Specification

Device Name : IGBT Intelligent Power Module

Type Name : 6MBP15VRB060-50

DWG. No. : MS6M01465

Date : Nov.-20-2012

This specification's contents may change without previous notice.

	DATE	NAME	APPROVED
DRAWN	Nov./20/2012	T.Yamada	G. Tada
CHECKED	Nov./20/2012	K.Ota	
CHECKED	Nov./20/2012	M.Kosaka	

REVISIONS

Fuji Electric Co.,Ltd.

Revised Records

Date	Classification	Index	Content	Drawn	Checked	Checked	Approved
Nov./20 2012	enactment	-	----------------	T.Yamada	K.Ota	M.Kosaka	Y. Toda

1.Scope: This specifies Fuji IGBT Intelligent Power Module “6MBP15VRB060-50”.

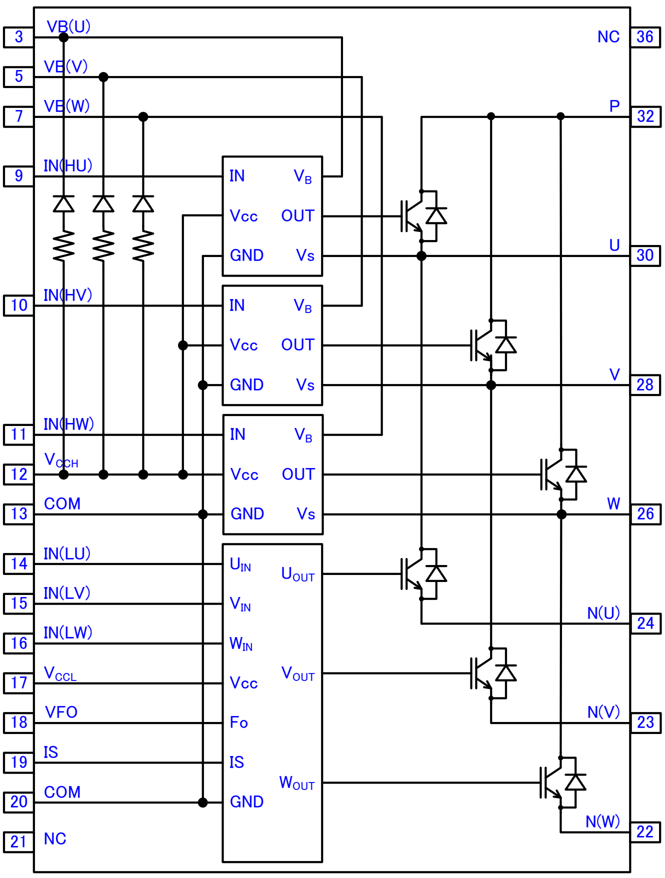
2.Construction:
Low-side IGBTs are separate emitter type
Short circuit protection
Temperature sensor output function
Overheating protection
Under voltage protection
Fault signal output function
Input interface : TTL (3.3V/5V) Active high logic

3.Applications: AC 100 ~ 240V three phase inverter drive for small power AC motor drives (such as compressor motor drive for air conditioner, compressor motor drive for heat pump applications, fan motor drive, ventilator motor drive)

4.Packing: Plastic tube
See to Page 11/27

5.Package Outline : Power-DIP36 (Package code:P633)
See to page 9/27

6. Terminal assign and Internal circuit



Pin No.	Pin Name	Pin Description
3	VB(U)	High-side bias voltage for U-phase IGBT driving
5	VB(V)	High-side bias voltage for V-phase IGBT driving
7	VB(W)	High-side bias voltage for W-phase IGBT driving
9	IN(HU)	Signal input for high side U-phase
10	IN(HV)	Signal input for high side V-phase
11	IN(HW)	Signal input for high side W-phase
12	V_{CCH}	High-side control supply
13	COM	Common supply ground
14	IN(LU)	Signal input for low side U-phase
15	IN(LV)	Signal input for low side V-phase
16	IN(LW)	Signal input for low side W-phase
17	V_{CCL}	Low-side control supply
18	VFO	Fault output
19	IS	Over current sensing voltage input
20	COM	Common supply ground
21	NC	
22	N(W)	Negative bus voltage input for W-phase
23	N(V)	Negative bus voltage input for V-phase
24	N(U)	Negative bus voltage input for U-phase
26	W	Motor W-phase output
28	V	Motor V-phase output
30	U	Motor U-phase output
32	P	Positive bus voltage input
36	NC	No Connection

7. Absolute Maximum Ratings at Tj=25°C,Vcc=15V (unless otherwise specified)

Items		Symbol	Characteristics	Unit	Remarks
Inverter block	DC Bus Voltage	V_{DC}	450	V	Note *1
	Bus Voltage (Surge)	$V_{DC(Surge)}$	500	V	Note *1
	Collector-Emitter Voltage	V_{CES}	600	V	
	Collector Current	$I_{C@25}$	15	A	Note *2
	Peak Collector Current	$I_{CP@25}$	30	A	Vcc=≧15V,Vb(*)≧15V Note *2
	Diode Forward current	$I_{F@25}$	15	A	Note *2
	Peak Diode Forward current	$I_{FP@25}$	30	A	Note *2
	Collector Power Dissipation	P_{D_IGBT}	38.5	W	per single IGBT Tc=25°C
	FWD Power Dissipation	P_{D_FWD}	20.5	W	per single FWD Tc=25°C
	Operating Junction Temperature	T_j	-40~ +150	°C	
Control circuit block	High-side Supply Voltage	V_{CCH}	20	V	Note *3
	Low-side Supply Voltage	V_{CCL}	20	V	Note *4
	High-side Bias Voltage for IGBT gate driving	VB(U) VB(V) VB(W)	20	V	Note *5
	Input Signal Voltage	V_{IN}	-0.5 ~ V_{CCH}+0.5 -0.5 ~ V_{CCL}+0.5	V	Note *6
	Input Signal Current	I_{IN}	3	mA	
	Fault Signal Voltage	V_{FO}	-0.5 ~ V_{CCL}+0.5	V	Note *7
	Fault Signal Current	I_{FO}	1	mA	sink current
	Over Current sensing Input Voltage	V_{IS}	-0.5 ~ V_{CCL}+0.5	V	Note *8
	Operating Junction Temperature	T_j	-40 ~ +150	°C	
Operating Case Temperature		Tc	-40 ~ +125	°C	
Storage Temperature		T_{stg}	-40 ~ +125	°C	
Isolation Voltage		Viso	AC 1500	Vrms	Sine wave,60Hz t=1min , Note *9

Note
*1 : Applied between P-N(U),P-N(V),P-N(W)
*2 : Pulse width and duty were limited by Tjmax.
*3 : Applied between V_{CCH}-COM.
*4 : Applied between V_{CCL}-COM.
*5 : Applied between VB(U)-U,VB(V)-V,VB(W)-W.
*6 : Applied between IN(HU)-COM,IN(HV)-COM,IN(HW)-COM,IN(LU)-COM,IN(LV)-COM,IN(LW)-COM.
*7 : Applied between VFO-COM.
*8 : Applied between IS-COM.
*9 : Applied between shorted all terminal and case.

8.Electrical Characteristics

8.1. Inverter block (Tj=25°C unless otherwise specified)

Description	Symbol	Conditions		min.	typ.	max.	Unit
Zero gate Voltage Collector current	I_{CES}	V_{CE} = 600V VIN= 0V	Tj=25°C	-	-	1	mA
			Tj=125°C	-	-	10	mA
Collector-Emitter saturation Voltage	$V_{CE(sat)}$	Vcc = +15V VB(*)=+15V VIN=5V I_C = 15A	Tj=25°C	-	1.80	2.25	V
			Tj=125°C	-	2.10	2.55	
FWD Forward voltage drop	V_F	I_F=15A VIN=0V	Tj=25°C	-	1.65	2.15	V
			Tj=125°C	-	1.55	-	
Turn-on time	ton	VDC = 300V I_C = 15A Vcc=15V VB(*)=15V Tj = 125°C Vin=0V <-> 5V See Fig.2-1		0.90	1.30	1.95	μs
Turn-on delay	td(on)			0.60	0.90	1.35	
Turn-on rise time	tr			-	0.18	0.30	
VCE-IC Cross time of turn-on	tc(on)				0.40	0.60	
Turn-off time	toff			-	1.07	1.61	
Turn-off delay	td(off)			-	0.90	1.35	
Turn-off fall time	tf			-	0.12	0.20	
VCE-IC Cross time of turn-on	tc(off)			-	0.17	0.26	
FWD Reverse Recovery time	trr				0.20	0.30	

8.2. Control circuit block (Tj=25°C unless otherwise specified)

Description	Symbol	Conditions		min.	typ.	max.	Unit
Circuit current of Low-side	I_{CCL}	V_{CCL}=15V	VIN=5V	-	0.55	0.8	mA
		V_{CCL}=15V	VIN=0V	-	0.55	0.8	
Circuit current of High-side	I_{CCH}	V_{CCH}=15V	VIN=5V	-	0.80	1.2	mA
		V_{CCH}=15V	VIN=0V	-	0.80	1.2	
Circuit current of Bootstrap circuit (per one uint)	I_{CCHB}	VB(U)=15V, VB(V)=15V, VB(W)=15V	VIN=5V	-	-	0.20	mA
			VIN=0V	-	-	0.20	
Input Signal threshold voltage	Vth(on)	Vin is increase. DC voltage applied to Vin. Note *6,Pw≥0.5μs		-	2.1	2.6	V
	Vth(off)	Vin is decrease. DC voltage applied to Vin. Note *6,Pw≥0.5μs		0.8	1.3	-	V
Input Signal threshold hysteresis voltage	Vth(hys)	Note *6 Pw≥0.5μs		0.35	0.80	-	V
Operational input pulse width of turn-on	$t_{IN(ON)}$	V_{IN}=0V to 5V rise up Note *6,Note *10		0.5	-	-	μs
Operational input pulse width of turn-off	$t_{IN(OFF)}$	V_{IN}=5V to 0V fall down Note *6,Note *10		0.5	-	-	μs
Input current	I_{IN}	V_{IN}=5V Note *6		0.7	1.0	1.5	mA
Input pull-down resistance	R_{IN}	Note *6		3.3	5.0	7.2	kΩ

8.2. Control circuit block (continued)

Description	Symbol	Conditions	min.	typ.	max.	Unit
Fault Output Voltage	V_{FO}(H)	V_{IS}=0V,VFO terminal pull up to 5V by 10kΩ	4.9	-	-	V
	V_{FO}(L)	V_{IS}=1V,I_{FO}=1mA	-	-	0.95	V
Fault Output pulse width	t_{FO}	Note *11,See Fig2-2,2-3	20	-	-	μs
Over Current Protection Voltage Level	V_{IS}(ref)	Vcc=15V Note *12 See Fig.2-2	0.43	0.48	0.53	V
Over Current Protection Delay time	td $_{(IS)}$		0.6	0.9	1.3	μs
LVIC Overheating protection	T_{OH}	- Note *14	115	125	135	°C
T_{OH} Hysteresis	T_{OH}(hys)		4	10	20	°C
Vcc Under Voltage Trip Level of Low-side	$V_{CCL(OFF)}$	Tj<150°C See Fig.2-3	10.3	-	12.5	V
Vcc Under Voltage Reset Level of Low-side	$V_{CCL(ON)}$		10.8	-	13.0	V
Vcc Under Voltage hysteresis	$V_{CCL(hys)}$		-	0.5	-	V
Vcc Under Voltage Trip Level of High-side	$V_{CCH(OFF)}$	Tj<150°C See Fig.2-4	8.3	-	10.3	V
Vcc Under Voltage Reset Level of High-side	$V_{CCH(ON)}$		8.8	-	10.8	V
Vcc Under Voltage hysteresis	$V_{CCH(hys)}$		-	0.5	-	V
VB Under Voltage Trip Level	$V_{B(OFF)}$	Tj<150°C See Fig.2-5	9.5	-	11.5	V
VB Under Voltage Reset Level	$V_{B(ON)}$		10.0	-	12.0	V
VB Under Voltage hysteresis	$V_{B(hys)}$		-	0.5	-	V
Forward voltage of Bootstrap diode	$V_{F(BSD)}$	Tj=25°C $I_{F(BSD)}$=10mA	0.90	1.4	1.90	V
	$V_{F(BSD)}$	Tj=25°C $I_{F(BSD)}$=100mA	2.3	4.3	6.3	

Note *10 : This IPM module might not make response if the input signal pulse width is less than $t_{IN(on)}$ and $t_{IN(off)}$.

Note *11 : Fault signal is asserted corresponding to an “Over-current protection”, an “Under-voltage protection” at low-side, and an “Over-heat protection”.
Under the condition of “Over-current protection” or “Under-voltage protection” or “Over-heat protection“, the fault signal is asserted continuously while these conditions are continuing. However, the minimum fault output pulse width is minimum 20μsec even if very short failure condition (which is less than 20μs) is triggered.

Note *12 : Over current protection is functioning only for the low-side arms.

Note *14 : Fig. 2-6 shows operation sequence of the Overheating protection.

9.Thermal Characteristics

Description	Symbol	min.	typ.	max.	Unit
Junction to Case Thermal Resistance (per single IGBT) Note *15	Rth(j-c)_IGBT	-	-	3.25	°C/W
Junction to Case Thermal Resistance (per single FWD) Note *15	Rth(j-c)_FWD	-	-	6.10	°C/W

Note *15 : Thermal compound with good thermal conductivity should be applied evenly with about +100μm~+200μm on the contacting surface of this device and heat-sink.

10.Mechanical Characteristics

Description	Symbol	Conditions	min.	typ.	max.	Unit
Tighten torque	-	Mounting screw : M3	0.59	0.69	0.98	Nm
Heat-sink side flatness	-	Note.*16	0	-	100	μm
Weight	-	-	-	9.3	-	g

Note *16 : Fig1-2 shows the measurement position of heat sink flatness

Fig.1-1 :
The measurement position of temperature sensor.

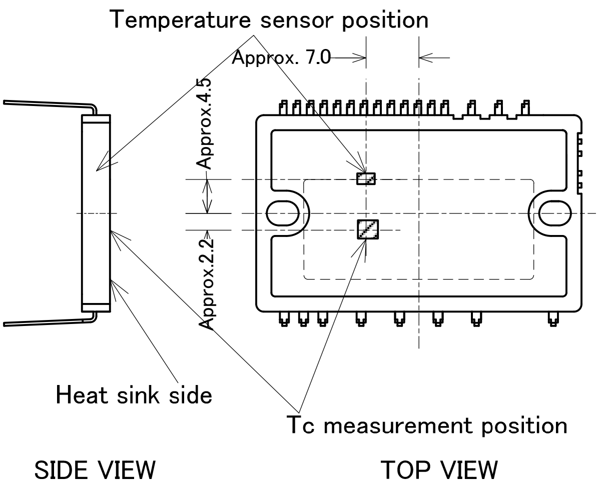
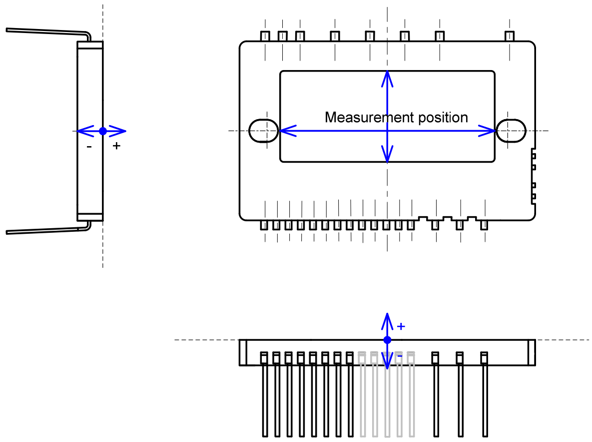


Fig1-2 :
The measurement position of heat sink flatness



11.Recommended Operation Conditions

All voltages are absolute voltages referenced to Vcc –potential unless otherwise specified.

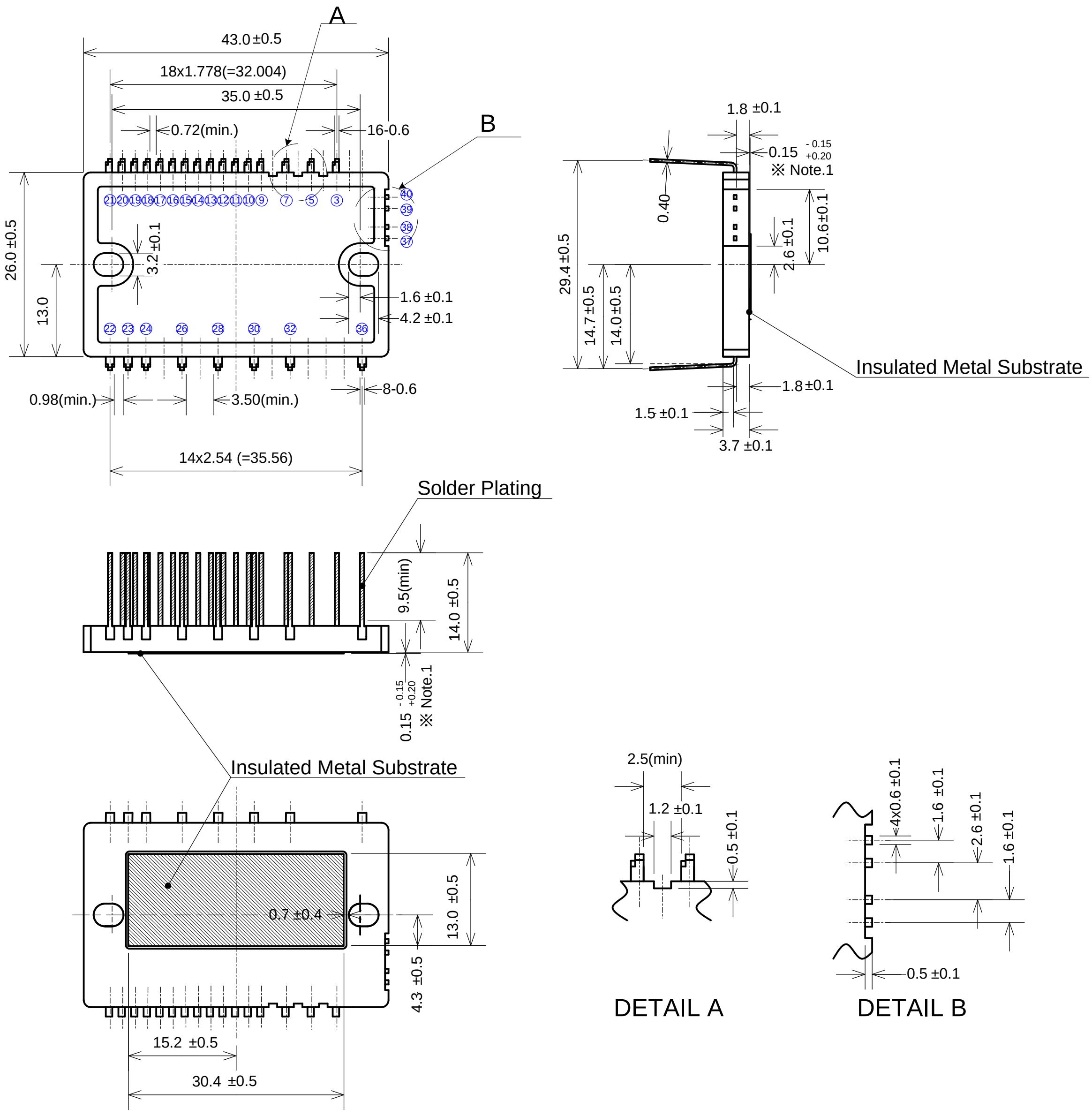
Description	Symbol	min.	typ.	max.	Unit
DC Bus Voltage	V_{DC}	0	300	400	V
High-side Bias Voltage for IGBT gate driving	V_B(*)	13.0	15.0	18.5	V
High-side Supply Voltage	V_{CCH}	13.5	15.0	16.5	V
Low-side Supply Voltage	V_{CCL}	13.5	15.0	16.5	V
Control Supply variation	ΔVB	-1	-	1	V/μs
	ΔVcc	-1	-	1	
Input signal voltage	V_{IN}	0	-	5	V
Voltage for current sensing	V_{ISC}	0	-	5	V
Potential difference of between Vcc to N (including surge)	V_{CC_N}	-5	-	5	V
Dead time for preventing arm-short (Tc≤125°C)	t_{DEAD}	1.0	-	-	μs
Allowable output current (Note *17)	I_o	-	-	8.0	A rms
Allowable minimum input pulse width (Note *18)	$PW_{IN(on)}$	0.5	-	-	μs
	$PW_{IN(off)}$	0.5	-	-	μs
PWM Input frequency	f_{PWM}	-	-	20	kHz
Operating Junction Temperature	Tj	-20	-	125	°C

Note

*17 : VDC=300V,VCC=VB=15V,PF=0.8,Sinusoidal PWM,Tj≤125°C, Tc≤100°C,f_{PWM}=5kHz

*18 : In the pulse width of 0.5us, the loss of IGBT increases for the saturation operation. To reduce the loss of IGBT, please enlarge the pulse width more than the switching time of IGBT. This IPM module might not make response if the input signal pulse width is less than $PW_{IN(on)}$ and $PW_{IN(off)}$.

12. Package outline dimensions



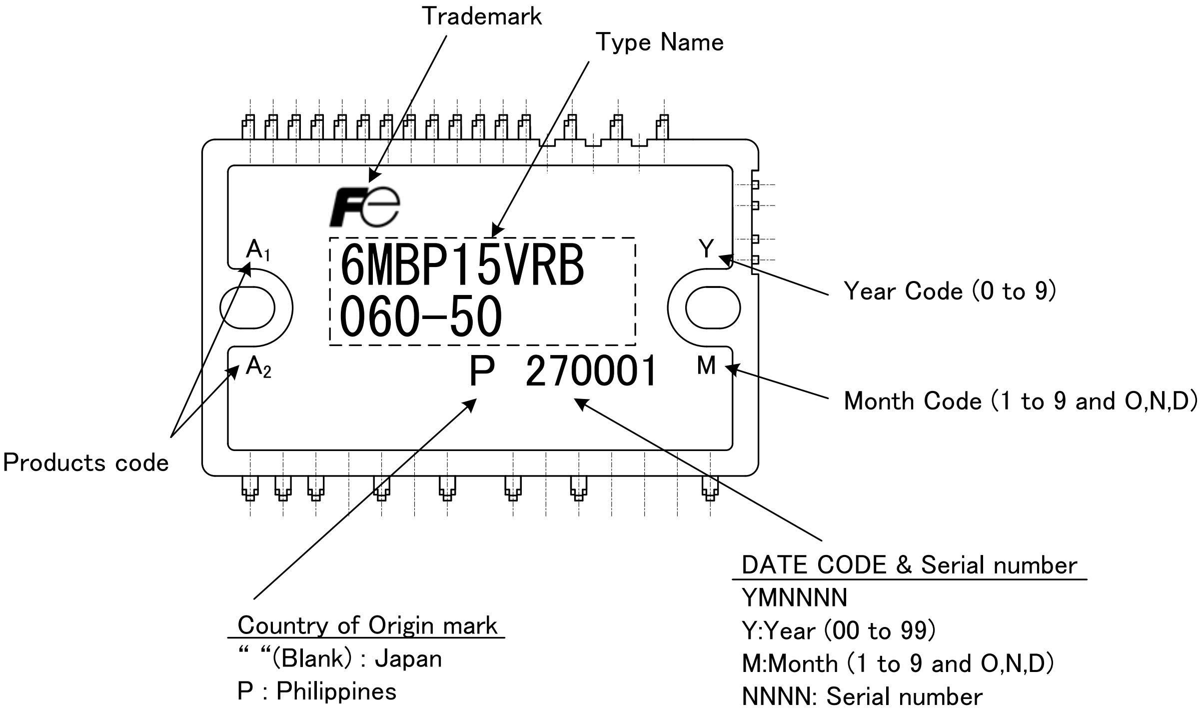
Unit : mm

Note.1
The IMS (Insulated Metal Substrate) deliberately protruded from back surface of case.
It is improved of thermal conductivity between IMS and heat-sink.

Pin No.	Pin Name
3	VB(U)
5	VB(V)
7	VB(W)
9	IN(HU)
10	IN(HV)
11	IN(HW)
12	V_{CCH}
13	COM
14	IN(LU)
15	IN(LV)
16	IN(LW)
17	V_{CCL}
18	VFO
19	IS
20	COM
21	NC

Pin No.	Pin Name
22	N(W)
23	N(V)
24	N(U)
26	W
28	V
30	U
32	P
36	NC
(37)	COM
(38)	V_{CCH}
(39)	IN(HV)
(40)	IN(HU)

13. Marking



Note

Product code A1 means current ratings , and "F" is marked.

Product code A_2 means variations , and "B" is marked.

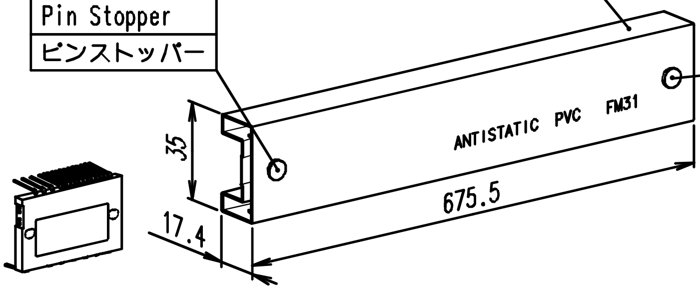
14. Packing

FEP P-DIP36 Packing Specification of Shipping Tube (FM31-PP)
FEP P-DIP36 スティック 納入梱包仕様 (FM31-PP)

Shipping Tube	FEP P-DIP36 スティック	材質：P.V.C.
Material : Polyvinyl Chloride (Coated with anti-static additives.)	製品収納数：最大15ケ/本	厚さ：0.7mm
Quantity : 15pcs(max.)		

Pin Stopper
ピンストッパー

Pin Stopper
ピンストッパー

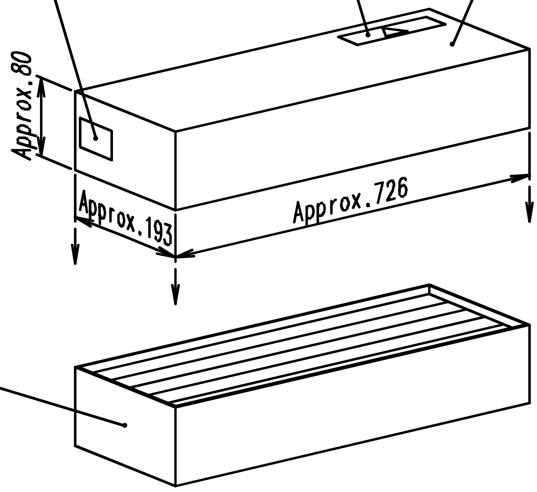


Lid of product Box	
Material : Corrugated Fibreboard	
FEP P-DIP36 スティック用梱包箱蓋	材質：段ボール 厚さ：4mm

Printing (static electricity handling attention)
静電気取扱注意印刷

Identification Label (MDnQD0014)
合格証

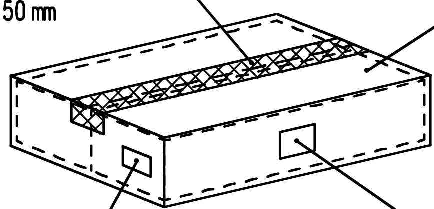
【Inner】
【内装】



Product Box	
Quantity : 300pcs(max.) / 20 Shipping Tube (max.) Material : Corrugated Fibreboard (C Flute) Inside size : Approx.72×177×678mm Note : Lose the space properly in the cushion material when the space is caused in the packing box.	
FEP P-DIP36 スティック梱包箱 製品収納数：300ケ(最大) / 箱 (4段x5列=20本(最大) / 箱)	材質：段ボール 厚さ：4mm
注）梱包箱内に隙間が生じる場合は、適宜緩衝材にて隙間を無くすこと。	

【Outer】
【外装】

Tape (Front and Back) -- Width : 50mm
テープ (表裏) -- 巾：50mm



Outer Box	
Box Capacity : 2 Inner Boxes (600pcs (max.)) Material : Corrugated Cardboard (BC Flute) Inside size : Approx.83×389×730mm	
外装箱 梱包数量：内装 2箱	材質：段ボール 厚さ：7mm

Printing (Indicator Label)
インジケータラベル印刷

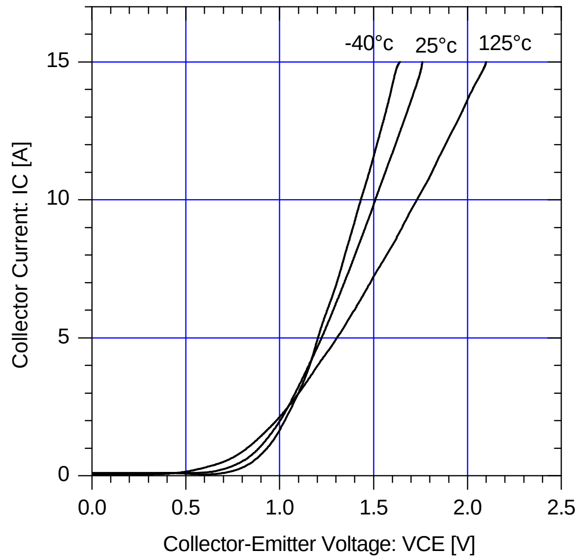
Printing (Case Mark Label)
ケースマークラベル印刷

UNIT : mm
寸法単位：mm

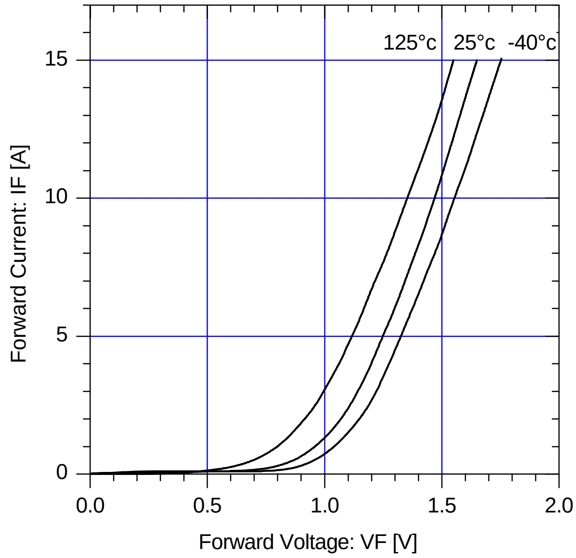
Note: 1. The above packaging method is a representative example.
Depending on the delivery quantity, the dimensions of the packaging may vary.
2. The dimensions of the packaging are given for reference.
3. Please understand that these specifications may be changed or improved without notice.

注）1. 本包装方法は、代表例を示します。納入数量により梱包箱寸法が異なる場合があります。
2. 梱包材の寸法は、参考値を示します。
3. 本仕様記載内容は、改良等のために、お断りなしに変更する場合がありますので御了承願います。

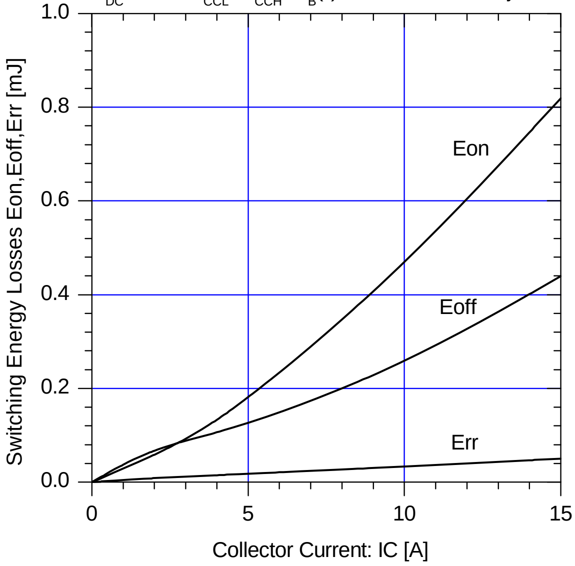
Typical On-state Voltage Drop Characteristics
$IC=f(VCE):V_{CCL}=V_{CCH}=V_B(*)=15V$, 80μs pulse test



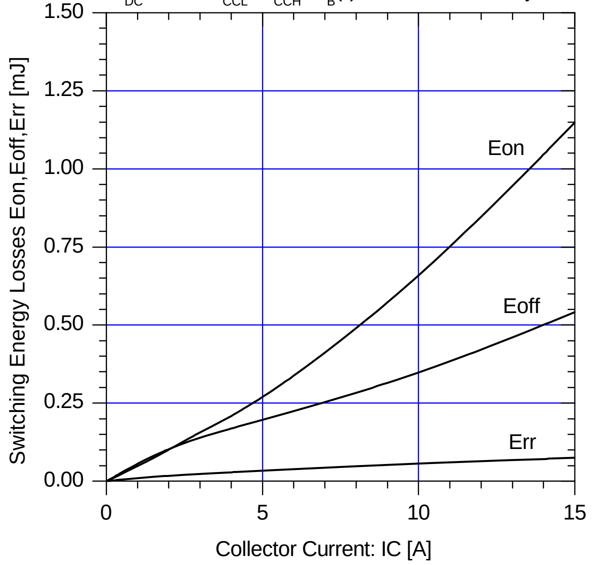
Typical FWD Forward Voltage Drop Characteristics
IF=f(VF):80μs pulse test



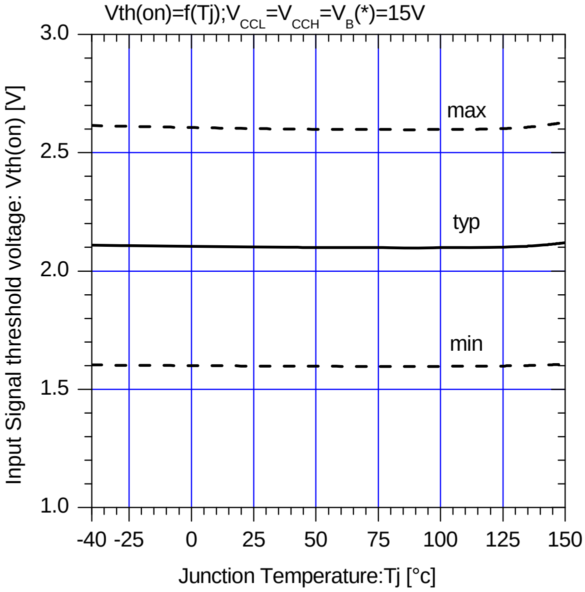
Typical Switching Loss vs. Collector Current
$V_{DC}=300V, V_{CCL}=V_{CCH}=V_B(*)=15V$, Vin=0V/5V, Tj=25°c



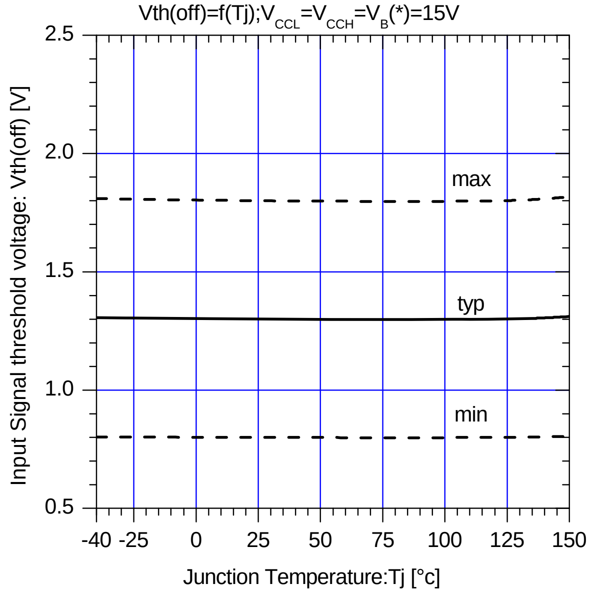
Typical Switching Loss vs. Collector Current
$V_{DC}=300V, V_{CCL}=V_{CCH}=V_B(*)=15V$, Vin=0V/5V, Tj=125°c



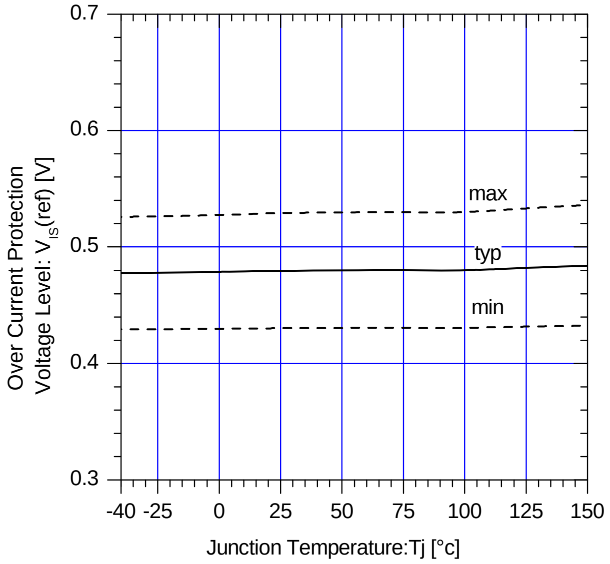
Input Signal Vth(on) Characteristics
$Vth(on)=f(Tj);V_{CCL}=V_{CCH}=V_B(*)=15V$



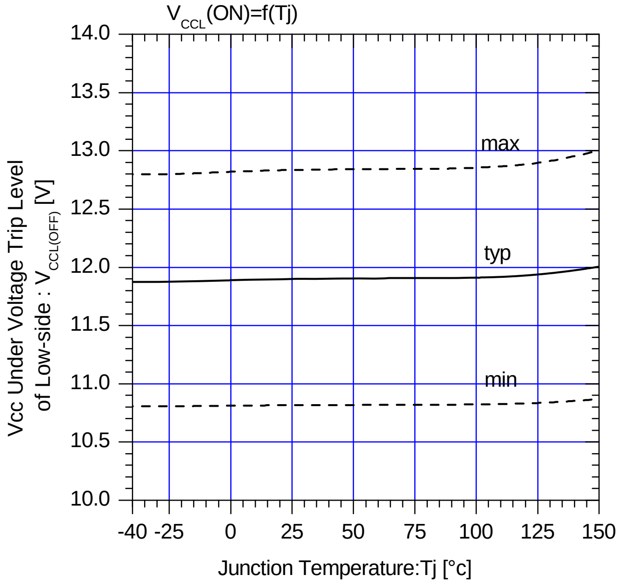
Input Signal Vth(off) Characteristics
$Vth(off)=f(Tj);V_{CCL}=V_{CCH}=V_B(*)=15V$



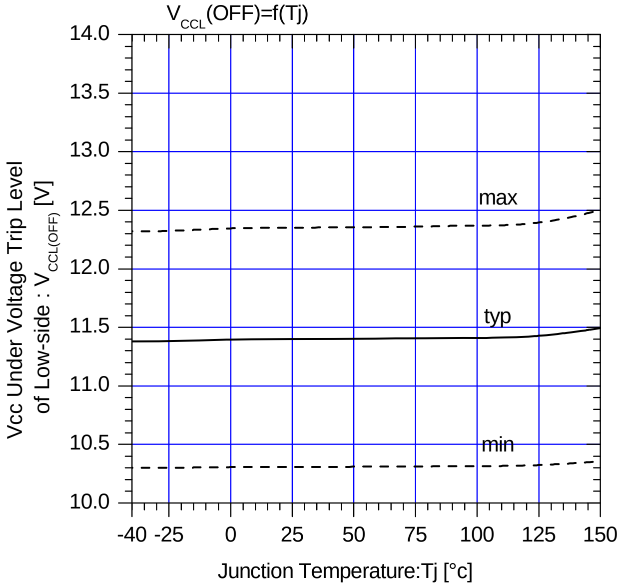
Over Current Protection Characteristics
V_{IS}(ref)=f(Tj);V_{CCL}=V_{CCH}=V_B(*)=15V



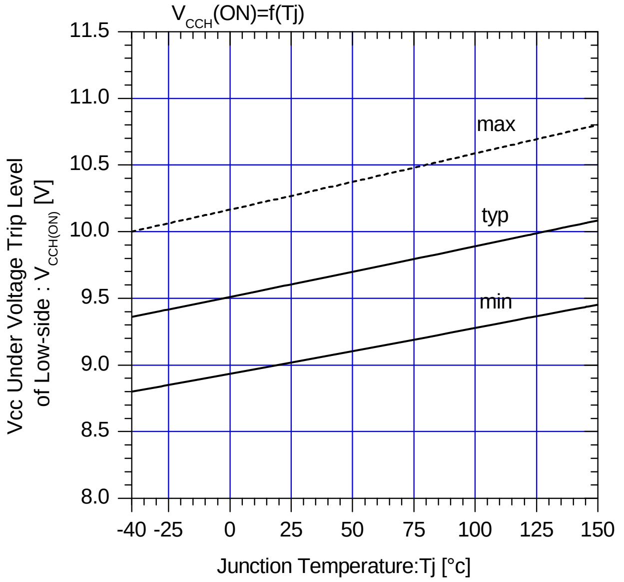
Under Voltage Protection Characteristics
V_{CCL}(ON)=f(Tj)



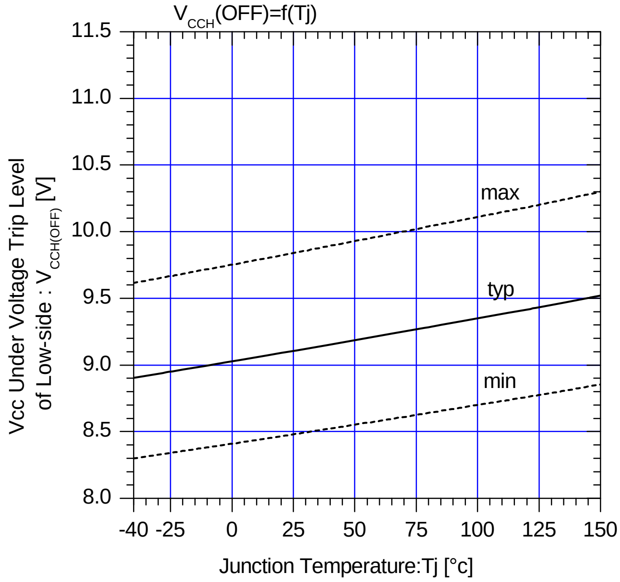
Under Voltage Protection Characteristics
V_{CCL}(OFF)=f(Tj)

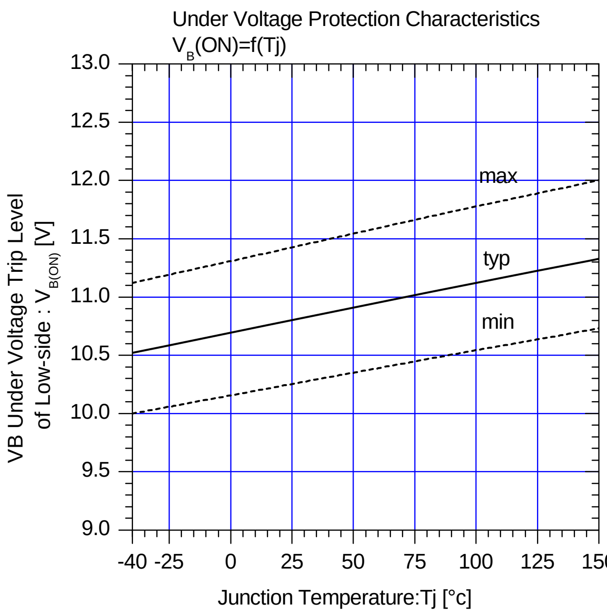


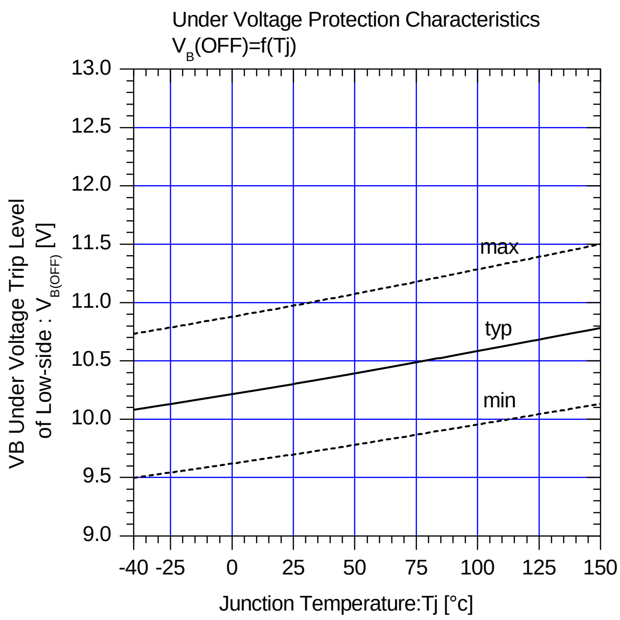
Under Voltage Protection Characteristics
V_{CCH}(ON)=f(Tj)

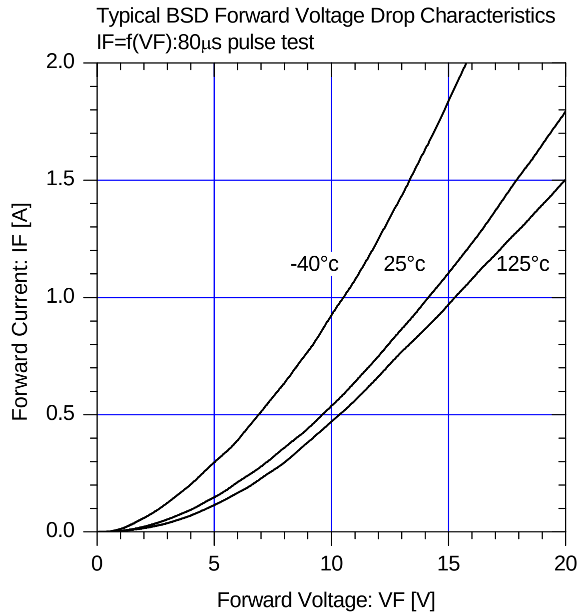


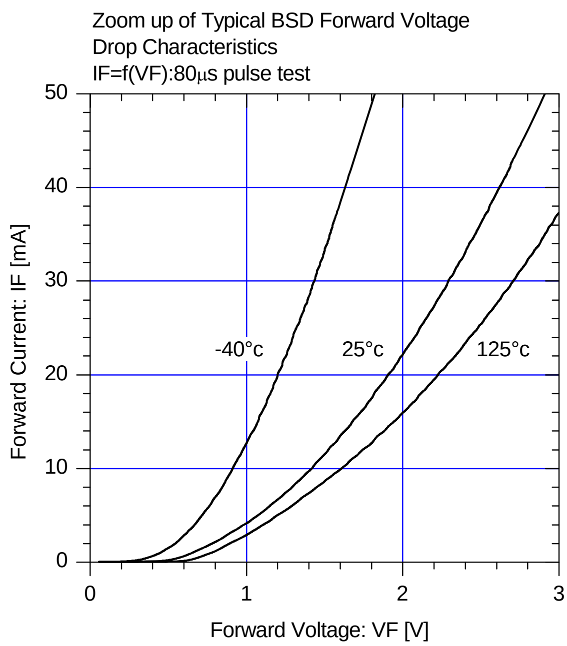
Under Voltage Protection Characteristics
V_{CCH}(OFF)=f(Tj)




Under Voltage Protection Characteristics
V_B(ON)=f(Tj)
VB Under Voltage Trip Level of Low-side : $V_{B(ON)}$ [V]
Junction Temperature:Tj [°c]
max
typ
min
13.0
12.5
12.0
11.5
11.0
10.5
10.0
9.5
9.0
-40 -25 0 25 50 75 100 125 150


Under Voltage Protection Characteristics
V_B(OFF)=f(Tj)
VB Under Voltage Trip Level of Low-side : $V_{B(OFF)}$ [V]
Junction Temperature:Tj [°c]
max
typ
min
13.0
12.5
12.0
11.5
11.0
10.5
10.0
9.5
9.0
-40 -25 0 25 50 75 100 125 150


Typical BSD Forward Voltage Drop Characteristics
IF=f(VF):80μs pulse test
Forward Current: IF [A]
Forward Voltage: VF [V]
-40°c
25°c
125°c
2.0
1.5
1.0
0.5
0.0
0 5 10 15 20


Zoom up of Typical BSD Forward Voltage
Drop Characteristics
IF=f(VF):80μs pulse test
Forward Current: IF [mA]
Forward Voltage: VF [V]
-40°c
25°c
125°c
50
40
30
20
10
0
0 1 2 3

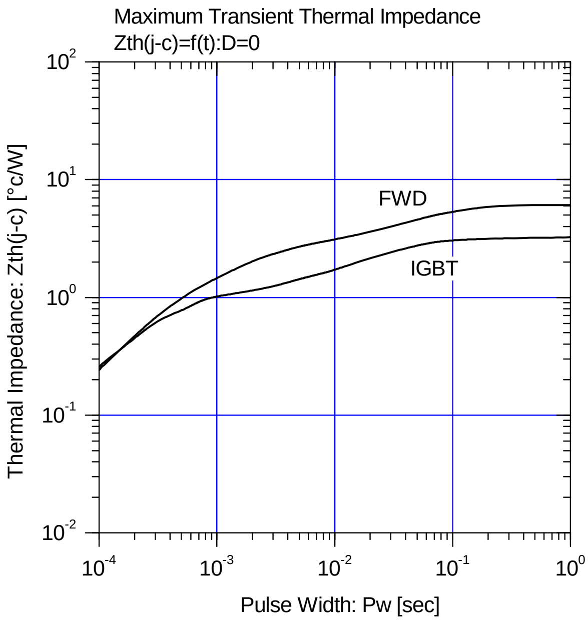

Maximum Transient Thermal Impedance
Zth(j-c)=f(t):D=0
Thermal Impedance: Zth(j-c) [°c/W]
Pulse Width: Pw [sec]
FWD
IGBT
10^2
10^1
10^0
10^{-1}
10^{-2}
10^{-4} 10^{-3} 10^{-2} 10^{-1} 10^0

Fig.2-1 Switching waveforms

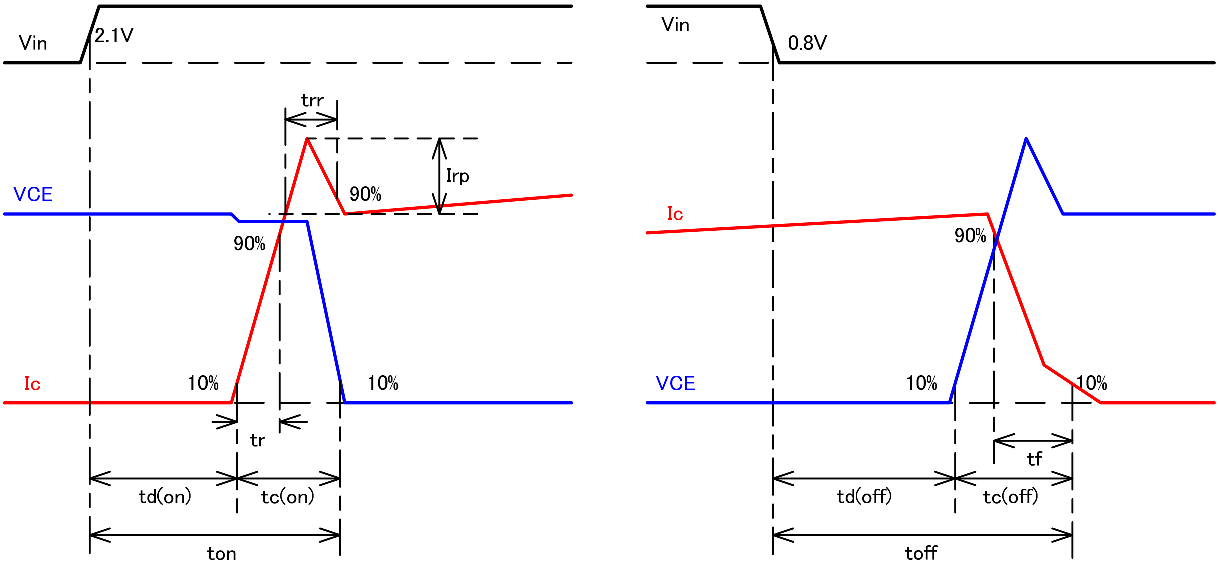
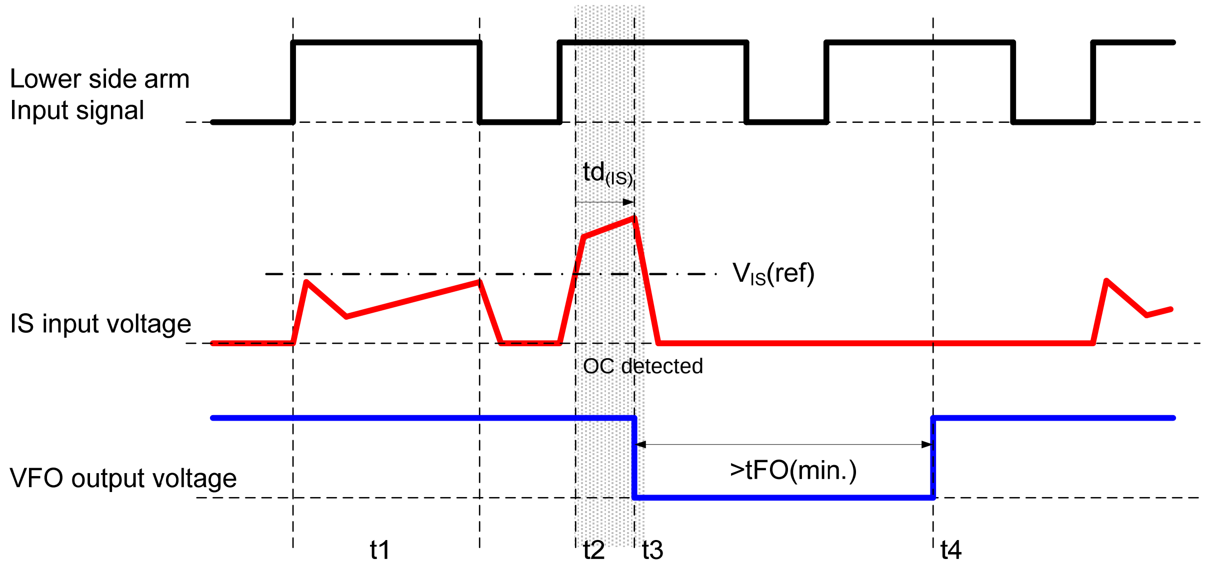


Fig.2-2 Operation sequence of Over current protection



Operation sequence of Over Current protection

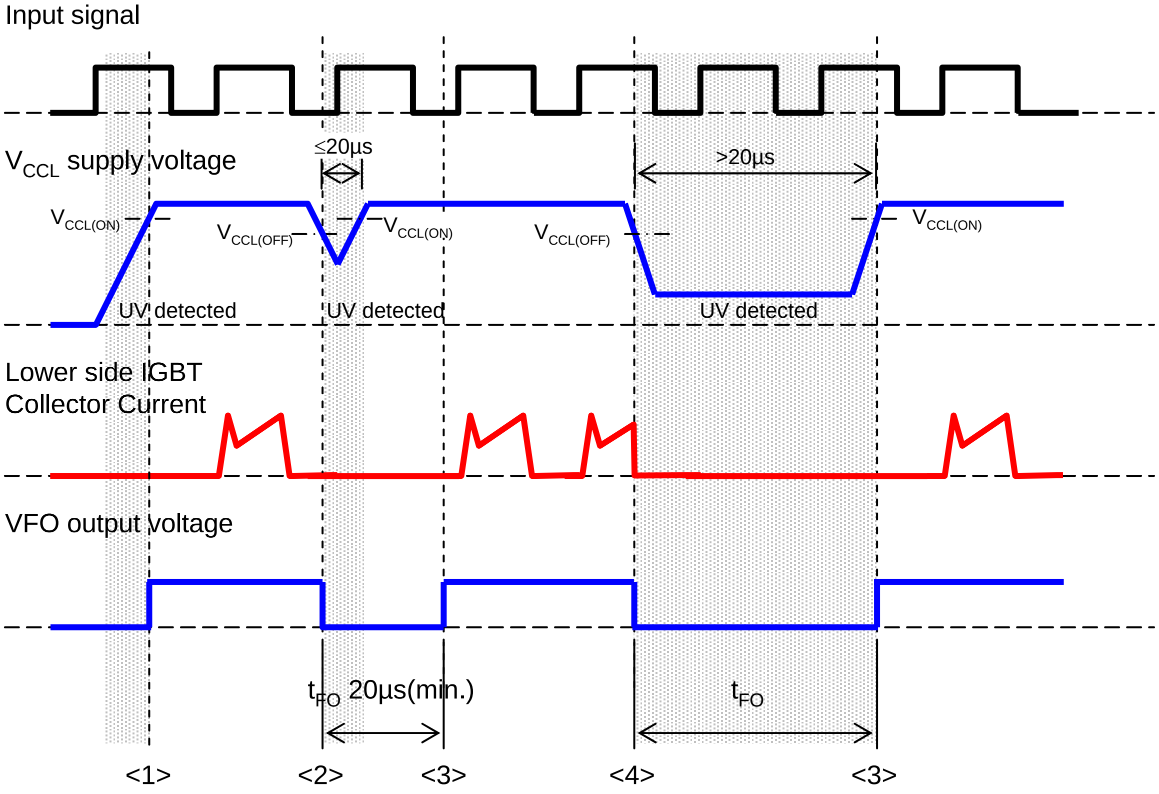
t1 : IS input voltage does not exceed V_{IS}(ref), while the collector current of the lower side IGBT is under the normal operation.

t2 : When IS input voltage exceeds V_{IS}(ref), the OC is detected.

t3 : The fault output VFO is activated and all lower side IGBT shut down simultaneously after the over current protection delay time $td_{(IS)}$. Inherently there is dead time of LVIC in $td_{(IS)}$.

t4 : After the fault output pulse width tFO, the OC is reset. Then next input signal is activated.

Fig.2-3 Operation sequence of V_{CCL} Under voltage trip (lower side arm)



Operation sequence of V_{CCL} Under Voltage protection (lower side arm)

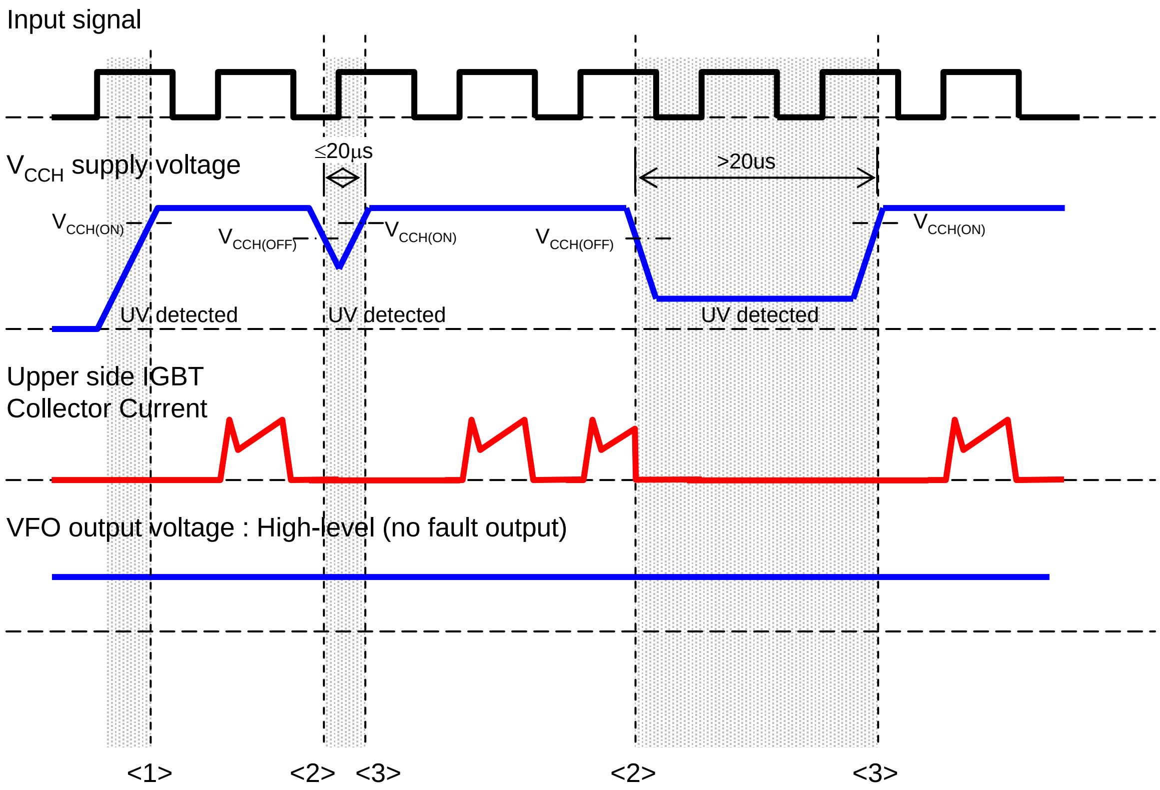
<1> When V_{CCL} is under $V_{CCL(ON)}$, all lower side IGBTs are OFF state.
After V_{CCL} rises $V_{CCL(ON)}$, the fault output VFO is released (high level).
And the LVIC starts to operate, then next input is activated.

<2> The fault output VFO is activated when V_{CCL} falls below $V_{CCL(OFF)}$, and all lower side IGBT remains OFF state.
When the voltage drop time is less than 20µs, the fault output pulse width is generated minimum 20µs and all lower side IGBTs are OFF state in spite of input signal condition during that time.

<3> UV is reset after t_{FO} when V_{CCL} exceeds $V_{CCL(ON)}$ and the fault output VFO is reset simultaneously.
And the LVIC starts to operate, then next input is activated.

<4> When the voltage drop time is more than t_{FO}, the fault output pulse width is generated and all lower side IGBTs are OFF state in spite of input signal condition during the same time.

Fig.2-4 Operation sequence of V_{CCH} Under voltage trip (upper side arm)



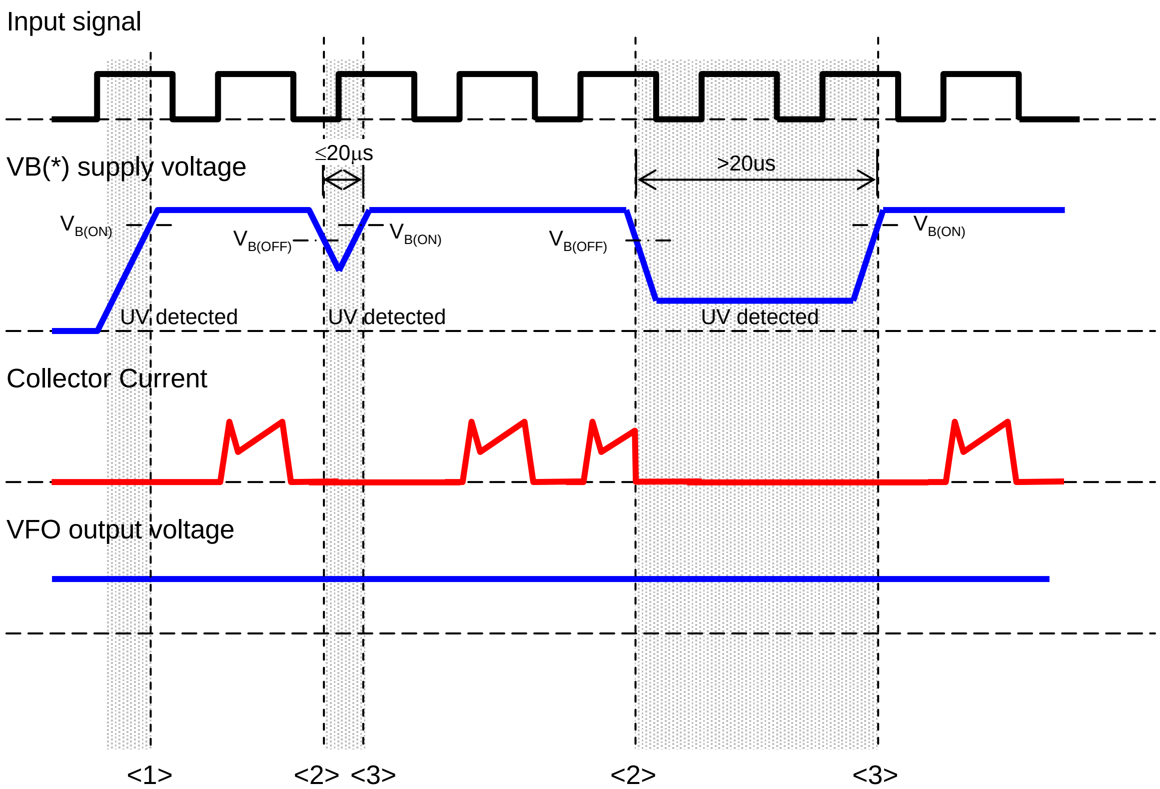
Operation sequence of V_{CCH} Under Voltage protection (upper side arm)

<1> When V_{CCH} is under $V_{CCH(ON)}$, the upper side IGBT is OFF state.
After V_{CCH} exceeds $V_{CCH(ON)}$, the HVIC starts to operate. Then next input is activated.
The fault output VFO is constant (high level) not to depend on V_{CCH}.

<2> After V_{CCH} falls below $V_{CCH(OFF)}$, the upper side IGBT remains OFF state.
But the fault output VFO keeps high level.

<3> The HVIC starts to operate after UV is reset, then next input is activated.

Fig.2-5 Operation sequence of VB Under voltage trip (upper side arm)



Operation sequence of VB(*)*18 Under voltage protection (upper side arm)

<1> When VB(*) is under $V_{B(ON)}$, the upper side IGBT is OFF state.
After VB(*) exceeds $V_{B(ON)}$, the HVIC starts to operate. Then next input is activated.
The fault output VFO is constant (high level) not to depend on VB(*).

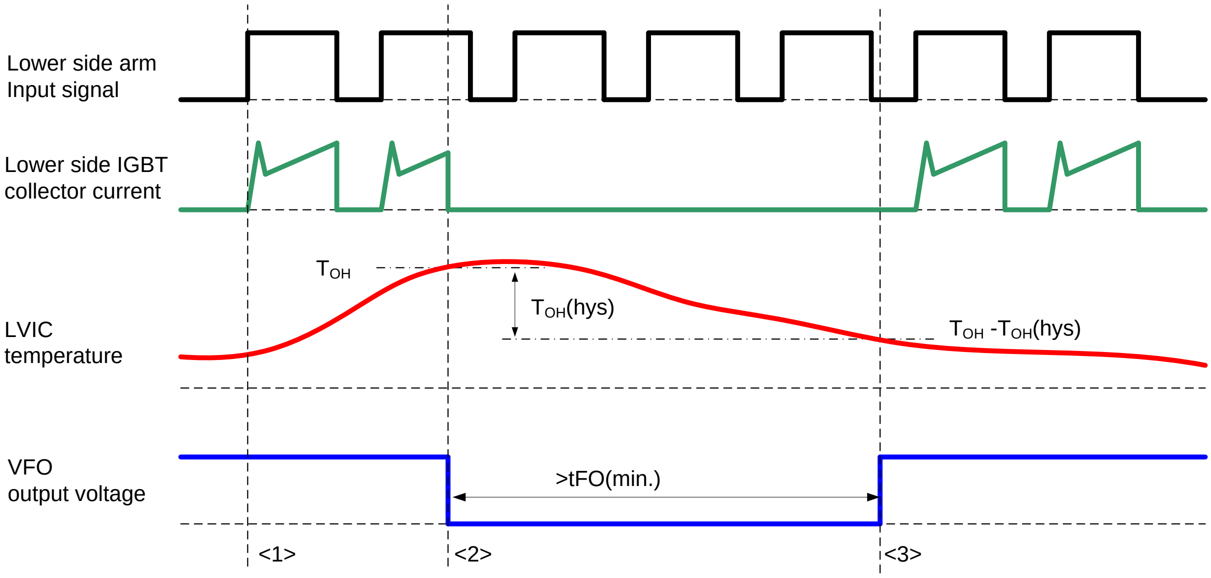
<2> After VB(*) falls below $V_{B(OFF)}$, the upper side IGBT remains OFF state.
But the fault output VFO keeps high level.

<3> The HVIC starts to operate after UV is reset, then next input is activated.

Note *18 : VB(*) : VB(U)-U,VB(V)-V,VB(W)-W

Note *19 : The fault output is not given HVIC bias conditions.

Fig.2-6 Overheat Protection



Operation sequence of the Overheat operation

This function is only applied to "6MBP**VRB060-50".

The IPM has the over-heating protection (OH) function by monitoring the LVIC temperature.

The T_{OH} sensor position is shown in Fig.1-1.

<1> The collector current of the lower side IGBT is under the normal operation while the LVIC temperature does not exceed T_{OH}.

<2> The IPM shutdown all lower side IGBTs while the LVIC temperature exceeds T_{OH}.

<3> The fault status is reset when the LVIC temperature drops below (T_{OH}-T_{OH}(hys)). The all lower side IGBTs restarted to normal operation.

15.Reliability test items

All guaranteed values are under the categories of reliability per non-assembled.
Each categories under the guaranteed reliability conform to EIAJ ED4701/100 method104 standards.

	Test No.	Test Items	Testing methods and Conditions	Reference Standard	Sampling number	Acceptance number
Mechanical test methods	1	Terminal Strength (Tensile)	Pull force : 10N Each terminals Force maintaining duration :10±5sec	EIAJ ED4701/400 method 401	5	(0:1)
	2	Mounting Strength	Screw size : M3 Tighten torque : 0.98N・m Base plate flatness : 100um Tighten to one side of screw.	EIAJ ED4701/400 method 402	5	
	3	Shock	Peak amplitude: 5km/s^2 Duration time : 1ms 3times for each X,Y&Z directions.	EIAJ ED4701/400 method 404	5	
	4	Resistance to Soldering Heat	Solder temp. : 260±5℃ Immersion time : 10±1sec Number of times : 2times Each terminal shall be immersed in the solder bath within 1 to 1.5mm from the body. Solder alloy: Sn-Ag-Cu type	EIAJ ED4701/300 method 302	5	
	5	Solderability	Solder temp. : 245±5℃ Immersion time : 5±0.5sec Each terminal shall be immersed in the solder bath within 1 to 1.5mm from the body. Solder alloy: Sn-Ag-Cu type	EIAJ ED4701/300 method 303	5	

	Test No.	Test Items	Testing methods and Conditions	Reference Standard	Sampling number	Acceptance number
Climatic test methods	6	High Temp. Storage	Temperature : 150+0/-5℃ Test duration : 1000hr	EIAJ ED4701/200 method 201	5	(0:1)
	7	Low Temp. Storage	Temperature : -40+5/-0℃ Test duration : 1000hr	EIAJ ED4701/200 method 202	5	
	8	Temperature Humidity Storage	Temperature : 85±2℃ Relative humidity : 85±5% Test duration : 1000hr	EIAJ ED4701/100 method 103	5	
	9	Temperature Humidity BIAS	Temperature : 85±2℃ Relative humidity : 85±5% Bias Voltage : Vcc(H)=VCC(L)=20V VCE=480V Test duration : 500hr	EIAJ ED4701/100 method 103	5	
	10	Unsaturated Pressurized Vapor	Temperature : 120±2℃ Relative humidity : 85±5% Vapor pressure : 0.17MPa Test duration : 48hr	EIAJ ED4701/100 method 103	5	
	11	Temperature Cycle	High temp.side : 150±5℃/30min. Low temp.side : -40±5℃/30min. RT : 5℃ ～ 35℃/5min. Number of cycles : 100cycles	EIAJ ED4701/100 method 105	5	
	12	Thermal Shock	Fluid : pure water(running water) High temp.side : 100+0/-5℃ Low temp.side : 0+5/-0℃ Duration time : HT 5min,LT 5min Number of cycles : 30cycles	EIAJ ED4701/300 method 307	5	
Endurance test methods	13	ΔTC Intermittent Operating Life	ΔTC =50degree Tch≦Tch(max.) Test duration : 5000 cycle	EIAJ ED4701/100 method 106	5	(0:1)
	14	ΔTj Intermittent Operating Life	ΔTj =100degree Tch≦Tch(max.) Test duration : 5000 cycle	EIAJ ED4701/100 method 106	5	
	15	High Temperature Reverse Bias	Temperature : Tch=150+0/-5℃ Bias Voltage : Vcc(H)=VCC(L)=20V VCE=510V Test duration : 1000hr	EIAJ ED4701/100 method 101	5	

Failure Criteria

Item		Symbols	Failure Criteria		Unit
			Lower Limit	Upper Limit	
Electrical Characteristics	Zero gate voltage Drain-Source current	IDSS	-----	USL	A
	Collector-Emitter saturation voltage	VCE(sat)	-----	USL	V
	FWD forward voltage drop	VF	-----	USL	V
	Input signal voltage threshold	Vth(on)	-----	USL	V
		Vth(off)	LSL	-----	V
	Circuit current of low side	ICCL	-----	USL	A
	Circuit current of high side	ICCH	-----	USL	A
	Circuit current of bootstrap circuit	ICCHB	-----	USL	A
	Transient thermal impedance of IGBT	ΔVCE(sat)	-----	S x 1.2	mV
	Transient thermal impedance of FWD	ΔVF	-----	S x 1.2	mV
External view	Marking Soldering Other damages	-----	With eyes or Microscope		-----
Internal view	Scanning acoustic tomograph	-----	1)Voids are less than 5% of the IGBT/FWD solder joint area. 2) Voids never cross the pattern gap, wire gap and frame gap.		-----

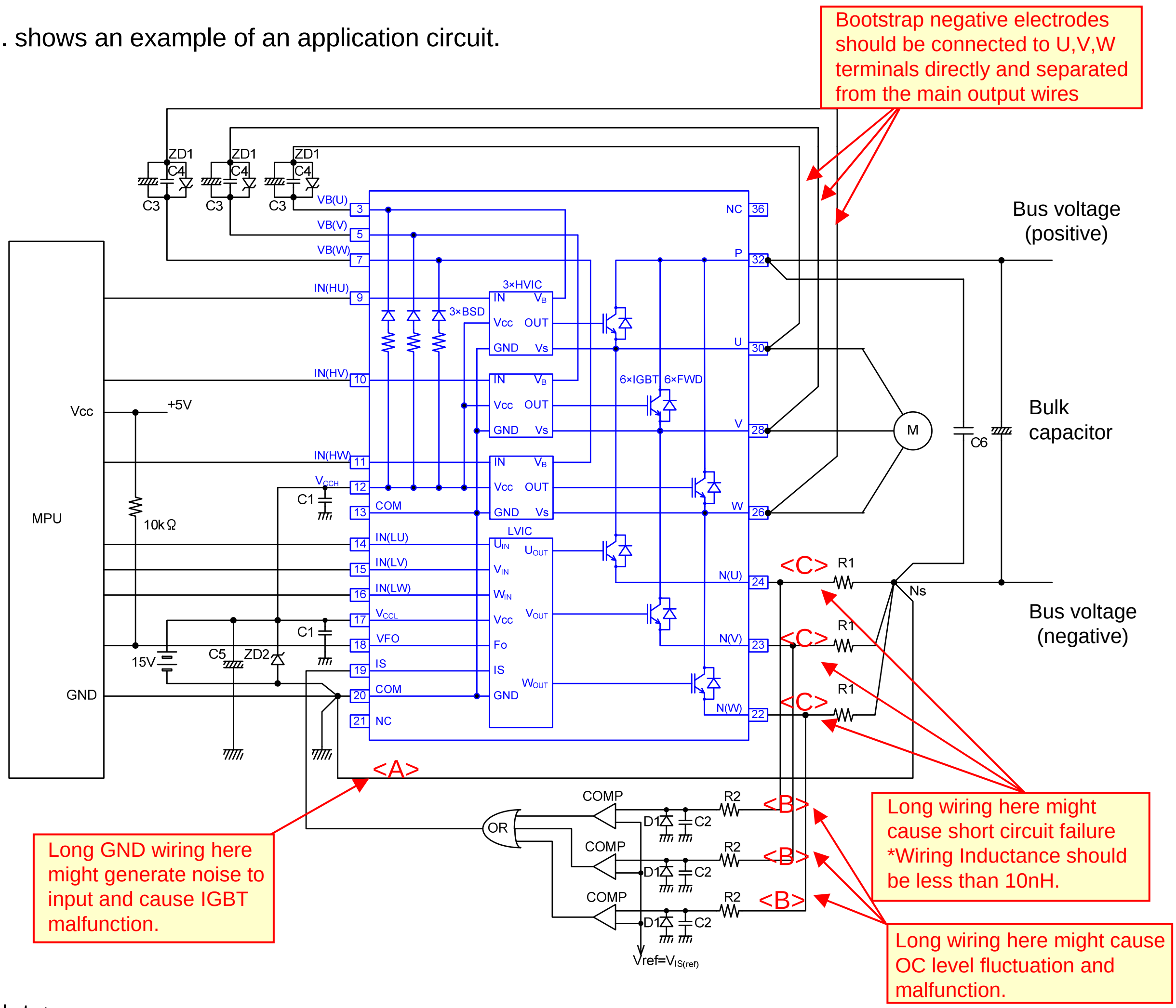
* LSL : Lower Specification Limit
* USL : Upper Specification Limit
* S : Initial value

* Before any of electrical characteristics measure, all testing related to the humidity have conducted after drying the package surface for more than an hour at 150℃

* Failure criteria of internal view is applied to Temperature cycle, Thermal shock ,DTC intermittent operating life and DTj intermittent operating life.

16. An example of application circuit.

Fig. shows an example of an application circuit.



<Note>

1. Input signal for drive is High-Active. There is a pull-down resistor built in the IC input circuit. To prevent malfunction, the wiring of each input should be as short as possible. When using R-C coupling circuit, make sure the input signal level meet the turn-on and turn-off threshold voltage.
2. By the function of the HVIC, it is possible of the direct coupling to microprocessor (MPU) without any photo-coupler or pulse-transformer isolation.
3. VFO output is open drain type. It should be pulled up to the positive side of a 5V power supply by a resistor of about 10kW.
4. To prevent erroneous protection, the wiring of (A), (B), (C) should be as short as possible.
5. The time constant R2-C2 of the protection circuit should be selected approximately 1.5μs.
   Over current (OC) shutdown time might vary due to the wiring pattern. Tight tolerance, temp-compensated type is recommended for R2, C2.
6. Please set the threshold voltage of the comparator reference input to be same as the IPM OC trip reference voltage $V_{IS(ref)}$.
7. Please use high speed type comparator and logic IC to detect OC condition quickly.
8. If negative voltage of R1 at the switching timing is applied, the schottky barrier diode D1 is recommended to be inserted parallel to R1.
9. All capacitors should be mounted as close to the terminals of the IPM as possible. (C1, C4 : narrow temperature drift, higher frequency and DC bias characteristic ceramic type are recommended, and C3, C5: narrow temperature drift, higher frequency and electrolytic type.)
10. To prevent surge destruction, the wiring between the snubber capacitor and the P terminal ,Ns node should be as short as possible. Generally a 0.1μ to 0.22μF snubber capacitor (C6) between the P terminal and Ns node is recommended.
11. Two COM terminals (13 & 20 pin) are connected inside the IPM, it must be connected either one to the signal GND outside and leave another one open.
12. It is recommended to insert a zener-diode (22V) between each pair of control supply terminals to prevent surge destruction.
13. If signal GND is connected to power GND by broad pattern, it may cause malfunction by power GND fluctuation. It is recommended to connect signal GND and power GND at only a point.

17. Warnings in operating and handling

- This product shall be used within its absolute maximum rating (voltage, current, and temperature). This product may be broken in case of using beyond the ratings.
- You must design the IPM to be operated within the specified maximum ratings (voltage, current, temperature, etc.) to prevent possible failure or destruction of devices.
- Make sure you follow the instructions in the MT6M08855 of application manual for a detailed usage , PCB layout and the installation, etc.
- The equipment containing IPM should have adequate fuses or circuit breakers to prevent the equipment from causing secondary destruction (ex. fire, explosion etc…).
- Please check the turn-off operating waveform, make sure that operating locus of the turn-off voltage and current are within the RBSOA specification.
- Consider the possible temperature rise not only for the junction and case, but also for the outer leads.
- The IPM are made of incombustible material. However, if a IPM fails, it may emit smoke or flame. Also, operating the IPM near any flammable place or material may cause the IPM to emit smoke or flame in case the IPM become even hotter during operation. Design the arrangement to prevent the spread of fire.
- Do not directly touch the leads or package of the IPM while power is supplied or during operation in order to avoid electric shock and burns.

- Please connect an adequate ceramic capacitor near the VCC pin and Ground.
  In order that VCC pin might be not directly impressed high frequency noise such as switching noise.
- When the noise is input to each control terminal of IPM, IPM may malfunction. Please confirm that neither the instable operation nor the malfunction occurs by the noise and use this IPM.
- Please connect an adequate ceramic capacitor near the VB pin and the VS pin to avoid high frequency noise.
- The voltage of input signal is must impress more than threshold voltage.

- Use this product after realizing enough working on environment and considering of product's reliability life. This product may be broken before target life of the system in case of using beyond the product's reliability life.
- Use this product within the delta-Tj power cycle curve and the delta-Tc power cycle curve.
  Power cycle capability is classified to delta-Tj mode which is stated as above and delta-Tc mode. Delta-TC mode is due to rise and down of case temperature (TC), and depends on cooling design of equipment which use this product. In application which has such frequent rise and down of TC, well consideration of product life time is necessary.
- The IPM should not used in an environment in the presence of acid, organic matter, or corrosive gas (hydrogen sulfide, sulfurous acid gas etc.)
- The IPM should not used in an irradiated environment since they are not radiation-proof.

- If excessive static electricity is applied to the control terminals, the devices can be broken. Implement some countermeasures against static electricity.
- Be careful when handling IPM for ESD damage. (It is an important consideration.)
- When handling IPM, hold them by the case (package body) and don’t touch the leads and terminals.
- It is recommended that any handling of IPM is done on grounded electrically conductive floor and tablemats.
- Before touching a IPM terminal, Discharge any static electricity from your body and clothes by grounding out through a high impedance resistor (about 1MΩ) .
- When soldering, in order to protect the IPM from static electricity, ground the soldering iron or soldering bath through a low impedance resistor.
- Never add mechanical stress to deform the main or control terminal.

18. Precautions in storage

- The IPM must be stored at a normal temperature of 5 to 35℃ and relative humidity of 45 to 75%. If the storage area is very dry, a humidifier may be required. In such a case, use only deionized water or boiled water, since the chlorine in tap water may corrode the leads.
- The IPM should not be subjected to rapid changes in temperature to avoid condensation on the surface of the IPM. Therefore store the IPM in a place where the temperature is steady.
- The IPM should not be stored on top of each other, since this may cause excessive external force on the case.
- The IPM should be stored with the lead terminals remaining unprocessed. Rust may cause presoldered connections to fail during later processing.
- The IPM should be stored in antistatic containers or shipping bags.
- Under the above storage condition, use the IPM within one year.

19. Compliance with pertaining to restricted substances

18-1) Compliance with the RoHS Regulations

This product will be fully compliant with the RoHS directive.

All of six substances below which are regulated by the RoHS directive in Europe are not included in this product.

* The six substances regulated by the RoHS Directive are:

Lead, Mercury, Hexavalent chromium, Cadmium, PBB (polybrominated biphenyls),

PBDE (polybrominated diphenyl ethers).

18-2) Compliance with the class-1 ODS and class-2 ODS. (ODS: Ozone-Depleting Substances)

This products does not contain and used the “Law concerning the Protection of the Ozone Layer through the Control of Specified Substances and Other Measures (JAPAN)”, and the Montreal Protocol.

20. CAUTIONS

- The product described in this specification is not designed nor made for being applied to the equipment or systems used under life-threatening situations.
  Do not use a product described in this specification for these applications , such as Aerospace equipment, Airborne equipment , Atomic control equipment , Submarine repeater equipment and Medical equipment.
- The products specified in this document is intended to be used with general-use electronic equipment (such as compressor motor drive for air conditioner, fan motor drive for air conditioner)
  If a product is intended to be used for any such special purpose, please contact a Fuji Electric Co., Ltd. or its sales agencies representative before designing.
- Fuji Electric is constantly making every endeavor to improve the product quality and reliability. However, semiconductor products may rarely happen to fail or malfunction. To prevent accidents causing injury or death, damage to property like by fire, and other social damage resulted from a failure or malfunction of the Fuji Electric semiconductor products, take some measures to keep safety such as redundant design, spread-fire-preventive design, and malfunction-protective design.
- When IPMs are used out of the range written in specifications, it can not guarantee. When IPMs are used and the phenomenon except the range of a statement of this specification occurs, please consult to our company.
- Use the latest version Specification and Application Manual every time in case of designing the new equipment.

21. DISCLAIMER

- If you have any question or any unclear matter in this specification and the application note, please contact Fuji Electric Co., Ltd. or its sales agencies.
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