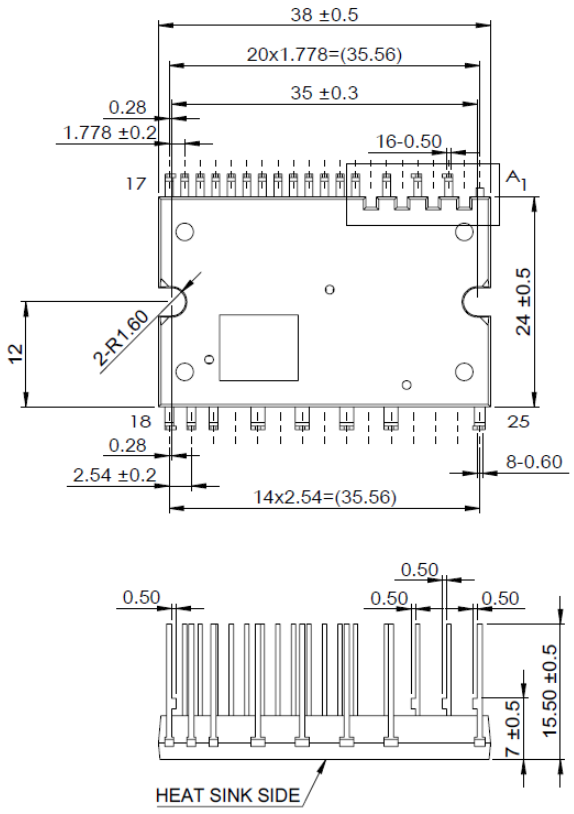
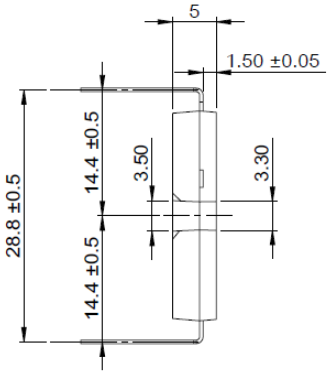
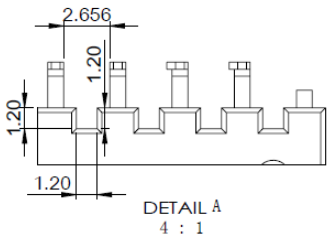
Compact -IPM ID20FFX60U1S

Features

- Adopt the latest trench IGBT technology to get a good overall loss trade-off.
- Open Emitter on N terminal for low cost current sensing application.
- Matched propagation delay and arm shooting through prevention.
- Built-in bootstrap diodes with current limiting resistor.
- Provided a fault signal (FO pin) and shut-off internal IGBT when suffer S.C. and under-voltage faulty event.
- RoHS compatible.
- UL 1557 Compliance.

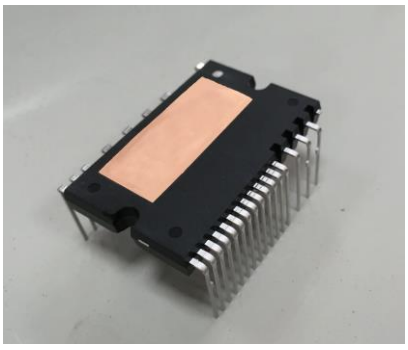






TERMINAL CODE

1 NC	16 COM
2 $V_{B(U)}$	17 NC
3 $V_{B(V)}$	18 N_W
4 $V_{B(W)}$	19 N_V
5 $IN_{(UH)}$	20 N_U
6 $IN_{(VH)}$	21 W
7 $IN_{(WH)}$	22 V
8 V_{CC}	23 U
9 COM	24 P
10 $IN_{(UL)}$	25NC
11 $IN_{(VL)}$	
12 $IN_{(WL)}$	
13 V_{CC}	
14 V_{FO}	
15 C_{SC}	



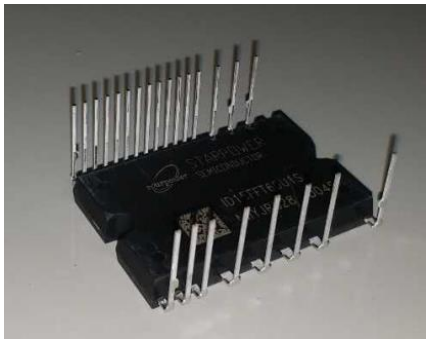


Table1: Pin Descriptions

No.	Symbol	Pin Description
1	NC	No connection
2	$V_{B(U)}$	High - side Bias Voltage for U Phase IGBT Driving
3	$V_{B(V)}$	High - side Bias Voltage for V Phase IGBT Driving
4	$V_{B(W)}$	High - side Bias Voltage for W Phase IGBT Driving
5	$IN_{(UH)}$	Signal Input Terminal for High-side U Phase
6	$IN_{(VH)}$	Signal Input Terminal for High-side V Phase
7	$IN_{(WH)}$	Signal Input Terminal for High-side W Phase
8	V_{CC}	Supply Voltage Terminal for Driver IC
9	COM	Reference Voltage Terminal for Driver IC
10	$IN_{(UL)}$	Signal Input Terminal for Low-side U Phase
11	$IN_{(VL)}$	Signal Input Terminal for Low-side V Phase
12	$IN_{(WL)}$	Signal Input Terminal for Low-side W Phase
13	V_{CC}	Supply Voltage Terminal for Driver IC
14	V_{FO}	Fault Output Terminal
15	Csc	Short-Current Detection Input
16	COM	Reference Voltage Terminal for Driver IC
17	NC	No connection
18	N_W	Negative DC-Link Input Terminal for W Phase
19	N_V	Negative DC-Link Input Terminal for V Phase
20	N_U	Negative DC-Link Input Terminal for U Phase
21	W	Output Terminal for W Phase
22	V	Output Terminal for V Phase
23	U	Output Terminal for U Phase
24	P	Positive DC – Link Input
25	NC	No connection

(see figure 2, next page)

Pin Configuration

Bottom View

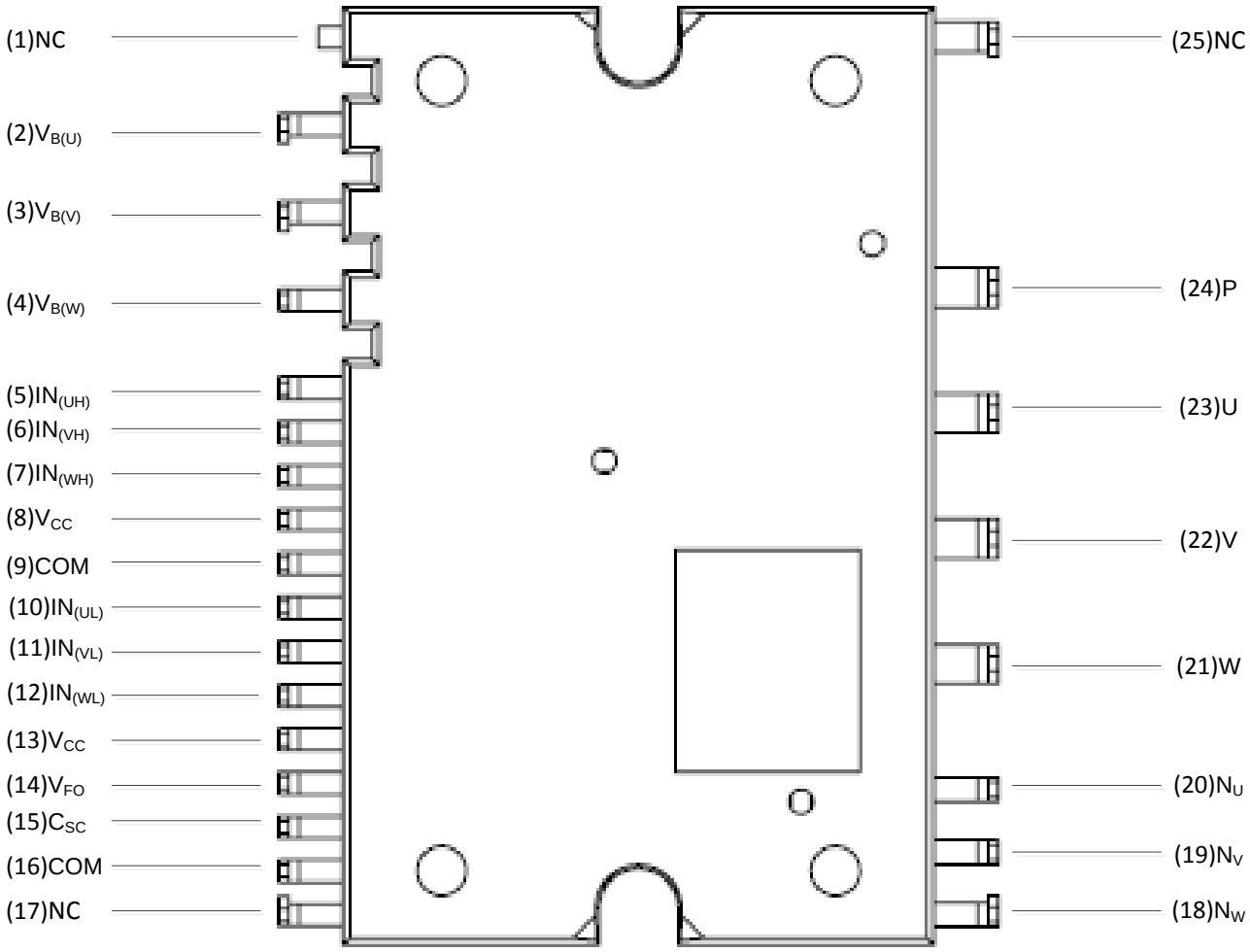


Figure 2. Pin Configuration

The IPM Internal Block Diagram

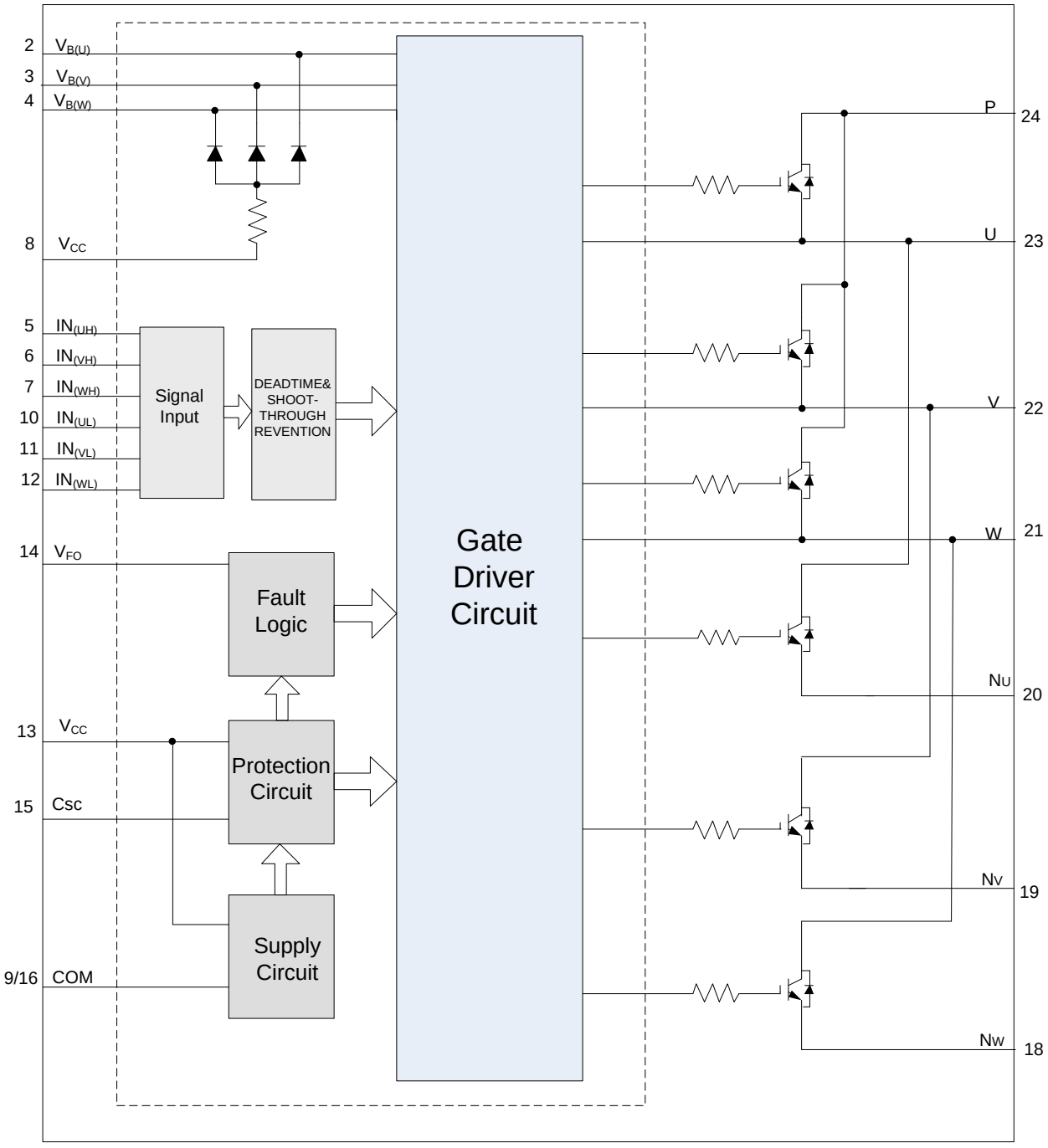


Figure 3. IPM Internal Block Diagram

Application:

- Short-circuit current protection AC 100~240Vrms class 3 phase output for low power motor control.
- Household electric appliances such as air conditioners, washing machines, refrigerators, etc..,
- Low power industrial servo drives applications such as sewing machine, treadmill, etc…

MAXIMUM RATINGS(T_j = 25℃)

INVERTER PART

Item	Symbol	Min.	Max.	Unit
Between collector to emitter voltage	V_{CES} (IGBT)	-	600	V
Supply voltage P-N	V_{PN}	-	450	V
Supply voltage (surge) P-N	$V_{PN\ (surge)}$	-	500	V
Each IGBT collector current	± I_C (Tc = 25℃)	-	20	A
Each IGBT collector current (peak)	± I_{CP} (Tc = 25℃, pulse)	-	60	A
Collector dissipation	P_C (Tc = 25℃, per one chip)	-	70	W
Junction temperature	T_j **(Note 1)**	-40	+150	℃

Note 1： Power chip in IPM is qualified for 150°C operation.But overall junction temperature should be limited by$T_j \leqq$ 125°C (@ Tc≦ 100°C) to fit long term reliability requirement.

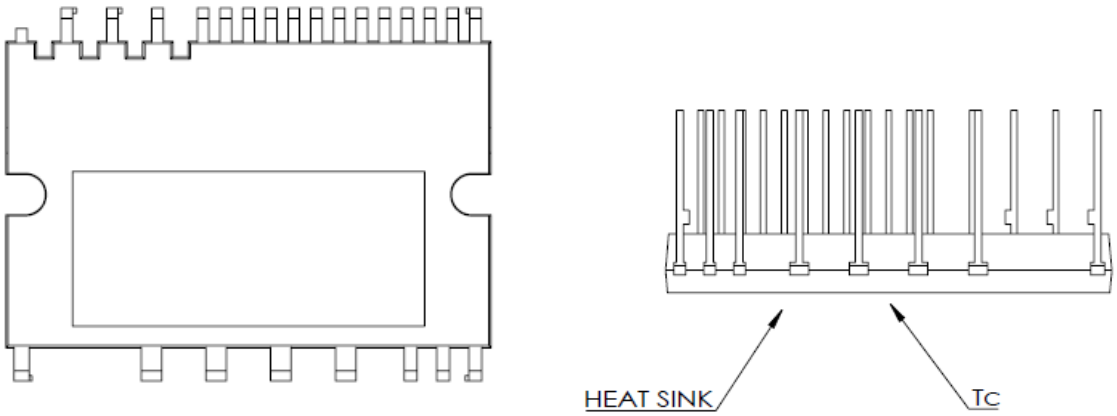
CONTROL PART

Item	Symbol	Min.	Max.	Unit
Driver IC supply voltage	V_{CC}	-0.3	20	V
P - side floating supply voltage	$V_{B(u)S(u),\ B(V)S(V),\ B(W)S(W)}$	-0.3	20	V
Current sensing input voltage	V_{SC}	-0.3	Vcc+0.3	V
Logic input voltage	$IN_{(UH)}$,$IN_{(VH)}$,$IN_{(WH)}$, $IN_{(UL)}$,$IN_{(VL)}$,$IN_{(WL)}$	-0.3	Vcc+0.3	V
Fault output voltage	V_{FO}	-0.3	Vcc+0.3	V
Fault output current	I_{FO}	-	10	mA

TOTAL SYSTEM

Item	Symbol	Min.	Max.	Unit
Module case operating temperature	T_C **(Note 2)**	-20	+100	℃
Storage temperature	T_{stg}	-40	+125	℃
Isolation voltage (60Hz Sinusoidal, AC 1 minute, pins to heat-sink plate)	V_{iso}	-	1500	Vrms

Control terminal



Power terminal

Figure 4.Tc Measurement Point

THERMAL RESISTANCE

Item	Symbol	Condition	Min.	Typ.	Max.	Unit
Junction to case thermal resistance	$R_{th(j-c)Q}$	IGBT part (1/6)	-	-	1.8	℃/W
	$R_{th(j-c)F}$	FWD part (1/6)	-	-	2.2	

ELECTRICAL CHARACTERISTICS(T_j = 25℃)

INVERTER PART

Item	Symbol	Condition		Min.	Typ.	Max.	Unit
Collector-emitter saturation voltage	$V_{CE\ (sat)}$	V_{CC} = $V_{B(U)S(U),\ B(V)S(V),\ B(W)S(W)}$= 15V,$I_C$ = 20A, V_{SC}= 0V	T_j=25℃	-	1.57	-	V
FWD forward voltage drop	V_F	Tj=25℃, - IC = 20A		-	1.54	-	V
Switching times **(Fig. 5)**	T_{on}	V_D = 300V, V_{CC} = $V_{B(U)S(U),\ B(V)S(V),\ B(W)S(W)}$= 15V, I_C = 20A, T_j=25℃, V_{IN} = 5V <—> 0V, V_{SC}= 0V, Inductive Load		-	0.7	-	μS
	T_r			-	0.15	-	
	$T_{c(on)}$			-	0.2	-	
	T_{off}			-	0.9	-	
	T_f			-	0.07	-	
	$T_{c(off)}$			-	0.15	-	
	T_{rr}			-	0.2	-	
Collector-emittercut-off current	I_{CES}	V_{CE} =V_{CES}		-	-	500	μA

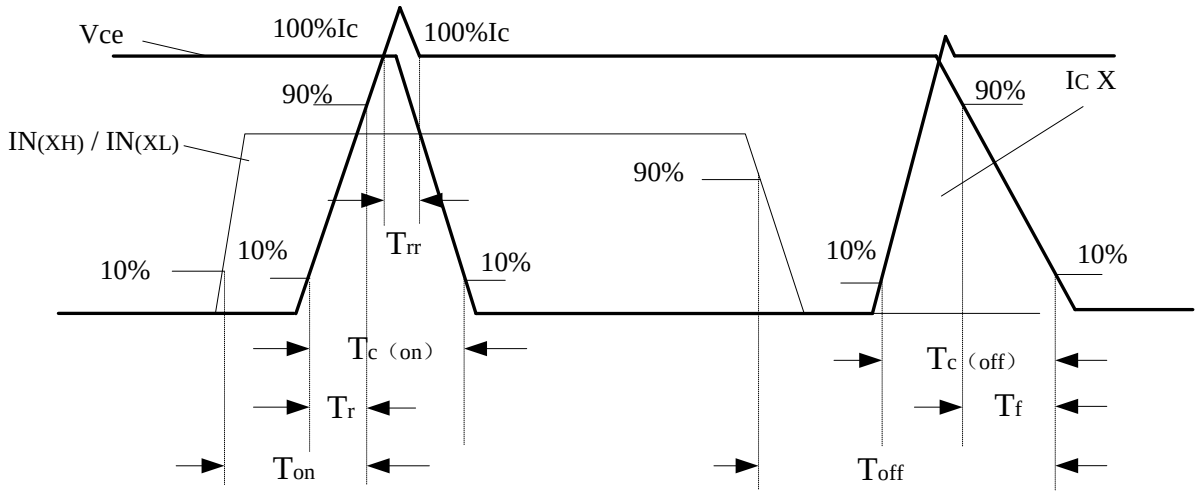


Figure 5. Switching Time Definition

CONTROL PART(T_j = 25℃)

Item	Symbol	Condition	Min.	Typ.	Max.	Unit
$IN_{(UH、VH、WH)}$, $IN_{(UL、VL、WL)}$ ON threshold voltage	$V_{th(on)}$		1.4	1.7	2.0	V
$IN_{(UH、VH、WH)}$,$IN_{(UL、VL、WL)}$ OFF threshold voltage	$V_{th(off)}$		2.2	2.5	2.8	V
$IN_{(UH、VH、WH)}$ input bias current	$I_{IN(UH、VH、WH)(HI)}$	$V_{IN(UH、VH、WH)}$ = 5V	-	-	220	μA
	$I_{IN(UH、VH、WH)(LO)}$	$V_{IN(UH、VH、WH)}$ = 0V	-	-	300	
$IN_{(UL、VL、WL)}$input bias current	$I_{IN(UL、VL、WL)(HI)}$	$V_{IN(UL、VL、WL)}$ = 5V	-	-	220	μA
	$I_{IN(UL、VL、WL)(LO)}$	$V_{IN(UL、VL、WL)}$ = 0V	-	-	300	
Driver IC supply voltage	V_{CC}		13.5	15.0	16.5	V
P - side floating supply voltage	$V_{B(U)S(U), B(V)S(V), B(W)S(W)}$		13.5	15.0	16.5	V
V_{CC} terminal input current	I_C		-	-	2.3	mA
Fault output voltage	V_{FOH}	V_{SC} =0V **(Note 2)**	4.9	-	-	V
	V_{FOL}	V_{SC}=1V	-	-	200	mV
Short circuit trip level	$V_{SC(ref)}$	V_{CC} =15V, T_j= 25℃	0.41	0.46	0.51	V
Fault output pulse width	t_{FOD}	**(Note 3)**	100	-	-	us
Supply circuit under voltage protection	UVT_{VCC}	Trip level	8.6	9.4	10.2	V
	UVR_{VCC}	Reset level	9.6	10.4	11.2	V
	UVH	Hysteresis	-	1.0	-	V
$IN_{(UL、VL、WL)}$ Input filter time	$t_{IN,FIL}$	VIN = 0 & 5V **(Note 4)**	100	200	-	ns
VF	Bootstrap diode forward voltage	If=3A,T_j= 25℃	0.8	-	1.1	V
R	Limiting resistance	Individual resistor	-	100	-	Ohm

Note 2：V_{FO} output is open collector type, so this signal line should be pulled up to the +5V power supply with approximately 4.7KΩ

Note 3：Fault output pulse width is filter capacitor of S.C. depended.

Note 4：For high side PWM, IN(UH、VH、WH) pulse width must be ≧ 1 us.

Input Filter Function

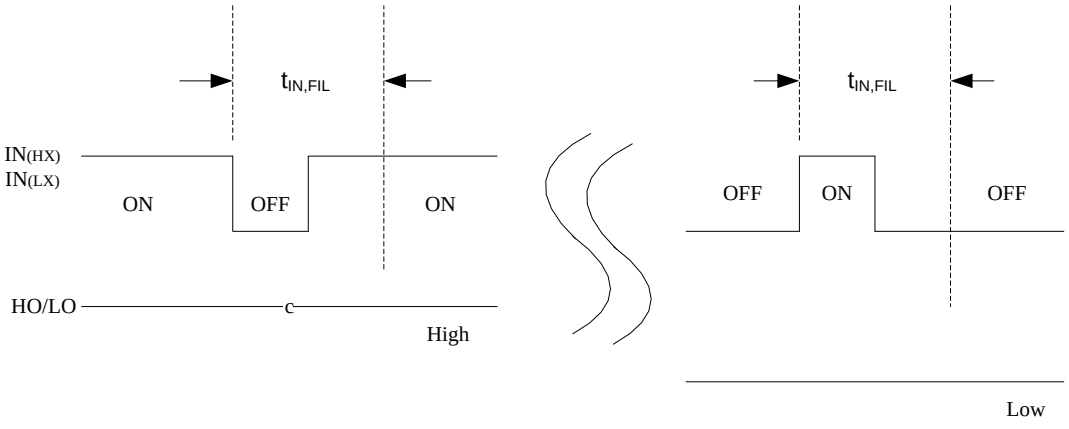


Figure 6.Input Filter Function

RECOMMENDED OPERATION CONDITIONS

Item	Symbol	Condition	Min.	Typ.	Max.	Unit
DC _ Link Supply voltage	V_D	Applied between P-N	0	400	450	V
Driver IC supply voltage	V_{CC}	Applied between V_{CC} - COM	13.5	15.0	16.5	V
P - side floating supply voltage	V_{BS}	Applied between $V_{B(u、v、w)} – V_{S(u、v、w)}$	13.5	15.0	16.5	V
Input ON threshold voltage	$V_{sc(ON)}$	Applied between $IN_{(UH、VH、WH)}$ - COM and $IN_{(UL、VL、WL)}$ - COM	0 ~ 0.65			
Input OFF threshold voltage	$V_{sc(OFF)}$		4.0 ~ 5.5			
Supply voltage ripple	ΔV_D , ΔV_{DB}		-1	-	1	V/μs
Arm shoot-through blocking time	t_{dead}		1	-	-	μs
PWM input frequency	f_{PWM}	T_C≦ 100℃, T_j≦ 125℃	-	15	-	kHz

MECHANICAL CHARACTERISTICS AND RATINGS

Item	Condition		Min.	Typ.	Max.	Unit
Mounting torque	Mounting screw：M3	Recommended 0.65N•m	0.60	0.65	0.70	N•m
Weight		--	-	11	-	g
Heat-sink flatness		--	-50	-	100	μm

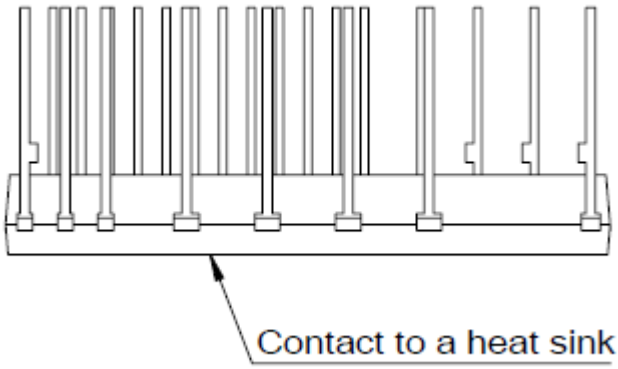


Figure 7. Measurement Location of Heat-sink Flatness

Input/Output Timing Diagram

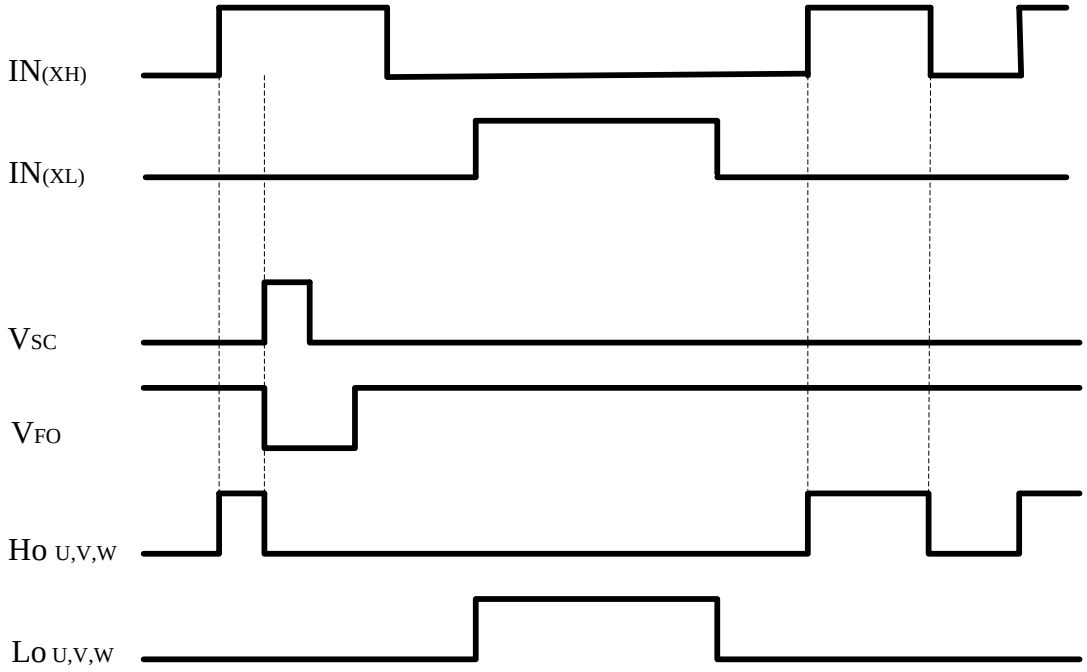
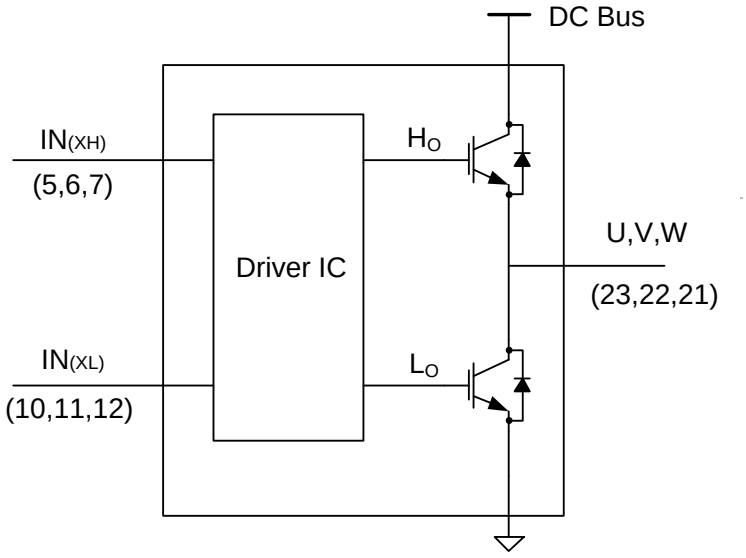


Figure 8.Input/Output Timing Diagram



Vsc	IN(XH)	IN(XL)	U,V,W
0	1	0	DC Bus
0	0	1	0
0	0	0	0
0	1	1	0
1	1	0	0
1	0	1	0

(X=U,V,W)

Figure 9.Input/OutputSignal Circuit

IPM Short-Circuit Protection Function

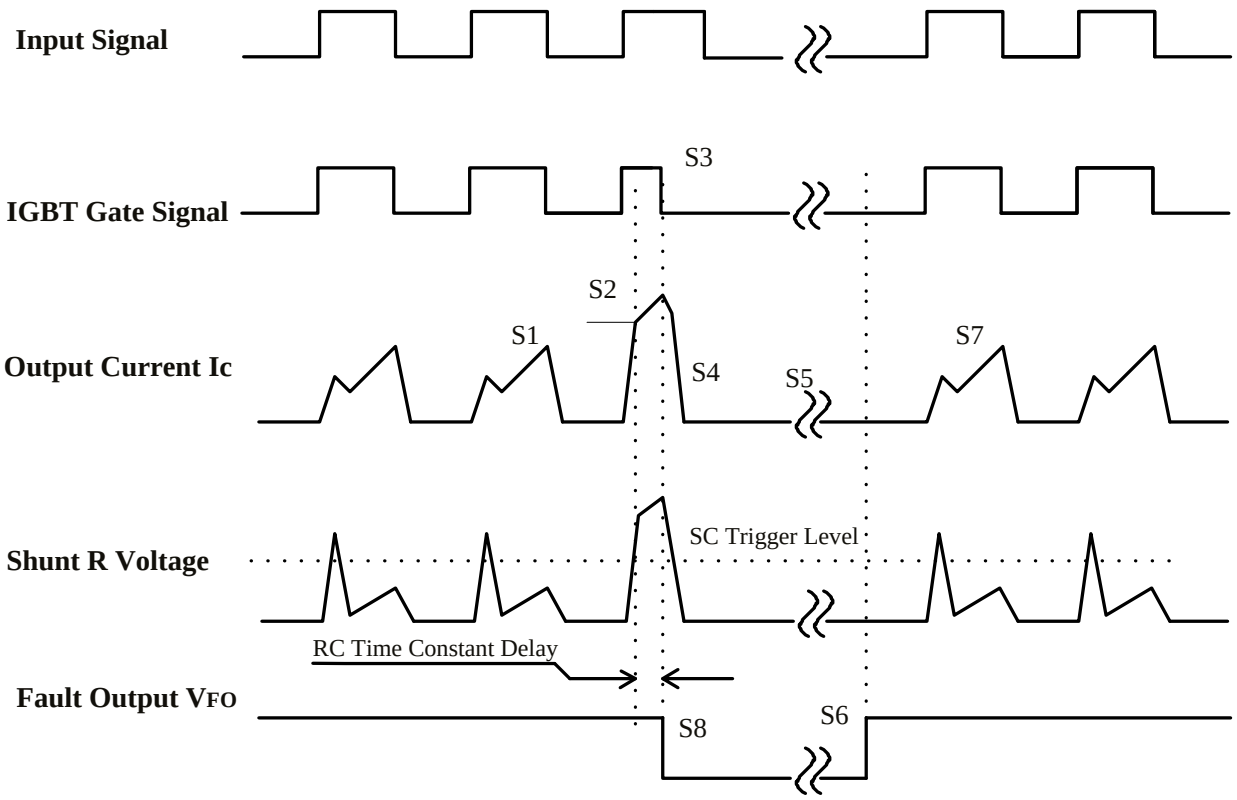


Figure 10. Timing Chart of SC Operation

S1. The IGBT's are controlled by input PWM signal.(Normal operation)

S2. Short circuit event occur and reach the limited level. (SC protection is trigger).

S3. IGBT gate driving signal is disabled.

S4. Current is cut off caused by IGBT turns OFF.

S5. Disabled state

S6. Fault level is kept on low level during the fault output activation

S7. IGBT returns for normal operation when fault state is reset

S8. Fault output startingonce SC protection is trigger.

IPM Under-Voltage Protection Function

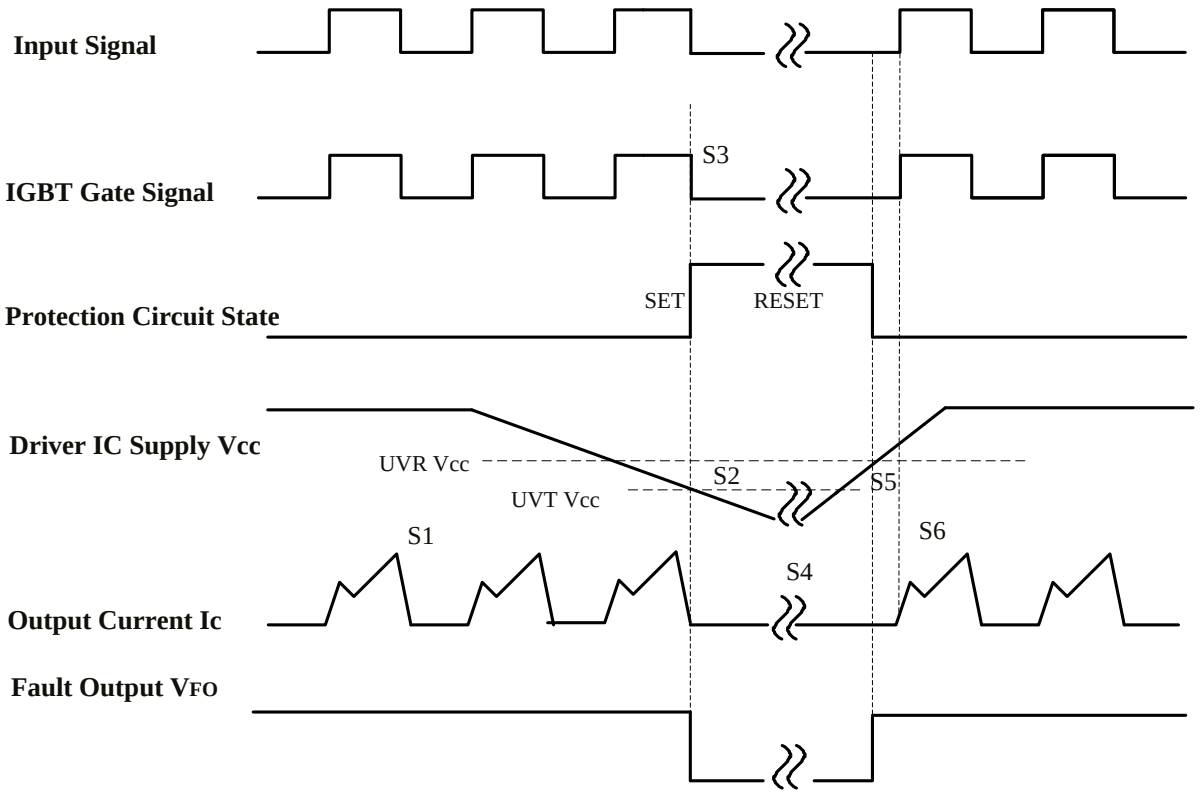


Figure11.Timing Chart of Under-Voltage Operation

S1. The IGBT's are controlled by input PWM signal.(Normal operation)
S2. Under-voltage protection is trigger
S3. IGBT driving signals are disabled when fault condition occur
S4. Fault state and the period will be able to control by external capacitor value.
S5. Under-voltage event is recovered
S6. IGBT returns for normal operation when fault state is reset

Direct Input (without Photo Coupler) Interface Example

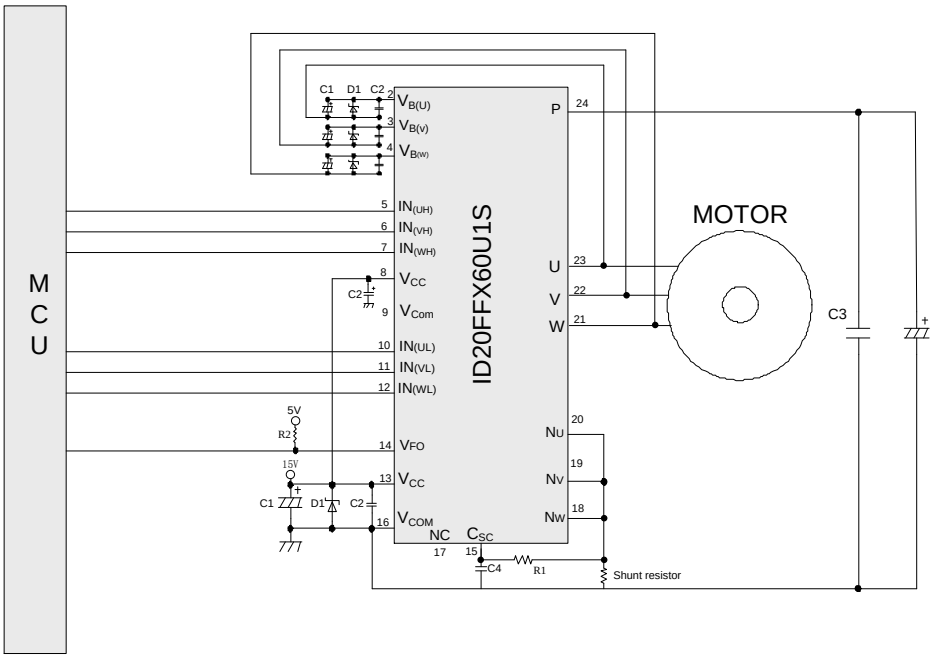


Figure12. Typical Application Circuit Interface Example without Photo-Coupler

Design reference:

1. R1 : 100Ω~1KΩ
2. R2 : 4.7~10KΩ (VFO output is open collector so to have a pull high resistor is needed.)
3. C1 : 10 ~ 100μF (Electrolytic, low impendence)
4. C2 :100 ~ 1000pF (Ceramic) (The capacitor could filter the noise, but should be careful to the dead time)
5. C4 :22nF ~ 44nF (Ceramic)
6. C8 : 220μF (Electrolytic, low impendence)
7. D1 : Zener diode (It is recommended to insert a Zener diode to prevent gate lifting and surge destruction)
8. Only connect either pin 9 or pin 16 to ground, do not connect both together to form the ground loop internally.

Current Sense Shceme

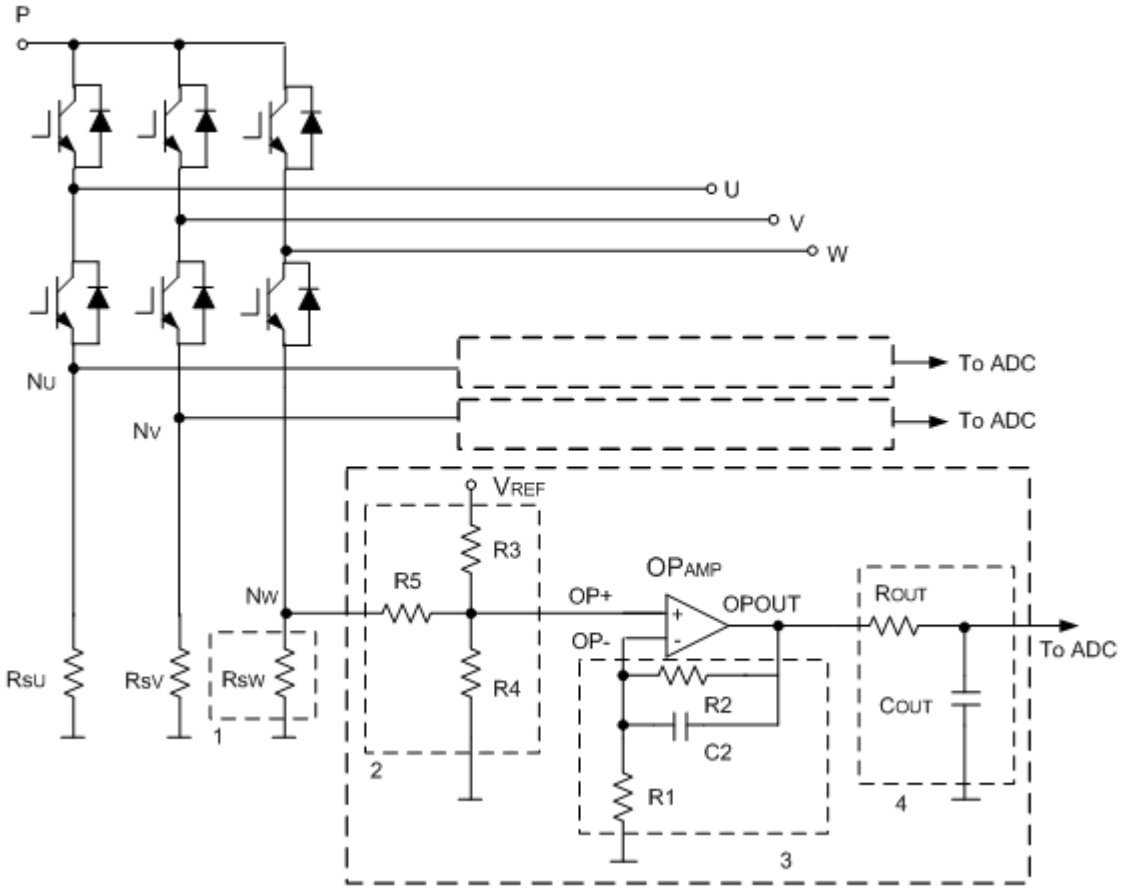


Figure13.Current Sense Scheme

Description :

1、Half-bridge current sensing
2、Voltage shifting of the V_{sense}
3、Voltage gain and filtering
4、Capacitor required by the ADC for sampling purpose

R_{OUT} resistor is usually required in order to make the OP_{AMP} stable when the C_{OUT} capacitance increases

Design Reference :

1. R1 :1.0 KΩ
2. R2 :5.6 KΩ
3. R3 :4.7 KΩ
4. R4: 910 Ω
5. R5 :910 Ω
6. ROUT : 1.0 KΩ
7. C2 :10pF (Ceramic)

Precautions on Electrostatic Electricity

(1) Operators must wear anti-static clothing and conductive shoes (or a leg or heel strap).

(2) Operators must wear a wrist strap grounded to earth via a resistor of about 1 MΩ.

(3) Soldering irons must be grounded from iron tip to earth, and must be used only at low voltages.

(4) If the tweezers you use are likely to touch the device terminals, use anti-static tweezers and in particular avoid metallic tweezers. If a charged device touches a low-resistance tool, rapid discharge can occur. When using vacuum tweezers, attach a conductive chucking pat to the tip, and connect it to a dedicated ground used especially for anti-static purposes (suggested resistance value: 10^4 to $10^8\Omega$).

(5) Do not place devices or their containers near sources of strong electrical fields (such as above a CRT).

(6) When storing printed circuit boards which have devices mounted on them, use a board container or bag that's protected against static charge. To avoid the occurrence of static charge or discharge due to friction, keep the boards separate from one other and do not stack them directly on top of one another.

(7) Ensure, if possible, that any articles (such as clipboards) which are brought to any location where the level of static electricity must be closely controlled are constructed of anti-static materials.

(8) In cases where the human body comes into direct contact with a device, be sure to wear anti-static finger covers or gloves (suggested resistance value: $10^8\Omega$ or less).

(9) Equipment safety covers installed near devices should have resistance ratings of $10^9\Omega$ or less.

(10) If a wrist strap cannot be used for some reason, and there is a possibility of imparting friction to devices, use an ionizer.

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