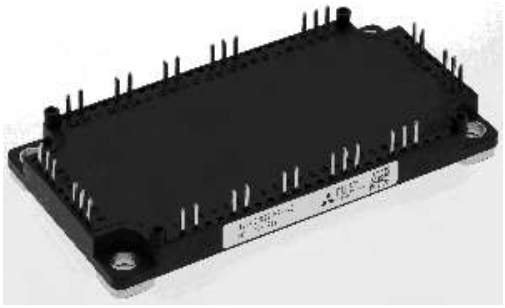
MITSUBISHI ELECTRIC

< IGBT MODULES >

CM35MXA-24S

HIGH POWER SWITCHING USE
INSULATED TYPE



CIB (Converter+Inverter+Chopper Brake)

Collector current I_C ..... **35** A
Collector-emitter voltage V_{CES} ..... **1200** V
Maximum junction temperature T_{jmax} ..... **175** °C

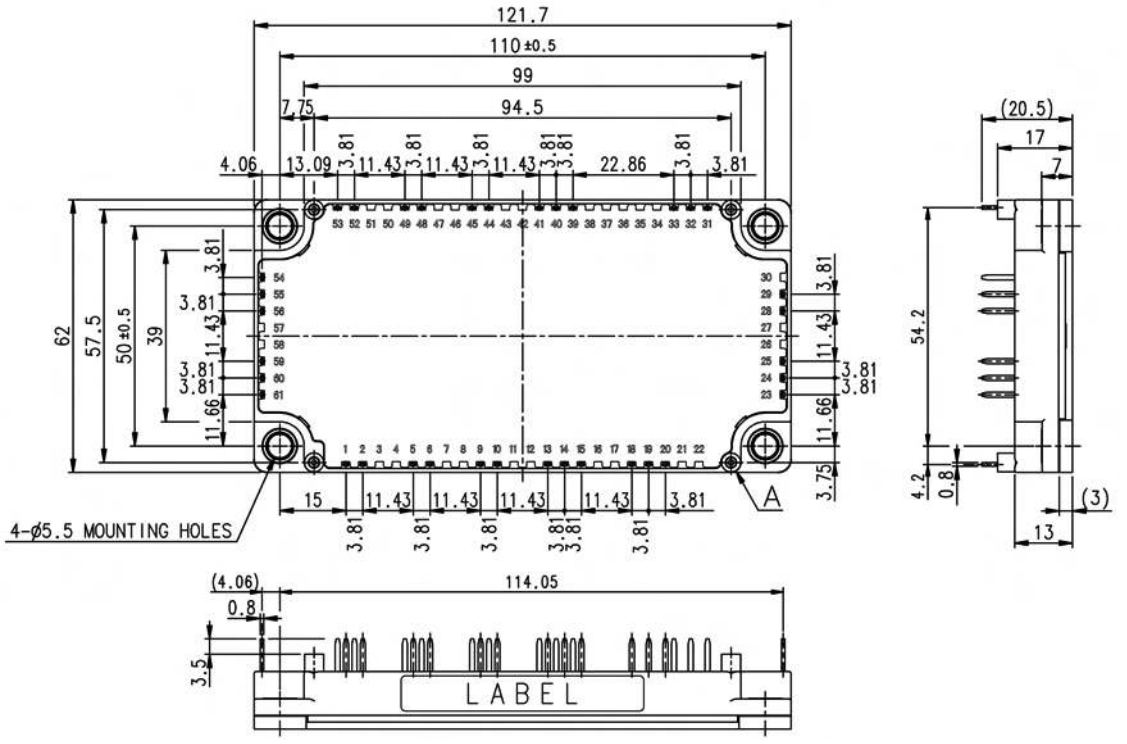
- Flat base Type
- Copper base plate
- Tin plating pin terminals
- RoHS Directive compliant
- Recognized under UL1557, File E323585

APPLICATION

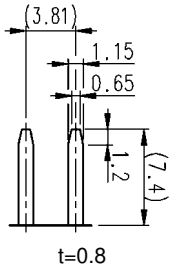
AC Motor Control, Motion/Servo Control, Power supply, etc.

OUTLINE DRAWING & INTERNAL CONNECTION

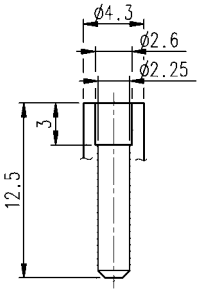
Dimension in mm



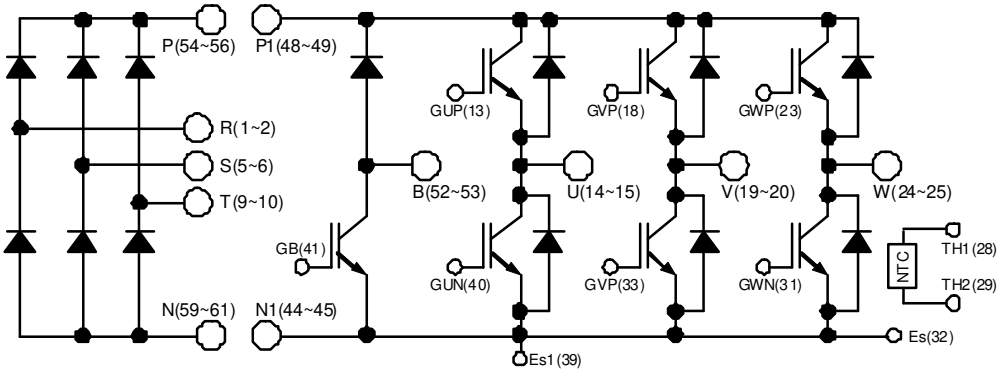
TERMINAL



SECTION A



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/DIODE

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 (Note2, 4)	35	A
I_{CRM}		Pulse, Repetitive (Note3)	70	
P_{tot}	Total power dissipation	T_C=25 °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	°C

BRAKE PART IGBT/DIODE

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 (Note2, 4)	35	A
I_{CRM}		Pulse, Repetitive (Note3)	70	
P_{tot}	Total power dissipation	T_C=25 °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	°C

CONVERTER PART DIODE

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 (Note4)	35	A
I_{FSM}	Surge forward current	The sine half wave 1 cycle peak value, f=60 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	°C

MODULE

Symbol	Item	Conditions	Rating	Unit
V_{isol}	Isolation voltage	Terminals to base plate, RMS, f=60 Hz, AC 1 min	2500	V
T_{Cmax}	Maximum case temperature	(Note4)	125	°C
T_{jop}	Operating junction temperature	Continuous operation (under switching)	-40 ~ +150	°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	mass	-	-	300	-	g
e_c	Flatness of base plate	On the centerline X, Y (Note5)	±0	-	+100	μm

ELECTRICAL CHARACTERISTICS (T_j =25 °C, unless otherwise specified)

INVERTER PART IGBT/DIODE

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/DIODE

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 °C, unless otherwise specified)

BRAKE PART IGBT/DIODE

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	
I_{RRM}	Reverse current	V_R=V_{RRM}, G-E short-circuited		-	-	1.0	mA
V_F	Forward voltage	I_F=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_F=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}	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 DIODE

Symbol	Item	Conditions	Limits			Unit
			Min.	Typ.	Max.	
I_{RRM}	Reverse current	V_R=V_{RRM}, T_j =150 °C	-	-	4.0	mA
V_F (Terminal)	Forward voltage	I_F=35 A (Note6)	-	1.2	1.6	V

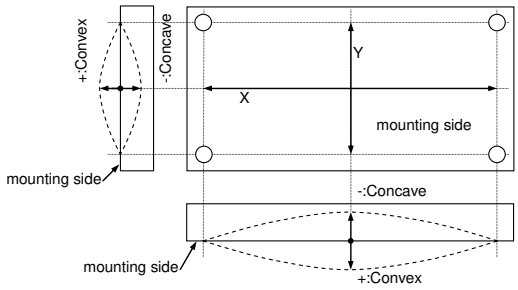
NTC THERMISTOR PART

Symbol	Item	Conditions	Limits			Unit
			Min.	Typ.	Max.	
R_{25}	Zero-power resistance	T_C=25 °C (Note4)	4.85	5.00	5.15	kΩ
ΔR/R	Deviation of resistance	R_{100}=493 Ω, T_C=100 °C (Note4)	-7.3	-	+7.8	%
$B_{(25/50)}$	B-constant	Approximate by equation (Note7)	-	3375	-	K
P_{25}	Power dissipation	T_C=25 °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 DIODE	-	-	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 DIODE	-	-	0.69	
$R_{th(j-c)D}$		Junction to case, per Converter DIODE	-	-	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 (DIODE).
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. $B_{(25/50)} = \ln(\frac{R_{25}}{R_{50}}) / (\frac{1}{T_{25}} - \frac{1}{T_{50}})$,

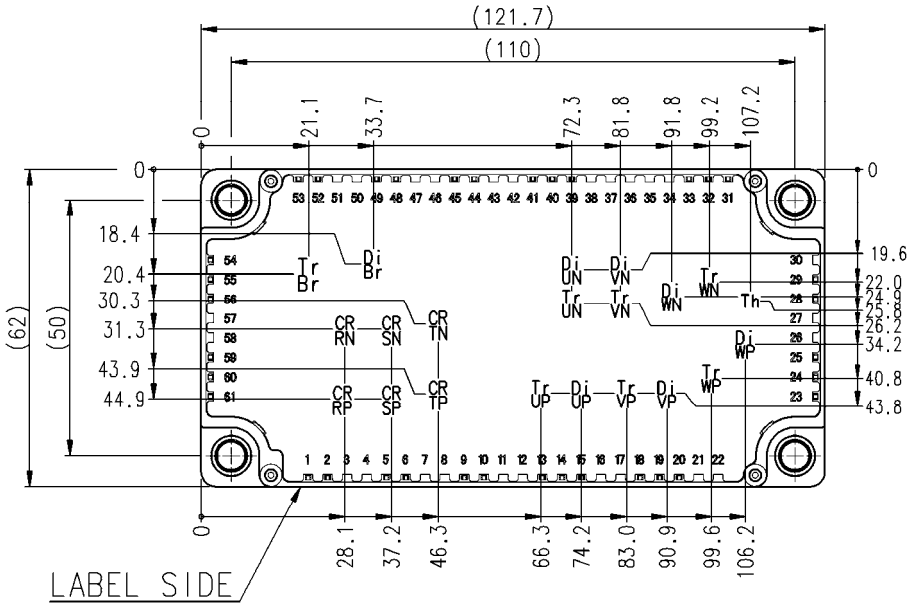
   R_{25}: resistance at absolute temperature T_{25} [K]; T_{25}=25 [°C]+273.15=298.15 [K]
   R_{50}: resistance at absolute temperature T_{50} [K]; T_{50}=50 [°C]+273.15=323.15 [K]
8. Typical value is measured by using thermally conductive grease of λ=0.9 W/(m·K).
9. Use the following screws when mounting the printed circuit board (PCB) on the stand offs.
   "φ2.6×10 or φ2.6×12 self tapping screw"
   The length of the screw depends on the thickness (t1.6~t2.0) 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	Inverter IGBT	18	-	180	Ω
			Brake IGBT	18	-	180	

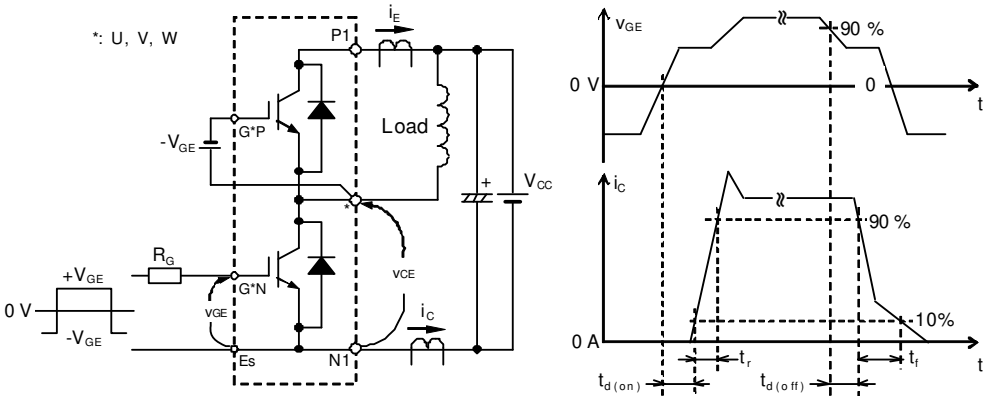
CHIP LOCATION (Top view)

Dimension in mm, tolerance: ±1 mm

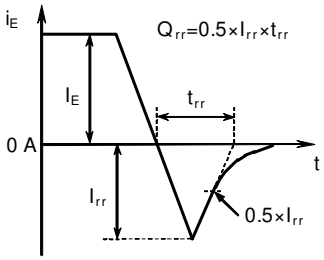


Tr*P/Tr*N/TrBr: IGBT, Di*P/Di*N: DIODE (*=U/V/W), DiBr: BRAKE DIODE, CR*P/CR*N: CONVERTER DIODE (*=R/S/T), Th: NTC thermistor

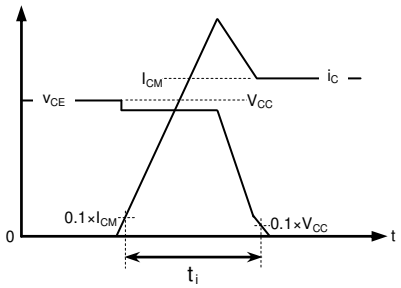
TEST CIRCUIT AND WAVEFORMS



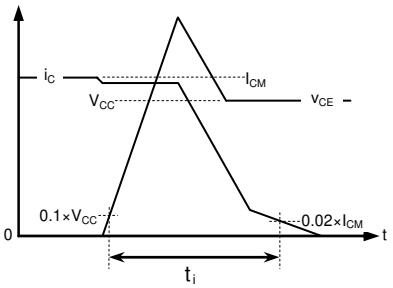
Switching characteristics test circuit and waveforms



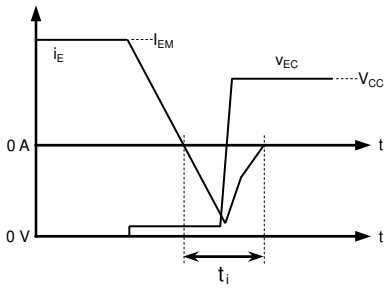
trr, Qrr test waveform



IGBT Turn-on switching energy



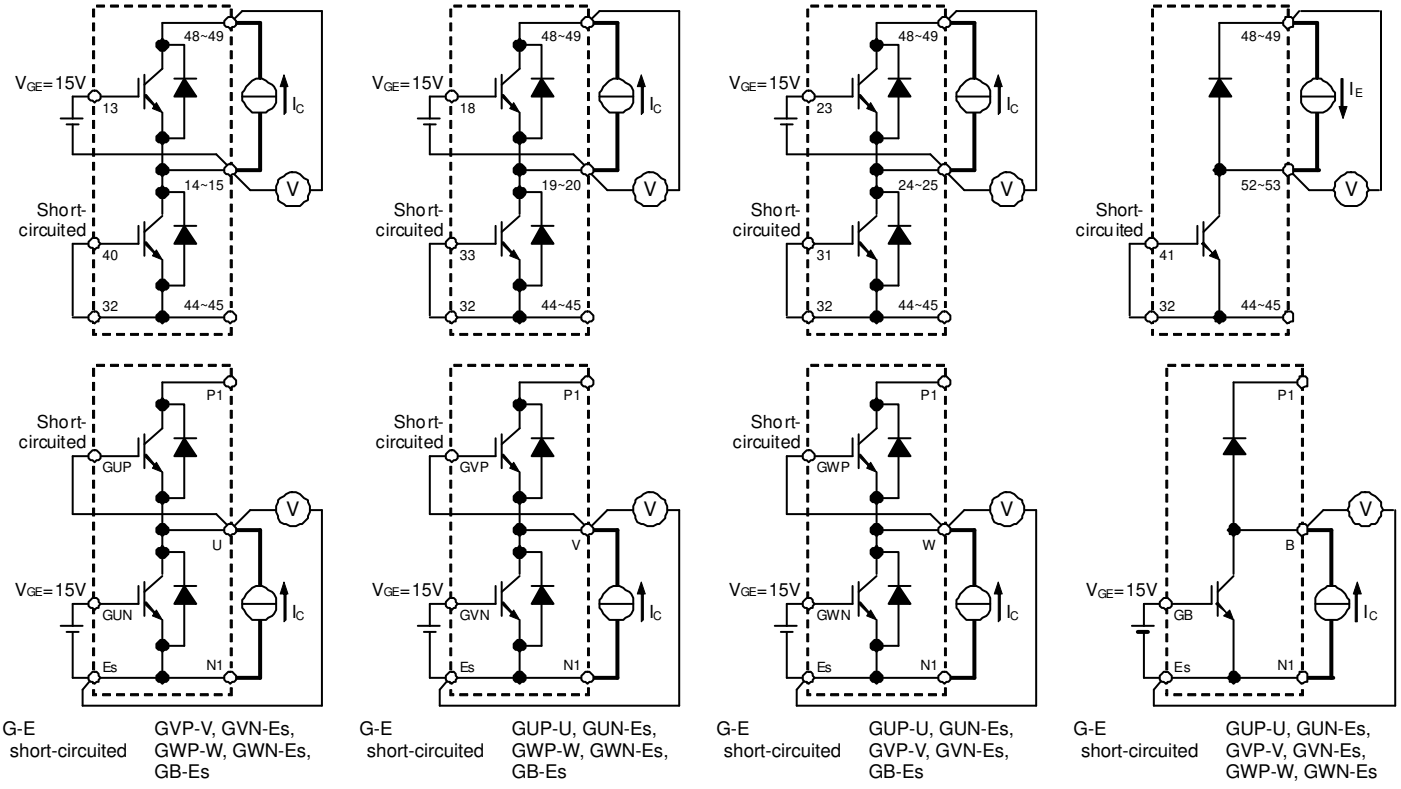
IGBT Turn-off switching energy



DIODE Reverse recovery energy

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

TEST CIRCUIT



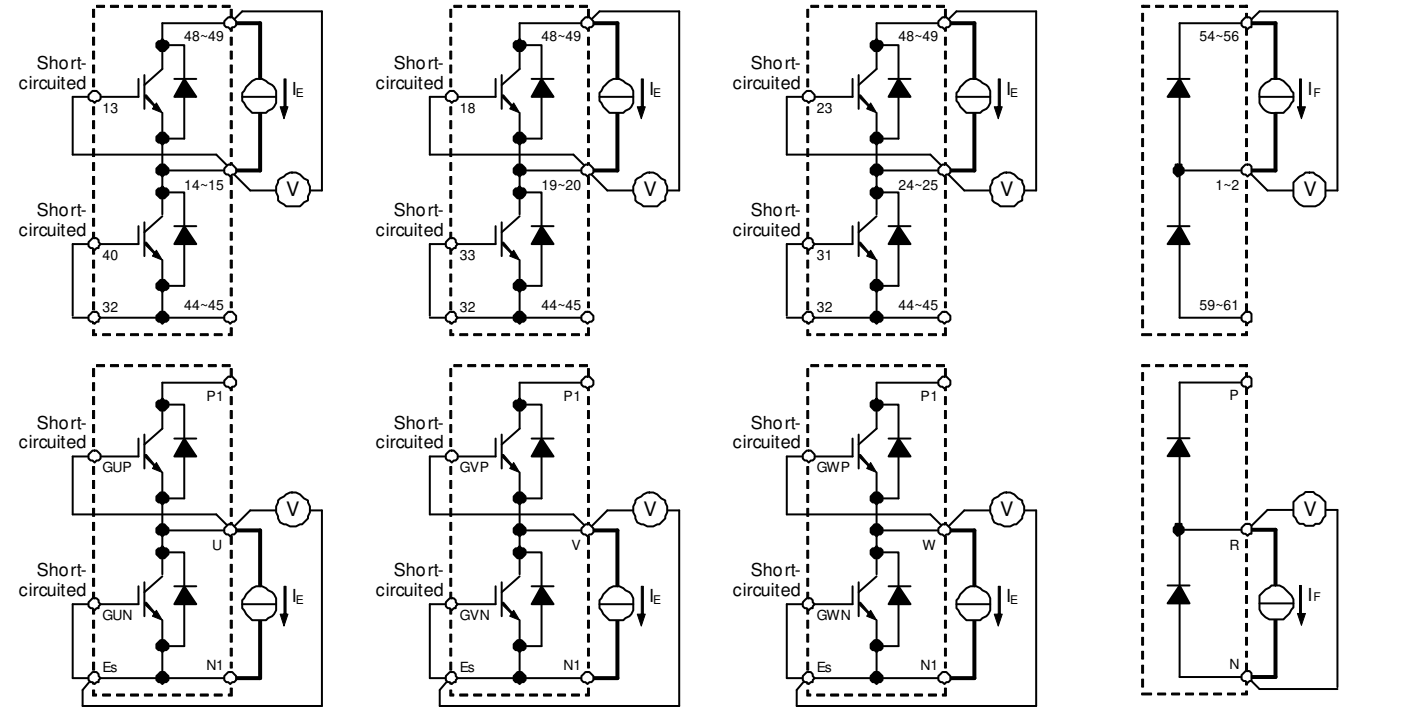
G-E short-circuited: GVP-V, GVN-Es, GWP-W, GWN-Es, GB-Es — UP / UN IGBT

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 / DIODE

V_{CEsat} / BRAKE DIODE V_F test circuit



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

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

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

CONVERTER DIODE (ex. phase-R)

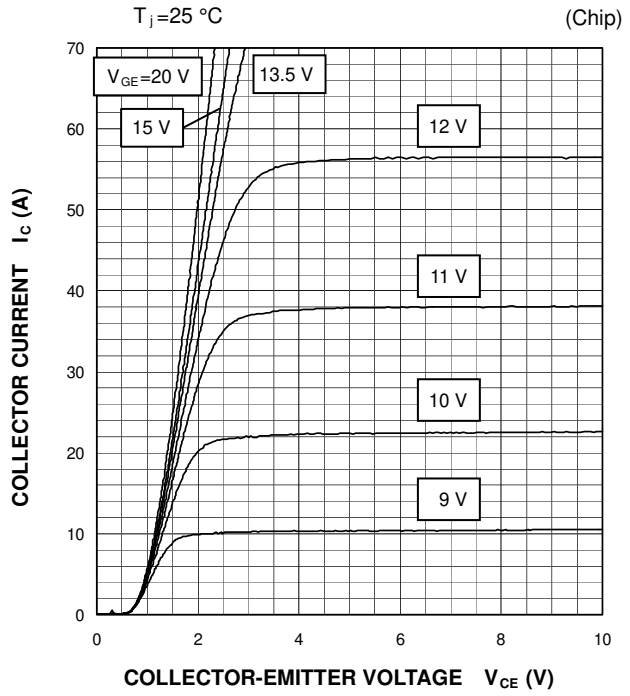
V_{EC} / CONVERTER DIODE V_F test circuit

* 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.

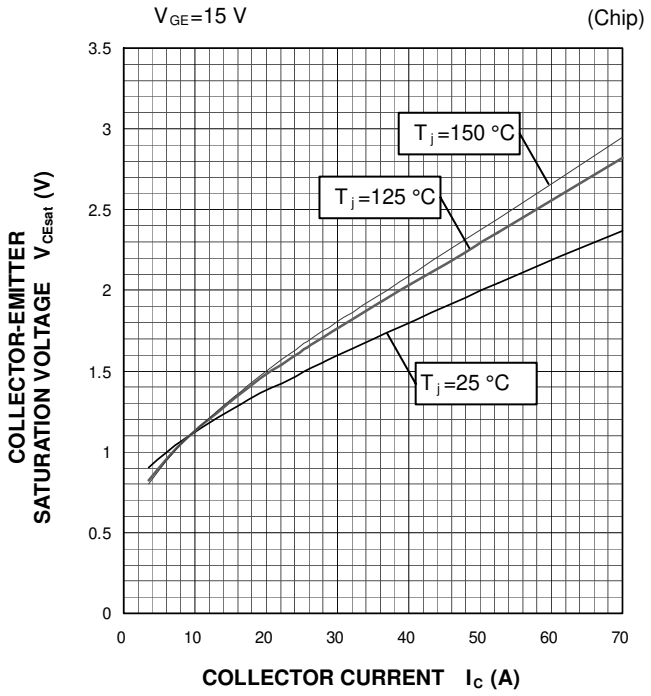
PERFORMANCE CURVES

INVERTER PART

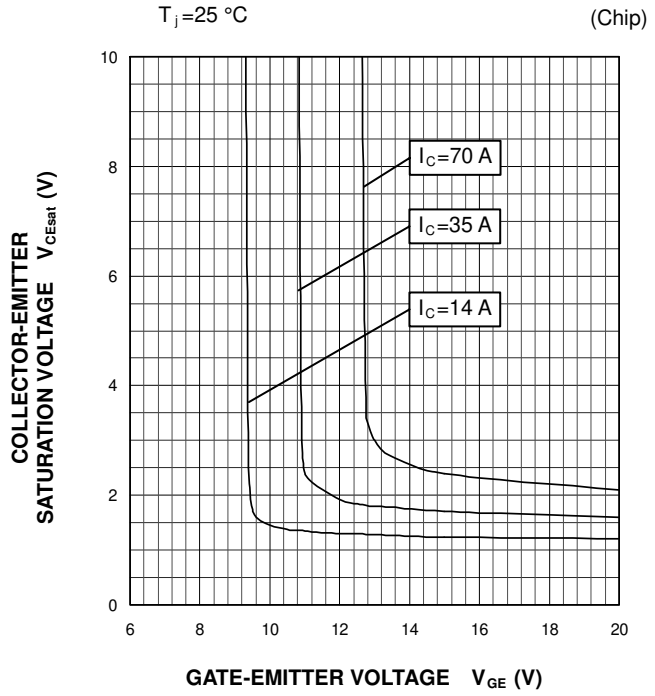
OUTPUT CHARACTERISTICS (TYPICAL)



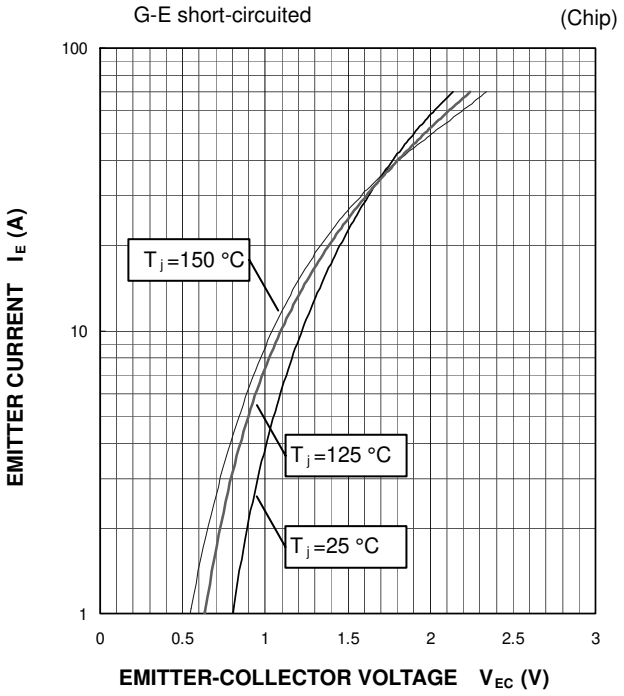
COLLECTOR-EMITTER SATURATION VOLTAGE CHARACTERISTICS (TYPICAL)



COLLECTOR-EMITTER SATURATION VOLTAGE CHARACTERISTICS (TYPICAL)



FREE WHEELING DIODE FORWARD CHARACTERISTICS (TYPICAL)

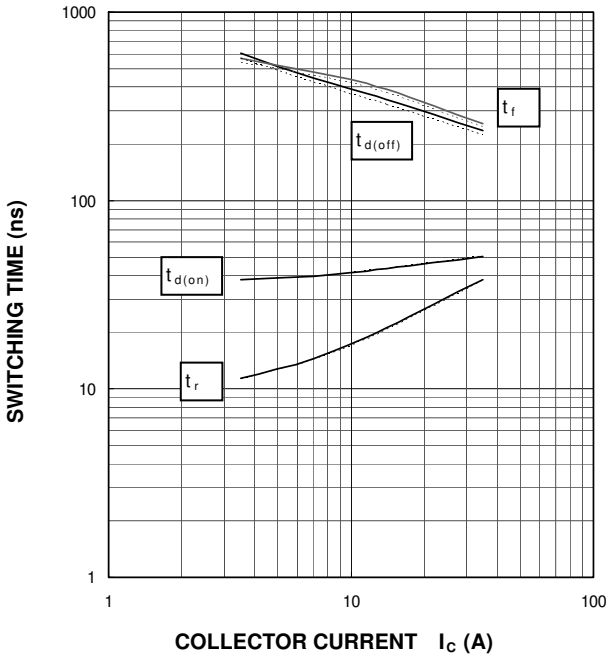


PERFORMANCE CURVES

INVERTER PART

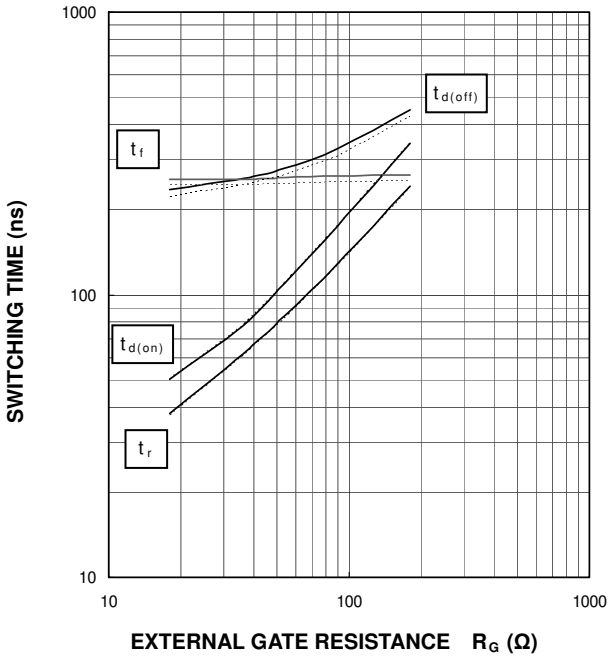
HALF-BRIDGE SWITCHING CHARACTERISTICS (TYPICAL)

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



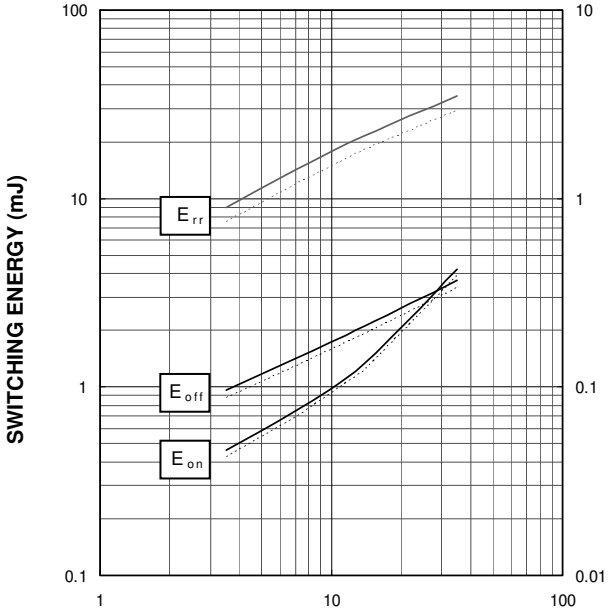
HALF-BRIDGE SWITCHING CHARACTERISTICS (TYPICAL)

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



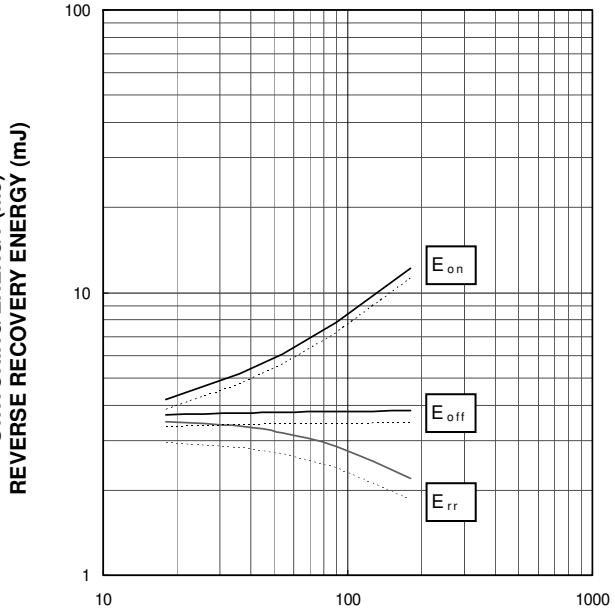
HALF-BRIDGE SWITCHING CHARACTERISTICS (TYPICAL)

V_{CC}=600 V, V_{GE}=±15 V, R_G=18 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=35 A,
INDUCTIVE LOAD, PER PULSE
———: T_j=150 °C, - - - - -: T_j=125 °C

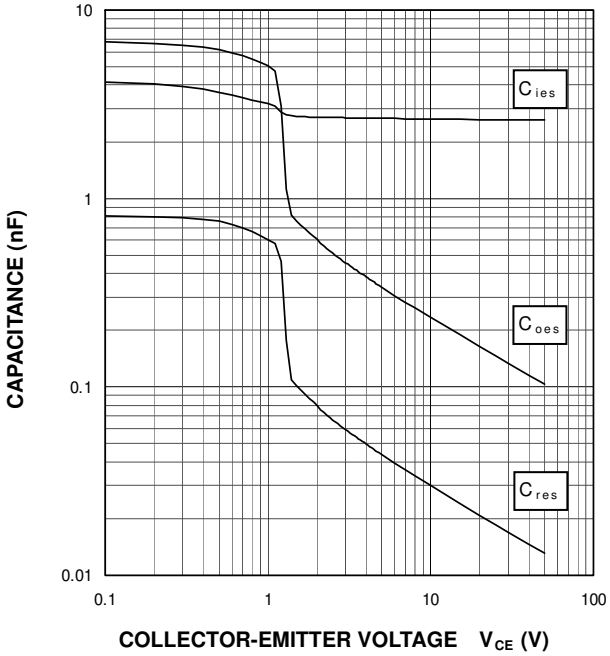


PERFORMANCE CURVES

INVERTER PART

CAPACITANCE CHARACTERISTICS (TYPICAL)

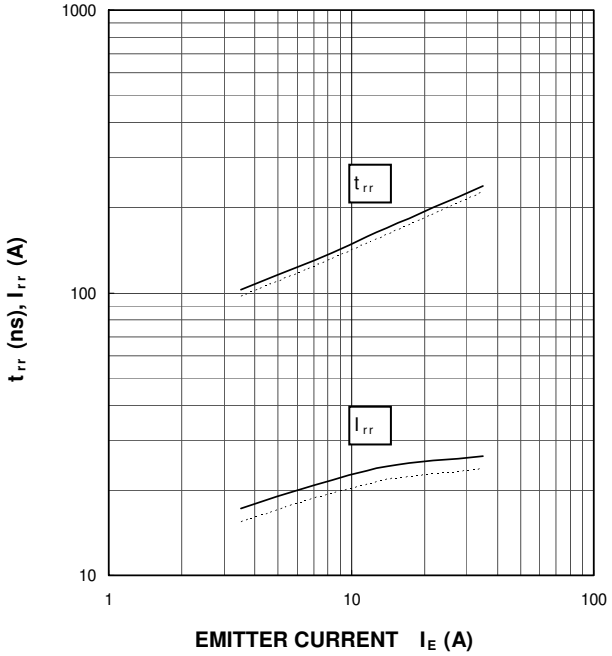
G-E short-circuited, T_j=25 °C



FREE WHEELING DIODE REVERSE RECOVERY CHARACTERISTICS (TYPICAL)

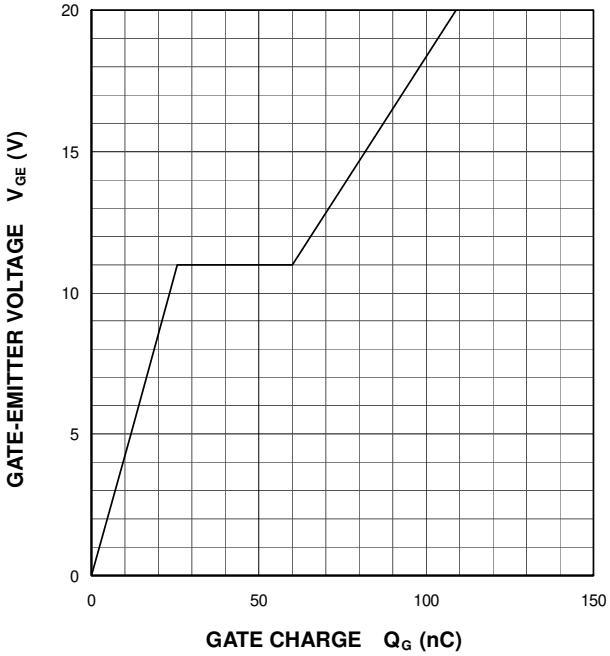
V_{CC}=600 V, V_{GE}=±15 V, R_G=18 Ω, INDUCTIVE LOAD

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



GATE CHARGE CHARACTERISTICS (TYPICAL)

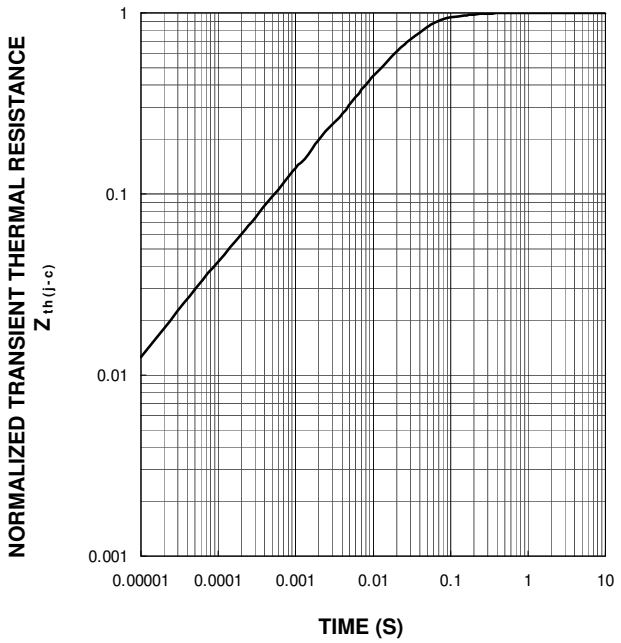
V_{CC}=600 V, I_C=35 A, T_j=25 °C



TRANSIENT THERMAL IMPEDANCE CHARACTERISTICS (MAXIMUM)

Single pulse, T_C=25 °C

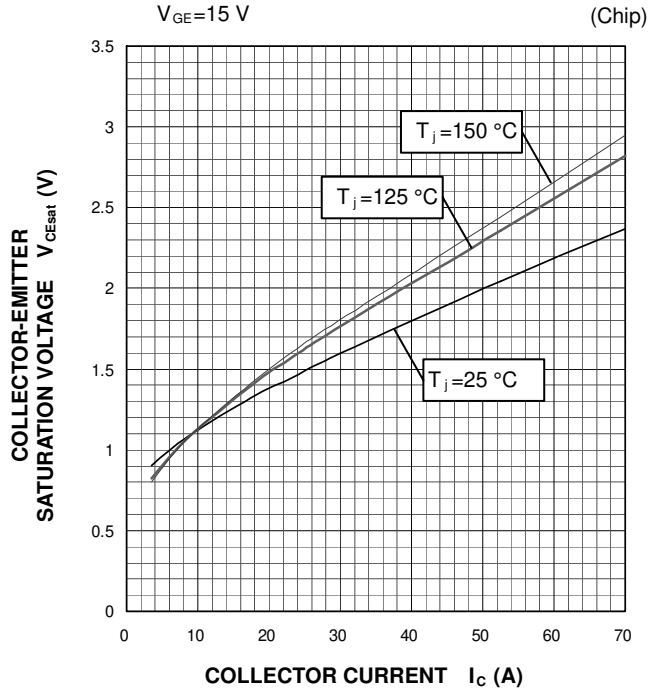
$R_{th(j-c)Q}$=0.42 K/W, $R_{th(j-c)D}$=0.69 K/W



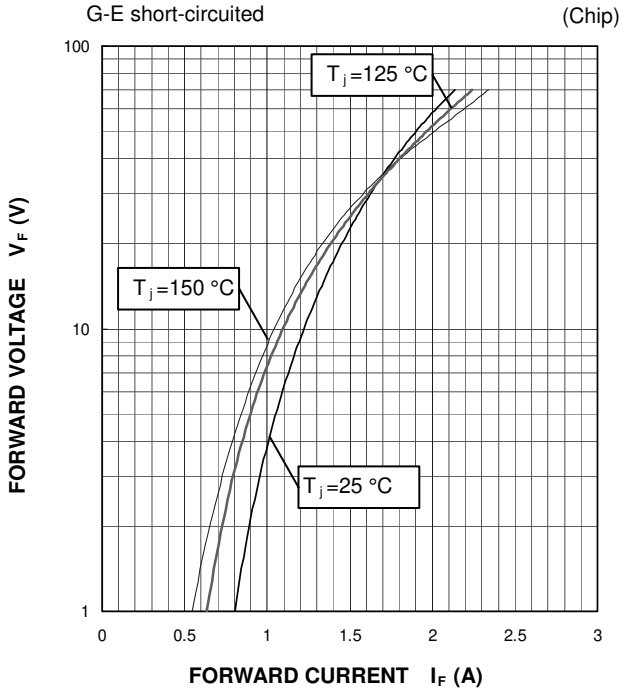
PERFORMANCE CURVES

BRAKE PART

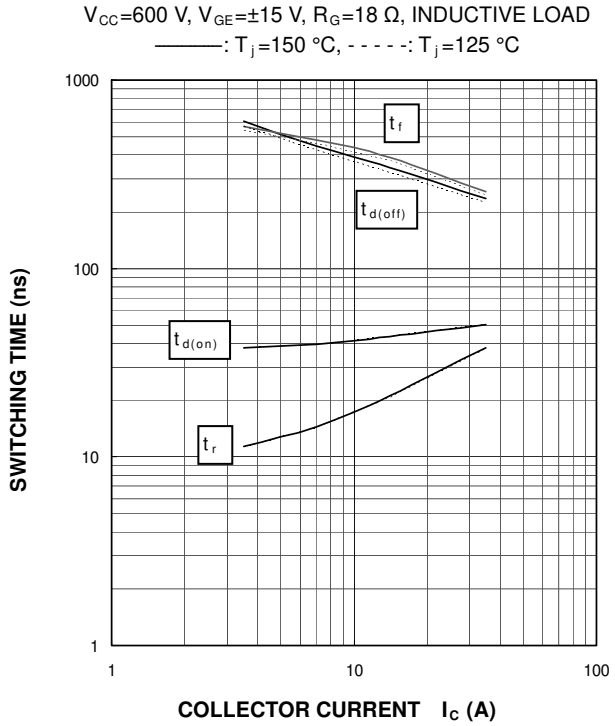
COLLECTOR-EMITTER SATURATION VOLTAGE CHARACTERISTICS (TYPICAL)



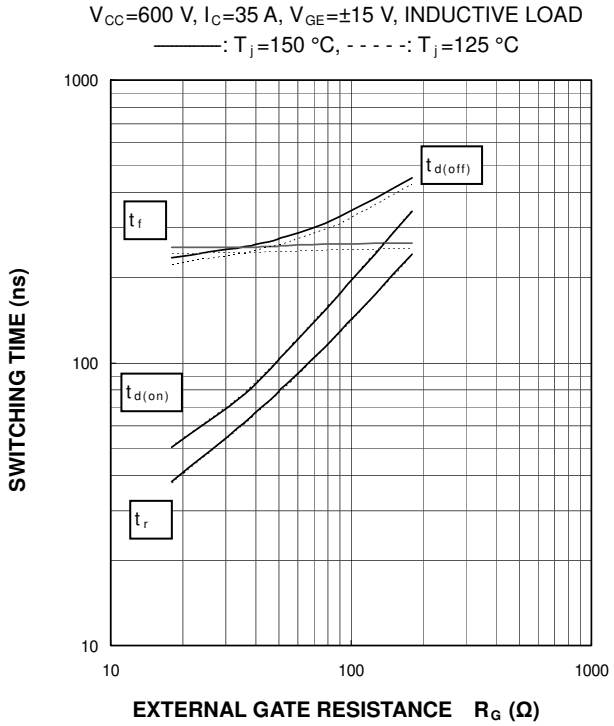
CLAMP DIODE FORWARD CHARACTERISTICS (TYPICAL)



HALF-BRIDGE SWITCHING CHARACTERISTICS (TYPICAL)



HALF-BRIDGE SWITCHING CHARACTERISTICS (TYPICAL)

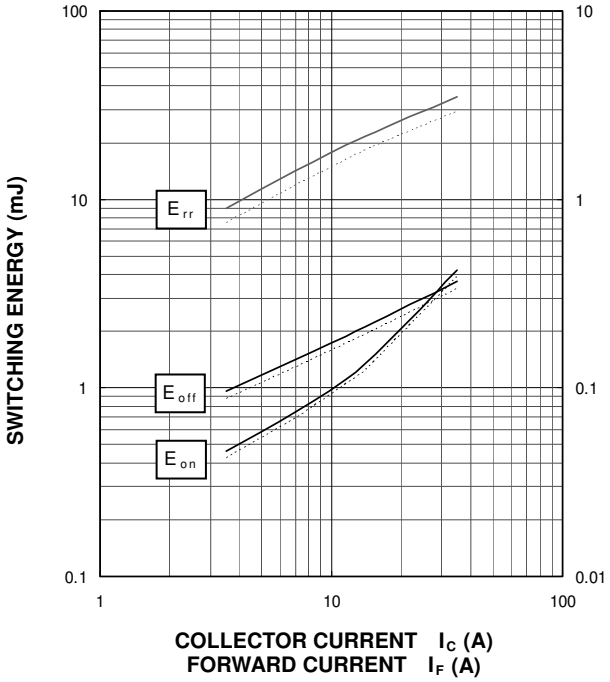


PERFORMANCE CURVES

BRAKE PART

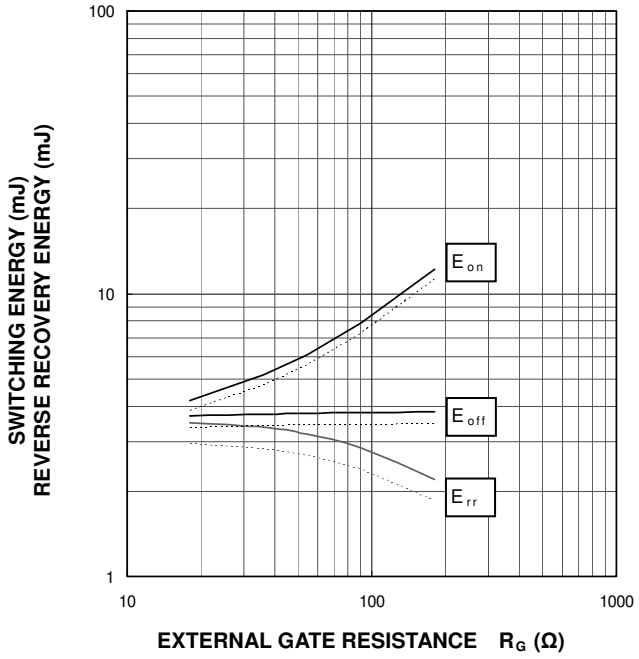
HALF-BRIDGE SWITCHING CHARACTERISTICS (TYPICAL)

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



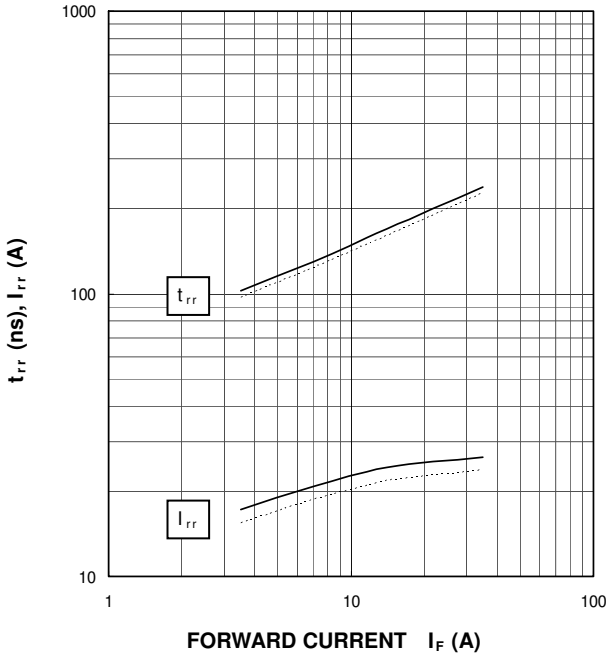
HALF-BRIDGE SWITCHING CHARACTERISTICS (TYPICAL)

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



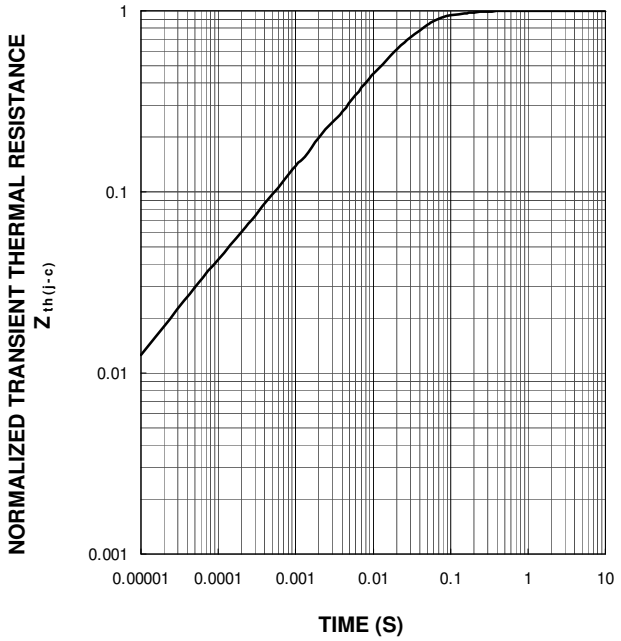
CLAMP DIODE REVERSE RECOVERY CHARACTERISTICS (TYPICAL)

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)

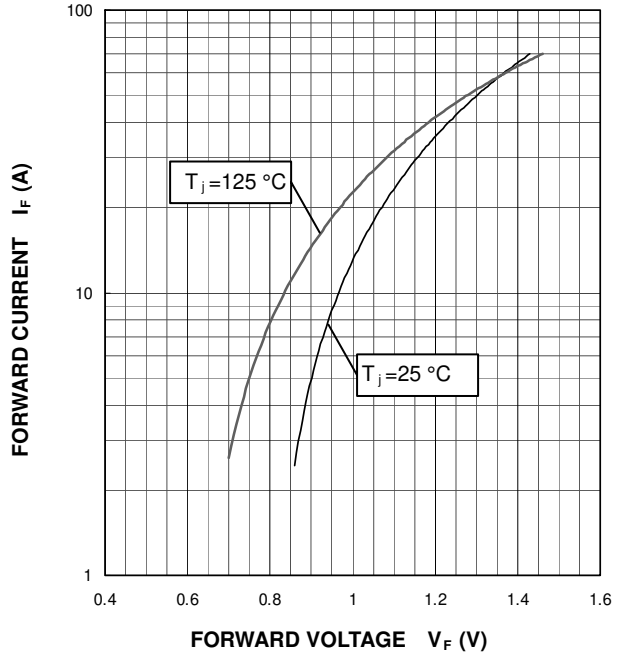
Single pulse, T_C=25 °C
$R_{th(j-c)Q}$=0.42 K/W, $R_{th(j-c)D}$=0.69 K/W



PERFORMANCE CURVES

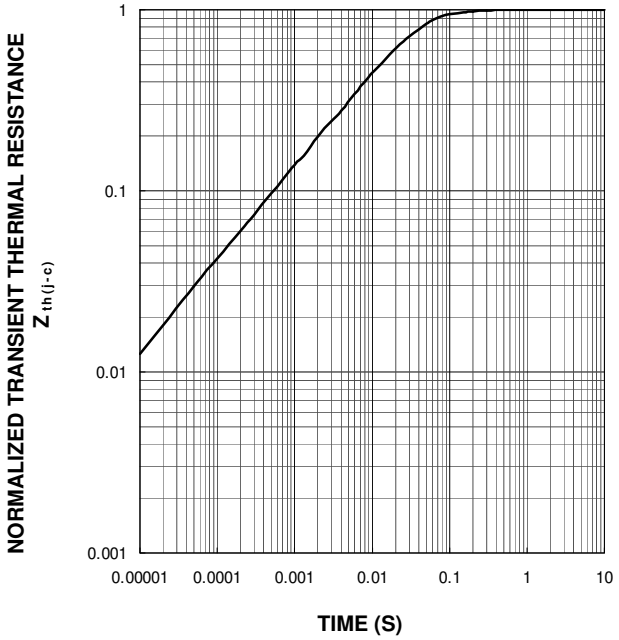
CONVERTER PART

CONVERTER DIODE FORWARD CHARACTERISTICS (TYPICAL)



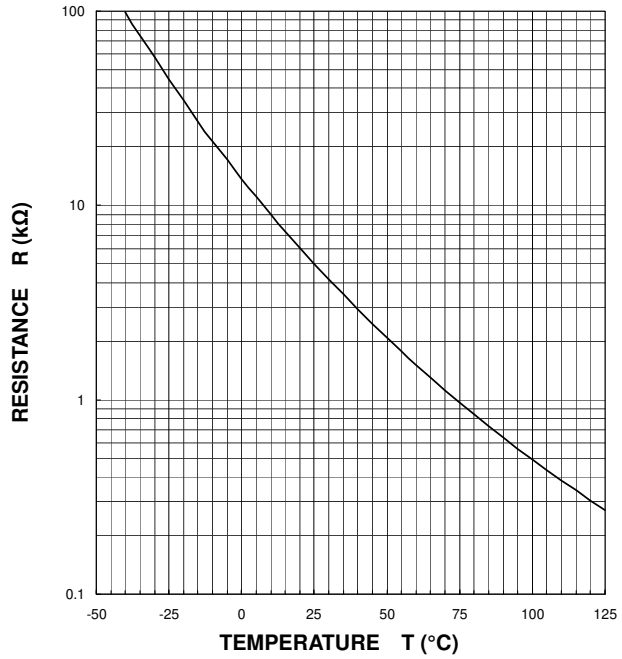
TRANSIENT THERMAL IMPEDANCE CHARACTERISTICS (MAXIMUM)

Single pulse, T_C=25 °C
$R_{th(j-c)D}$=0.45 K/W



NTC thermistor part

TEMPERATURE CHARACTERISTICS (TYPICAL)



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