

650V, 30A Trench Field Stop IGBT

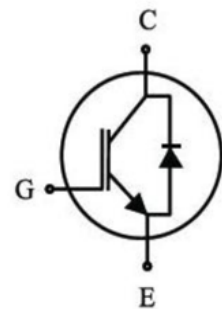
Features

- * $V_{CE}=650V$, $I_C = 30A$ (@100°C)
 $V_{CE(sat)}=1.66V$, $I_C=30A$ (Typ.),
- * High reliability
- * Low gate charge
- * Trench Field Stop technology
- * Low switching losses
- * Low V_{CEsat}
- * ROHS compliant
- * With anti-parallel fast recovery diode
- * Positive temperature coefficient
- * TO247-3L and TO-220F Package

Applications

- Motor drive
- Power management for inverter systems

Pin Description and Schematic



Trench Field Stop IGBT

Package Marking And Ordering Information

Device	Marking ^[1]	Device Package	Quantity
HCR30T65GT247BP	HCR30T65G xx	TO247-3L	1800pcs/Box
HCR30T65FT22FBP	HCR30T65F xx	TO-220F	1000pcs/Box

Note 1. The "HCR30T65G or HCR30T65F" is product type and the "xx" is date code.

650V, 30A Trench Field Stop IGBT

Absolute Maximum Ratings

$T_C = 25^\circ\text{C}$, unless otherwise specified

Parameter	Symbol	HCR30T65G	HCR30T65F	Unit
Collector-emitter voltage	V_{CE}	650		V
Continuous collector current, $T_C = 25^\circ\text{C}$	I_C	60		A
Continuous collector current, $T_C = 100^\circ\text{C}$	I_C	30		A
Pulsed collector current (Note 1)	I_{CM}	90		A
Diode continuous forward current, $T_C = 25^\circ\text{C}$	I_F	60		A
Diode continuous forward current, $T_C = 100^\circ\text{C}$	I_F	30		A
Diode maximum forward current	I_{FM}	90		A
Gate-emitter voltage	V_{GE}	± 30		V
Short circuit withstand time $V_{GE} = 15\text{V}$, $V_{CC} \leq 400\text{V}$, $T_J \leq 175^\circ\text{C}$ Allowed number of short circuits < 1000; time between short circuits $\geq 1.0\text{s}$	t_{SC}	5.0		μs
Power dissipation, $T_C = 25^\circ\text{C}$	P_D	187	48	W
Maximum operating junction temperature	T_J	175		$^\circ\text{C}$
Storage temperature range	T_{STG}	-55 to +175		$^\circ\text{C}$
Maximum lead temperature for soldering	T_L	260		$^\circ\text{C}$

Note 1: Collector current is limited by maximum junction temperature.

Thermal Characteristics

Parameter	Symbol	HCR30T65G	HCR30T65F	Unit
Thermal resistance, junction to case (IGBT)	$R_{th(j-c)}$	0.8	3.1	$^\circ\text{C/W}$
Thermal resistance, junction to case (diode)	$R_{th(j-c)}$	0.8	4.4	$^\circ\text{C/W}$
Thermal resistance, junction to ambient	$R_{th(j-A)}$	40	78	$^\circ\text{C/W}$

650V, 30A Trench Field Stop IGBT
Electrical Characteristics
 $T_C = 25^{\circ}\text{C}$, unless otherwise specified

Parameter	Symbol	Test Conditions	Min.	Typ.	Max.	Unit
Off-state Characteristics						
Collector-emitter breakdown voltage	BV_{CES}	$V_{GE} = 0V, I_C = 250\mu A$	650	-	-	V
Breakdown voltage temperature coefficient	$\Delta BV_{CES}/\Delta T_J$	$I_C = 1mA$, referenced to 25°C	-	0.65	-	V/ $^{\circ}\text{C}$
Zero gate voltage collector current	I_{CES}	$V_{CE} = 650V, V_{GE} = 0V$	-	-	4	μA
Gate-emitter leakage current	$I_{GES(F/R)}$	$V_{CE} = 0V, V_{GE} = \pm 30V$	-	-	± 200	nA
On-state Characteristics						
Gate-emitter threshold voltage	$V_{GE(th)}$	$V_{CE} = V_{GE}, I_C = 1mA$	4.8	5.4	6.1	V
Collector-emitter saturation voltage	V_{CESAT}	$V_{GE} = 15V, I_C = 30A$, $T_J = 25^{\circ}\text{C}$	-	1.66	2.0	V
Collector-emitter saturation voltage	V_{CESAT}	$V_{GE} = 15V, I_C = 30A$, $T_J = 125^{\circ}\text{C}$	-	1.90	-	V
Collector-emitter saturation voltage	V_{CESAT}	$V_{GE} = 15V, I_C = 30A$, $T_J = 175^{\circ}\text{C}$	-	2.05	-	V

Gate Charge and Capacitance Characteristics

Parameter	Symbol	Test Conditions	Min.	Typ.	Max.	Unit
Total gate charge	Q_g	$V_{CE} = 520V, I_C = 30A$, $V_{GE} = 15V$	-	66	-	nC
Gate-emitter charge	Q_{ge}		-	27	-	nC
Gate-collector charge	Q_{gc}		-	18	-	nC

Parameter	Symbol	Test Conditions	Min.	Typ.	Max.	Unit
Input capacitance	C_{ies}	$V_{CE} = 25V, V_{GE} = 0V$, $f = 1.0MHz$	-	1446	-	pF
Output capacitance	C_{oes}		-	64	-	pF
Reverse transfer capacitance	C_{res}		-	15	-	pF

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Electrical Characteristics (Continued)
Dynamic Characteristics

Parameter	Symbol	Test Conditions	Min.	Typ.	Max.	Unit
Turn-on delay time	$t_{d(on)}$	$V_{GE} = 15V$, $V_{CC} = 400V$, $I_C = 30A$, $R_G = 5\Omega$, $T_J = 25^\circ C$; inductive load	-	13	-	ns
Turn-on rise time	t_r		-	9	-	ns
Turn-off delay time	$t_{d(off)}$		-	68	-	ns
Turn-off fall time	t_f		-	57	-	ns
Turn-on energy	E_{on}		-	0.53	-	mJ
Turn-off energy	E_{off}		-	0.48	-	mJ
Total switching energy	E_{ts}		-	1.01	-	mJ

Parameter	Symbol	Test Conditions	Min.	Typ.	Max.	Unit
Turn-on delay time	$t_{d(on)}$	$V_{GE} = 15V$, $V_{CC} = 400V$, $I_C = 30A$, $R_G = 5\Omega$, $T_J = 175^\circ C$; inductive load	-	12	-	ns
Turn-on rise time	t_r		-	11	-	ns
Turn-off delay time	$t_{d(off)}$		-	83	-	ns
Turn-off fall time	t_f		-	96	-	ns
Turn-on energy	E_{on}		-	0.60	-	mJ
Turn-off energy	E_{off}		-	0.70	-	mJ
Total switching energy	E_{ts}		-	1.30	-	mJ

Short Circuit Characteristics and Gate Resistance

Parameter	Symbol	Test Conditions	Min.	Typ.	Max.	Unit
Short circuit collector current (maximum 100 short circuits; interval $\geq 1.0s$)	$I_{C(sc)}$	$V_{GE} = 15V$, $V_{CC} \leq 400V$, $t_{SC} \leq 5\mu s$, $T_J \leq 175^\circ C$	-	120	-	A
Gate resistance	R_g	$f = 1.0MHz$, V_{CE} open	-	3.6	-	Ω

650V, 30A Trench Field Stop IGBT
Diode Characteristics

$T_C = 25^\circ\text{C}$, unless otherwise specified

Parameter	Symbol	Test Conditions	Min.	Typ.	Max.	Unit
Diode forward voltage	V_{FM}	$I_F = 30\text{A}$	-	1.64	2.0	V
Reverse recovery time	t_{rr}	$I_F = 15\text{A}, T_J = 25^\circ\text{C},$ $dI/dt = 200\text{A}/\mu\text{s}$	-	145	-	ns
Reverse recovery current	I_{rr}	$I_F = 15\text{A}, T_J = 25^\circ\text{C},$ $dI/dt = 200\text{A}/\mu\text{s}$	-	4.2	-	A
Reverse recovery charge	Q_{rr}	$I_F = 15\text{A}, T_J = 25^\circ\text{C},$ $dI/dt = 200\text{A}/\mu\text{s}$	-	326	-	nC
Reverse recovery time	t_{rr}	$I_F = 30\text{A}, T_J = 25^\circ\text{C},$ $dI/dt = 200\text{A}/\mu\text{s}$	-	158	-	ns
Reverse recovery current	I_{rr}	$I_F = 30\text{A}, T_J = 25^\circ\text{C},$ $dI/dt = 200\text{A}/\mu\text{s}$	-	4.5	-	A
Reverse recovery charge	Q_{rr}	$I_F = 30\text{A}, T_J = 25^\circ\text{C},$ $dI/dt = 200\text{A}/\mu\text{s}$	-	374	-	nC
Reverse recovery time	t_{rr}	$I_F = 15\text{A}, T_J = 175^\circ\text{C},$ $dI/dt = 200\text{A}/\mu\text{s}$	-	193	-	ns
Reverse recovery current	I_{rr}	$I_F = 15\text{A}, T_J = 175^\circ\text{C},$ $dI/dt = 200\text{A}/\mu\text{s}$	-	8.5	-	A
Reverse recovery charge	Q_{rr}	$I_F = 15\text{A}, T_J = 175^\circ\text{C},$ $dI/dt = 200\text{A}/\mu\text{s}$	-	916	-	nC
Reverse recovery time	t_{rr}	$I_F = 30\text{A}, T_J = 175^\circ\text{C},$ $dI/dt = 200\text{A}/\mu\text{s}$	-	269	-	ns
Reverse recovery current	I_{rr}	$I_F = 30\text{A}, T_J = 175^\circ\text{C},$ $dI/dt = 200\text{A}/\mu\text{s}$	-	8.7	-	A
Reverse recovery charge	Q_{rr}	$I_F = 30\text{A}, T_J = 175^\circ\text{C},$ $dI/dt = 200\text{A}/\mu\text{s}$	-	1126	-	nC

Typical Characteristics

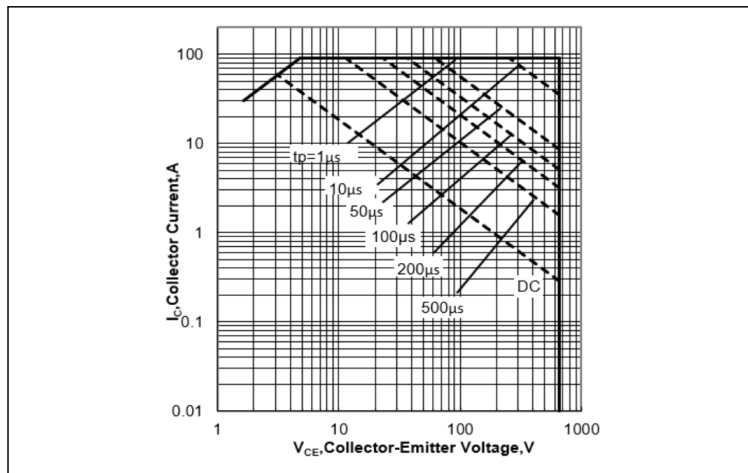


Figure 1. Forward Bias Safe Operating Area for TO247-3L

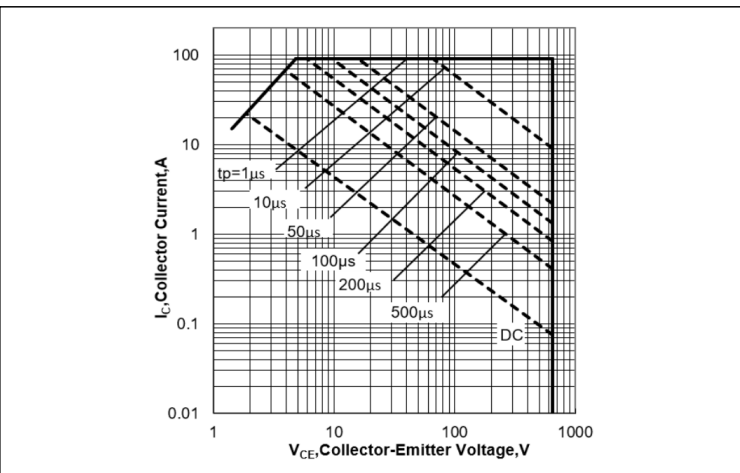


Figure 2. Forward Bias Safe Operating Area for TO-220F

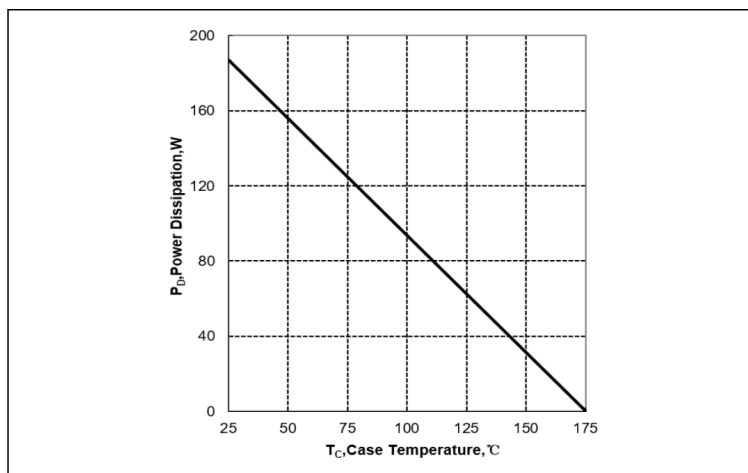


Figure 3. Power Dissipation vs Case Temperature for TO247-3L

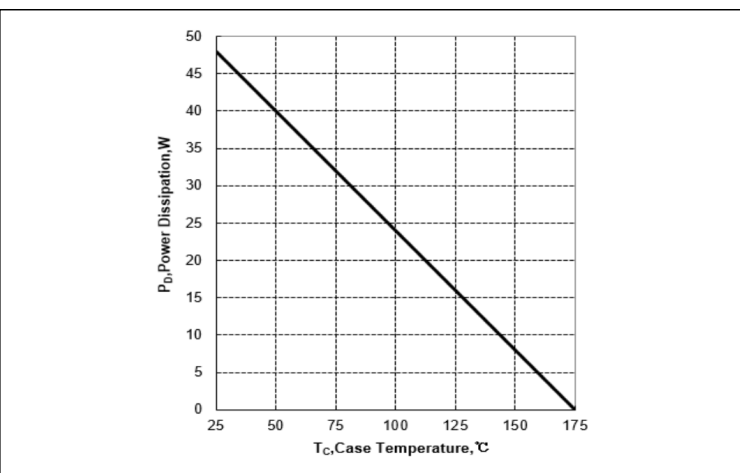


Figure 4. Power Dissipation vs Case Temperature for TO-220F

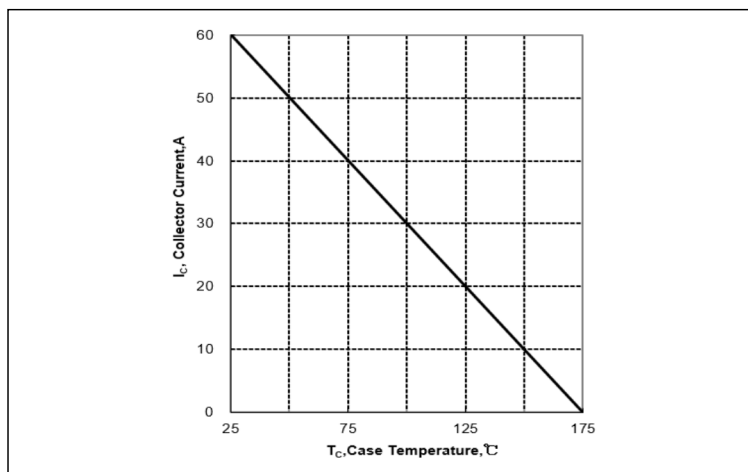


Figure 5. Collector Current vs Case Temperature

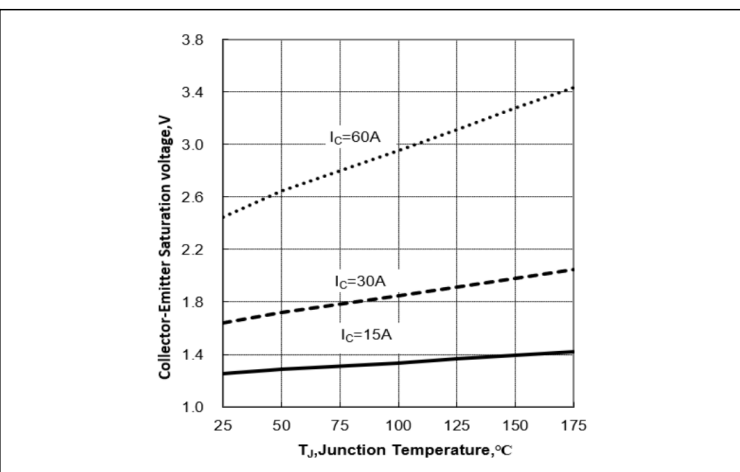


Figure 6. Typical Collector-Emitter Saturation Voltage vs Junction Temperature

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Typical Characteristics (Continued)

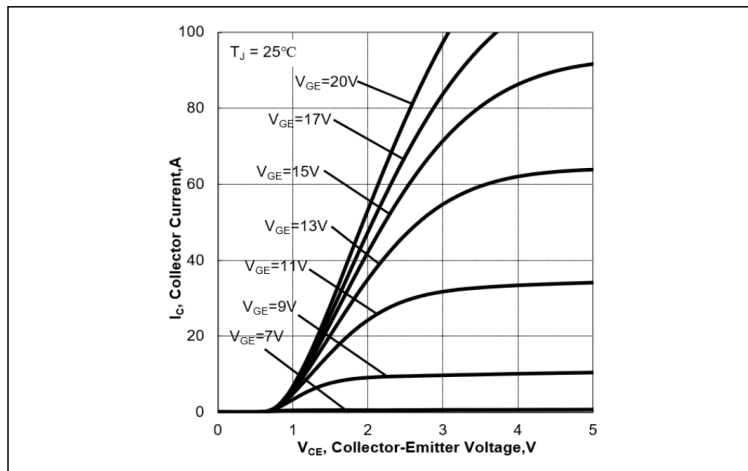


Figure 7. Typical Output Characteristics ($T_J=25^{\circ}\text{C}$)

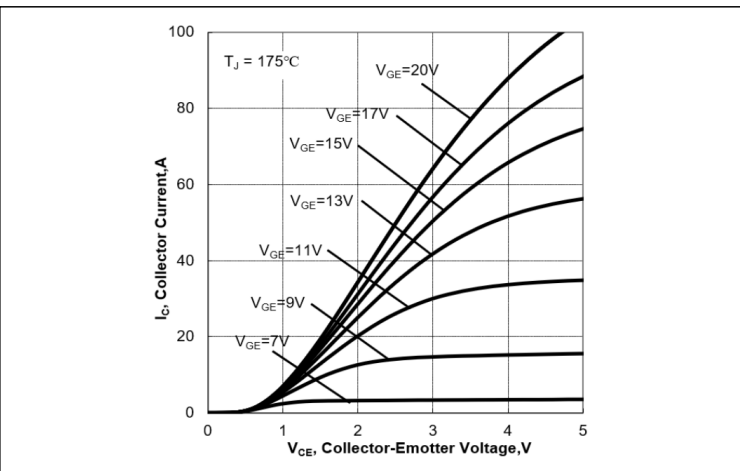


Figure 8. Typical Output Characteristics ($T_J=175^{\circ}\text{C}$)

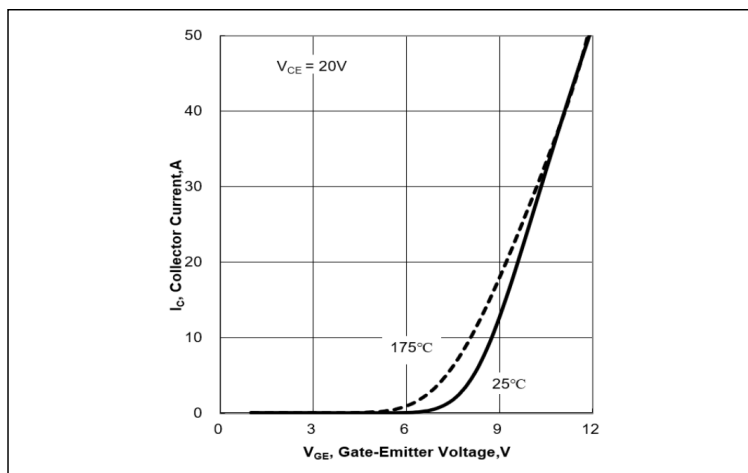


Figure 9. Typical Transfer Characteristics

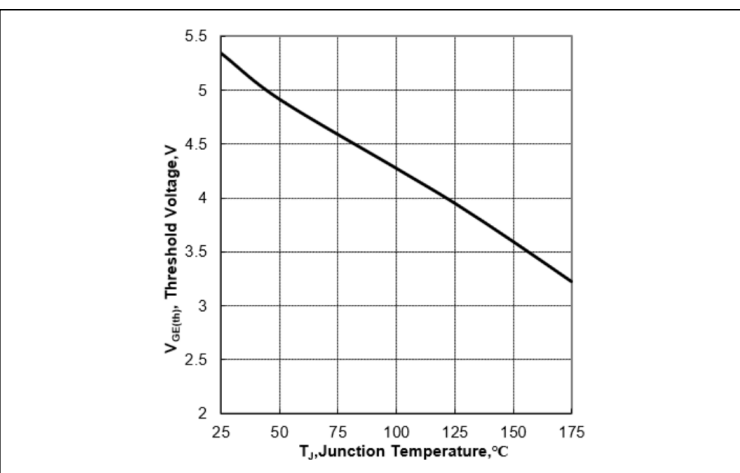


Figure 10. Typical Gate-Emmitter Threshold Voltage vs Junction Temperature

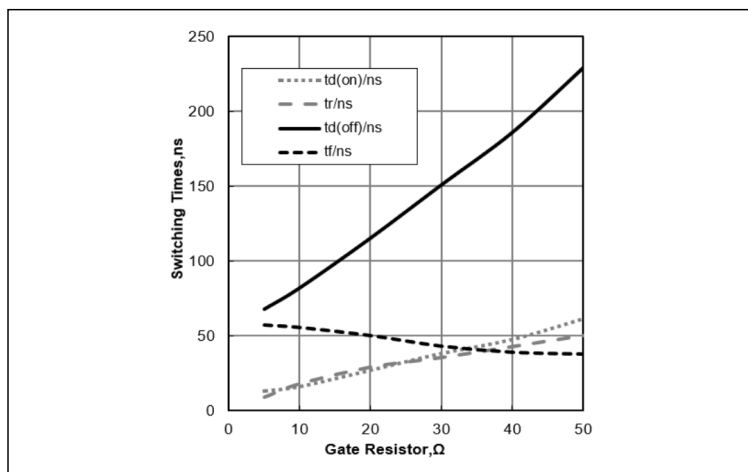


Figure 11. Typical Switching Times vs Gate Resistor ($T_J=25^{\circ}\text{C}$, $V_{CE}=400\text{V}$, $V_{GE}=15/0\text{V}$, $I_C=30\text{A}$)

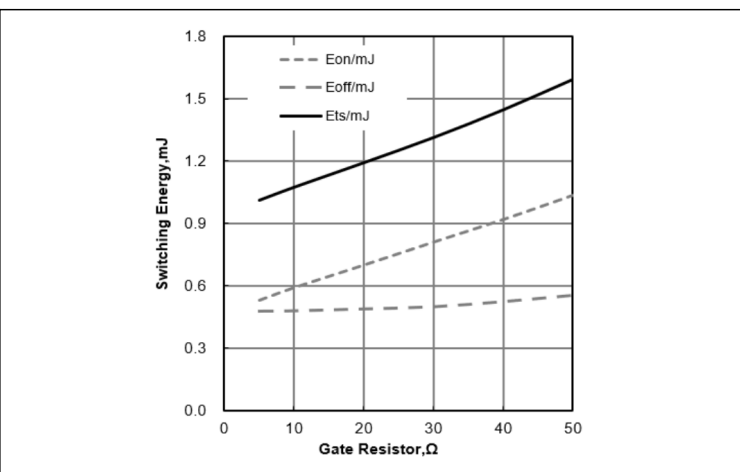


Figure 12. Typical Switching Energy vs Gate Resistor ($T_J=25^{\circ}\text{C}$, $V_{CE}=400\text{V}$, $V_{GE}=15/0\text{V}$, $I_C=30\text{A}$)

650V, 30A Trench Field Stop IGBT

Typical Characteristics (Continued)

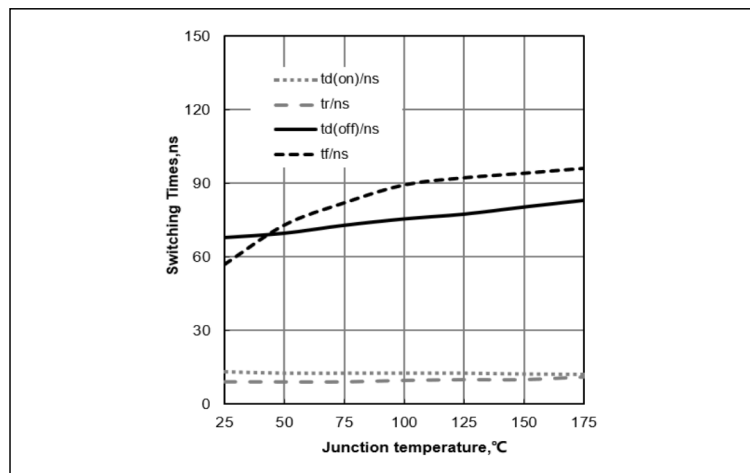


Figure 13. Typical Switching Times vs Junction Temperature ($V_{CE}=400V$, $V_{GE}=15/0V$, $I_C=30A$)

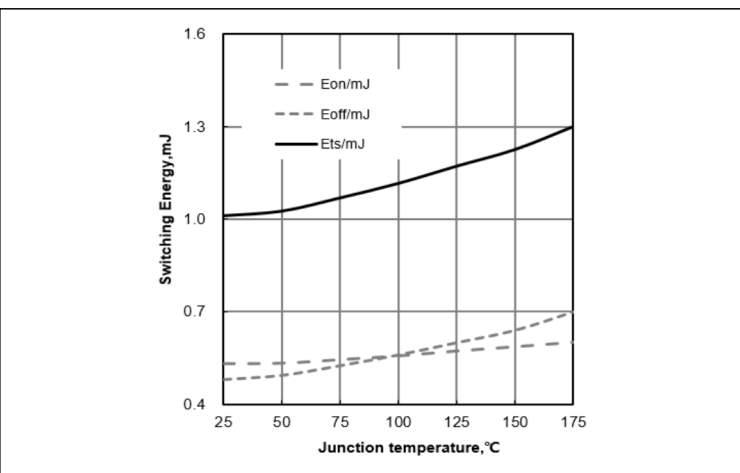


Figure 14. Typical Switching Energy vs Junction Temperature ($V_{CE}=400V$, $V_{GE}=15/0V$, $I_C=30A$)

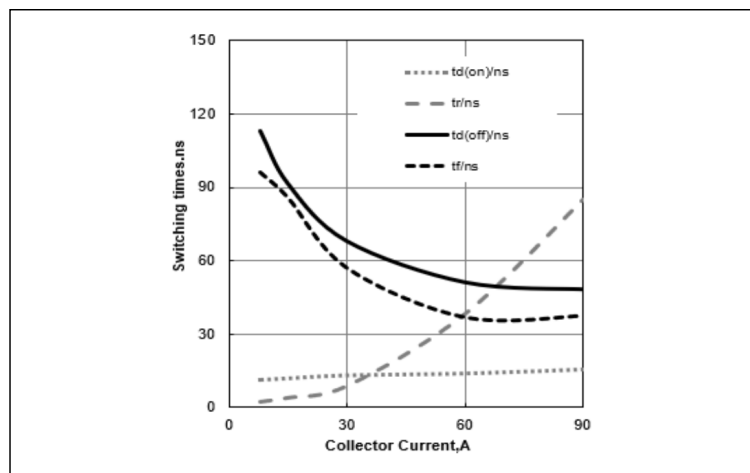


Figure 15. Typical Switching Times vs Collector Current ($T_J=25^\circ C$, $V_{CE}=400V$, $V_{GE}=15/0V$)

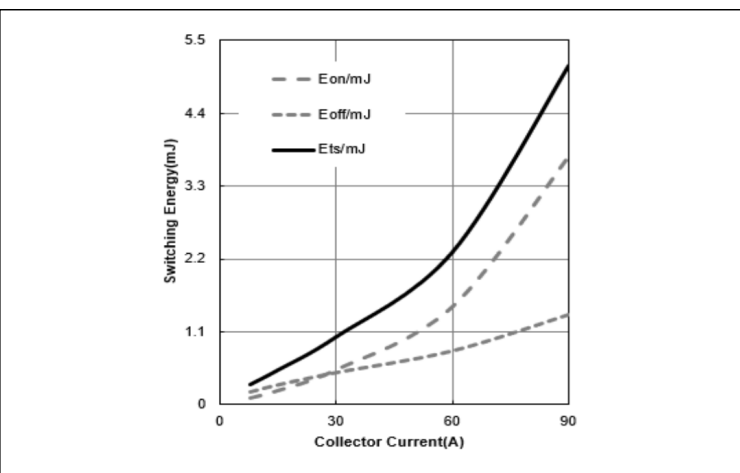


Figure 16. Typical Switching Energy vs Collector Current ($T_J=25^\circ C$, $V_{CE}=400V$, $V_{GE}=15/0V$)

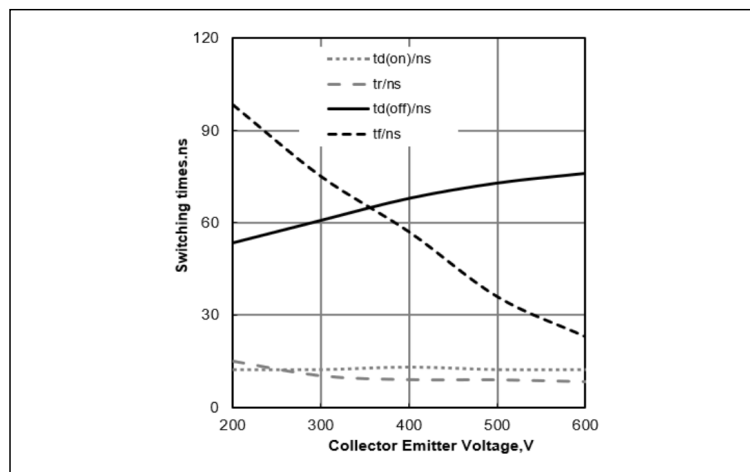


Figure 17. Typical Switching Times vs V_{CE} ($T_J=25^\circ C$, $V_{GE}=15/0V$, $I_C=30A$)

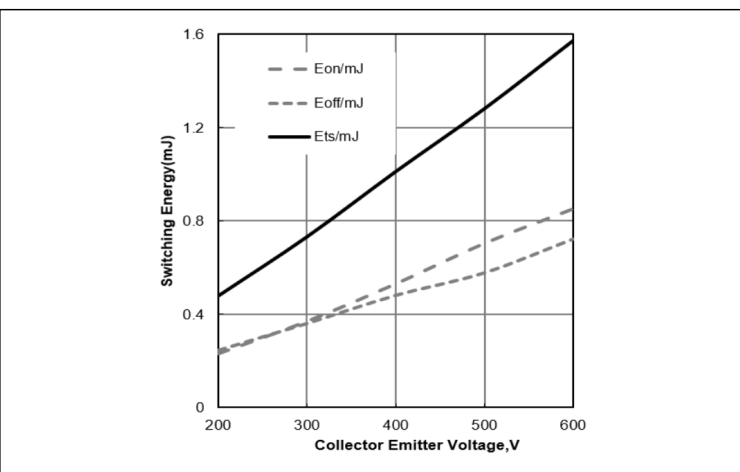


Figure 18. Typical Switching Energy vs V_{CE} ($T_J=25^\circ C$, $V_{GE}=15/0V$, $I_C=30A$)

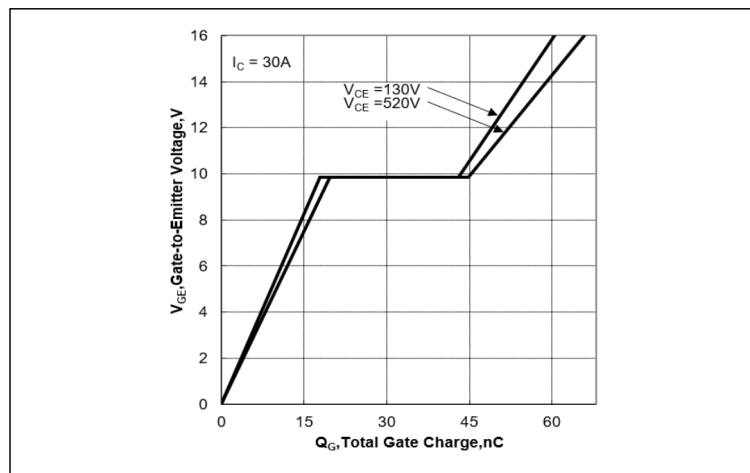
650V, 30A Trench Field Stop IGBT
Typical Characteristics (Continued)


Figure 19. Typical Gate Charge

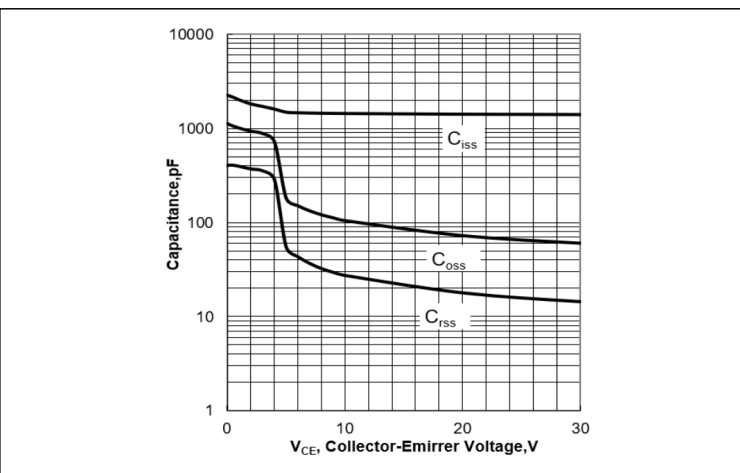


Figure 20. Typical Capacitance vs Collector-Emitter Voltage

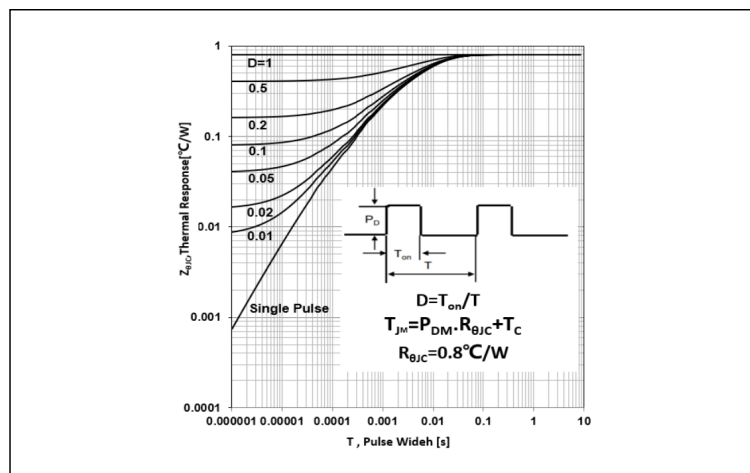


Figure 21. IGBT Transient Thermal Impedance vs Pulse Width (TO247-3L)

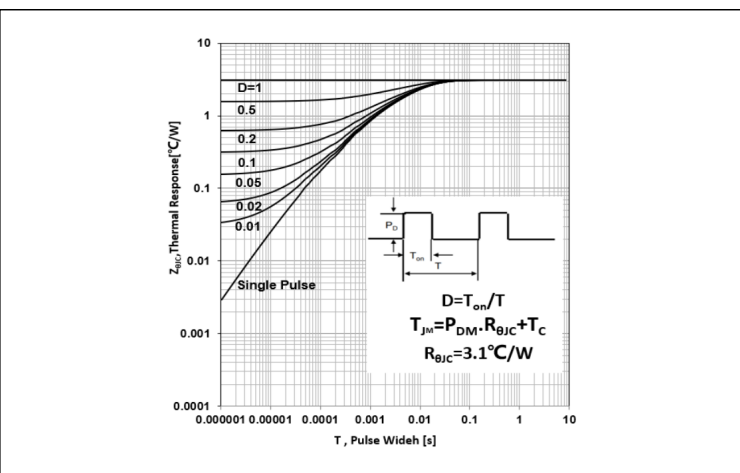


Figure 22. IGBT Transient Thermal Impedance vs Pulse Width (TO-220F)

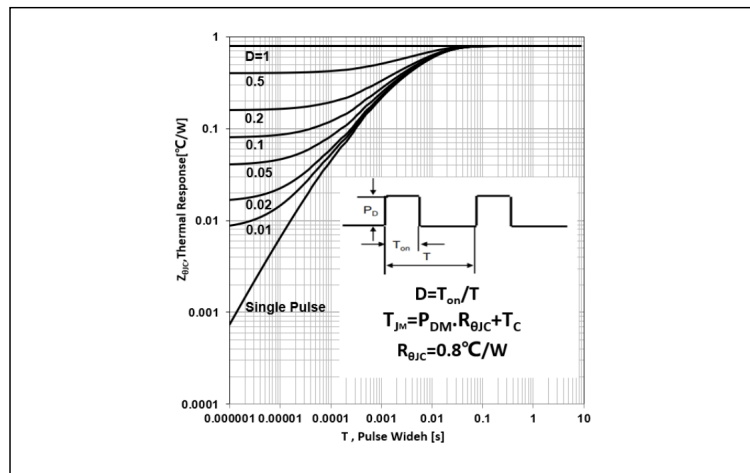


Figure 23. Diode Transient Thermal Impedance vs Pulse Width (TO247-3L)

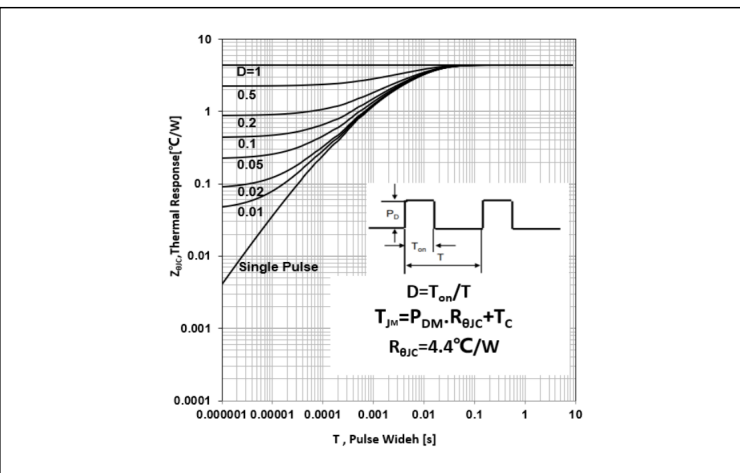


Figure 24. Diode Transient Thermal Impedance vs Pulse Width (TO-220F)

Typical Characteristics and Test Waveforms

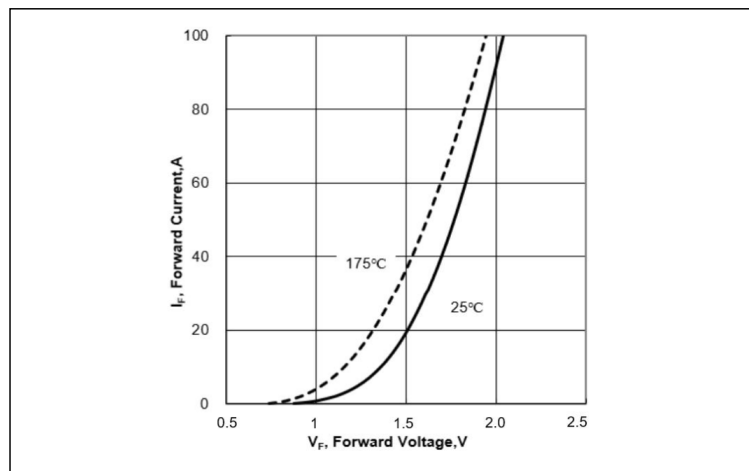
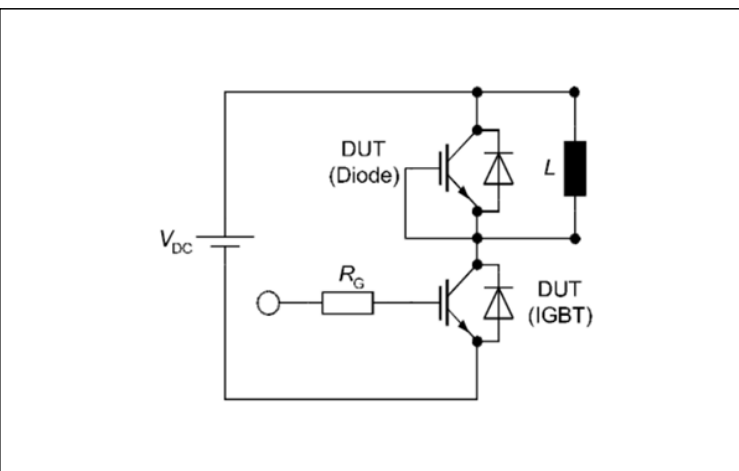
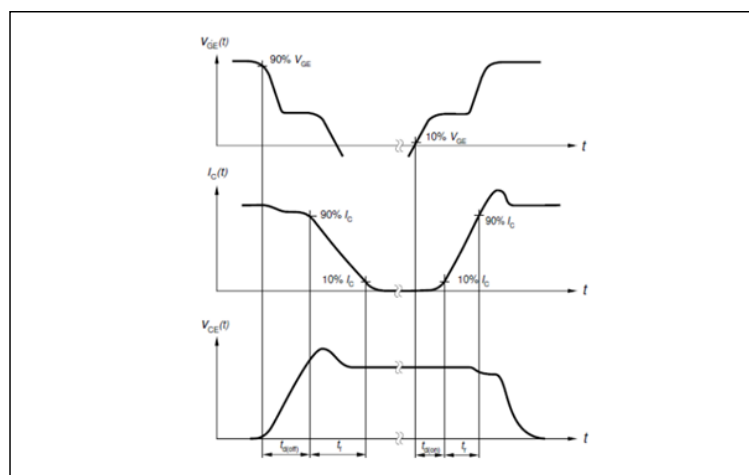


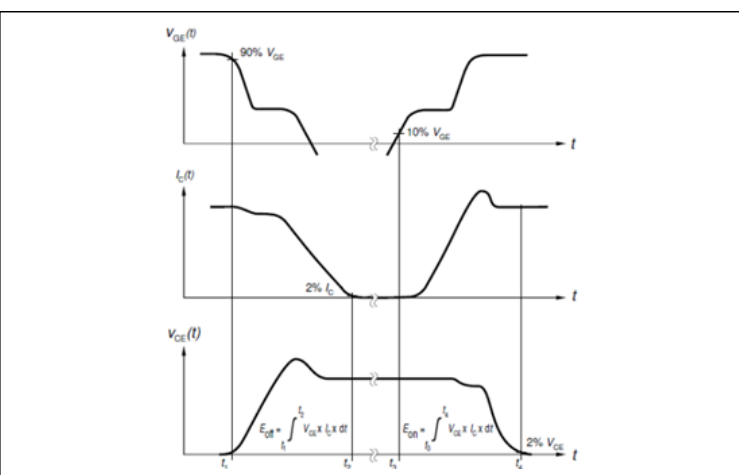
Figure 25. Typical Diode Forward Current vs Forward Voltage



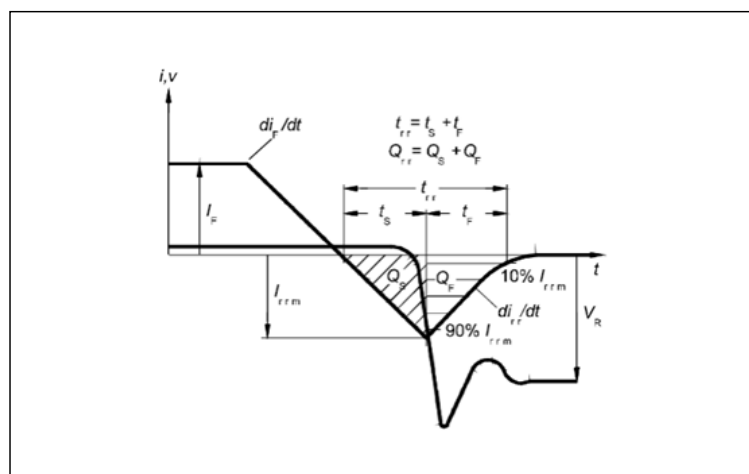
Inductive Switching Test Circuit



Definition of switching times



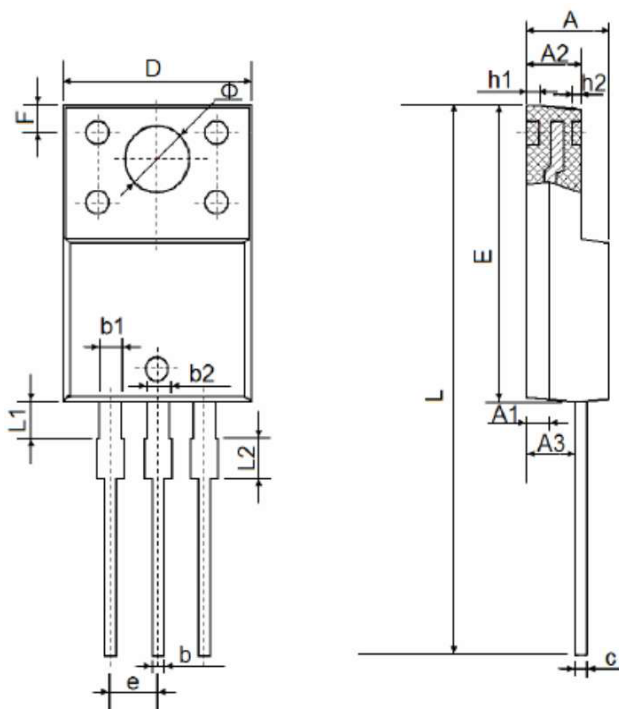
Definition of switching losses



Definition of diode switching characteristics

650V, 30A Trench Field Stop IGBT
Package Dimensions
HCR30T65F - TO-220F Package

Unit: mm

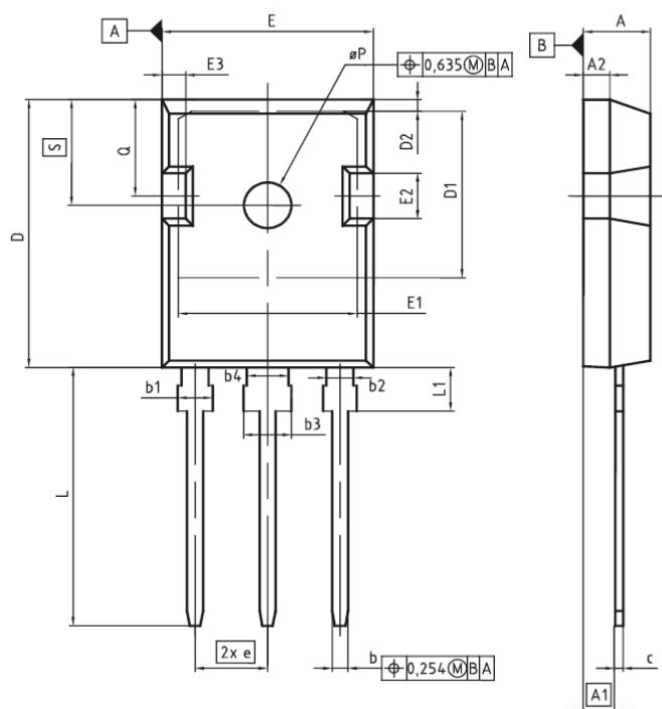


Symbol	Dimensions in Millimeters		Dimensions in Inches	
	Min.	Max.	Min.	Max.
A	4.300	4.700	0.169	0.185
A1	1.300REF		0.051REF	
A2	2.800	3.200	0.110	0.126
A3	2.500	2.900	0.098	0.114
b	0.500	0.750	0.020	0.030
b1	1.100	1.350	0.043	0.053
b2	1.500	1.750	0.059	0.069
c	0.500	0.750	0.020	0.030
D	9.960	10.360	0.392	0.408
E	14.800	15.200	0.583	0.598
e	2.540TYP.		0.100TYP	
F	2.700REF		0.106REF	
Φ	3.500REF		0.138REF	
h1	0.800REF		0.031REF	
h2	0.500REF		0.020REF	
L	28.000	28.400	1.102	1.118
L1	1.700	1.900	0.067	0.075
L2	1.900	2.100	0.075	0.083

Package Dimensions

HCR30T65G - TO247-3L Package

Unit: mm

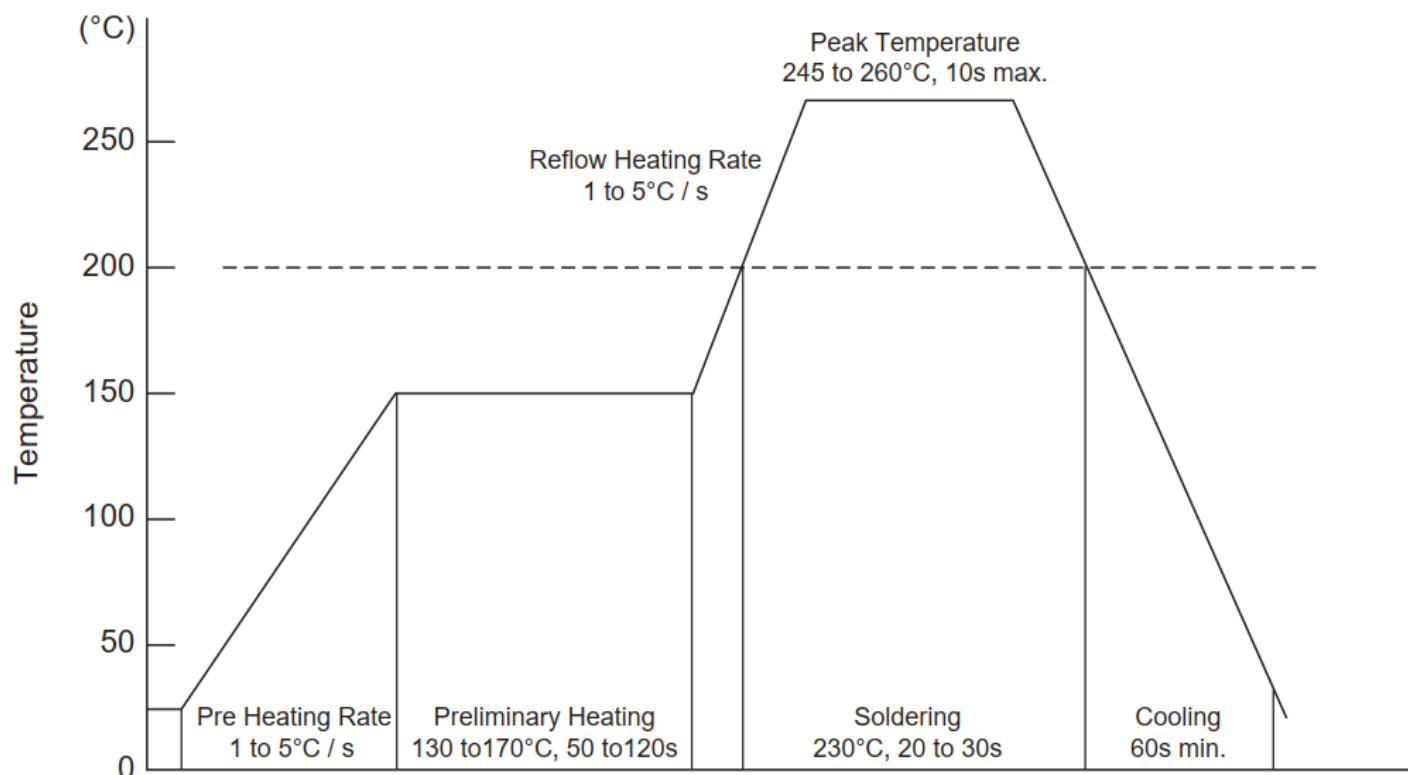


Symbol	Dimensions in Millimeters		Dimensions in Inches	
	Min.	Max.	Min.	Max.
A	4.83	5.21	0.190	0.205
A1	2.27	2.54	0.089	0.100
A2	1.85	2.16	0.073	0.085
b	1.07	1.33	0.042	0.052
b1	1.90	2.41	0.075	0.095
b2	1.90	2.16	0.075	0.085
b3	2.87	3.38	0.113	0.133
b4	2.87	3.13	0.113	0.123
c	0.55	0.68	0.022	0.027
D	20.80	21.10	0.819	0.831
D1	16.25	17.65	0.640	0.695
D2	0.95	1.35	0.037	0.053
E	15.70	16.13	0.618	0.635
E1	13.10	14.15	0.516	0.557
E2	3.68	5.10	0.145	0.201
E3	1.00	2.60	0.039	0.102
e	5.44 (BSC)		0.214 (BSC)	
N	3		3	
L	19.80	20.32	0.780	0.800
L1	4.10	4.47	0.161	0.176
ϕP	3.50	3.70	0.138	0.146
Q	5.49	6.00	0.216	0.236
S	6.04	6.30	0.238	0.248

650V, 30A Trench Field Stop IGBT

Conditions of Soldering and Storage

Recommended condition of reflow soldering



Recommended peak temperature is over 245°C. If peak temperature is below 245°C, you may adjust the following parameters:

- Time length of peak temperature (longer)
- Time length of soldering (longer)
- Thickness of solder paste (thicker)

Conditions of hand soldering

- Temperature: 300°C
- Time: 3s max
- Times: one time

Storage conditions

- Temperature: 5 to 40°C
- Humidity: 30 to 80% RH
- Recommended period: One year after manufacturing