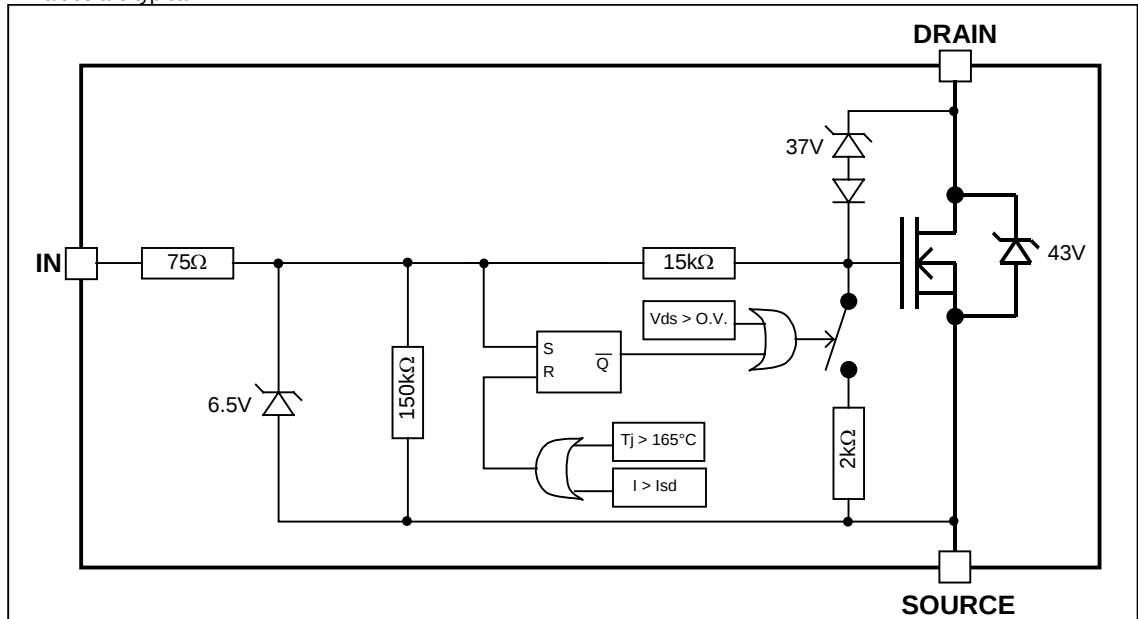
(2) Guaranteed by design

Lead Assignments



Functional Block Diagram

All values are typical



All curves are typical values. Operating in the shaded area is not recommended.

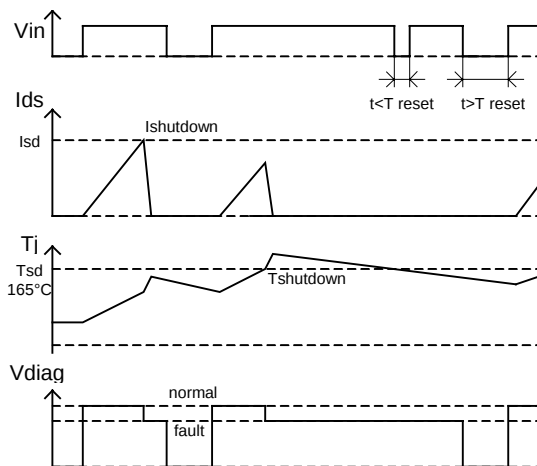


Figure 1 – Timing diagram

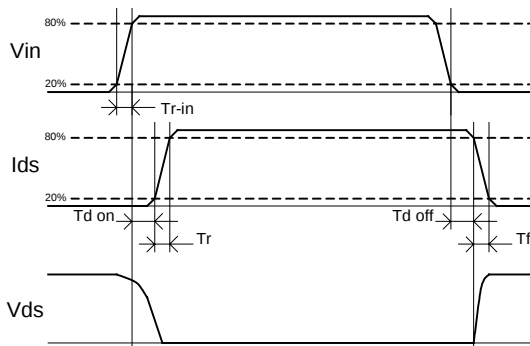


Figure 2 – IN rise time & switching definitions

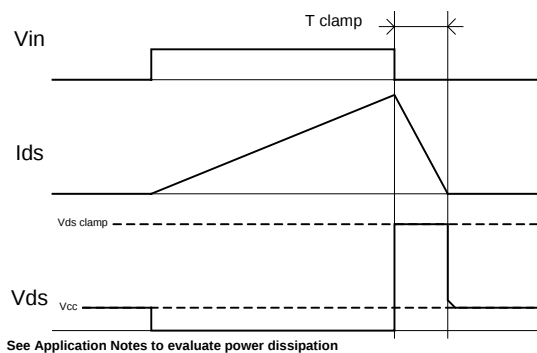


Figure 3 – Active clamp waveforms

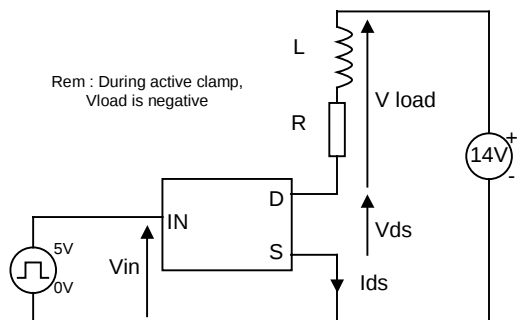


Figure 4 – Active clamp test circuit

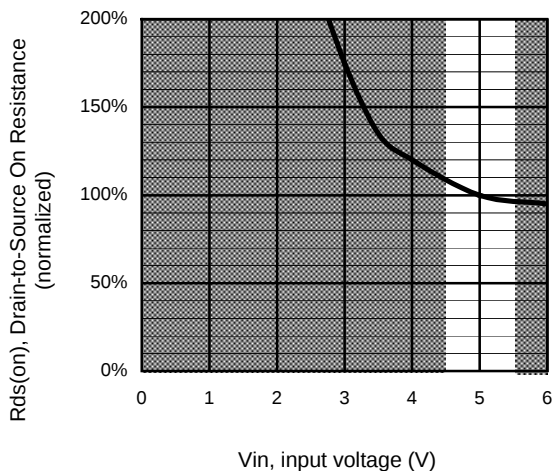


Figure 5 – Normalized $R_{ds(on)}$ (%) Vs Input voltage (V)

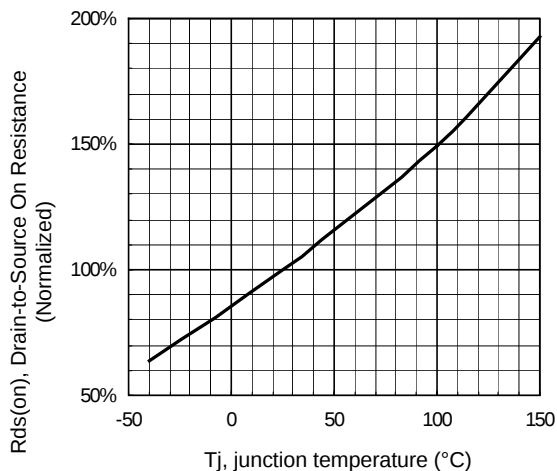


Figure 6 - Normalized $R_{ds(on)}$ (%) Vs T_j (°C)

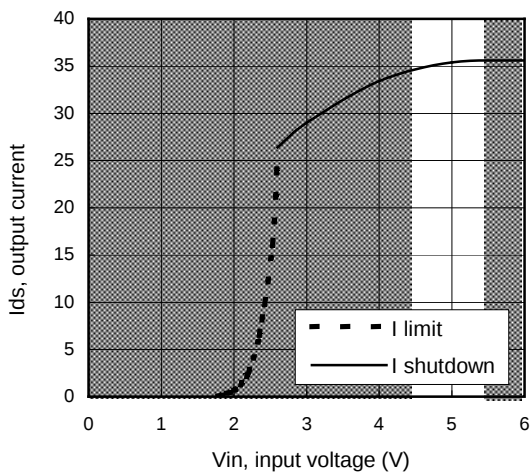


Figure 7 – Current limitation and current shutdown Vs Input voltage (V)

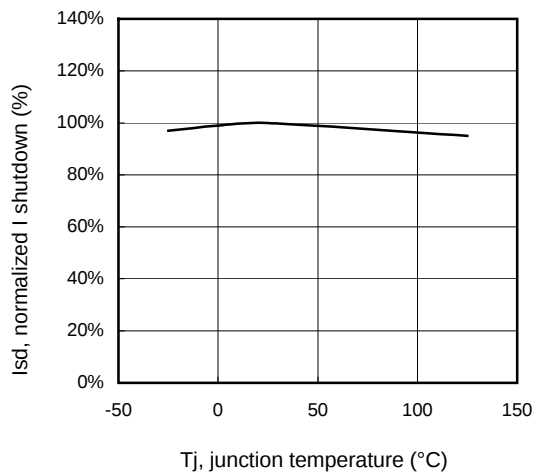


Figure 8 – Normalized $I_{shutdown}$ (%) Vs junction temperature (°C)

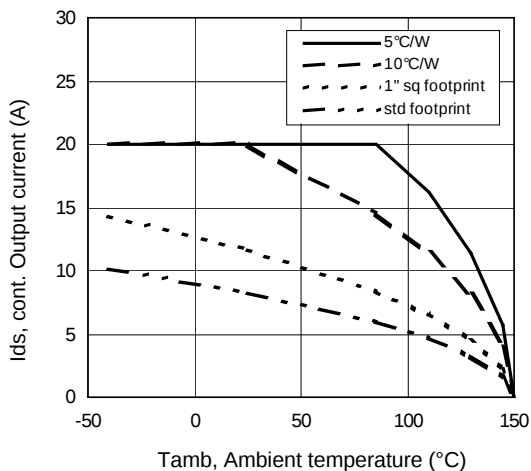


Figure 9 – Max. continuous output current (A) Vs Ambient temperature (°C)

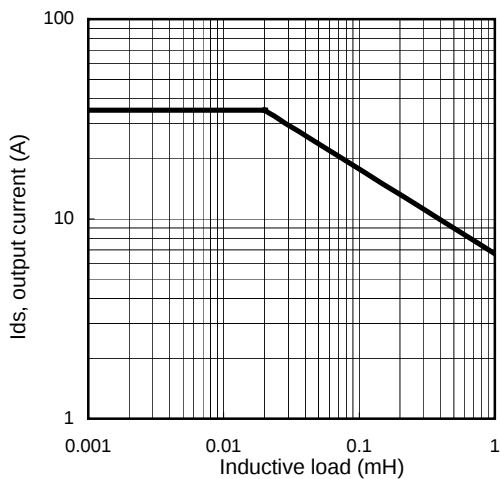


Figure 11 – Max. output current (A) Vs Inductive load (mH)

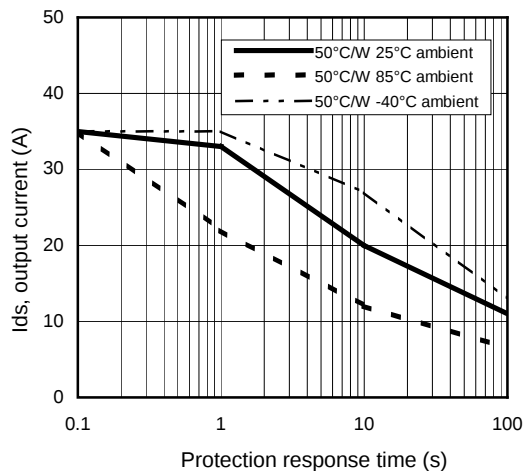


Figure 10 – Ids (A) Vs over temperature protection response time (s)

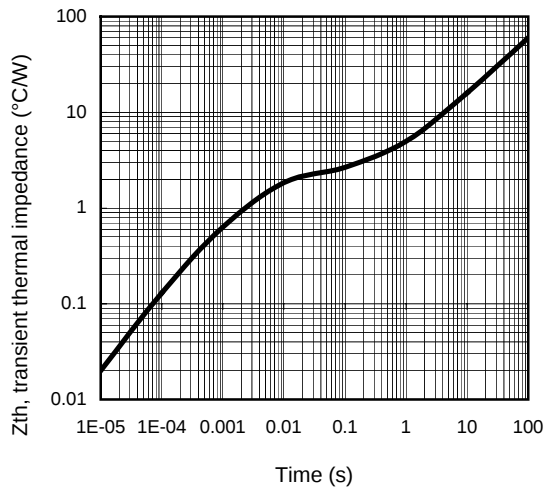
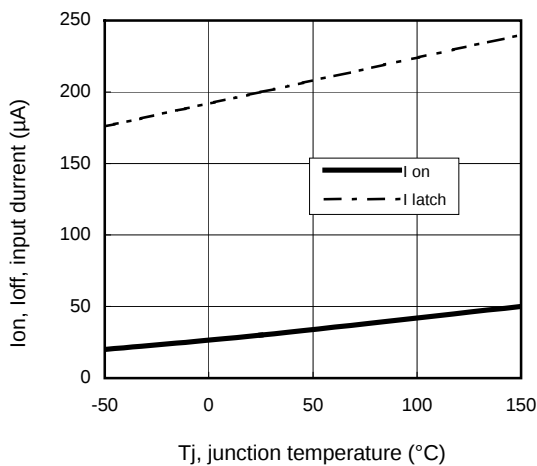
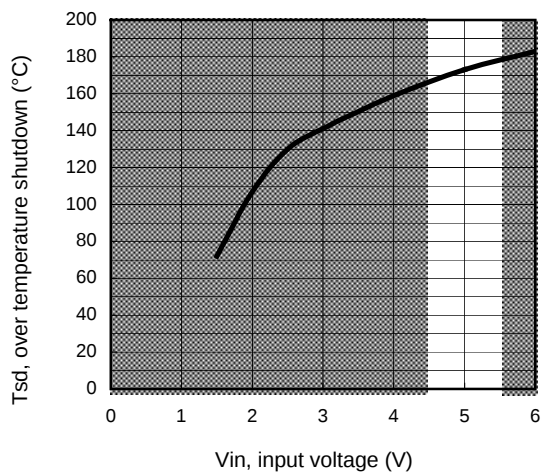


Figure 12 – Transient thermal impedance (°C/W) Vs time (s)

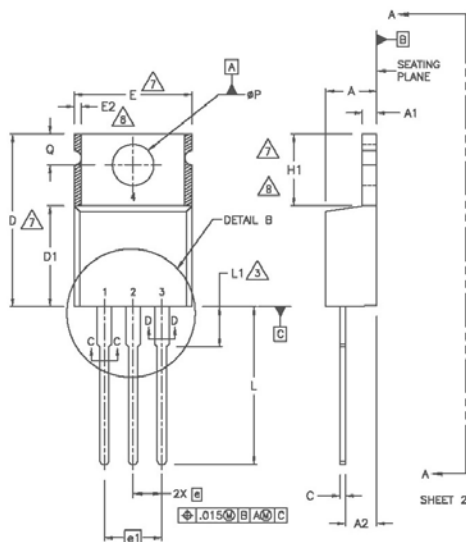
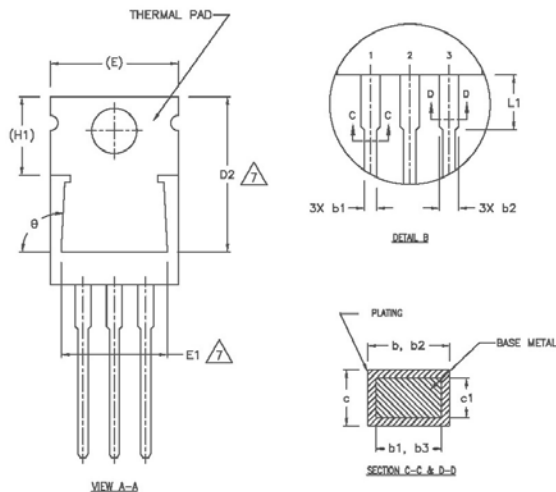


**Figure 13 – Input current (µA) On and Off
Vs junction temperature (°C)**



**Figure 14 – Over temperature shutdown (°C)
Vs input voltage (V)**

Case Outline – TO-220 AB – Automotive Q100 PbF qualified

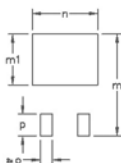
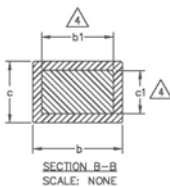
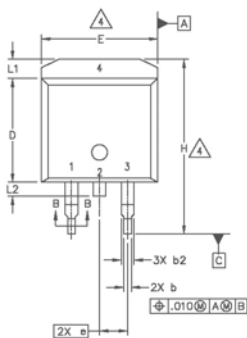
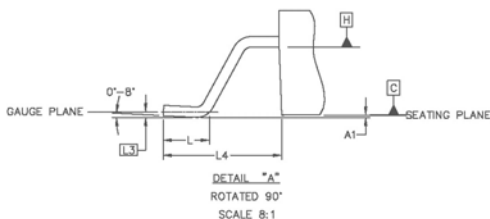
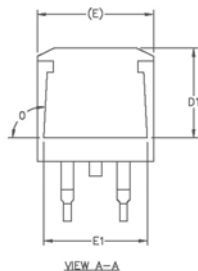


SYMBOL	DIMENSIONS				NOTES
	MILLIMETERS		INCHES		
	MIN.	MAX.	MIN.	MAX.	
A	3.56	4.82	.140	.190	5
A1	0.51	1.40	.020	.055	
A2	2.04	2.92	.080	.115	
b	0.38	1.01	.015	.040	
b1	0.38	0.96	.015	.038	
b2	1.15	1.77	.045	.070	5
b3	1.15	1.73	.045	.068	
c	0.36	0.61	.014	.024	
c1	0.36	0.56	.014	.022	
D	14.22	16.51	.560	.650	
D1	8.38	9.02	.330	.355	7
D2	12.19	12.88	.480	.507	
E	9.66	10.66	.380	.420	4,7
E1	8.38	8.89	.330	.350	7
e	2.54 BSC		.100 BSC		7,8
e1	5.08		.200 BSC		
H1	5.85	6.55	.230	.270	
L	12.70	14.73	.500	.580	
L1	—	6.35	—	.250	
øP	3.54	4.08	.139	.161	3
Q	2.54	3.42	.100	.135	
ø	90°-93°		90°-93°		

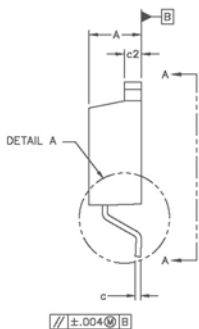
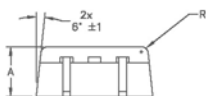
NOTES:

- 1 DIMENSIONING AND TOLERANCING PER ASME Y14.5 M- 1994.
- 2 DIMENSIONS ARE SHOWN IN INCHES [MILLIMETERS].
- 3 LEAD DIMENSION AND FINISH UNCONTROLLED IN L1.
- 4 DIMENSION D & E DO NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED .005" (0.127) PER SIDE. THESE DIMENSIONS ARE MEASURED AT THE OUTERMOST EXTREMES OF THE PLASTIC BODY.
- 5 DIMENSION b1 & c1 APPLY TO BASE METAL ONLY.
- 6 CONTROLLING DIMENSION : INCHES.
- 7 THERMAL PAD CONTOUR OPTIONAL WITHIN DIMENSIONS E, H1, D2 & E1
- 8 DIMENSION E2 X H1 DEFINE A ZONE WHERE STAMPING AND SINGULATION IRREGULARITIES ARE ALLOWED.
- 9 LEADS AND DRAIN ARE PLATED WITH 100% Sn

Case Outline - D²Pak (SMD-220) - Automotive Q100 PbF MSL1 qualified



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SCALE 2:1

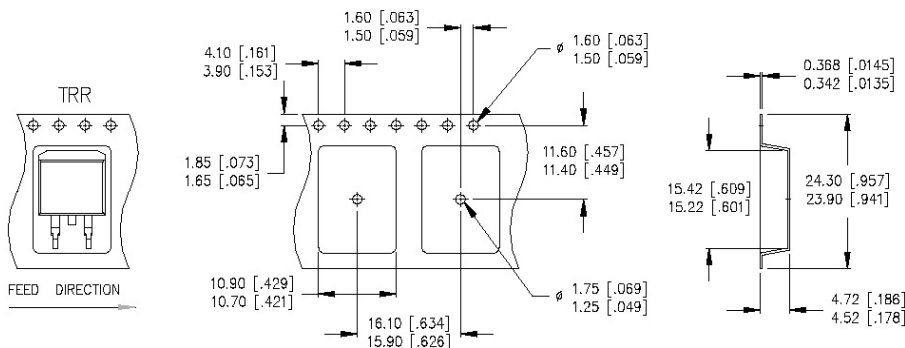


SYM BO L	DIMENSIONS				NOTES
	MILLIMETERS		INCHES		
	MIN.	MAX.	MIN.	MAX.	
A	4.06	4.83	.160	.190	4
A1	0.00	0.254	.000	.010	
b	0.51	0.99	.020	.039	
b1	0.51	0.89	.020	.035	
b2	1.14	1.78	.045	.070	4
c	0.38	0.74	.015	.029	
c1	0.38	0.58	.015	.023	
c2	1.14	1.65	.045	.065	3
D	8.51	9.65	.335	.380	
D1	8.86		.270		
E	9.65	10.67	.380	.420	3
E1	6.22		.245		
e	2.54 BSC		.100 BSC		
H	14.61	15.88	.575	.625	
L	1.78	2.79	.070	.110	
L1		1.65		.065	
L2	1.27	1.78	.050	.070	
L3	0.25 BSC		.010 BSC		
L4	4.78	5.28	.188	.208	
m	17.78		.700		
m1	8.89		.350		
n	11.43		.450		
o	2.08		.082		
p	3.81		.150		
R	0.51	0.71	.020	.028	
θ	90°	93°	90°	93°	

NOTES:

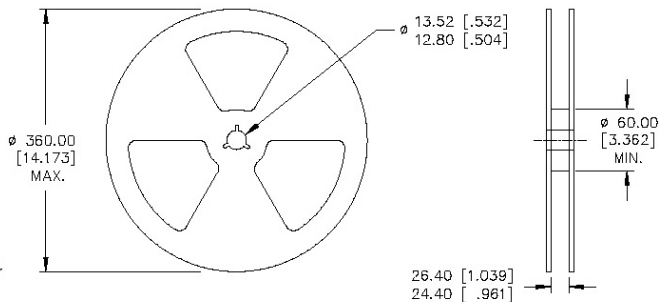
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M-1994
2. DIMENSIONS ARE SHOWN IN MILLIMETERS [INCHES]
3. DIMENSION D & E DO NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED 0.127 [0.005"] PER SIDE. THESE DIMENSIONS ARE MEASURED AT THE OUTMOST EXTREMES OF THE PLASTIC BODY.
4. DIMENSION b1 AND c1 APPLY TO BASE METAL ONLY.
5. CONTROLLING DIMENSION: INCH.
6. LEADS & DRAIN CONTACT ARE PLATED : 100% Sn

Tape & Reel - D²Pak (SMD220)



NOTES:

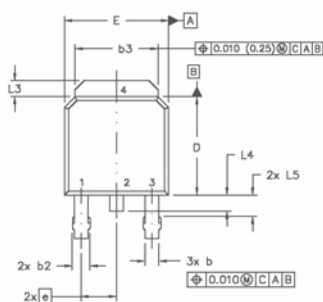
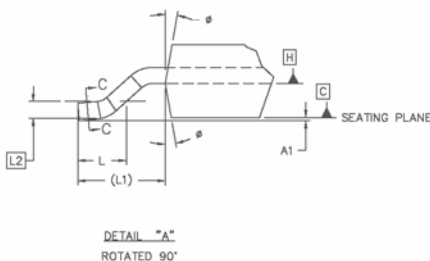
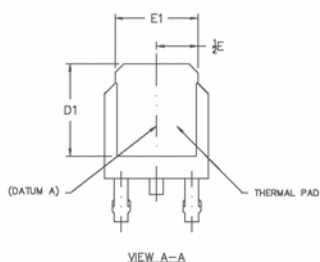
1. OUTLINE CONFORMS TO EIA-481 & EIA-541.
2. DIMENSIONS ARE SHOWN IN MILLIMETERS [INCH].



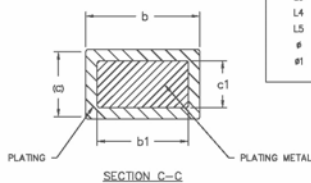
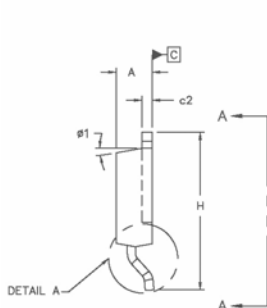
NOTES:

1. OUTLINE CONFORMS TO EIA-481 & EIA-541.
2. DIMENSIONS ARE SHOWN IN MILLIMETERS [INCHES].

Case Outline – D-Pak - Automotive Q100 PbF MSL1 qualified



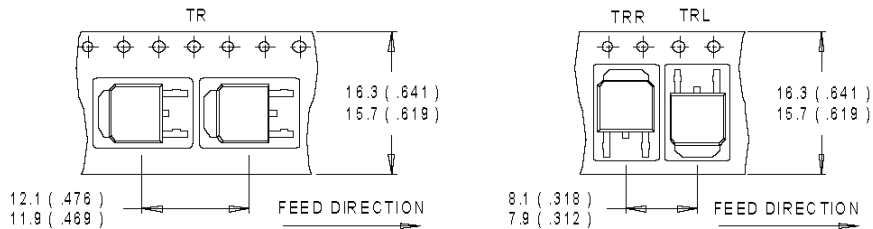
SYMBOL	DIMENSIONS				NOTES
	MILLIMETERS		INCHES		
	MIN.	MAX.	MIN.	MAX.	
A	2.18	2.39	.086	.094	
A1		0.13		.005	
b	0.64	0.89	.025	.035	5
b1	0.64	0.79	.025	.0331	5
b2	0.76	1.14	.030	.045	
b3	4.95	5.46	.195	.215	
c	0.46	0.61	.018	.024	5
c1	0.41	0.56	.016	.022	5
c2	.046	0.89	.018	.035	5
D	5.97	6.22	.235	.245	6
D1	5.21	—	.205	—	4
E	6.35	6.73	.250	.265	6
E1	4.32	—	.170	—	4
e	2.29		.090 BSC		
H	8.40	10.41	.370	.410	
L	1.40	1.78	.055	.070	
L1	2.74 REF.		.108 REF.		
L2	.0501 BSC		.020 BSC		
L3	0.89	1.27	.035	.050	
L4		1.02		.040	
L5	1.14	1.52	.045	.060	3
ø	0"	10"	0"	10"	
ø1	0"	15"	0"	15"	



NOTES:

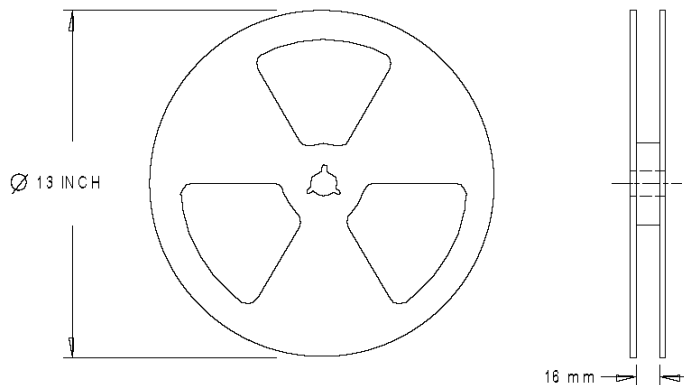
- 1.0 DIMENSIONING AND TOLERANCING PER ASME Y14.5 M- 1994.
- 2.0 DIMENSIONS ARE SHOWN IN INCHES [MILLIMETERS].
- 3.0 LEAD DIMENSION UNCONTROLLED IN L5
- 4.0 DIMENSION D1 AND E1 ESTABLISH A MINIMUM MOUNTING SURFACE FOR THERMAL PAD.
- 5.0 SECTION C-C DIMENSIONS APPLY TO THE FLAT SECTION OF THE LEAD BETWEEN .005 [0.127] AND .010 [0.2540] FROM THE LEAD TIP.
- 6.0 DIMENSION D & E DO NOT INCLUDE MOLD FLASH; MOLD FLASH SHALL NOT EXCEED .005" (0.127) PER SIDE. THESE DIMENSIONS ARE MEASURED AT THE OUTERMOST EXTREMES OF THE PLASTIC BODY.
- 7.0 OUTLINE CONFORMS TO JEDEC OUTLINE TO-252AA.
- 8.0 LEADS AND DRAIN ARE PLATED WITH 100% Sn

Tape & Reel - D-Pak



NOTES :

1. CONTROLLING DIMENSION : MILLIMETER.
2. ALL DIMENSIONS ARE SHOWN IN MILLIMETERS (INCHES).
3. OUTLINE CONFORMS TO EIA-481 & EIA-541.



NOTES :

1. OUTLINE CONFORMS TO EIA-481.

Dimensions are shown in millimeters (inches)

