

650V N-Channel Enhancement Mode Power IGBT

MAIN CHARACTERISTICS

I_C @TC=100℃	20A
V_{CE}	650V
$V_{CE(sat)}$ -typ	1.75V

FEATURES

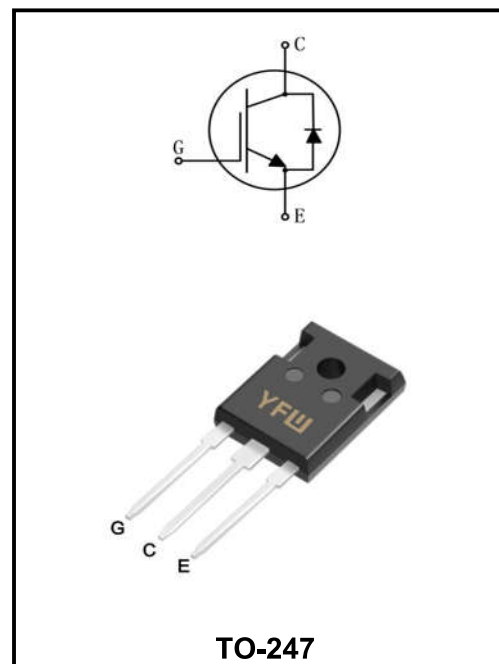
- ◆ Positive temperature coefficient
- ◆ Fast Switching
- ◆ Low $V_{CE(sat)}$
- ◆ Reliable and Rugged

APPLICATIONS

- ◆ Motor drives
- ◆ Air Condition Inverters

MECHANICAL DATA

- ◆ Case: Molded plastic
- ◆ Mounting Position: Any
- ◆ Molded Plastic: UL Flammability Classification Rating 94V-0
- ◆ Lead free in compliance with EU RoHS 2011/65/EU directive
- ◆ Solder bath temperature 275℃ maximum, 10s per JESD 22-B106



TO-247

Maximum Ratings

Characteristics	Symbol	Value	Unit
Collector-emitter voltage	V_{CES}	650	V
Gate-emitter voltage	V_{GES}	±30	V
Continuous collector current (TC=25℃)	I_C	40	A
Continuous collector current (TC=100℃)		20	A
Pulsed collector current, tp limited by Tvjmax	I_{CM}	60	A
Diode continuous forward current (TC=25℃)	I_F	40	A
Diode continuous forward current (TC=100℃)		20	A
Diode maximum current, tp limited by Tvjmax	I_{FM}	60	A
Short circuit withstand time	t_{sc}	10	μs
Power dissipation (TC=25℃)	P_{tot}	176	W
Operating junction temperature range	T_{vj}	-55 to +175	℃
Storage temperature range	T_{stg}	-55 to +175	℃

Thermal characteristics

Characteristics	Symbol	Values		Unit
		Typ	Max.	
Thermal resistance, junction to case for IGBT	$R_{th(j-c)}$	-	0.85	℃/ W
Thermal resistance, junction to case for Diode	$R_{th(j-c)}$	-	0.98	℃/ W
Thermal resistance, junction to ambient	$R_{th(j-a)}$	-	40	℃/ W

Note1: Pulse test: 300 μs pulse width, 2 % duty cycle

Electrical characteristics of IGBT at $T_{vj}=25^{\circ}\text{C}$ unless otherwise specified

Characteristics	Test Condition	Symbol	Min	Typ	Max	Unit
Collector-emitter breakdown voltage	$V_{GE}=0V, I_C=250\mu A$	$B_{V_{CES}}$	650	-	-	V
Collector-emitter leakage current	$V_{CE}=650V, V_{GE}=0V$	I_{CES}	-	-	10	μA
Gate leakage current, forward	$V_{GE}=\pm 20V, V_{CE}=0V$	I_{GES}	-	-	± 200	nA
Gate-emitter threshold voltage	$V_{GE}=V_{CE}, I_C=1mA$	$V_{GE(th)}$	4.3	5.3	6.3	V
Collector-emitter saturation voltage	$V_{GE}=15V, I_C=20A$	$V_{CE(sat)}$	-	1.75	2.05	V
	$V_{GE}=15V, I_C=20A, T_{vj}=175^{\circ}\text{C}$		-	1.98	-	V
Input capacitance	$V_{CE}=25V$ $V_{GE}=0V$ $f=1MHz$	C_{ies}	-	780	-	pF
Output capacitance		C_{oes}	-	46	-	pF
Reverse transfer capacitance		C_{res}	-	22	-	pF
Total gate charge	$V_{CC}=520V, V_{GE}=15V, I_C=20A$	Q_g	-	45	-	nC
Gate-emitter charge		Q_{ge}	-	9	-	nC
Gate-collector charge		Q_{gc}	-	22	-	nC
Turn-on delay time	$V_{CC}=400V$ $V_{GE}=15V$ $I_C=20A$ $R_G=5\Omega$ Inductive load	$t_{d(on)}$	-	12	-	ns
Rise time		t_r	-	24	-	ns
Turn-off delay time		$t_{d(off)}$	-	40	-	ns
Fall time		t_f	-	68	-	ns
Turn-on energy		E_{on}	-	0.26	-	mJ
Turn-off energy		E_{off}	-	0.39	-	mJ
Total switching energy		E_{ts}	-	0.65	-	mJ
Turn-on delay time		$t_{d(on)}$	-	14	-	ns
Rise time		t_r	-	32	-	ns
Turn-off delay time		$t_{d(off)}$	-	81	-	ns
Fall time		t_f	-	60	-	ns
Turn-on energy		E_{on}	-	0.4	-	mJ
Turn-off energy		E_{off}	-	0.57	-	mJ
Total switching energy		E_{ts}	-	0.97	-	mJ
Diode forward voltage	$I_F=20A$	V_F	-	1.46	1.76	V
	$I_F=20A, T_{vj}=175^{\circ}\text{C}$		-	1.3	-	V
Diode reverse recovery time	$V_R=400V$ $I_F=20A$ $diF/dt=-200A/\mu s$	t_{rr}	-	47	-	ns
Diode peak reverse recovery current		I_{rrm}	-	4.8	-	A
Diode reverse recovery charge		Q_{rr}	-	67	-	nC
Diode reverse recovery time	$V_R=400V$ $I_F=20A$ $diF/dt=-200A/\mu s, T_{vj}=175^{\circ}\text{C}$	t_{rr}	-	62	-	ns
Diode peak reverse recovery current		I_{rrm}	-	6.3	-	A
Diode reverse recovery charge		Q_{rr}	-	102	-	nC

Figure 1: Power Dissipation

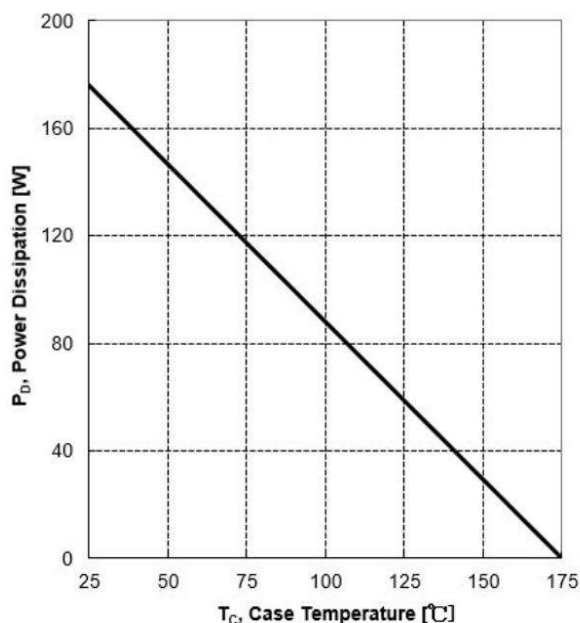


Figure 2: Collector Current vs. Case Temperature

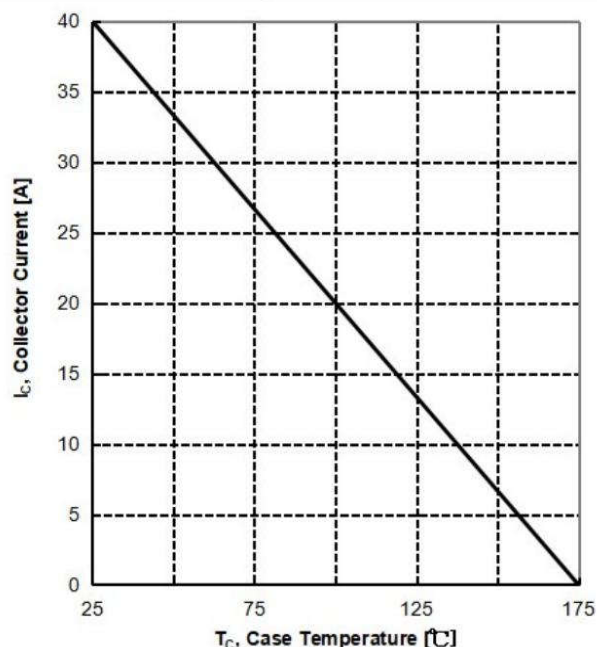


Figure 3: Safe Operation Area

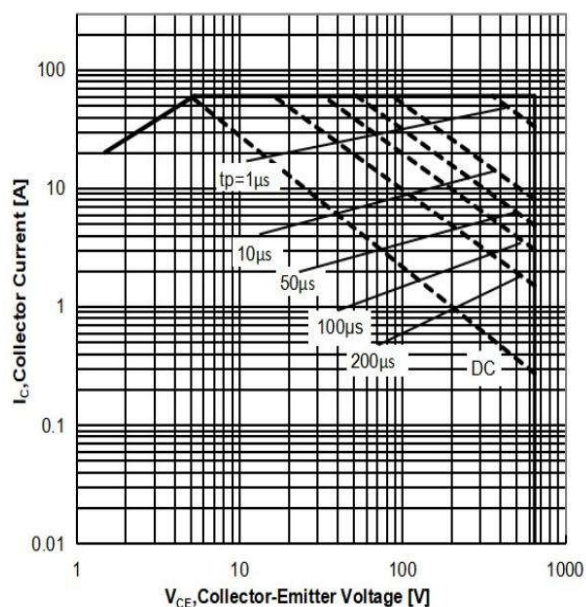
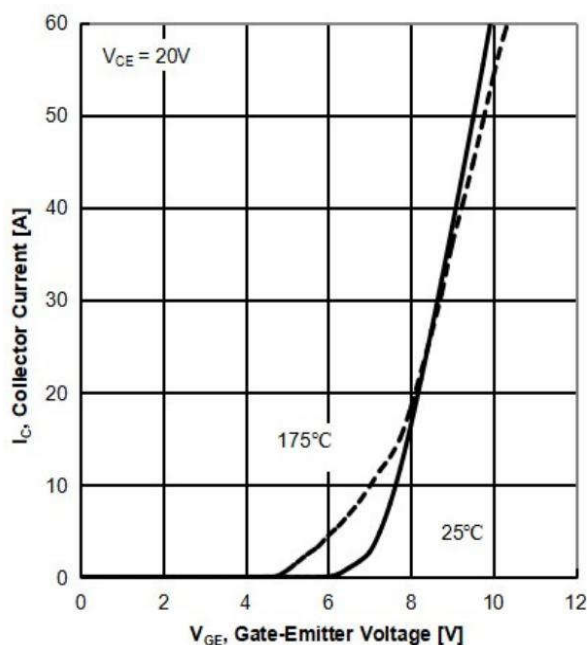


Figure 4: Typical Transfer Characteristics



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Figure 5: Typical Output Characteristics

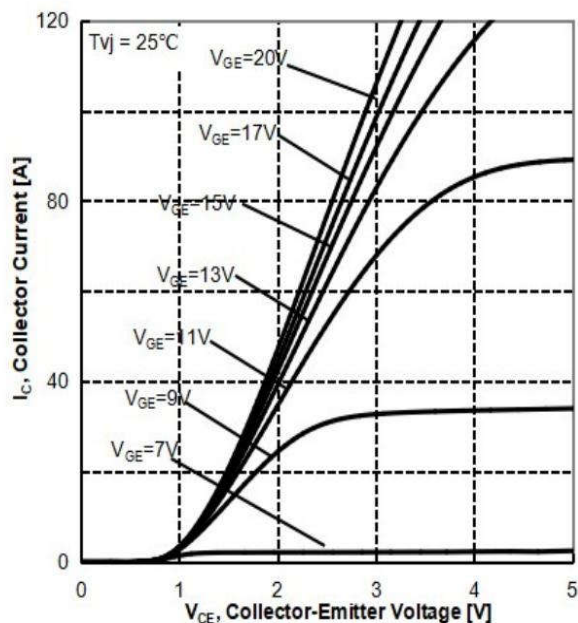


Figure 6: Typical Output Characteristics

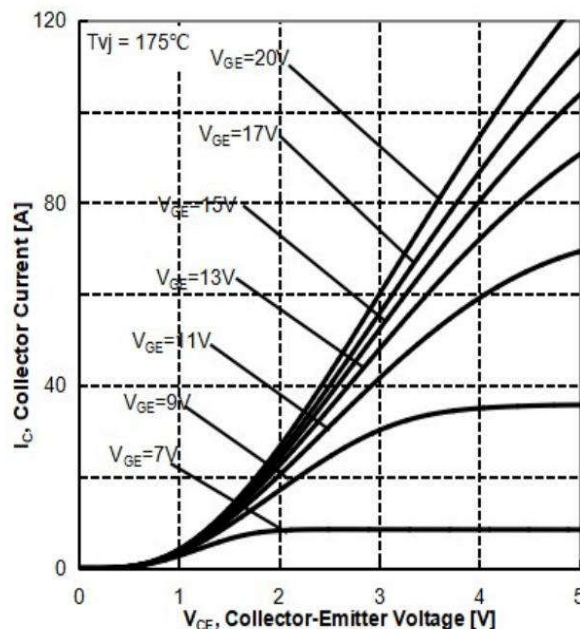


Figure 7: Typical Collector-Emitter Saturation Voltage vs. Junction Temperature

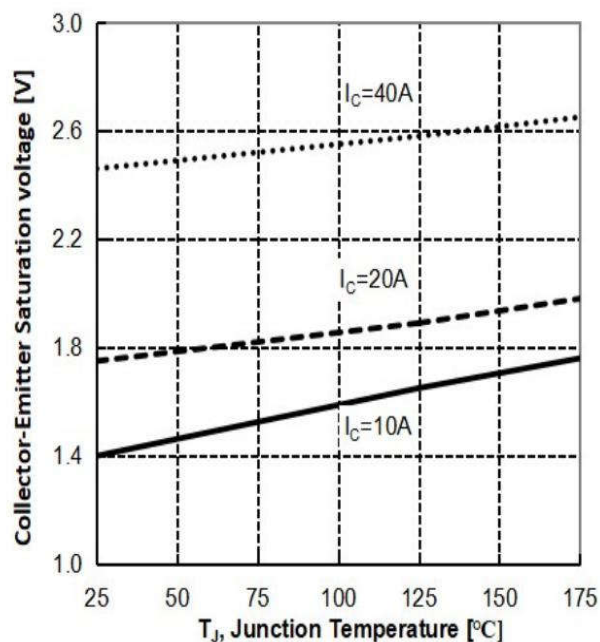
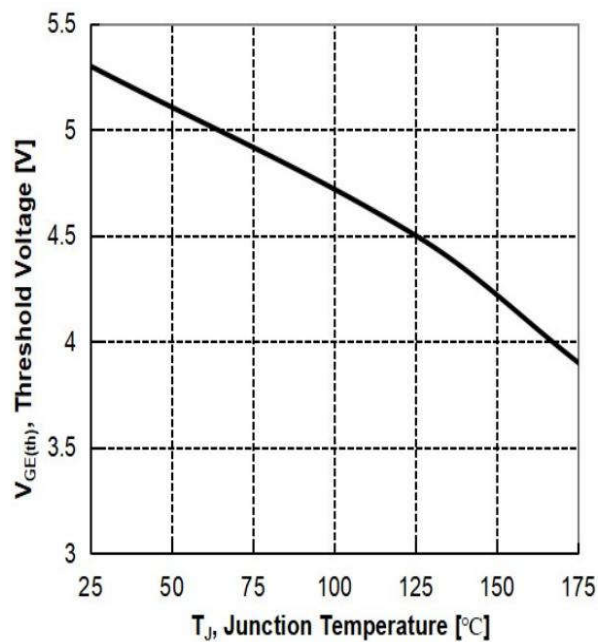


Figure 8: Typical Gate-Emitter Threshold Voltage vs. Junction Temperature



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Figure 9: Typical Switching Times vs. Gate Resistor ($T_J=25^{\circ}\text{C}$, $V_{CE}=400\text{V}$, $V_{GE}=15\text{V}$, $I_C=20\text{A}$)

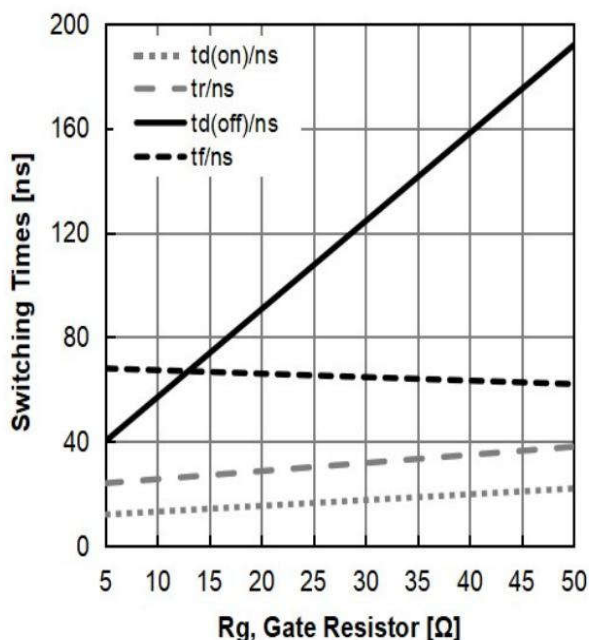


Figure 10: Typical Switching Energy vs. Gate Resistor ($T_J=25^{\circ}\text{C}$, $V_{CE}=400\text{V}$, $V_{GE}=15\text{V}$, $I_C=20\text{A}$)

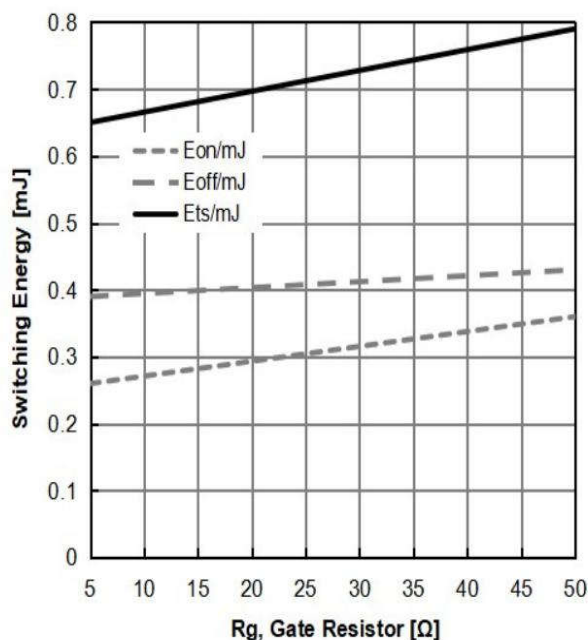


Figure 11: Typical Switching Times vs. Junction Temperature ($V_{CE}=400\text{V}$, $V_{GE}=15\text{V}$, $I_C=20\text{A}$, $R_g=5\Omega$)

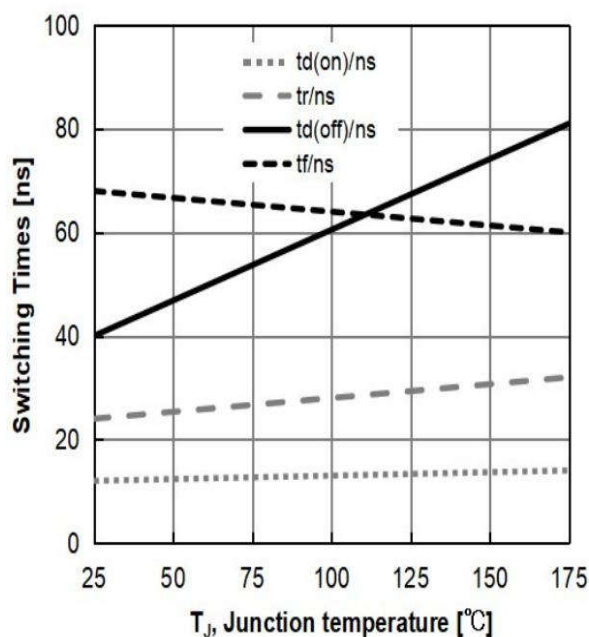
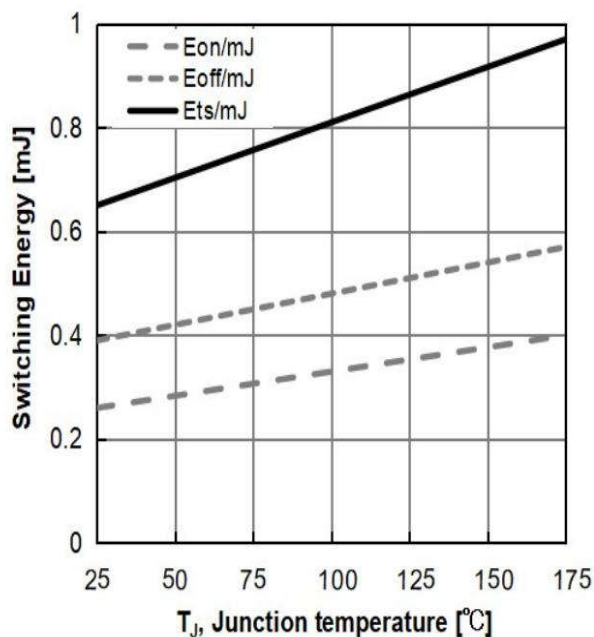


Figure 12: Typical Switching Energy vs. Junction Temperature ($V_{CE}=400\text{V}$, $V_{GE}=15\text{V}$, $I_C=20\text{A}$, $R_g=5\Omega$)



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Figure 13: Typical Switching Times vs. Collector Current ($T_J=25^\circ\text{C}$, $V_{CE}=400\text{V}$, $V_{GE}=15\text{V}$, $R_g=5\Omega$)

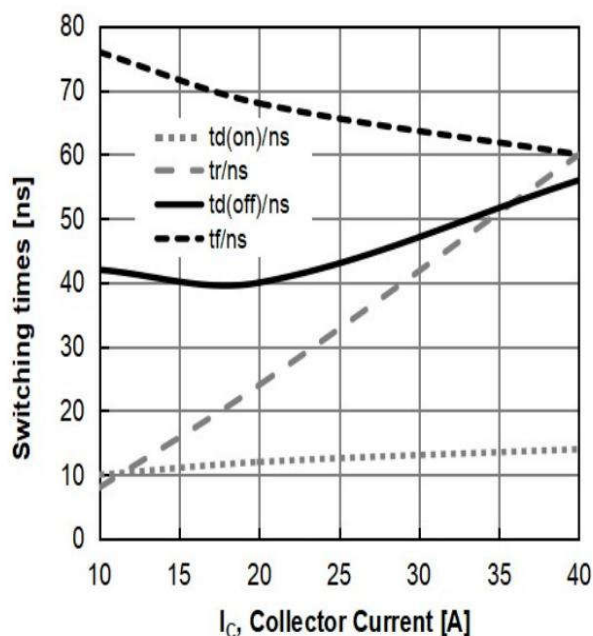


Figure 14: Typical Switching Energy vs. Collector Current ($T_J=25^\circ\text{C}$, $V_{CE}=400\text{V}$, $V_{GE}=15\text{V}$, $R_g=5\Omega$)

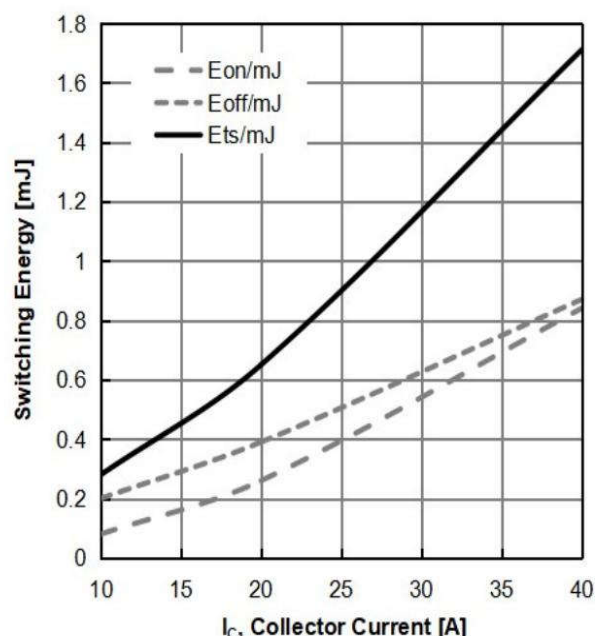


Figure 15: Typical Switching Times vs. VCE ($T_J=25^\circ\text{C}$, $V_{GE}=15\text{V}$, $I_C=20\text{A}$, $R_g=5\Omega$)

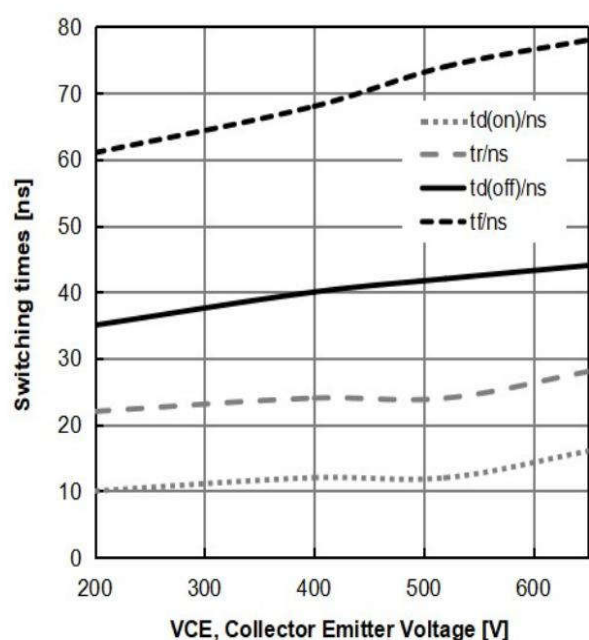
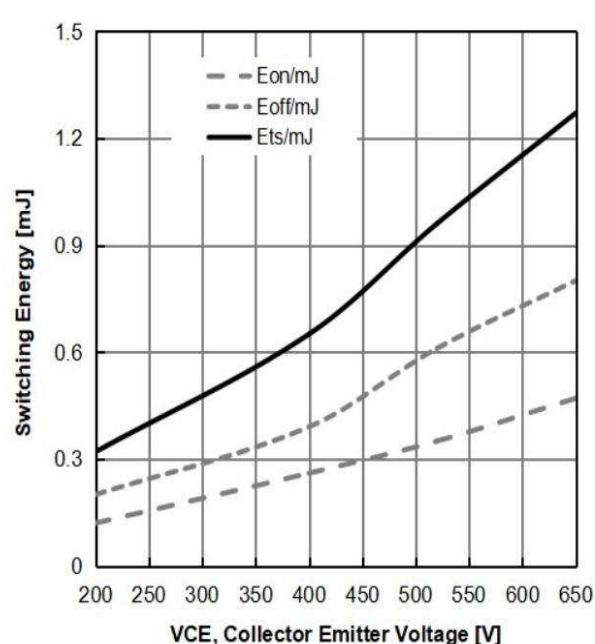


Figure 16: Typical Switching Energy vs. VCE ($T_J=25^\circ\text{C}$, $V_{GE}=15\text{V}$, $I_C=20\text{A}$, $R_g=5\Omega$)



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Figure 17: Typical Capacitance vs. Collector- Emitter Voltage

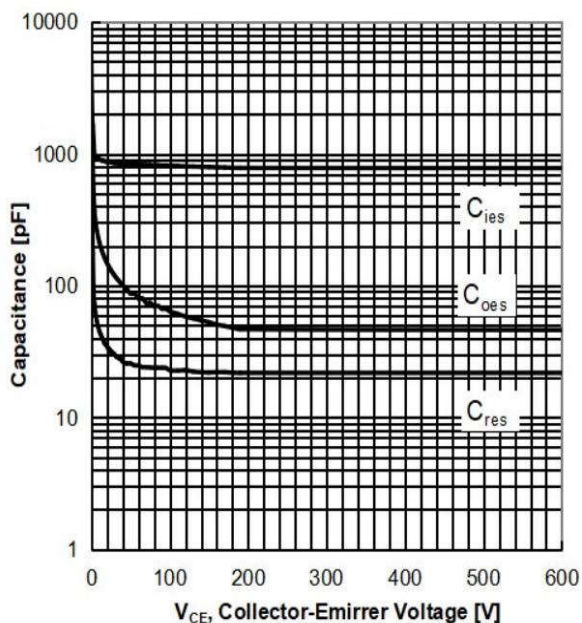


Figure 18: Typical Gate Charge

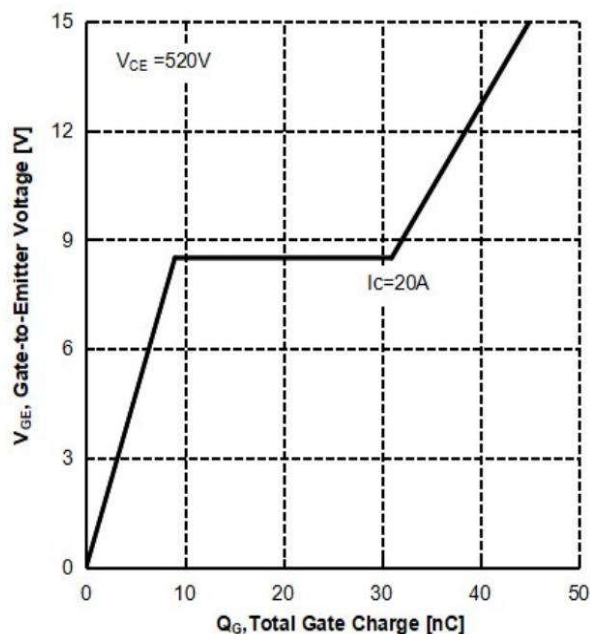


Figure 19: IGBT Transient Thermal Impedance vs. Pulse Width

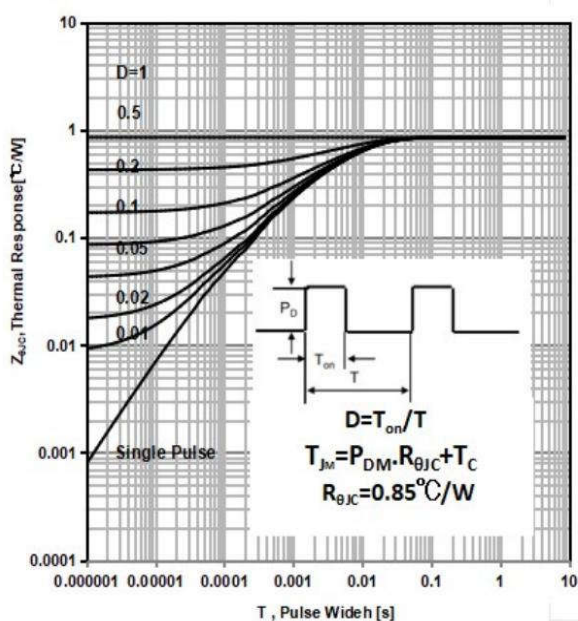
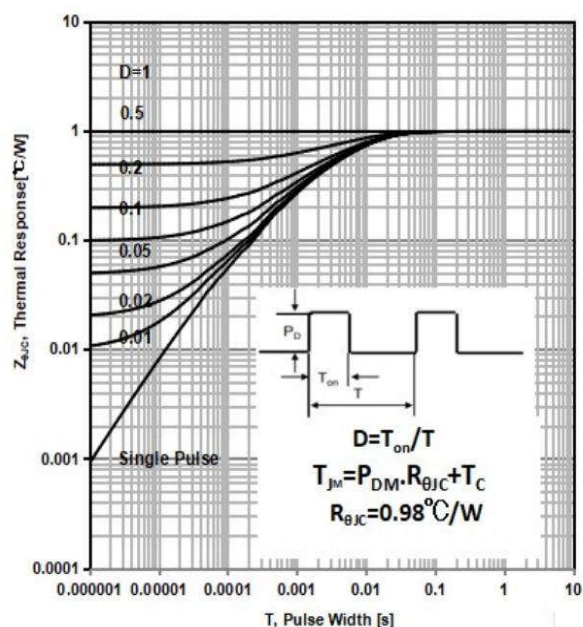
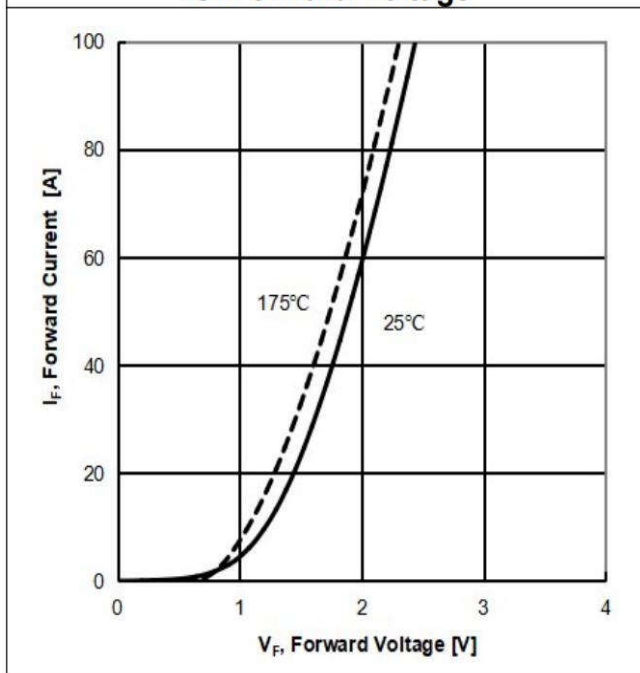


Figure 20: Diode Transient Thermal Impedance vs. Pulse Width

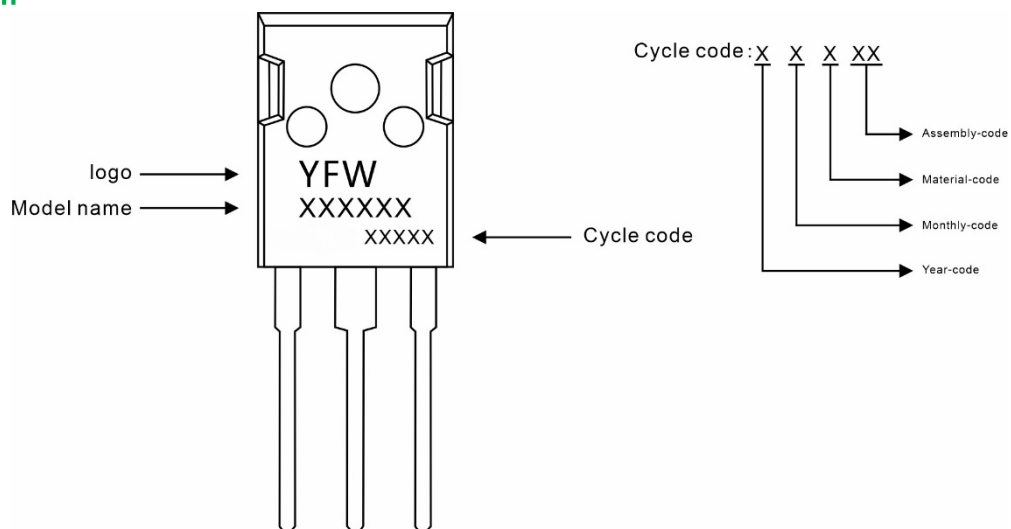


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Figure 21: Typical Diode Forward Current vs. Forward Voltage



Marking Diagram



Ordering information

Model name	Package	Unit Weight	Base Quantity	Packing Quantity
YFWG20T65HAP	TO-247	0.209oz(5.93g)	30pcs/tube	600PCS/Box 2400PCS/Carton

Package Dimensions

TO-247

Symbol	Dimensions in mm		Dimensions in Inch	
	Min.	Max.	Min.	Max.
A	4.90	5.10	0.193	0.201
A1	1.90	2.10	0.075	0.083
A2	2.29	2.54	0.090	0.100
b	1.00	1.40	0.039	0.055
b1	2.00	2.20	0.079	0.087
b2	3.00	3.20	0.118	0.126
c	0.50	0.70	0.020	0.028
D	15.75	16.05	0.620	0.632
E	20.20	20.80	0.795	0.819
e	5.45 (BSC)		0.215 (BSC)	
e1	10.90 (BSC)		0.429 (BSC)	
F	6.05	6.25	0.238	0.246
F1	5.80	6.00	0.228	0.236
L	20.10	20.40	0.791	0.803
L1	4.05	4.35	0.159	0.171
Φ	3.50	3.70	0.138	0.146

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