



BIPN60020C

Intelligent Power Module

General Description

BIPN60020C 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.

Package Features

BIP27-4426

- 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 and bootstrap diode
- Isolation rating of 2500Vrms/min



Applications

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

Typical Application Circuit

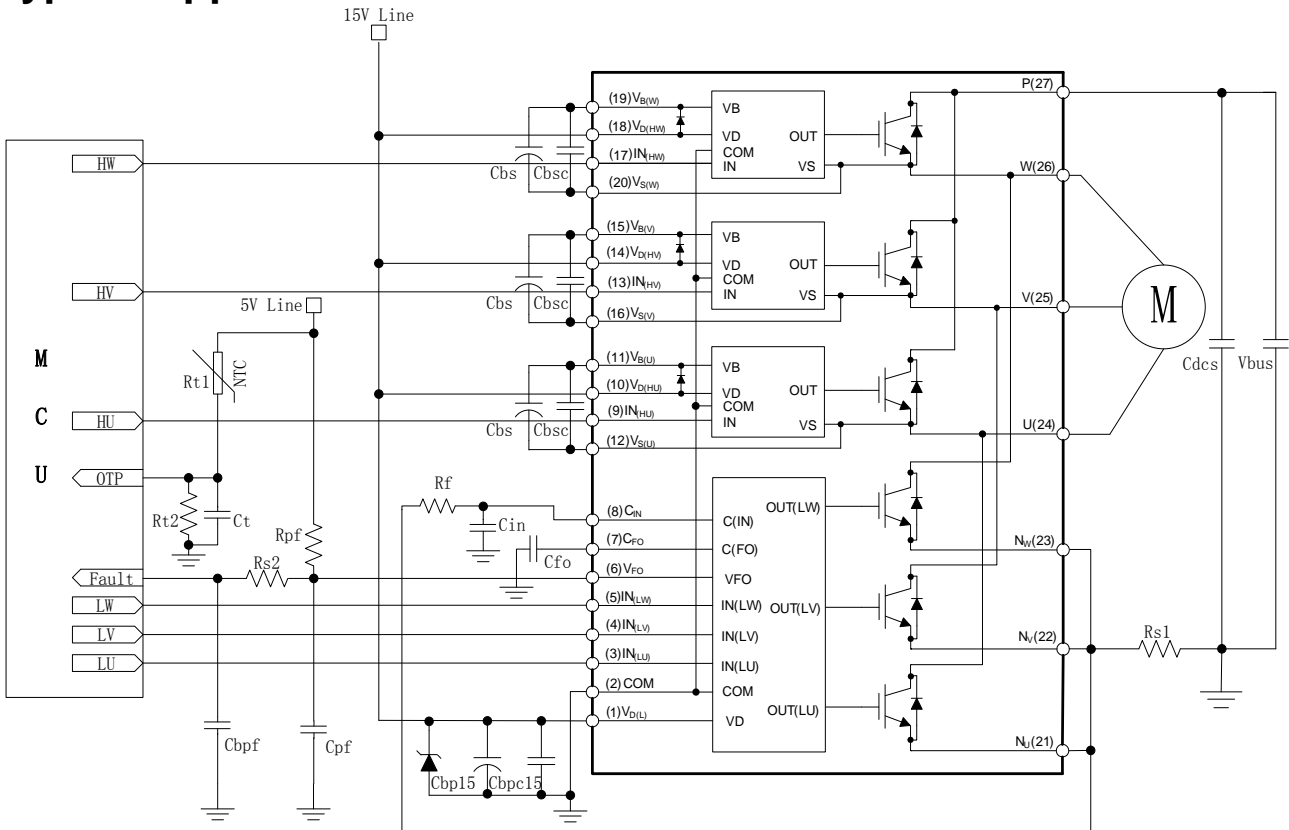


Fig 1. Typical Application Circuit

Pin Configuration

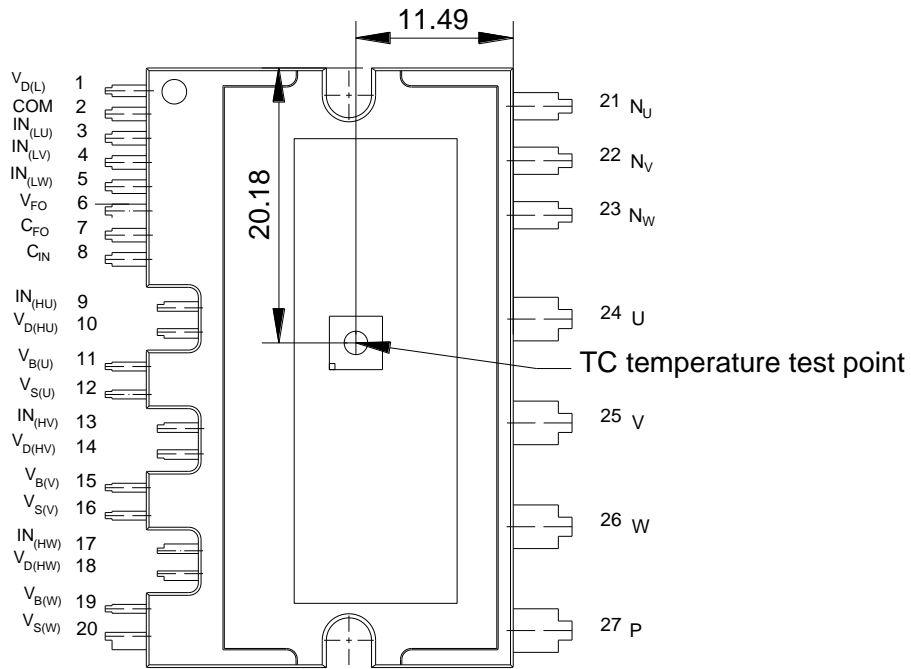


Fig 2. Pin Configuration(Top View)

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) -COM	-0.3~V _D +0.3	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

Bootstrap Diode Part

Symbol	Parameter	Conditions	Ratings	Units
V _{RRM}	Maximum Repetitive Reverse Voltage		600	V
I _F	Forward Current	T _C = 25°C	0.5	A
I _{FP}	Forward Current (Peak)	T _C = 25°C, Under 1ms Pulse Width	2	A
T _J	Junction temperature		-20~+125	°C

Total System



Symbol	Parameter	Conditions	Ratings	Units
$V_{PN(Prot)}$	Self protection supply voltage limit (short circuit protection capability)	$V_D = 13.5\sim 16.5V$, inverter part $T_J = 125^\circ C$, non-repetitive, less than 5us	400	V
T_C	Module case operation temperature	$-20^\circ C \leq T_J \leq 125^\circ C$	-20~+100	$^\circ C$
T_{STG}	Storage temperature		-40~+125	$^\circ C$
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.	
$R_{th(j-c)Q}$	Junction to case thermal resistance	Inverter IGBT part (per 1/6 module)	-	-	1.63	$^\circ C/W$
$R_{th(j-c)F}$		Inverter FRD part (per 1/6 module)	-	-	2.48	$^\circ C/W$

Electrical Characteristics ($T_J = 25^\circ C$, unless otherwise noted)

Inverter Part

Symbol	Parameter	Conditions	Limits			Units
			Min.	Typ.	Max.	
$V_{CE(SAT)}$	Collector-emitter saturation voltage	$V_D = V_{BS} = 15V, V_{IN} = 5V, I_C = 20A, T_J = 25^\circ C$	---	2.0	2.3	V
V_F	FRD forward voltage	$V_{IN} = 0V, I_C = 15A, T_J = 25^\circ C$	---	1.9	2.3	
HS	ton	$V_{PN} = 300V, V_D = V_{BS} = 15V$ $I_C = 20A, V_{IN} = 0 \leftrightarrow 5V$ 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	$V_{CE} = V_{CES}, V_{GE} = 0V, T_J = 25^\circ C$	---	---	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.

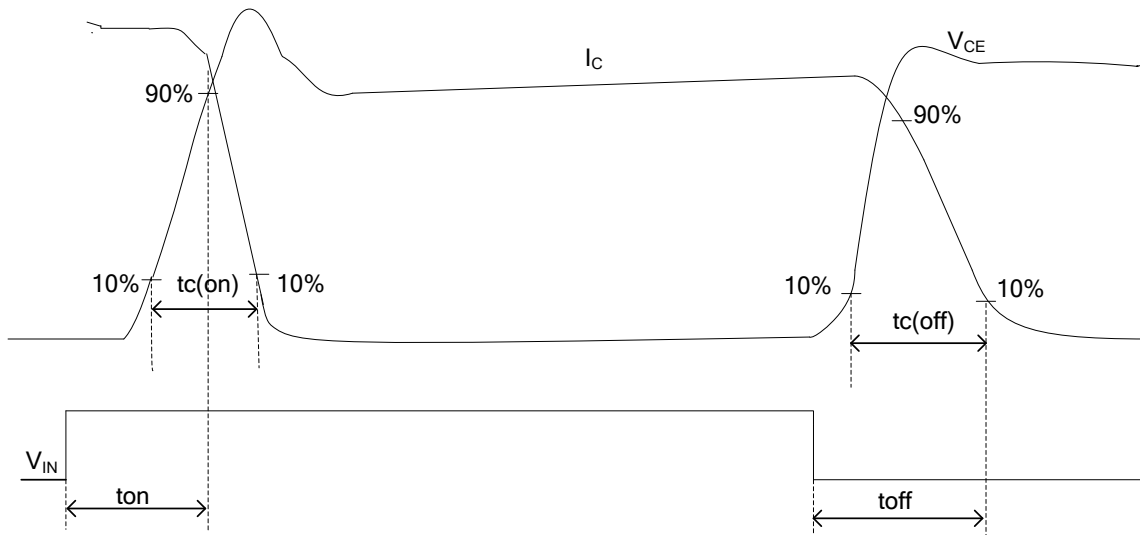


Fig 3. Switching Time Definition

Control Part

Symbol	Parameter	Conditions	Limits			Units
			Min.	Typ.	Max.	
I_{DL}	Quiescent V_D supply current	$V_D=15V, IN_{(LU,LV, LW)}=0V$	---	---	600	μA
I_{DH}		$V_D=15V, IN_{(HU,HV, HW)}=0V$	---	---	300	μA
I_{QBS}	Quiescent V_{BS} supply current	$V_{BS}=15V, IN_{(HU,HV, HW)}=0V$	---	---	150	
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 = -20~100°C, $V_D = 15V$ (Note3)	0.44	0.51	0.56	
UV_{DLD}	Supply circuit under-voltage protection	Detection level (LS)	11.0	12.0	13.0	V
UV_{DLR}		Rest level (LS)	12.0	13.0	14.0	
UV_{BSD}		Detection level (HS)	9.0	10.0	11.0	
UV_{BSR}		Rest level (HS)	10.0	11.0	12.0	
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-side.

Note 4 : The fault output pulse-width 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].

Bootstrap Diode Part

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Units
V_F	Forward Voltage	$I_F = 0.5A, T_C = 25^\circ C$	---	1.15	---	V
t_{rr}	Reverse Recovery Time	$I_F = 0.5A, T_C = 25^\circ C$	---	40	---	ns

Mechanical Characteristics and Ratings

Parameter	Conditions		Limits			Units
			Min.	Typ.	Max.	
Mounting torque	Mounting screw: - M3	Recommended 0.62N.m	0.51	0.62	0.72	N.m
Weight			---	15.0	---	g
Device flatness		(See Fig 4)	0	---	120	um

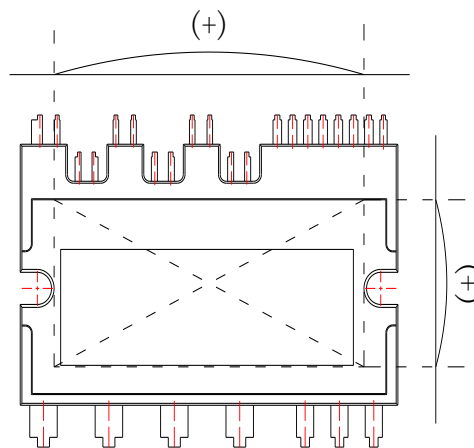


Fig 4. Flatness Measurement Position

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	15.0	16.5	
V_{BS}	High-side bias voltage	Applied between $V_{B(U)}-V_{S(U)}, V_{B(V)}-V_{S(V)}, V_{B(W)}-V_{S(W)}$	13.5	15.0	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}	PWMinput 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

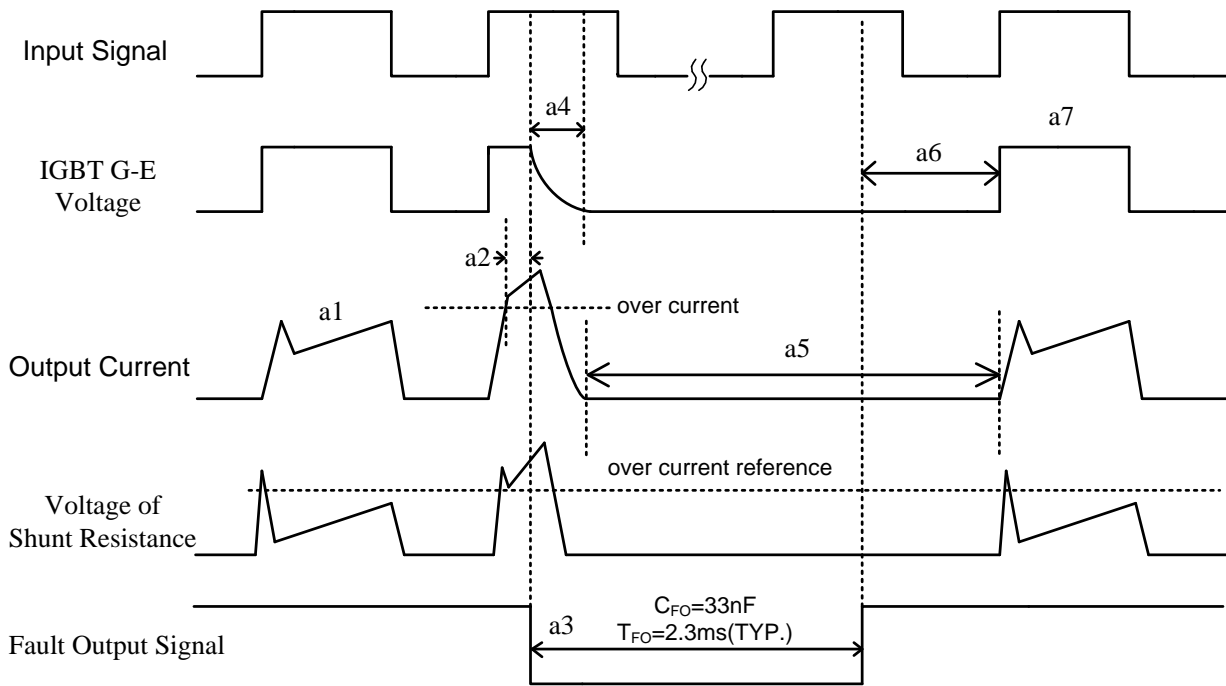


Fig 5.Over Current Protection

(Low-side only ,with the external shunt resistance and RC filter)

- a1 Normal operation: IGBT ON and carrying current
- a2 Over current detection and filter
- a3 Fault output timer operation starts: The pulse width of the V_{FO} is set by the external capacitor C_{FO}
- a4 IGBT turns off softly
- a5 IGBT OFF state
- a6 V_{FO} finishes output, but IGBTs don't turn on until inputting next ON signal.
- a7 Normal operation: IGBT ON and outputs current by next ON signal(L→H).

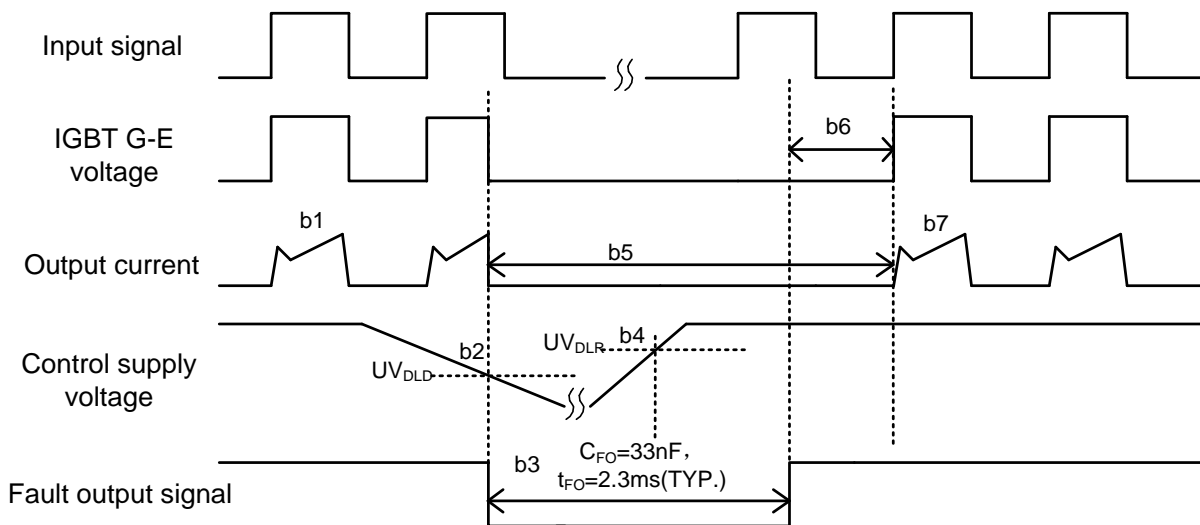


Fig 6.Under-Voltage Protection of Low-side

- b1 Normal operation: IGBT ON and carrying current
- b2 Under voltage detection (UV_{DLD})
- b3 Fault output timer operation starts: The pulse width of the V_{FO} is set by the external capacitor C_{FO}
- b4 Under voltage reset (UV_{DLR})
- b5 IGBT OFF state
- b6 VFO finishes output, but IGBTs don't turn on until inputting next ON signal.
- b7 Normal operation: IGBT ON and outputs current by next ON signal(L→H).

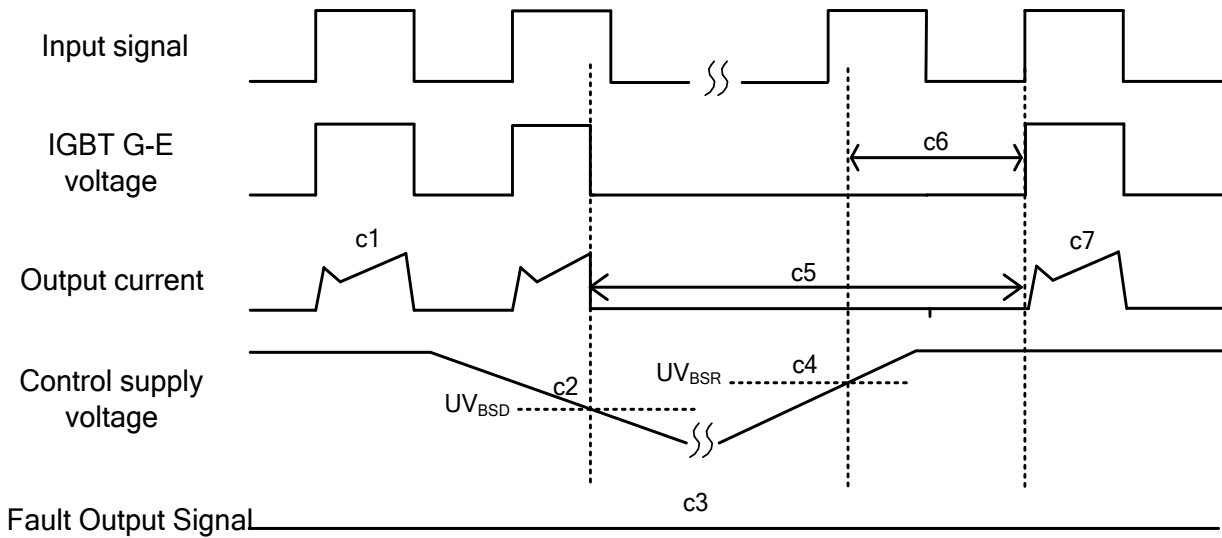


Fig 7.Under-Voltage Protection of High-side

- 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 Under voltage reset, but IGBTs don't turn on until inputting next ON signal.
- c7 Normal operation: IGBT ON and outputs current by next ON signal(L→H).

Internal Equivalent Circuit and Input/Output Pins

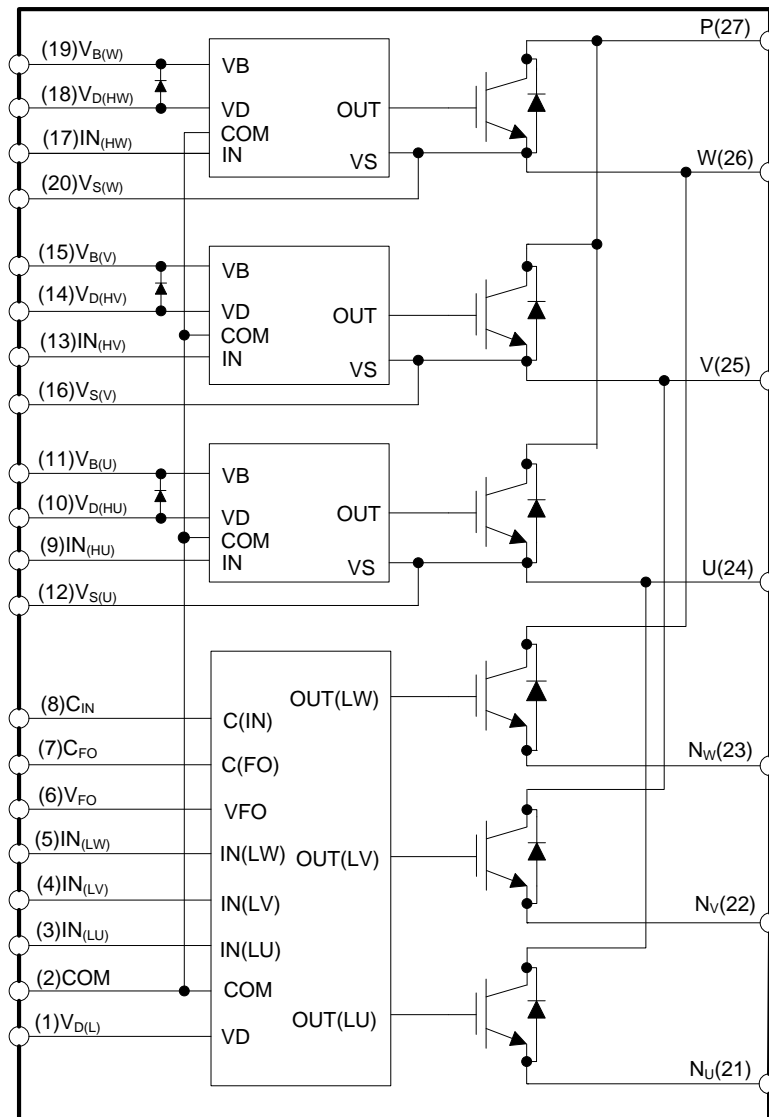


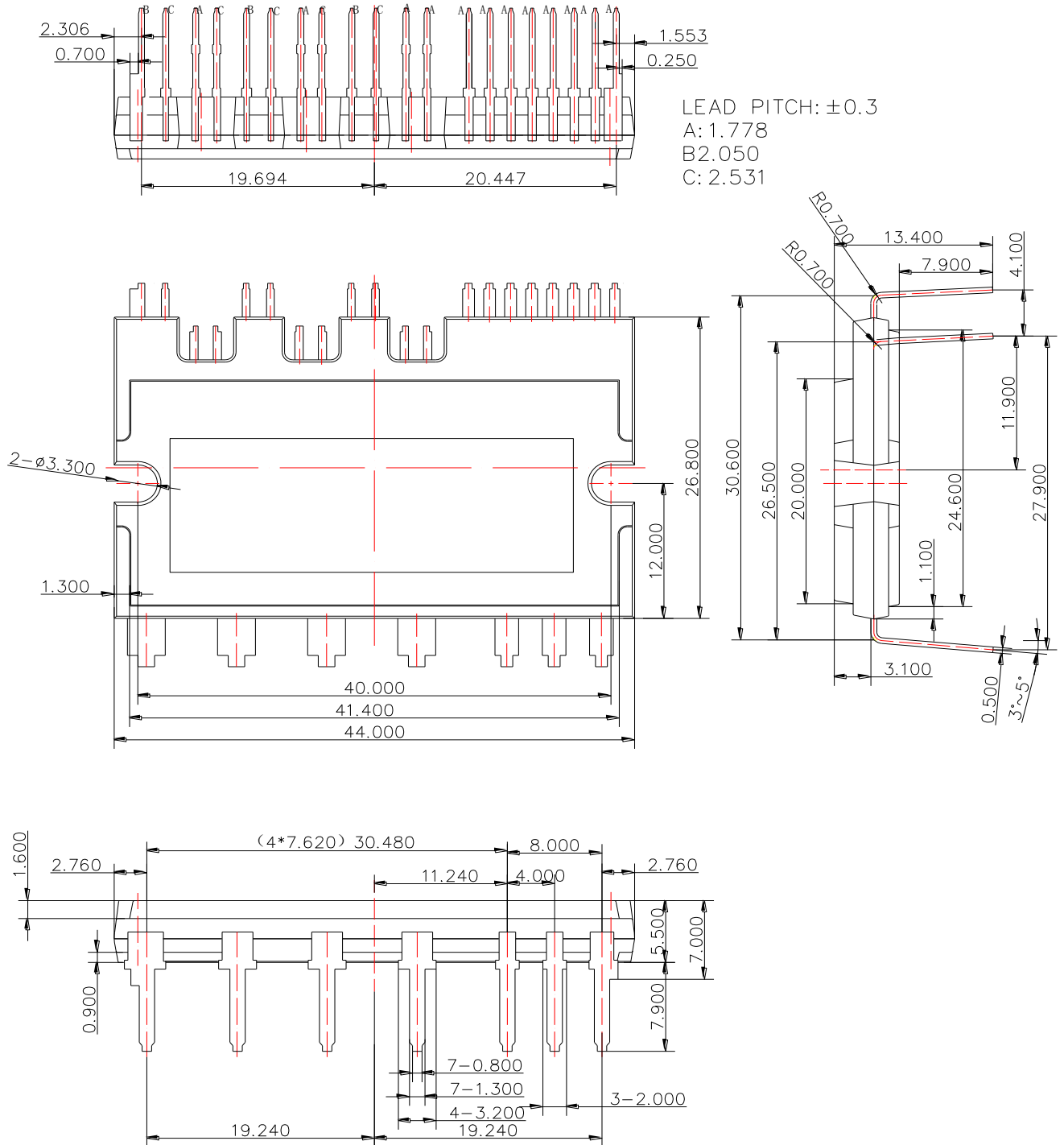
Fig 8. Internal Equivalent Circuit and Input/Output Pins

Note:

1. Inverter low-side is composed of three IGBTs, freewheeling diodes 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, freewheeling diodes, bootstrap diodes and three drive ICs for each IGBT

Detailed Package Outline Drawings (Unit: mm)

Package: BIP27-4426



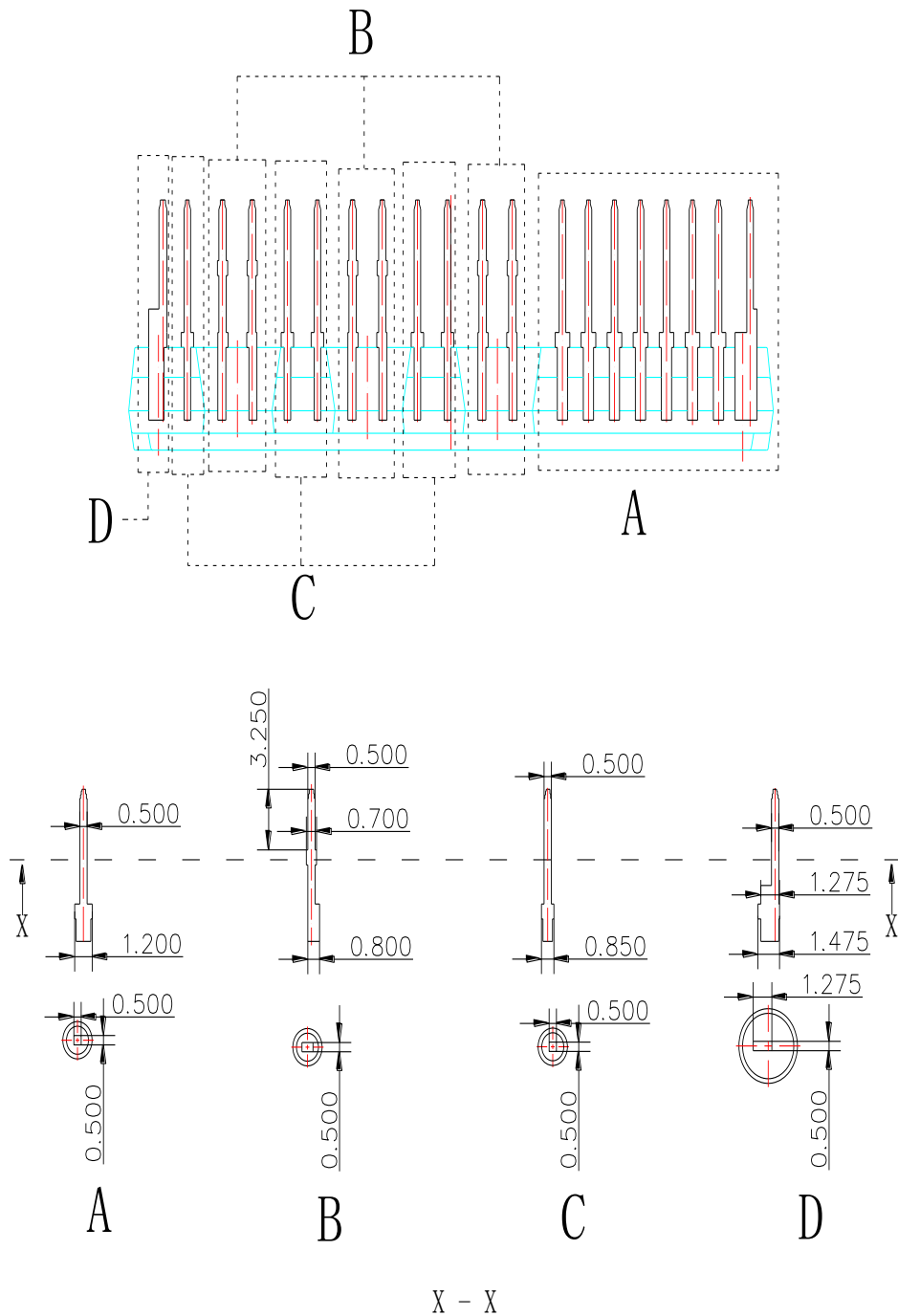


Fig 9.Detailed Package Outline Drawings

Packing

package	pcs/tube	tube/ inner box	inner box/ carton	pcs/carton
tube	10	7	5	350



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