



Intelligent Power Module

BIP60020 is an advanced intelligent power module that BYD has newly developed and designed to provide very compact and high performance as ac motor drivers mainly targeting low-power inverter-driven applications like air conditioner and washing machine. It combines optimized circuit protection and drive matched to low-loss IGBT. System reliability is further enhanced by the integrated under-voltage lock-out and Over-current protection. The high speed built-in HVIC provides optocoupler less single-supply IGBT gate driving capability that further reduce the over all size of the inverter system design. Each phase current of inverter can be monitored separately due to the divided negative dc terminals.

- Three-phase inverter drive for small power ac motor control
- Home appliances applications like air conditioner and washing machine

- Very low thermal resistance due to using DBC
- 600V-20A 3-phase IGBT inverter bridge including control ICs for gate driving and protection
- Divided negative dc-link terminals for inverter current sensing applications
- Single-grounded power supply due to built-in HVIC
- Isolation rating of 2500Vrms/min

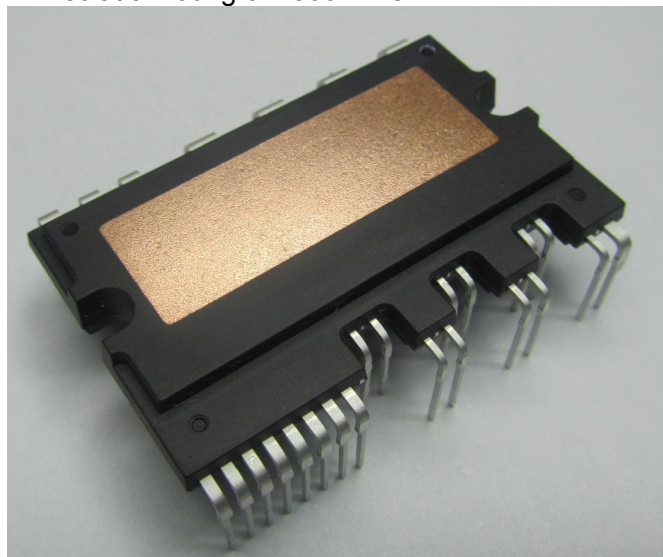
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Fig 1. Typical Application Circuit

Pin Configuration

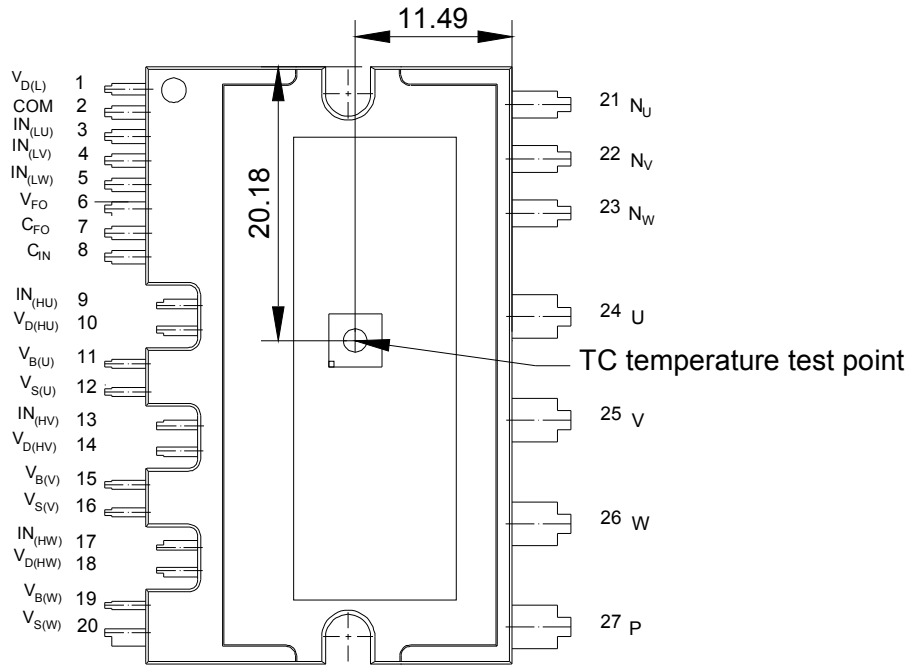


Fig 2. Pin Configuration(Top View)

Pin Descriptions

Pin	Name	Descriptions
1	$V_{D(L)}$	Low-side Common Bias Voltage for IC and IGBTs Driving
2	COM	Common Supply Ground
3	$IN_{(LU)}$	Signal Input for Low-side U Phase
4	$IN_{(LV)}$	Signal Input for Low-side V Phase
5	$IN_{(LW)}$	Signal Input for Low-side W Phase
6	V_{FO}	Fault Output
7	C_{FO}	Capacitor for Fault Output Duration Time Selection
8	C_{IN}	Capacitor (Low-pass Filter) for Over-Current Detection Input
9	$IN_{(HU)}$	Signal Input for High-side U Phase
10	$V_{D(HU)}$	High-side Bias Voltage for U Phase IC
11	$V_{B(U)}$	High-side Bias Voltage for U Phase IGBT Driving
12	$V_{S(U)}$	High-side Bias Voltage Ground for U Phase IGBT Driving
13	$IN_{(HV)}$	Signal Input for High-side V Phase
14	$V_{D(HV)}$	High-side Bias Voltage for V Phase IC
15	$V_{B(V)}$	High-side Bias Voltage for V Phase IGBT Driving
16	$V_{S(V)}$	High-side Bias Voltage Ground for V Phase IGBT Driving
17	$IN_{(HW)}$	Signal Input for High-side W Phase
18	$V_{D(HW)}$	High-side Bias Voltage for W Phase IC
19	$V_{B(W)}$	High-side Bias Voltage for W Phase IGBT Driving
20	$V_{S(W)}$	High-side Bias Voltage Ground for W Phase IGBT Driving
21	N_U	Negative DC-Link Input for U Phase
22	N_V	Negative DC-Link Input for V Phase



23	N _W	Negative DC-Link Input for W Phase
24	U	Output for U Phase
25	V	Output for V Phase
26	W	Output for W Phase
27	P	Positive DC-Link Input

Absolute Maximum Ratings (T_J = 25°C, unless otherwise noted)

Inverter Part

Symbol	Parameter	Conditions	Ratings	Units
V _{PN}	Supply voltage	Applied between P-N _U , N _V , N _W	450	V
V _{PN(surge)}	Supply voltage (surge)	Applied between P-N _U , N _V , N _W	500	V
V _{CES}	Collector-emitter voltage	V _{GE} =0V, I _{CES} =100uA, T _J =25°C	600	V
±I _C	Each IGBT collector current	T _C = 25°C	20	A
±I _{CP}	Each IGBT collector current (peak)	T _C = 25°C, less than 1ms	40	A
P _C	Collector dissipation	T _C = 25°C, per 1 chip	61	W
T _J	Junction temperature	(Note 1)	-20~+125	°C

Note 1 : The maximum junction temperature rating of the power chips integrated within the IPM is 150°C (@ T_C ≤ 100°C). However, to ensure safe operation of the IPM, the average junction temperature should be limited to T_J(ave) ≤ 125°C (@ T_C ≤ 100°C).

Control Part

Symbol	Parameter	Conditions	Ratings	Units
V _D	Control supply voltage	Applied between V _{D(HU)} , V _{D(HV)} , V _{D(HW)} , V _{D(L)} -COM	20	V
V _{DB}	Control supply voltage	Applied between V _{B(U)} -V _{S(U)} , V _{B(V)} -V _{S(V)} , V _{B(W)} -V _{S(W)}	20	V
V _{IN}	Input voltage	Applied between IN _(HU) , IN _(HV) , IN _(HW) , IN _(LU) , IN _(LV) , IN _(LW)	-0.3~7	V
V _{FO}	Fault output supply voltage	Applied between V _{FO} -COM	-0.3~V _D +0.3	V
I _{FO}	Fault output current	Sink current at V _{FO} terminal	5.0	mA
V _{CIN}	Current sensing input voltage	Applied between C _{IN} -COM	-0.3~V _D +0.3	V

Total System

Symbol	Parameter	Conditions	Ratings	Units
V _{PN(PROT)}	Self protection supply voltage limit (short circuit protection capability)	V _D = 13.5~16.5V, Inverter part T _J = 125°C, non-repetitive, less than 5us	400	V
T _C	Module case operation temperature	-20 °C ≤ T _J ≤ 125 °C	-20~+100	°C
T _{STG}	Storage temperature		-40~+125	°C
V _{ISO}	Isolation voltage	60Hz, Sinusoidal, AC 1 minute, connecting pins to heat-sink plate	2500	Vrms

Thermal Resistance

Symbol	Parameter	Conditions	Limits			Units
			Min.	Typ.	Max.	
Rth(j-c)Q	Junction to case thermal resistance	Inverter IGBT part (per 1/6 module)	-	-	1.63	°C/W
Rth(j-c)F		Inverter FRD part (per 1/6 module)	-	-	2.48	°C/W

Electrical Characteristics (T_J = 25°C, unless otherwise noted)

Inverter Part

Symbol	Parameter	Conditions	Limits			Units
			Min.	Typ.	Max.	
V _{CE(SAT)}	Collector-Emitter Saturation Voltage	V _D =V _{BS} =15V, V _{IN} =5V, I _C =20A, T _J =25°C	---	2	2.3	V
V _F	FRD Forward Voltage	V _{IN} =0V, I _C =15A, T _J =25°C	---	1.9	2.3	
HS	ton	V _{PN} =300V, V _D =V _{BS} =15V I _C = 20A, V _{IN} = 0 ↔ 5V Inductive load (Note 2)	---	720	---	ns
	tc(on)		---	340	---	
	toff		---	940	---	
	tc(off)		---	220	---	
LS	ton		---	780	---	
	tc(on)		---	390	---	
	toff		---	1225	---	
	tc(off)		---	265	---	
I _{CES}	Collector-Emitter Leakage Current	V _{CE} =V _{CES} , V _{GE} =0V, T _J =25°C	---	---	100	μA

Note 2 : ton and toff include the propagation delay time of the internal drive IC. tc(on) and tc(off) are the switching time of IGBT itself under the given gate driving condition internally. See figure 3.

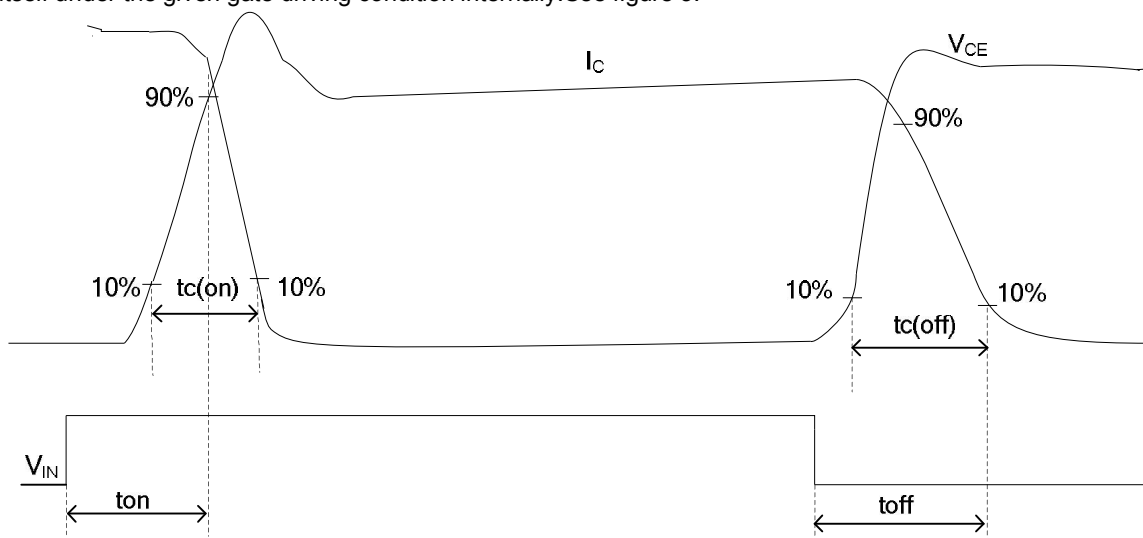


Fig 3. Switching Time Definition

Control Part

Symbol	Parameter	Conditions	Limits			Units
			Min.	Typ.	Max.	
I_{DL}	Quiescent V_D Supply Current	$V_D=15V, IN_{(LU, LV, LW)}=0V$	---	---	450	μA
I_{DH}		$V_D=15V, IN_{(HU, HV, HW)}=0V$	---	---	400	μA
I_{QBS}	Quiescent V_{BS} Supply Current	$V_{BS}=15V, IN_{(HU, HV, HW)}=0V$	---	---	90	μA
V_{FOH}	Fault Output Voltage	$V_{SC}=0V, V_{FO}$ Circuit: 4.7K to 5V Pull-up	4.5	---	---	V
V_{FOL}		$V_{SC}=1V, V_{FO}$ Circuit: 4.7K to 5V Pull-up	---	---	0.8	
$V_{CIN(ref)}$	Short Circuit Trip Level	$TC = -20 \sim 100^{\circ}C, V_D = 15V$ (Note3)	0.44	0.51	0.56	
UV_{DD}	Supply Circuit Under-Voltage Protection	Detection Level (LS)	11.1	12.5	13.3	V
UV_{DR}		Rest Level (LS)	12.1	13.5	14.3	
UV_{BSD}		Detection Level (HS)	8.8	10.1	11.2	
UV_{BSR}		Rest Level (HS)	9.8	11.1	12.2	
t_{FO}	Fault-out Pulse Width	$C_{FO}=26nF$ (Note4)	---	1.80	---	ms
		$C_{FO}=33nF$ (Note4)	---	2.30	---	
$V_{IN(ON)}$	ON Threshold Voltage	Applied between $IN_{(HU)}, IN_{(HV)}, IN_{(HW)}, IN_{(LU)}, IN_{(LV)}, IN_{(LW)}$ -COM	3.0	---	---	V
$V_{IN(OFF)}$	OFF Threshold Voltage		---	---	0.8	

Note 3 : Short circuit protection is functioning only at the low-arms.

Note 4 : The fault output pulsewidth t_{FO} depends on the capacitance value of C_{FO} according to the following approximate equation : $C_{FO} \approx 14.3 * 10^{-6} * t_{FO} [F]$.

Mechanical Characteristics and Ratings

Parameter	Conditions	Limits			Units
		Min.	Typ.	Max.	
Mounting Torque	Mounting Screw: - M3	0.51	0.62	0.72	N.m
Weight		---	15.0	---	g
Device Flatness	(See Fig.4)	0	---	120	μm

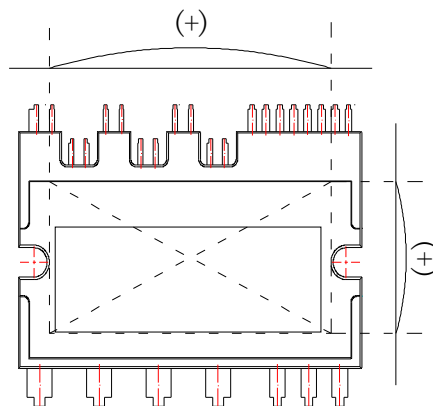


Fig 4. Flatness Measurement Position

Recommended Operating Conditions

Symbol	Parameter	Conditions	Recommended value			
			Min.	Typ.	Max.	Units
V_{PN}	Supply Voltage	Applied between P – N_U, N_V, N_W	---	300	400	V
V_D	Control Supply Voltage	Applied between $V_{D(HU)}, V_{D(HV)}, V_{D(HW)}, V_{D(L)}-COM$	13.5	15	16.5	
V_{BS}	High-side Bias Voltage	Applied between $V_{B(U)} - V_{S(U)}, V_{B(V)} - V_{S(V)}, V_{B(W)} - V_{S(W)}$	13.0	15	18.5	
$\Delta V_D, \Delta V_{DB}$	Control Supply variation		-1	---	1	V/ μs
t_{DEAD}	Blanking Time for Preventing Arm-short	For Each Input Signal	2.0	---	---	μs
f_{PWM}	PWM Input Signal	$-20^{\circ}C \leq T_C \leq 100^{\circ}C, -20^{\circ}C \leq T_J \leq 125^{\circ}C$	---	---	20	KHz
V_{SEN}	Voltage for Current Sensing	Applied between $N_U, N_V, N_W - COM$ (Including surge voltage)	-4	---	4	V

Time charts of IPM Protection Function

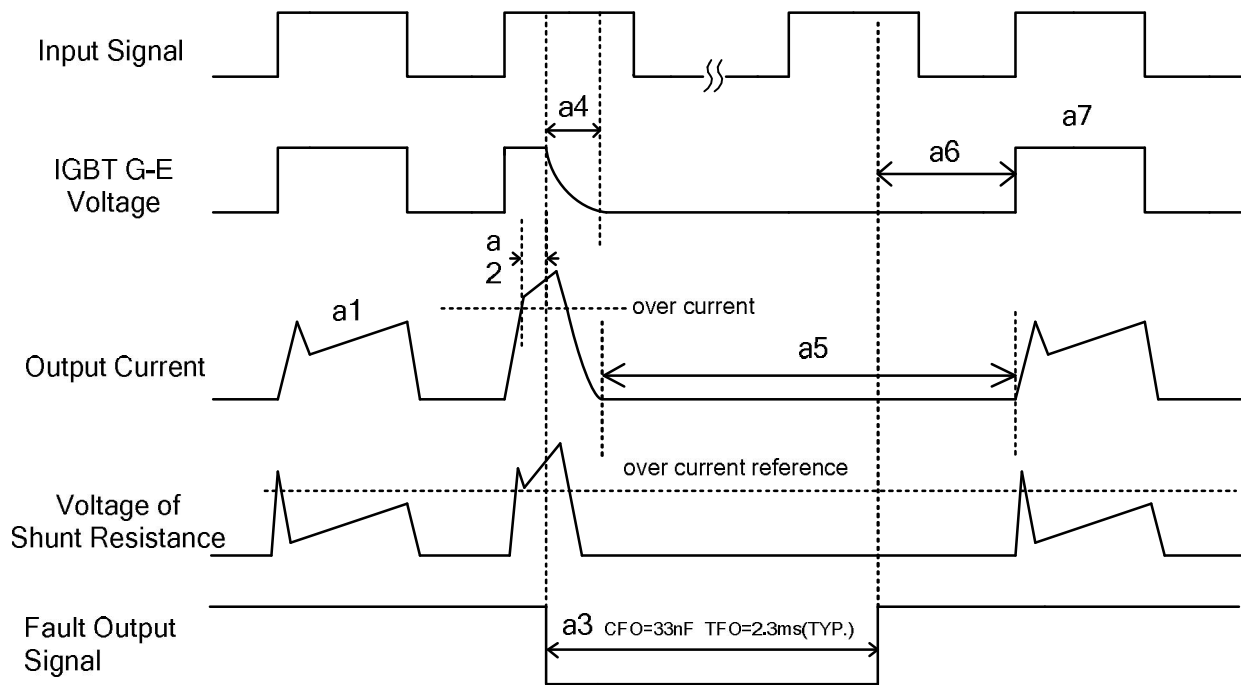


Fig 5.Over current protection

(with the external shunt resistance and RC connection)

- a1 Normal operation: IGBT ON and carrying current
- a2 Over current detection
- a3 Fault output timer operation starts: The pulse width of the FO is set by the external capacitor C_{FO}
- a4 IGBT turns off softly
- a5 IGBT OFF state
- a6 Output synchronised with input
- a7 Normal operation: IGBT ON and carrying current

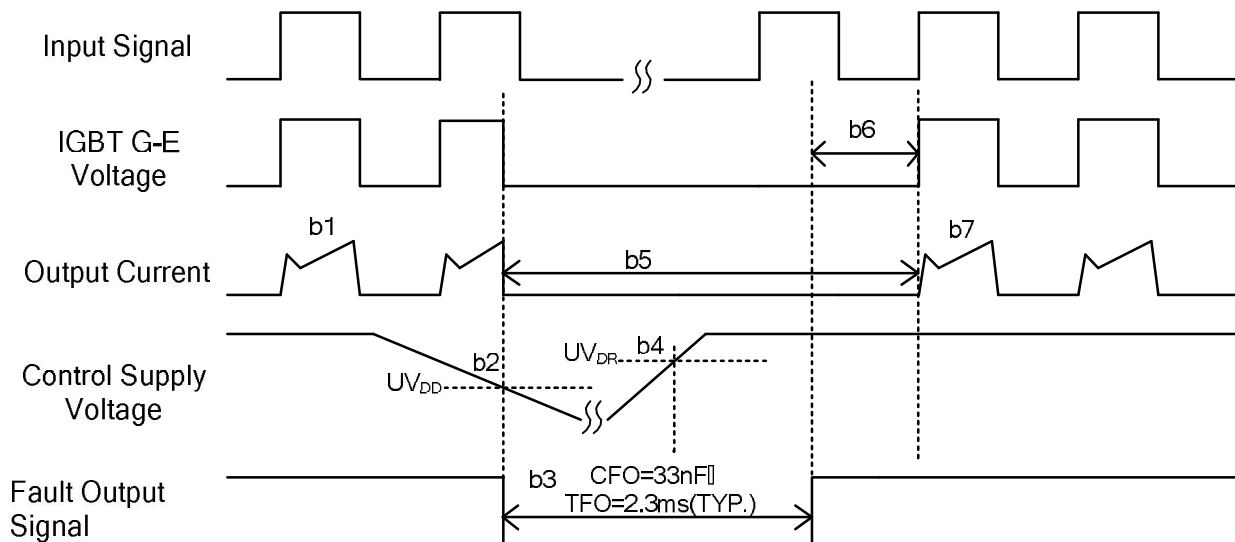


Fig 6.Under-Voltage Protection of Low-side

- b1** Normal operation: IGBT ON and carrying current
- b2** Under voltage detection (UV_{DD})
- b3** Fault output timer operation starts: The pulse width of the FO is set by the external capacitor C_{FO}
- b4** Under voltage reset (UV_{DR})
- b5** IGBT OFF state
- b6** Output synchronised with input
- b7** Normal operation: IGBT ON and carrying current

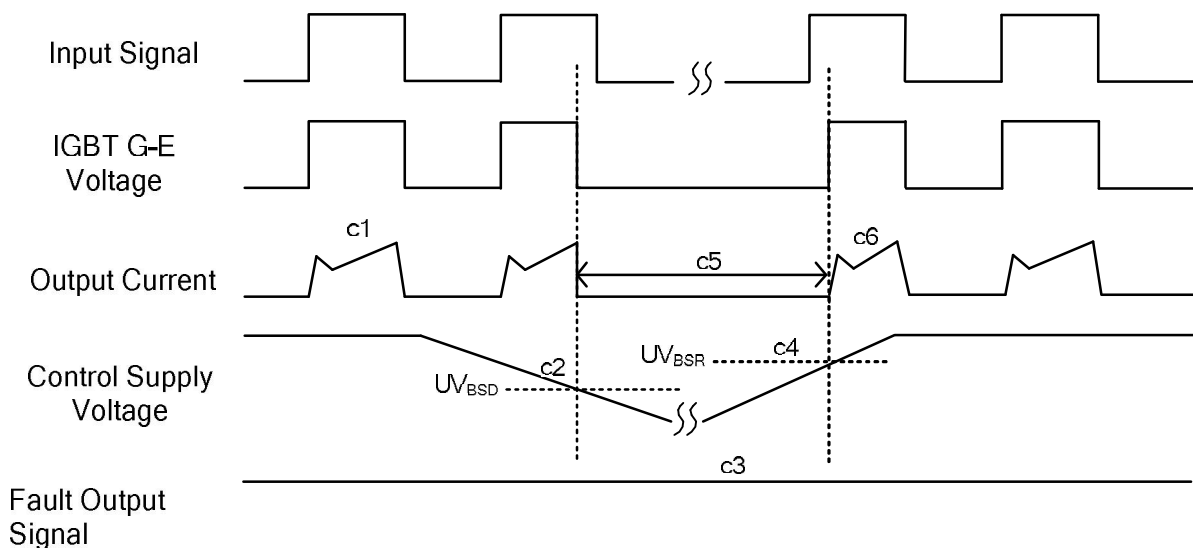


Fig 7.Under-Voltage Protection of High-side

- c1** Normal operation: IGBT ON and carrying current
- c2** Under voltage detection (UV_{BSD})
- c3** No fault output signal
- c4** Under voltage reset (UV_{BSR})
- c5** IGBT OFF state
- c6** Normal operation: IGBT ON and carrying current

Internal Equivalent Circuit and Input/Output Pins

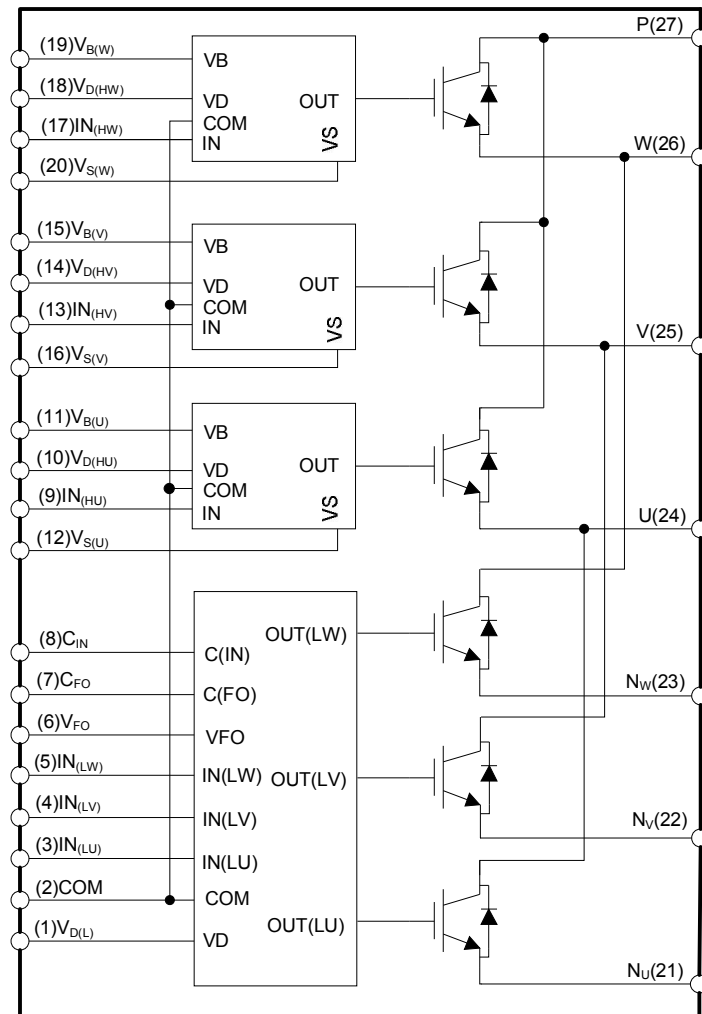


Fig 8.

Note:

1. Inverter low-side is composed of three IGBTs, FRD for each IGBT and one control IC. It has gate drive and protection functions.
2. Inverter power side is composed of four inverter dc-link input terminals and three inverter output terminals.
3. Inverter high-side is composed of three IGBTs, FRDs and three drive ICs for each IGBT.



Detailed Package Outline Drawings (Unit: mm)

Package: BIP27-4426

