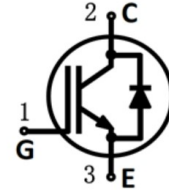


650V40A 绝缘栅双极型晶体管

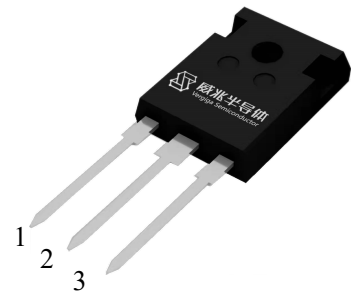
■ 特点/Features

- CoolWatt®II 沟槽栅场截止技术/CoolWatt®II Trench-FS technology
- 低饱和压降/Low V_{CEsat}
- 低动态损耗/Low switching losses
- 反并联快恢复二极管/With anti-parallel fast recovery diode
- 正温度系数/Positive temperature coefficient
- 高可靠性/High reliability



■ 应用领域/Applications

- 电源类/Power
- PV/光伏领域
- 工业焊机/Industrial welding
- 功率因素校正/PFC



TO-247

型号/Part ID	V_{CE} (V)	I_{CNOM} (A)	$V_{CESAT@25^{\circ}C}$ (V)	封装/Package	丝印/Marking
HCKW40N65H2	650	40	1.45	TO-247	K40H652

■ 最大额定值/Maximum Rated Values

符号 Symbol	参数 Parameter	条件 Condition	值 Value	单位 Unit
V_{CES}	集电极-发射极电压 Collector-emitter voltage	$T_{vj}=25^{\circ}C$	650	V
I_C	集电极连续直流电流 DC collector current	$T_C = 25^{\circ}C$ $T_C = 100^{\circ}C$	80 40	A
I_{Cpuls}	集电极可重复脉冲电流 Pulse collector current	$T_{vj}\leq 150^{\circ}C$	120	A
V_{RRM}	二极管反向峰值电压 Repetitive peak reverse voltage	$T_{vj}=25^{\circ}C$	650	V
I_F	二极管连续直流电流 Diode continuous forward current	$T_C = 25^{\circ}C$ $T_C = 100^{\circ}C$	80 40	A
I_{Fpuls}	二极管可重复脉冲电流 Diode pulse current	$T_{vj}\leq 150^{\circ}C$	120	A

V_{GE}	栅极-发射极电压 Gate-emitter voltage	$T_{vj}=25^{\circ}\text{C}$	± 20	V
P_{tot}	总耗散功率 Power dissipation	$T_C = 25^{\circ}\text{C}$	333	W
T_{vj}	可工作结温 Operating junction temperature		$-40 \sim +175$	$^{\circ}\text{C}$
T_{stg}	储存温度 Storage temperature		$-50 \sim +150$	$^{\circ}\text{C}$
M	安装扭矩 Mounting torque	M3	0.6	Nm

■ 热特性/Thermal Characteristic

符号 Symbol	参数 Parameter	最大值 Maximum	单位 Unit
$R_{thJC-IGBT}$	IGBT 芯片到底板热阻 IGBT thermal resistance junction-case	0.45	K/W
$R_{thJC-FRD}$	二极管芯片到底板热阻 FRD thermal resistance junction-case	1.3	K/W
R_{thJA}	芯片到环境热阻 Thermal resistance junction-ambient	40	K/W

■ 电气特性/Electrical Characteristic

符号 Symbol	参数 Parameter	测试条件 Test conditions	值Value			单位 Unit
			最小 Min.	典型 Typ.	最大 Max.	
$V_{(BR)CES}$	集电极-发射极击穿电压 Collector-emitter breakdown voltage	$V_{GE} = 0V$, $I_C = 0.25mA$, $T_{vj} = 25^{\circ}\text{C}$	650	—	—	V
$V_{CE(sat)}$	集电极-发射极饱和压降 Collector-emitter saturation voltage	$V_{GE} = 15V$, $I_C = 40A$, $T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 150^{\circ}\text{C}$	— —	1.45 1.75	1.65 —	
$V_{GE(th)}$	门极开启阈值电压 Gate-emitter threshold voltage	$V_{GE} = V_{CE}$, $I_C = 1.5mA$, $T_{vj} = 25^{\circ}\text{C}$	5.50	6.05	6.50	
V_F	二极管正向导通压降 Diode forward voltage	$V_{GE} = 0V$, $I_F = 40A$, $T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 150^{\circ}\text{C}$	— —	1.85 1.65	2.10 —	
I_{GES}	门极-发射极漏电流 Zero gate voltage collector current	$V_{GE} = 20V$, $V_{CE} = 0V$	—	—	200	nA
I_{CES}	集电极-发射极漏电 Zero gate voltage collector current	$V_{CE} = 650V$, $V_{GE} = 0V$, $T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 150^{\circ}\text{C}$	—	—	0.25 0.50	mA
R_{Gin}	内部门极电阻 Integrated gate resistor	—	—	0	—	Ω
C_{ies}	输入电容 Input capacitance	$V_{GE} = 0V$, $V_{CE} = 30V$,	—	5710	—	pF

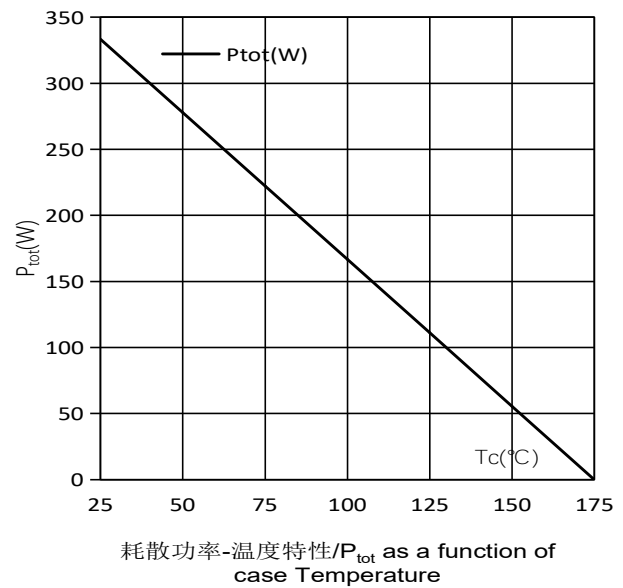
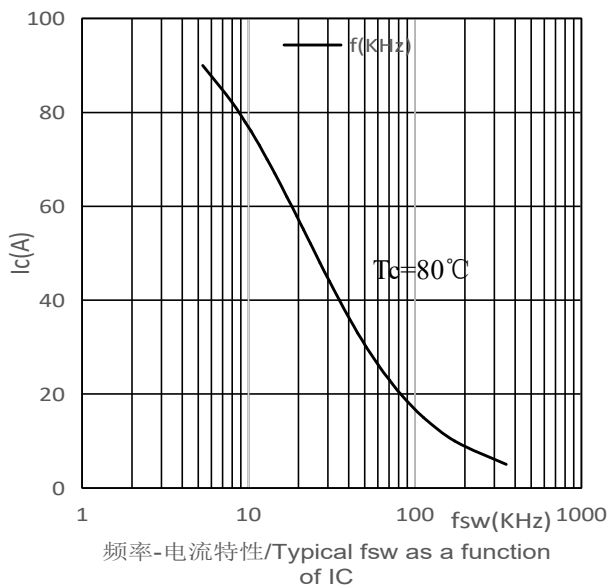
C_{oes}	输出电容 Output capacitance	$f = 1\text{MHz}, T_{vj}=25^{\circ}\text{C}$	—	125	—	
C_{res}	反向传输电容 Reverse transfer capacitance		—	96.9	—	
Q_g	门极电量 Gate charge	$I_C = 40\text{A}, V_{CE}=520\text{V},$ $V_{GE}=15\text{V}, T_{vj}=25^{\circ}\text{C}$	—	266	—	nC
Q_{ge}	门极-发射极电量 Gate-emitter charge		—	44.4	—	
Q_{gc}	门极-集电极电量 Gate-collector charge		—	127	—	
$V_{GE(pl)}$	米勒平台电压 Gate-emitter plateau voltage	$I_C = 40\text{A}, V_{CE}=520\text{V},$ $V_{GE}=0/15\text{V}, T_{vj}=25^{\circ}\text{C}$	—	8.65	—	V

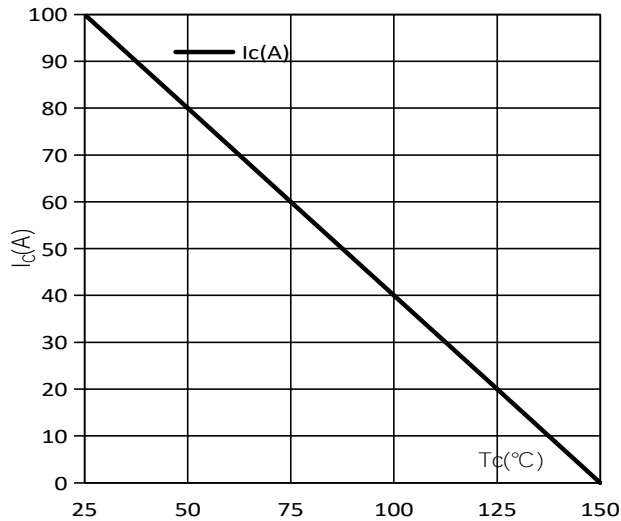
■ 动态特性/Dynamic Characteristic (With inductive load)

符号 Symbol	参数 Parameter	测试条件 Test conditions	值Value			单位 Unit
			最小 Min.	典型 Typ.	最大 Max.	
IGBT 特性_25℃/IGBT Characteristic_25℃:						
T _{d(on)}	开启延迟时间 Turn-on delay time	V _{cc} =400V,I _c =40A, R _{on} =20 Ω , R _{off} =20 Ω , C _{ge} =0nF,V _{GE} =0/15V, L _{load} =100uH,T _{vj} =25℃	—	122	—	ns
T _r	上升时间 Rise time		—	85.6	—	
T _{d(off)}	关闭延迟时间 Turn-off delay time		—	561	—	
t _f	下降时间 Fall time		—	34.9	—	
E _{on}	单次开启损耗 Turn-on energy		—	1.29	—	mJ
E _{off}	单次关闭损耗 Turn-off energy		—	1.04	—	
E _{total}	单脉冲总损耗 Total switch energy		—	2.33	—	
IGBT 特性_150℃/IGBT Characteristic_150℃:						
T _{d(on)}	开启延迟时间 Turn-on delay time	V _{cc} =400V,I _c =40A, R _{on} =20 Ω , R _{off} =20 Ω , C _{ge} =0nF,V _{GE} =0/15V, L _{load} =100uH,T _{vj} =25℃	—	107	—	ns
T _r	上升时间 Rise time		—	97	—	
T _{d(off)}	关闭延迟时间 Turn-off delay time		—	609	—	
t _f	下降时间 Fall time		—	53.7	—	
E _{on}	单次开启损耗 Turn-on energy		—	2.10	—	mJ
E _{off}	单次关闭损耗 Turn-off energy		—	1.35	—	
E _{total}	单脉冲总损耗 Total switch energy		—	3.45	—	
二极管特性_25℃/Diode Characteristic_25℃:						
E _{rec}	反向恢复损耗 Reverse recovery energy	I _F = 40 A,V _R =400V, V _{GE} =0/15 V,R _{ON} =20 Ω ,T _{vj} =25℃	—	113.6	—	uJ
t _{rr}	二极管反向恢复时间 Diode reverse recovery time		—	120.7	—	nS
Q _{rr}	二极管反向恢复电量 Diode reverse recovery charge		—	459.5	—	nC
I _{rrm}	反向恢复峰值电流 Diode peak reverse recovery current		—	7.5	—	A
di _{rr} /dt	恢复下降电流最大电流变化率		—	72	—	A/uS

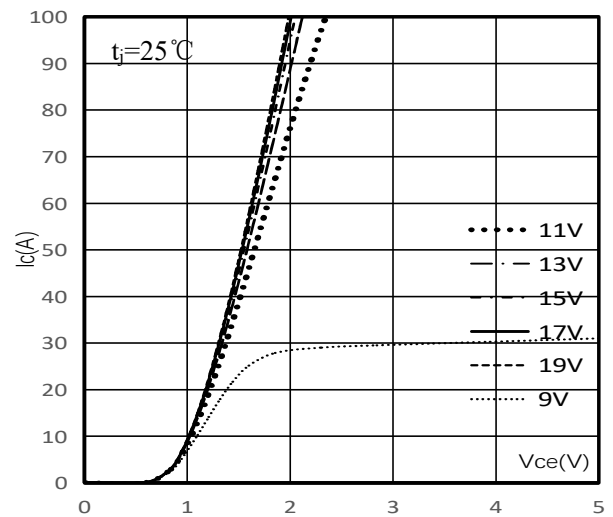
	Diode peak rate of fall of reverse Recovery current during t_{rr}					
二极管特性_150°C/Diode Characteristic_150°C:						
Erec	反向恢复损耗 Reverse recovery energy	$I_F = 40\text{ A}, V_R = 400\text{ V},$ $V_{GE} = 0/15\text{ V}, R_{ON} = 20\ \Omega,$ $T_{vj} = 150^\circ\text{C}$	—	296	—	uJ
trr	二极管反向恢复时间 Diode reverse recovery time		—	165.9	—	nS
Qrr	二极管反向恢复电量 Diode reverse recovery charge		—	1311	—	nC
Irrm	反向恢复峰值电流 Diode peak reverse recovery current		—	14.6	—	A
di_r/dt	恢复下降电流最大电流变化率 Diode peak rate of fall of reverse Recovery current during t_{rr}		—	301	—	A/uS

■ 特征曲线/ Characteristic Curve

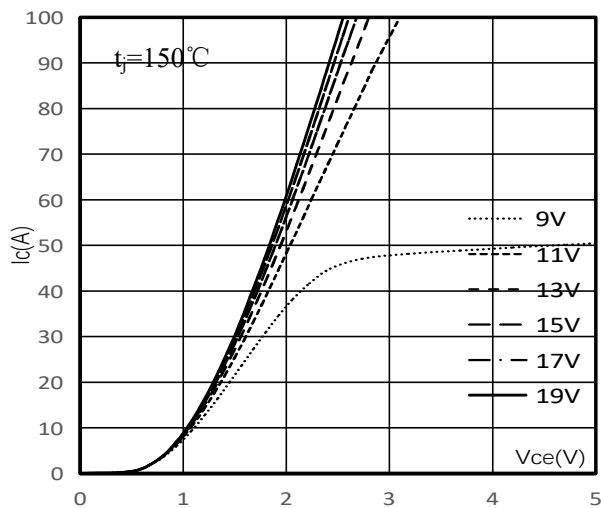




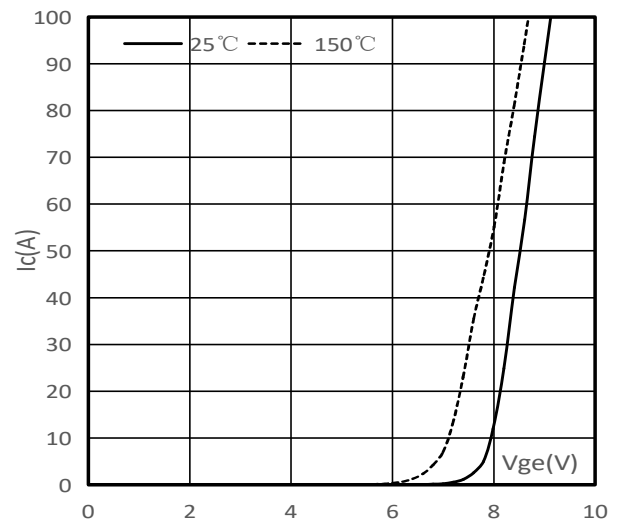
电流-底板温度特性/ I_C as a function of case temperature



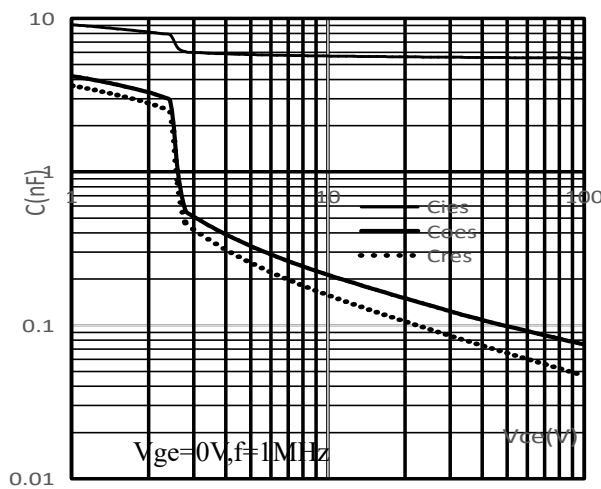
输出特性_25°C / Typical Output Characteristic_25°C



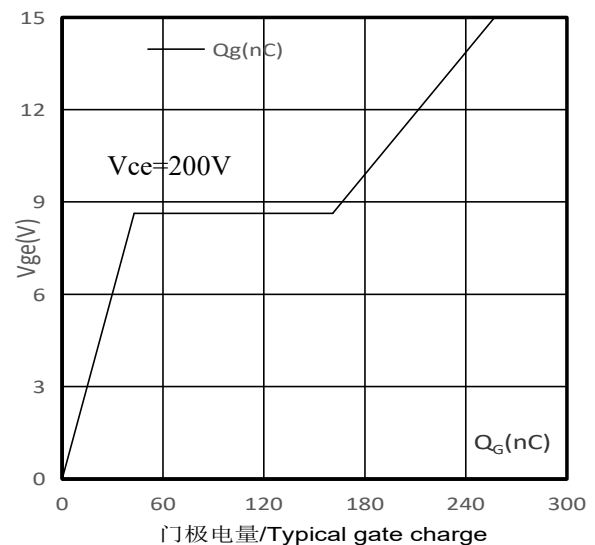
输出特性_150°C / Typical Output Characteristic_150°C



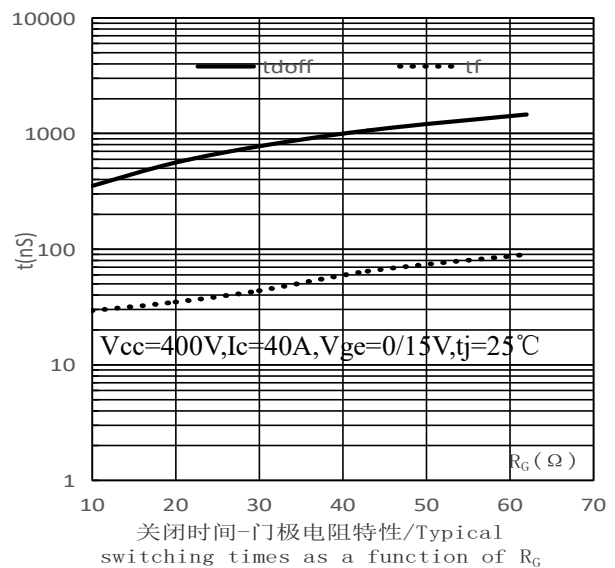
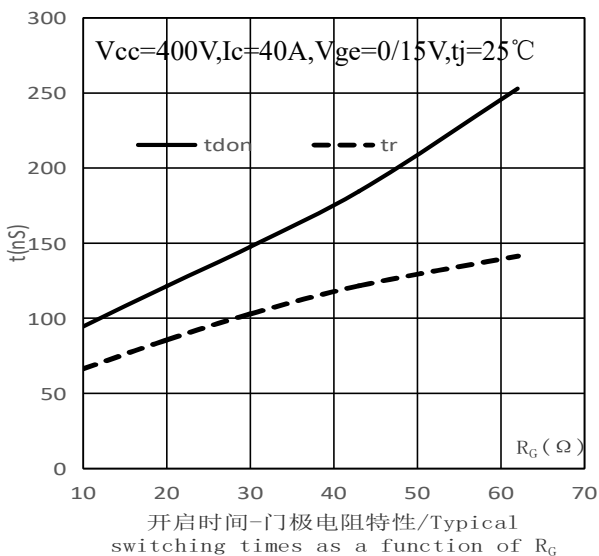
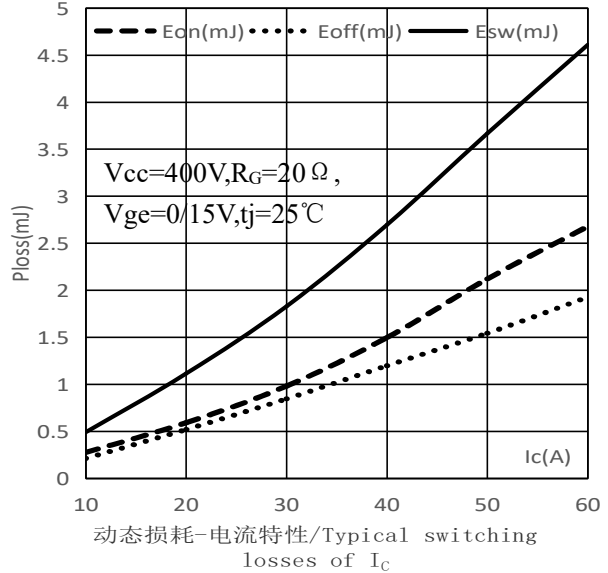
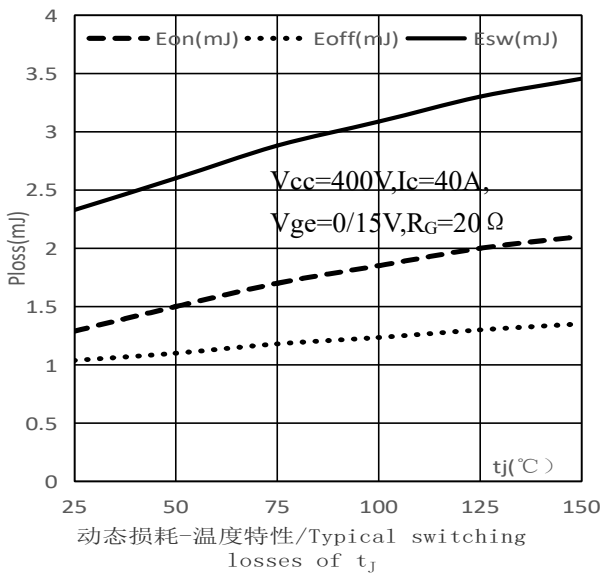
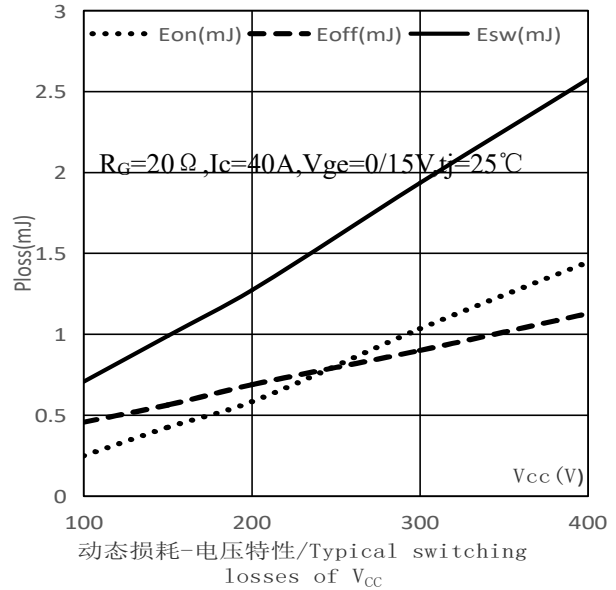
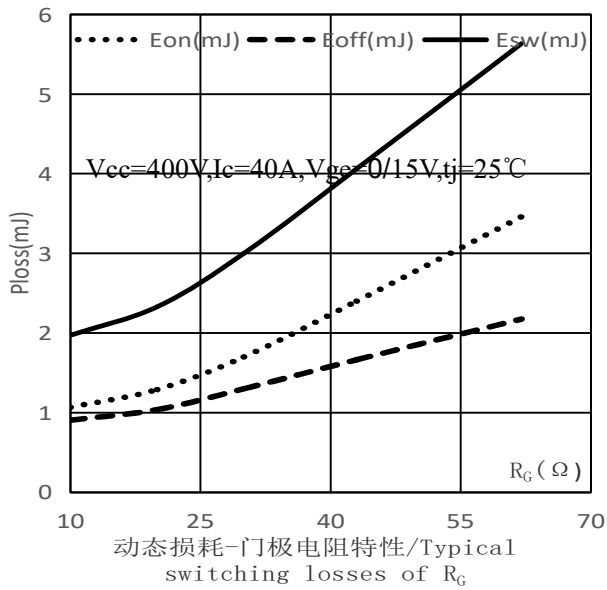
输出特性 / Typical Output Characteristic

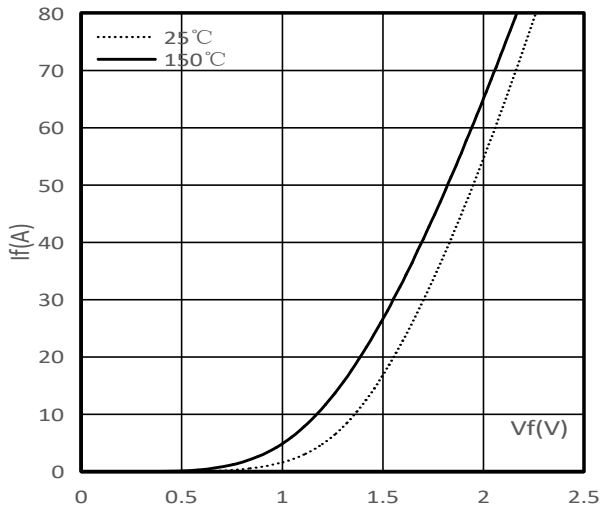


寄生电容/Capacitance as a function of V_{CE}

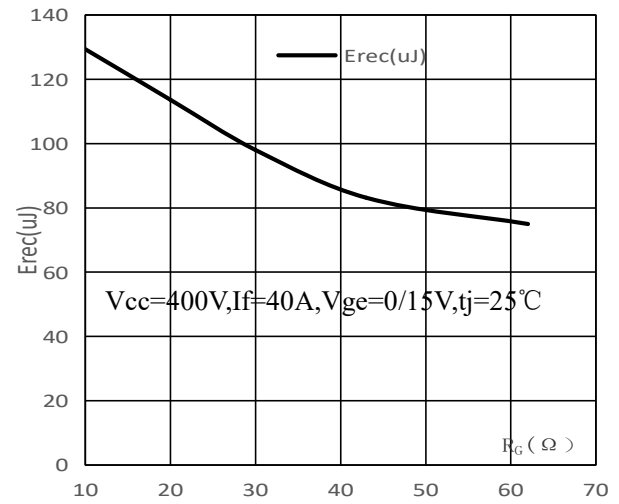


门极电量 / Typical gate charge

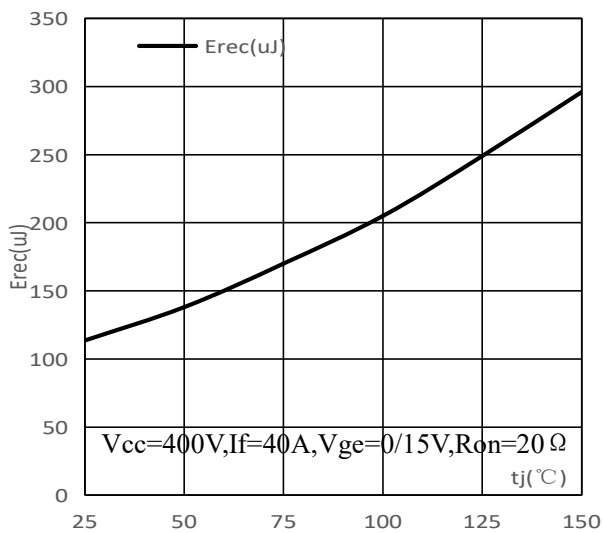




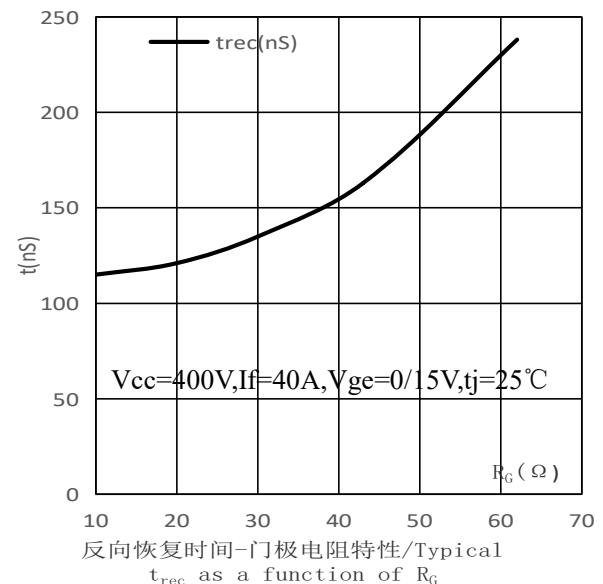
二极管压降/Typical I_F as a function of V_F



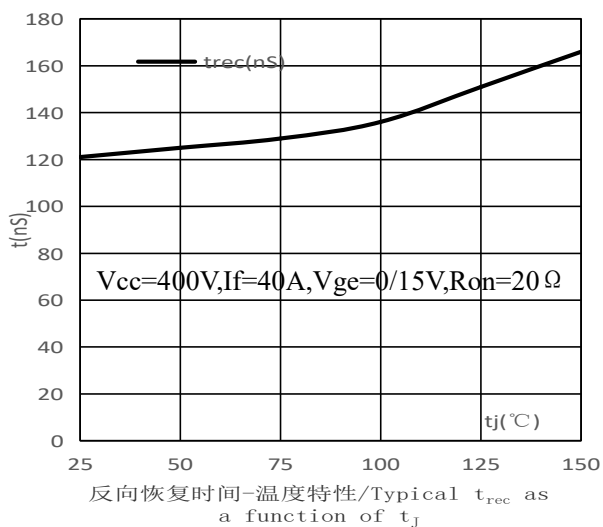
反向恢复损耗-门极电阻特性/Typical E_{REC} as a function of R_G



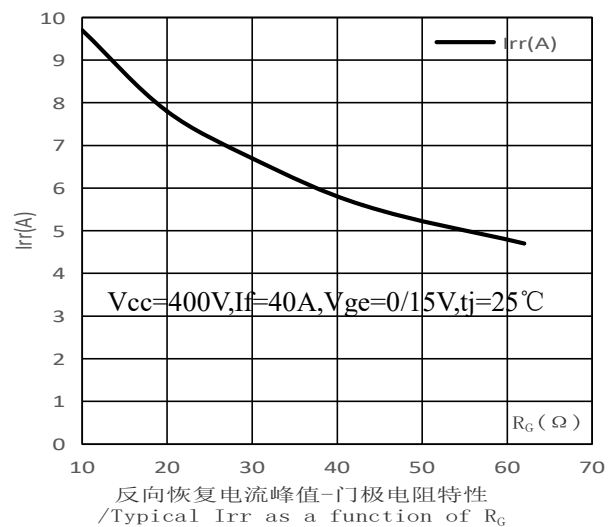
反向恢复损耗-温度特性/Typical E_{REC} as a function of t_j



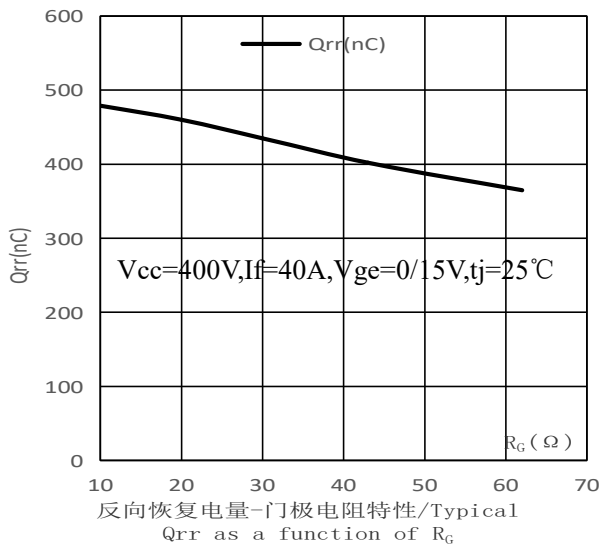
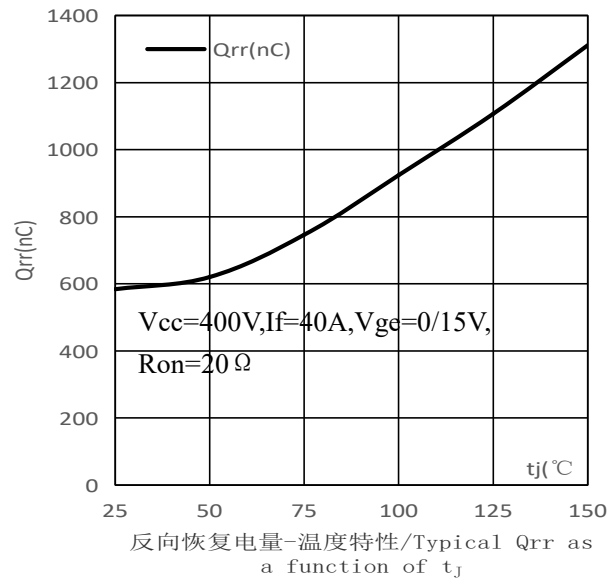
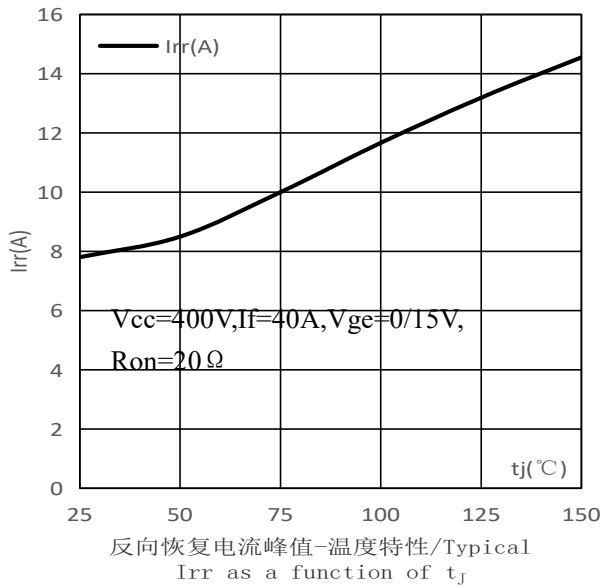
反向恢复时间-门极电阻特性/Typical t_{rec} as a function of R_G



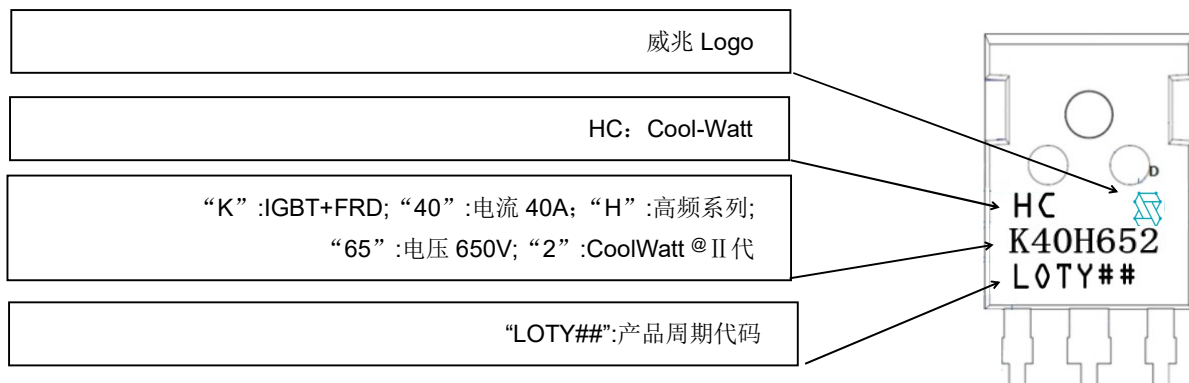
反向恢复时间-温度特性/Typical t_{rec} as a function of t_j



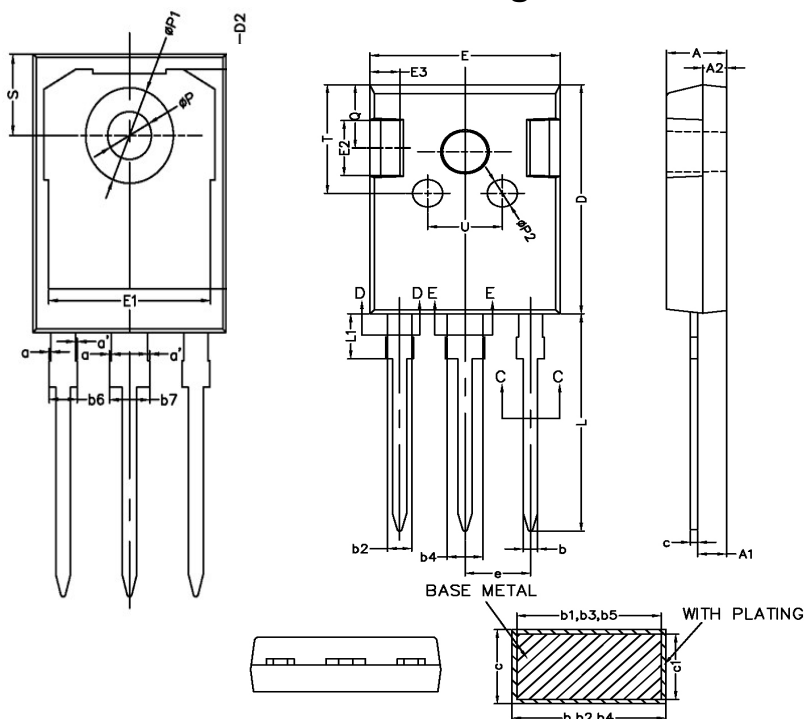
反向恢复电流峰值-门极电阻特性/Typical I_{rr} as a function of R_G



■ 丝印信息/Marking Information



■ To-247 尺寸数据/TO-247 Package Outline Data



单位:mm/Unit:mm

SYMBOL	MIN	NOM	MAX
A	4.90	5.00	5.10
A1	2.31	2.41	2.51
A2	1.90	2.00	2.10
a	0	—	0.15
a'	0	—	0.15
b	1.16	—	1.26
b1	1.15	1.2	1.22
b2	1.96	—	2.06
b3	1.95	2.00	2.02
b4	2.96	—	3.06
b5	2.95	3.00	3.02
b6	—	—	2.25
b7	—	—	3.25
c	0.59	—	0.66
c1	0.58	0.60	0.62
D	20.90	21.00	21.10
D1	16.25	16.55	16.85
D2	1.05	1.20	1.35
E	15.70	15.80	15.90
E1	13.10	13.30	13.50
E2	4.90	5.00	5.10
E3	2.40	2.50	2.60
e	5.34	5.44	5.54
L	19.80	19.92	20.10
L1	—	—	4.30
P	3.50	3.60	3.70
P1	—	—	7.40
P2	2.40	2.50	2.60
Q	5.60	—	6.00
S	6.05	6.15	6.25
T	9.80	—	10.20
U	6.00	—	6.40