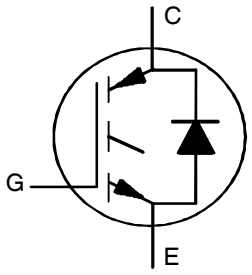
International
IOR Rectifier

SMPS IGBT

PD - 95329

IRGP35B60PDPbF

WARP2 SERIES IGBT WITH
ULTRAFAST SOFT RECOVERY DIODE



n-channel

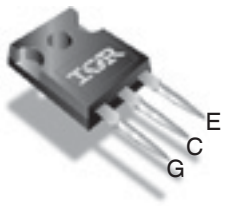
V_{CES} = 600V
$V_{CE(on)}$ typ. = 1.85V
@ V_{GE} = 15V I_C = 22A

Equivalent MOSFET Parameters ①
$R_{CE(on)}$ typ. = 84mΩ
I_D (FET equivalent) = 35A

Applications
- Telecom and Server SMPS
- PFC and ZVS SMPS Circuits
- Uninterruptable Power Supplies
- Consumer Electronics Power Supplies
- Lead-Free

Features
- NPT Technology, Positive Temperature Coefficient
- Lower V_{CE}(SAT)
- Lower Parasitic Capacitances
- Minimal Tail Current
- HEXFRED Ultra Fast Soft-Recovery Co-Pack Diode
- Tighter Distribution of Parameters
- Higher Reliability

Benefits
- Parallel Operation for Higher Current Applications
- Lower Conduction Losses and Switching Losses
- Higher Switching Frequency up to 150kHz



TO-247AC

Absolute Maximum Ratings

	Parameter	Max.	Units
V_{CES}	Collector-to-Emitter Voltage	600	V
I_C @ T_C = 25°C	Continuous Collector Current	60	A
I_C @ T_C = 100°C	Continuous Collector Current	34	
I_{CM}	Pulse Collector Current (Ref. Fig. C.T.4)	120	
I_{LM}	Clamped Inductive Load Current ②	120	
I_F @ T_C = 25°C	Diode Continous Forward Current	40	
I_F @ T_C = 100°C	Diode Continous Forward Current	15	
I_{FRM}	Maximum Repetitive Forward Current ③	60	
V_{GE}	Gate-to-Emitter Voltage	±20	V
P_D @ T_C = 25°C	Maximum Power Dissipation	308	W
P_D @ T_C = 100°C	Maximum Power Dissipation	123	
T_J T_{STG}	Operating Junction and Storage Temperature Range	-55 to +150	°C
	Soldering Temperature for 10 sec.	300 (0.063 in. (1.6mm) from case)	
	Mounting Torque, 6-32 or M3 Screw	10 lbf·in (1.1 N·m)	

Thermal Resistance

	Parameter	Min.	Typ.	Max.	Units
$R_{\theta JC}$ (IGBT)	Thermal Resistance Junction-to-Case-(each IGBT)	—	—	0.41	°C/W
$R_{\theta JC}$ (Diode)	Thermal Resistance Junction-to-Case-(each Diode)	—	—	1.7	
$R_{\theta CS}$	Thermal Resistance, Case-to-Sink (flat, greased surface)	—	0.24	—	
$R_{\theta JA}$	Thermal Resistance, Junction-to-Ambient (typical socket mount)	—	—	40	
	Weight	—	6.0 (0.21)	—	g (oz)

Electrical Characteristics @ T_J = 25°C (unless otherwise specified)

	Parameter	Min.	Typ.	Max.	Units	Conditions	Ref.Fig
$V_{(BR)CES}$	Collector-to-Emitter Breakdown Voltage	600	—	—	V	V_{GE} = 0V, I_C = 500µA	
$\Delta V_{(BR)CES}/\Delta T_J$	Temperature Coeff. of Breakdown Voltage	—	0.78	—	V/°C	V_{GE} = 0V, I_C = 1mA (25°C-125°C)	
R_G	Internal Gate Resistance	—	1.7	—	Ω	1MHz, Open Collector	
$V_{CE(on)}$	Collector-to-Emitter Saturation Voltage	—	1.85	2.15	V	I_C = 22A, V_{GE} = 15V	4, 5,6,8,9
		—	2.25	2.55		I_C = 35A, V_{GE} = 15V	
		—	2.37	2.80		I_C = 22A, V_{GE} = 15V, T_J = 125°C	
		—	3.00	3.45		I_C = 35A, V_{GE} = 15V, T_J = 125°C	
$V_{GE(th)}$	Gate Threshold Voltage	3.0	4.0	5.0	V	I_C = 250µA	7,8,9
$\Delta V_{GE(th)}/\Delta TJ$	Threshold Voltage temp. coefficient	—	-10	—	mV/°C	V_{CE} = V_{GE}, I_C = 1.0mA	
gfe	Forward Transconductance	—	36	—	S	V_{CE} = 50V, I_C = 22A, PW = 80µs	
I_{CES}	Collector-to-Emitter Leakage Current	—	3.0	375	µA	V_{GE} = 0V, V_{CE} = 600V	
		—	0.35	—	mA	V_{GE} = 0V, V_{CE} = 600V, T_J = 125°C	
V_{FM}	Diode Forward Voltage Drop	—	1.30	1.70	V	I_F = 15A, V_{GE} = 0V	10
		—	1.20	1.60		I_F = 15A, V_{GE} = 0V, T_J = 125°C	
I_{GES}	Gate-to-Emitter Leakage Current	—	—	±100	nA	V_{GE} = ±20V, V_{CE} = 0V	

Switching Characteristics @ T_J = 25°C (unless otherwise specified)

	Parameter	Min.	Typ.	Max.	Units	Conditions	Ref.Fig
Qg	Total Gate Charge (turn-on)	—	160	240		I_C = 22A	17
Q_{gc}	Gate-to-Collector Charge (turn-on)	—	55	83	nC	V_{CC} = 400V	CT1
Q_{ge}	Gate-to-Emitter Charge (turn-on)	—	21	32		V_{GE} = 15V	
E_{on}	Turn-On Switching Loss	—	220	270		I_C = 22A, V_{CC} = 390V	CT3
E_{off}	Turn-Off Switching Loss	—	215	265	µJ	V_{GE} = +15V, R_G = 3.3Ω, L = 200µH	
E_{total}	Total Switching Loss	—	435	535		T_J = 25°C ④	
$t_{d(on)}$	Turn-On delay time	—	26	34		I_C = 22A, V_{CC} = 390V	CT3
t_r	Rise time	—	6.0	8.0	ns	V_{GE} = +15V, R_G = 3.3Ω, L = 200µH	
$t_{d(off)}$	Turn-Off delay time	—	110	122		T_J = 25°C ④	
t_f	Fall time	—	8.0	10			
E_{on}	Turn-On Switching Loss	—	410	465		I_C = 22A, V_{CC} = 390V	CT3
E_{off}	Turn-Off Switching Loss	—	330	405	µJ	V_{GE} = +15V, R_G = 3.3Ω, L = 200µH	11,13
E_{total}	Total Switching Loss	—	740	870		T_J = 125°C ④	WF1,WF2
$t_{d(on)}$	Turn-On delay time	—	26	34		I_C = 22A, V_{CC} = 390V	CT3
t_r	Rise time	—	8.0	11	ns	V_{GE} = +15V, R_G = 3.3Ω, L = 200µH	12,14
$t_{d(off)}$	Turn-Off delay time	—	130	150		T_J = 125°C ④	WF1,WF2
t_f	Fall time	—	12	16			
C_{ies}	Input Capacitance	—	3715	—		V_{GE} = 0V	16
C_{oes}	Output Capacitance	—	265	—		V_{CC} = 30V	
C_{res}	Reverse Transfer Capacitance	—	47	—	pF	f = 1Mhz	
C_{oes} eff.	Effective Output Capacitance (Time Related) ⑤	—	135	—		V_{GE} = 0V, V_{CE} = 0V to 480V	15
C_{oes} eff. (ER)	Effective Output Capacitance (Energy Related) ⑤	—	179	—			
RBSOA	Reverse Bias Safe Operating Area	FULL SQUARE				T_J = 150°C, I_C = 120A V_{CC} = 480V, Vp =600V Rg = 22Ω, V_{GE} = +15V to 0V	3 CT2
t_{rr}	Diode Reverse Recovery Time	—	42	60	ns	T_J = 25°C I_F = 15A, V_R = 200V,	19
		—	74	120		T_J = 125°C di/dt = 200A/µs	
Q_{rr}	Diode Reverse Recovery Charge	—	80	180	nC	T_J = 25°C I_F = 15A, V_R = 200V,	21
		—	220	600		T_J = 125°C di/dt = 200A/µs	
I_{rr}	Peak Reverse Recovery Current	—	4.0	6.0	A	T_J = 25°C I_F = 15A, V_R = 200V,	19,20,21,22
		—	6.5	10		T_J = 125°C di/dt = 200A/µs	CT5

Notes:

① $R_{CE(on)}$ typ. = equivalent on-resistance = $V_{CE(on)}$ typ./ I_C, where $V_{CE(on)}$ typ.= 1.85V and I_C =22A. I_D (FET Equivalent) is the equivalent MOSFET I_D rating @ 25°C for applications up to 150kHz. These are provided for comparison purposes (only) with equivalent MOSFET solutions.

② V_{CC} = 80% (V_{CES}), V_{GE} = 15V, L = 28 µH, R_G = 22 Ω.

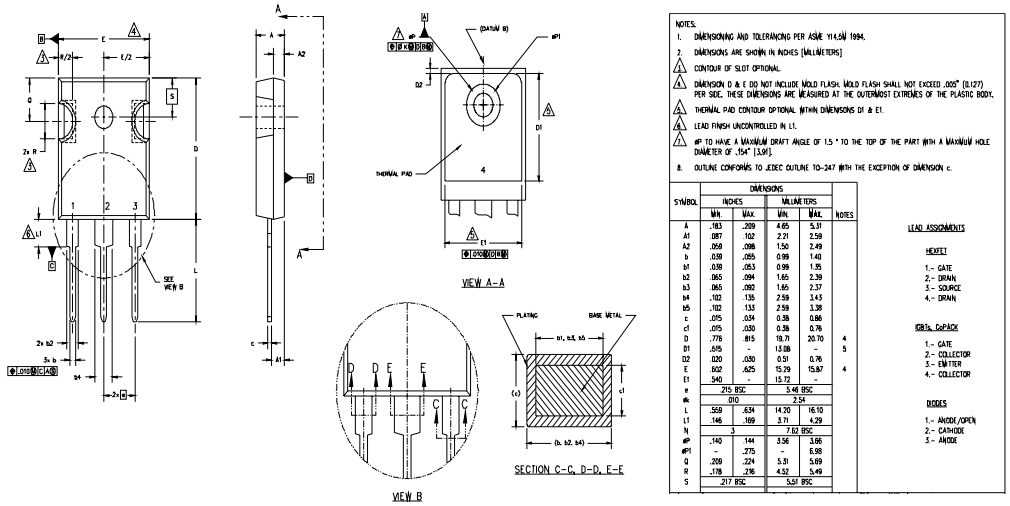
③ Pulse width limited by max. junction temperature.

④ Energy losses include "tail" and diode reverse recovery, Data generated with use of Diode 30ETH06.

⑤ C_{oes} eff. is a fixed capacitance that gives the same charging time as C_{oes} while V_{CE} is rising from 0 to 80% V_{CES}.
C_{oes} eff.(ER) is a fixed capacitance that stores the same energy as C_{oes} while V_{CE} is rising from 0 to 80% V_{CES}.

TO-247AC Package Outline

Dimensions are shown in millimeters (inches)

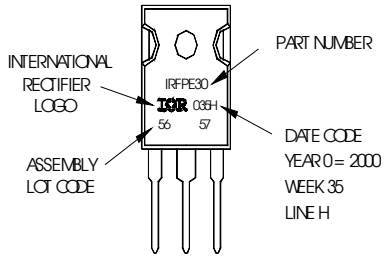


SYMBOL	DIMENSIONS				NOTES
	INCHES		MILLIMETERS		
	MIN.	MAX.	MIN.	MAX.	
A	.183	.209	4.65	5.31	
A1	.087	.102	2.21	2.59	
A2	.059	.098	1.50	2.49	
b	.039	.055	0.99	1.40	
b1	.039	.053	0.99	1.35	
b2	.065	.094	1.65	2.39	
b3	.065	.092	1.65	2.37	
b4	.102	.135	2.59	3.43	
b5	.102	.133	2.59	3.38	
c	.015	.034	0.38	0.86	
c1	.015	.030	0.38	0.76	
D	.776	.815	19.71	20.70	4
D1	.515	-	13.08	-	5
D2	.020	.030	0.51	0.76	
E	.602	.625	15.29	15.87	4
E1	.540	-	13.72	-	
e	.215 BSC		5.46 BSC		
øk	.010		0.254		
L	.559	.634	14.20	16.10	
L1	.146	.169	3.71	4.29	
N	3		7.62 BSC		
øP	.140	.144	3.56	3.66	
øP1	-	.275	-	6.98	
Q	.209	.224	5.31	5.69	
R	.178	.216	4.52	5.49	
S	.217 BSC		5.51 BSC		

TO-247AC Part Marking Information

EXAMPLE: THIS IS AN IRFPE30
WITH ASSEMBLY
LOT CODE 5657
ASSEMBLED ON WW35, 2000
IN THE ASSEMBLY LINE "H"

Note: "P" in assembly line position indicates "Lead-Free"



TO-247AC package is not recommended for Surface Mount Application.

Data and specifications subject to change without notice.
This product has been designed and qualified for Industrial market.
Qualification Standards can be found on IR's Web site.

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