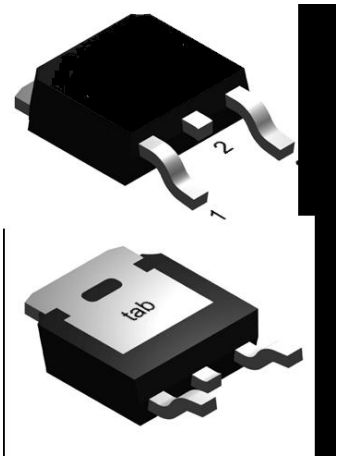
GaN Enhancement-mode Power Transistor

Features

- Enhancement-mode transistor - normally-OFF power switch
- Ultra-high switching frequency
- No reverse-recovery charge
- Low gate charge, low output charge
- Qualified for industrial applications according to JEDEC standards
- ESD safeguard
- RoHS, Pb-free



Applications

- AC-DC converters
- DC-DC converters
- Totem pole PFC
- Fast battery charging
- High-density power conversion
- High-efficiency power conversion
- TV display

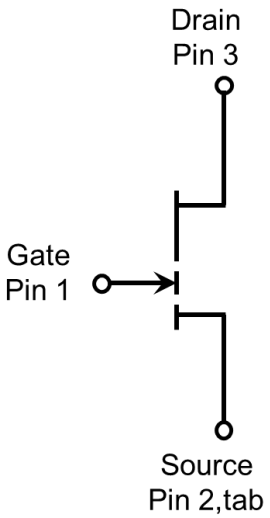


Table 1 Key Performance Parameters at T_j = 25 °C

Parameters	Values	Units
$V_{DS, max}$	650	V
$R_{DS(on), max}$	480	mΩ
$Q_{G, typ}$	1.2	nC
$I_{D, Pulse}$	9	A
Q_{OSS} @ 400 V	9.9	nC
Q_{rr}	0	nC

Gate	1
Source	2,tab
Drain	3

Table 2 Ordering Information

Type/Ordering Code	Package	Marking
CID9N65E3	TO252-3L, 2500 pcs/reel	CID9N65E

1 Maximum ratings

at T_j = 25 °C unless otherwise specified. Continuous application of maximum ratings can deteriorate transistor lifetime. For further information, contact Tokmas sales office.

Table 3 Maximum rating

Parameters	Symbols	Values			Units	Notes/Test Conditions
		Min.	Typ.	Max.		
Drain-source voltage	$V_{DS, max}$	-	-	650	V	V_{GS} = 0 V, I_D = 10 µA
Drain-source voltage transient [1]	$V_{DS, transient}$	-	-	750	V	V_{GS} = 0 V, V_{DS} = 750 V
Continuous current, drain-source	I_D	-	-	4.8	A	T_c = 25 °C
Pulsed current, drain-source [2]	$I_{D, pulse}$	-	-	9	A	T_c = 25 °C; V_G = 6 V
Pulsed current, drain-source [2]	$I_{D, pulse}$	-	-	6	A	T_c = 125 °C; V_G = 6 V
Gate-source voltage, continuous [3]	V_{GS}	-1.4	-	+7	V	T_j = -55 °C to 150 °C
Gate-source voltage, pulsed	$V_{GS, pulse}$	-	-	+10	V	T_j = -55 °C to 150 °C; t_{Pulse} = 50 ns, f = 100 kHz; open drain
Power dissipation	P_{tot}	-	-	39	W	T_c = 25 °C
Operating temperature	T_j	-55	-	+150	°C	
Storage temperature	T_{stg}	-55	-	+150	°C	

1. $V_{DS, transient}$ is intended for surge rating during non-repetitive events, t_{Pulse} < 1 µs.
2. Pulse width = 10 µs.
3. The minimum V_{GS} is clamped by ESD protection circuit, as shown in Figure 8.

2 Thermal characteristics

Table 4 Thermal characteristics

Parameters	Symbols	Values			Units	Notes/Test Conditions
		Min.	Typ.	Max.		
Thermal resistance, junction-case	R_{thJC}	-	-	TBD	°C/W	
Reflow soldering temperature	T_{sold}	-	-	260	°C	MSL3

3 Electrical characteristics

at T_j = 25 °C, unless specified otherwise.

Table 5 Static characteristics

Parameters	Symbols	Values			Units	Notes/Test Conditions
		Min.	Typ.	Max.		
Gate threshold voltage	$V_{GS(TH)}$	1.2	1.5	2.2	V	I_D = 5.2 mA; V_{DS} = V_{GS}; T_j = 25 °C
		-	1.5	-		I_D = 5.2 mA; V_{DS} = V_{GS}; T_j = 125 °C
Drain-source leakage current	I_{DSS}	-	-	10	μA	V_{DS} = 650 V; V_{GS} = 0 V; T_j = 25 °C
		-	-	50		V_{DS} = 650 V; V_{GS} = 0 V; T_j = 125 °C
Gate-source leakage current	I_{GSS}	-	-	200	μA	V_{GS} = 6 V; V_{DS} = 0 V
Drain-source on-state resistance	$R_{DS(on)}$	-	334	480	mΩ	V_{GS} = 6 V; I_D = 2 A; T_j = 25 °C
		-	584	-	mΩ	V_{GS} = 6 V; I_D = 2 A; T_j = 125 °C
Gate resistance	R_G	-	6	-	Ω	f = 5 MHz; open drain

Table 6 Dynamic characteristics

Parameters	Symbols	Values			Units	Notes/Test Conditions
		Min.	Typ.	Max.		
Input capacitance	C_{iss}	-	42	-	pF	V_{GS} = 0 V; V_{DS} = 400 V; f = 100 kHz
Output capacitance	C_{oss}	-	13	-	pF	V_{GS} = 0 V; V_{DS} = 400 V; f = 100 kHz
Reverse transfer capacitance	C_{rss}	-	0.3	-	pF	V_{GS} = 0 V; V_{DS} = 400 V; f = 100 kHz
Effective output capacitance, energy related [1]	$C_{o(er)}$	-	16	-	pF	V_{GS} = 0 V; V_{DS} = 0 to 400 V
Effective output capacitance, time related [2]	$C_{o(tr)}$	-	24	-	pF	V_{GS} = 0 V; V_{DS} = 0 to 400 V
Output charge	Q_{OSS}	-	9.9	-	nC	V_{GS} = 0 V; V_{DS} = 0 to 400 V
Turn-on delay time	$t_{d(on)}$	-	12	-	ns	V_{DS} = 400 V; I_D = 4 A; L = 470 μH; V_{GS} = 6 V; R_{on} = 10 Ω; R_{off} = 2 Ω
Turn-off delay time	$t_{d(off)}$	-	12	-	ns	
Rise time	t_r	-	4	-	ns	
Fall time	t_f	-	20	-	ns	

1. $C_{o(er)}$ is the fixed capacitance that gives the same stored energy as C_{OSS} while V_{DS} is rising from 0 to 400 V.
2. $C_{o(tr)}$ is the fixed capacitance that gives the same charging time as C_{OSS} while V_{DS} is rising from 0 to 400 V.

Table 7 Gate charge characteristics

Parameters	Symbols	Values			Units	Notes/Test Conditions
		Min.	Typ.	Max.		
Gate charge	Q_G	-	1.2	-	nC	V_{GS} = 0 to 6 V; V_{DS} = 400 V; I_D = 2 A
Gate-source charge	Q_{GS}	-	0.1	-	nC	
Gate-drain charge	Q_{GD}	-	0.5	-	nC	
Gate plateau voltage	V_{plat}	-	2.7	-	V	V_{DS} = 400 V; I_D = 2 A

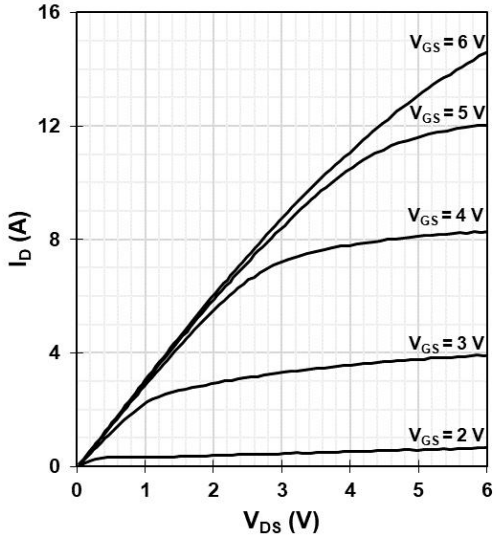
Table 8 Reverse conduction characteristics

Parameters	Symbols	Values			Units	Notes/Test Conditions
		Min.	Typ.	Max.		
Source-drain reverse voltage	V_{SD}	-	3	-	V	V_{GS} = 0 V; I_{SD} = 2 A
Pulsed current, reverse	$I_{S,\ pulse}$	-	10	-	A	V_{GS} = 6 V
Reverse recovery charge	Q_{rr}	-	0	-	nC	I_{SD} = 2 A; V_{DS} = 400 V
Reverse recovery time	t_{rr}	-	0	-	ns	
Peak reverse recovery current	I_{rrm}	-	0	-	A	

4 Electrical characteristics diagrams

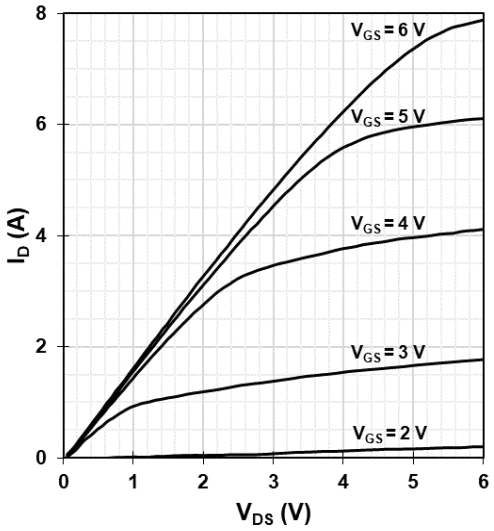
at T_j = 25 °C, unless specified otherwise.

Figure 1 Typ. output characteristics



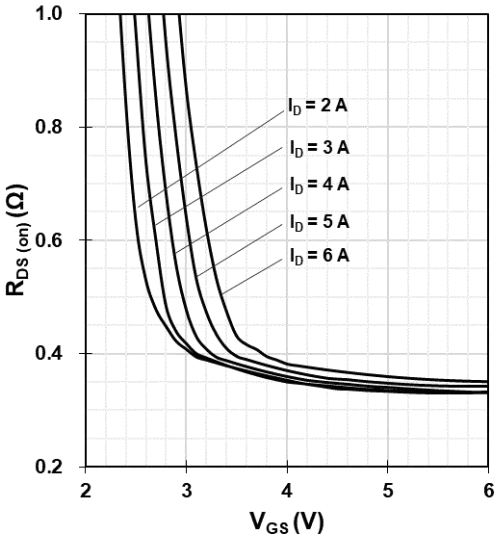
$I_D = f(V_{DS}, V_{GS})$; T_j = 25 °C

Figure 2 Typ. output characteristics



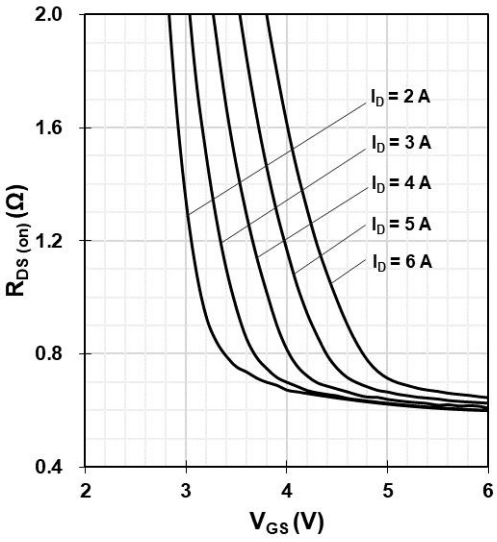
$I_D = f(V_{DS}, V_{GS})$; T_j = 125 °C

Figure 3 Typ. drain-source on-state resistance



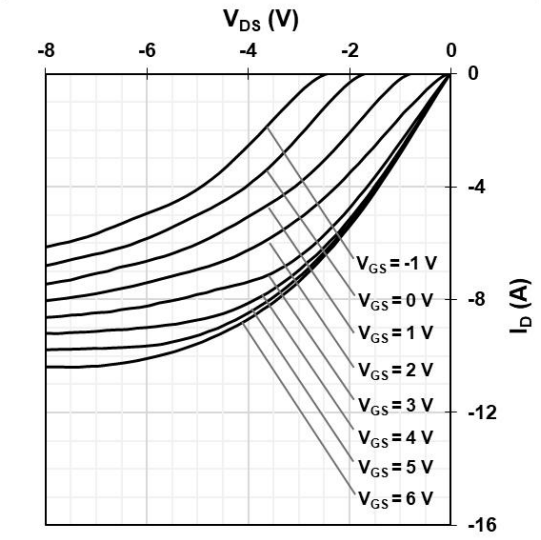
$R_{DS(on)} = f(I_D, V_{GS})$; T_j = 25 °C

Figure 4 Typ. drain-source on-state resistance



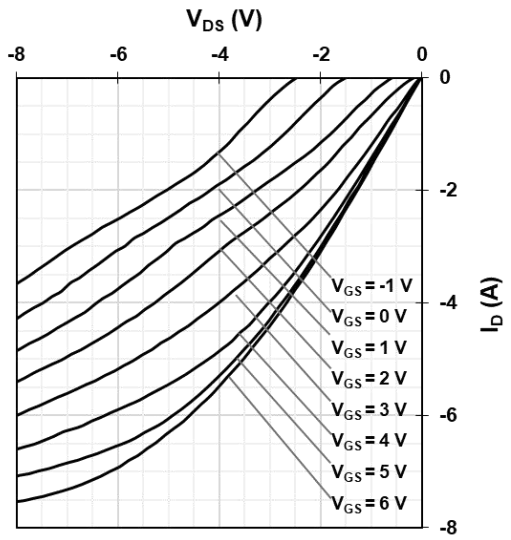
$R_{DS(on)} = f(I_D, V_{GS})$; T_j = 125 °C

Figure 5 Typ. channel reverse characteristics



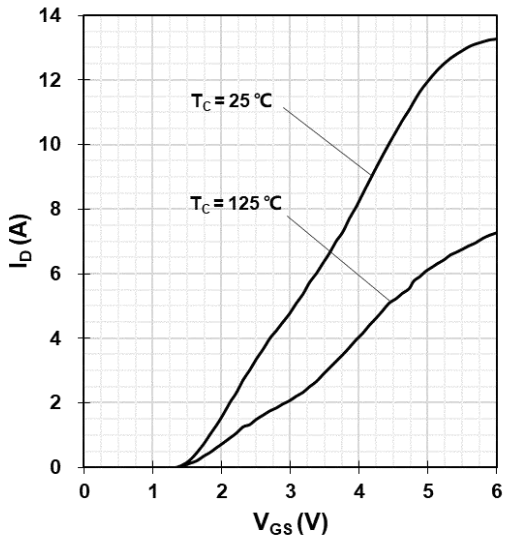
$I_D = f(V_{DS}, V_{GS})$; T_j = 25 °C

Figure 6 Typ. channel reverse characteristics



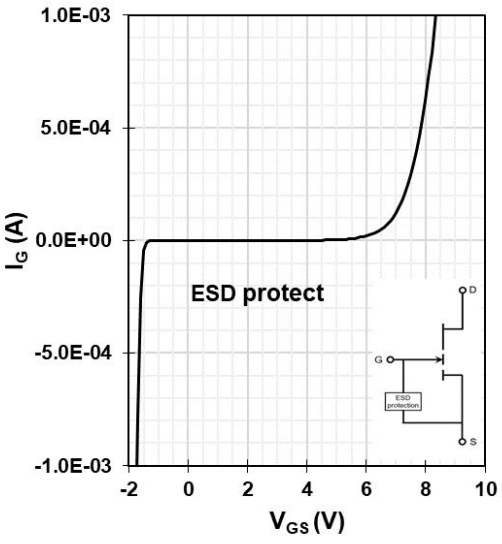
$I_D = f(V_{DS}, V_{GS})$; T_j = 125 °C

Figure 7 Typ. transfer characteristics



$I_D = f(V_{GS})$; V_{DS} = 5 V

Figure 8 Typ. gate-to-source leakage



$I_G = f(V_{GS})$; I_G reverse turn on by ESD unit; V_D = open

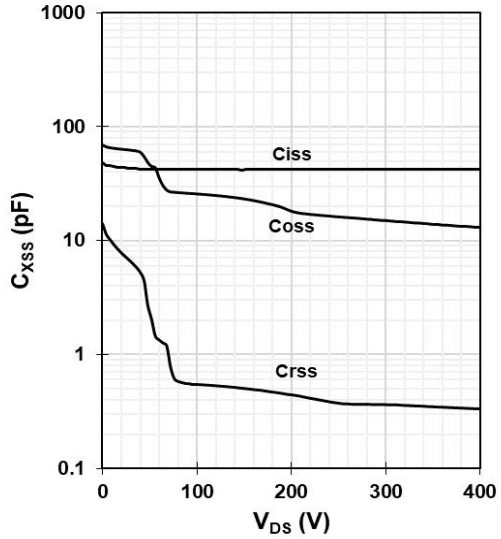
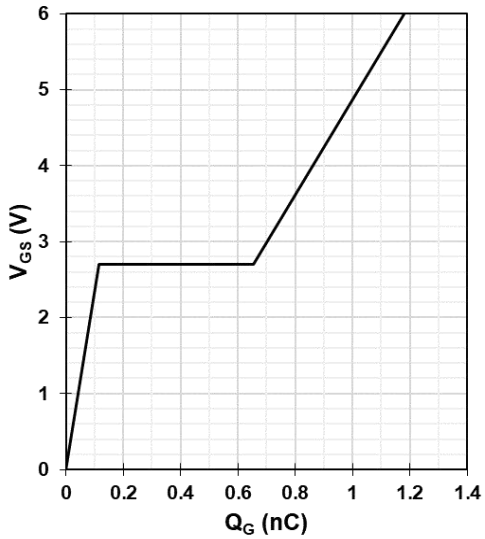
Figure 9 Typ. capacitances	Figure 10 Typ. gate charge
	
C_{XSS} = f(V_{DS}); Freq. = 100 kHz	V_{GS} = f(Q_G); V_{DS} = 400 V; I_D = 2 A

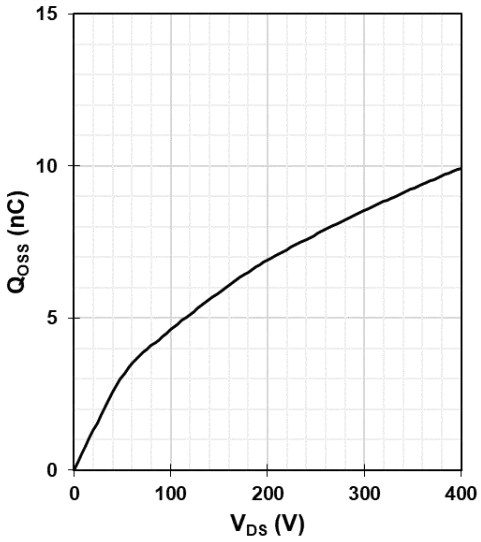
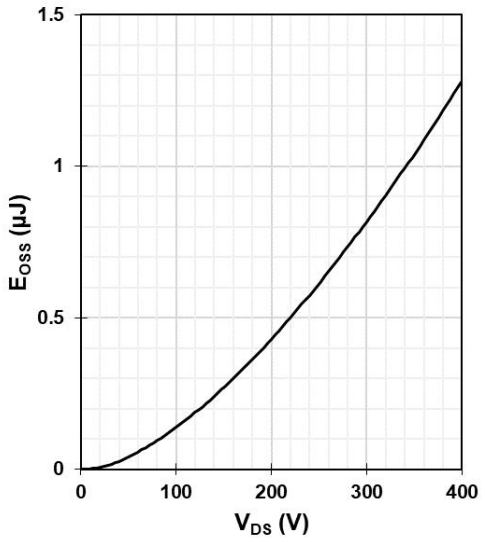
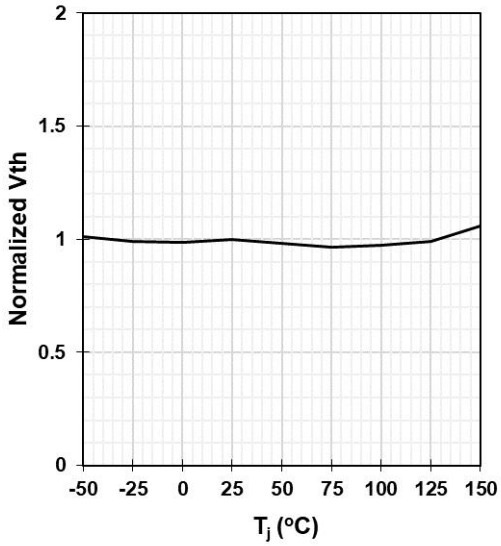
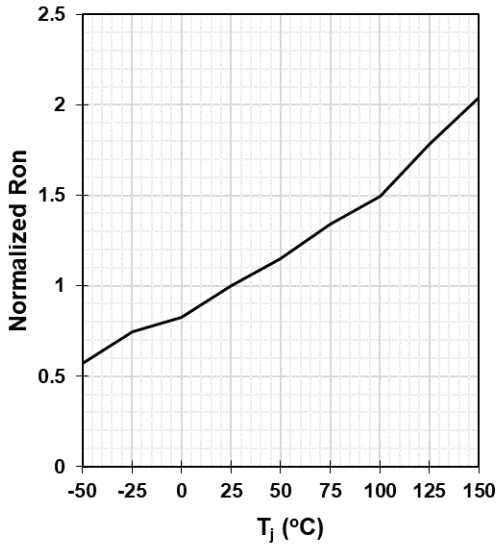
Figure 11 Typ. output charge	Figure 12 Typ. C_{OSS} stored energy
	
Q_{OSS} = f(V_{DS}); Freq. = 100 kHz	E_{OSS} = f(V_{DS}); Freq. = 100 kHz

Figure 13 Gate threshold voltage



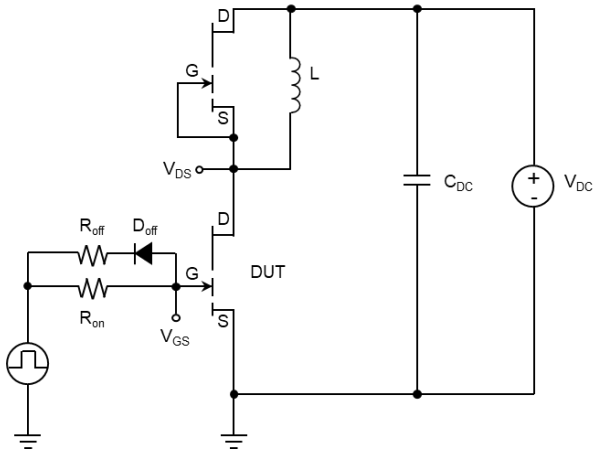
$V_{GS(TH)} = f(T_j)$; $V_{GS} = V_{DS}$; $I_D = 5.2$ mA

Figure 14 Drain-source on-state resistance



$R_{DS(on)} = f(T_j)$; $I_D = 2$ A; $V_{GS} = 6$ V

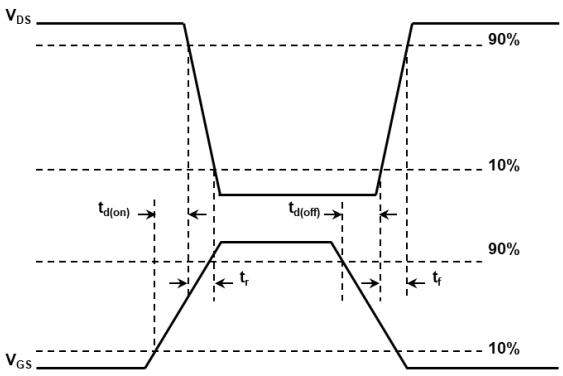
Figure 15 Switching times test circuit



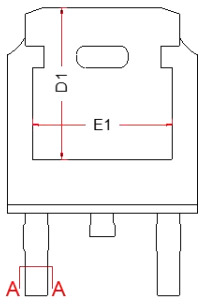
V_{DS} = 400 V, I_D = 4 A, L = 470 µH, V_{GS} = 6 V,

R_{on} = 10 Ω, R_{off} = 2 Ω

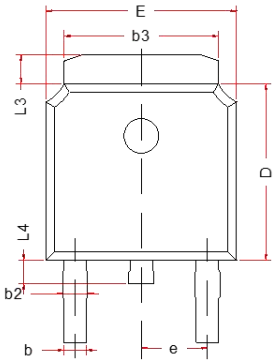
Figure 16 Typ. switching times waveform



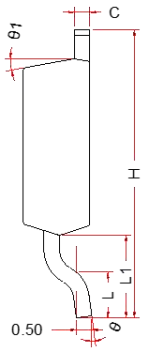
5 Package outlines



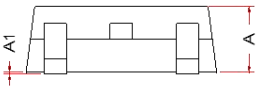
BOTTOM VIEW



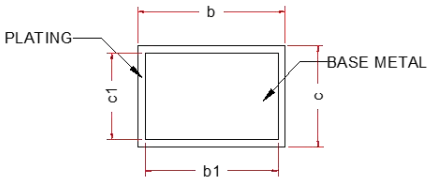
TOP VIEW



SIDE VIEW



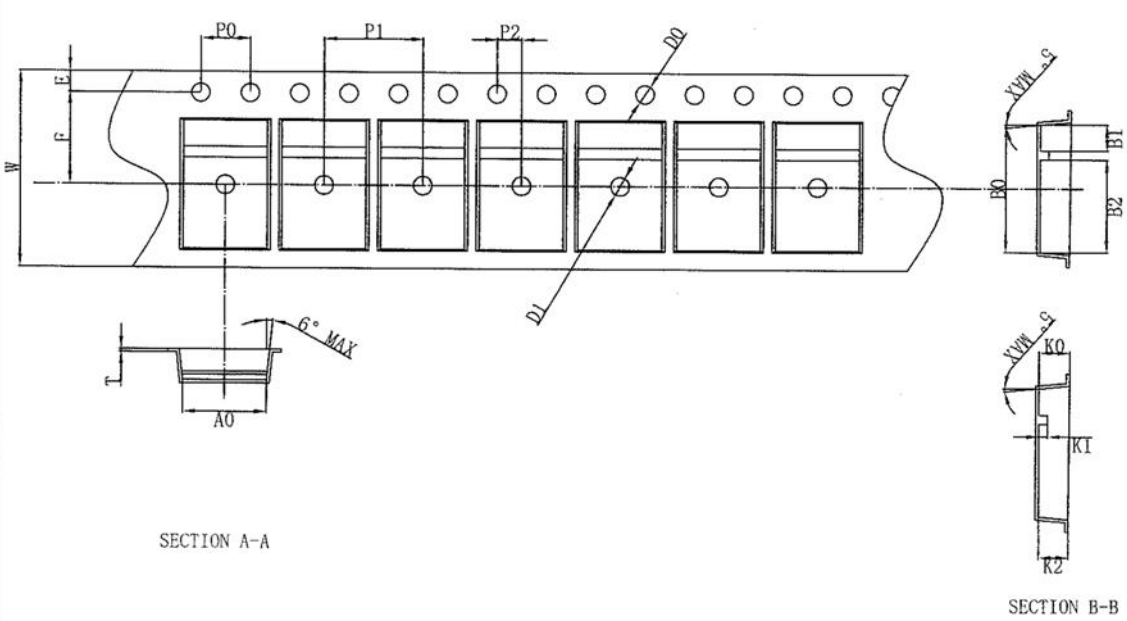
SIDE VIEW



SECTION A-A

	MIN	MID	MAX
A	2.20	2.30	2.40
A1	0.00	---	0.12
b	0.65	---	0.89
b1	0.64	0.76	0.79
b2	0.76	0.86	1.10
b3	5.20	5.33	5.46
c	0.48	---	0.60
c1	0.47	0.51	0.55
D	6.00	6.10	6.20
D1	5.21	---	---
E	6.50	6.60	6.70
E1	4.32	---	---
e	2.29BSC		
H	9.70	9.95	10.20
L	1.40	1.50	1.60
L1	2.84REF		
L3	0.90	---	1.27
L4	0.60	0.80	1.00
θ	0°	---	10°

6 Reel information



SYMBOL	DIMENSION	SYMBOL	DIMENSION
W	16.00±0.30	10P0	40.00±0.20
E	1.75±0.10	P1	8.00±0.10
F	7.50±0.05	A0	6.80±0.10
D0	1.625±0.125	B0	10.40±0.10
D1	1.55±0.05	K0	2.5±0.10
P0	4.00±0.10	T	0.25±0.05
P2	2.00±0.10	K1	0.70±0.05
B1	2.10±0.05	K2	2.40±0.10
B2	7.55±0.05