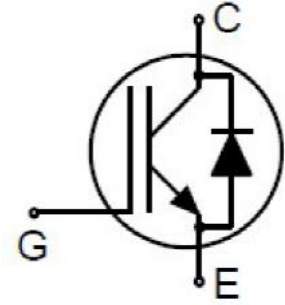


Features

- High breakdown voltage to 650V for improved reliability
- Trench-stop technology offering:
 - High speed switching
 - High ruggedness, temperature stable behavior
 - Short circuit withstand time: 7 μ s
 - Low $V_{CE(SAT)}$
 - Easy parallel switching capability due to positive temperature coefficient in $V_{CE(SAT)}$
- Built in Very Fast & Soft Recovery FRD
- RoHS compliant with Halogen-free

HF

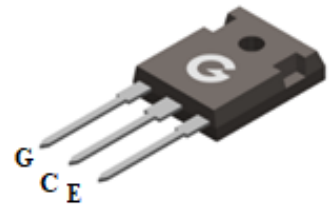


Applications

- General Inverter
- Relay Circuit
- Heater for Automotive

Mechanical Data

- Case: TO-247
- Molding Compound: UL Flammability Classification Rating 94V-0
- Terminals: Matte tin-plated leads; solderability-per MIL-STD-202, Method 208



TO-247

Ordering Information

Part Number	Package	Shipping Quantity	Marking Code
GKU60N65ES5	TO-247	30 pcs / Tube	KU60N65ES5

Maximum Ratings (@ $T_C = 25^\circ\text{C}$ unless otherwise specified)

Parameter	Symbol	Value	Unit
Collector-to-Emitter Voltage	V_{CES}	650	V
Gate-Emitter Voltage	V_{GES}	± 20	V
DC Collector Current ($T_C = 25^\circ\text{C}$, limited by maximum T_J)	I_C	120	A
DC Collector Current ($T_C = 100^\circ\text{C}$, limited by maximum T_J)		60	A
Diode Continuous Forward Current ($T_C = 25^\circ\text{C}$, limited by maximum T_J)	I_F	120	A
Diode Continuous Forward Current ($T_C = 100^\circ\text{C}$, limited by maximum T_J)		60	A
Pulsed Collector Current (Pulse width limited by maximum T_J , $V_{GE} = 15\text{V}$)	I_{CM}	180	A
Pulsed Diode Current (Pulse width limited by maximum T_J)	I_{FM}	180	A
Short Circuit Withstand Time ($V_{GE} = 15\text{V}$, $V_{CE} \leq 400\text{V}$)	T_{SC}	7	μs
Soldering Temperature, Wave Soldering 1.6mm (0.063in.) from case for 10s	T_{sold}	260	$^\circ\text{C}$
Power Dissipation ($T_C = 25^\circ\text{C}$)	P_D	300	W
Operating Junction Temperature Range	T_J	-55 ~ +175	$^\circ\text{C}$
Storage Temperature Range	T_{STG}	-55 ~ +150	$^\circ\text{C}$

Thermal Characteristics

Parameter	Symbol	Min.	Typ.	Max.	Unit
Thermal Resistance Junction-to-Case, IGBT	$R_{\theta JC}$	-	-	0.5	°C/W
Thermal Resistance Junction-to-Case, Diode		-	-	0.8	°C/W
Thermal Resistance Junction-to-Air	$R_{\theta JA}$	-	-	40	°C/W

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

Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Unit
Static Characteristics						
$V_{(BR)CES}$	Collector-Emitter Breakdown Voltage	$V_{GE} = 0V, I_C = 250\mu A$	650	-	-	V
I_{CES}	Collector-Emitter Leakage Current	$V_{CE} = 650V, V_{GE} = 0V, T_J = 25^\circ\text{C}$	-	-	1	μA
		$V_{CE} = 650V, V_{GE} = 0V, T_J = 175^\circ\text{C}$	-	-	4	mA
I_{GES}	Gate to Emitter Leakage Current	$V_{GE} = \pm 20V, V_{CE} = 0V$	-	-	± 100	nA
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	$V_{GE} = 15V, I_C = 60A, T_J = 25^\circ\text{C}$	-	1.52	1.95	V
		$V_{GE} = 15V, I_C = 60A, T_J = 175^\circ\text{C}$	-	1.86	-	V
$V_{GE(th)}$	Gate Threshold Voltage	$V_{CE} = V_{GE}, I_C = 250\mu A$	4.1	5.0	5.8	V
R_G	Gate Resistance	$V_{GE} = 0V, f = 1\text{MHz}$	-	0.93	-	Ω
Dynamic Characteristics						
Q_G	Total Gate-Charge	$V_{CC} = 520V, V_{GE} = 15V, I_C = 60A$	-	446	-	nC
C_{ies}	Input Capacitance	$V_{CE} = 25V$	-	11290	-	pF
C_{oes}	Output Capacitance	$V_{GE} = 0V$	-	151	-	
C_{res}	Reverse Transfer Capacitance	$f = 1\text{MHz}$	-	63	-	
$I_{C(SC)}$	Short Circuit Collector Current	$V_{GE} = 15V, t_{SC} \leq 7\mu s$ $V_{CC} = 400V, T_J = 25^\circ\text{C}$	-	685	-	A
Switching Characteristics						
$t_{d(on)}$	Turn-on Delay Time	$V_{CE} = 400V$ $V_{GE} = 15V$ $I_C = 60A$ $R_G = 10\Omega$ $T_J = 25^\circ\text{C}$	-	131	-	ns
t_r	Turn-on Rise Time		-	116	-	
$t_{d(off)}$	Turn-Off Delay Time		-	492	-	
t_f	Turn-Off Fall Time		-	136	-	
E_{on}	Turn-On Switching Loss		-	2.22	-	mJ
E_{off}	Turn-Off Switching Loss		-	2.19	-	

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

Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Unit
Dynamic Characteristics						
V_{FM}	Diode Forward Voltage	$I_F = 60\text{A}$, $V_{GE} = 0\text{V}$	-	1.6	-	V
t_{rr}	Reverse recovery time	$V_{GE} = 0\text{V}$, $I_F = 50\text{A}$ $di/dt = 300\text{A}/\mu\text{s}$	-	88	-	ns
Q_{rr}	Reverse recovery charge		-	396	-	nC
I_{rrm}	Peak Reverse Recovery Current		-	8.65	-	A

Ratings and Characteristics Curves (@ $T_A = 25^\circ\text{C}$ unless otherwise specified)

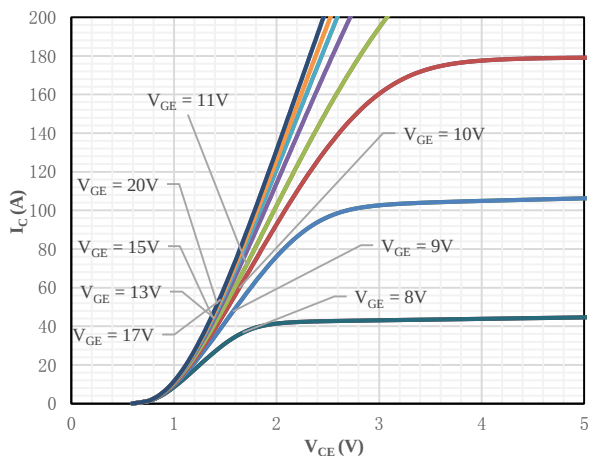


Fig 1 Typical Output Characteristics

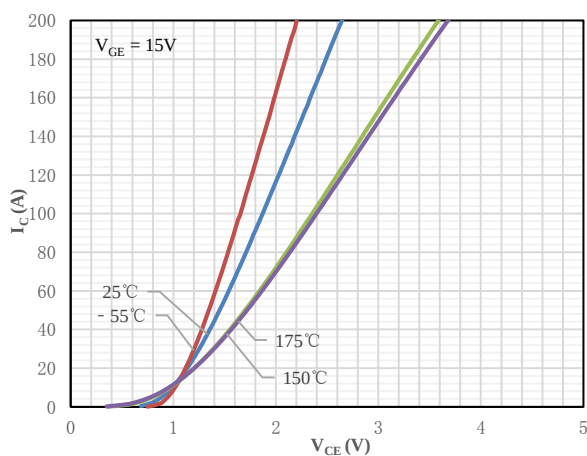


Fig 2 Saturation Voltage Characteristics

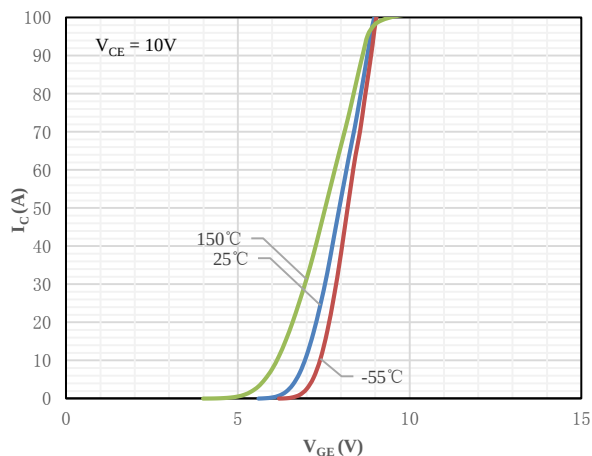


Fig 3 Transfer Characteristics

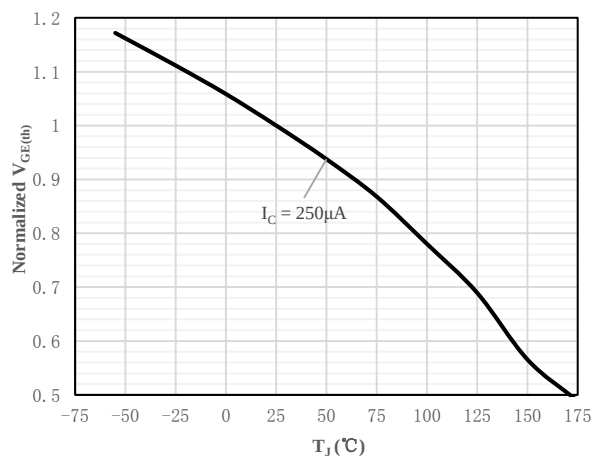


Fig 4 Normalized $V_{GE(th)}$ vs. Junction Temperature

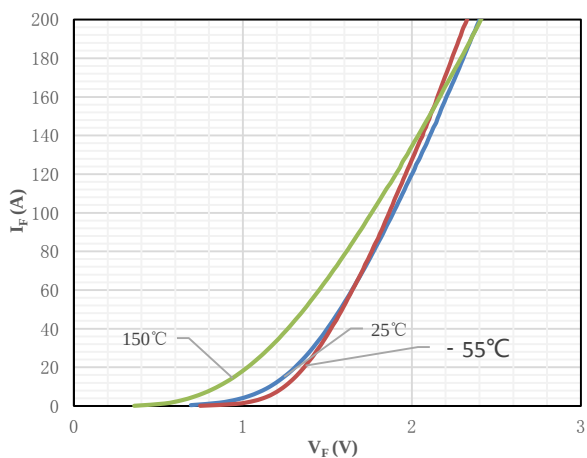


Fig 5 Diode forward current as a function of forward voltage V_F vs. I_F

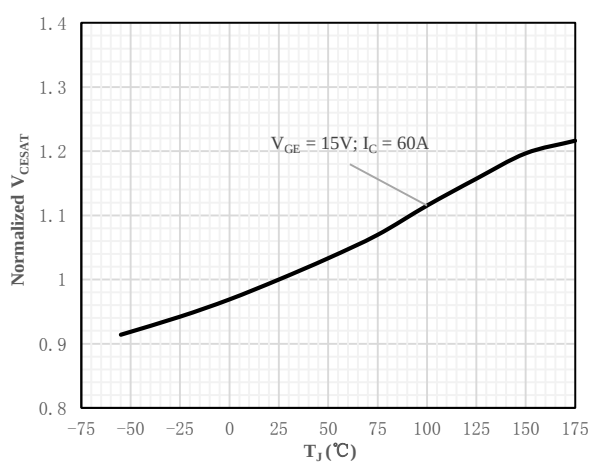


Fig 6 Normalized Collector-Emitter Saturation Voltage vs. Junction Temperature

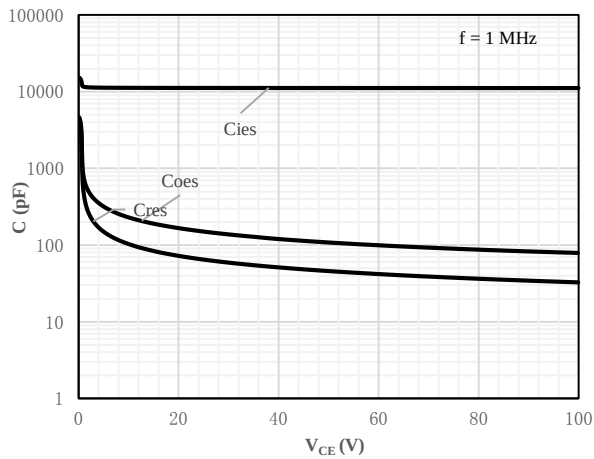


Fig 7 Capacitance Characteristics

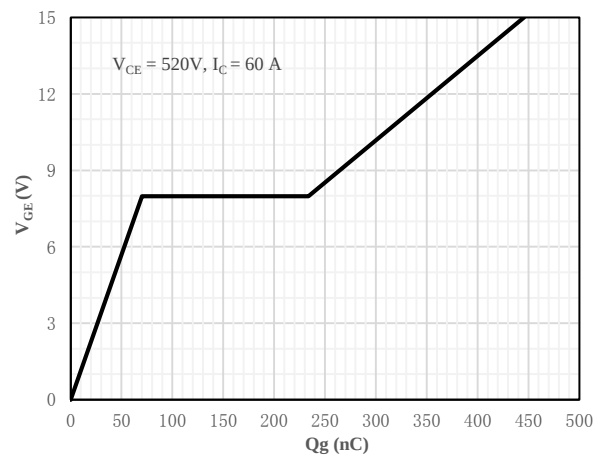


Fig 8 Gate-Charge Characteristics

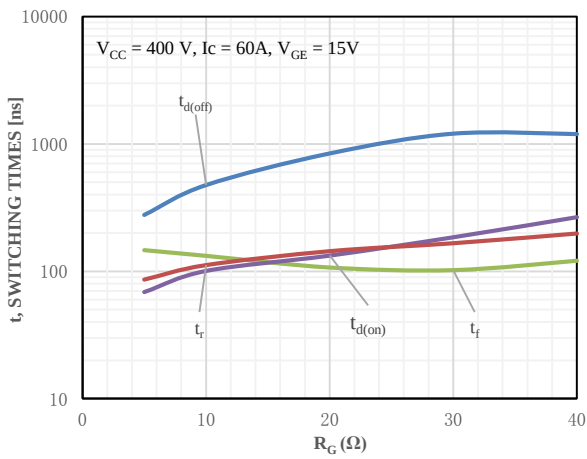


Fig 9 Switching Times vs. Gate Resistor

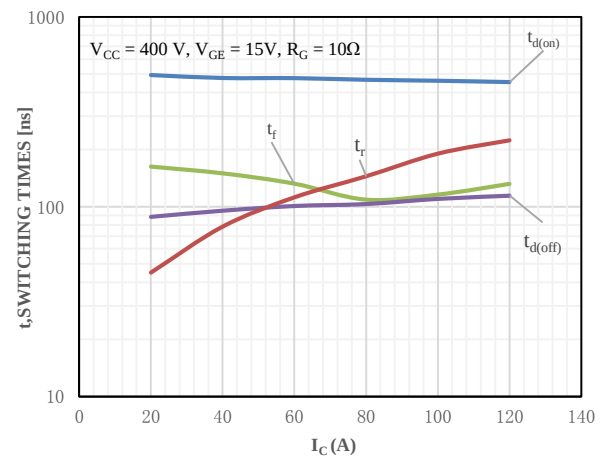


Fig 10 Switching Times vs. Collector Current

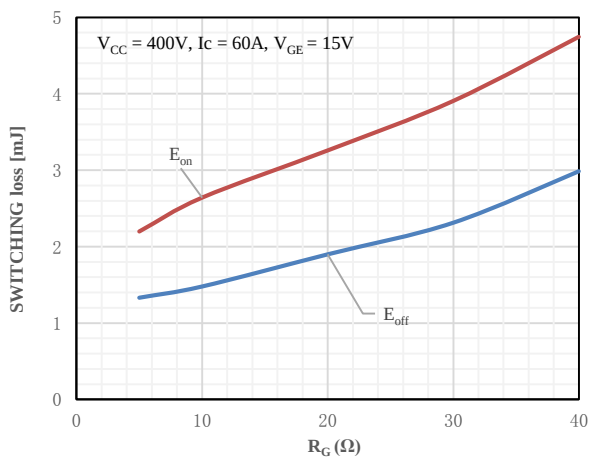


Fig 11 Switching Loss vs. Gate Resistor

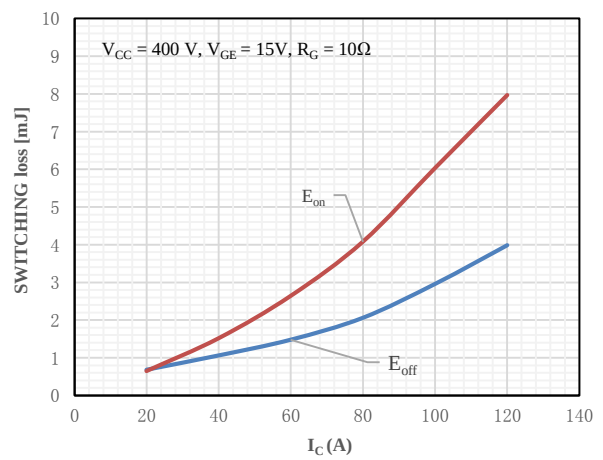


Fig 12 Switching Loss vs. Collector Current

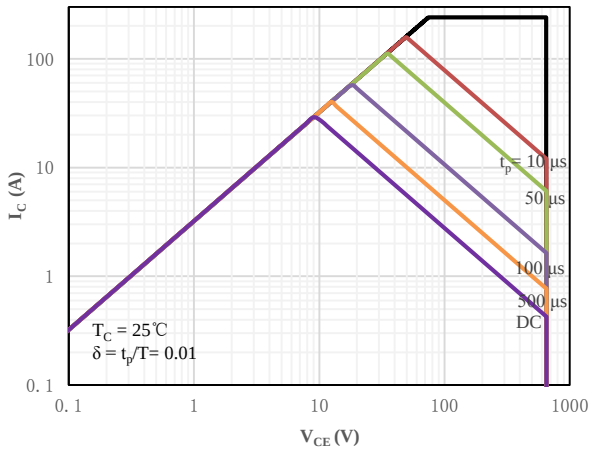


Fig 13 SOA characteristics

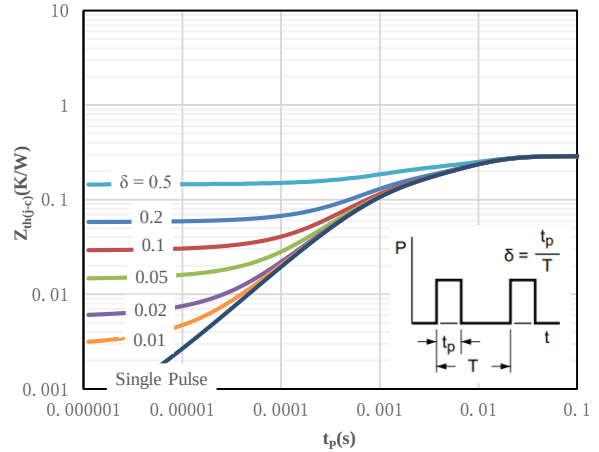


Fig 14 Maximum transient thermal impedance

Waveform definitions

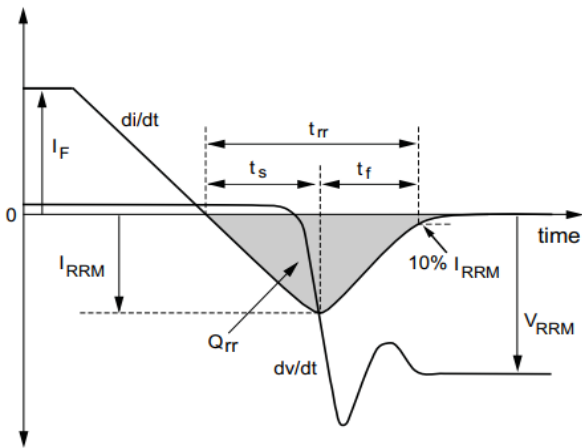


Fig 1 Diode Reverse Recovery Waveform Definitions

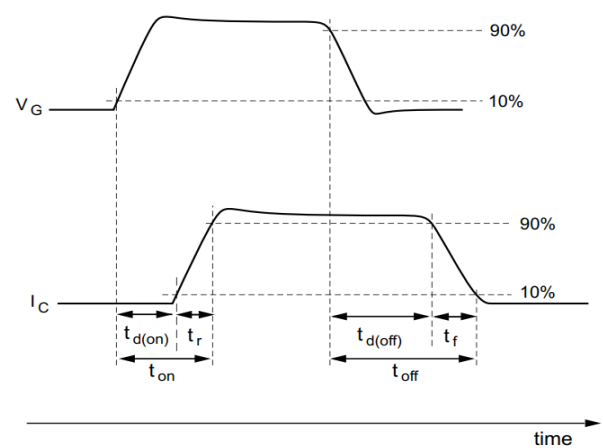


Fig 2 IGBT Switching Times Definitions

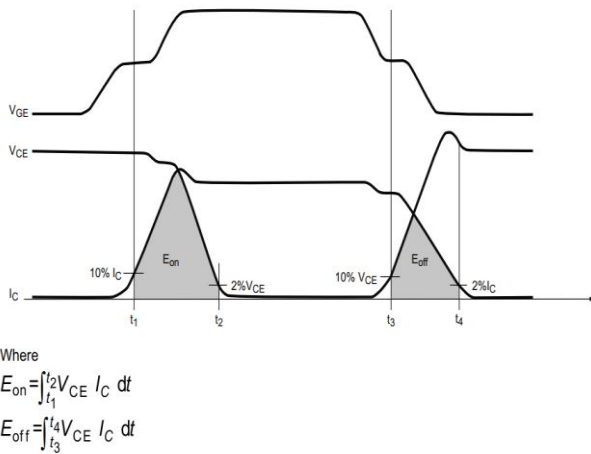
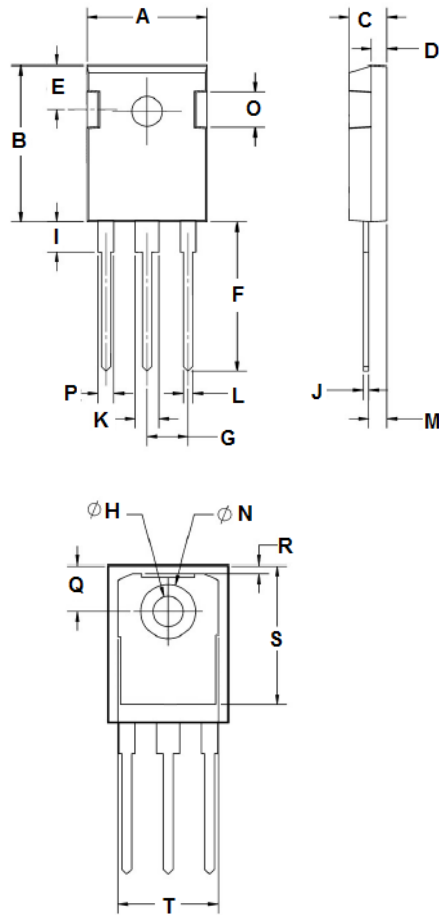


Fig 3 IGBT Switching Energy Loss Definitions

Package Outline Dimensions (Unit: mm)



TO-247		
Dimension	Min.	Max.
A	15.50	16.10
B	20.70	21.30
C	4.70	5.30
D	1.80	2.20
E	5.20	5.80
F	19.70	20.30
G	5.20	5.60
H	3.30	3.70
I	3.90	4.30
J	0.50	0.70
K	2.80	3.20
L	1.00	1.40
M	2.20	2.60
N	7.00	7.20
O	4.90	5.30
P	1.80	2.20
Q	5.70	5.90
R	0.80	1.20
S	17.00	17.80
T	13.60	14.20