

**650V N-Channel Enhancement Mode Power IGBT**

**MAIN CHARACTERISTICS**

<b>I<sub>c</sub> @TC=100°C</b>	60A
<b>V<sub>CE</sub></b>	650V
<b>VCE(sat)-typ</b>	1.8V

**FEATURES**

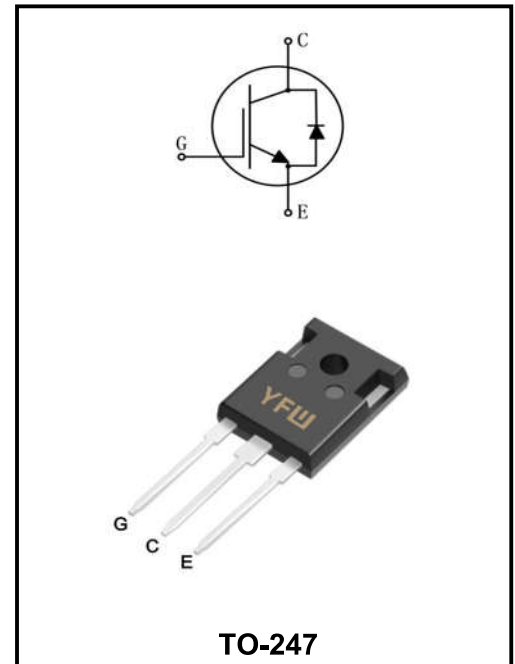
- ◆ Trench and field-stop technology
- ◆ Easy parallel switching capability

**APPLICATIONS**

- ◆ Energy storage
- ◆ Solar string inverter
- ◆ Uninterruptible power supplies

**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°C maximum,10s per JESD 22-B106



**Maximum Ratings**

Characteristics	Symbol	Value	Unit
Collector-emitter voltage	<b>V<sub>CEs</sub></b>	650	<b>V</b>
Gate-emitter voltage	<b>V<sub>GES</sub></b>	±20	<b>V</b>
Continuous collector current (TC=25°C)	<b>I<sub>c</sub></b>	120	<b>A</b>
Continuous collector current (TC=100°C)		60	<b>A</b>
Pulsed collector current, tp limited by Tvjmax	<b>I<sub>CM</sub></b>	240	<b>A</b>
Diode continuous forward current (TC=100°C)	<b>I<sub>F</sub></b>	60	<b>A</b>
Diode maximum current, tp limited by Tvjmax	<b>I<sub>FM</sub></b>	240	<b>A</b>
Power dissipation (TC=25°C)	<b>P<sub>tot</sub></b>	312	<b>W</b>
Power dissipation (TC=100°C)		156	<b>W</b>
Operating junction temperature range	<b>T<sub>vj</sub></b>	-40 to +175	<b>°C</b>
Storage temperature range	<b>T<sub>stg</sub></b>	-40 to +150	<b>°C</b>

**Thermal characteristics**

Characteristics	Symbol	Values		Unit
		Typ	Max.	
Thermal resistance, junction to case for IGBT	$R_{th(j-c)}$	-	0.48	K/ W
Thermal resistance, junction to case for Diode	$R_{th(j-c)}$	-	0.7	K/ W
Thermal resistance, junction to ambient	$R_{th(j-a)}$	-	40	K/ W

**Note1:Pulse test: 300  $\mu$ s 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	$V_{CE}=650V, V_{GE}=0V$	$I_{CES}$	-	-	50	$\mu A$	
Gate leakage current, forward	$V_{GE}=\pm 20V, V_{CE}=0V$	$I_{GES}$	-	-	$\pm 100$	nA	
Gate-emitter threshold voltage	$V_{GE}=V_{CE}, I_c=1mA$	$V_{GE(th)}$	4.7	5	5.3	V	
Collector-emitter saturation voltage	$V_{GE}=15V, I_c=60A$	$V_{CE(sat)}$	-	1.8	-	V	
	$V_{GE}=15V, I_c=60A, T_{vj}=175^{\circ}\text{C}$		-	2.5	-	V	
Input capacitance	$V_{CE}=30V$ $V_{GE}=0V$ $f=1MHz$	$C_{ies}$	-	3860	-	pF	
Output capacitance		$C_{oes}$	-	170	-	pF	
Reverse transfer capacitance		$C_{res}$	-	30	-	pF	
Total gate charge	$V_{CC}=520V, V_{GE}=15V, I_c=60A$	$Q_g$	-	120	-	nC	
Turn-on delay time	$V_{CC}=400V$ $V_{GE}=15V$ $I_c=60A$ $R_G=10\Omega$ Inductive load	$t_d(on)$	-	44	-	ns	
Rise time		$t_r$	-	100	-	ns	
Turn-off delay time		$t_d(off)$	-	166	-	ns	
Fall time		$t_f$	-	75	-	ns	
Turn-on energy		$E_{on}$	-	2.3	-	mJ	
Turn-off energy		$E_{off}$	-	1.3	-	mJ	
Total switching energy		$E_{ts}$	-	3.6	-	mJ	
Turn-on delay time		$V_{CC}=400V$ $V_{GE}=15V$ $I_c=60A$ $R_G=10\Omega$ Inductive load $T_{vj}=175^{\circ}\text{C}$	$t_d(on)$	-	45	-	ns
Rise time			$t_r$	-	105	-	ns
Turn-off delay time			$t_d(off)$	-	180	-	ns
Fall time	$t_f$		-	76	-	ns	
Turn-on energy	$E_{on}$		-	3.6	-	mJ	
Turn-off energy	$E_{off}$		-	1.6	-	mJ	
Total switching energy	$E_{ts}$		-	5.2	-	mJ	
Diode forward voltage	$I_F=60A$		$V_F$	-	1.7	-	V
	$I_F=60A, T_{vj}=175^{\circ}\text{C}$	-		1.4	-	V	
Diode reverse recovery time	$V_R=400V$ $I_F=60A$ $diF/dt=-450A/\mu s$	$t_{rr}$	-	78	-	ns	
Diode peak reverse recovery current		$I_{rrm}$	-	14	-	A	
Diode reverse recovery charge		$Q_{rr}$	-	600	-	nC	
Diode reverse recovery time		$t_{rr}$	-	155	-	ns	
Diode peak reverse recovery current	$V_R=400V$ $I_F=60A$ $diF/dt=-450A/\mu s, T_{vj}=175^{\circ}\text{C}$	$I_{rrm}$	-	25	-	A	
Diode reverse recovery charge		$Q_{rr}$	-	2300	-	nC	

**RATINGS AND CHARACTERISTIC CURVES**

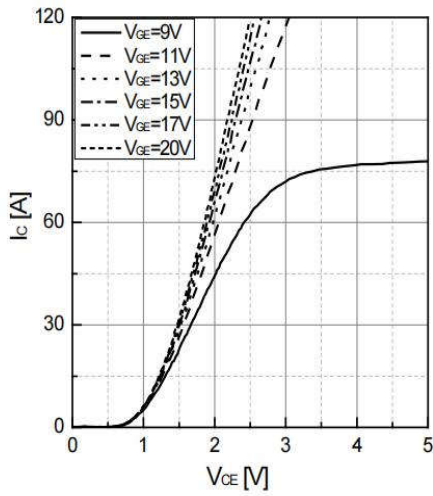


Fig 1. Typical output characteristic ( $T_{vj}=25^{\circ}\text{C}$ )

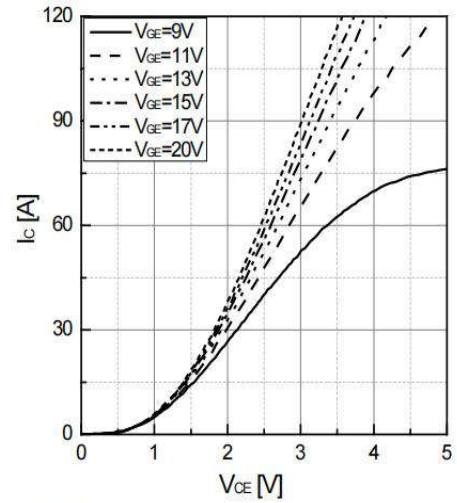


Fig 2. Typical output characteristic ( $T_{vj}=175^{\circ}\text{C}$ )

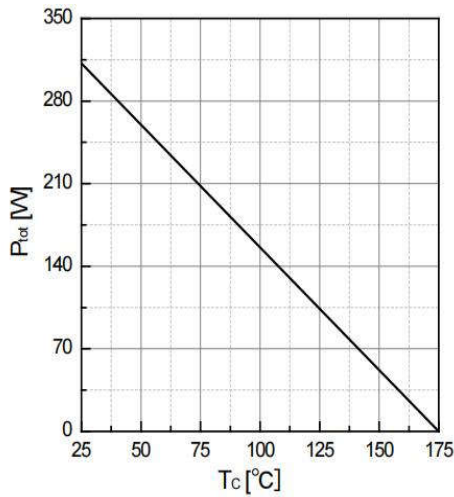


Fig 3. Power dissipation as a function of  $T_c$

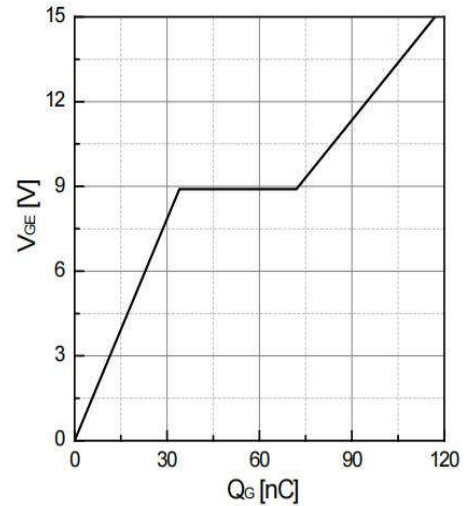


Fig 4. Typical Gate charge

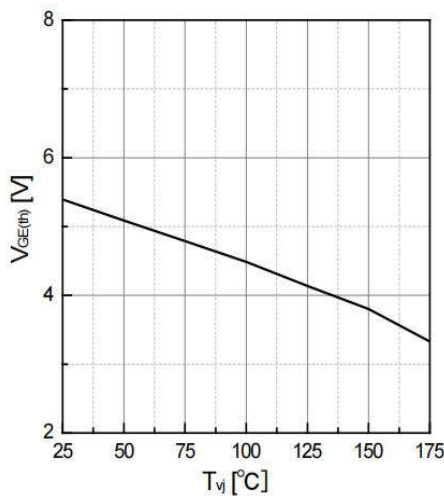


Fig 5. Typical  $V_{GE(th)}$  as a function of  $T_{vj}$   
( $I_c=1\text{mA}$ )

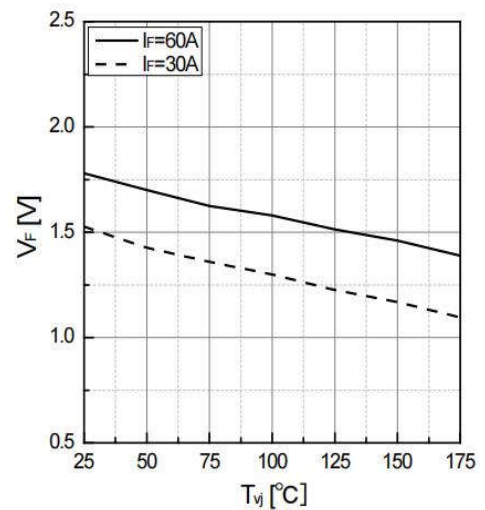


Fig 6. Typical  $V_F$  as a function of  $T_{vj}$

**RATINGS AND CHARACTERISTIC CURVES**

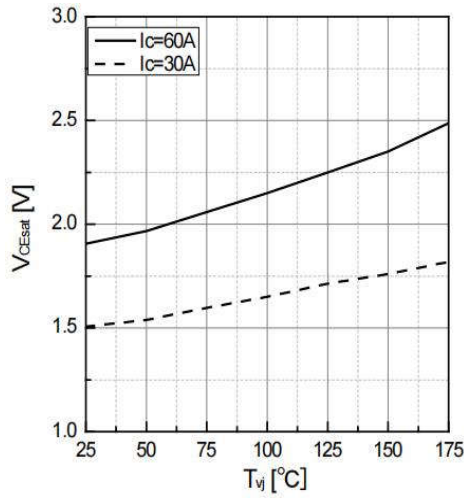


Fig 7. Typical  $V_{CEsat}$  as a function of  $T_{vj}$

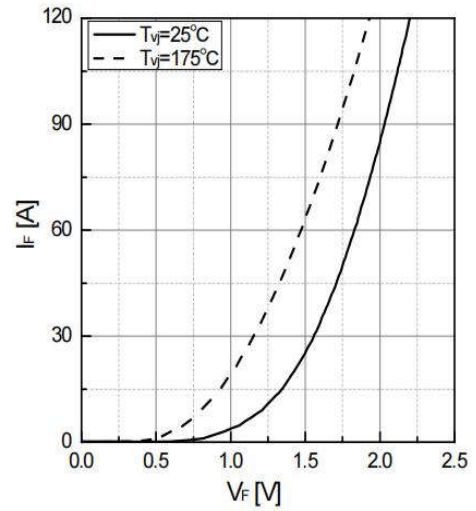


Fig 8. Typical  $I_F$  as a function of  $V_F$

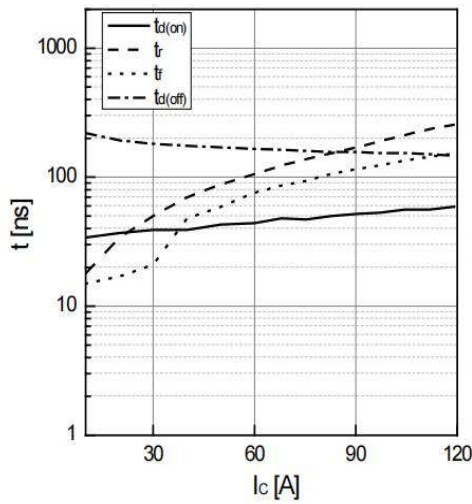


Fig 9. Typical switching time as a function of  $I_c$

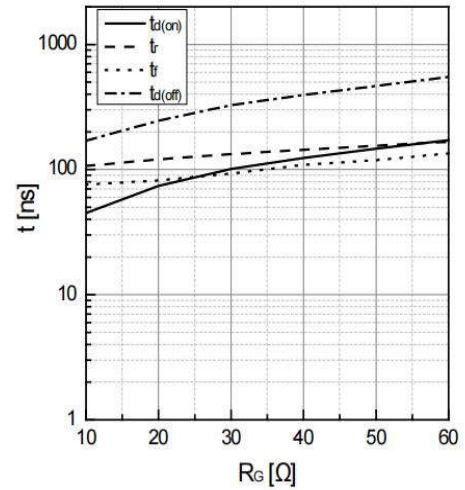


Fig 10. Typical switching times as a function of  $R_G$

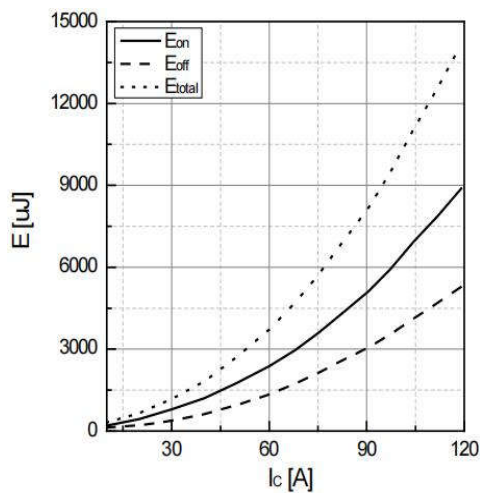


Fig 11. Typical switching energy losses as a function of  $I_c$

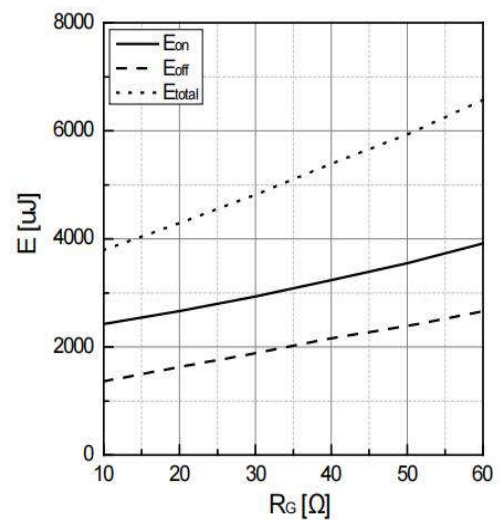


Fig 12. Typical switching energy losses as a function of  $R_G$

**RATINGS AND CHARACTERISTIC CURVES**

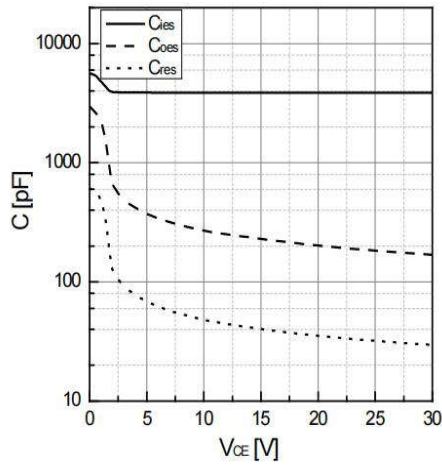


Fig 13. Typical capacitance as a function of  $V_{CE}$   
( $f=1\text{Mhz}$ ,  $V_{GE}=0\text{V}$ )

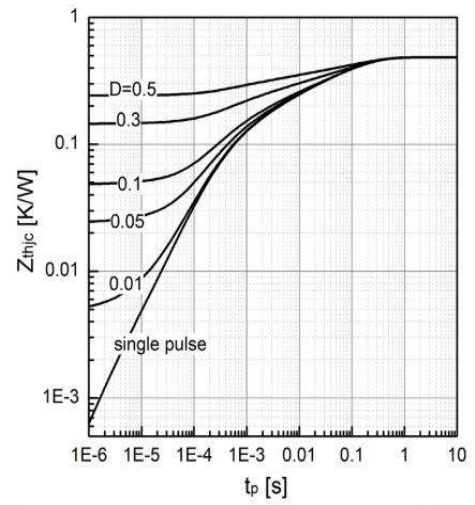
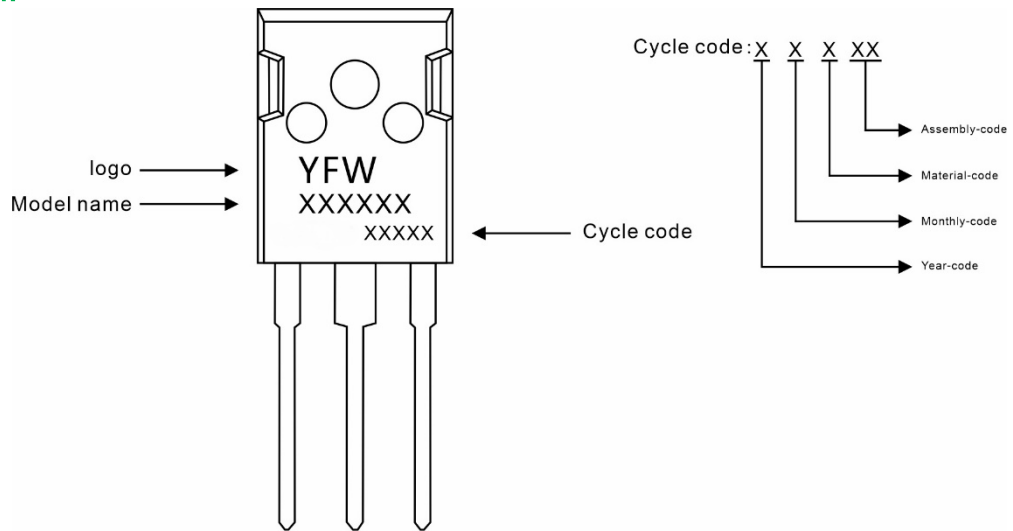


Fig 14. Transient thermal impedance of IGBT

**Marking Diagram**



**Ordering information**

Model name	Package	Unit Weight	Base Quantity	Packing Quantity
YFWG60T65AP	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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