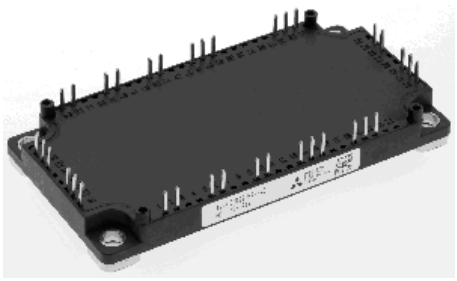
MITSUBISHI ELECTRIC

< IGBT MODULES >

CM50MXA-24S

HIGH POWER SWITCHING USE
INSULATED TYPE



CIB (Converter+Inverter+Chopper Brake)

Collector current I_C ..... **50** A
Collector-emitter voltage V_{CES} ..... **1200** V
Maximum junction temperature T_{jmax} ..... **175** °C

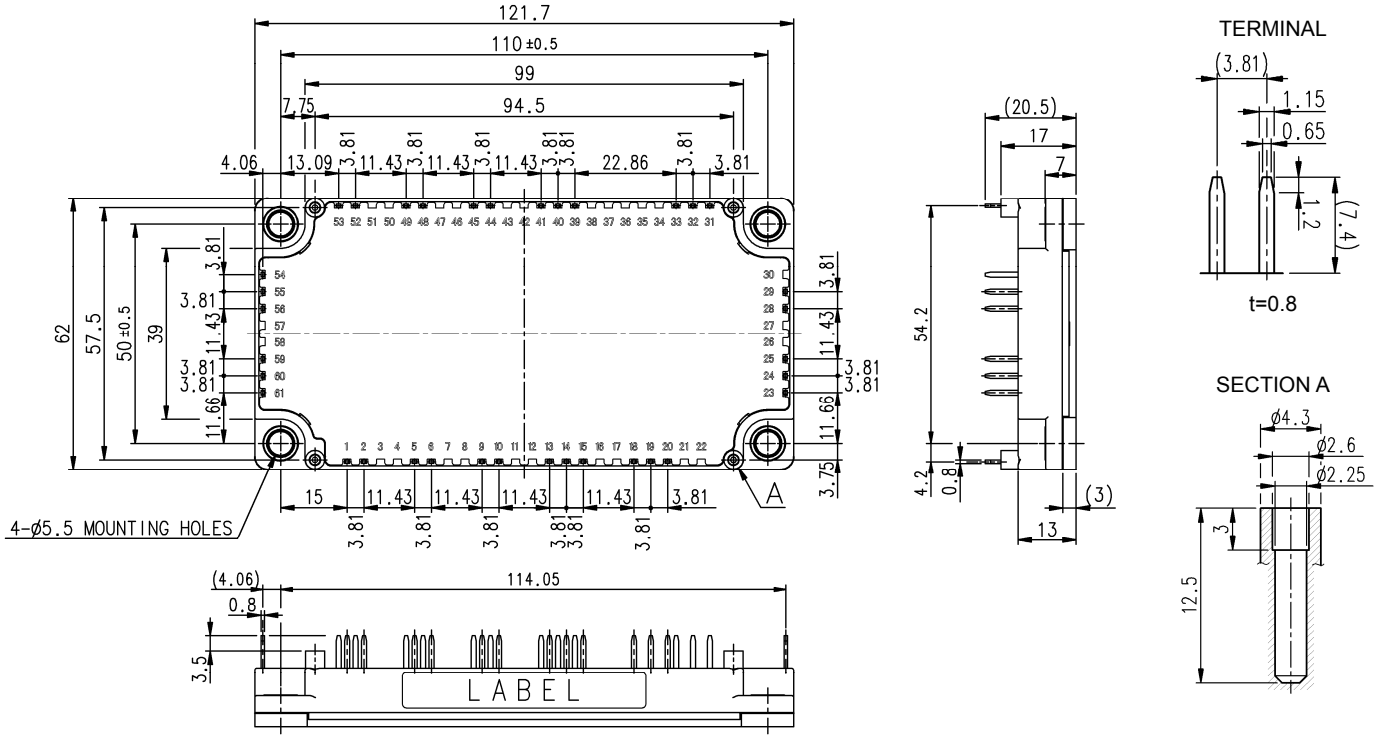
- ●Flat base Type
- ●Copper base plate (non-plating)
- ●Tin plating pin terminals
- ●RoHS Directive compliant
- ●Recognized under UL1557, File E323585

APPLICATION

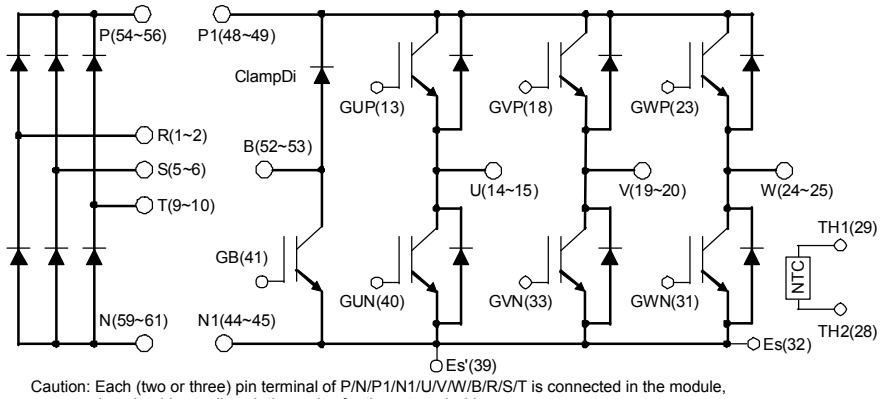
AC Motor Control, Motion/Servo Control, Power supply, etc.

OUTLINE DRAWING & INTERNAL CONNECTION

Dimension in mm



INTERNAL CONNECTION



Caution: Each (two or three) pin terminal of P/N/P1/N1/U/V/W/B/R/S/T is connected in the module, but should use all each three pins for the external wiring.

Tolerance otherwise specified

Division of Dimension		Tolerance
0.5	to 3	±0.2
over 3	to 6	±0.3
over 6	to 30	±0.5
over 30	to 120	±0.8
over 120	to 400	±1.2

The tolerance of size between terminals is assumed to be ±0.4.

ABSOLUTE MAXIMUM RATINGS (T_j=25 °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 °C (Note.2, 4)	50	A
I_{CRM}		Pulse, Repetitive (Note.3)	100	
P_{tot}	Total power dissipation	T_C=25 °C (Note.2, 4)	425	W
I_E (Note.1)	Emitter current	T_C=25 °C (Note.2, 4)	50	A
I_{ERM} (Note.1)		Pulse, Repetitive (Note.3)	100	
T_{jmax}	Maximum junction temperature	-	175	°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 °C (Note.2, 4)	35	A
I_{CRM}		Pulse, Repetitive (Note.3)	70	
P_{tot}	Total power dissipation	T_C=25 °C (Note.2, 4)	355	W
V_{RRM}	Repetitive peak reverse voltage	G-E short-circuited	1200	V
I_F	Forward current	T_C=25 °C (Note.2, 4)	35	A
I_{FRM}		Pulse, Repetitive (Note.3)	70	
T_{jmax}	Maximum junction temperature	-	175	°C

CONVERTER PART Di

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 °C (Note.2)	50	A
I_{FSM}	Surge forward current	The sine half wave 1 cycle peak value, f=60 Hz, non-repetitive	500	A
I^2t	Current square time	Value for one cycle of surge current	1040	A^2s
T_{jmax}	Maximum junction temperature	-	150	°C

MODULE

Symbol	Item	Conditions	Rating	Unit
T_{Cmax}	Maximum case temperature	(Note.2)	125	°C
T_{jop}	Operating junction temperature	-	-40 ~ +150	°C
T_{stg}	Storage temperature	-	-40 ~ +125	
V_{isol}	Isolation voltage	Terminals to base plate, RMS, f=60 Hz, AC 1 min	2500	V

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 (Note.5)	±0	-	+100	μm

ELECTRICAL CHARACTERISTICS (T_j=25 °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	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=5 mA, V_{CE}=10 V		5.4	6.0	6.6	V
V_{CEsat}	Collector-emitter saturation voltage	I_C=50 A (Note.6), 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=50 A (Note.6), 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		-	-	5.0	nF
C_{oes}	Output capacitance			-	-	1.0	
C_{res}	Reverse transfer capacitance			-	-	0.08	
Q_G	Gate charge	V_{CC}=600 V, I_C=50 A, V_{GE}=15 V		-	117	-	nC
$t_{d(on)}$	Turn-on delay time	V_{CC}=600 V, I_C=50 A, V_{GE}=±15 V, R_G=13 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} (Note.1)	Emitter-collector voltage	I_E=50 A (Note.6), 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=50 A (Note.6), 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} (Note.1)	Reverse recovery time	V_{CC}=600 V, I_E=50 A, V_{GE}=±15 V, R_G=13 Ω, Inductive load		-	-	300	ns
Q_{rr} (Note.1)	Reverse recovery charge			-	2.7	-	μC
E_{on}	Turn-on switching energy per pulse	V_{CC}=600 V, I_C=I_E=50 A, V_{GE}=±15 V, R_G=13 Ω, T_j=150 °C, Inductive load		-	5.5	-	mJ
E_{off}	Turn-off switching energy per pulse			-	5.3	-	
E_{rr} (Note.1)	Reverse recovery energy per pulse			-	4.5	-	mJ
$R_{CC'+EE'}$	Internal lead resistance	Main terminals-chip, per switch, T_C=25 °C (Note.2)		-	-	5.0	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 (Note.6), 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 (Note.6), 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 °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 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_F	Forward voltage	I_F=35 A (Note.6), 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_F=35 A (Note.6), 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}	Reverse recovery time	V_{CC}=600 V, I_F=35 A, V_{GE}=±15 V, R_G=18 Ω, Inductive load		-	-	300	ns
Q_{rr}	Reverse recovery charge			-	1.9	-	µC
E_{on}	Turn-on switching energy per pulse	V_{CC}=600 V, I_C=I_F=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}	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 °C	-	-	6	mA
V_F (Terminal)	Forward voltage	I_F=50 A (Note.6)	-	1.2	1.6	V

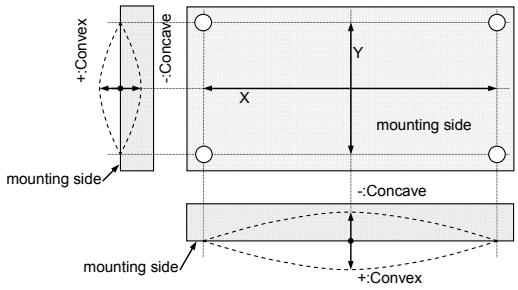
NTC THERMISTOR PART

Symbol	Item	Conditions	Limits			Unit
			Min.	Typ.	Max.	
R_{25}	Zero-power resistance	T_C=25 °C (Note.2)	4.85	5.00	5.15	kΩ
ΔR/R	Deviation of resistance	T_C=100 °C, R_{100}=493 Ω	-7.3	-	+7.8	%
$B_{(25/50)}$	B-constant	Approximate by equation (Note.7)	-	3375	-	K
P_{25}	Power dissipation	T_C=25 °C (Note.2)	-	-	10	mW

THERMAL RESISTANCE CHARACTERISTICS

Symbol	Item	Conditions	Limits			Unit
			Min.	Typ.	Max.	
$R_{th(j-c)Q}$	Thermal resistance (Note.2)	Junction to case, per Inverter IGBT	-	-	0.35	K/W
$R_{th(j-c)D}$		Junction to case, per Inverter FWDi	-	-	0.63	
$R_{th(j-c)Q}$		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	-	-	0.33	K/W
$R_{th(c-s)}$	Contact thermal resistance (Note.2)	Case to heat sink, per 1 module, Thermal grease applied (Note.8)	-	15	-	K/kW

Note.1: Represent ratings and characteristics of the anti-parallel, emitter-collector free wheeling diode (FWDi).
2: 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.
3: Pulse width and repetition rate should be such that the device junction temperature (T_j) dose not exceed T_{jmax} rating.
4: Junction temperature (T_j) should not increase beyond T_{jmax} rating.
5: The base plate (mounting side) flatness measurement points (X, Y) are as follows of the following figure.



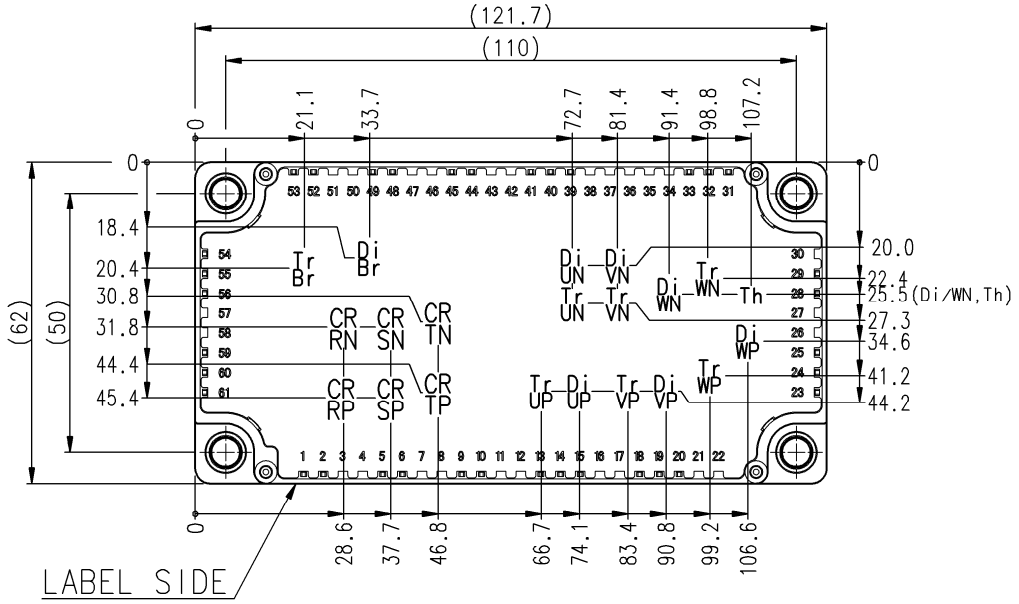
6: Pulse width and repetition rate should be such as to cause negligible temperature rise. Refer to the figure of test circuit.
7: $B_{(25/50)} = \ln(\frac{R_{25}}{R_{50}}) / (\frac{1}{T_{25}} - \frac{1}{T_{50}})$,
R_{25}: resistance at absolute temperature T_{25} [K]; T_{25}=25 [°C]+273.15=298.15 [K]
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 λ=0.9 W/(m·K).
9: Use the following screws when mounting the printed circuit board (PCB) on the stand offs.
"M2.6×10 or M2.6×12 self tapping screw"
The length of the screw depends on the thickness of the PCB.

RECOMMENDED OPERATING CONDITIONS (T_a=25 °C)

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-Es1/ G*P-*/G*N-Es(*=U, V, W) terminals		13.5	15.0	16.5	V
R_G	External gate resistance	Per switch	Inverter IGBT	13	-	130	Ω
			Brake IGBT	18	-	180	

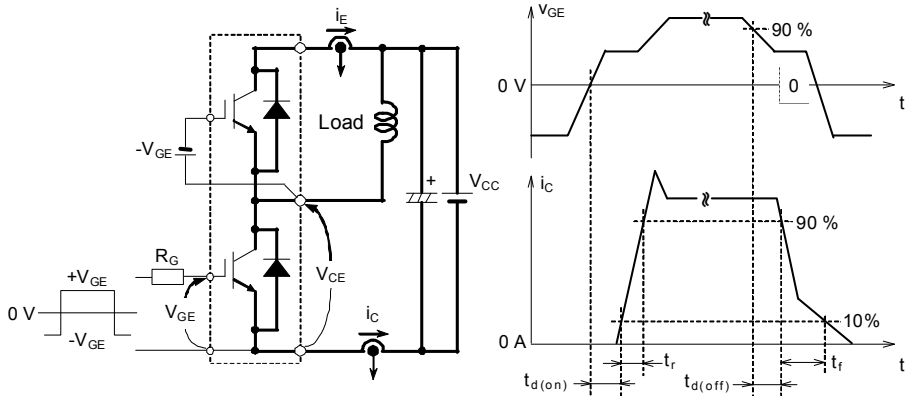
CHIP LOCATION (Top view)

Dimension in mm, tolerance: ±1 mm

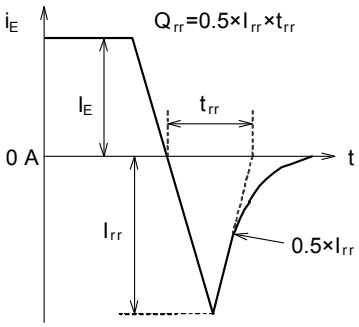


Tr*P/Tr*N/TrBr: IGBT, Di*P/Di*N: FWDi (*=U/V/W), DiBr: ClampDi, CR*P/CR*N: ConvDi (*=R/S/T), Th: NTC thermistor

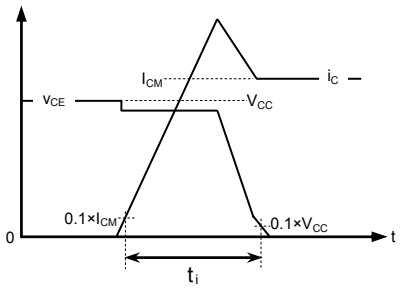
TEST CIRCUIT AND WAVEFORMS



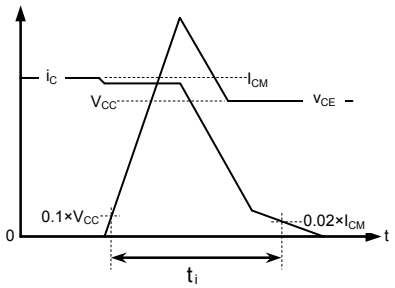
Switching characteristics test circuit and waveforms



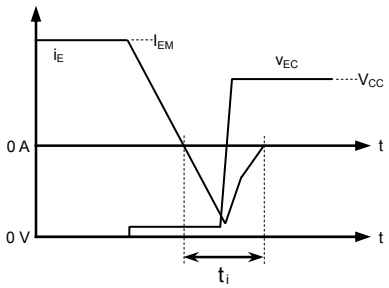
trr, Qrr test waveform



IGBT Turn-on switching energy



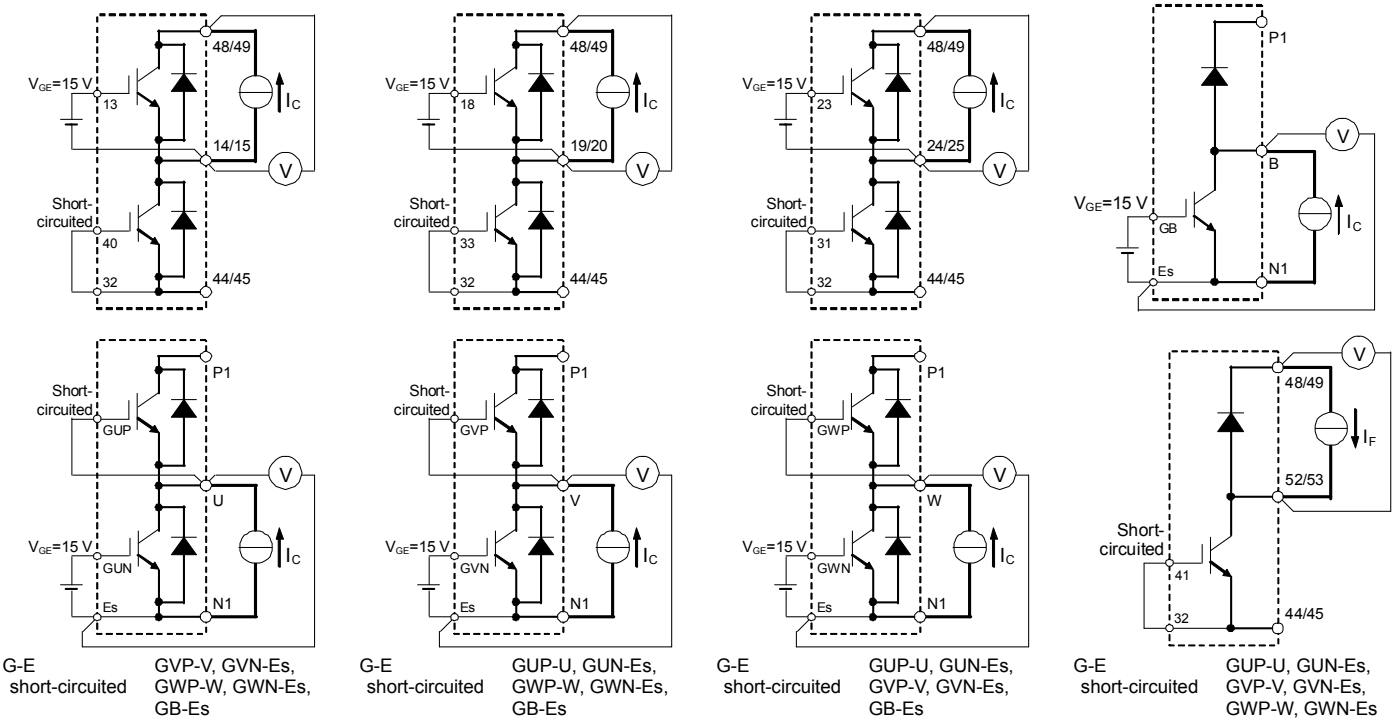
IGBT Turn-off switching energy



FWDi Reverse recovery energy

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

TEST CIRCUIT



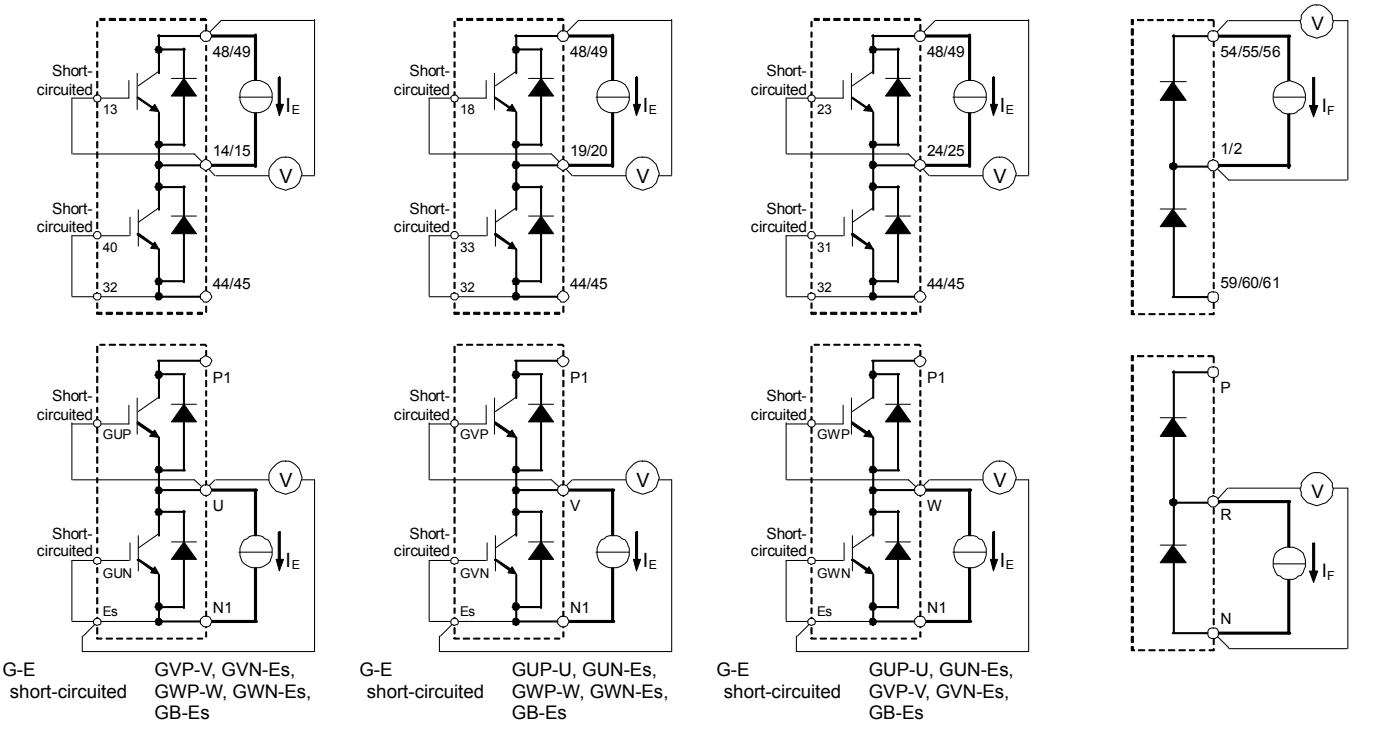
G-E short-circuited: GVP-V, GVN-Es, GWP-W, GWN-Es, GB-Es — UP / UN IGBT

G-E short-circuited: GUP-U, GUN-Es, GWP-W, GWN-Es, GB-Es — VP / VN IGBT

G-E short-circuited: GUP-U, GUN-Es, GVP-V, GVN-Es, GB-Es — WP / WN IGBT

G-E short-circuited: GUP-U, GUN-Es, GVP-V, GVN-Es, GWP-W, GWN-Es — Brake IGBT / ClampDi

V_{CEsat} / ClampDi V_F test circuit



G-E short-circuited: GVP-V, GVN-Es, GWP-W, GWN-Es, GB-Es — UP / UN FWDi

G-E short-circuited: GUP-U, GUN-Es, GWP-W, GWN-Es, GB-Es — VP / VN FWDi

G-E short-circuited: GUP-U, GUN-Es, GVP-V, GVN-Es, GB-Es — WP / WN FWDi

ConvDi (ex. phase-R)

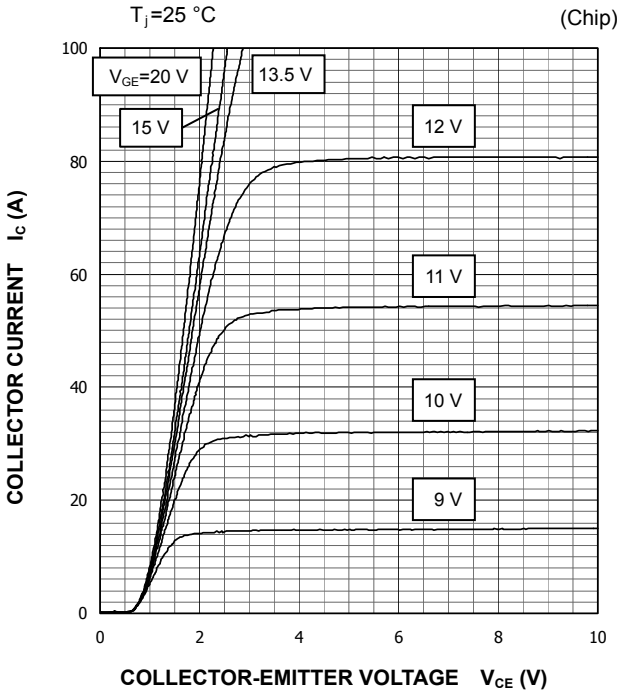
V_{EC} / ConvDi V_F test circuit

* 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.

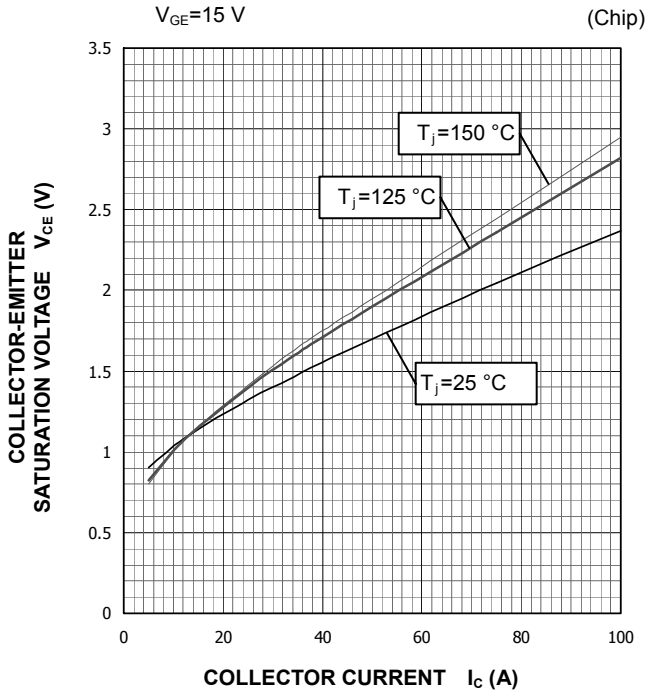
PERFORMANCE CURVES

INVERTER PART

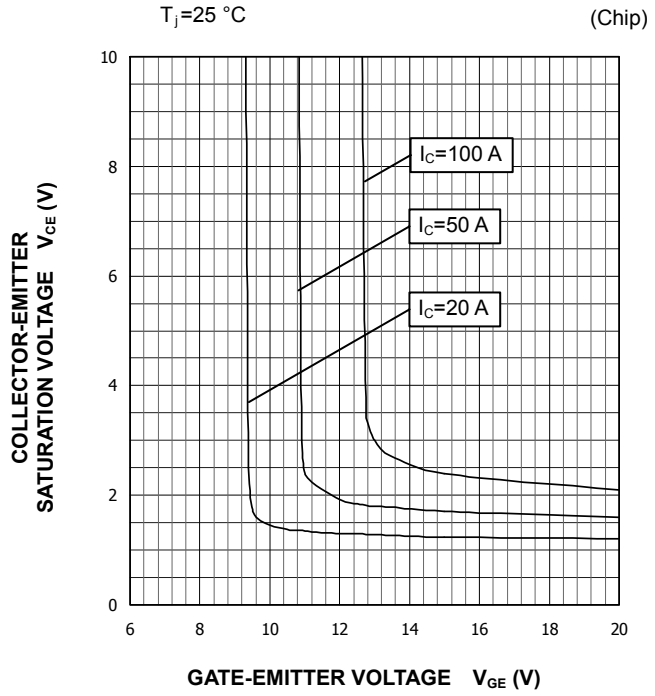
OUTPUT CHARACTERISTICS (TYPICAL)



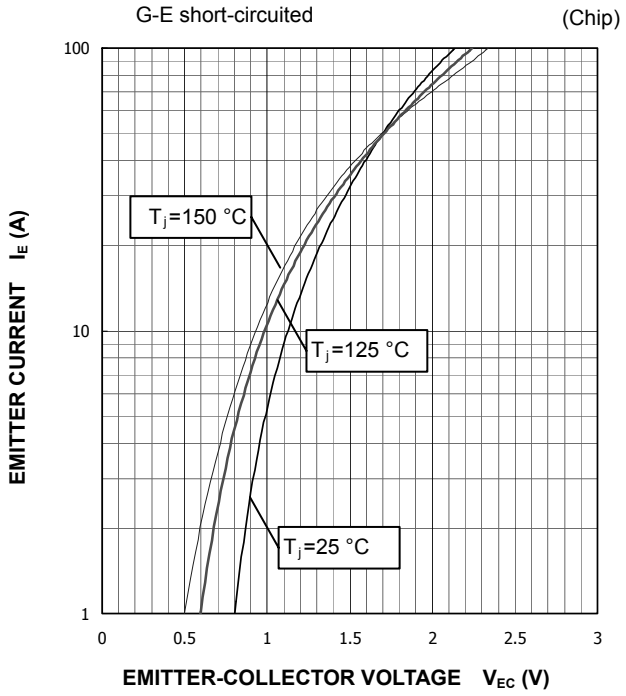
COLLECTOR-EMITTER SATURATION VOLTAGE CHARACTERISTICS (TYPICAL)



COLLECTOR-EMITTER SATURATION VOLTAGE CHARACTERISTICS (TYPICAL)



FREE WHEELING DIODE FORWARD CHARACTERISTICS (TYPICAL)

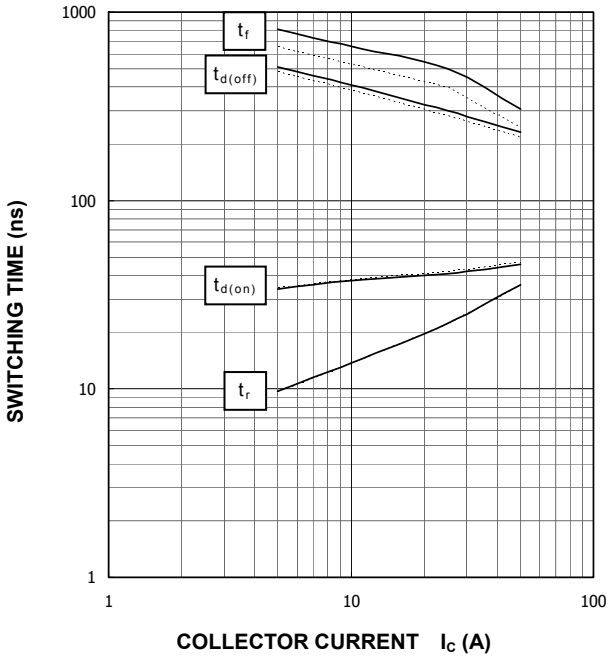


PERFORMANCE CURVES

INVERTER PART

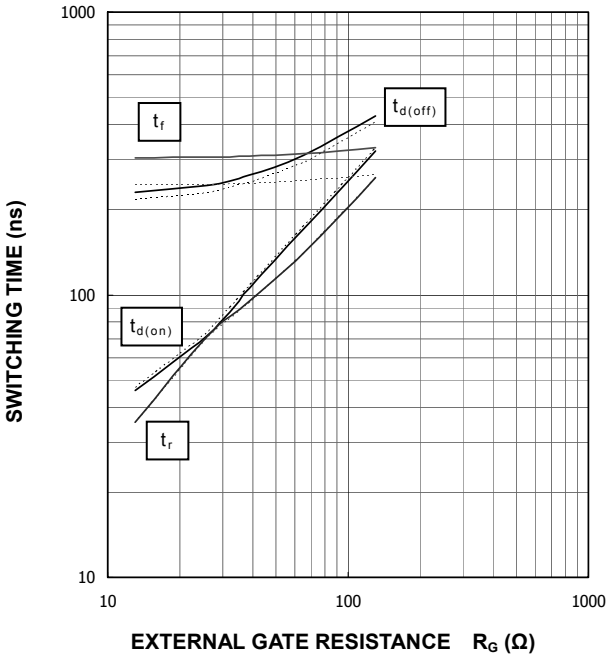
**HALF-BRIDGE
SWITCHING CHARACTERISTICS
(TYPICAL)**

V_{CC}=600 V, V_{GE}=±15 V, R_G=13 Ω, INDUCTIVE LOAD
————: T_j=150 °C, - - - - -: T_j=125 °C



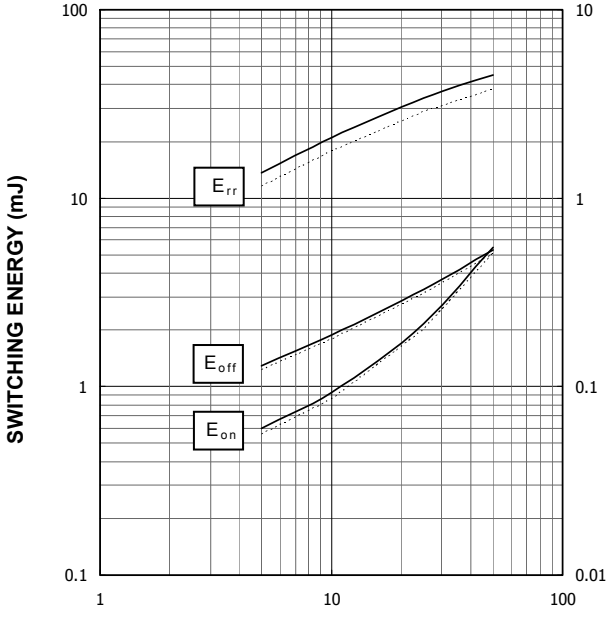
**HALF-BRIDGE
SWITCHING CHARACTERISTICS
(TYPICAL)**

V_{CC}=600 V, V_{GE}=±15 V, I_C=50 A, INDUCTIVE LOAD
————: T_j=150 °C, - - - - -: T_j=125 °C



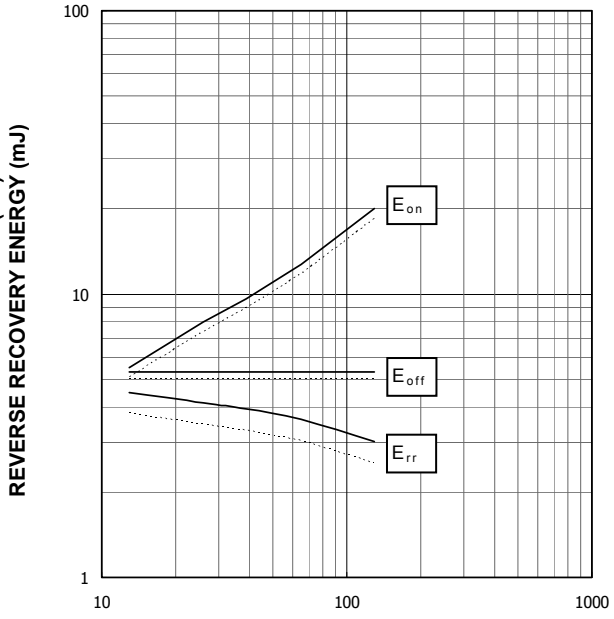
**HALF-BRIDGE
SWITCHING CHARACTERISTICS
(TYPICAL)**

V_{CC}=600 V, V_{GE}=±15 V, R_G=13 Ω,
INDUCTIVE LOAD, PER PULSE
————: T_j=150 °C, - - - - -: T_j=125 °C



**HALF-BRIDGE
SWITCHING CHARACTERISTICS
(TYPICAL)**

V_{CC}=600 V, V_{GE}=±15 V, I_C=50 A,
INDUCTIVE LOAD, PER PULSE
————: T_j=150 °C, - - - - -: T_j=125 °C

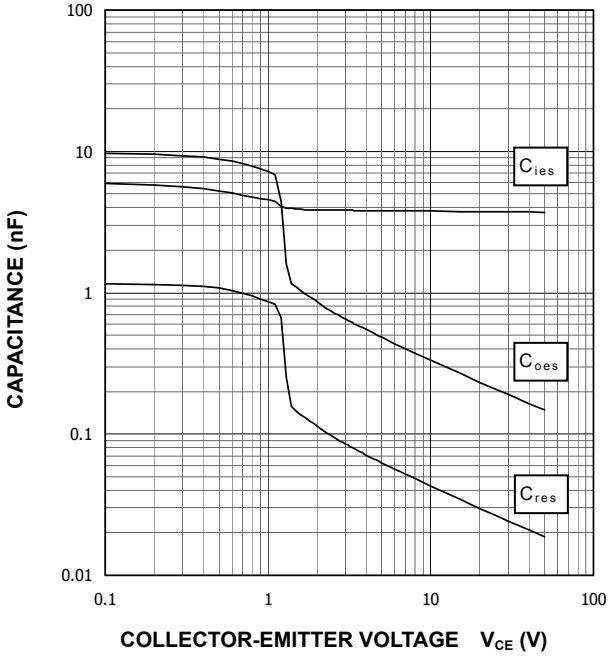


PERFORMANCE CURVES

INVERTER PART

CAPACITANCE CHARACTERISTICS (TYPICAL)

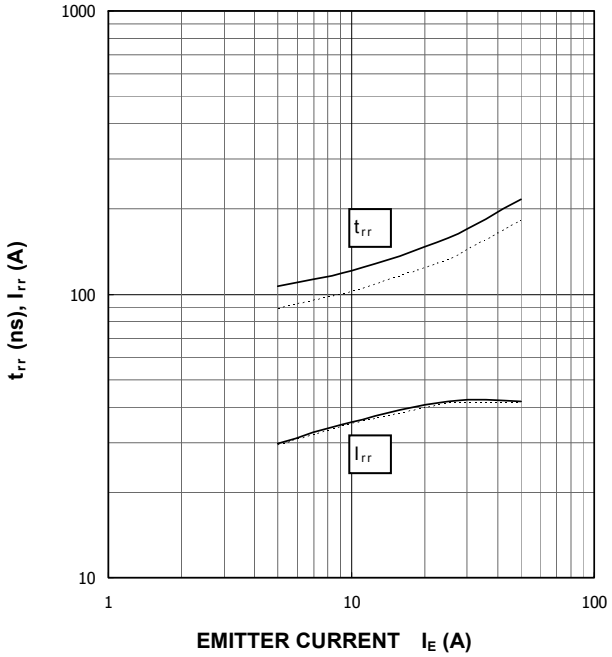
G-E short-circuited, T_j=25 °C



FREE WHEELING DIODE REVERSE RECOVERY CHARACTERISTICS (TYPICAL)

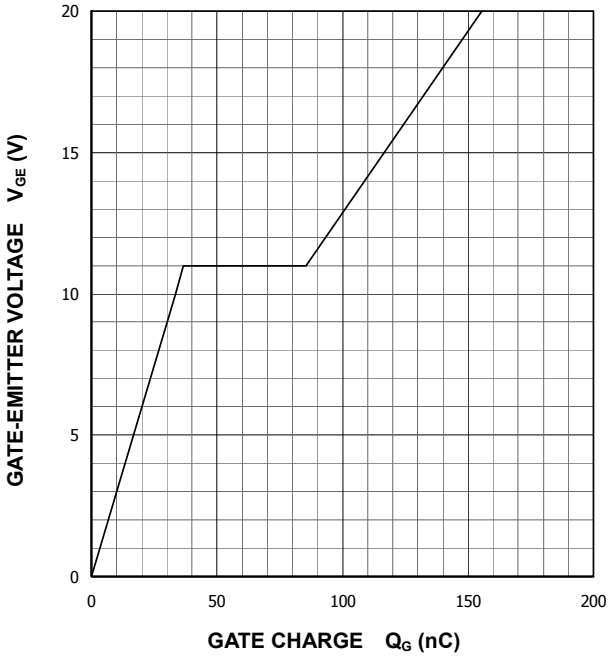
V_{CC}=600 V, V_{GE}=±15 V, R_G=13 Ω, INDUCTIVE LOAD

————: T_j=150 °C, - - - - -: T_j=125 °C



GATE CHARGE CHARACTERISTICS (TYPICAL)

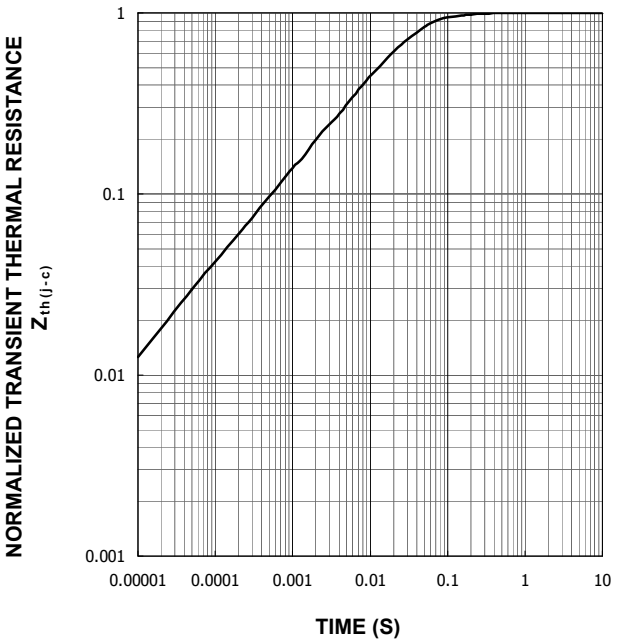
V_{CC}=600 V, I_C=50 A, T_j=25 °C



TRANSIENT THERMAL IMPEDANCE CHARACTERISTICS (MAXIMUM)

Single pulse, T_C=25 °C

$R_{th(j-c)Q}$=0.35 K/W, $R_{th(j-c)D}$=0.63 K/W

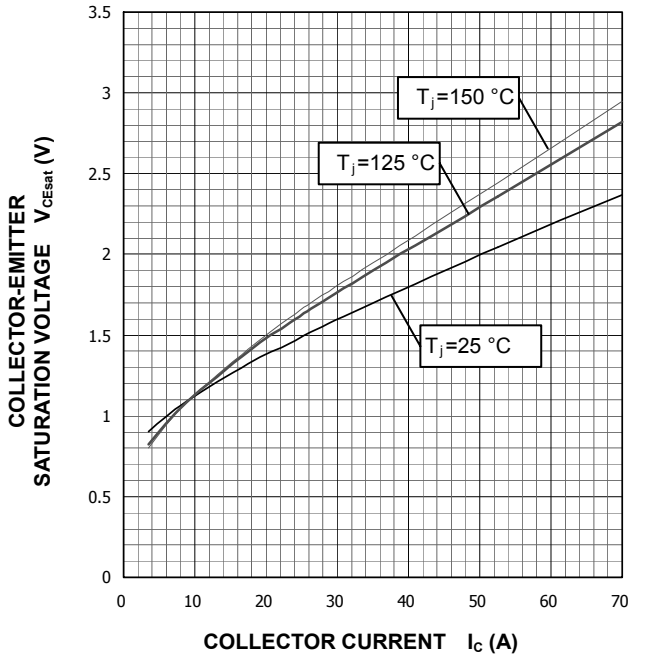


PERFORMANCE CURVES

BRAKE PART

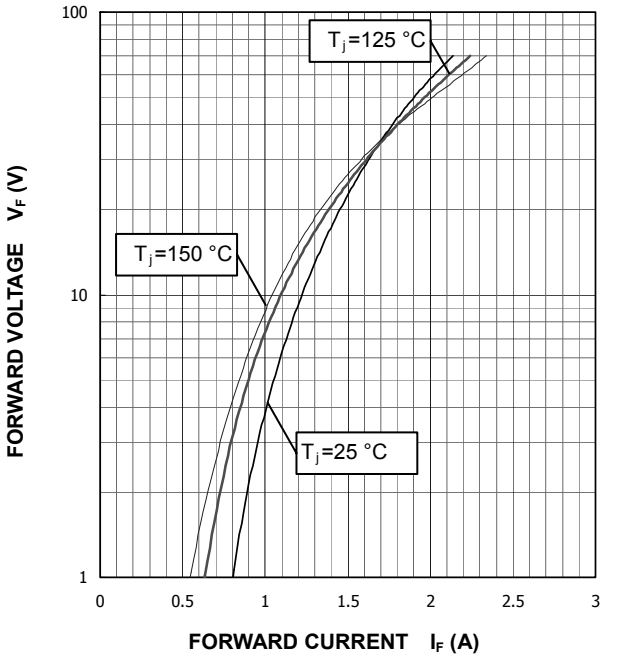
COLLECTOR-EMITTER SATURATION VOLTAGE CHARACTERISTICS (TYPICAL)

V_{GE}=15 V (Chip)



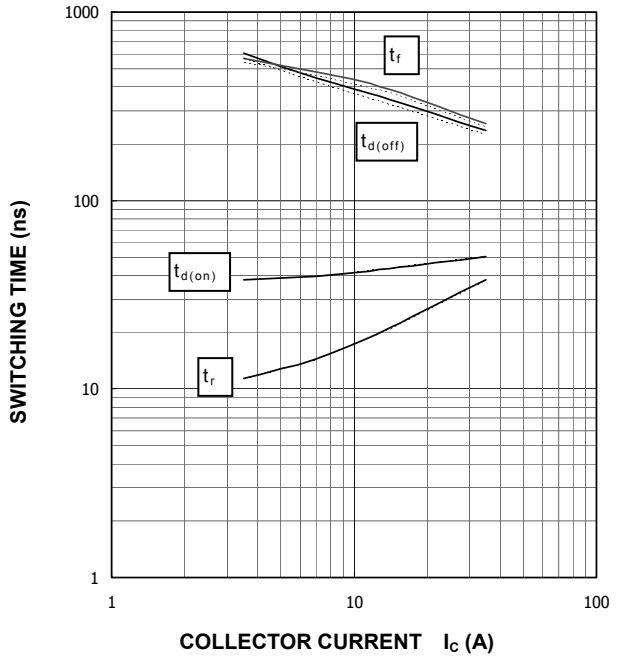
CLAMP DIODE FORWARD CHARACTERISTICS (TYPICAL)

G-E short-circuited (Chip)



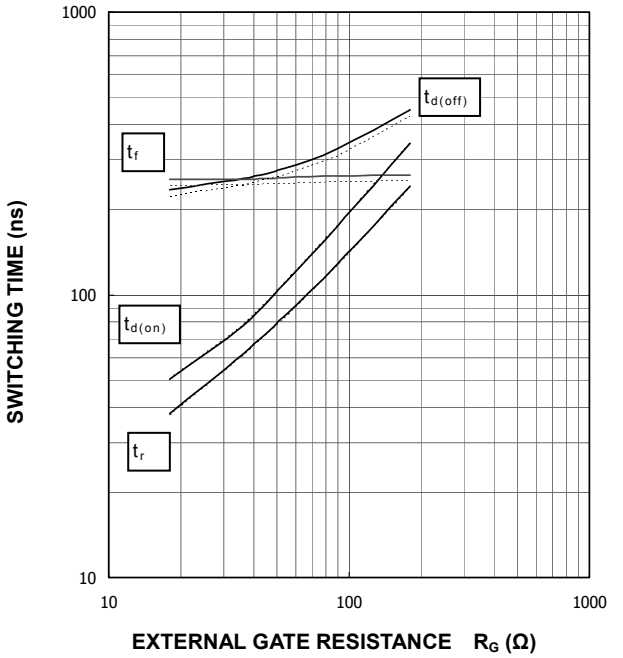
HALF-BRIDGE SWITCHING CHARACTERISTICS (TYPICAL)

V_{CC}=600 V, V_{GE}=±15 V, R_G=18 Ω, INDUCTIVE LOAD
————: T_j=150 °C, - - - - -: T_j=125 °C



HALF-BRIDGE SWITCHING CHARACTERISTICS (TYPICAL)

V_{CC}=600 V, I_C=35 A, V_{GE}=±15 V, INDUCTIVE LOAD
————: T_j=150 °C, - - - - -: T_j=125 °C

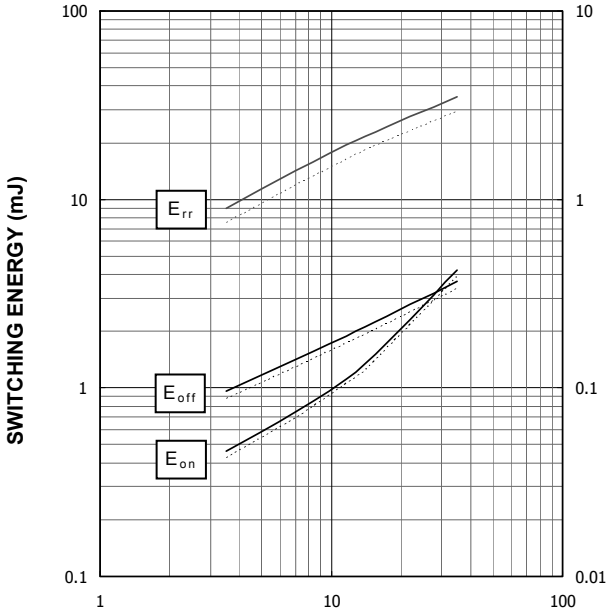


PERFORMANCE CURVES

BRAKE PART

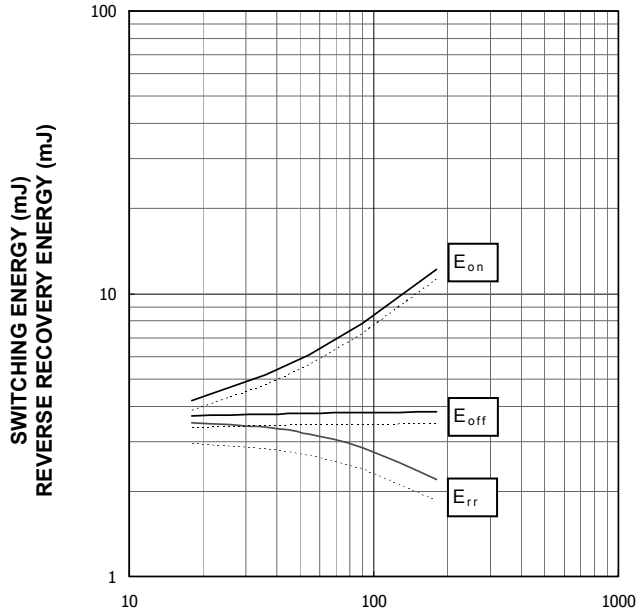
**HALF-BRIDGE
SWITCHING CHARACTERISTICS
(TYPICAL)**

V_{CC}=600 V, V_{GE}=±15 V, R_G=18 Ω,
INDUCTIVE LOAD, PER PULSE
————: T_j=150 °C, - - - - -: T_j=125 °C



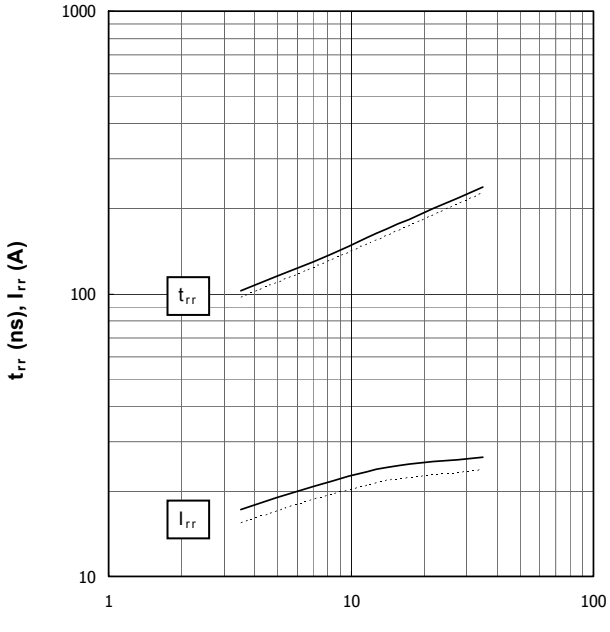
**HALF-BRIDGE
SWITCHING CHARACTERISTICS
(TYPICAL)**

V_{CC}=600 V, I_C/I_F=35 A, V_{GE}=±15 V,
INDUCTIVE LOAD, PER PULSE
————: T_j=150 °C, - - - - -: T_j=125 °C



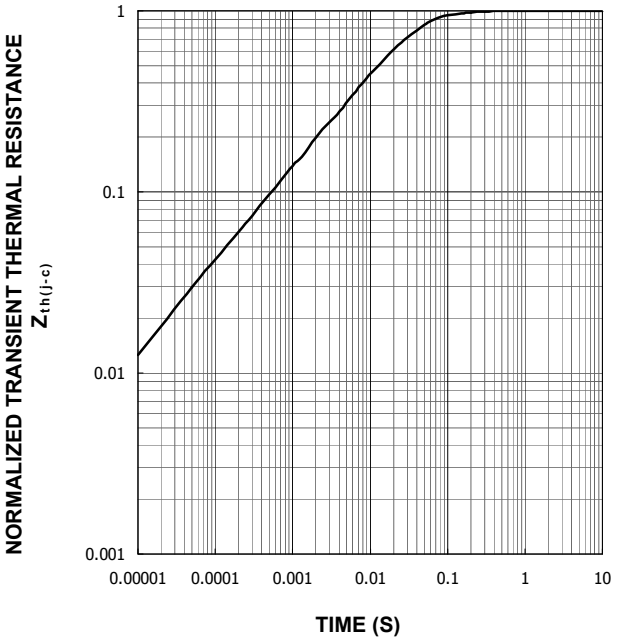
**CLAMP DIODE
REVERSE RECOVERY CHARACTERISTICS
(TYPICAL)**

V_{CC}=600 V, V_{GE}=±15 V, R_G=18 Ω, INDUCTIVE LOAD
————: T_j=150 °C, - - - - -: T_j=125 °C



**TRANSIENT THERMAL IMPEDANCE CHARACTERISTICS
(MAXIMUM)**

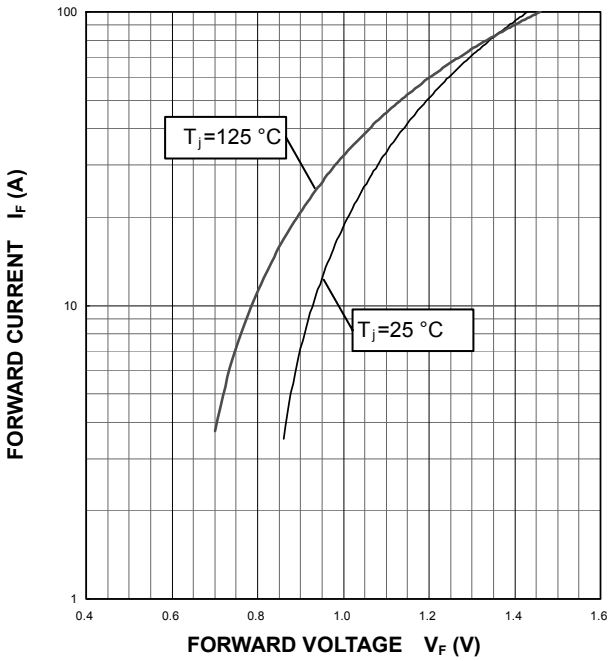
Single pulse, T_C=25 °C
$R_{th(j-c)Q}$=0.42 K/W, $R_{th(j-c)D}$=0.69 K/W



PERFORMANCE CURVES

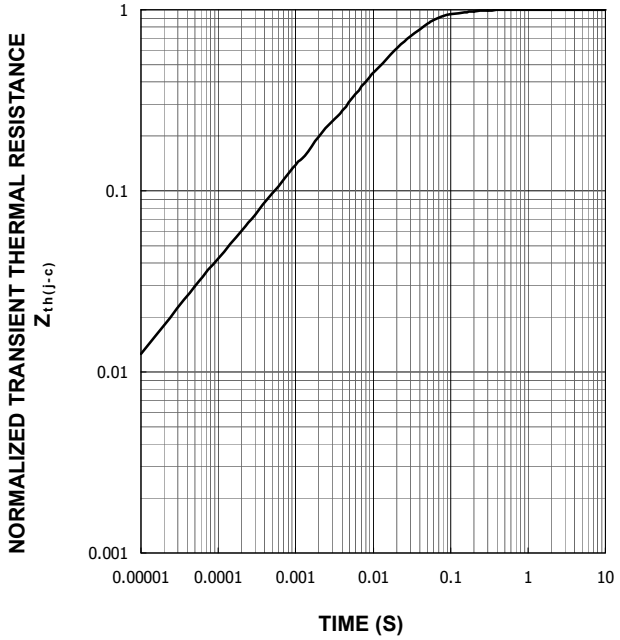
CONVERTER PART

CONVERTER DIODE FORWARD CHARACTERISTICS (TYPICAL)



TRANSIENT THERMAL IMPEDANCE CHARACTERISTICS (MAXIMUM)

Single pulse, T_C=25 °C
$R_{th(j-c)D}$=0.33 K/W



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