

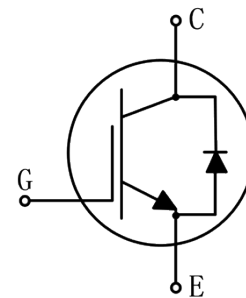
Key performance:

- $V_{CE}=650V$
- $I_C=20A@T_C=100^{\circ}C$
- $V_{CE(sat)}=1.6 V$

TO-220F

Features:

- High ruggedness performance.
- 10 μ s short circuit capability.
- Positive $V_{CE(sat)}$ temperature coefficient.
- High efficiency for motor control.
- Excellent current sharing in parallel operation.
- RoHS compliant.



Applications:

- Home appliances
- Motor drives
- General inverter

Package parameters

Type	Marking	Package	Packaging method
VSG20N65-TF	VSG20N65	TO-220F	Tube

Maximum ratings

Symbol	Parameter	Values	Unit
V_{CES}	Collector-emitter voltage	650	V
V_{GES}	Gate-emitter voltage	± 20	V
I_C	Continuous collector current ($T_C=25^\circ\text{C}$)	40	A
	Continuous collector current ($T_C=100^\circ\text{C}$)	20	A
I_{CM}	Pulsed collector current, t_p limited by T_{vjmax}	80	A
I_F	Diode continuous forward current ($T_C=100^\circ\text{C}$)	20	A
I_{FM}	Diode maximum current, t_p limited by T_{vjmax}	80	A
t_{sc}	Short circuit withstand time	10	μs
P_{tot}	Power dissipation ($T_C=25^\circ\text{C}$)	53	W
	Power dissipation ($T_C=100^\circ\text{C}$)	26	W
T_{vj}	Operating junction temperature range	-40 to +175	$^\circ\text{C}$
T_{stg}	Storage temperature range	-55 to +150	$^\circ\text{C}$

Thermal characteristics

Symbol	Parameter	Values		Unit
		Typ.	Max.	
$R_{th(j-c)}$	Thermal resistance, junction to case for IGBT	-	2.8	K/ W
$R_{th(j-c)}$	Thermal resistance, junction to case for Diode	-	4.1	K/ W
$R_{th(j-a)}$	Thermal resistance, junction to ambient	-	50	K/ W

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

Static characteristics

Symbol	Parameter	Test condition	Values			Unit
			Min.	Typ.	Max.	
BV_{CES}	Collector-emitterbreakdown voltage	$V_{GE}=0V, I_C=250\mu A$	650	-	-	V
I_{CES}	Collector-emitter leakage current	$V_{CE}=650V, V_{GE}=0V$	-	-	50	μA
I_{GES}	Gate leakage current, forward	$V_{GE}=20V, V_{CE}=0V$	-	-	100	nA
	Gate leakage current, reverse	$V_{GE}=-20V, V_{CE}=0V$	-	-	-100	nA
$V_{GE(th)}$	Gate-emitter threshold voltage	$V_{GE}=V_{CE}, I_C=1mA$	5.2	5.7	6.2	V
$V_{CE(sat)}$	Collector-emitter saturation voltage	$V_{GE}=15V, I_C=20A$	-	1.6	-	V
		$V_{GE}=15V, I_C=20A, T_{vj}=175^{\circ}\text{C}$	-	2.0	-	V

Dynamic characteristics

Symbol	Parameter	Test condition	Values			Unit
			Min.	Typ.	Max.	
C_{ies}	Input capacitance	$V_{CE}=30V$ $V_{GE}=0V$ $f=1MHz$	-	1700	-	pF
C_{oes}	Output capacitance		-	72	-	pF
C_{res}	Reverse transfer capacitance		-	13	-	pF
Q_g	Total gate charge	$V_{CC}=520V$ $V_{GE}=15V$ $I_C=20A$	-	71	-	nC

Switching characteristics

Symbol	Parameter	Test condition	Values			Unit
			Min.	Typ.	Max.	
$t_{d(on)}$	Turn-on delay time	$V_{CC}=400V$ $V_{GE}=0/15V$ $I_C=20A$ $R_G=10\Omega$ Inductive load	-	21	-	ns
t_r	Rise time		-	23	-	ns
$t_{d(off)}$	Turn-off delay time		-	120	-	ns
t_f	Fall time		-	63	-	ns
E_{on}	Turn-on energy		-	0.37	-	mJ
E_{off}	Turn-off energy		-	0.46	-	mJ
E_{ts}	Total switching energy		-	0.83	-	mJ
$t_{d(on)}$	Turn-on delay time	$V_{CC}=400V$ $V_{GE}=0/15V$ $I_C=20A$ $R_G=10\Omega$ Inductive load $T_{vj}=175^{\circ}C$	-	21	-	ns
t_r	Rise time		-	23	-	ns
$t_{d(off)}$	Turn-off delay time		-	141	-	ns
t_f	Fall time		-	108	-	ns
E_{on}	Turn-on energy		-	0.59	-	mJ
E_{off}	Turn-off energy		-	0.67	-	mJ
E_{ts}	Total switching energy		-	1.26	-	mJ

Electrical characteristics of Diode ($T_{vj}=25^{\circ}\text{C}$ unless otherwise specified)

Symbol	Parameter	Test condition	Values			Unit
			Min.	Typ.	Max.	
V_F	Diode forward voltage	$I_F=20\text{A}$	-	1.6	-	V
		$I_F=20\text{A}, T_{vj}=175^{\circ}\text{C}$	-	1.2	-	V
t_{rr}	Diode reverse recovery time	$V_R=400\text{V}$ $I_F=20\text{A}$ $di_F/dt=-500\text{A}/\mu\text{s}$	-	62	-	ns
I_{rrm}	Diode peak reverse recovery current		-	12	-	A
Q_{rr}	Diode reverse recovery charge		-	472	-	nC
t_{rr}	Diode reverse recovery time	$V_R=400\text{V}$ $I_F=20\text{A}$ $di_F/dt=-500\text{A}/\mu\text{s}$	-	90	-	ns
I_{rrm}	Diode peak reverse recovery current		-	19	-	A
Q_{rr}	Diode reverse recovery charge	$T_{vj}=175^{\circ}\text{C}$	-	1130	-	nC

Typical performance characteristics

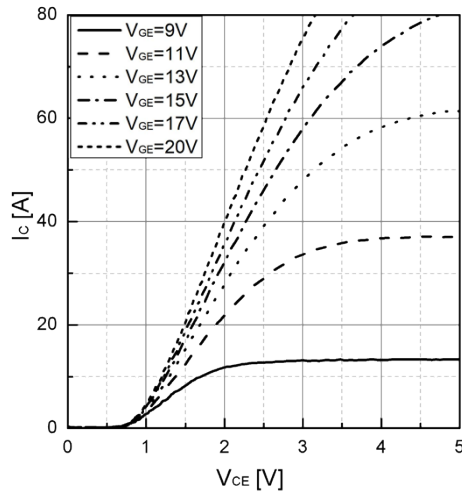


Fig 1. Typical output characteristic ($T_{vj}=25^{\circ}\text{C}$)

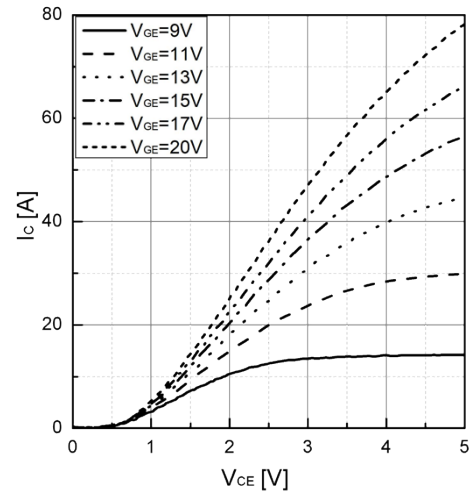


Fig 2. Typical output characteristic ($T_{vj}=175^{\circ}\text{C}$)

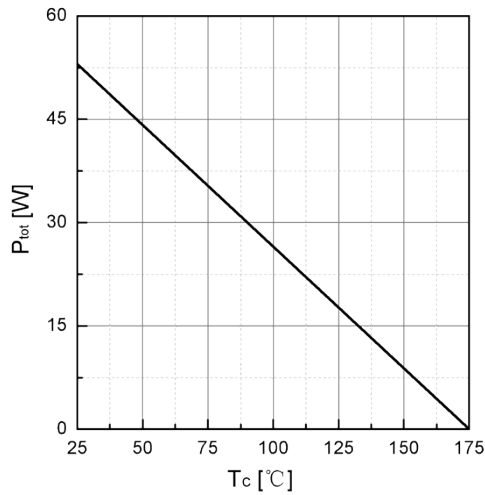


Fig 3. Power dissipation as a function of T_c

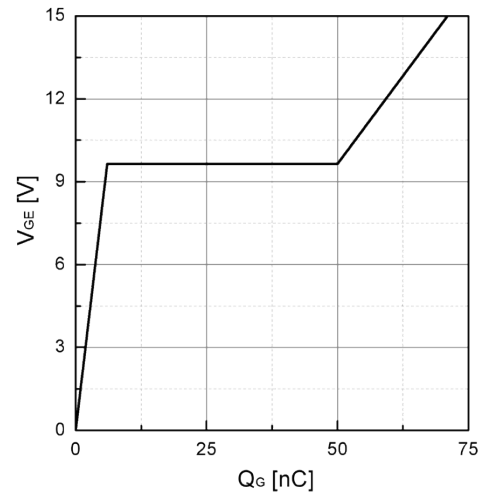


Fig 4. Typical Gate charge

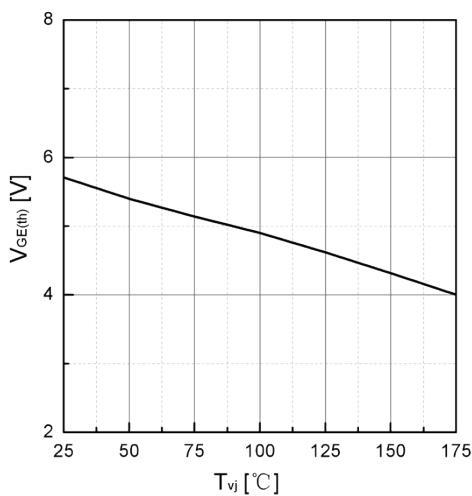


Fig 5. Typical $V_{GE(th)}$ as a function of T_{vj}
($I_C=1\text{mA}$)

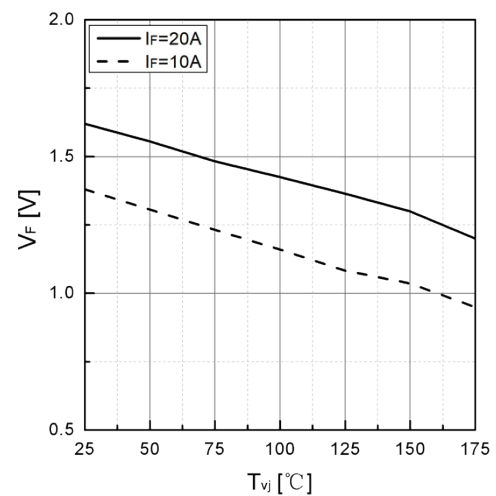


Fig 6. Typical V_F as a function of T_{vj}

Typical performance characteristics

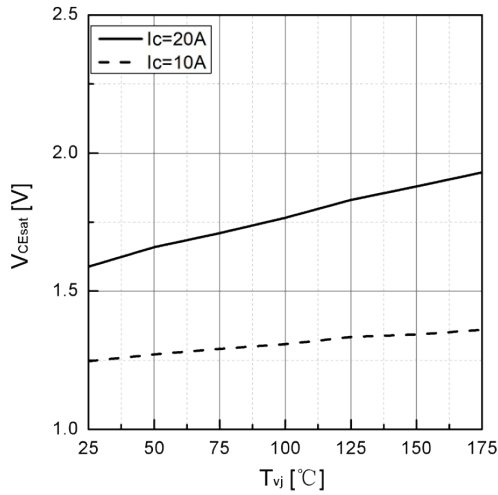


Fig 7. Typical V_{CEsat} as a function of T_{vj}

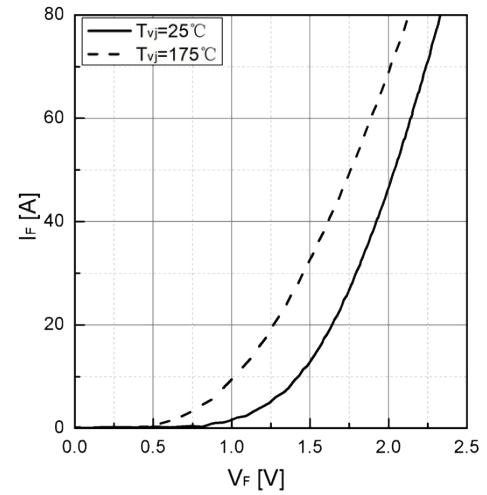


Fig 8. Typical I_F as a function of V_F

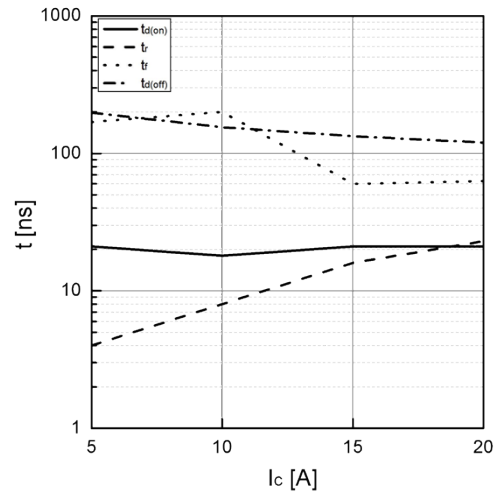


Fig 9. Typical switching time as a function of I_C

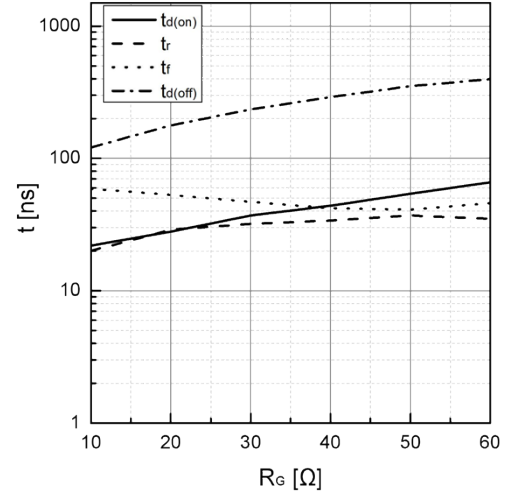


Fig 10. Typical switching times as a function of R_G

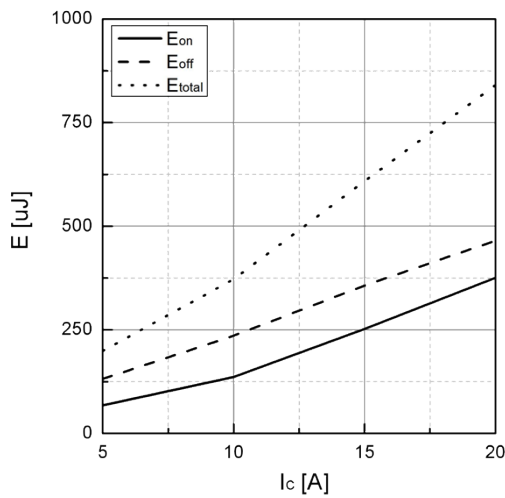


Fig 11. Typical switching energy losses as a function of I_C

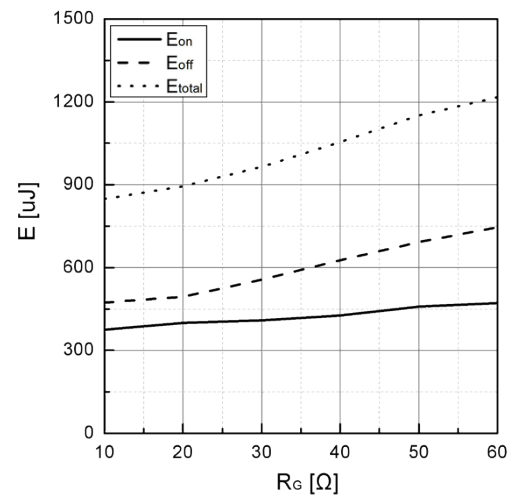


Fig 12. Typical switching energy losses as a function of R_G

Typical performance characteristics

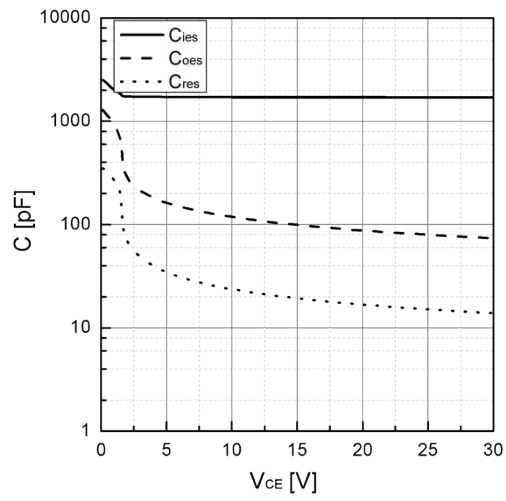


Fig 13. Typical capacitance as a function of V_{CE}
($f=1\text{MHz}$, $V_{GE}=0\text{V}$)