ALPHA & OMEGA SEMICONDUCTOR

AOD5B65M1

650V, 5A Alpha IGBT™

With soft and fast recovery anti-parallel diode

General Description

- Latest AlphaIGBT (α IGBT) technology
- 650V breakdown voltage
- Very fast and soft recovery freewheeling diode
- High efficient turn-on di/dt controllability
- Low VCE(SAT) enables high efficiencies
- Low turn-off switching loss and softness
- Very good EMI behavior
- High short-circuit ruggedness

Applications

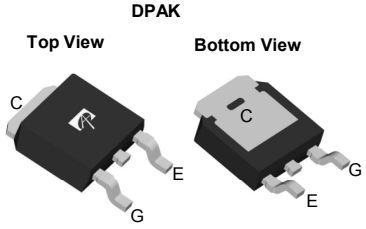
- Motor Drives
- Home appliance applications such as refrigerators and washing machines
- Fan, Pumps, Vacuum Cleaner
- Other Hard Switching Applications

Product Summary

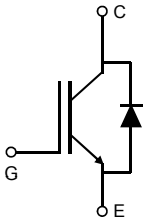
V_{CE}	650V
I_C (T_C=100°C)	5A
$V_{CE(sat)}$ (T_J=25°C)	1.57V

Green Product

TO-252
DPAK



AOD5B65M1



Orderable Part Number	Package Type	Form	Minimum Order Quantity
AOD5B65M1	TO252	Tape & Reel	2500

Absolute Maximum Ratings T_A=25°C unless otherwise noted

Parameter		Symbol	AOD5B65M1	Units
Collector-Emitter Voltage		V_{CE}	650	V
Gate-Emitter Voltage		V_{GE}	±30	V
Continuous Collector Current	T_C=25°C	I_C	10	A
	T_C=100°C		5	
Pulsed Collector Current, Limited by T_{Jmax}		I_{CM}	15	A
Turn off SOA, $V_{CE} \leqslant$ 650V, Limited by T_{Jmax}		I_{LM}	15	A
Continuous Diode Forward Current	T_C=25°C	I_F	10	A
	T_C=100°C		5	
Diode Pulsed Current, Limited by T_{Jmax}		I_{FM}	15	A
Short circuit withstanding time 1) V_{GE} = 15V, $V_{CC} \leqslant$ 400V, $T_J \leqslant$ 150°C		t_{SC}	5	µs
Power Dissipation	T_C=25°C	P_D	69	W
	T_C=100°C		28	
Junction and Storage Temperature Range		T_J, T_{STG}	-55 to 150	°C
Maximum lead temperature for soldering purpose, 1/8" from case for 5 seconds		T_L	300	°C

Thermal Characteristics

Parameter	Symbol	AOD5B65M1	Units
Maximum Junction-to-Ambient	$R_{\theta JA}$	55	°C/W
Maximum IGBT Junction-to-Case	$R_{\theta JC}$	1.8	°C/W
Maximum Diode Junction-to-Case	$R_{\theta JC}$	5.5	°C/W

1) Allowed number of short circuits: <1000; time between short circuits: >1s.

Electrical Characteristics (T_J=25°C unless otherwise noted)

Symbol	Parameter	Conditions		Min	Typ	Max	Units
STATIC PARAMETERS							
BV_{CES}	Collector-Emitter Breakdown Voltage	I_C=1mA, V_{GE}=0V, T_J=25°C		650	-	-	V
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	V_{GE}=15V, I_C=5A	T_J=25°C	-	1.57	1.98	V
			T_J=125°C	-	1.87	-	
			T_J=150°C	-	1.95	-	
V_F	Diode Forward Voltage	V_{GE}=0V, I_C=5A	T_J=25°C	-	1.8	2.25	V
			T_J=125°C	-	1.79	-	
			T_J=150°C	-	1.75	-	
$V_{GE(th)}$	Gate-Emitter Threshold Voltage	V_{CE}=5V, I_C=1mA		-	5.1	-	V
I_{CES}	Zero Gate Voltage Collector Current	V_{CE}=650V, V_{GE}=0V	T_J=25°C	-	-	10	µA
			T_J=125°C	-	-	100	
			T_J=150°C	-	-	500	
I_{GES}	Gate-Emitter leakage current	V_{CE}=0V, V_{GE}=±30V		-	-	±100	nA
g_{FS}	Forward Transconductance	V_{CE}=20V, I_C=5A		-	4.1	-	S
DYNAMIC PARAMETERS							
C_{ies}	Input Capacitance	V_{GE}=0V, V_{CC}=25V, f=1MHz		-	348	-	pF
C_{oes}	Output Capacitance			-	36	-	pF
C_{res}	Reverse Transfer Capacitance			-	13	-	pF
Q_g	Total Gate Charge	V_{GE}=15V, V_{CC}=520V, I_C=5A		-	14	-	nC
Q_{ge}	Gate to Emitter Charge			-	3	-	nC
Q_{gc}	Gate to Collector Charge			-	6.5	-	nC
$I_{C(SC)}$	Short circuit collector current	V_{GE}=15V, V_{CC}=400V, $t_{sc}\leqslant$5us, $T_J\leqslant$150°C		-	30	-	A
R_g	Gate resistance	V_{GE}=0V, V_{CC}=0V, f=1MHz		-	6	-	Ω
SWITCHING PARAMETERS, (Load Inductive, T_J=25°C)							
$t_{D(on)}$	Turn-On DelayTime	T_J=25°C, V_{GE}=15V, V_{CC}=400V, I_C=5A, R_G=60Ω		-	8.5	-	ns
t_r	Turn-On Rise Time			-	13	-	ns
$t_{D(off)}$	Turn-Off Delay Time			-	106	-	ns
t_f	Turn-Off Fall Time			-	18	-	ns
E_{on}	Turn-On Energy			-	0.08	-	mJ
E_{off}	Turn-Off Energy			-	0.07	-	mJ
E_{total}	Total Switching Energy			-	0.15	-	mJ
t_{rr}	Diode Reverse Recovery Time	T_J=25°C, I_F=5A, dI/dt=200A/µs, V_{CC}=400V		-	195	-	ns
Q_{rr}	Diode Reverse Recovery Charge			-	0.24	-	µC
I_{rm}	Diode Peak Reverse Recovery Current			-	2.78	-	A
SWITCHING PARAMETERS, (Load Inductive, T_J=150°C)							
$t_{D(on)}$	Turn-On DelayTime	T_J=150°C, V_{GE}=15V, V_{CC}=400V, I_C=5A, R_G=60Ω		-	7	-	ns
t_r	Turn-On Rise Time			-	14	-	ns
$t_{D(off)}$	Turn-Off Delay Time			-	127	-	ns
t_f	Turn-Off Fall Time			-	30	-	ns
E_{on}	Turn-On Energy			-	0.09	-	mJ
E_{off}	Turn-Off Energy			-	0.12	-	mJ
E_{total}	Total Switching Energy			-	0.21	-	mJ
t_{rr}	Diode Reverse Recovery Time	T_J=150°C, I_F=5A, dI/dt=200A/µs, V_{CC}=400V		-	273	-	ns
Q_{rr}	Diode Reverse Recovery Charge			-	0.38	-	µC
I_{rm}	Diode Peak Reverse Recovery Current			-	3.3	-	A

TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

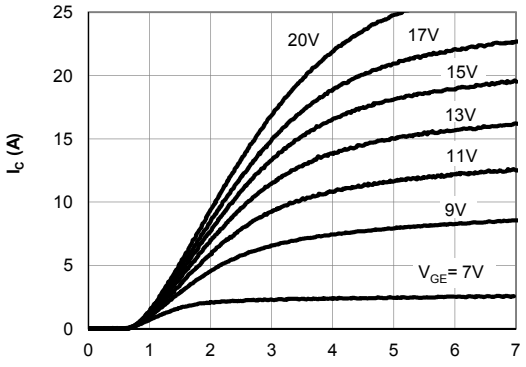


Figure 1: Output Characteristic (T_j=25°C)

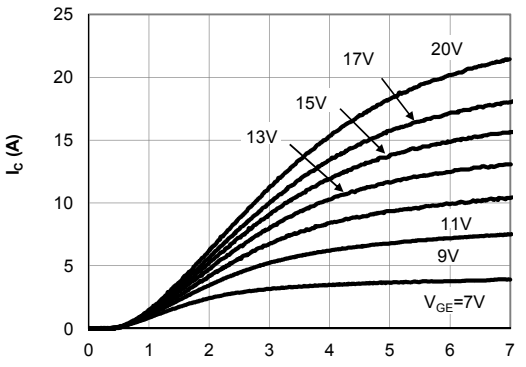


Figure 2: Output Characteristic (T_j=150°C)

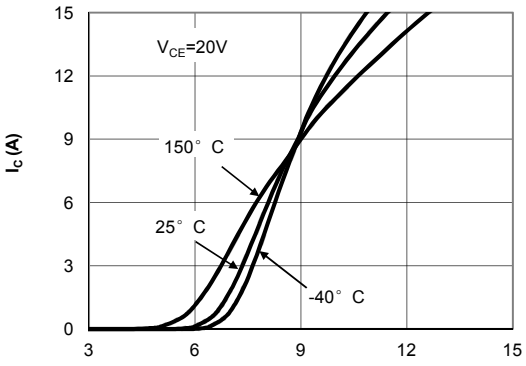


Figure 3: Transfer Characteristic

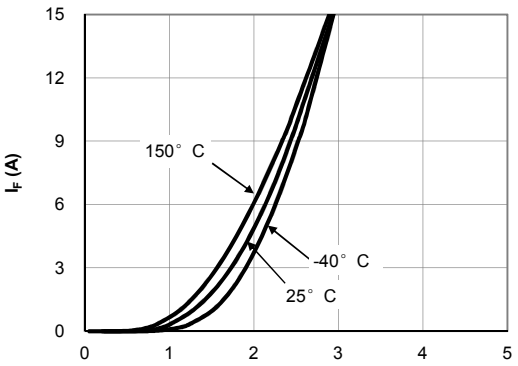


Figure 4: Diode Characteristic

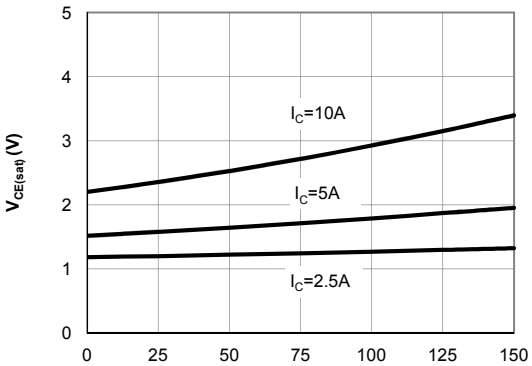


Figure 5: Collector-Emitter Saturation Voltage vs. Junction Temperature

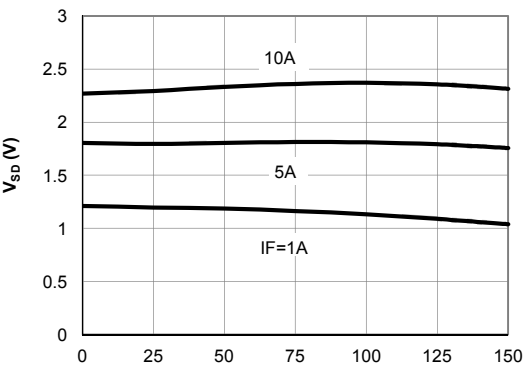


Figure 6: Diode Forward voltage vs. Junction Temperature

TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

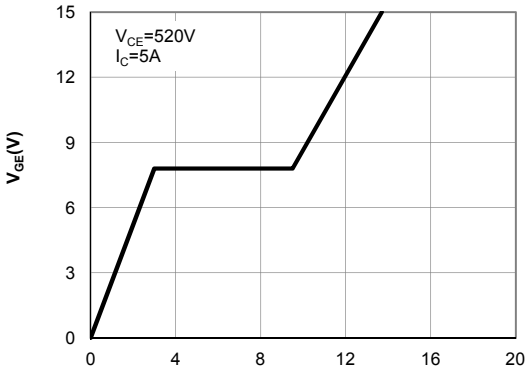


Figure 7: Gate-Charge Characteristics

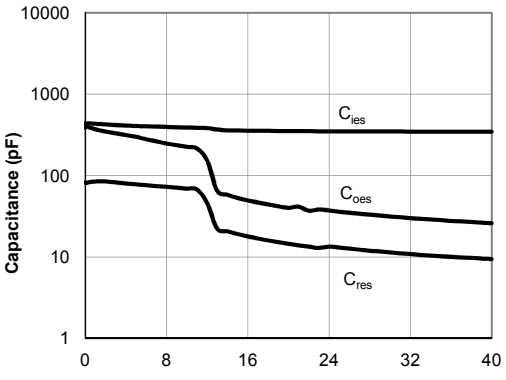


Figure 8: Capacitance Characteristic

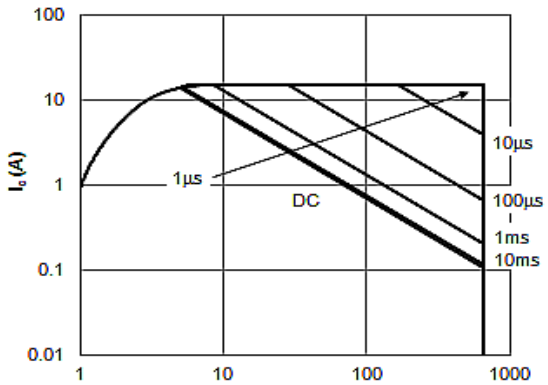


Figure 9: Forward Bias Safe Operating Area (T_C=25°C,V_{GE}=15V)

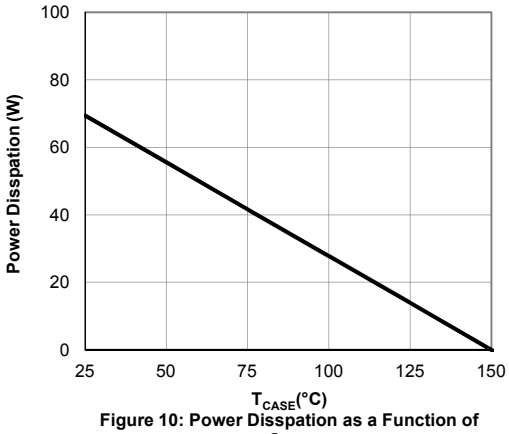


Figure 10: Power Disspation as a Function of Case

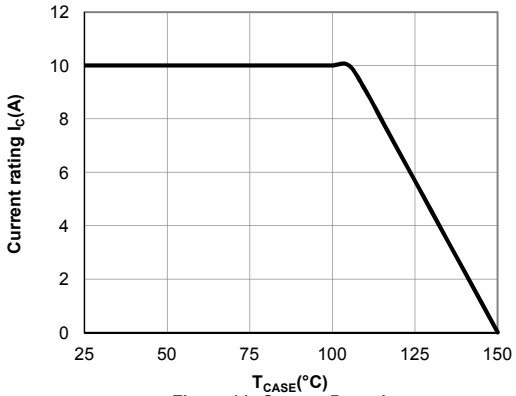


Figure 11: Current De-rating

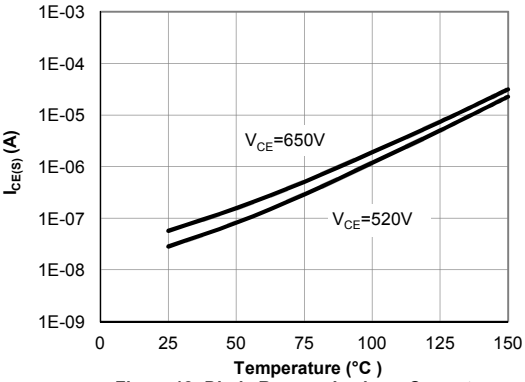


Figure 12: Diode Reverse Leakage Current vs. Junction Temperature

TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

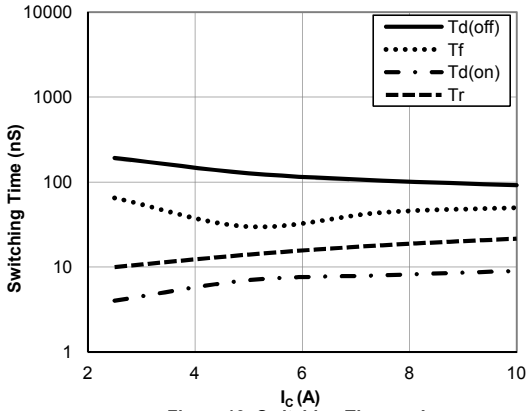


Figure 13: Switching Time vs. I_C
(T_j=150°C,V_{GE}=15V,V_{CE}=400V,R_g=60Ω)

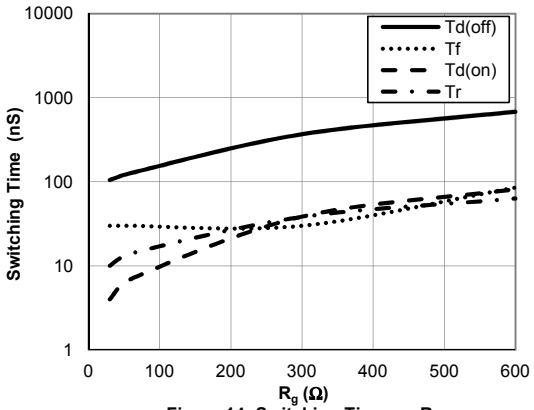


Figure 14: Switching Time vs. R_g
(T_j=150°C,V_{GE}=15V,V_{CE}=400V,I_C=5A)

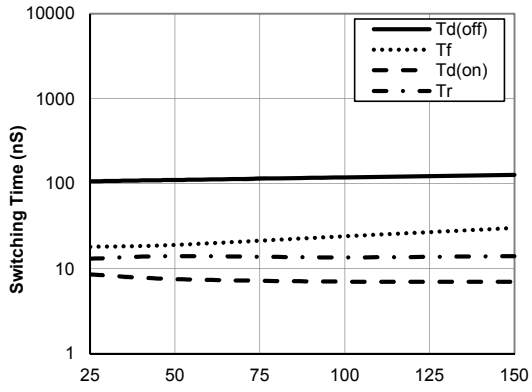


Figure 15: Switching Time vs.T_j
(V_{GE}=15V,V_{CE}=400V,I_C=5A,R_g=60Ω)

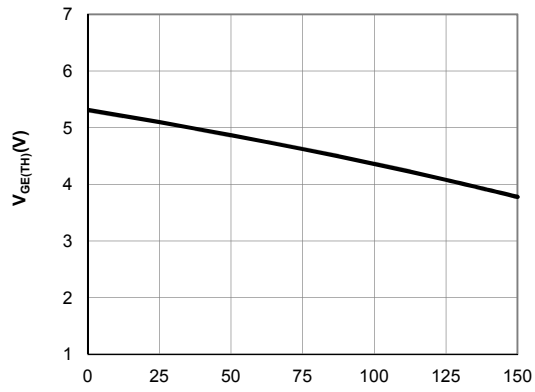


Figure 16: $V_{GE(TH)}$ vs. T_j

TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

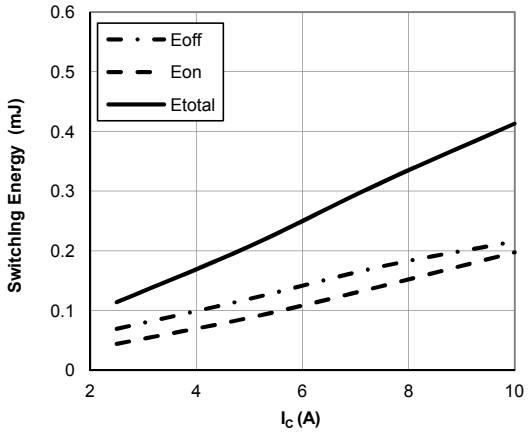


Figure 17: Switching Loss vs. I_C
(T_j=150°C,V_{GE}=15V,V_{CE}=400V,R_g=60Ω)

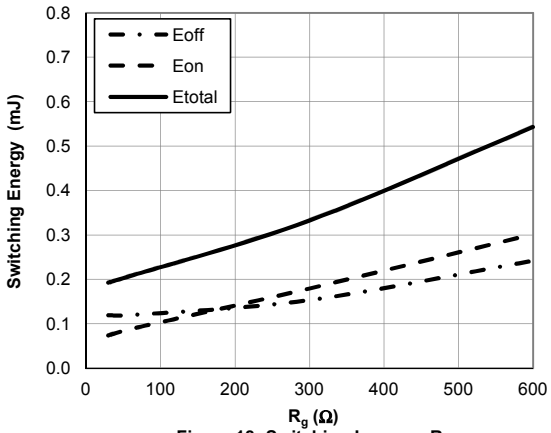


Figure 18: Switching Loss vs. R_g
(T_j=150°C,V_{GE}=15V,V_{CE}=400V,I_C=5A)

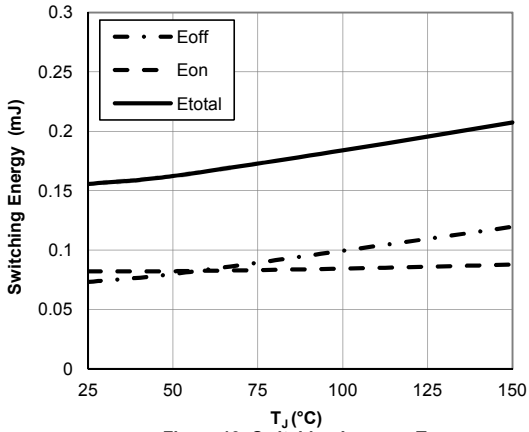


Figure 19: Switching Loss vs. T_j
(V_{GE}=15V,V_{CE}=400V,I_C=5A,R_g=60Ω)

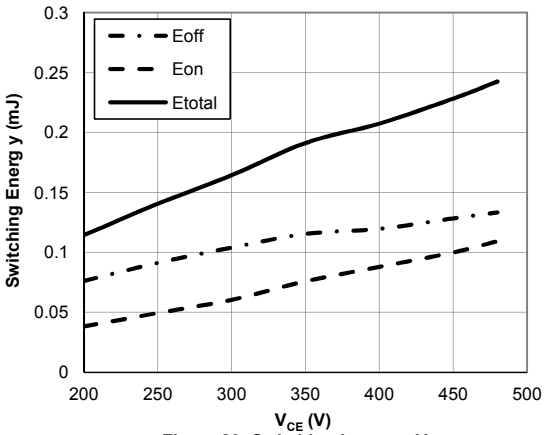


Figure 20: Switching Loss vs. V_{CE}
(T_j=150°C,V_{GE}=15V,I_C=5A,R_g=60Ω)

TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

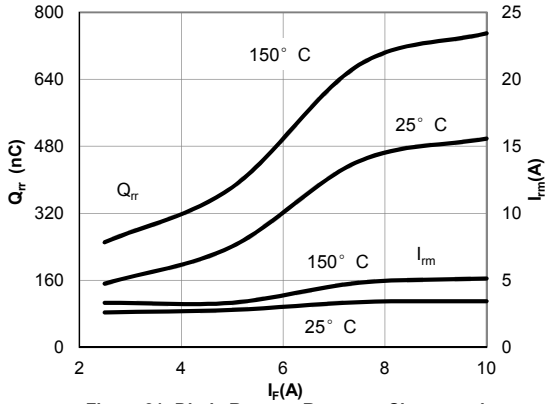


Figure 21: Diode Reverse Recovery Charge and Peak Current vs. Conduction Current (V_{GE}=15V,V_{CE}=400V,di/dt=200A/µs)

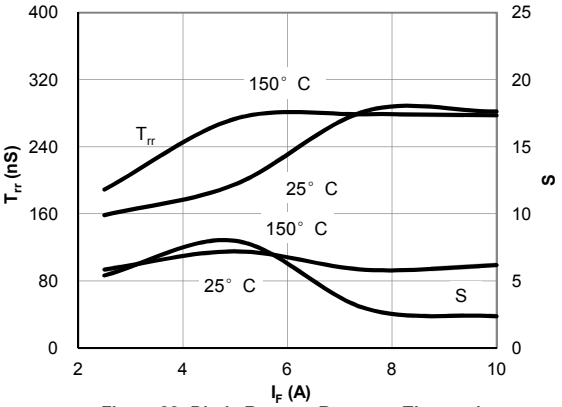


Figure 22: Diode Reverse Recovery Time and Softness Factor vs. Conduction Current (V_{GE}=15V,V_{CE}=400V,di/dt=200A/µs)

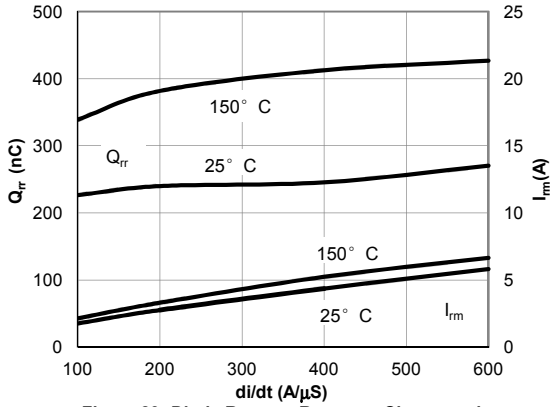


Figure 23: Diode Reverse Recovery Charge and Peak Current vs. di/dt (V_{GE}=15V,V_{CE}=400V,I_F=5A)

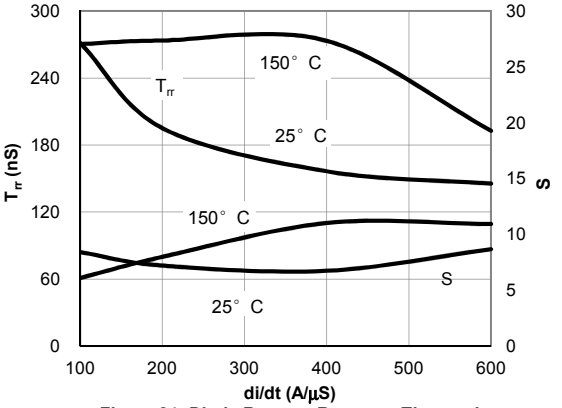


Figure 24: Diode Reverse Recovery Time and Softness Factor vs. di/dt (V_{GE}=15V,V_{CE}=400V,I_F=5A)

TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

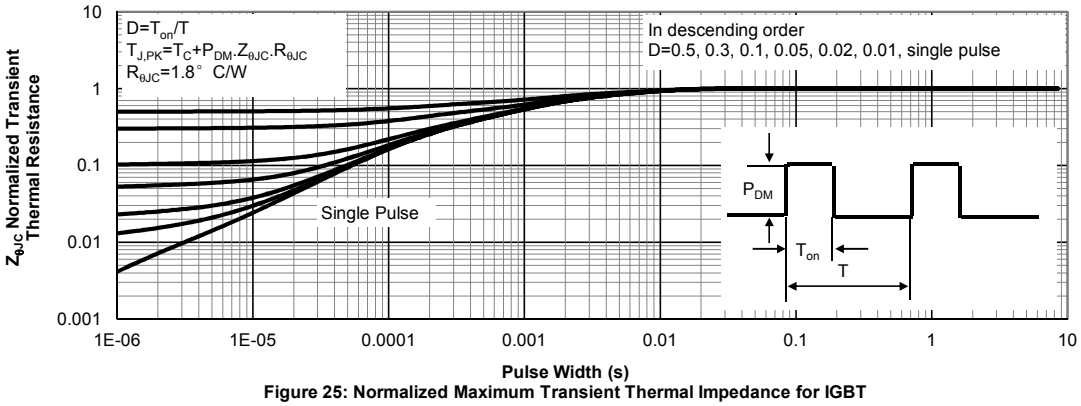


Figure 25: Normalized Maximum Transient Thermal Impedance for IGBT

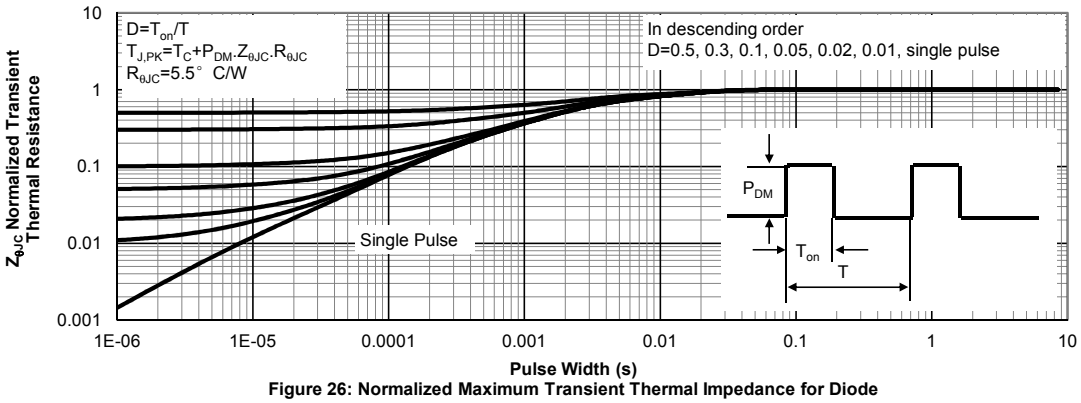


Figure 26: Normalized Maximum Transient Thermal Impedance for Diode

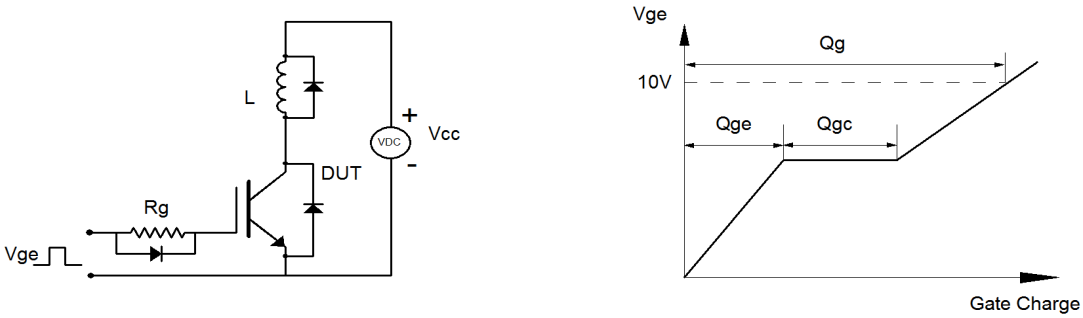


Figure A: Gate Charge Test Circuit & Waveforms

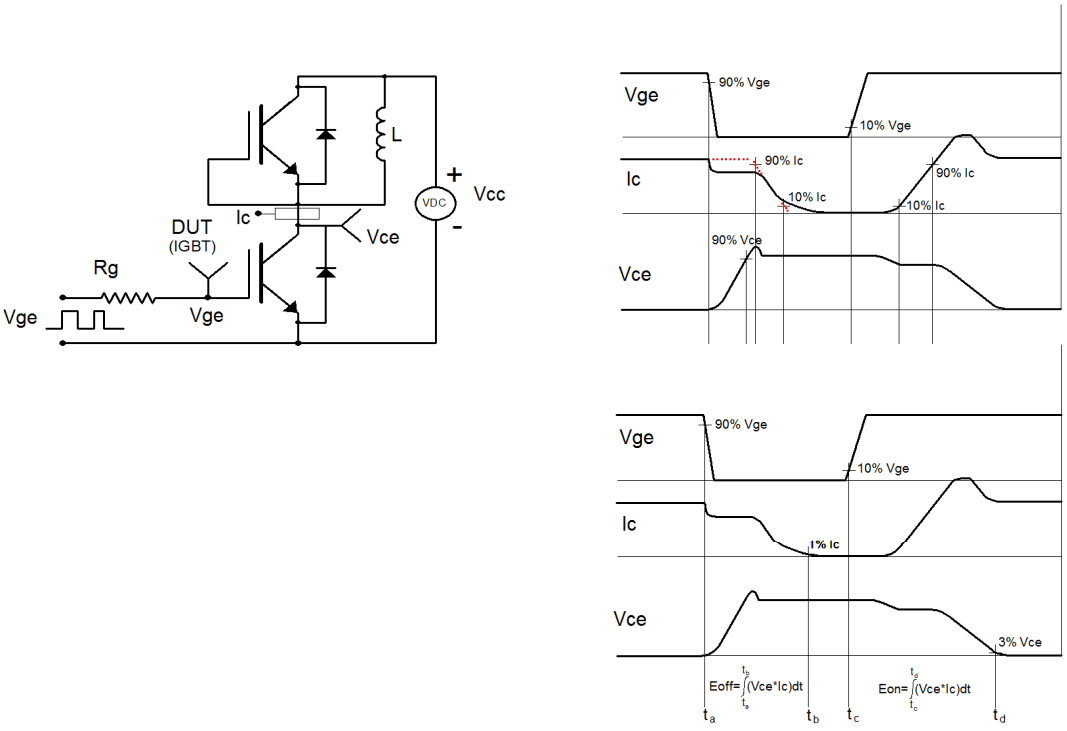


Figure B: Inductive Switching Test Circuit & Waveforms

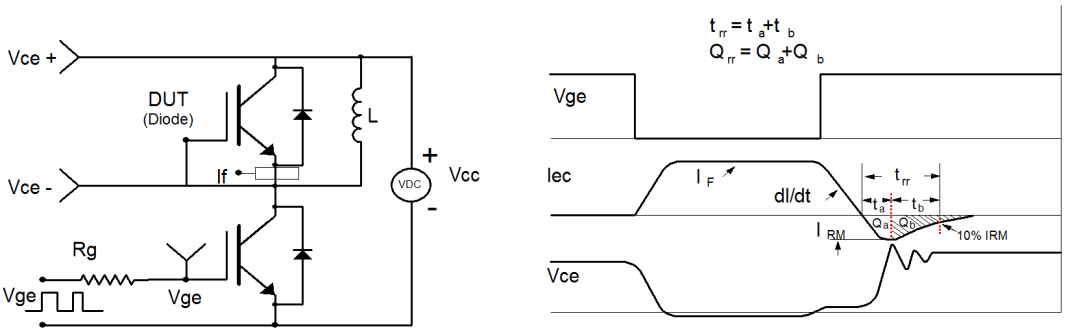
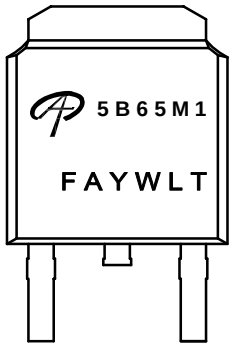


Figure C: Diode Recovery Test Circuit & Waveforms

ALPHA & OMEGA SEMICONDUCTOR

Document No.	PD-02300
Version	A
Title	AOD5B65M1 Marking Description

TO252(DPAK) PACKAGE MARKING DESCRIPTION



Green product

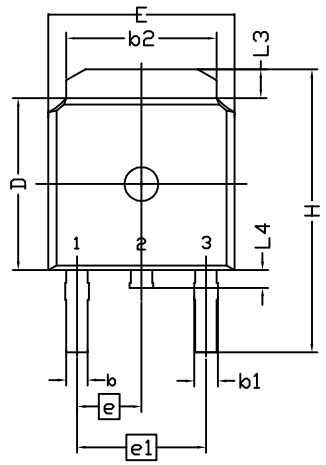
NOTE:
LOGO - AOS Logo
5B65M1 - Part number code
F - Fab code
A - Assembly location code
Y - Year code
W - Week code
L&T - Assembly lot code

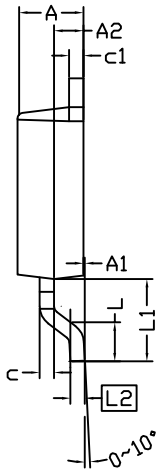
PART NO.	DESCRIPTION	CODE
AOD5B65M1	Green product	5B65M1

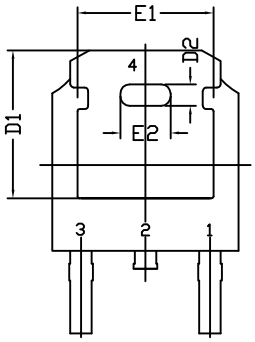
ALPHA & OMEGA
SEMICONDUCTOR, LTD.

Document No.	PO−00009
Version	S

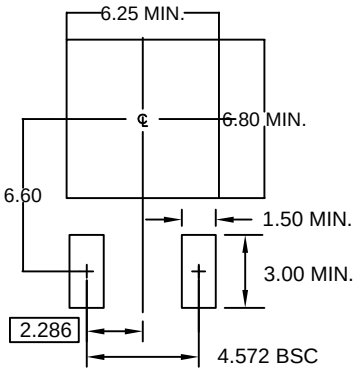
TO252(DPAK) PACKAGE OUTLINE







RECOMMENDED LAND PATTERN



UNIT: mm

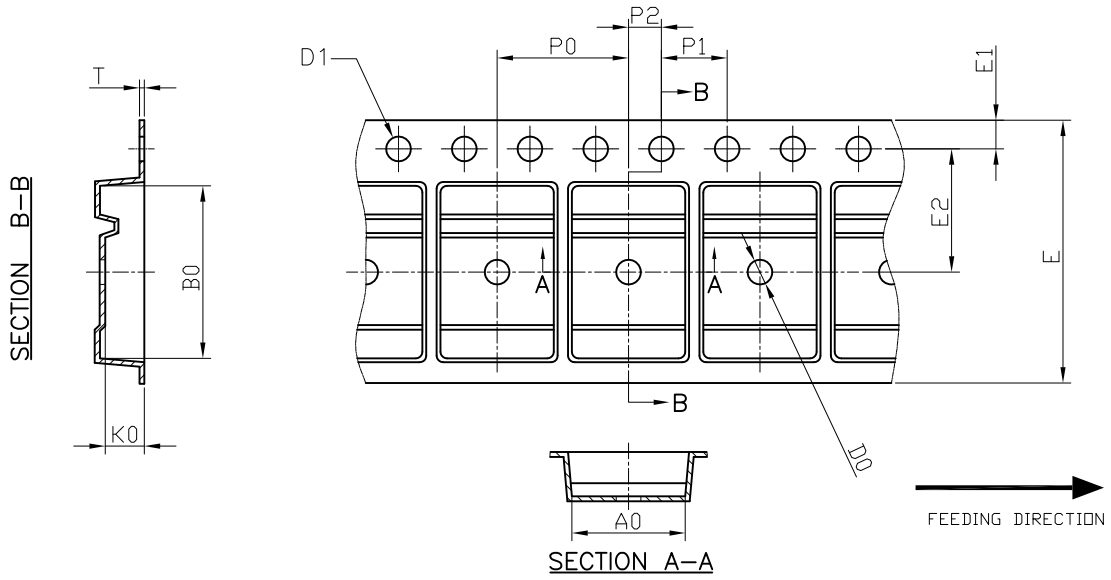
SYMBOL	DIMENSION IN MILLIMETERS			DIMENSIONS IN INCHES		
	MIN.	NOM.	MAX.	MIN.	NOM.	MAX.
A	2.184	2.286	2.388	0.086	0.090	0.094
A1	0.000	-----	0.127	0.000	-----	0.005
A2	0.889	1.041	1.143	0.035	0.041	0.045
b	0.635	0.762	0.889	0.025	0.030	0.035
b1	0.762	0.840	1.143	0.030	0.033	0.045
b2	4.953	5.340	5.461	0.195	0.210	0.215
c	0.450	0.508	0.610	0.018	0.020	0.024
c1	0.450	0.508	0.610	0.018	0.020	0.024
D	5.969	6.096	6.223	0.235	0.240	0.245
D1	5.210	5.249	5.380	0.205	0.207	0.212
D2	0.662	0.762	0.862	0.026	0.030	0.034
E	6.350	6.604	6.731	0.250	0.260	0.265
E1	4.318	4.826	4.901	0.170	0.190	0.193
E2	1.678	1.778	1.878	0.066	0.070	0.074
e	2.286 BSC			0.090 BSC		
e1	4.572 BSC			0.180 BSC		
H	9.398	10.033	10.414	0.370	0.395	0.410
L	1.270	1.520	2.032	0.050	0.060	0.080
L1	2.921 REF.			0.115REF.		
L2	0.408	0.508	0.608	0.016	0.020	0.024
L3	0.889	1.016	1.270	0.035	0.040	0.050
L4	0.635	-----	1.016	0.025	-----	0.040

NOTE
1. PACKAGE BODY SIZES EXCLUDE MOLD FLASH AND GATE BURRS. MOLD FLASH SHOULD BE LESS THAN 6 MILS.
2. DIMENSION L IS MEASURED IN GAUGE PLANE
3. TOLERANCE 0.10 mm UNLESS OTHERWISE SPECIFIED
4. CONTROLLING DIMENSION IS MILLIMETER. CONVERTED INCH DIMENSIONS ARE NOT NECESSARILY EXACT.
5. REFER TO JEDEC TO-252 (AA)

ALPHA & OMEGA SEMICONDUCTOR

DPAK Tape and Reel Data

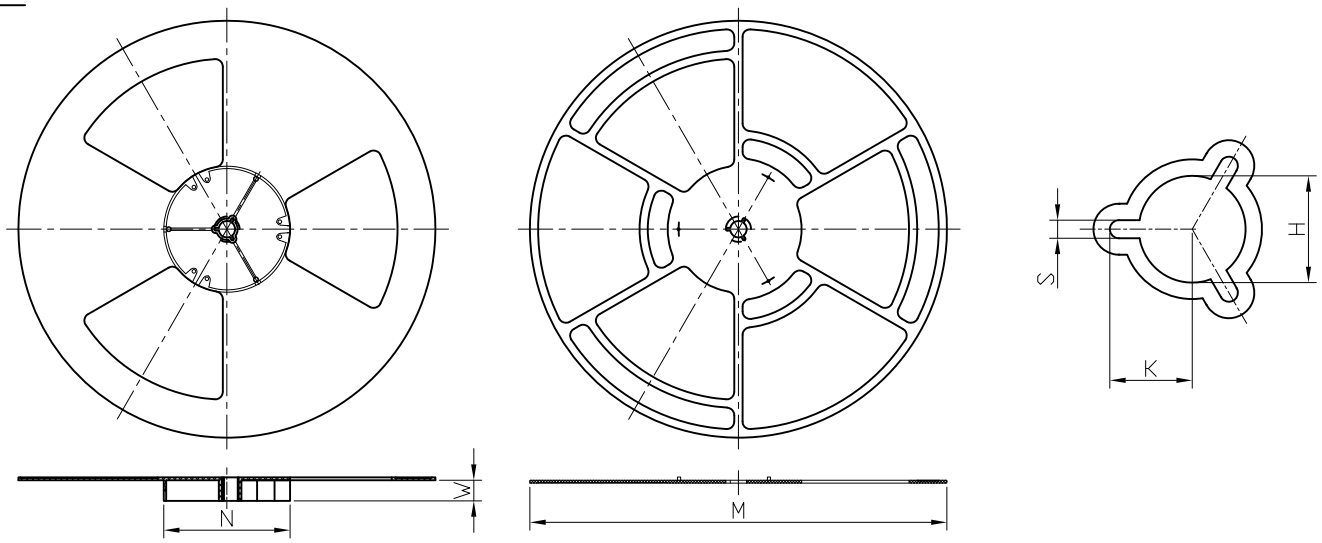
DPAK Carrier Tape



UNIT: MM

PACKAGE	A0	B0	K0	D0	D1	E	E1	E2	P0	P1	P2	T
DPAK (16 mm)	6.90 ±0.10	10.50 ±0.10	2.50 ±0.10	1.50 +0.1 −0	1.50 +0.1 −0	16.00 ±0.30	1.75 ±0.10	7.50 ±0.10	8.00 ±0.10	4.00 ±0.10	2.00 ±0.10	0.30 ±0.05

DPAK Reel



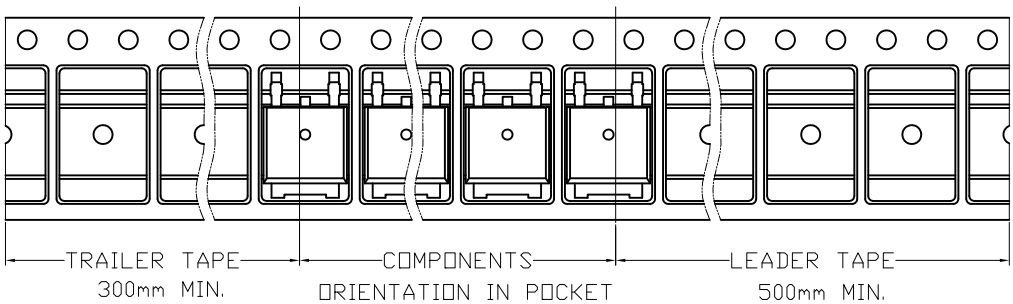
UNIT: MM

TAPE SIZE	REEL SIZE	M	N	W	H	K	S
16 mm	ø330	ø330.00 +0.25 −4.00	ø100.00 ±0.2	16.4 +2.0 −0.0	ø13.00 +0.50 −0.20	10.5 ±0.25	2.2 ±0.25

DPAK Tape

Leader / Trailer & Orientation

Unit Per Reel: 2500pcs



AOS Semiconductor
Product Reliability Report

AOD5B65M1, rev A

Plastic Encapsulated Device

ALPHA & OMEGA Semiconductor, Inc

www.aosmd.com

This AOS product reliability report summarizes the qualification result for AOD5B65M1. Accelerated environmental tests are performed on a specific sample size, and then followed by electrical test at end point. Review of final electrical test result confirms that AOD5B65M1 passes AOS quality and reliability requirements. The released product will be categorized by the process family and be routine monitored for continuously improving the product quality.

Table of Contents:

I. Product Description
II. Package and Die information
III. Reliability Stress Test Summary and Results
IV. Reliability Evaluation

I. Product Description:

• Latest AlphaIGBT (α IGBT) technology
• 650V breakdown voltage
• Very fast and soft recovery freewheeling diode
• High efficient turn-on di/dt controllability
• Low $V_{CE(SAT)}$ enables high efficiencies
• Low turn-off switching loss and softness
• Very good EMI behavior
• High short-circuit ruggedness

Details refer to the datasheet.

II. Die / Package Information:

	AOD5B65M1
Process	Standard sub-micron 650V Alpha IGBT™ with Diode
Package Type	TO-252
Lead Frame	Bare Cu
Die Attach	Solder Paste
Bond	Al wire
Mold Material	Epoxy resin with silica filler
Moisture Level	Level 1

ALPHA & OMEGA SEMICONDUCTOR

III. Reliability Stress Test Summary and Results

Test Item	Test Condition	Time Point	Total Sample Size	Number of Failures	Reference Standard
HTGB	Temp = 150°C , Vge=100% of Vgemax	168 / 500 / 1000 hours	924 pcs	0	JESD22-A108
HTRB	Temp = 150°C , Vce=80% of Vcemax	168 / 500 / 1000 hours	924 pcs	0	JESD22-A108
MSL Precondition	168hr 85°C / 85%RH + 3 cycle reflow@260°C (MSL 1)	-	5313 pcs	0	JESD22-A113
HAST	130°C , 85%RH, 33.3 psia, Vce = 80% of Vcemax up to 42V	96 hours	924 pcs	0	JESD22-A110
H3TRB	85°C , 85%RH, Vce = 80% of Vcemax up to 100V	1000 hours	924 pcs	0	JESD22-A101
Autoclave	121°C , 29.7psia, RH=100%	96 hours	924 pcs	0	JESD22-A102
Temperature Cycle	-65°C to 150°C , air to air,	1000 cycles	924 pcs	0	JESD22-A104
HTSL	Temp = 150°C	1000 hours	924 pcs	0	JESD22-A103
Power Cycling	Δ Tj = 100°C	15000 cycles	693 pcs	0	AEC Q101

Note: The reliability data presents total of available generic data up to the published date.

IV. Reliability Evaluation

FIT rate (per billion): 1.91
MTTF = 59839 years

The presentation of FIT rate for the individual product reliability is restricted by the actual burn-in sample size. Failure Rate Determination is based on JEDEC Standard JESD 85. FIT means one failure per billion hours.

Failure Rate = $Chi^2 \times 10^9$ **/ [**2 (N) (H) (Af)**] =** 1.91
MTTF = 10^9 / FIT = 59839 years

Chi² = Chi Squared Distribution, determined by the number of failures and confidence interval
N = Total Number of units from burn-in tests
H = Duration of burn-in testing
Af = Acceleration Factor from Test to Use Conditions (Ea = 0.7eV and Tuse = 55°C)
Acceleration Factor [**Af**] = **Exp** [Ea / **k** (1/Tj u – 1/Tj s)]

Acceleration Factor ratio list:

	55 deg C	70 deg C	85 deg C	100 deg C	115 deg C	130 deg C	150 deg C
Af	259	87	32	13	5.64	2.59	1

Tj s = Stressed junction temperature in degree (Kelvin), K = C+273.16
Tj u =The use junction temperature in degree (Kelvin), K = C+273.16
k = Boltzmann's constant, 8.617164 X 10^{-5}eV / K