

< IGBT MODULES >

CM35MXA-24S

HIGH POWER SWITCHING USE
INSULATED TYPEABSOLUTE MAXIMUM RATINGS ($T_J=25\text{ }^{\circ}\text{C}$, unless otherwise specified)

INVERTER PART IGBT/FWDI

Symbol	Item	Conditions	Rating	Unit
V_{CES}	Collector-emitter voltage	G-E short-circuited	1200	V
V_{GES}	Gate-emitter voltage	C-E short-circuited	± 20	V
I_C	Collector current	DC, $T_C=125\text{ }^{\circ}\text{C}$ (Note2, 4)	35	A
I_{CRM}		Pulse, Repetitive (Note3)	70	
P_{tot}	Total power dissipation	$T_C=25\text{ }^{\circ}\text{C}$ (Note2, 4)	355	W
I_E (Note1)	Emitter current	(Note2)	35	A
I_{ERM} (Note1)		Pulse, Repetitive (Note3)	70	
T_{jmax}	Maximum junction temperature	Instantaneous event (overload)	175	$^{\circ}\text{C}$

BRAKE PART IGBT/CLAMPDI

Symbol	Item	Conditions	Rating	Unit
V_{CES}	Collector-emitter voltage	G-E short-circuited	1200	V
V_{GES}	Gate-emitter voltage	C-E short-circuited	± 20	V
I_C	Collector current	DC, $T_C=125\text{ }^{\circ}\text{C}$ (Note2, 4)	35	A
I_{CRM}		Pulse, Repetitive (Note3)	70	
P_{tot}	Total power dissipation	$T_C=25\text{ }^{\circ}\text{C}$ (Note2, 4)	355	W
V_{RRM}	Repetitive peak reverse voltage	G-E short-circuited	1200	V
I_F	Forward current	(Note2)	35	A
I_{FRM}		Pulse, Repetitive (Note3)	70	
T_{jmax}	Maximum junction temperature	Instantaneous event (overload)	175	$^{\circ}\text{C}$

CONVERTER PART CONVDI

Symbol	Item	Conditions	Rating	Unit
V_{RRM}	Repetitive peak reverse voltage	-	1600	V
E_a	Recommended AC input voltage	RMS	440	V
I_O	DC output current	3-phase full wave rectifying, $T_C=125\text{ }^{\circ}\text{C}$ (Note4)	35	A
I_{FSM}	Surge forward current	The sine half wave 1 cycle peak value, $f=60\text{ Hz}$, non-repetitive	350	A
I^2t	Current square time	Value for one cycle of surge current	510	A^2s
T_{jmax}	Maximum junction temperature	Instantaneous event (overload)	150	$^{\circ}\text{C}$

MODULE

Symbol	Item	Conditions	Rating	Unit
V_{isol}	Isolation voltage	Terminals to base plate, RMS, $f=60\text{ Hz}$, AC 1 min	2500	V
T_{Cmax}	Maximum case temperature	(Note4)	125	$^{\circ}\text{C}$
T_{jop}	Operating junction temperature	Continuous operation (under switching)	-40 ~ +150	$^{\circ}\text{C}$
T_{stg}	Storage temperature	-	-40 ~ +125	

MECHANICAL CHARACTERISTICS

Symbol	Item	Conditions	Limits			Unit
			Min.	Typ.	Max.	
M_s	Mounting torque	Mounting to heat sink M 5 screw	2.5	3.0	3.5	N·m
d_s	Creepage distance	Terminal to terminal	6.47	-	-	mm
		Terminal to base plate	14.27	-	-	
d_a	Clearance	Terminal to terminal	6.47	-	-	mm
		Terminal to base plate	12.33	-	-	
m	Weight	-	-	300	-	g
e_c	Flatness of base plate	On the centerline X, Y (Note5)	± 0	-	+100	μm

< IGBT MODULES >

CM35MXA-24S

HIGH POWER SWITCHING USE
INSULATED TYPEELECTRICAL CHARACTERISTICS ($T_J=25\text{ }^{\circ}\text{C}$, unless otherwise specified)

INVERTER PART IGBT/FWDi

Symbol	Item	Conditions		Limits			Unit
				Min.	Typ.	Max.	
I _{CES}	Collector-emitter cut-off current	V _{CE} =V _{CES} , G-E short-circuited		-	-	1.0	mA
I _{GES}	Gate-emitter leakage current	V _{GE} =V _{GES} , C-E short-circuited		-	-	0.5	μA
V _{GE(th)}	Gate-emitter threshold voltage	I _C =3.5 mA, V _{CE} =10 V		5.4	6.0	6.6	V
V _{CESat}	Collector-emitter saturation voltage	I _C =35 A ^(Note6) , V _{GE} =15 V, (Terminal)	T _J =25 °C	-	1.80	2.25	V
			T _J =125 °C	-	2.00	-	
			T _J =150 °C	-	2.05	-	
		I _C =35 A ^(Note6) , V _{GE} =15 V, (Chip)	T _J =25 °C	-	1.70	2.15	V
			T _J =125 °C	-	1.90	-	
			T _J =150 °C	-	1.95	-	
C _{ies}	Input capacitance	V _{CE} =10 V, G-E short-circuited		-	-	3.5	nF
C _{oes}	Output capacitance			-	-	0.7	
C _{res}	Reverse transfer capacitance			-	-	0.06	
Q _G	Gate charge	V _{CC} =600 V, I _C =35 A, V _{GE} =15 V		-	82	-	nC
t _{d(on)}	Turn-on delay time	V _{CC} =600 V, I _C =35 A, V _{GE} =±15 V, R _G =18 Ω, Inductive load		-	-	300	ns
t _r	Rise time			-	-	200	
t _{d(off)}	Turn-off delay time			-	-	600	
t _f	Fall time			-	-	300	
V _{EC} ^(Note1)	Emitter-collector voltage	I _E =35 A ^(Note6) , G-E short-circuited, (Terminal)	T _J =25 °C	-	1.80	2.25	V
			T _J =125 °C	-	1.80	-	
			T _J =150 °C	-	1.80	-	
		I _E =35 A ^(Note6) , G-E short-circuited, (Chip)	T _J =25 °C	-	1.70	2.15	V
			T _J =125 °C	-	1.70	-	
			T _J =150 °C	-	1.70	-	
t _{rr} ^(Note1)	Reverse recovery time	V _{CC} =600 V, I _E =35 A, V _{GE} =±15 V, R _G =18 Ω, Inductive load		-	-	300	ns
Q _{rr} ^(Note1)	Reverse recovery charge			-	1.9	-	μC
E _{on}	Turn-on switching energy per pulse	V _{CC} =600 V, I _C =I _E =35 A, V _{GE} =±15 V, R _G =18 Ω, T _J =150 °C, Inductive load		-	4.2	-	mJ
E _{off}	Turn-off switching energy per pulse			-	3.7	-	
E _{rr} ^(Note1)	Reverse recovery energy per pulse			-	3.5	-	mJ
R _{CC'+EE'}	Internal lead resistance	Main terminals-chip, per switch, T _C =25 °C ^(Note4)		-	-	5.7	mΩ
r _g	Internal gate resistance	Per switch		-	0	-	Ω

BRAKE PART IGBT/CLAMPDi

Symbol	Item	Conditions		Limits			Unit
				Min.	Typ.	Max.	
I _{CES}	Collector-emitter cut-off current	V _{CE} =V _{CES} , G-E short-circuited		-	-	1.0	mA
I _{GES}	Gate-emitter leakage current	V _{GE} =V _{GES} , C-E short-circuited		-	-	0.5	μA
V _{GE(th)}	Gate-emitter threshold voltage	I _C =3.5 mA, V _{CE} =10 V		5.4	6.0	6.6	V
V _{CESat}	Collector-emitter saturation voltage	I _C =35 A (Note6), V _{GE} =15 V, (Terminal)	T _J =25 °C	-	1.80	2.25	V
			T _J =125 °C	-	2.00	-	
			T _J =150 °C	-	2.05	-	
		I _C =35 A (Note6), V _{GE} =15 V, (Chip)	T _J =25 °C	-	1.70	2.15	V
			T _J =125 °C	-	1.90	-	
			T _J =150 °C	-	1.95	-	
C _{ies}	Input capacitance	V _{CE} =10 V, G-E short-circuited		-	-	3.5	nF
C _{oes}	Output capacitance			-	-	0.7	
C _{res}	Reverse transfer capacitance			-	-	0.06	
Q _G	Gate charge	V _{CC} =600 V, I _C =35 A, V _{GE} =15 V		-	82	-	nC

ELECTRICAL CHARACTERISTICS (cont.; $T_J=25\text{ }^\circ\text{C}$, unless otherwise specified)

BRAKE PART IGBT/CLAMPDi

Symbol	Item	Conditions	Limits			Unit
			Min.	Typ.	Max.	
$t_{d(on)}$	Turn-on delay time	$V_{CC}=600\text{ V}$, $I_C=35\text{ A}$, $V_{GE}=\pm 15\text{ V}$, $R_G=18\text{ }\Omega$, Inductive load	-	-	300	ns
t_r	Rise time		-	-	200	
$t_{d(off)}$	Turn-off delay time		-	-	600	
t_f	Fall time		-	-	300	
V_F	Forward voltage	$I_F=35\text{ A}$ (Note6), G-E short-circuited, (Terminal)	$T_J=25\text{ }^\circ\text{C}$	1.80	2.25	V
			$T_J=125\text{ }^\circ\text{C}$	1.80	-	
			$T_J=150\text{ }^\circ\text{C}$	1.80	-	
		$I_F=35\text{ A}$ (Note6), G-E short-circuited, (Chip)	$T_J=25\text{ }^\circ\text{C}$	1.70	2.15	V
			$T_J=125\text{ }^\circ\text{C}$	1.70	-	
			$T_J=150\text{ }^\circ\text{C}$	1.70	-	
t_{rr}	Reverse recovery time	$V_{CC}=600\text{ V}$, $I_F=35\text{ A}$, $V_{GE}=\pm 15\text{ V}$, $R_G=18\text{ }\Omega$, Inductive load	-	-	300	ns
Q_{rr}	Reverse recovery charge		-	1.9	-	μC
E_{on}	Turn-on switching energy per pulse	$V_{CC}=600\text{ V}$, $I_C=I_F=35\text{ A}$, $V_{GE}=\pm 15\text{ V}$, $R_G=18\text{ }\Omega$, $T_J=150\text{ }^\circ\text{C}$, Inductive load	-	4.2	-	mJ
E_{off}	Turn-off switching energy per pulse		-	3.7	-	
E_{rr}	Reverse recovery energy per pulse		-	3.5	-	mJ
r_g	Internal gate resistance	-	-	0	-	Ω

CONVERTER PART CONVDi

Symbol	Item	Conditions	Limits			Unit
			Min.	Typ.	Max.	
I_{RRM}	Repetitive peak reverse current	$V_R=V_{RRM}$, $T_J=150\text{ }^\circ\text{C}$	-	-	4.0	mA
V_F (Terminal)	Forward voltage	$I_F=35\text{ A}$ (Note6)	-	1.2	1.6	V

NTC THERMISTOR PART

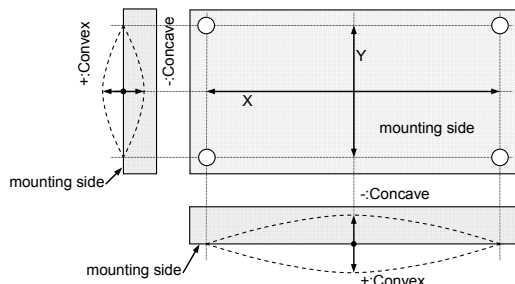
Symbol	Item	Conditions	Limits			Unit
			Min.	Typ.	Max.	
R_{25}	Zero-power resistance	$T_C=25\text{ }^\circ\text{C}$ (Note4)	4.85	5.00	5.15	k Ω
$\Delta R/R$	Deviation of resistance	$R_{100}=493\text{ }\Omega$, $T_C=100\text{ }^\circ\text{C}$ (Note4)	-7.3	-	+7.8	%
$B_{(25/50)}$	B-constant	Approximate by equation (Note7)	-	3375	-	K
P_{25}	Power dissipation	$T_C=25\text{ }^\circ\text{C}$ (Note4)	-	-	10	mW

THERMAL RESISTANCE CHARACTERISTICS

Symbol	Item	Conditions	Limits			Unit
			Min.	Typ.	Max.	
$R_{th(j-c)Q}$	Thermal resistance (Note4)	Junction to case, per Inverter IGBT	-	-	0.42	K/W
$R_{th(j-c)D}$		Junction to case, per Inverter FWDi	-	-	0.69	
$R_{th(j-c)Q}$		Junction to case, per Brake IGBT	-	-	0.42	K/W
$R_{th(j-c)D}$		Junction to case, per Brake ClampDi	-	-	0.69	
$R_{th(j-c)D}$		Junction to case, per Converter ConvDi	-	-	0.45	K/W
$R_{th(c-s)}$	Contact thermal resistance (Note4)	Case to heat sink, per 1 module, Thermal grease applied (Note8)	-	15	-	K/kW

Note1. Represent ratings and characteristics of the anti-parallel, emitter-collector free wheeling diode (FWDi).

2. Junction temperature (T_j) should not increase beyond T_{jmax} rating.
3. Pulse width and repetition rate should be such that the device junction temperature (T_j) dose not exceed T_{jmax} rating.
4. Case temperature (T_c) and heat sink temperature (T_s) are defined on the each surface (mounting side) of base plate and heat sink just under the chips. Refer to the figure of chip location.
5. The base plate (mounting side) flatness measurement points (X, Y) are as follows of the following figure.



6. Pulse width and repetition rate should be such as to cause negligible temperature rise.
Refer to the figure of test circuit.

$$7. B_{(25/50)} = \ln \left(\frac{R_{25}}{R_{50}} \right) / \left(\frac{1}{T_{25}} - \frac{1}{T_{50}} \right),$$

R_{25} : resistance at absolute temperature T_{25} [K]; $T_{25}=25$ [°C]+273.15=298.15 [K]

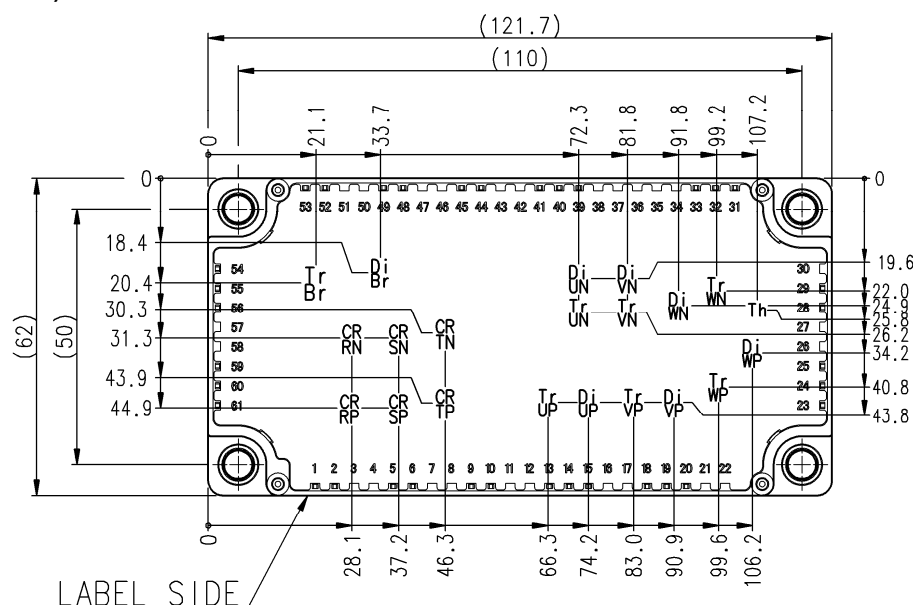
R_{50} : resistance at absolute temperature T_{50} [K]; $T_{50}=50$ [°C]+273.15=323.15 [K]

8. Typical value is measured by using thermally conductive grease of $\lambda=0.9$ W/(m·K).
9. Use the following screws when mounting the printed circuit board (PCB) on the stand offs.
"ST2.6×10 or ST2.6×12 self tapping screw"
The length of the screw depends on the thickness of the PCB.

RECOMMENDED OPERATING CONDITIONS

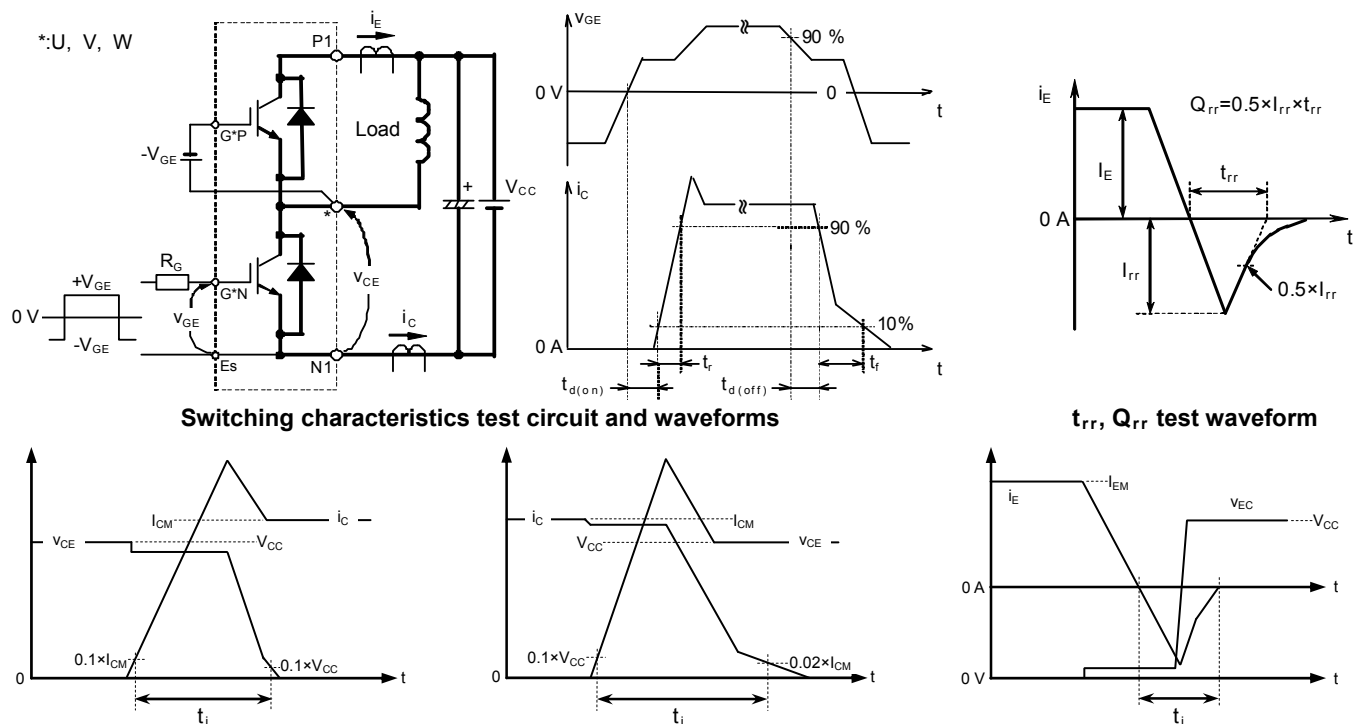
Symbol	Item	Conditions	Limits			Unit
			Min.	Typ.	Max.	
V_{CC}	(DC) Supply voltage	Applied across P-N/P1-N1 terminals	-	600	850	V
V_{GEon}	Gate (-emitter drive) voltage	Applied across GB-Es/ G*P-*/G*N-Es(*=U, V, W) terminals	13.5	15.0	16.5	V
R_G	External gate resistance	Per switch				Ω
		Inverter IGBT	18	-	180	
		Brake IGBT	18	-	180	

CHIP LOCATION (Top view)

Dimension in mm, tolerance: ± 1 mm

Tr*P/Tr*N/Tr*Br: IGBT, Di*P/Di*N: FWDi (*=U/V/W), Di*Br: ClampDi, CR*P/CR*N: ConvDi (*=R/S/T), Th: NTC thermistor

TEST CIRCUIT AND WAVEFORMS



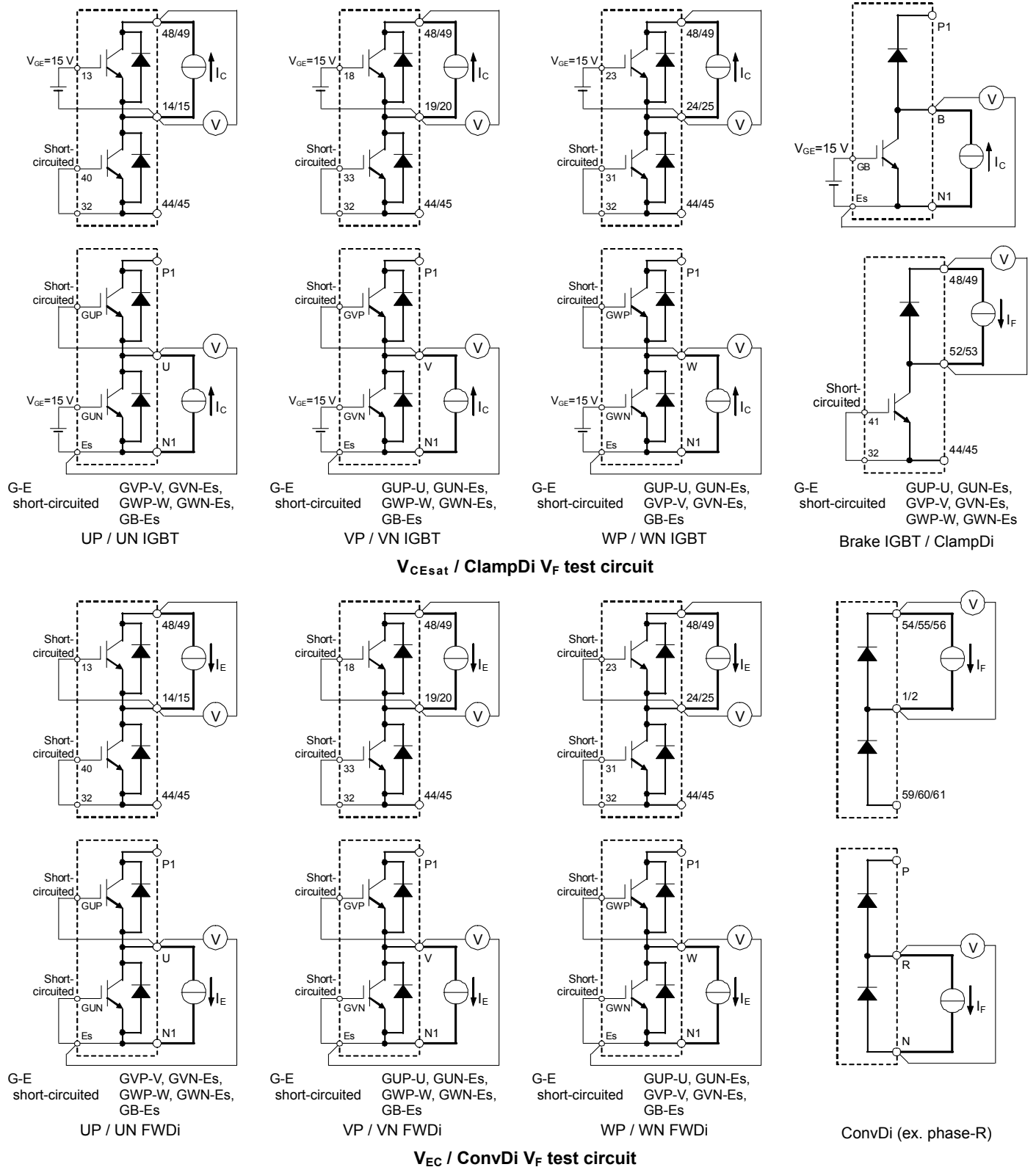
IGBT Turn-on switching energy

IGBT Turn-off switching energy

FWDi Reverse recovery energy

Turn-on / Turn-off switching energy and Reverse recovery energy test waveforms (Integral time instruction drawing)

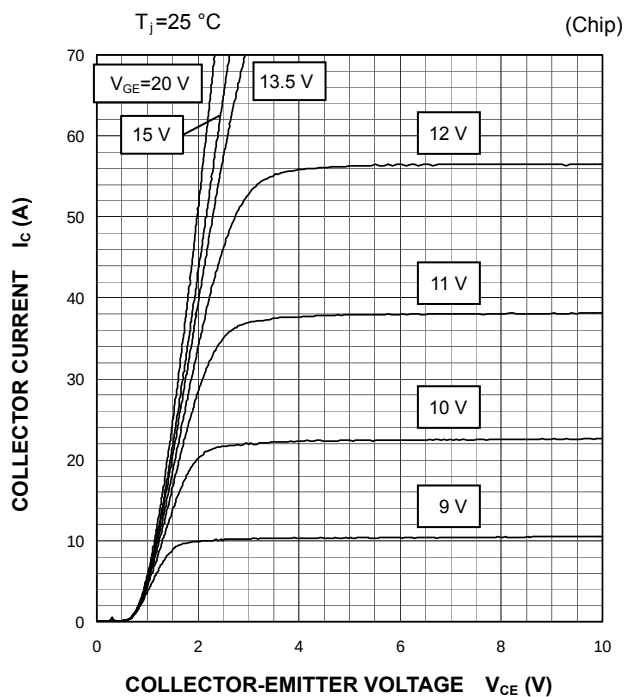
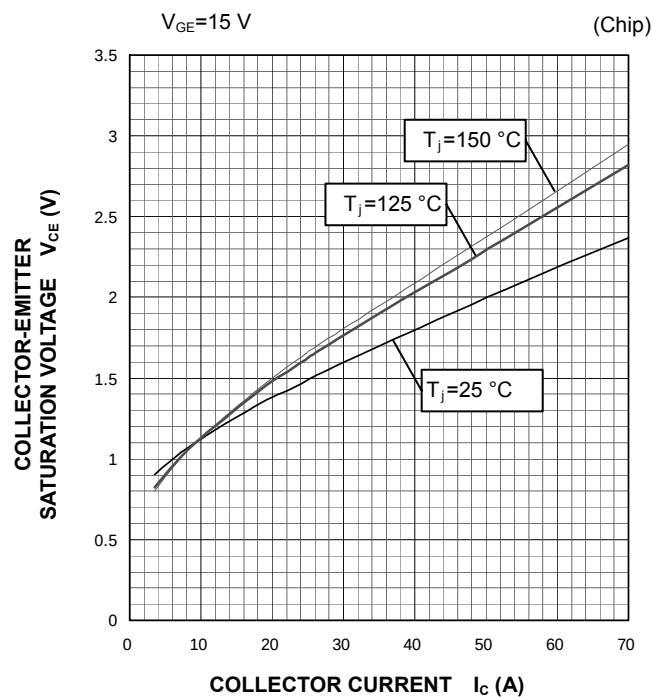
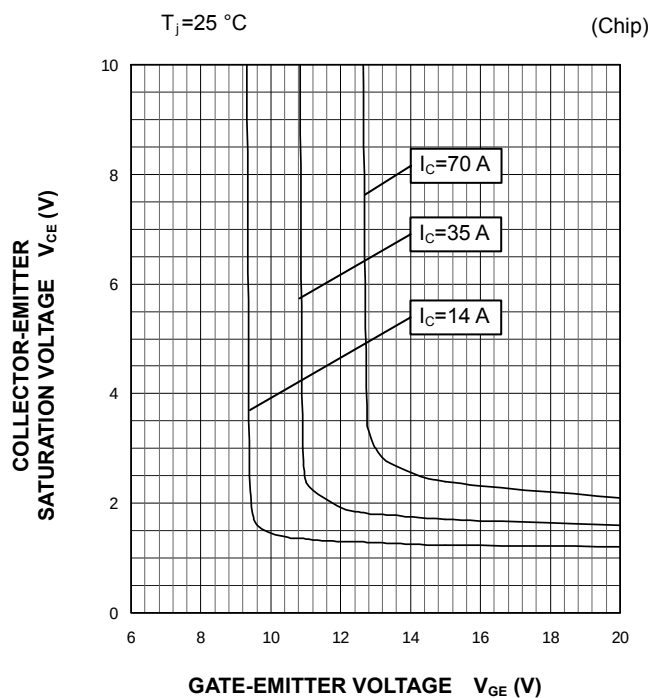
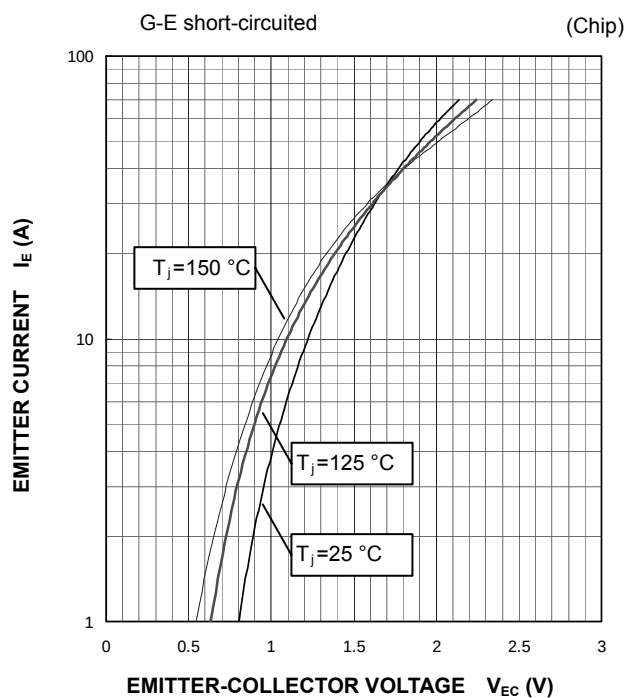
TEST CIRCUIT



* In the above test circuit, should use all three main pin terminals (P1/N1/P/N/U/V/W) for connection with the terminals and the current source.

PERFORMANCE CURVES

INVERTER PART

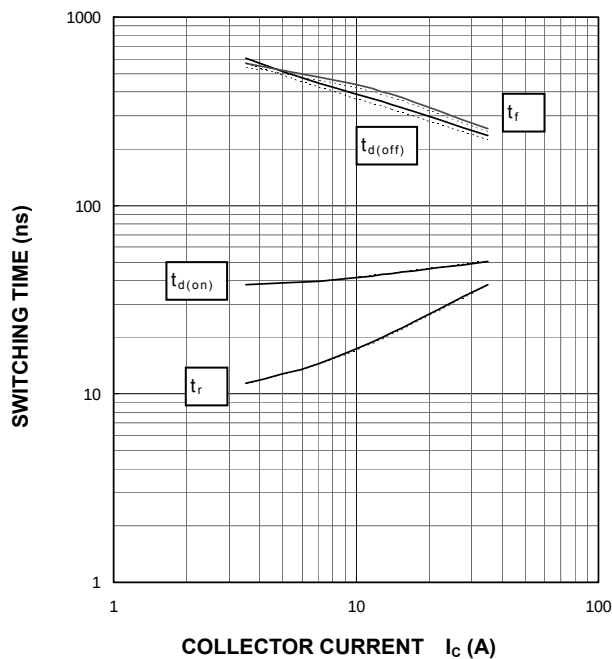
OUTPUT CHARACTERISTICS
(TYPICAL)COLLECTOR-EMITTER SATURATION VOLTAGE
CHARACTERISTICS
(TYPICAL)COLLECTOR-EMITTER SATURATION VOLTAGE
CHARACTERISTICS
(TYPICAL)FREE WHEELING DIODE
FORWARD CHARACTERISTICS
(TYPICAL)

PERFORMANCE CURVES

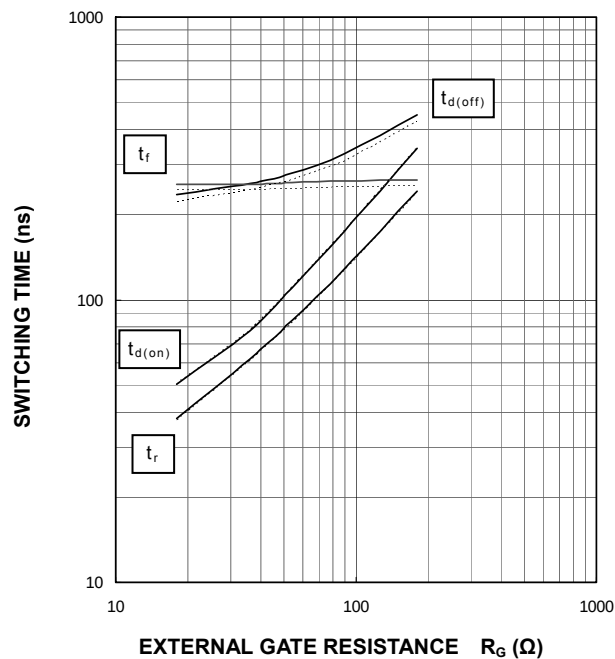
INVERTER PART

HALF-BRIDGE
SWITCHING CHARACTERISTICS
(TYPICAL)

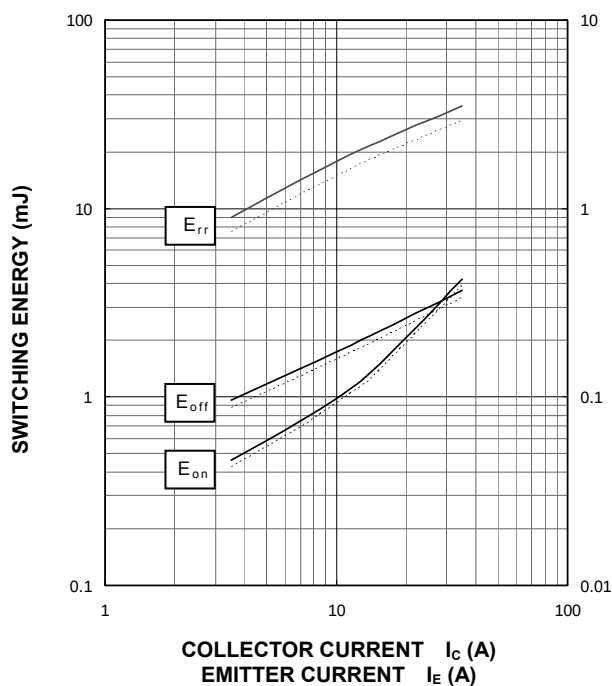
$V_{CC}=600\text{ V}$, $V_{GE}=\pm 15\text{ V}$, $R_G=18\ \Omega$, INDUCTIVE LOAD
 —: $T_J=150\text{ }^\circ\text{C}$, - - - - -: $T_J=125\text{ }^\circ\text{C}$

HALF-BRIDGE
SWITCHING CHARACTERISTICS
(TYPICAL)

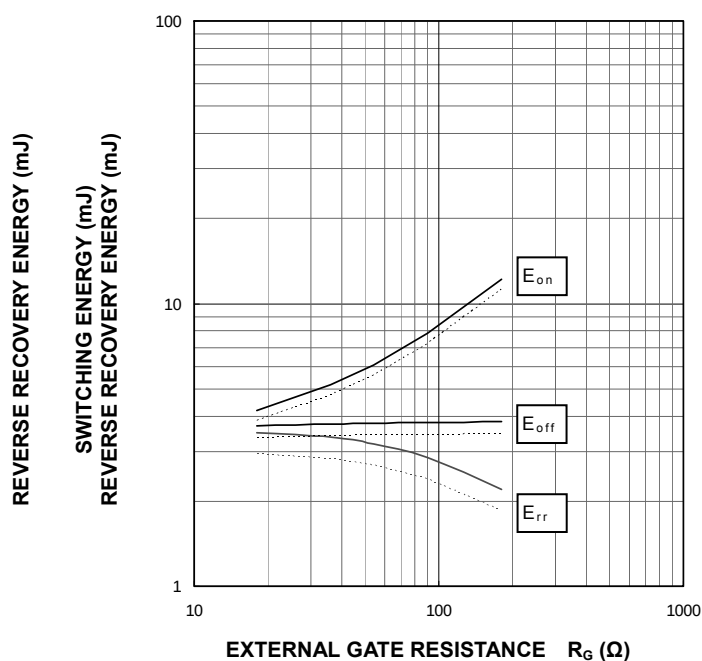
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 —: $T_J=150\text{ }^\circ\text{C}$, - - - - -: $T_J=125\text{ }^\circ\text{C}$

HALF-BRIDGE
SWITCHING CHARACTERISTICS
(TYPICAL)

$V_{CC}=600\text{ V}$, $V_{GE}=\pm 15\text{ V}$, $R_G=18\ \Omega$,
INDUCTIVE LOAD, PER PULSE
 —: $T_J=150\text{ }^\circ\text{C}$, - - - - -: $T_J=125\text{ }^\circ\text{C}$

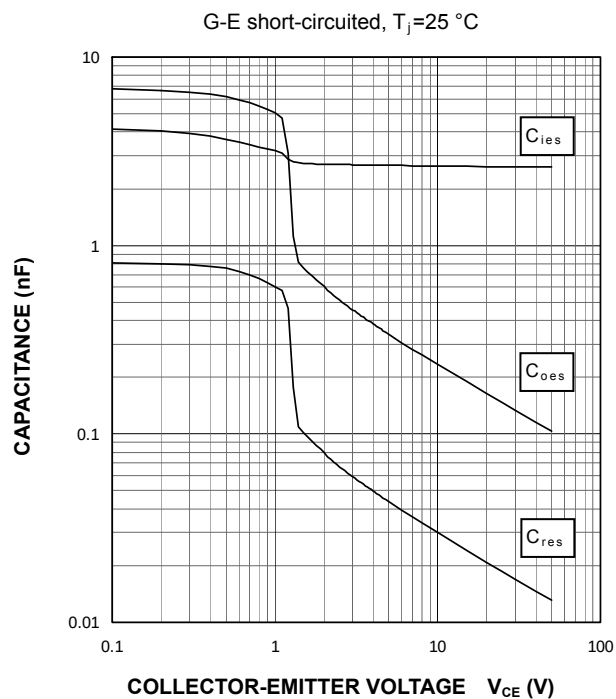
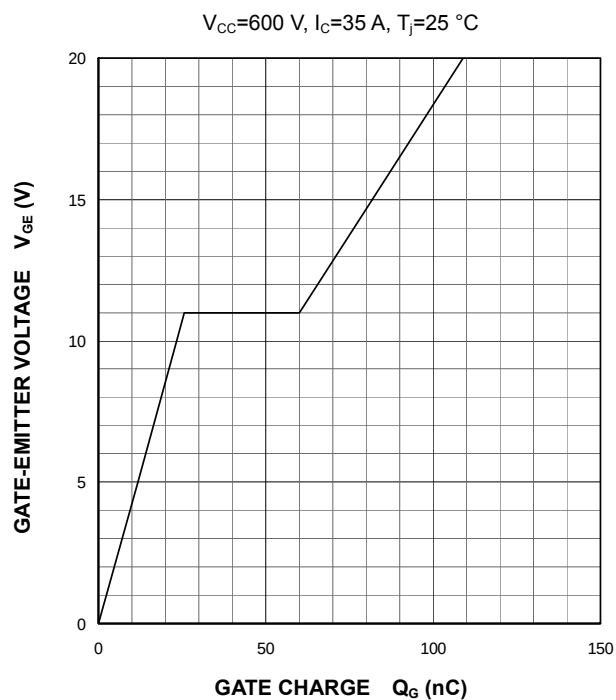
HALF-BRIDGE
SWITCHING CHARACTERISTICS
(TYPICAL)

$V_{CC}=600\text{ V}$, $V_{GE}=\pm 15\text{ V}$, $I_C=35\text{ A}$,
INDUCTIVE LOAD, PER PULSE
 —: $T_J=150\text{ }^\circ\text{C}$, - - - - -: $T_J=125\text{ }^\circ\text{C}$

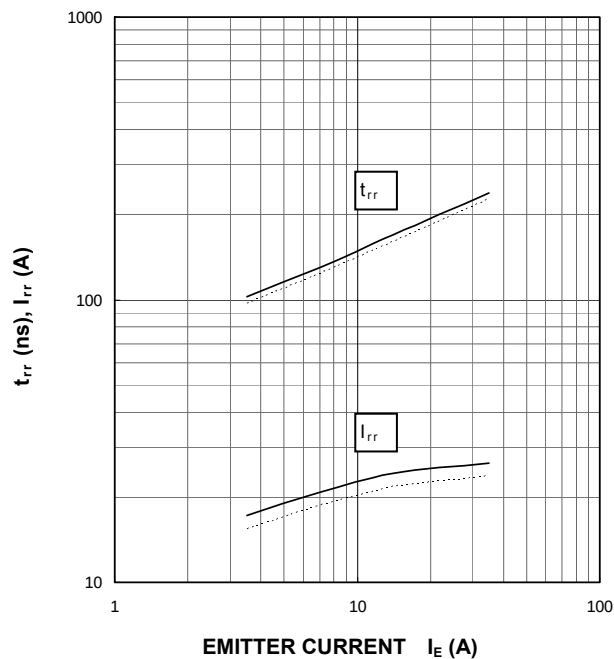


PERFORMANCE CURVES

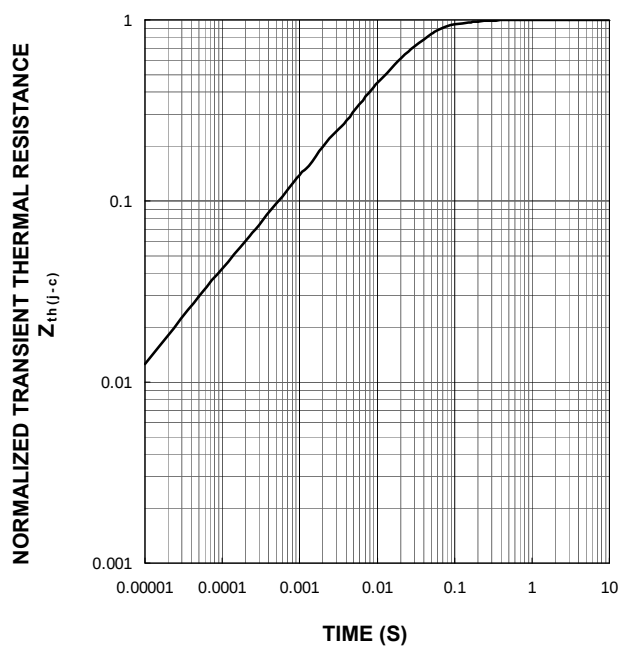
INVERTER PART

CAPACITANCE CHARACTERISTICS
(TYPICAL)GATE CHARGE CHARACTERISTICS
(TYPICAL)FREE WHEELING DIODE
REVERSE RECOVERY CHARACTERISTICS
(TYPICAL)

$V_{CC}=600\text{ V}$, $V_{GE}=\pm 15\text{ V}$, $R_G=18\text{ }\Omega$, INDUCTIVE LOAD
—: $T_J=150\text{ }^{\circ}\text{C}$, - - - : $T_J=125\text{ }^{\circ}\text{C}$

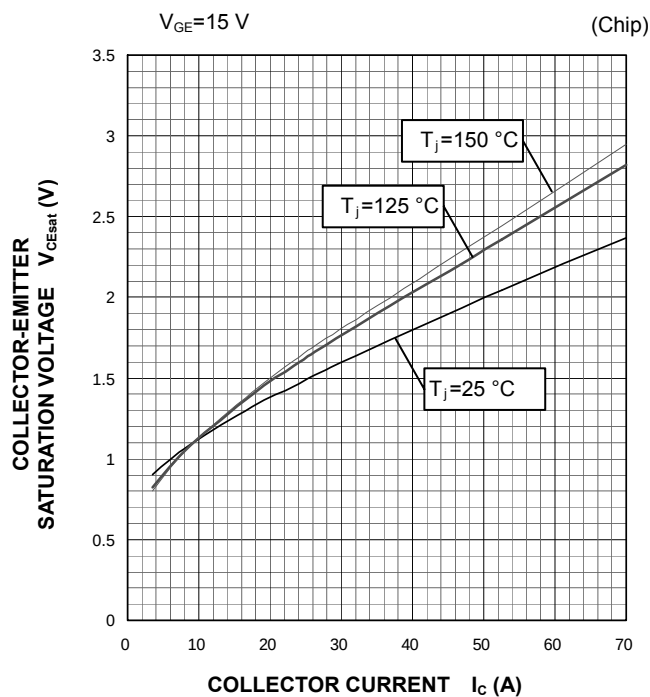
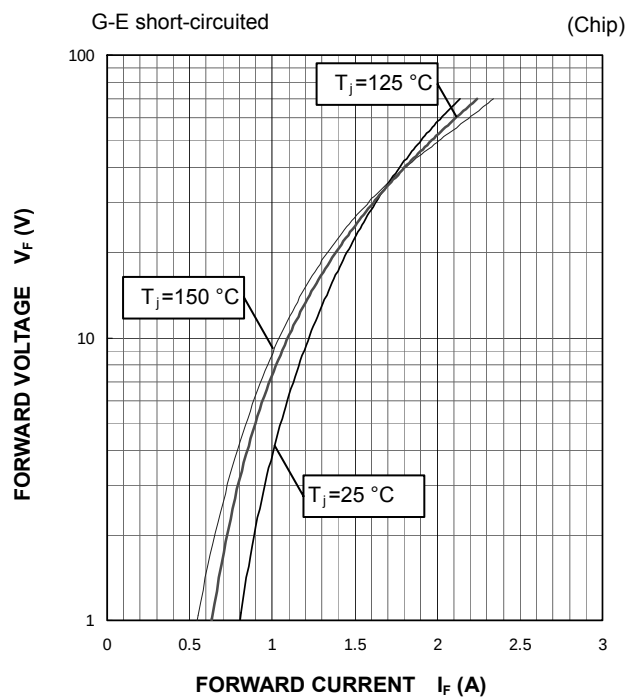
TRANSIENT THERMAL IMPEDANCE CHARACTERISTICS
(MAXIMUM)

Single pulse, $T_C=25\text{ }^{\circ}\text{C}$
 $R_{th(j-c)Q}=0.42\text{ K/W}$, $R_{th(j-c)D}=0.69\text{ K/W}$

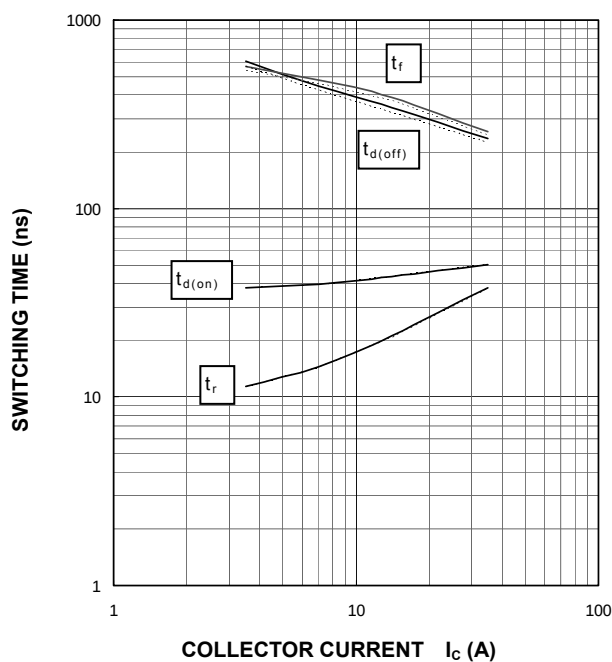


PERFORMANCE CURVES

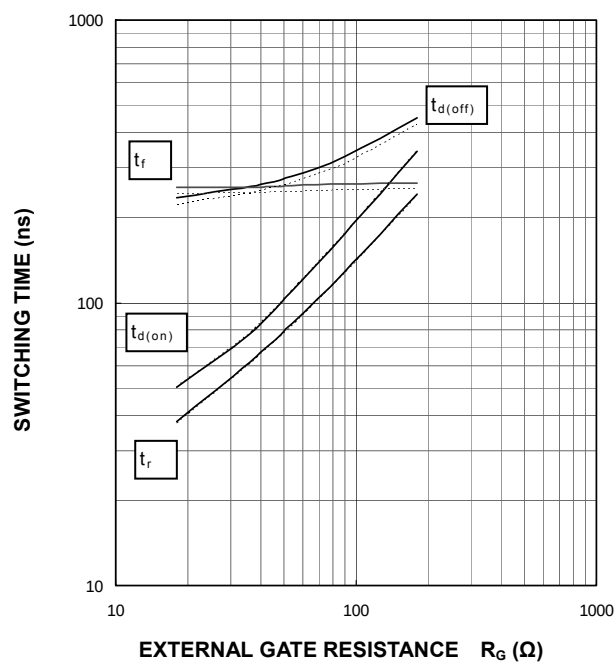
BRAKE PART

COLLECTOR-EMITTER SATURATION
VOLTAGE CHARACTERISTICS
(TYPICAL)CLAMP DIODE
FORWARD CHARACTERISTICS
(TYPICAL)HALF-BRIDGE
SWITCHING CHARACTERISTICS
(TYPICAL)

$V_{CC}=600\text{ V}$, $V_{GE}=\pm 15\text{ V}$, $R_G=18\ \Omega$, INDUCTIVE LOAD
 —: $T_j=150^\circ\text{C}$, - - - - : $T_j=125^\circ\text{C}$

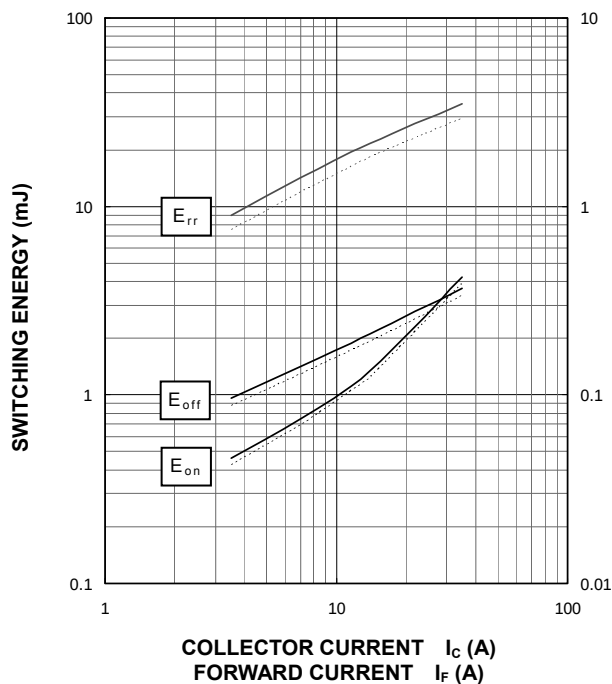
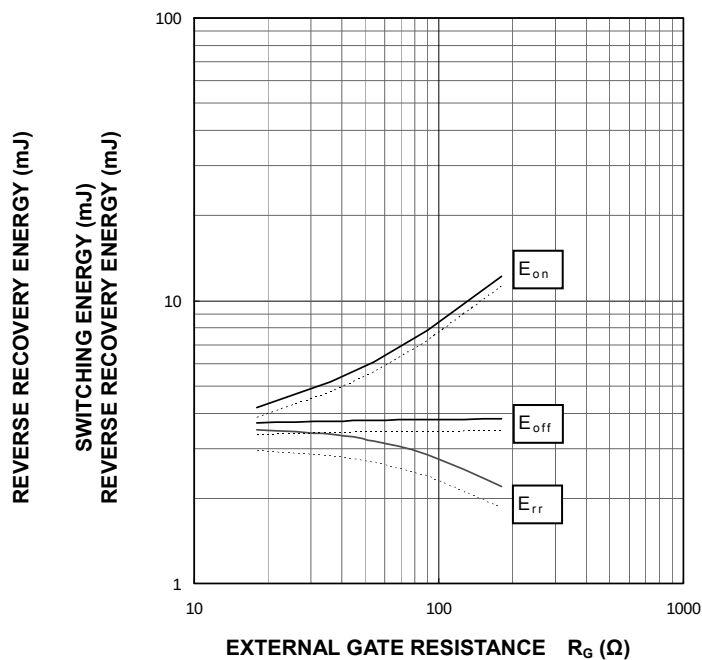
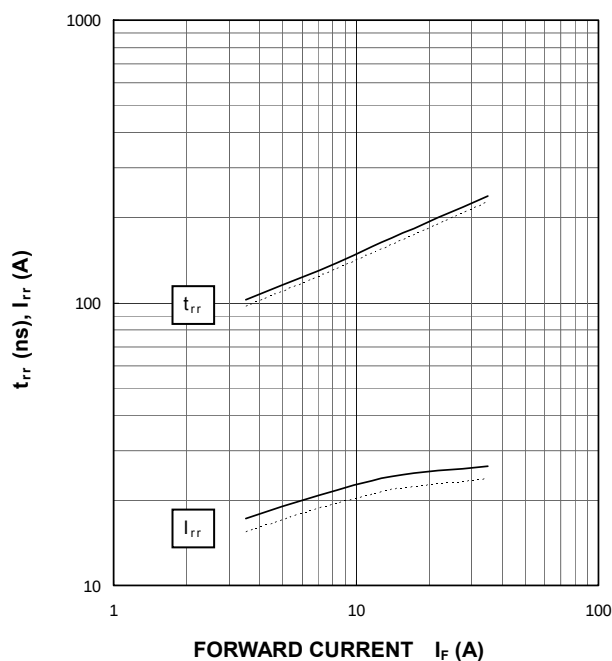
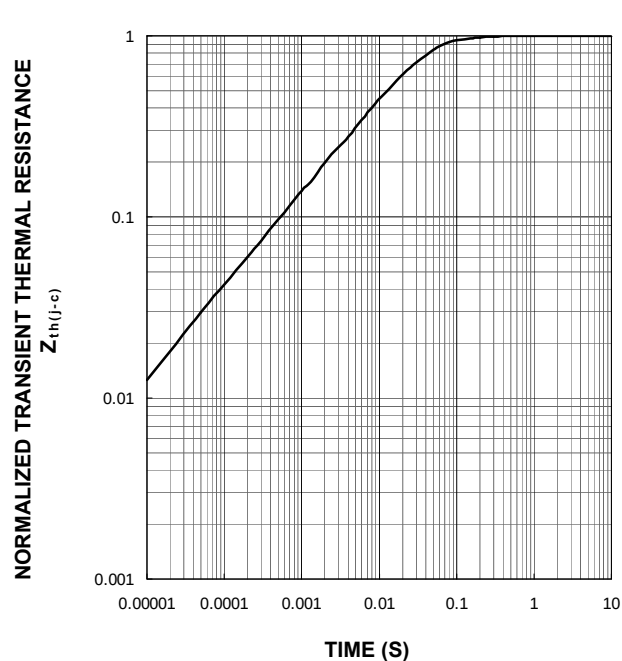
HALF-BRIDGE
SWITCHING CHARACTERISTICS
(TYPICAL)

$V_{CC}=600\text{ V}$, $I_C=35\text{ A}$, $V_{GE}=\pm 15\text{ V}$, INDUCTIVE LOAD
 —: $T_j=150^\circ\text{C}$, - - - - : $T_j=125^\circ\text{C}$



PERFORMANCE CURVES

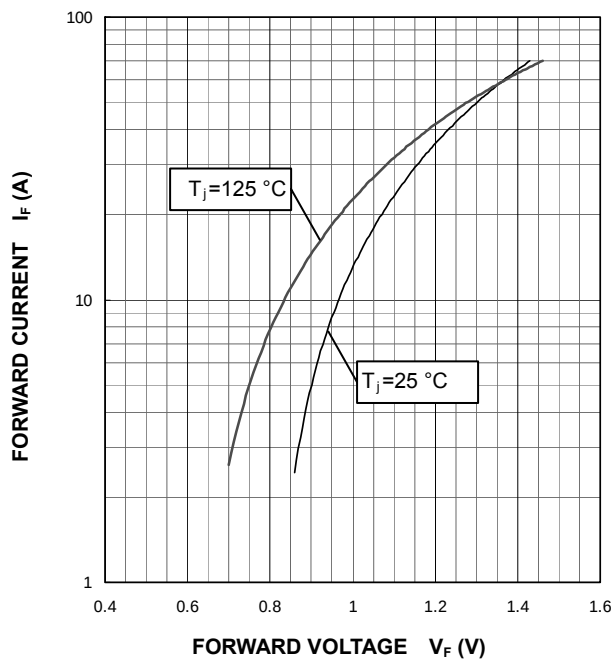
BRAKE PART

HALF-BRIDGE
SWITCHING CHARACTERISTICS
(TYPICAL) $V_{CC}=600\text{ V}$, $V_{GE}=\pm 15\text{ V}$, $R_G=18\ \Omega$,
INDUCTIVE LOAD, PER PULSE—: $T_J=150\text{ }^\circ\text{C}$, - - - - -: $T_J=125\text{ }^\circ\text{C}$ HALF-BRIDGE
SWITCHING CHARACTERISTICS
(TYPICAL) $V_{CC}=600\text{ V}$, $I_C/I_F=35\text{ A}$, $V_{GE}=\pm 15\text{ V}$,
INDUCTIVE LOAD, PER PULSE—: $T_J=150\text{ }^\circ\text{C}$, - - - - -: $T_J=125\text{ }^\circ\text{C}$ CLAMP DIODE
REVERSE RECOVERY CHARACTERISTICS
(TYPICAL) $V_{CC}=600\text{ V}$, $V_{GE}=\pm 15\text{ V}$, $R_G=18\ \Omega$, INDUCTIVE LOAD—: $T_J=150\text{ }^\circ\text{C}$, - - - - -: $T_J=125\text{ }^\circ\text{C}$ TRANSIENT THERMAL IMPEDANCE CHARACTERISTICS
(MAXIMUM)Single pulse, $T_C=25\text{ }^\circ\text{C}$ $R_{th(j-c)Q}=0.42\text{ K/W}$, $R_{th(j-c)D}=0.69\text{ K/W}$ 

PERFORMANCE CURVES

CONVERTER PART

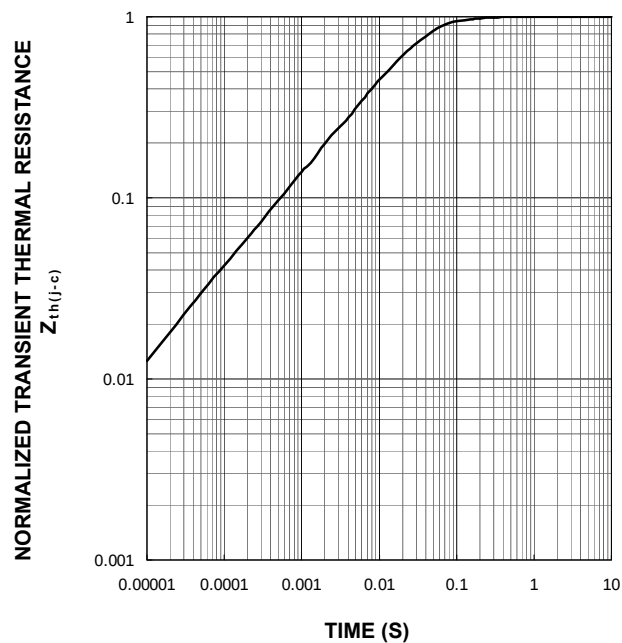
CONVERTER DIODE
FORWARD CHARACTERISTICS
(TYPICAL)



TRANSIENT THERMAL IMPEDANCE CHARACTERISTICS
(MAXIMUM)

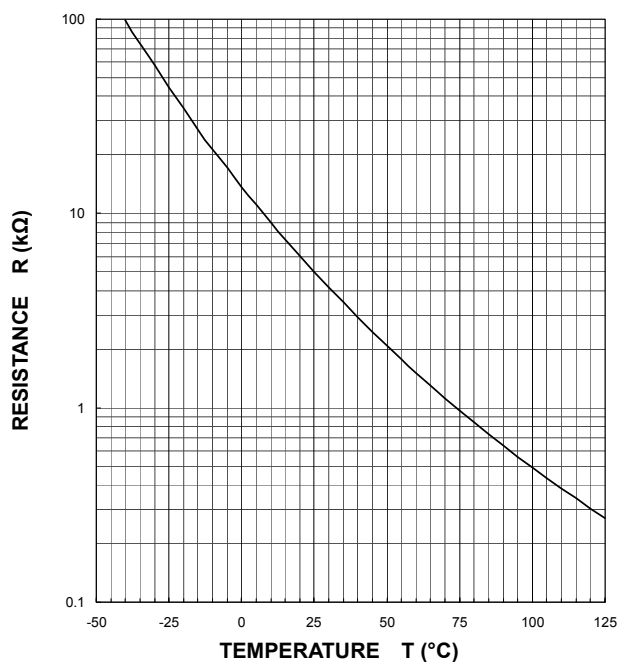
Single pulse, $T_C = 25\text{ °C}$

$R_{th(j-c)D} = 0.45\text{ K/W}$



NTC thermistor part

TEMPERATURE CHARACTERISTICS
(TYPICAL)



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