

IGBT Modules

- Temperature protection provided by directly detecting the junction temperature of the IGBTs
- Low power loss and soft switching
- High performance and high reliability IGBT with overheating protection
- Higher reliability because of a big decrease in number of parts in built-in control circuit

Technical drawing showing the front and side views of the 'Indication on module'.

Front View (Top):

- Overall width: 64 ± 0.5
- Overall height: 70 ± 0.5
- Top section dimensions: 5.08 , 7.62 , 5.08 , 7.62 , 5.08 , 7.62 , $2.54 \times 5 = 12.7$
- Left side dimensions: 15 , 4.5 , 16.5
- Right side dimensions: 49.5 ± 0.5 , 47.3
- Internal dimensions: 50.8 ± 0.8 , 60 ± 0.3 , 28.8 , 28.8
- Mounting holes: $4-\phi 3$, $4-\phi 2$, $2-\phi 4.5 \pm 0.3$
- Radius: $R5$
- Section lines: A-B, P, U, V, W, N

Side View (Right):

- Overall width: 12 ± 0.5
- Overall height: 20.8
- Top section dimensions: 0.5 ± 0.1 , 0.5 ± 0.5 , 9.5
- Bottom section dimensions: 0.8 ± 0.1 , 5 ± 0.5
- Section lines: A, B

Bottom View:

- Overall width: 18 ± 0.5
- Overall height: 20.5
- Top section dimensions: 0.7 ± 0.1 , 4.1 , 12.3 , 13.8 , 13.8 , 20.5
- Section lines: A, B
- Label: Indication on module

FM6M1914c
2023/03

6MBP25XAA120-50

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Absolute maximum ratings

 $T_c=25^{\circ}\text{C}$, $T_{vj}=25^{\circ}\text{C}$, $V_{CC}=15\text{V}$ unless otherwise specified

Items		Symbol	Conditions	Min.	Max.	Units
Collector-Emitter voltage		V_{CES}	*1	-	1200	V
Short circuit voltage		V_{SC}	*2	400	800	V
Inverter	Collector current	I_C	DC	-	25	A
		I_{CP}	1ms	-	50	A
		$-I_C$	Duty=100% *3	-	25	A
	Total power dissipation	P_{tot}	IGBT 1 device *4	-	182	W
Brake	Collector current	I_C	DC	-	-	A
		I_{CP}	1ms	-	-	A
	Forward current of diode	I_F		-	-	A
	Total power dissipation	P_{tot}	IGBT 1 device *4	-	-	W
Supply voltage of pre-driver		V_{CC}	*5	-0.5	20	V
Input signal voltage		V_{in}	*6	-0.5	$V_{CC}+0.5$	V
Alarm signal voltage		V_{ALM}	*7	-0.5	V_{CC}	V
Alarm signal current		I_{ALM}	*8	-	20	mA
Virtual junction temperature		T_{vj}		-	175	$^{\circ}\text{C}$
Operating virtual junction temperature		T_{vjop}		-	150	$^{\circ}\text{C}$
Operating case temperature		T_c		-20	125	$^{\circ}\text{C}$
Storage temperature		T_{stg}		-40	125	$^{\circ}\text{C}$
Solder temperature		T_{sol}	*9	-	260	$^{\circ}\text{C}$
Isolating voltage		V_{isol}	*10	-	2500	Vrms
Mounting torque of screws to heat sink		M_s	Mounting(M4)	1.3	1.7	Nm
Mounting torque of screws to terminals		M_t	Main terminals(M4)	-	-	Nm

Notes

- *1: V_{CES} shall be applied to the input voltage between terminal P-(U,V, W) and (U,V, W)-N.
 *2: In the case of the load inductance to be over 1 μH .
 *3: Duty=150 $^{\circ}\text{C}/R_{th(i-c)D}/(I_F \times V_F \text{ Max.}) \times 100$
 *4: $P_{tot}=150^{\circ}\text{C}/R_{th(i-c)Q}$
 *5: V_{CC} shall be applied to the input voltage between terminal No.3 and 1, 6 and 4, 9 and 7, 11 and 10.
 *6: V_{in} shall be applied to the input voltage between terminal No.2 and 1, 5 and 4, 8 and 7, 12~14 and 10.
 *7: V_{ALM} shall be applied to the voltage between terminal No.15 and 10.
 *8: I_{ALM} shall be applied to the input current to terminal No.15.
 *9: Immersion time 10 $\pm$ 1sec. 1 time.
 *10: Terminal to base, 50/60Hz sine wave 1 min. All terminals should be connected together during the test.

Electrical characteristics

Main circuit

 $T_{vj}=25^{\circ}\text{C}$, $V_{CC}=15\text{V}$ unless otherwise specified

Item		Symbol	Conditions	Min.	Typ.	Max.	Units
Inverter	Collector current at off signal input	I_{CES}	$V_{CE} = 1200\text{V}$	-	-	1.0	mA
	Collector-Emitter saturation voltage	$V_{CE(sat)}$	$I_C = 25\text{A}$ Terminal	-	-	1.80	V
			Chip	-	1.45	-	V
	Forward voltage of FWD	V_F	$I_F = 25\text{A}$ Terminal	-	-	2.30	V
			Chip	-	1.90	-	V
Brake	Collector current at off signal input	I_{CES}	$V_{CE} = -V$	-	-	-	mA
	Collector-Emitter saturation voltage	$V_{CE(sat)}$	$I_C = -A$ Terminal	-	-	-	V
			Chip	-	-	-	V
	Forward voltage of FWD	V_F	$I_F = -A$ Terminal	-	-	-	V
			Chip	-	-	-	V
Switching time *11	t_{on}	t_{on}	$I_C = 25\text{A}$ $T_{vj} = 150^{\circ}\text{C}$	0.5	-	-	μs
		$t_{d(on)}$	$V_{DC} = 600\text{V}$	0.5	-	-	μs
		t_{off}		-	-	2.0	μs
		$t_{d(off)}$		-	-	1.7	μs
	t_{rr}	t_{rr}	$I_F = 25\text{A}$ $T_{vj} = 150^{\circ}\text{C}$ $V_{DC} = 600\text{V}$	-	-	0.5	μs

*11: Turn on time (t_{on}) = $t_{d(on)} + t_r$, Turn off time (t_{off}) = $t_{d(off)} + t_f$

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● Control circuit

 $T_{vj}=25^{\circ}\text{C}$, $V_{CC}=15\text{V}$ unless otherwise specified

Item	Symbol	Conditions		Min.	Typ.	Max.	Units
Supply current of P-side pre-driver (per one unit)	I_{ccp}	Switching frequency (f_{sw}) = 0~15kHz T_C = -20~125°C		-	-	9	mA
Supply current of N-side pre-driver	I_{ccn}			-	-	22	mA
Input sinal threshold voltage	$V_{in th(on)}$	V_{in} -GND	ON	1.2	1.4	1.6	V
	$V_{in th(off)}$		OFF	1.5	1.7	1.9	V

● Protection circuit

 $T_{vj}=25^{\circ}\text{C}$, $V_{CC}=15\text{V}$ unless otherwise specified

Item	Symbol	Conditions	Min.	Typ.	Max.	Units
Over current protection level	I_{OC}	$T_{vj}=150^{\circ}\text{C}$	38	-	-	A
			-	-	-	A
Over current protection delay time	t_{dOC}	$T_{vj}=150^{\circ}\text{C}$	-	4.0	-	μs
Short circuit protection delay time	t_{dSC}	$T_{vj}=150^{\circ}\text{C}$	-	1.0	-	μs
IGBT chips over heating protection temperature level	T_{jOH}	Surface of IGBT chips	175	-	-	$^{\circ}\text{C}$
Over heating protection hysteresis	T_{jH}		-	20	-	$^{\circ}\text{C}$
Under voltage protection level	V_{UV}		11.0	-	12.5	V
Under voltage protection hysteresis	V_H		0.2	0.5	-	V
Alarm signal hold time	$t_{ALM(OC)}$	ALM-GND	1.0	2.0	2.4	ms
	$t_{ALM(UV)}$	$T_C=-20 \sim 125^{\circ}\text{C}$ $V_{CC} \geq 10\text{V}$	3.5	4.0	4.5	ms
	$t_{ALM(TjOH)}$		7.0	8.0	9.0	ms
Alarm signal voltage	V_{ALMH}	ALM-GND, without protection	14.5	-	15.0	V
Resistance for current limit	R_{ALM}		960	-	1570	Ω

■ Thermal resistance characteristics ($T_C = 25^{\circ}\text{C}$)

Item			Symbol	Min.	Typ.	Max.	Units
Thermal resistance junction to case *12	Inverter	IGBT	$R_{th(j-c)Q}$	-	-	0.82	K/W
		FWD	$R_{th(j-c)D}$			1.18	K/W
	Brake	IGBT	$R_{th(j-c)Q}$	-	-	-	K/W
		FWD	$R_{th(j-c)D}$	-	-	-	K/W
Thermal resistance case to heat sink *13			$R_{th(c-s)}$	-	0.05	-	K/W

*12: For 1 device, the measurement point of the case is just under the chip.

*13: This is the value which is defined mounting on the additional heat sink with 1 W/(m·K) thermal grease.

■ Noise immunity ($V_{DC}=600\text{V}$, $V_{CC}=15\text{V}$)

Item	Conditions	Min.	Typ.	Max.	Units
Common mode rectangular noise	Pulse width 1 μs , polarity $\pm$, 10min. Judge: no over-current, no miss operating	± 2.0	-	-	kV

■ Recommended operating conditions

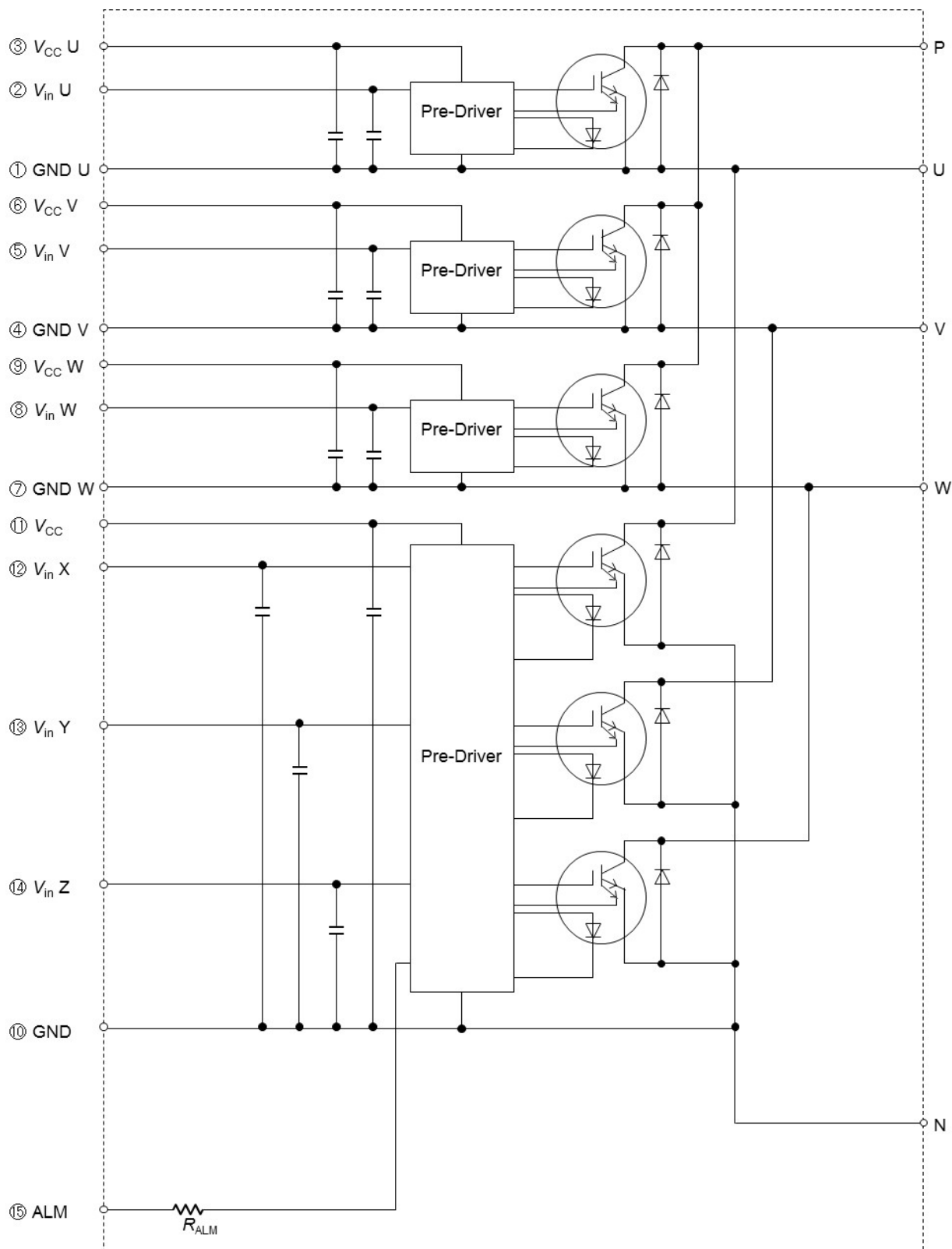
Item	Symbol	Min.	Typ.	Max.	Units
DC bus voltage	V_{DC}	-	-	800	V
Power supply voltage of pre-driver	V_{CC}	13.5	15.0	16.5	V
Switching frequency of IPM	f_{SW}	-	-	20.0	kHz
Arm short through blocking time for IPM's input signal *14	t_{dead}	1.5	-	-	μs
Screw torque (M4)	-	1.3	-	1.7	Nm

*14: $t_{dead} = t_{off} - t_{d(on)}$

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■ Block diagram



Pre-drivers include following functions

1. Amplifier for driver
2. Short circuit protection
3. Under voltage lockout circuit
4. Over current protection
5. IGBT chip over heating protection

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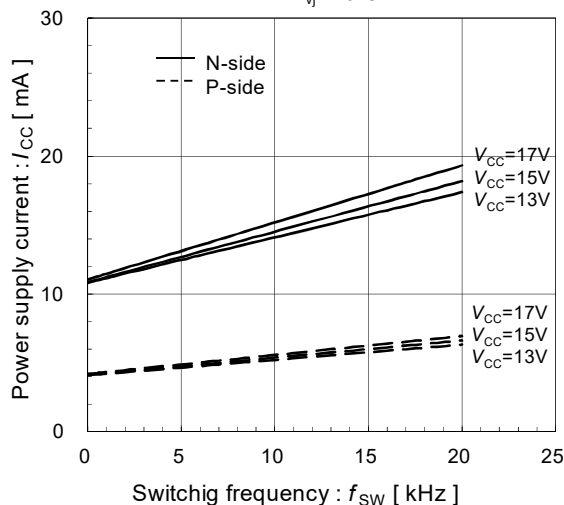
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■ Characteristics (representative)

● Control circuit

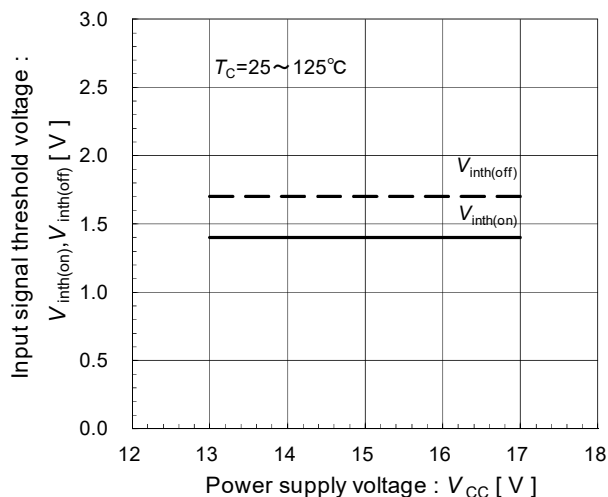
Power supply current vs. Switching frequency (typ.)

$T_{vj} = 25^{\circ}\text{C}$

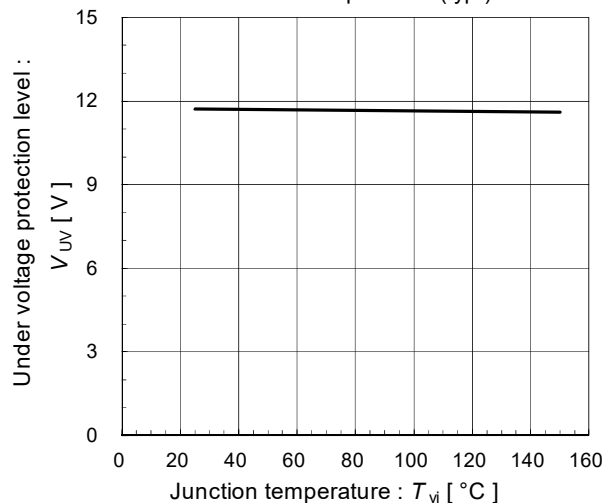


Input signal threshold voltage vs. Power supply voltage (typ.)

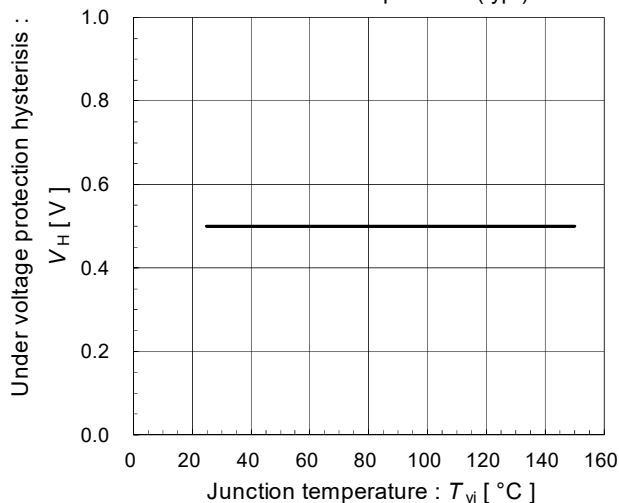
$T_C = 25 \sim 125^{\circ}\text{C}$



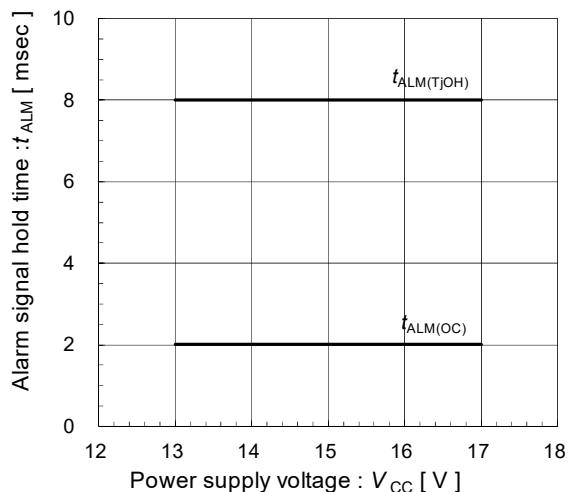
Under voltage protection level vs. Junction temperature (typ.)



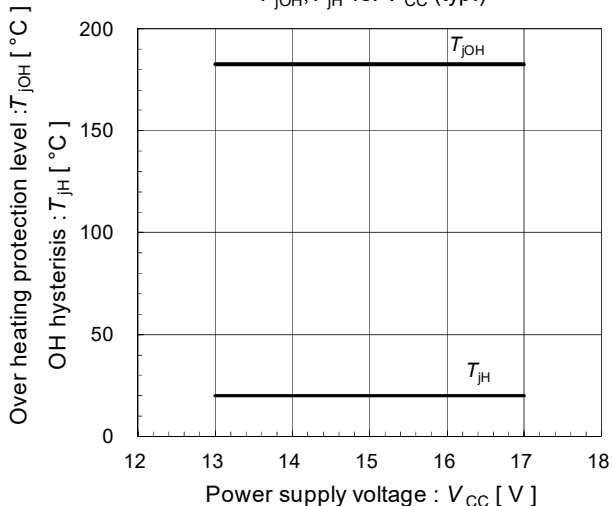
Under voltage protection hysteresis vs. Junction temperature (typ.)



Alarm signal hold time vs. Power supply voltage (typ.)



Over heating characteristics T_{JOH}, T_{JH} vs. V_{CC} (typ.)

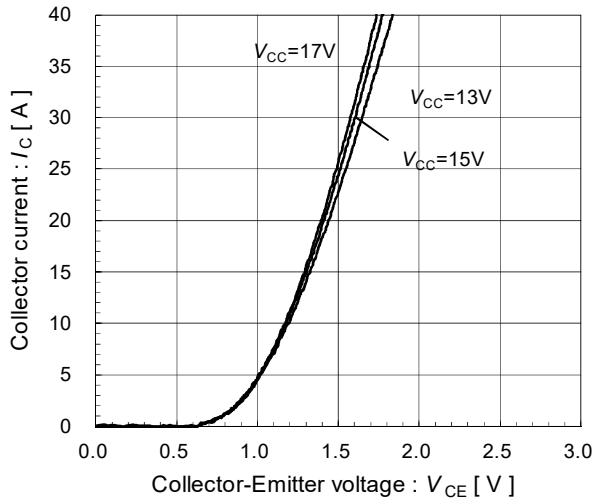


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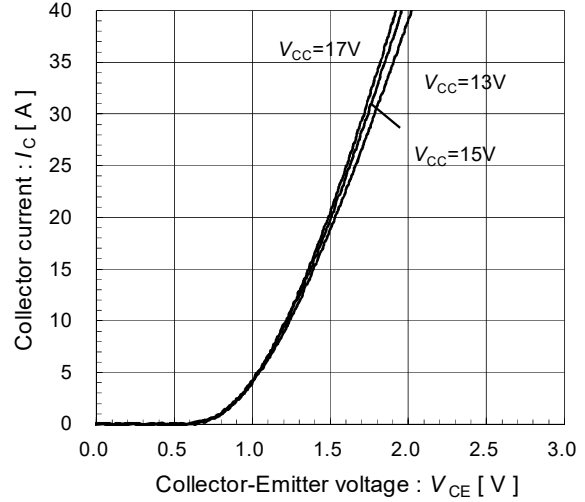
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● Inverter

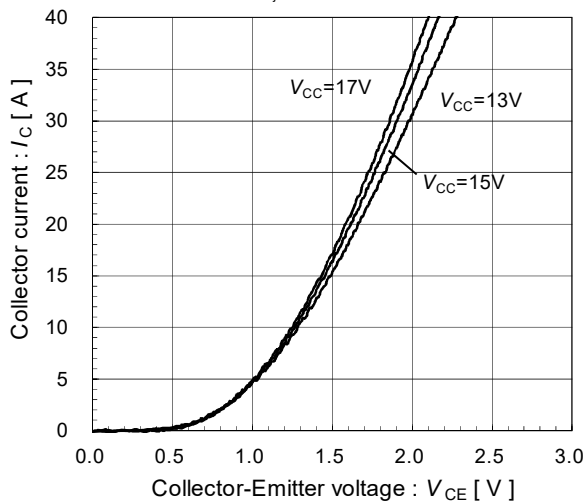
Collector current vs. Collector-Emitter voltage (typ.)
 $T_{vj}=25^{\circ}\text{C}$ [Chip]



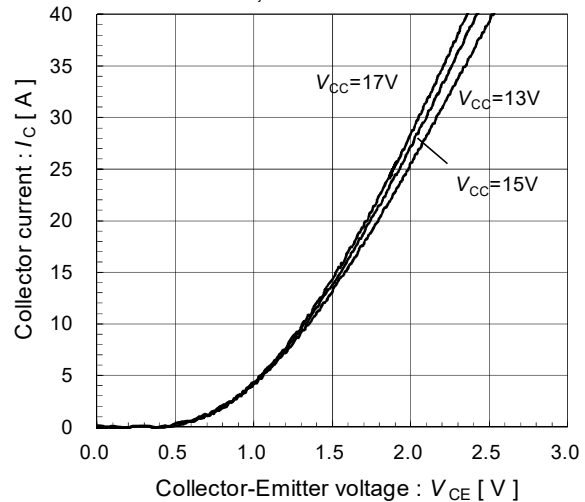
Collector current vs. Collector-Emitter voltage (typ.)
 $T_{vj}=25^{\circ}\text{C}$ [Terminal]



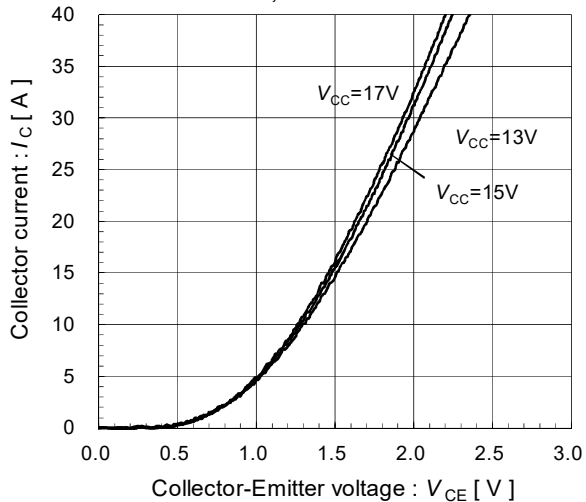
Collector current vs. Collector-Emitter voltage (typ.)
 $T_{vj}=125^{\circ}\text{C}$ [Chip]



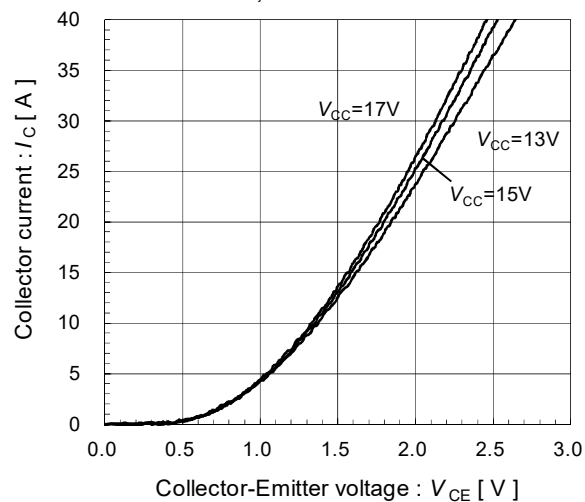
Collector current vs. Collector-Emitter voltage (typ.)
 $T_{vj}=125^{\circ}\text{C}$ [Terminal]



Collector current vs. Collector-Emitter voltage (typ.)
 $T_{vj}=150^{\circ}\text{C}$ [Chip]



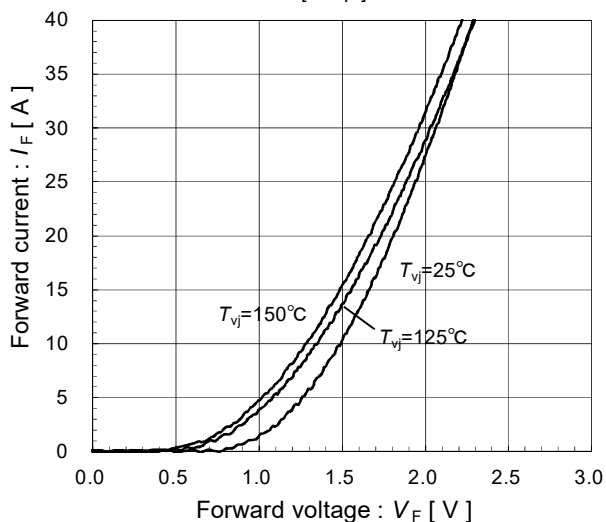
Collector current vs. Collector-Emitter voltage (typ.)
 $T_{vj}=150^{\circ}\text{C}$ [Terminal]



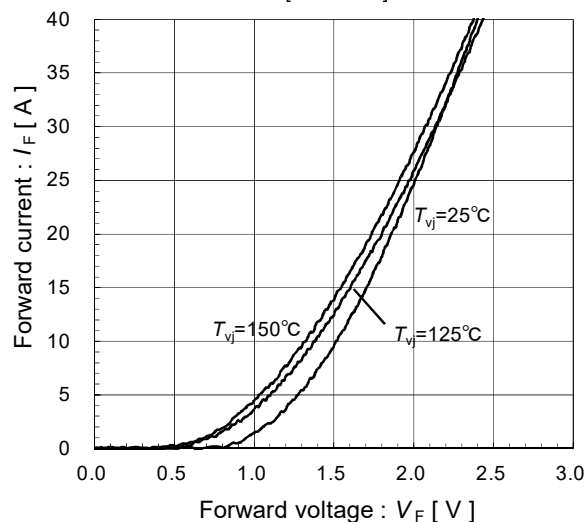
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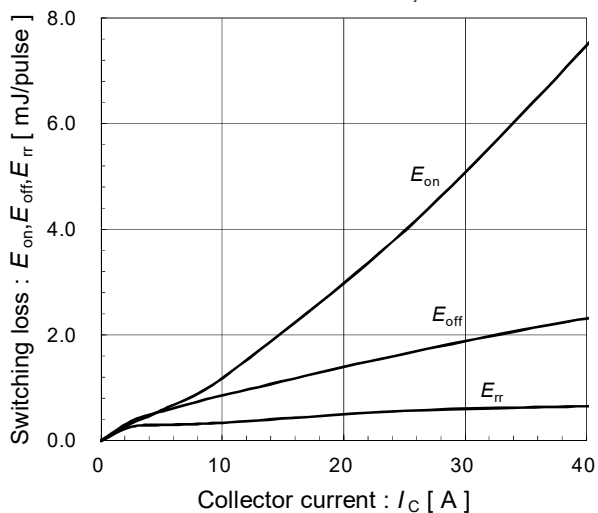
Forward current vs. Forward voltage (typ.)
[Chip]



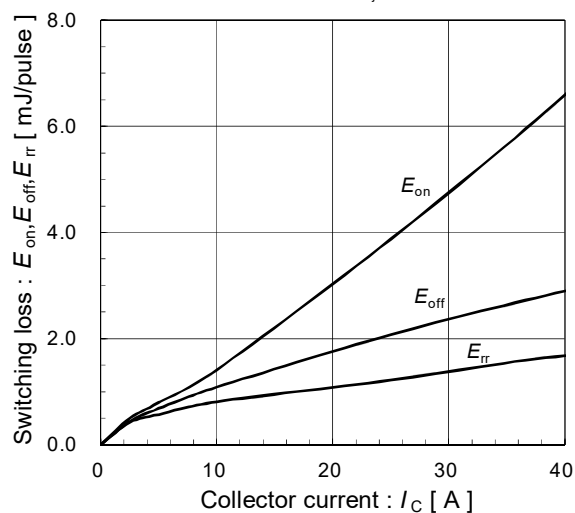
Forward current vs. Forward voltage (typ.)
[Terminal]



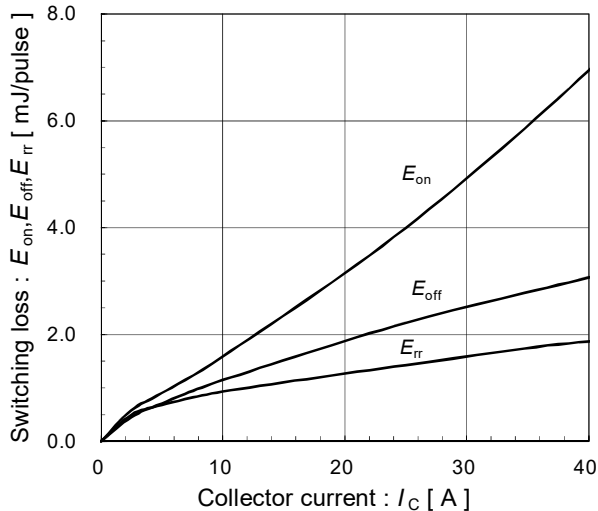
Switching loss vs. Collector current (typ.)
 $V_{DC}=600\text{V}, V_{CC}=15\text{V}, T_{vj}=25^\circ\text{C}$



Switching loss vs. Collector current (typ.)
 $V_{DC}=600\text{V}, V_{CC}=15\text{V}, T_{vj}=125^\circ\text{C}$



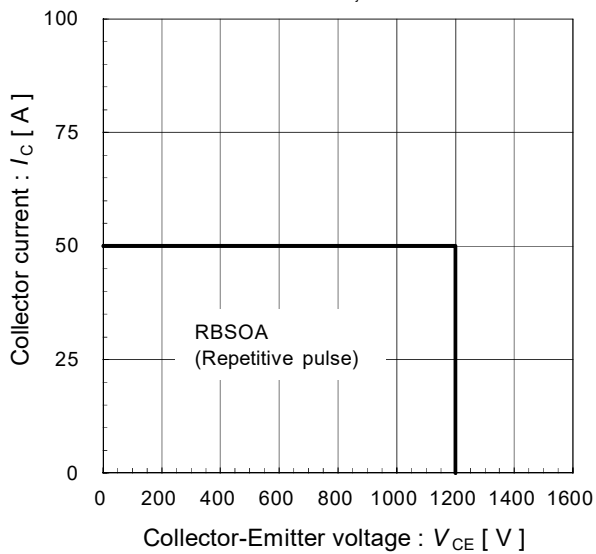
Switching loss vs. Collector current (typ.)
 $V_{DC}=600\text{V}, V_{CC}=15\text{V}, T_{vj}=150^\circ\text{C}$



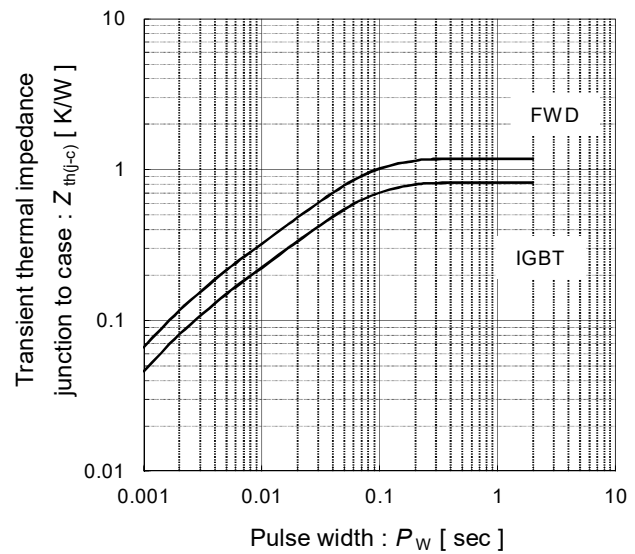
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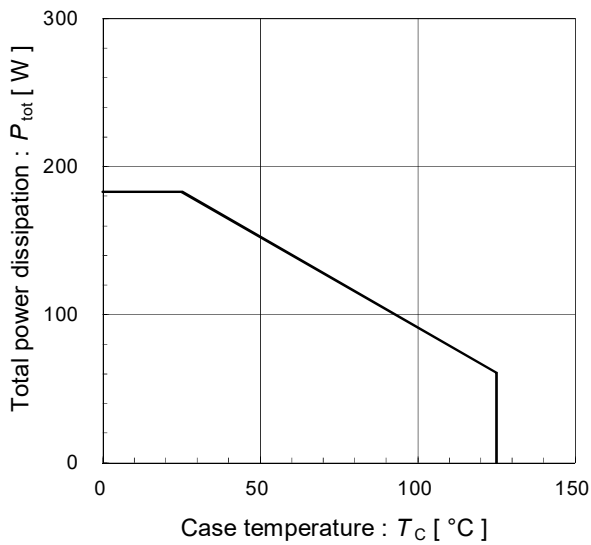
Reversed biased safe operating area (max.)
 $V_{CC}=15V, T_{vj}=150^{\circ}C$



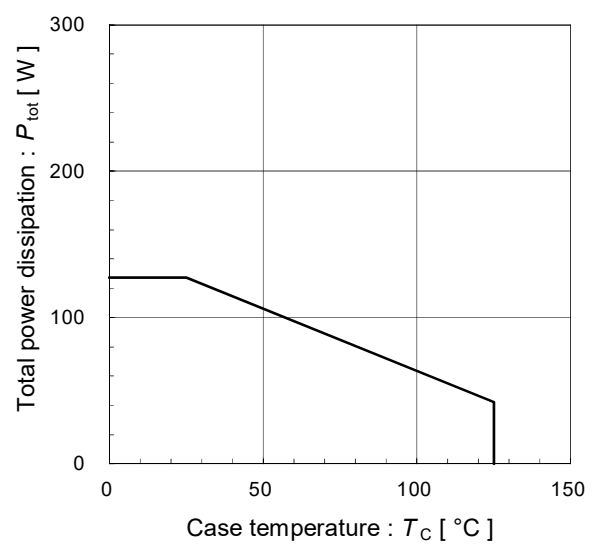
Transient thermal resistance (max.)



Power derating for IGBT (max.)
 [per device]



Power derating for FWD (max.)
 [per device]

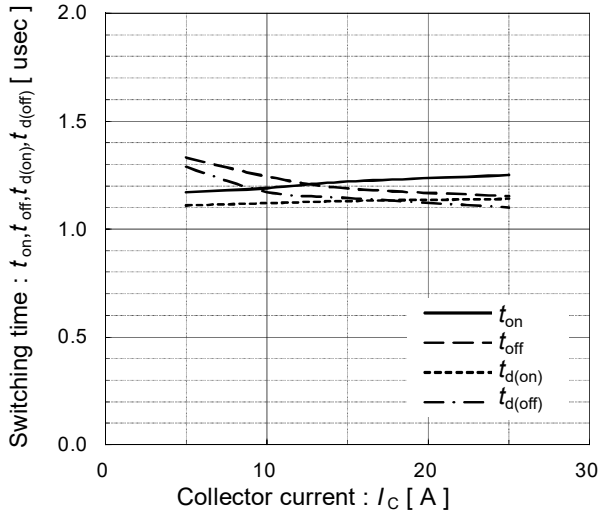


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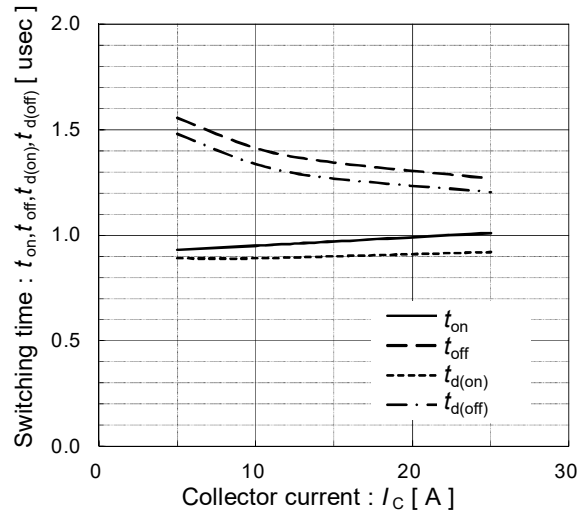
Switching time vs. Collector current (typ.)

$V_{DC}=600V, V_{CC}=15V, T_{vj}=25^{\circ}C$



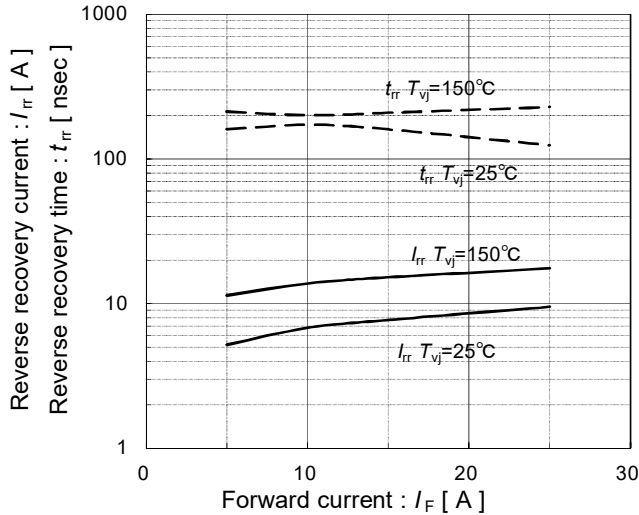
Switching time vs. Collector current (typ.)

$V_{DC}=600V, V_{CC}=15V, T_{vj}=150^{\circ}C$



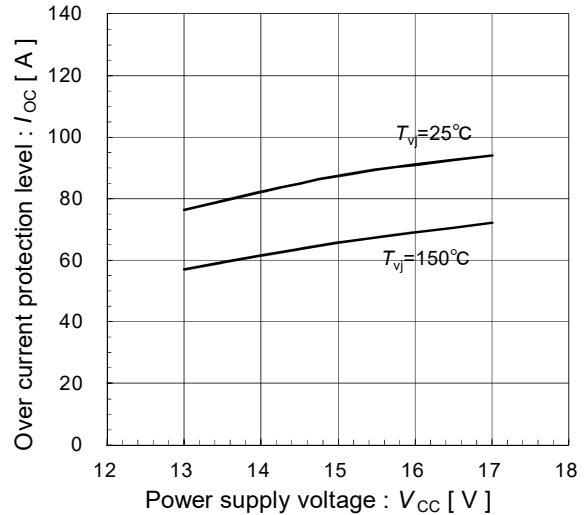
Reverse recovery characteristics (typ.)

$V_{DC}=600V, V_{CC}=15V$



Over current protection vs. Power supply voltage (typ.)

$V_{DC}=600V$



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