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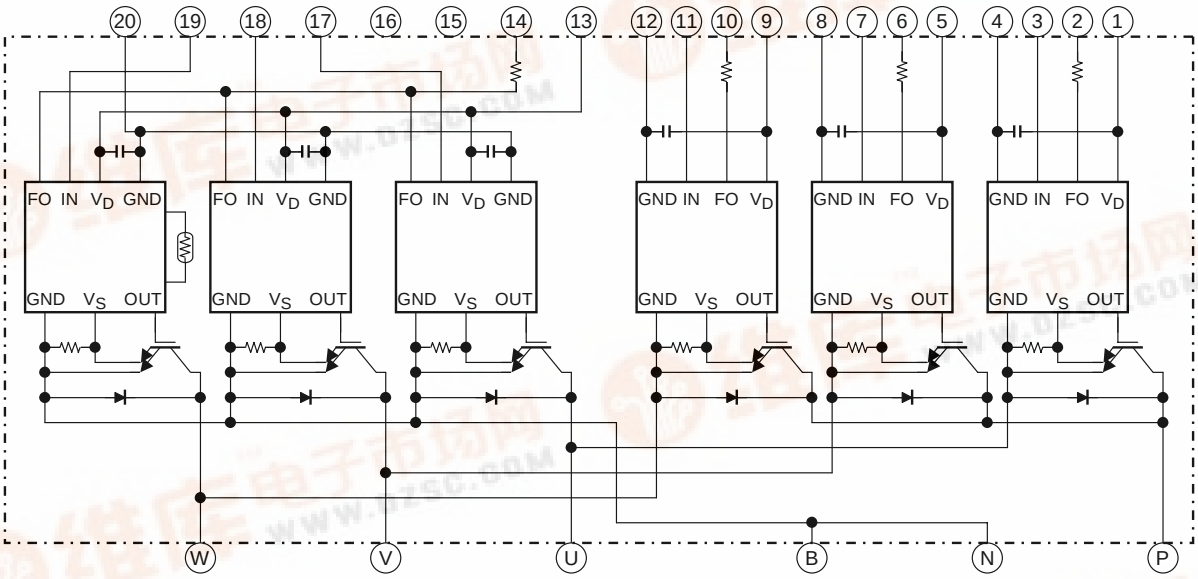
MITSUBISHI SEMICONDUCTOR <Intelligent Power Module>

MIG50J6CSB1W (600V/50A 6in1)

High Power Switching Applications
Motor Control Applications

- Integrates inverter, circuit and control circuits (IGBT drive units, and units for protection against short-circuit current, overcurrent, undervoltage and overtemperature) into a single package.
- The electrodes are isolated from the case
- Low thermal resistance
- $V_{CE\ (sat)}$ = 1.8 V (typ.)
- UL recognized: File No. E87989

Equivalent Circuit



1.	V_D (U)	2.	FO (U)	3.	IN (U)	4.	GND (U)	5.	V_D (V)	6.	FO (V)	7.	IN (V)
8.	GND (V)	9.	V_D (W)	10.	FO (W)	11.	IN (W)	12.	GND (W)	13.	V_D (L)	14.	FO (L)
15.	Open	16.	Open	17.	IN (X)	18.	IN (Y)	19.	IN (Z)	20.	GND (L)		

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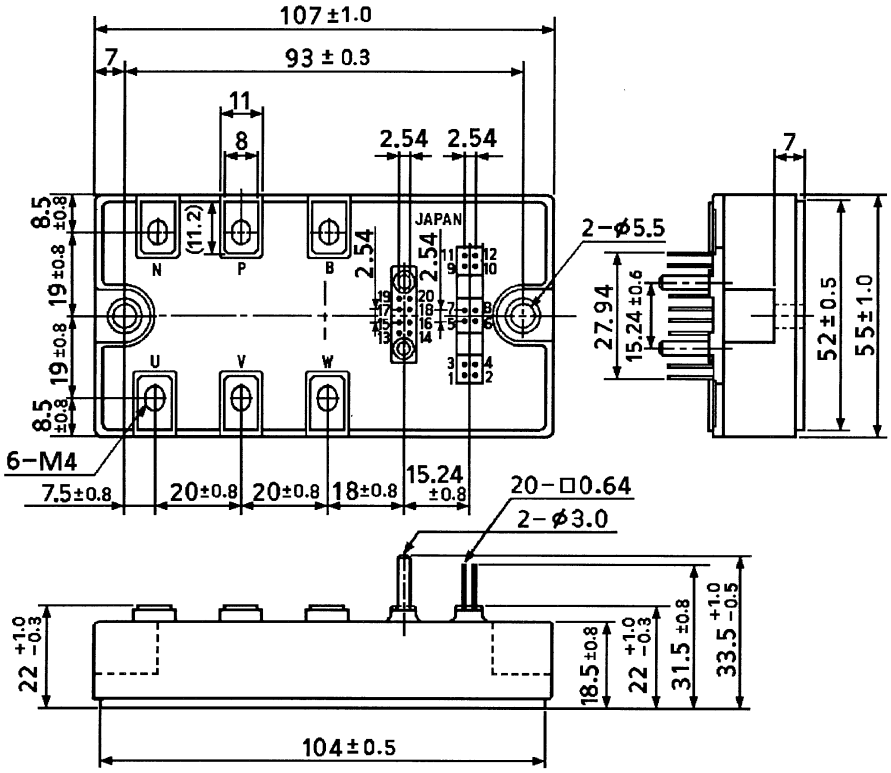
Package Dimensions

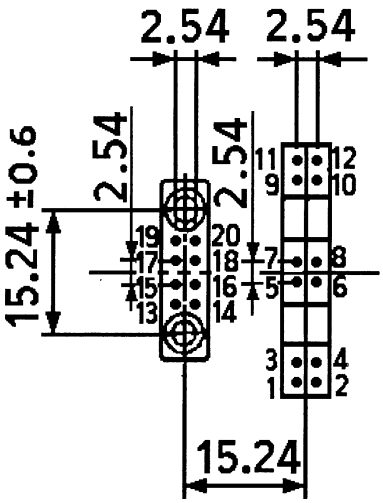
Unit: mm



1.	V_D (U)	2.	FO (U)	3.	IN (U)	4.	GND (U)	5.	V_D (V)	6.	FO (V)
7.	IN (V)	8.	GND (V)	9.	V_D (W)	10.	FO (W)	11.	IN (W)	12.	GND (W)
13.	V_D (L)	14.	FO (L)	15.	Open	16.	Open	17.	IN (X)	18.	IN (Y)
19.	IN (Z)	20.	GND (L)								

Signal Terminal Layout

Unit: mm



1.	V_D (U)	2.	FO (U)	3.	IN (U)	4.	GND (U)	5.	V_D (V)	6.	FO (V)
7.	IN (V)	8.	GND (V)	9.	V_D (W)	10.	FO (W)	11.	IN (W)	12.	GND (W)
13.	V_D (L)	14.	FO (L)	15.	Open	16.	Open	17.	IN (X)	18.	IN (Y)
19.	IN (Z)	20.	GND (L)								

Maximum Ratings (T_j = 25°C)

Stage	Characteristic	Condition	Symbol	Rating	Unit
Inverter	Supply voltage	P-N Power terminal	V_{CC}	450	V
	Collector-emitter voltage	—	V_{CES}	600	V
	Collector current	Tc = 25°C, DC	I_C	50	A
	Forward current	Tc = 25°C, DC	I_F	50	A
	Collector power dissipation	Tc = 25°C, DC	P_C	340	W
	Junction temperature	—	T_j	150	°C
Control	Control supply voltage	V_D-GND Terminal	V_D	20	V
	Input voltage	IN-GND Terminal	V_{IN}	20	V
	Fault output voltage	FO-GND Terminal	V_{FO}	20	V
	Fault output current	FO sink current	I_{FO}	14	mA
Module	Operating temperature	—	Tc	−20~ + 100	°C
	Storage temperature range	—	T_{stg}	−40~ + 125	°C
	Isolation voltage	AC 1 min	V_{ISO}	2500	V
	Screw torque (Terminal)	M4	—	2	N·m
	Screw torque (Mounting)	M5	—	3	

Electrical Characteristics

1. Inverter stage

Characteristics	Symbol	Test Condition		Min	Typ.	Max	Unit
Collector cut-off current	I_{CEX}	V_{CE} = 600 V	T_j = 25°C	—	—	1	mA
			T_j = 125°C	—	—	10	
Collector-emitter saturation voltage	$V_{CE\ (sat)}$	V_D = 15 V I_C = 50 A V_{IN} = 15 V → 0 V	T_j = 25°C	1.5	1.8	2.2	V
			T_j = 125°C	—	2.0	—	
Forward voltage	V_F	I_F = 50 A, T_j = 25°C		—	2.0	2.5	V
Switching time	t_{on}	V_{CC} = 300 V, I_C = 50 A V_D = 15 V, V_{IN} = 15 V ↔ 0 V T_j = 25°C, Inductive load (Note 1)		—	1.3	2.2	μs
	$t_{c\ (on)}$			—	0.25	—	
	t_{rr}			—	0.2	—	
	t_{off}			—	1.1	2.1	
	$t_{c\ (off)}$			—	0.2	—	

Note 1: Switching time test circuit and timing chart

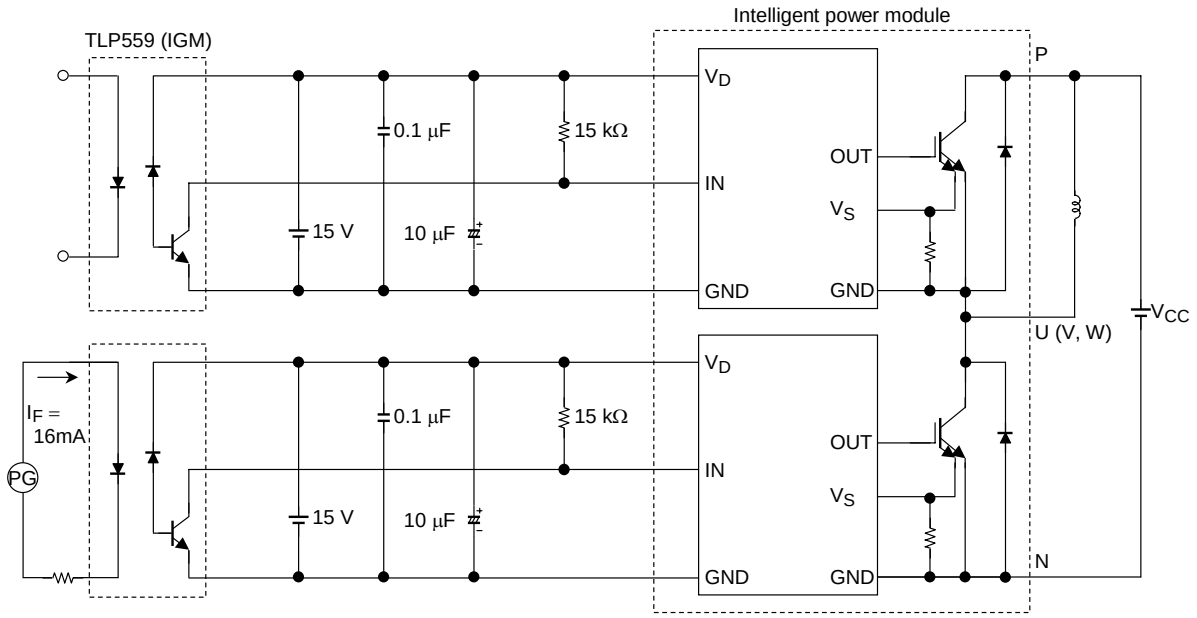
2. Control stage (T_j = 25°C)

Characteristics		Symbol	Test Condition	Min	Typ.	Max	Unit
Control circuit current	High side	$I_{D\ (H)}$	V_D = 15 V	—	13	17	mA
	Low side	$I_{D\ (L)}$		—	39	51	
Input on signal voltage		$V_{IN\ (on)}$	V_D = 15 V	1.4	1.6	1.8	V
Input off signal voltage		$V_{IN\ (off)}$		2.2	2.5	2.8	
Fault output current	Protection	$I_{FO\ (on)}$	V_D = 15 V	—	10	12	mA
	Normal	$I_{FO\ (off)}$		—	—	0.1	
Over current protection trip level	Inverter	OC	V_D = 15 V, $T_j \leqq$ 125°C	80	—	—	A
Short circuit protection trip level	Inverter	SC	V_D = 15 V, $T_j \leqq$ 125°C	80	—	—	A
Over cuttent cut-off time		$t_{off\ (OC)}$	V_D = 15 V	—	5	—	μs
Over temperature protection	Trip level	OT	Case temperature	110	118	125	°C
	Reset level	OTr		—	98	—	
Control supply under voltage protection	Trip level	UV	—	11.0	12.0	12.5	V
	Reset level	UVr		12.0	12.5	13.0	
Fault output pulse width		t_{FO}	V_D = 15 V	1	2	3	ms

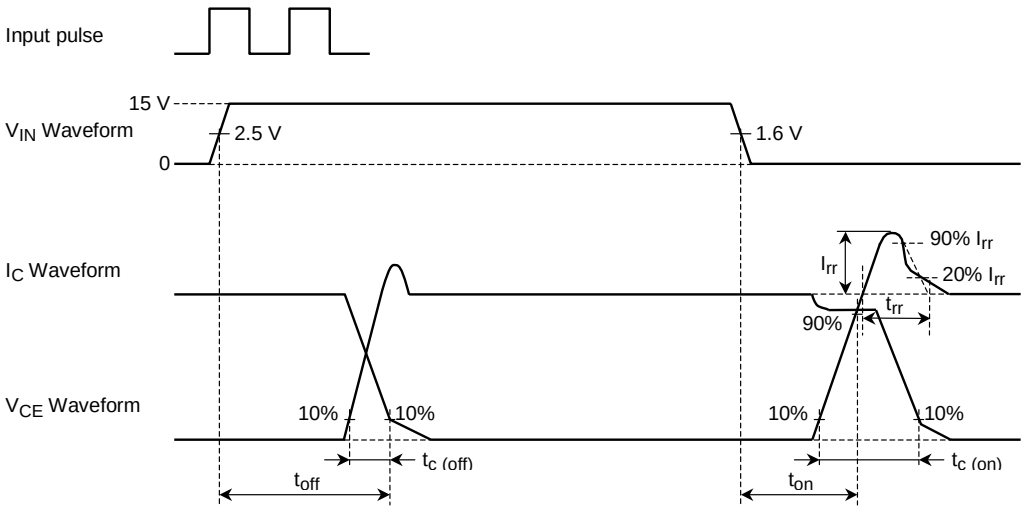
3. Thermal resistance (Tc= 25°C)

Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
Junction to case thermal resistance	$R_{th\ (j\text{-}c)}$	IGBT	—	—	0.360	°C/W
		FRD	—	—	0.550	
Case to fin thermal resistance	$R_{th\ (c\text{-}f)}$	Compound is applied	—	0.017	—	°C/W

Switching Time Test Circuit



Timing Chart

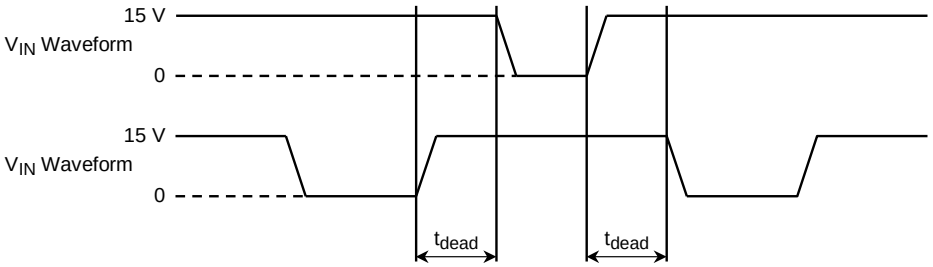


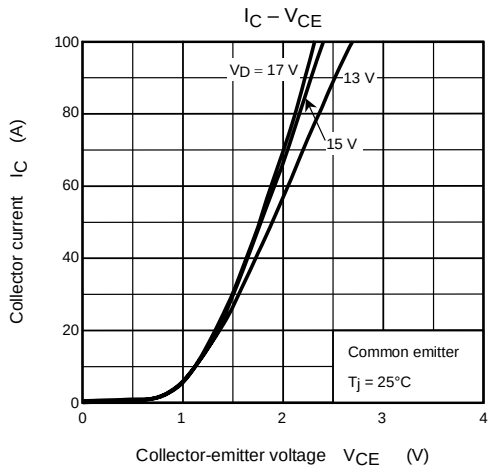
4. Recommended conditions for application

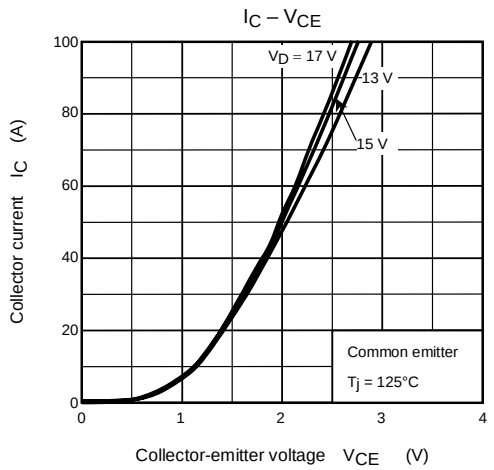
Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
Supply voltage	V_{CC}	P-N Power terminal	—	300	400	V
Control supply voltage	V_D	V_D-GND Signal terminal	13.5	15	16.5	V
Carrier frequency	fc	PWM Control	—	—	20	kHz
Dead time	t_{dead}	Switching time test circuit (See page.6) (Note 2)	3	—	—	μs

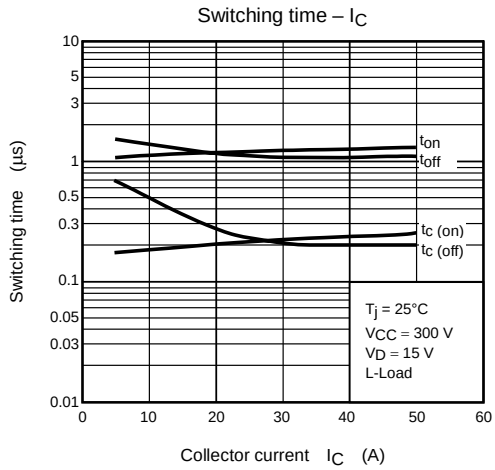
Note 2: The table lists Dead time requirements for the module input, excluding photocoupler delays. When specifying dead time requirements for the photocoupler input, please add photocoupler delays to the dead time given above.

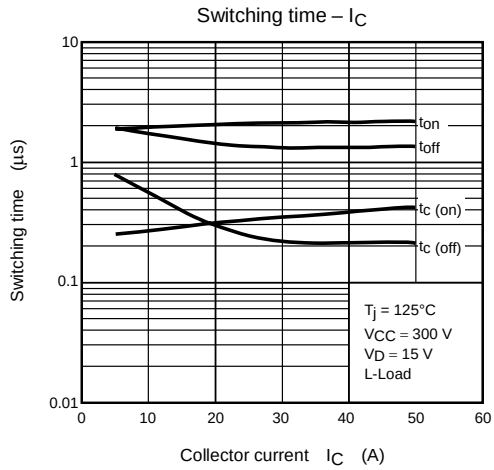
Dead Time Timing Chart

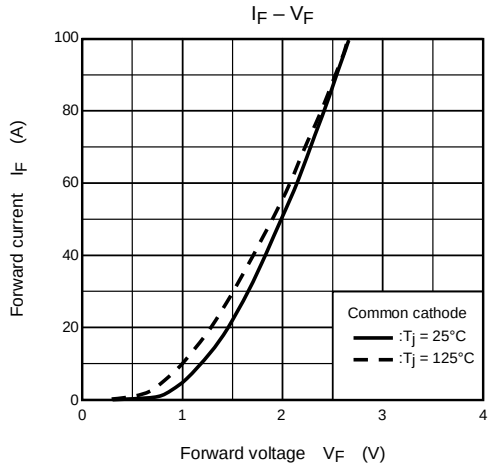


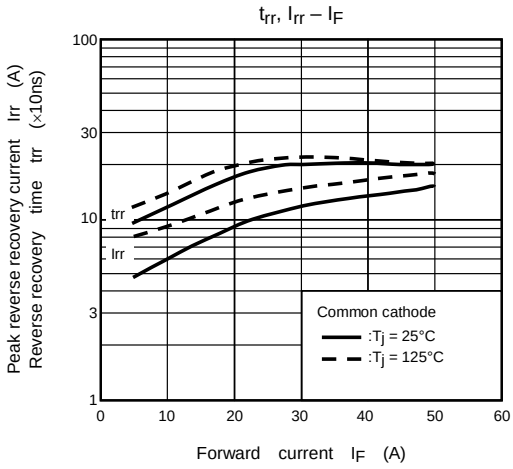

IC – VCE
VD = 17 V
13 V
15 V
Common emitter
Tj = 25°C
Collector current IC (A)
Collector-emitter voltage VCE (V)

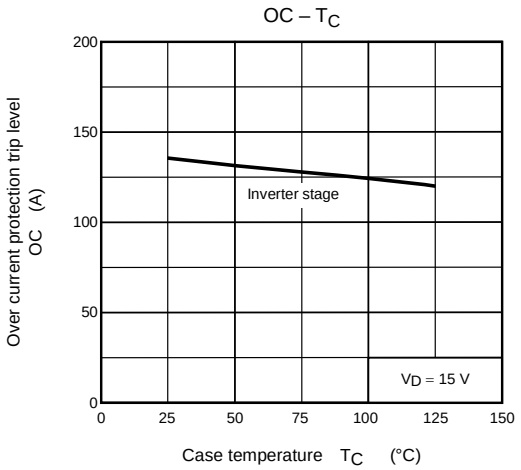

IC – VCE
VD = 17 V
13 V
15 V
Common emitter
Tj = 125°C
Collector current IC (A)
Collector-emitter voltage VCE (V)

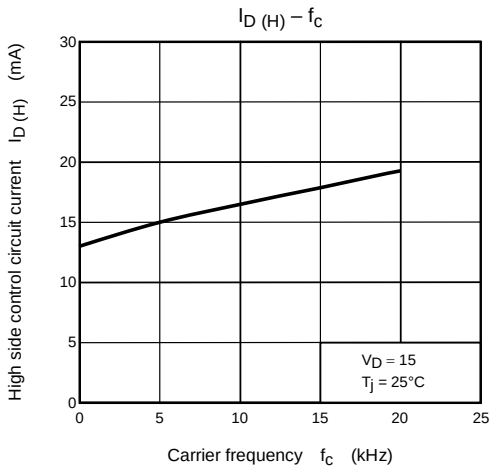

Switching time – IC
ton
toff
tc (on)
tc (off)
Tj = 25°C
VCC = 300 V
VD = 15 V
L-Load
Switching time (μs)
Collector current IC (A)

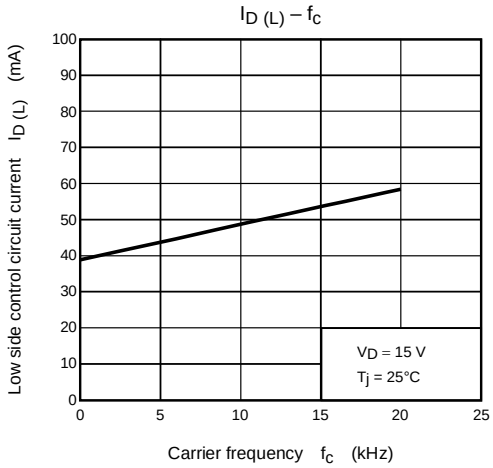

Switching time – IC
ton
toff
tc (on)
tc (off)
Tj = 125°C
VCC = 300 V
VD = 15 V
L-Load
Switching time (μs)
Collector current IC (A)

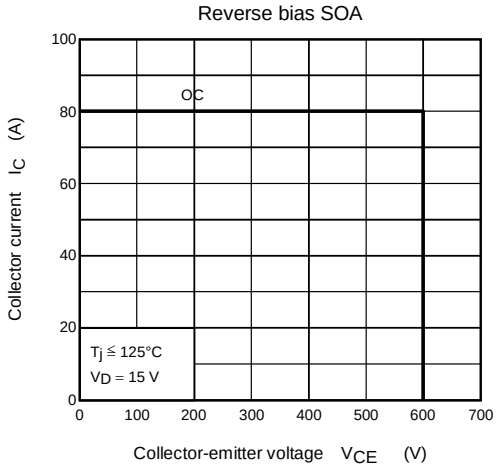

IF – VF
Common cathode
:Tj = 25°C
:Tj = 125°C
Forward current IF (A)
Forward voltage VF (V)

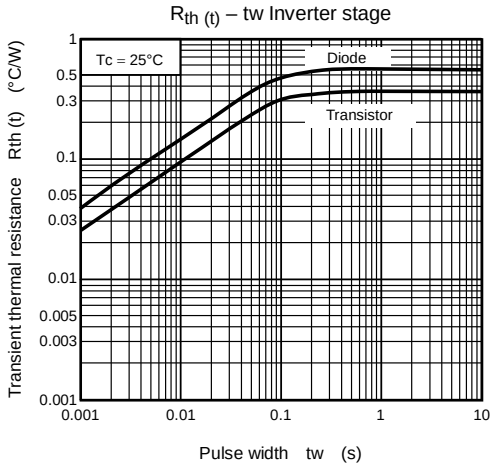

trr, Irr – IF
trr
Irr
Common cathode
:Tj = 25°C
:Tj = 125°C
Peak reverse recovery current Irr (A)
Reverse recovery time trr (×10ns)
Forward current IF (A)

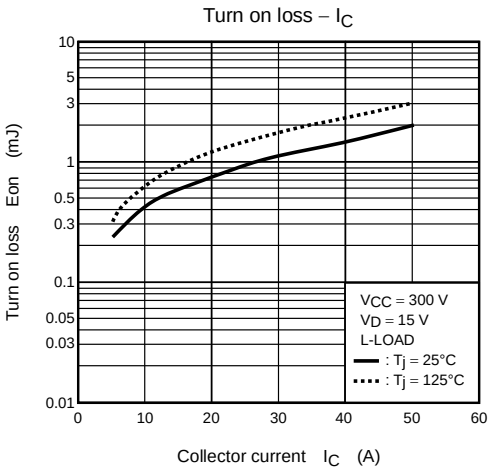

OC – TC
Over current protection trip level OC (A)
200
150
100
50
0
Inverter stage
VD = 15 V
0
25
50
75
100
125
150
Case temperature TC (°C)

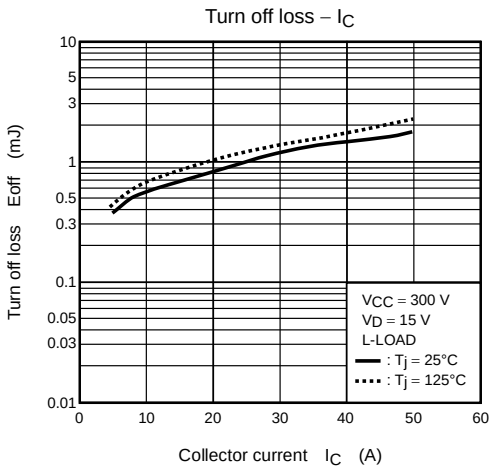

ID (H) – fc
High side control circuit current ID (H) (mA)
30
25
20
15
10
5
0
VD = 15
Tj = 25°C
0
5
10
15
20
25
Carrier frequency fc (kHz)


ID (L) – fc
Low side control circuit current ID (L) (mA)
100
90
80
70
60
50
40
30
20
10
0
VD = 15 V
Tj = 25°C
0
5
10
15
20
25
Carrier frequency fc (kHz)


Reverse bias SOA
Collector current IC (A)
100
80
60
40
20
0
OC
Tj ≦ 125°C
VD = 15 V
0
100
200
300
400
500
600
700
Collector-emitter voltage VCE (V)


Rth (t) – tw Inverter stage
Transient thermal resistance Rth (t) (°C/W)
1
0.5
0.3
0.1
0.05
0.03
0.01
0.005
0.003
0.001
Tc = 25°C
Diode
Transistor
0.001
0.01
0.1
1
10
Pulse width tw (s)


Turn on loss – I_C
Turn on loss Eon (mJ)
10
5
3
1
0.5
0.3
0.1
0.05
0.03
0.01
0
10
20
30
40
50
60
Collector current I_C (A)
V_{CC} = 300 V
V_D = 15 V
L-LOAD
: T_j = 25°C
: T_j = 125°C


Turn off loss – I_C
Turn off loss Eoff (mJ)
10
5
3
1
0.5
0.3
0.1
0.05
0.03
0.01
0
10
20
30
40
50
60
Collector current I_C (A)
V_{CC} = 300 V
V_D = 15 V
L-LOAD
: T_j = 25°C
: T_j = 125°C