AOTF20B65LN2

650V, 20A AlphaIGBT™

With Soft and Fast Recovery Anti-Parallel Diode

General Description

- Latest AlphaIGBT (αIGBT) technology
- 650V breakdown voltage
- Very low $V_{CE(sat)}$
- Very fast and soft recovery freewheeling diode
- High efficient turn-on di/dt controllability
- Low Turn-Off switching loss and softness
- Very good EMI behavior

Applications

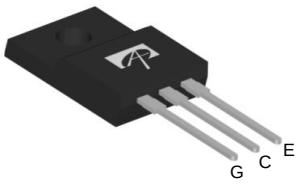
- Motor drives
- Power tools and sewing machines
- Mid to high range switching frequency converters
- Other hard switching applications

Product Summary

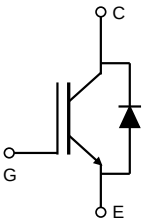
V_{CE}	650V
I_C (T_C=100°C)	20A
$V_{CE(sat)}$ (T_J=25°C)	1.54V

Green Product

TO-220F



AOTF20B65LN2



Orderable Part Number	Package Type	Form	Minimum Order Quantity
AOTF20B65LN2	TO220F	Tube	1000

Absolute Maximum Ratings T_A=25°C unless otherwise noted

Parameter		Symbol	AOTF20B65LN2	Units
Collector-Emitter Voltage		V_{CE}	650	V
Gate-Emitter Voltage		V_{GE}	±30	V
Continuous Collector Current	T_C=25°C	I_C	40[2]	A
	T_C=100°C		20[2]	
Pulsed Collector Current, Limited by T_{Jmax}		I_{CM}	60	A
Turn off SOA, V_{CE}≤650V, Limited by T_{Jmax}		I_{LM}	60	A
Continuous Diode Forward Current	T_C=25°C	I_F	40[2]	A
	T_C=100°C		20[2]	
Diode Pulsed Current, Limited by T_{Jmax}		I_{FM}	60	A
Short Circuit Withstanding Time [1] V_{GE}=15V, V_{CC}≤400V, T_J≤150°C		t_{SC}	5	µs
Power Dissipation	T_C=25°C	P_D	45	W
	T_C=100°C		18	
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	AOTF20B65LN2	Units
Maximum Junction-to-Ambient	$R_{\theta JA}$	65	°C/W
Maximum IGBT Junction-to-Case	$R_{\theta JC}$	2.8	°C/W
Maximum Diode Junction-to-Case	$R_{\theta JC}$	3.2	°C/W

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

(2) TO220F I_C follows TO220/TO263.

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=20A	T_J=25°C	-	1.54	1.95	V
			T_J=125°C	-	1.83	-	
			T_J=150°C	-	1.91	-	
V_F	Diode Forward Voltage	V_{GE}=0V, I_F=20A	T_J=25°C	-	1.6	2.1	V
			T_J=125°C	-	1.66	-	
			T_J=150°C	-	1.63	-	
$V_{GE(th)}$	Gate-Emitter Threshold Voltage	V_{CE}=5V, I_C=1mA		-	4.7	-	V
I_{CES}	Zero Gate Voltage Collector Current	V_{CE}=650V, V_{GE}=0V	T_J=25°C	-	-	10	µA
			T_J=125°C	-	-	500	
			T_J=150°C	-	-	1000	
I_{GES}	Gate-Emitter leakage current	V_{CE}=0V, V_{GE}=±30V		-	-	±100	nA
g_{FS}	Forward Transconductance	V_{CE}=20V, I_C=20A		-	19	-	S
DYNAMIC PARAMETERS							
C_{ies}	Input Capacitance	V_{GE}=0V, V_{CC}=25V, f=1MHz		-	1237	-	pF
C_{oes}	Output Capacitance			-	124	-	pF
C_{res}	Reverse Transfer Capacitance			-	38	-	pF
Q_g	Total Gate Charge	V_{GE}=15V, V_{CC}=520V, I_C=20A		-	52	-	nC
Q_{ge}	Gate to Emitter Charge			-	14	-	nC
Q_{gc}	Gate to Collector Charge			-	22	-	nC
$I_{C(SC)}$	Short Circuit Collector Current	V_{GE}=15V, V_{CC}=400V, t_{sc}≤5us, T_J≤150°C		-	150	-	A
R_g	Gate resistance	V_{GE}=0V, V_{CC}=0V, f=1MHz		-	11	-	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=20A, R_G=15Ω		-	23	-	ns
T_r	Turn-On Rise Time			-	23	-	ns
$T_{d(off)}$	Turn-Off Delay Time			-	135	-	ns
T_f	Turn-Off Fall Time			-	12	-	ns
E_{on}	Turn-On Energy			-	0.45	-	mJ
E_{off}	Turn-Off Energy			-	0.26	-	mJ
E_{total}	Total Switching Energy			-	0.71	-	mJ
T_{rr}	Diode Reverse Recovery Time	T_J=25°C, I_F=20A, dI/dt=200A/µs, V_{CC}=400V		-	266	-	ns
Q_{rr}	Diode Reverse Recovery Charge			-	0.6	-	µC
I_{rm}	Diode Peak Reverse Recovery Current			-	5.4	-	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=20A, R_G=15Ω		-	22	-	ns
T_r	Turn-On Rise Time			-	24	-	ns
$T_{d(off)}$	Turn-Off Delay Time			-	160	-	ns
T_f	Turn-Off Fall Time			-	20	-	ns
E_{on}	Turn-On Energy			-	0.49	-	mJ
E_{off}	Turn-Off Energy			-	0.44	-	mJ
E_{total}	Total Switching Energy			-	0.93	-	mJ
T_{rr}	Diode Reverse Recovery Time	T_J=150°C, I_F=20A, dI/dt=200A/µs, V_{CC}=400V		-	363	-	ns
Q_{rr}	Diode Reverse Recovery Charge			-	1.3	-	µC
I_{rm}	Diode Peak Reverse Recovery Current			-	6.9	-	A

TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

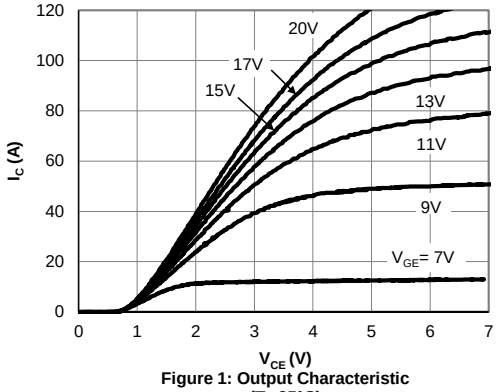


Figure 1: Output Characteristic (T_j=25°C)

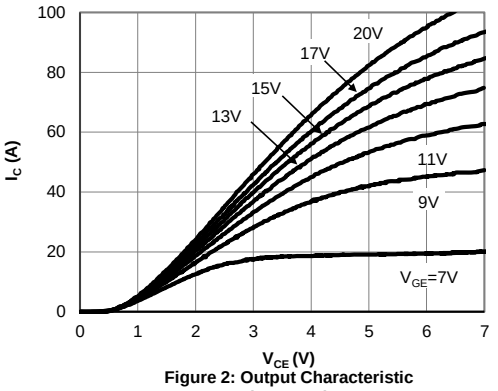


Figure 2: Output Characteristic (T_j=150°C)

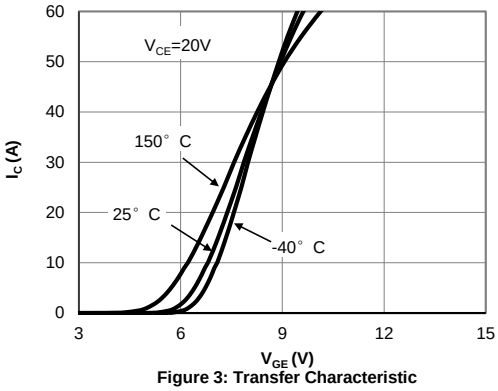


Figure 3: Transfer Characteristic

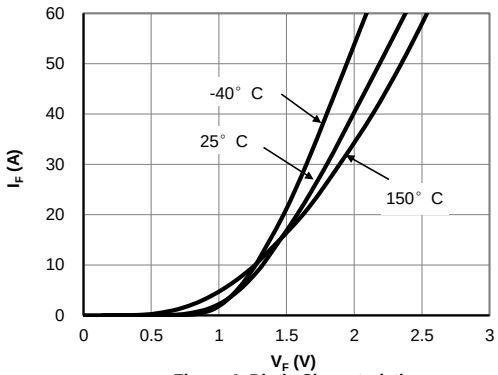


Figure 4: Diode Characteristic

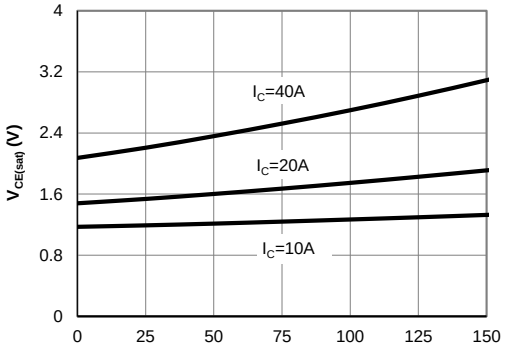


Figure 5: Collector-Emitter Saturation Voltage vs. Junction Temperature

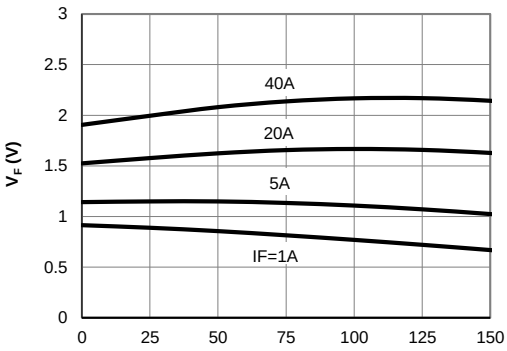


Figure 6: Diode Forward voltage vs. Junction Temperature

TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

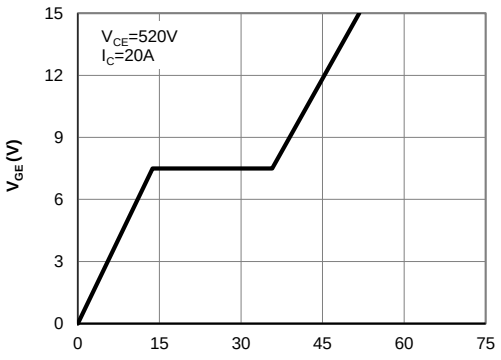


Figure 7: Gate-Charge Characteristics

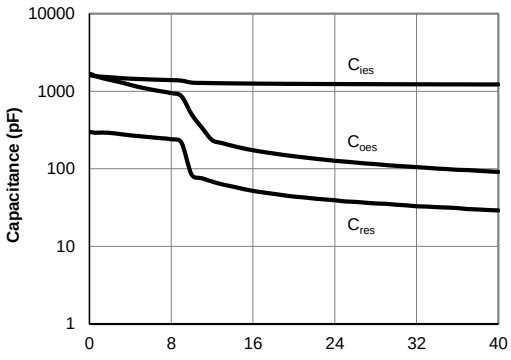


Figure 8: Capacitance Characteristic

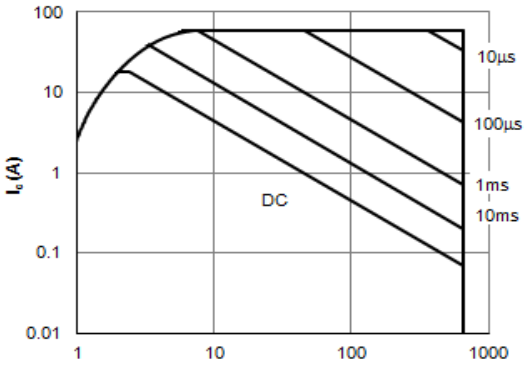


Figure 9: Forward Bias Safe Operating Area
(T_C=25°C, V_{GE}=15V)

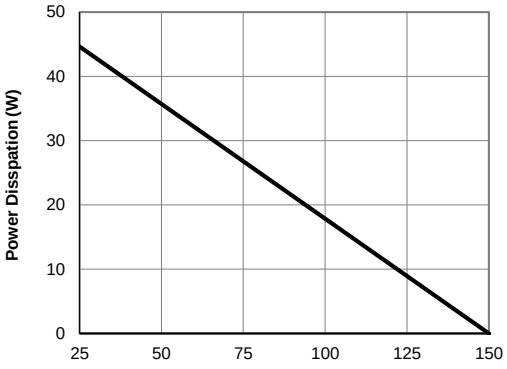


Figure 10: Power Disspation as a Function of Case

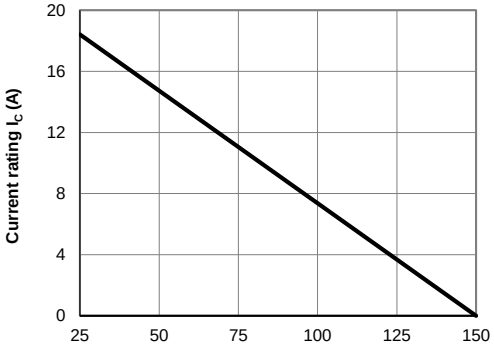


Figure 11: Current De-rating

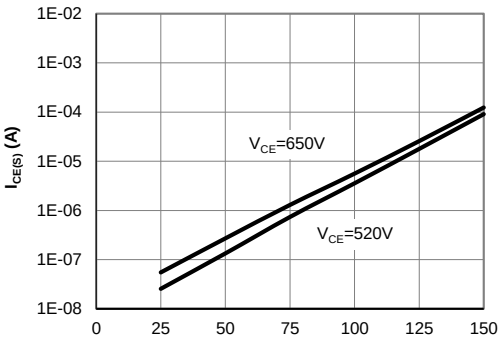


Figure 12: Diode Reverse Leakage Current vs. Junction Temperature

TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

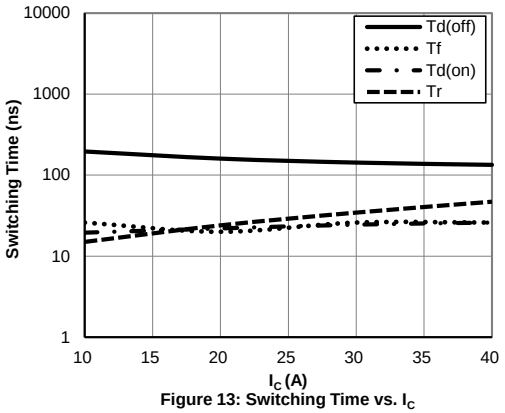


Figure 13: Switching Time vs. I_C
(T_j=150°C, V_{GE}=15V, V_{CE}=400V, R_g=15Ω)

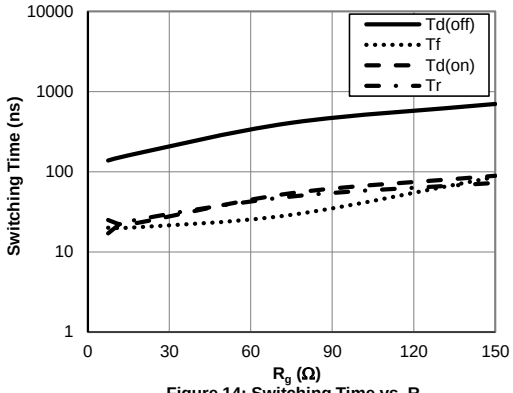


Figure 14: Switching Time vs. R_g
(T_j=150°C, V_{GE}=15V, V_{CE}=400V, I_C=20A)

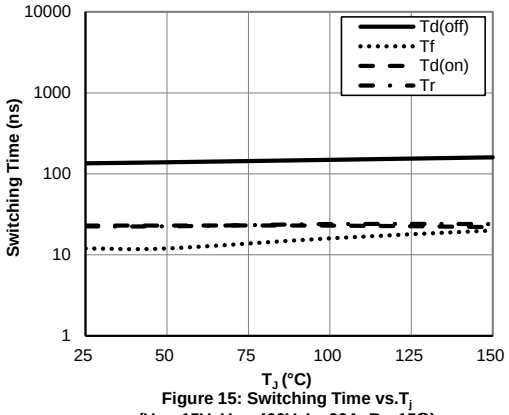


Figure 15: Switching Time vs.T_j
(V_{GE}=15V, V_{CE}=400V, I_C=20A, R_g=15Ω)

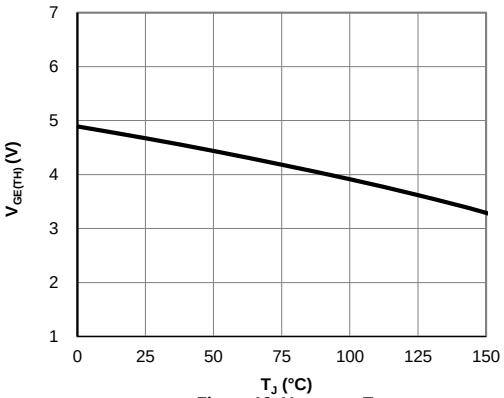


Figure 16: $V_{GE(TH)}$ vs. T_j

TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

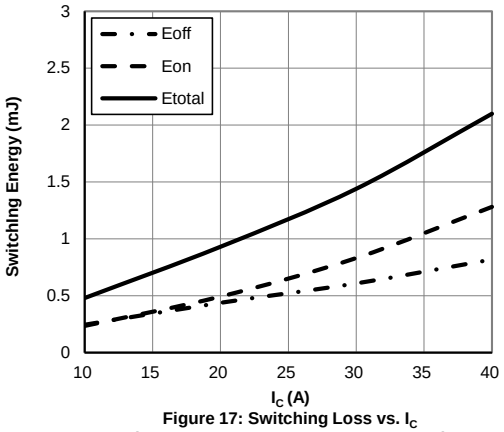


Figure 17: Switching Loss vs. I_C
(T_j=150°C, V_{GE}=15V, V_{CE}=400V, R_g=15Ω)

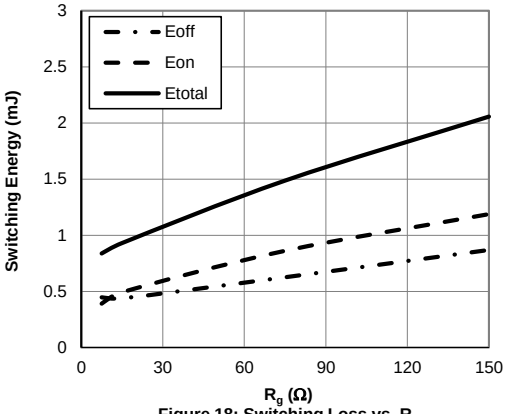


Figure 18: Switching Loss vs. R_g
(T_j=150°C, V_{GE}=15V, V_{CE}=400V, I_C=20A)

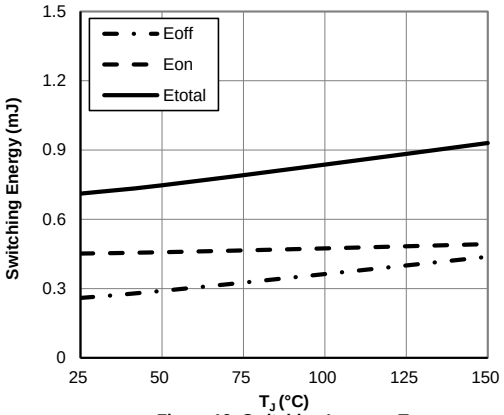


Figure 19: Switching Loss vs. T_j
(V_{GE}=15V, V_{CE}=400V, I_C=20A, R_g=15Ω)

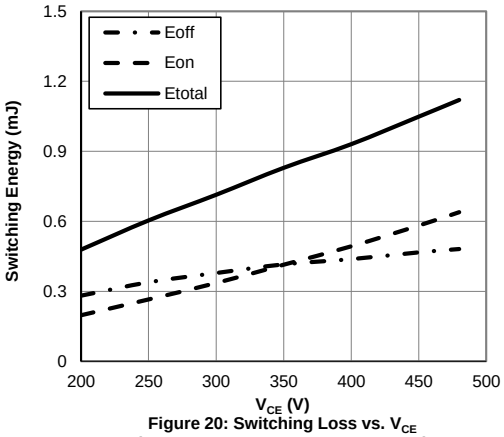


Figure 20: Switching Loss vs. V_{CE}
(T_j=150°C, V_{GE}=15V, I_C=20A, R_g=15Ω)

TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

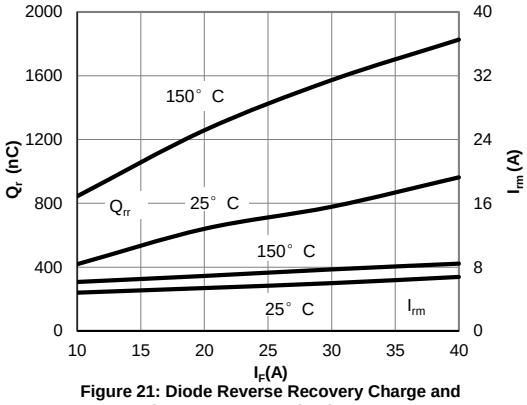


Figure 21: Diode Reverse Recovery Charge and Peak Current vs. Conduction Current (V_{GE}=15V, V_{CE}=400V, di/dt=200A/µs)

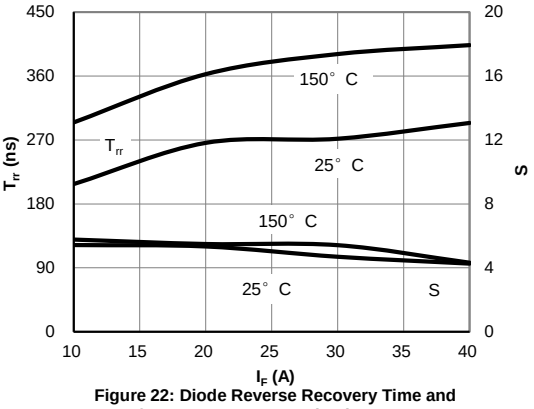


Figure 22: Diode Reverse Recovery Time and Softness Factor vs. Conduction Current (V_{GE}=15V, V_{CE}=400V, di/dt=200A/µs)

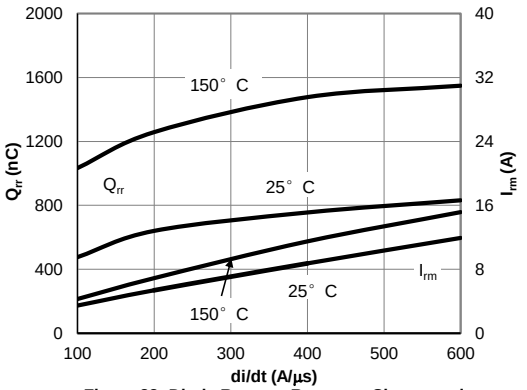


Figure 23: Diode Reverse Recovery Charge and Peak Current vs. di/dt (V_{GE}=15V, V_{CE}=400V, I_F=20A)

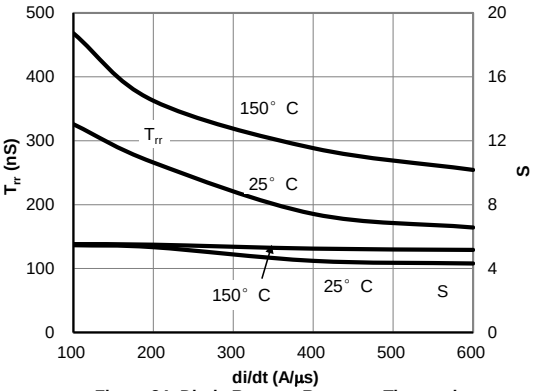


Figure 24: Diode Reverse Recovery Time and Softness Factor vs. di/dt (V_{GE}=15V, V_{CE}=400V, I_F=20A)

TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

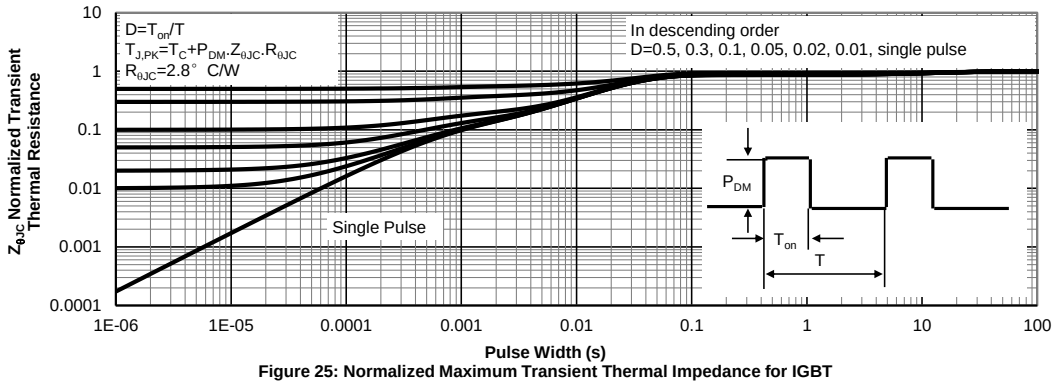


Figure 25: Normalized Maximum Transient Thermal Impedance for IGBT

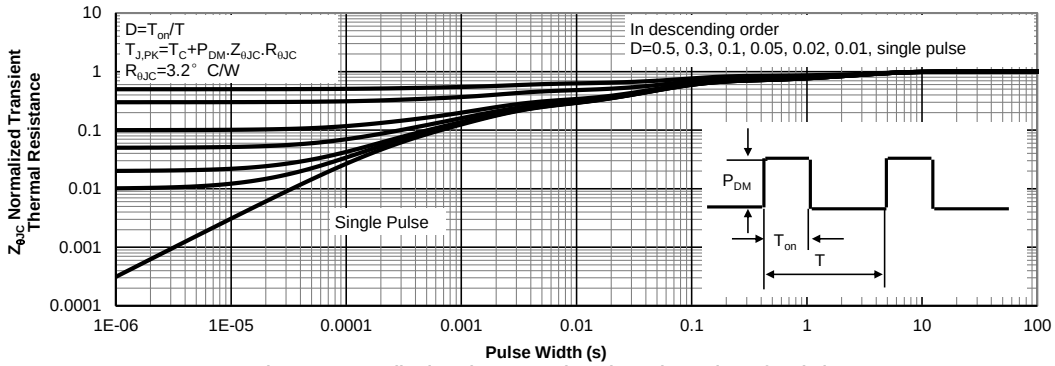


Figure 26: Normalized Maximum Transient Thermal Impedance for Diode

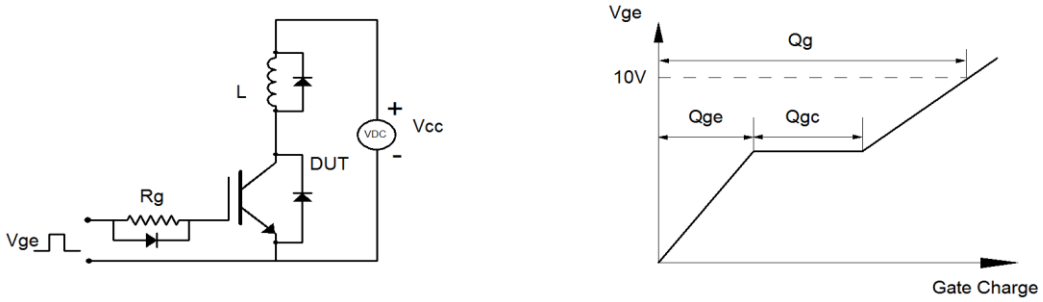


Figure A: Gate Charge Test Circuit & Waveforms

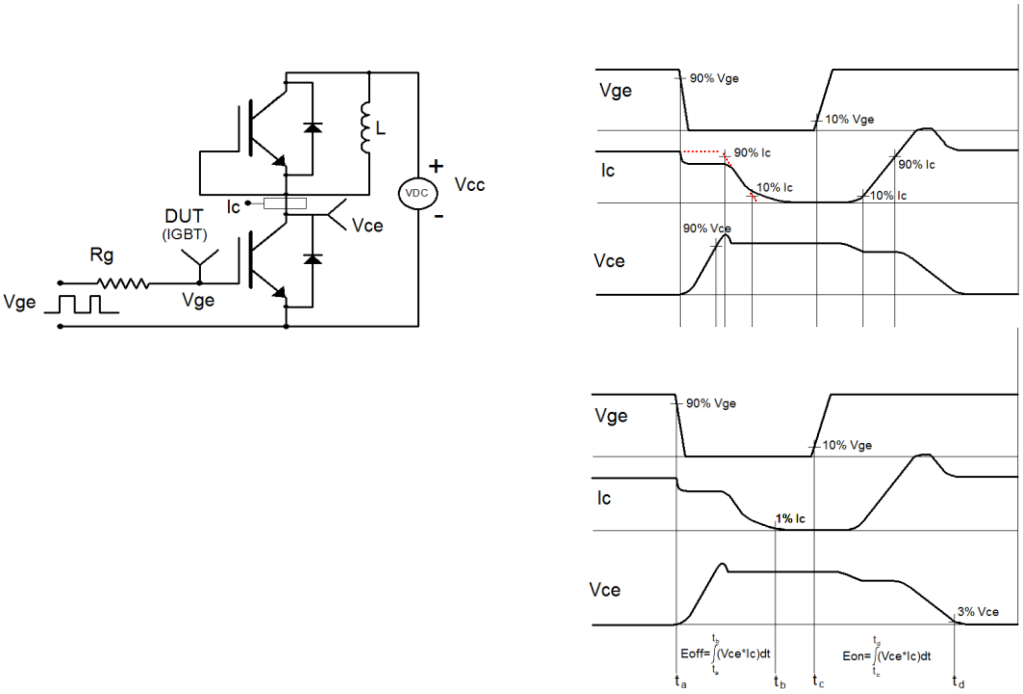


Figure B: Inductive Switching Test Circuit & Waveforms

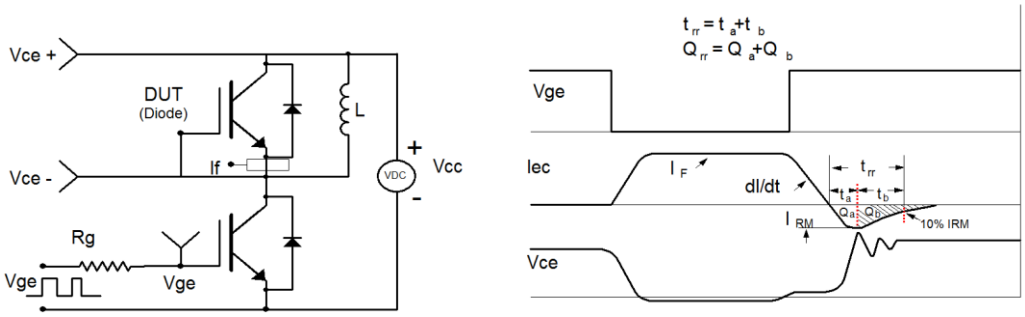
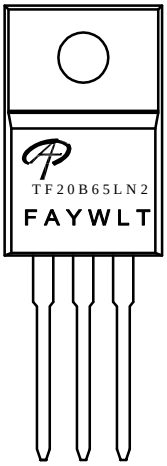


Figure C: Diode Recovery Test Circuit & Waveforms

ALPHA & OMEGA SEMICONDUCTOR

Document No.	PD-02568
Version	A
Title	AOTF20B65LN2 Marking Description

TO220F PACKAGE MARKING DESCRIPTION



Standard product

NOTE:

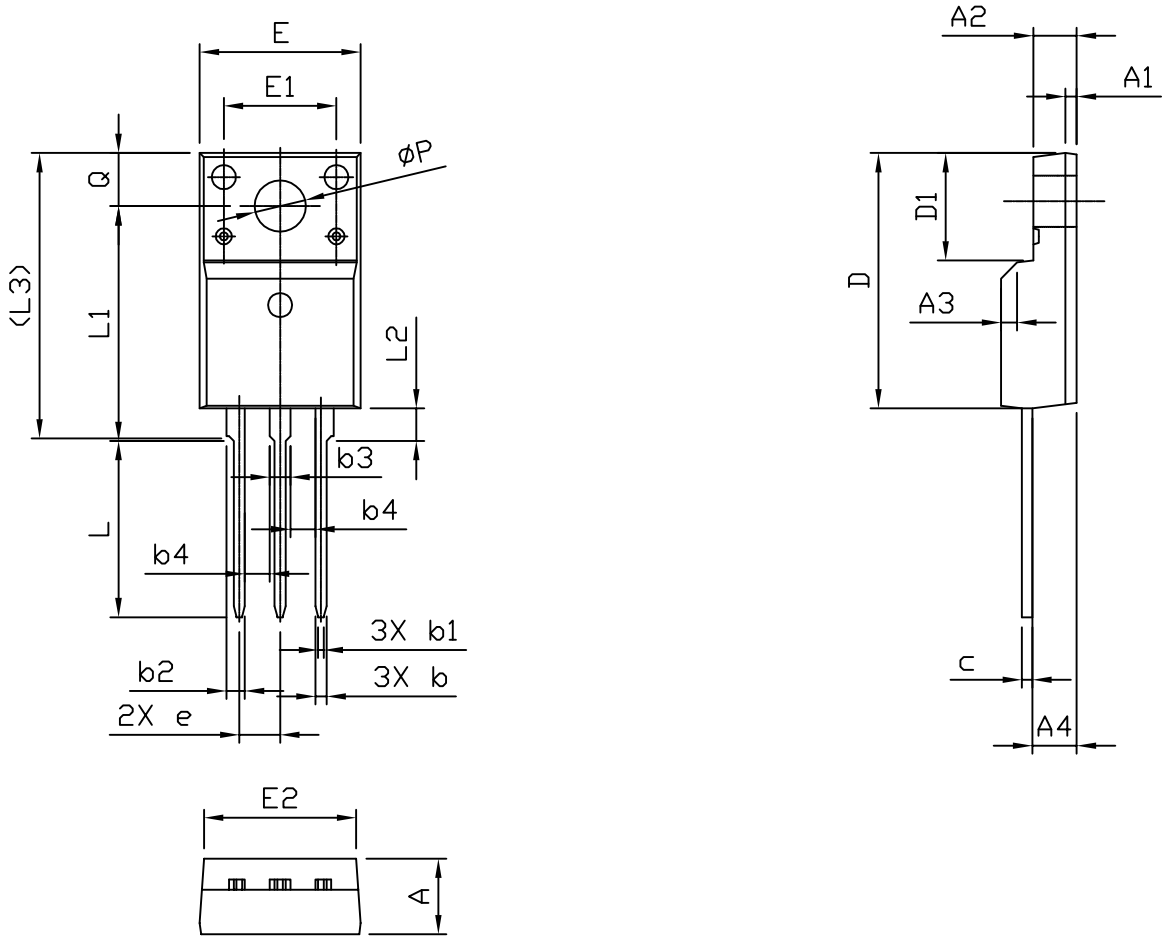
LOGO	- AOS Logo
TF20B65LN2	- Part number code
F	- Fab code
A	- Assembly location code
Y	- Year code
W	- Week code
L&T	- Assembly lot code

PART NO.	DESCRIPTION	CODE
AOTF20B65LN2	Standard product	TF20B65LN2

ALPHA & OMEGA SEMICONDUCTOR

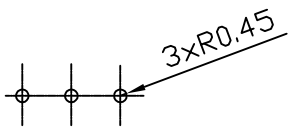
Document No.	PO-00059
Version	F

TO220F PACKAGE OUTLINE



SYMBOLS	DIMENSIONS IN MILLIMETERS			DIMENSIONS IN INCHES		
	MIN	NOM	MAX	MIN	NOM	MAX
A	4.50	4.70	4.90	0.177	0.185	0.193
A1	---	0.70	---	---	0.028	---
A2	2.34	2.54	2.74	0.092	0.100	0.108
A3		1X45°			0.039X45°	
A4	2.66	2.76	2.86	0.105	0.106	0.113
b	0.59	0.69	0.79	0.023	0.027	0.031
b1	0.25	0.35	0.45	0.010	0.014	0.018
b2	1.14	1.24	1.29	0.045	0.049	0.051
b3	1.28	1.38	1.43	0.050	0.054	0.056
b4		1.40 MIN.			0.055 MIN.	
c	0.59	0.64	0.74	0.023	0.025	0.029
D	15.67	15.87	16.07	0.617	0.625	0.633
D1	6.48	6.68	6.88	0.255	0.263	0.271
e		2.54 BSC			0.100 BSC.	
E	9.96	10.16	10.36	0.392	0.400	0.408
E1	---	7.00	---	---	0.276	---
E2	9.26	9.46	9.66	0.365	0.372	0.380
L	10.76	10.96	11.16	0.424	0.431	0.439
L1	14.39	14.59	14.79	0.567	0.574	0.582
L2	1.70	2.03	2.20	0.067	0.080	0.087
(L3)	---	17.75	17.90	----	0.699	0.705
Q	3.20	3.30	3.40	0.126	0.130	0.134
ØP	3.08	3.18	3.28	0.121	0.125	0.129

RECOMMENDATION OF HOLE PATTERN



UNIT: mm

NOTE
1. PACKAGE BODY SIZES EXCLUDE MOLD FLASH AND GATE BURRS.
   MOLD FLASH SHOULD BE LESS THAN 6 MIL.
2. TOLERANCE 0.100 MILLIMETERS UNLESS OTHERWISE SPECIFIED.
3. CONTROLLING DIMENSION IS MILLIMETER.
   CONVERTED INCH DIMENSIONS ARE NOT NECESSARILY EXACT.
4. DIMENSION WITH "()" IS FOR REFERENCE.

AOS Semiconductor
Product Reliability Report

AOTF20B65LN2, rev A

Plastic Encapsulated Device

ALPHA & OMEGA Semiconductor, Inc

www.aosmd.com

Apr, 2018

This AOS product reliability report summarizes the qualification result for AOTF20B65LN2. 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 AOTF20B65LN2 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.

I. 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	462 pcs	0	JESD22-A108
HTRB	Temp = 150°C , Vce=100% of Vcemax	168 / 500 / 1000 hours	462 pcs	0	JESD22-A108
HAST	130°C , 85%RH, 33.3 psia, Vce = 80% of Vcemax up to 42V	96 hours	693 pcs	0	JESD22-A110
H3TRB	85°C , 85%RH, Vce = 80% of Vcemax up to 100V	1000 hours	693 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	693 pcs	0	JESD22-A103
IOL	∆ Tj = 100°C	8572 cycles	693 pcs	0	AEC Q101
Resistance to Solder Heat	Temp = 270°C	15 seconds	30 pcs	0	JESD22-B106

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

II. Reliability Evaluation

FIT rate (per billion): 3.82
MTTF =29919 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)**] =** 3.82

MTTF = 10^9 / FIT = 29919 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

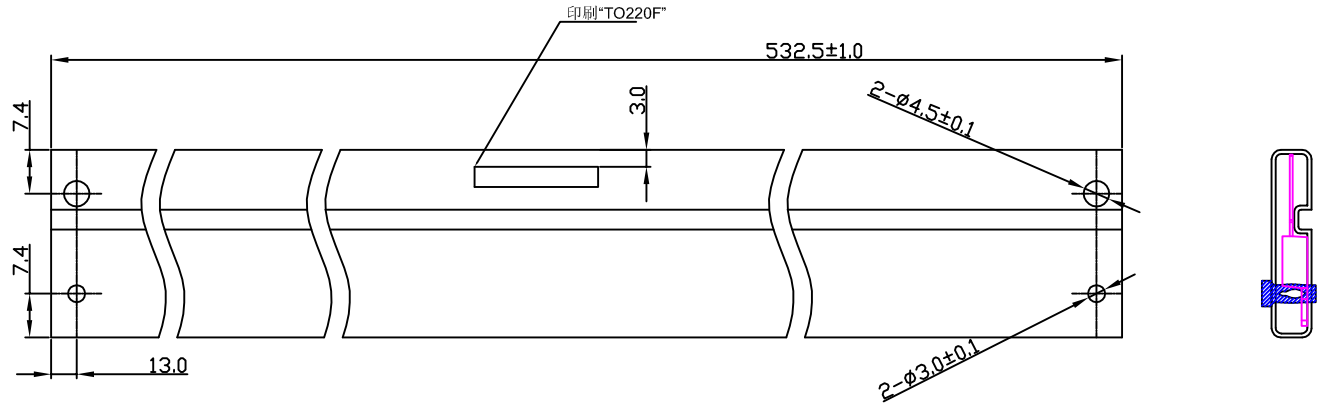
Tj u =The use junction temperature in degree (Kelvin), K = C+273.16

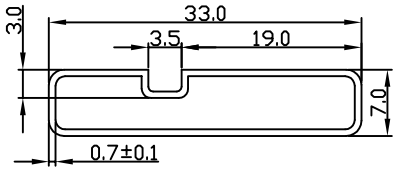
k = Boltzmann's constant, 8.617164 X 10^{-5}eV / K

ALPHA & OMEGA SEMICONDUCTOR

TO220F/TO220FL TUBE Data

TO220F/TO220FL TUBE





2:1

NOTE

1. TUBE
   - MATERIAL : POLYVINYL CHLORIDE
   - COLOR : TRANSPARENCY
   - PRINT COLOR: BLACK
   - CAMBAR : 1.5 MAX
   - ALL DIMENSION: MM
2. PIN
   - COLOR : GREEN (ONE PIN MUST BE INSERTED IN LEFT-SIDE OF " TO220F" AND ANOTHER PIN IS FREE.)
3. ALL UNSPECIFICATED SPECIFICATIONS FOLLOW TUBE GENERAL SPEC. UNSPECIFICATED TOLERANCE ±0.2
4. PACKING Q'TY :

PKG	Q'TY(PCS)
TO220F/ TO220FL	50