

**WARP2 SERIES IGBT WITH ULTRAFAST SOFT RECOVERY DIODE**
**Applications**

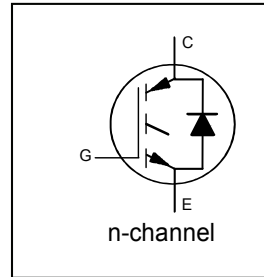
- Automotive HEV and EV
- PFC and ZVS SMPS Circuits

**Features**

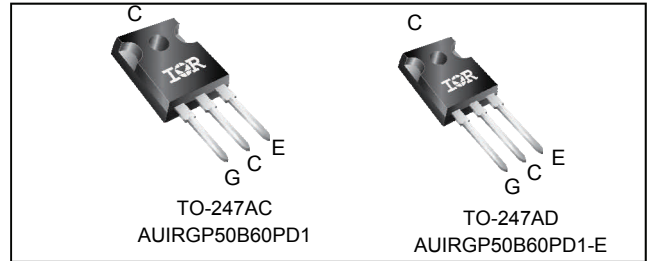
- Low  $V_{CE(ON)}$  NPT Technology, Positive Temperature Coefficient
- Lower Parasitic Capacitances
- Minimal Tail Current
- HEXFRED Ultra Fast Soft-Recovery Co-Pack Diode
- Tighter Distribution of Parameters
- Lead-Free, RoHS Compliant
- Automotive Qualified \*

**Benefits**

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



$V_{CES} = 600V$   
 $V_{CE(on)}$  typ. = 2.00V  
 @  $V_{GE} = 15V$   $I_C = 33A$   
**Equivalent MOSFET Parameters**Ⓓ  
 $R_{CE(on)}$  typ. = 61mΩ  
 $I_D$  (FET equivalent) = 50A



G	C	E
Gate	Collector	Emitter

Base Part Number	Package Type	Standard Pack		Orderable Part Number
		Form	Quantity	
AUIRGP50B60PD1	TO-247AC	Tube	25	AUIRGP50B60PD1
AUIRGP50B60PD1-E	TO-247AD	Tube	25	AUIRGP50B60PD1-E

**Absolute Maximum Ratings**

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only; and functional operation of the device at these or any other condition beyond those indicated in the specifications is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability. The thermal resistance and power dissipation ratings are measured under board mounted and still air conditions. Ambient temperature ( $T_A$ ) is 25°C, unless otherwise specified.

	Parameter	Max.	Units
$V_{CES}$	Collector-to-Emitter Voltage	600	V
$I_C @ T_C = 25^\circ C$	Continuous Collector Current	75 <sup>Ⓓ</sup>	A
$I_C @ T_C = 100^\circ C$	Continuous Collector Current	45	
$I_{CM}$	Pulse Collector Current (Ref. Fig. C.T.4)	150	
$I_{LM}$	Clamped Inductive Load Current <sup>②</sup>	150	
$I_F @ T_C = 25^\circ C$	Diode Continuous Forward Current	40	
$I_F @ T_C = 100^\circ C$	Diode Continuous Forward Current	15	
$I_{FSM}$	Maximum Repetitive Forward Current <sup>③</sup>	60	V
$V_{GE}$	Gate-to-Emitter Voltage	±20	
$P_D @ T_C = 25^\circ C$	Maximum Power Dissipation	390	
$P_D @ T_C = 100^\circ C$	Maximum Power Dissipation	156	
$T_J$	Operating Junction and Storage Temperature Range	-55 to +150	°C
$T_{STG}$			
	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) <sup>④</sup>	—	—	0.32	°C/W
$R_{\theta JC}$ (Diode)	Thermal Resistance Junction-to-Case (each Diode) <sup>④</sup>	—	—	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)

\* Qualification standards can be found at [www.infineon.com](http://www.infineon.com)

**Electrical Characteristics @ T<sub>J</sub> = 25°C (unless otherwise specified)**

	Parameter	Min.	Typ.	Max.	Units	Conditions	Ref. Fig.
V <sub>(BR)CES</sub>	Collector-to-Emitter Breakdown Voltage	600	—	—	V	V <sub>GE</sub> = 0V, I <sub>C</sub> = 500μA	
ΔV <sub>(BR)CES</sub> /ΔT <sub>J</sub>	Temperature Coeff. of Breakdown Voltage	—	0.31	—	V/°C	V <sub>GE</sub> = 0V, I <sub>C</sub> = 1mA (25°C-125°C)	
R <sub>G</sub>	Internal Gate Resistance	—	1.7	—	Ω	1MHz, Open Collector	4,5,6,8,9
V <sub>CE(on)</sub>	Collector-to-Emitter Saturation Voltage	—	2.00	2.35	V	I <sub>C</sub> = 33A, V <sub>GE</sub> = 15V	
		—	2.45	2.85		I <sub>C</sub> = 50A, V <sub>GE</sub> = 15V	
		—	2.60	2.95		I <sub>C</sub> = 33A, V <sub>GE</sub> = 15V, T <sub>J</sub> = 125°C	
		—	3.20	3.60		I <sub>C</sub> = 50A, V <sub>GE</sub> = 15V, T <sub>J</sub> = 125°C	
V <sub>GE(th)</sub>	Gate Threshold Voltage	3.0	4.0	5.0	V	I <sub>C</sub> = 250μA	7,8,9
ΔV <sub>GE(th)</sub> /ΔT <sub>J</sub>	Threshold Voltage temp. coefficient	—	-10	—	mV/°C	V <sub>CE</sub> = V <sub>GE</sub> , I <sub>C</sub> = 1.0mA	
g <sub>fe</sub>	Forward Transconductance	—	41	—	S	V <sub>CE</sub> = 50V, I <sub>C</sub> = 33A, PW = 80μs	
I <sub>CES</sub>	Collector-to-Emitter Leakage Current	—	5.0	500	μA	V <sub>GE</sub> = 0V, V <sub>CE</sub> = 600V	
		—	1.0	—	mA	V <sub>GE</sub> = 0V, V <sub>CE</sub> = 600V, T <sub>J</sub> = 125°C	
V <sub>FM</sub>	Diode Forward Voltage Drop	—	1.30	1.70	V	I <sub>F</sub> = 15A	10
		—	1.20	1.60		I <sub>F</sub> = 15A, T <sub>J</sub> = 125°C	
I <sub>GES</sub>	Gate-to-Emitter Leakage Current	—	—	±100	nA	V <sub>GE</sub> = ±20V, V <sub>CE</sub> = 0V	

**Switching Characteristics @ T<sub>J</sub> = 25°C (unless otherwise specified)**

	Parameter	Min.	Typ.	Max.	Units	Conditions	Ref. Fig.
Q <sub>g</sub>	Total Gate Charge (turn-on)	—	205	308	nC	I <sub>C</sub> = 33A V <sub>GE</sub> = 15V V <sub>CC</sub> = 400V	17 CT1
Q <sub>ge</sub>	Gate-to-Emitter Charge (turn-on)	—	70	105			
Q <sub>gc</sub>	Gate-to-Collector Charge (turn-on)	—	30	45			
E <sub>on</sub>	Turn-On Switching Loss	—	255	305	μJ	I <sub>C</sub> = 33A, V <sub>CC</sub> = 390V, V <sub>GE</sub> = +15V, R <sub>G</sub> = 3.3Ω, L = 200μH, T <sub>J</sub> = 25°C ④	CT3
E <sub>off</sub>	Turn-Off Switching Loss	—	375	445			
E <sub>total</sub>	Total Switching Loss	—	630	750			
t <sub>d(on)</sub>	Turn-On delay time	—	30	40			
t <sub>r</sub>	Rise time	—	10	15	ns	I <sub>C</sub> = 33A, V <sub>CC</sub> = 390V, V <sub>GE</sub> = +15V, R <sub>G</sub> = 3.3Ω, L = 200μH, T <sub>J</sub> = 125°C ④	CT3 12,14 WF1,WF2
t <sub>d(off)</sub>	Turn-Off delay time	—	130	150			
t <sub>f</sub>	Fall time	—	11	15	μJ	I <sub>C</sub> = 33A, V <sub>CC</sub> = 390V, V <sub>GE</sub> = +15V, R <sub>G</sub> = 3.3Ω, L = 200μH, T <sub>J</sub> = 125°C ④	CT3 11,13 WF1,WF2
E <sub>on</sub>	Turn-On Switching Loss	—	580	700			
E <sub>off</sub>	Turn-Off Switching Loss	—	480	550	ns	I <sub>C</sub> = 33A, V <sub>CC</sub> = 390V, V <sub>GE</sub> = +15V, R <sub>G</sub> = 3.3Ω, L = 200μH, T <sub>J</sub> = 125°C ④	CT3 12,14 WF1,WF2
E <sub>total</sub>	Total Switching Loss	—	1060	1250			
t <sub>d(on)</sub>	Turn-On delay time	—	26	35	ns	I <sub>C</sub> = 33A, V <sub>CC</sub> = 390V, V <sub>GE</sub> = +15V, R <sub>G</sub> = 3.3Ω, L = 200μH, T <sub>J</sub> = 125°C ④	CT3 12,14 WF1,WF2
t <sub>r</sub>	Rise time	—	13	20			
t <sub>d(off)</sub>	Turn-Off delay time	—	146	165	pF	V <sub>GE</sub> = 0V V <sub>CC</sub> = 30V f = 1.0Mhz	16
t <sub>f</sub>	Fall time	—	15	20			
C <sub>ies</sub>	Input Capacitance	—	3648	—	pF	V <sub>GE</sub> = 0V V <sub>CC</sub> = 30V f = 1.0Mhz	15
C <sub>oes</sub>	Output Capacitance	—	322	—			
C <sub>res</sub>	Reverse Transfer Capacitance	—	56	—			
C <sub>oes eff.</sub>	Effective Output Capacitance (Time Related) ⑤	—	215	—			
C <sub>oes eff. (ER)</sub>	Effective Output Capacitance (Energy Related) ⑥	—	163	—		V <sub>GE</sub> = 0V, V <sub>CE</sub> = 0V to 480V	
RBSOA	Reverse Bias Safe Operating Area	FULL SQUARE				T <sub>J</sub> = 150°C, I <sub>C</sub> = 150A V <sub>CC</sub> = 480V, V <sub>p</sub> = 600V R <sub>g</sub> = 22Ω, V <sub>GE</sub> = +15V to 0V	3 CT2
t <sub>rr</sub>	Diode Reverse Recovery Time	—	42	60	ns	T <sub>J</sub> = 25°C	19
		—	74	120		T <sub>J</sub> = 125°C	
Q <sub>rr</sub>	Diode Reverse Recovery Charge	—	80	180	nC	T <sub>J</sub> = 25°C I <sub>F</sub> = 15A,	21
		—	220	600		T <sub>J</sub> = 125°C V <sub>R</sub> = 200V,	
I <sub>rr</sub>	Peak Reverse Recovery Current	—	4.0	6.0	A	T <sub>J</sub> = 25°C di/dt = 200A/μs	19,20,21,22
		—	6.5	10		T <sub>J</sub> = 125°C	

- Notes:**
- ① R<sub>CE(on)</sub> typ. = equivalent on-resistance = V<sub>CE(on)</sub> typ. / I<sub>C</sub>, where V<sub>CE(on)</sub> typ. = 2.00V and I<sub>C</sub> = 33A. I<sub>D</sub> (FET Equivalent) is the equivalent MOSFET I<sub>D</sub> rating @ 25°C for applications up to 150kHz. These are provided for comparison purposes (only) with equivalent MOSFET solutions.
  - ② V<sub>CC</sub> = 80% (V<sub>CES</sub>), V<sub>GE</sub> = 20V, L = 28 μH, R<sub>G</sub> = 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<sub>oes eff.</sub> is a fixed capacitance that gives the same charging time as C<sub>oes</sub> while V<sub>CE</sub> is rising from 0 to 80% V<sub>CES</sub>. C<sub>oes eff.(ER)</sub> is a fixed capacitance that stores the same energy as C<sub>oes</sub> while V<sub>CE</sub> is rising from 0 to 80% V<sub>CES</sub>.
  - ⑥ Calculated continuous current based on maximum allowable junction temperature. Package current limit is 60A. Note that current limitations arising from heating of the device leads may occur with some lead mounting arrangements.