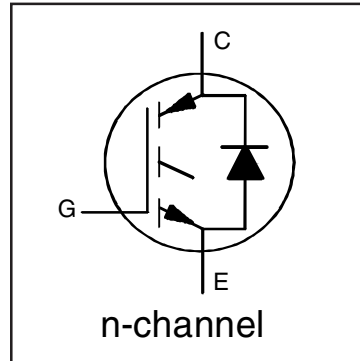


# IRGB4056DPbF

## INSULATED GATE BIPOLAR TRANSISTOR WITH ULTRAFAST SOFT RECOVERY DIODE

### Features

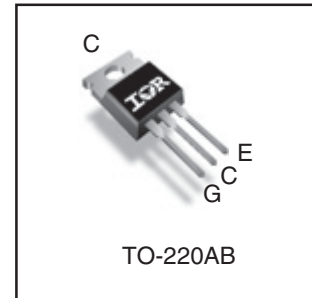
- Low  $V_{CE(ON)}$  Trench IGBT Technology
- Low switching losses
- Maximum Junction temperature 175 °C
- 5  $\mu$ S short circuit SOA
- Square RBSOA
- 100% of the parts tested for 4X rated current ( $I_{LM}$ )
- Positive  $V_{CE(ON)}$  Temperature co-efficient
- Ultra fast soft Recovery Co-Pak Diode
- Tight parameter distribution
- Lead Free Package



$V_{CES} = 600V$
$I_C = 12A, T_C = 100^\circ C$
$t_{SC} \geq 5\mu s, T_{J(max)} = 175^\circ C$
$V_{CE(on)} \text{ typ.} = 1.55V$

### Benefits

- High Efficiency in a wide range of applications
- Suitable for a wide range of switching frequencies due to Low  $V_{CE(ON)}$  and Low Switching losses
- Rugged transient Performance for increased reliability
- Excellent Current sharing in parallel operation
- Low EMI



<b>G</b>	<b>C</b>	<b>E</b>
Gate	Collector	Emitter

### Absolute Maximum Ratings

	Parameter	Max.	Units
$V_{CES}$	Collector-to-Emitter Voltage	600	V
$I_C @ T_C = 25^\circ C$	Continuous Collector Current	24	A
$I_C @ T_C = 100^\circ C$	Continuous Collector Current	12	
$I_{CM}$	Pulse Collector Current	48	
$I_{LM}$	Clamped Inductive Load Current $\text{\textcircled{D}}$	48	
$I_F @ T_C = 25^\circ C$	Diode Continuous Forward Current	24	
$I_F @ T_C = 100^\circ C$	Diode Continuous Forward Current	12	
$I_{FM}$	Diode Maximum Forward Current $\text{\textcircled{D}}$	48	
$V_{GE}$	Continuous Gate-to-Emitter Voltage	$\pm 20$	V
	Transient Gate-to-Emitter Voltage	$\pm 30$	
$P_D @ T_C = 25^\circ C$	Maximum Power Dissipation	140	W
		$P_D @ T_C = 100^\circ C$	
$T_J$	Operating Junction and	-55 to +175	°C
$T_{STG}$	Storage Temperature Range		
	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)	—	—	1.07	°C/W
$R_{\theta JC}$ (Diode)	Thermal Resistance Junction-to-Case-(each Diode)	—	—	3.66	
$R_{\theta CS}$	Thermal Resistance, Case-to-Sink (flat, greased surface)	—	0.50	—	
$R_{\theta JA}$	Thermal Resistance, Junction-to-Ambient (typical socket mount)	—	80	—	

### Electrical Characteristics @ $T_J = 25^\circ\text{C}$ (unless otherwise specified)

	Parameter	Min.	Typ.	Max.	Units	Conditions	Ref.Fig
$V_{(BR)CES}$	Collector-to-Emitter Breakdown Voltage	600	—	—	V	$V_{GE} = 0V, I_C = 100\mu A$ ④	CT6
$\Delta V_{(BR)CES}/\Delta T_J$	Temperature Coeff. of Breakdown Voltage	—	0.30	—	V/ $^\circ\text{C}$	$V_{GE} = 0V, I_C = 1mA$ (25 $^\circ\text{C}$ -175 $^\circ\text{C}$ )	CT6
$V_{CE(on)}$	Collector-to-Emitter Saturation Voltage	—	1.55	1.85	V	$I_C = 12A, V_{GE} = 15V, T_J = 25^\circ\text{C}$	5,6,7
		—	1.90	—		$I_C = 12A, V_{GE} = 15V, T_J = 150^\circ\text{C}$	9,10,11
		—	1.97	—		$I_C = 12A, V_{GE} = 15V, T_J = 175^\circ\text{C}$	
$V_{GE(th)}$	Gate Threshold Voltage	4.0	—	6.5	V	$V_{CE} = V_{GE}, I_C = 350\mu A$	9, 10,
$\Delta V_{GE(th)}/\Delta T_J$	Threshold Voltage temp. coefficient	—	-18	—	mV/ $^\circ\text{C}$	$V_{CE} = V_{GE}, I_C = 1.0mA$ (25 $^\circ\text{C}$ - 175 $^\circ\text{C}$ )	11, 12
$g_{fe}$	Forward Transconductance	—	7.7	—	S	$V_{CE} = 50V, I_C = 12A, PW = 80\mu s$	
$I_{CES}$	Collector-to-Emitter Leakage Current	—	2.0	25	$\mu A$	$V_{GE} = 0V, V_{CE} = 600V$	
		—	475	—		$V_{GE} = 0V, V_{CE} = 600V, T_J = 175^\circ\text{C}$	
$V_{FM}$	Diode Forward Voltage Drop	—	2.10	3.10	V	$I_F = 12A$	8
		—	1.61	—		$I_F = 12A, T_J = 175^\circ\text{C}$	
$I_{GES}$	Gate-to-Emitter Leakage Current	—	—	$\pm 100$	nA	$V_{GE} = \pm 20V$	

### Switching Characteristics @ $T_J = 25^\circ\text{C}$ (unless otherwise specified)

	Parameter	Min.	Typ.	Max.	Units	Conditions	Ref.Fig
$Q_g$	Total Gate Charge (turn-on)	—	25	38	nC	$I_C = 12A$ $V_{GE} = 15V$ $V_{CC} = 400V$	24
$Q_{ge}$	Gate-to-Emitter Charge (turn-on)	—	7.0	11			CT1
$Q_{gc}$	Gate-to-Collector Charge (turn-on)	—	11	16			
$E_{on}$	Turn-On Switching Loss	—	75	118	$\mu J$	$I_C = 12A, V_{CC} = 400V, V_{GE} = 15V$ $R_G = 22\Omega, L = 200\mu H, L_S = 150nH, T_J = 25^\circ\text{C}$ Energy losses include tail & diode reverse recovery	CT4
$E_{off}$	Turn-Off Switching Loss	—	225	273			
$E_{total}$	Total Switching Loss	—	300	391			
$t_{d(on)}$	Turn-On delay time	—	31	40	ns	$I_C = 12A, V_{CC} = 400V, V_{GE} = 15V$ $R_G = 22\Omega, L = 200\mu H, L_S = 150nH, T_J = 25^\circ\text{C}$	CT4
$t_r$	Rise time	—	17	24			
$t_{d(off)}$	Turn-Off delay time	—	83	94			
$t_f$	Fall time	—	24	31			
$E_{on}$	Turn-On Switching Loss	—	185	—	$\mu J$	$I_C = 12A, V_{CC} = 400V, V_{GE} = 15V$ $R_G = 22\Omega, L = 100\mu H, L_S = 150nH, T_J = 175^\circ\text{C}$ ④ Energy losses include tail & diode reverse recovery	13, 15
$E_{off}$	Turn-Off Switching Loss	—	355	—			CT4
$E_{total}$	Total Switching Loss	—	540	—			WF1, WF2
$t_{d(on)}$	Turn-On delay time	—	30	—	ns	$I_C = 12A, V_{CC} = 400V, V_{GE} = 15V$ $R_G = 22\Omega, L = 200\mu H, L_S = 150nH$ $T_J = 175^\circ\text{C}$	14, 16
$t_r$	Rise time	—	18	—			CT4
$t_{d(off)}$	Turn-Off delay time	—	102	—			WF1
$t_f$	Fall time	—	41	—			WF2
$C_{ies}$	Input Capacitance	—	765	—	pF	$V_{GE} = 0V$ $V_{CC} = 30V$ $f = 1.0Mhz$	23
$C_{oes}$	Output Capacitance	—	52	—			
$C_{res}$	Reverse Transfer Capacitance	—	23	—			
RBSOA	Reverse Bias Safe Operating Area	FULL SQUARE				$T_J = 175^\circ\text{C}, I_C = 48A$ $V_{CC} = 480V, V_p = 600V$ $R_G = 22\Omega, V_{GE} = +15V$ to 0V	4 CT2
SCSOA	Short Circuit Safe Operating Area	5	—	—	$\mu s$	$V_{CC} = 400V, V_p = 600V$ $R_G = 22\Omega, V_{GE} = +15V$ to 0V	22, CT3 WF4
$E_{rec}$	Reverse Recovery Energy of the Diode	—	280	—	$\mu J$	$T_J = 175^\circ\text{C}$	17, 18, 19
$t_{rr}$	Diode Reverse Recovery Time	—	68	—	ns	$V_{CC} = 400V, I_F = 12A$	20, 21
$I_{rr}$	Peak Reverse Recovery Current	—	19	—	A	$V_{GE} = 15V, R_G = 22\Omega, L = 200\mu H, L_S = 150nH$	WF3

#### Notes:

- ①  $V_{CC} = 80\% (V_{CES}), V_{GE} = 20V, L = 100\mu H, R_G = 22\Omega$ .
- ② This is only applied to TO-220AB package.
- ③ Pulse width limited by max. junction temperature.
- ④ Refer to AN-1086 for guidelines for measuring  $V_{(BR)CES}$  safely.