DIP-25

Intelligent Power

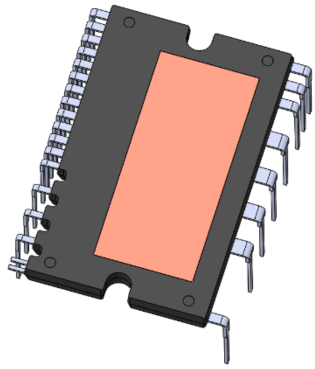
Module 600V / 30A IGBT

SS060N030DIP25

Confidential, Shared Under NDA

Rev 0.6

Description



- DIP25 is a highly integrated and reliable three phase brushless DC motor drive circuit, which is mainly used in low power variable frequency drives, such as air conditioners, refrigerators, washing machines, etc.

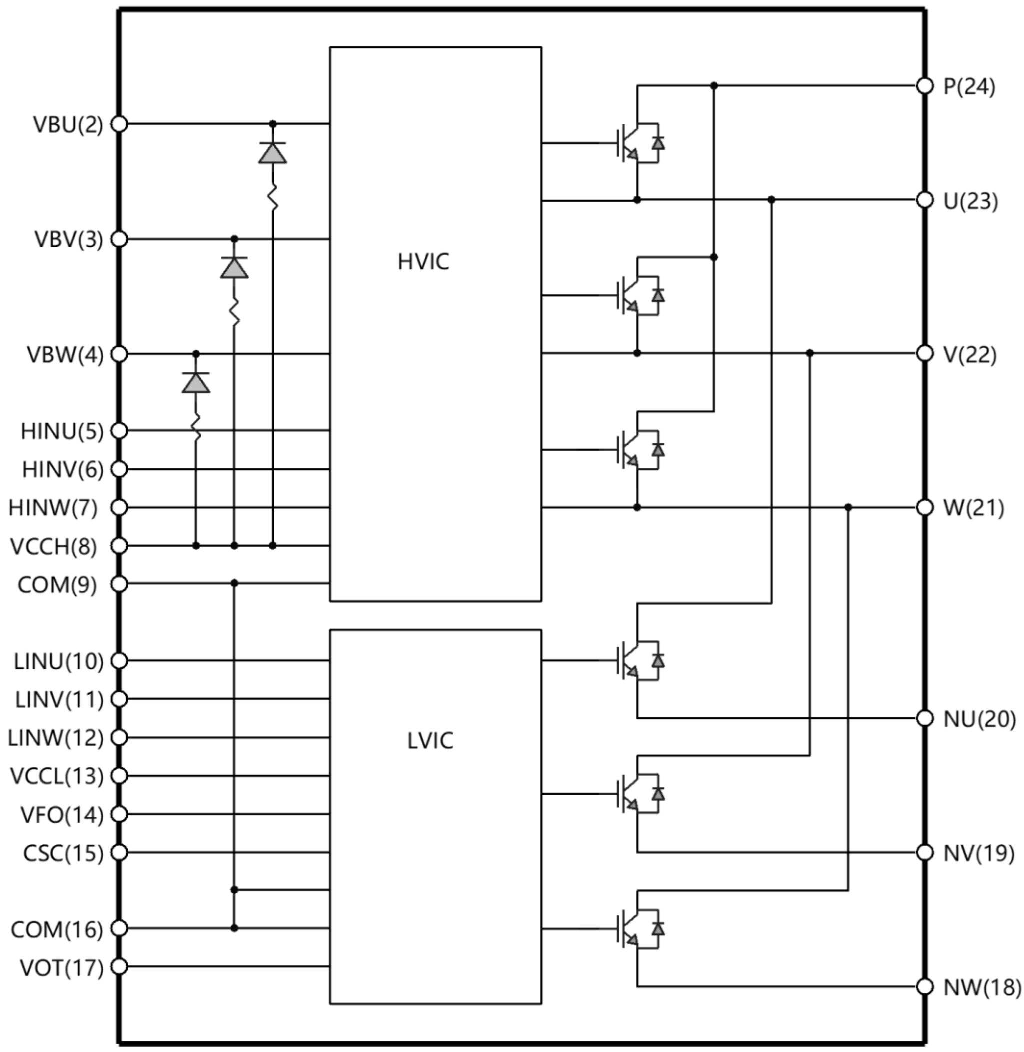
Features

- Built-in 6 low loss 600V/30A IGBT&FRD
- Built-in bootstrap diodes with current limiting resistor
- Built-in under voltage protection and over temperature, over current protection and temperature output

Applications

- AC 100~240V (DC voltage:400V or below) three phase low power motor inverter drive

INTERNAL CIRCUIT



MAXIMUM RATINGS (T_j = 25°C, unless otherwise noted)

Table 1 Inverter Part

Symbol	Parameter	Conditions	Ratings	Unit
V_{PN}	Supply voltage	Applied between P-NU,NV,NW	450	V
$V_{PN(surge)}$	Supply voltage (surge)	Applied between P-NU,NV,NW	500	V
V_{CE}	Collector-emitter voltage	T_C = 25 °C	600	V
$\pm I_C$	Each IGBT collector current	T_C = 25 °C	30	A
$\pm I_{cp}$	Each IGBT collector current(peak)	T_C = 25 °C,less than 1ms	60	A
T_j	Junction temperature		-40 to +150	°C

Table 2 Control Part

Symbol	Parameter	Conditions	Ratings	Unit
V_D	Control supply voltage	Applied between VCCH-COM,VCCL-COM	20	V
V_{DB}	Control supply voltage(high side)	Applied between VBU-U, VBV-V,VBW-W	20	V
V_{IN}	Input voltage	Applied between HINU,HINV,HINW,LINU,LINV,LINW-COM	-0.5~V_D+0.5	V
V_{FO}	Fault output supply voltage	Applied between F_O-COM	-0.5~V_D+0.5	V
I_{FO}	Fault output current	Sink current at F_O terminal	1	mA
V_{SC}	Current sensing input voltage	Applied between CSC-COM	-0.5~V_D+0.5	V

Table 3 Total System

Symbol	Parameter	Conditions	Ratings	Unit
$V_{PN(PORT)}$	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 2us	400	V
T_C	Module case operation temperature	Measurement point of Tc is described in Fig.1	-30 to +105	°C
T_{STG}	Storage temperature		-40 to +125	°C
V_{ISO}	Isolation voltage	60Hz, Sinusoidal, AC 1min, between connected all pins and heat sink plate	2000	V_{rms}
T	Mounting torque	Recommended torque : 0.62 N.m	0.5-0.75	N.m

Fig. 1 T_C MEASUREMENT POINT

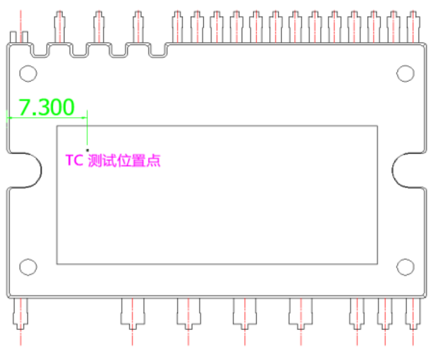


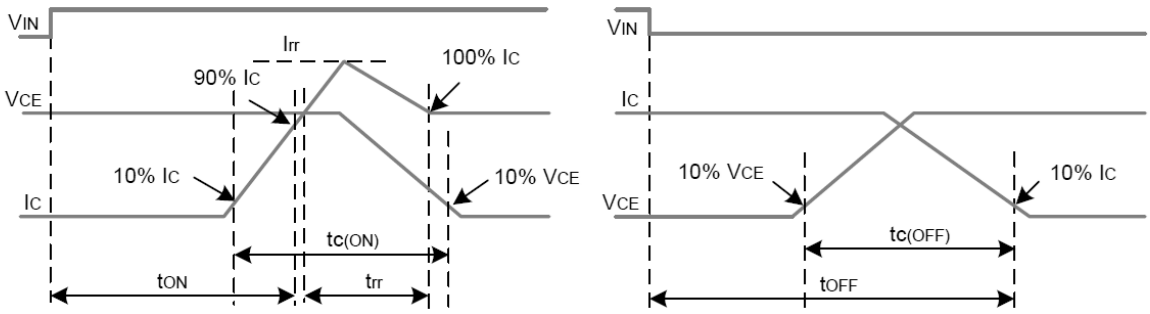
Table 4 Thermal Resistance

Symbol	Parameter	Conditions	Limits			Unit
			Min.	Typ.	Max.	
$R_{th(j-c)Q}$	Junction to case thermal resistance	Inverter IGBT part (per 1/6 module)	-	-	1.8	K/W
$R_{th(j-c)F}$	Junction to case thermal resistance	Inverter FRD part (per 1/6 module)	-	-	2.0	K/W

ELECTRICAL CHARACTERISTICS (T=25°C, unless otherwise noted)

Table 5 Inverter Part

Symbol	Parameter	condition		Limits Min.	Limits Typ.	Limits Max.	Unit
$V_{CE(sat)}$	Collector-emitter saturation voltage	VCC=VBS = 15V, VIN= 5V	I_C= 30A, Tj= 25°C	-	1.7	2.0	V
			I_C= 30A, Tj= 125°C	-	1.85	2.3	
V_F	Forward voltage	VIN= 0V	I_F= -30A,T_J=25°C	-	2.35	2.5	V
			I_F= -30A,T_J=125°C	-	2.45	2.6	V
t_{on}	Switching times	V_{PN}= 400V, V_{CC}= V_{BS}= 15V I_C= 30A, T_j= 125°C, V_{IN}= 0↔5V Inductive Load (upper-lower arm)		-	1.0	2.0	μs
$t_{C(on)}$				-	0.4	0.6	μs
t_{off}				-	1.5	2.0	μs
$t_{C(off)}$				-	0.15	0.3	μs
t_{rr}				-	0.3	-	μs
I_{CES}	Collector-emitter cut-off current	V_{CE}=V_{CES}	T_j= 25°C	-	-	1	mA
			T_j= 125°C	-	-	10	



Switch on Switch off

Table 6 Control Part

Symbol	Parameter	Condition		Limits Min.	Limits Typ.	Limits Max.	Unit
I_{QCC}	Quiescent circuit current	Total of VCCH-COM,VCCL-COM	VCC=15V, VIN=0V	-	0.3	-	mA
			VCC=15V, VIN=5V	-	0.3	-	
I_{QBS}		Each part of VBU-U, VBV-V,VBW-W	VCC=VBS=15V, VIN=0V	-	-	0.10	
			VCC=VBS=15V, VIN=5V	-	-	0.10	
$V_{SC(ref)}$	Short circuit trip level	V_{CC} = 15V		0.45	0.50	0.55	V
UV_{BSD}	HIGH-side Control supply under-voltage protection(UV)	Tj ≤125°C	Trip level	8.0	9.0	10.0	V
UV_{BSR}			Reset level	9.0	10.0	11.0	V
UV_{CCD}	LOW-side Control supply under-voltage protection(UV)		Trip level	8.0	10.0	11.0	V
UV_{CCR}			Reset level	10.0	11.0	12.0	V
VOT	Temperature Output	(Fig 3)	LVIC Temperature=95℃	2.63	2.77	2.91	V
			LVIC Temperature=25℃	0.88	1.13	1.39	V
OT_t	Over temperature protection	VCC = 15V Detect LVIC temperature	Trip level	120	130	140	°C
OT_{rh}			Hysteresis of trip-reset	-	10	-	°C
V_{FOH}	Fault output voltage	V_{SC} = 0V, FO terminal pulled up to 5V by 10kΩ		4.8	-	-	V
V_{FOL}		V_{SC} = 1V, IFO = 10mA		-	-	0.5	V
tFO	Fault output pulse width	(Fig.5)		-	65	-	μs
I_{IN}	Input current	VIN = 5V		-	1.0	1.5	mA
Vth(on)	ON threshold voltage	Applied between HINU, HINV, HINW,LINU, LINV, LINW-COM		2.6	-	-	V
Vth(off)	OFF threshold voltage			-	-	0.8	
Vth(hys)	ON/OFF threshold hysteresis voltage			0.25	1.8	-	
R	Built-in limiting resistance	Included in bootstrap Diode		80	90	100	Ω

Fig. 2 Characteristics of Bootstrap Di V_F-I_F curve (@Ta=25° C) Including Voltage Drop by Limiting Resistor (Right chart is enlarged chart.)

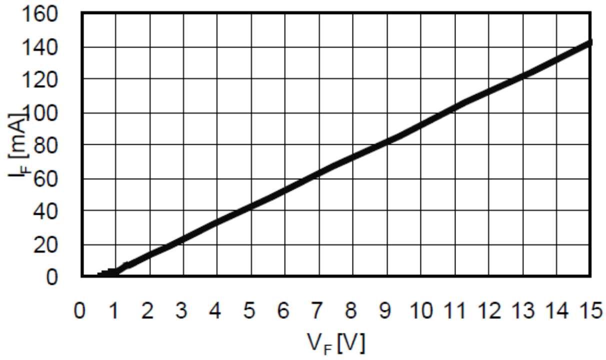


Fig. 3 Temperature of LVIC vs. V_{OT} Output Characteristics

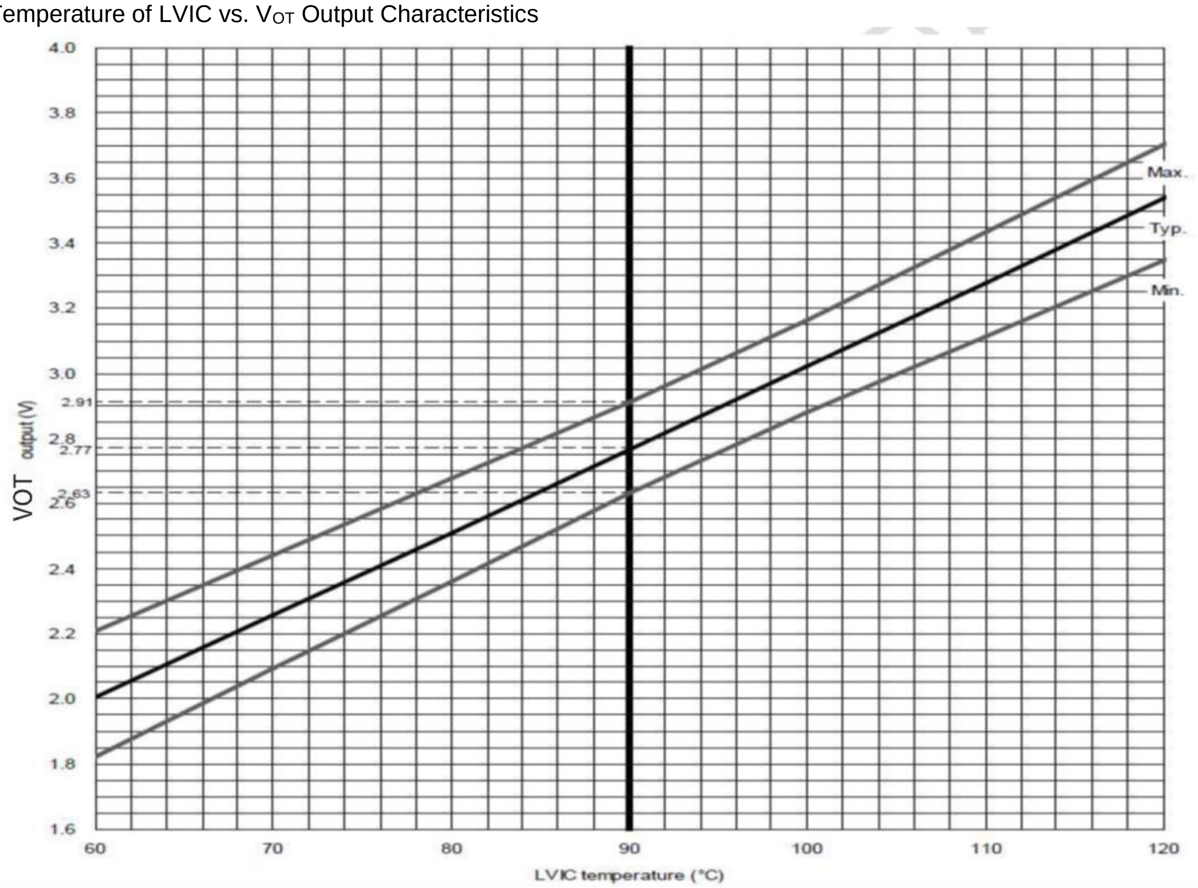
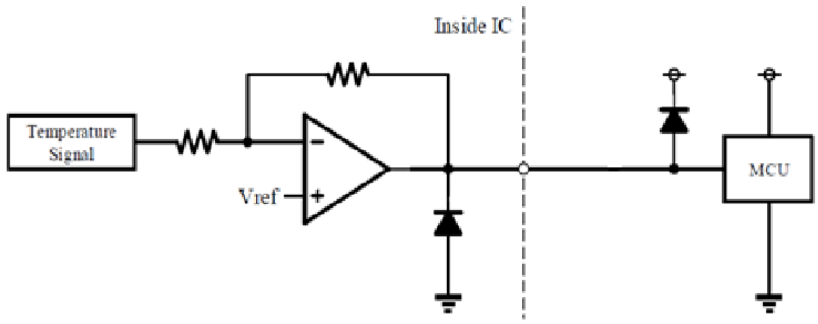


Fig. 4 Pattern Wiring around the Analog Voltage Output Circuit [V_{OT} terminal]



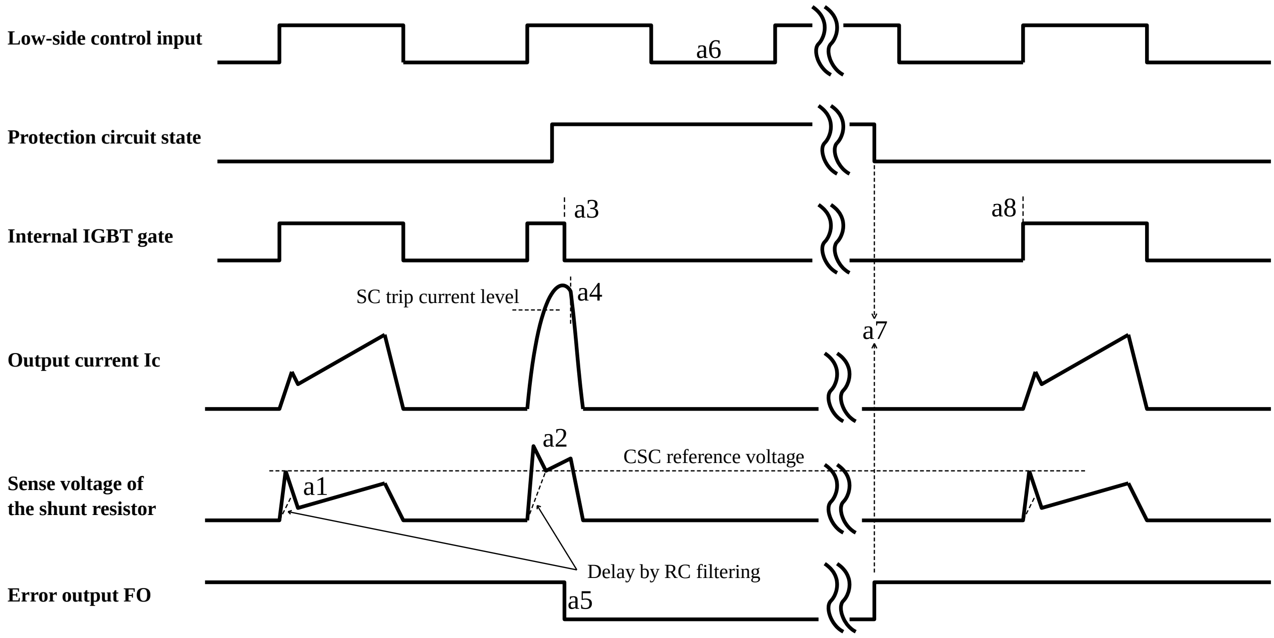
In the case of using VOT with low voltage controller like 3.3V MCU, VOT output might exceed control supply voltage 3.3V when temperature rises excessively. If system uses low voltage controller, it is recommended to insert a clamp diode between control supply of the controller and VOT output for preventing over voltage destruction.

Table 7 Recommended operation conditions

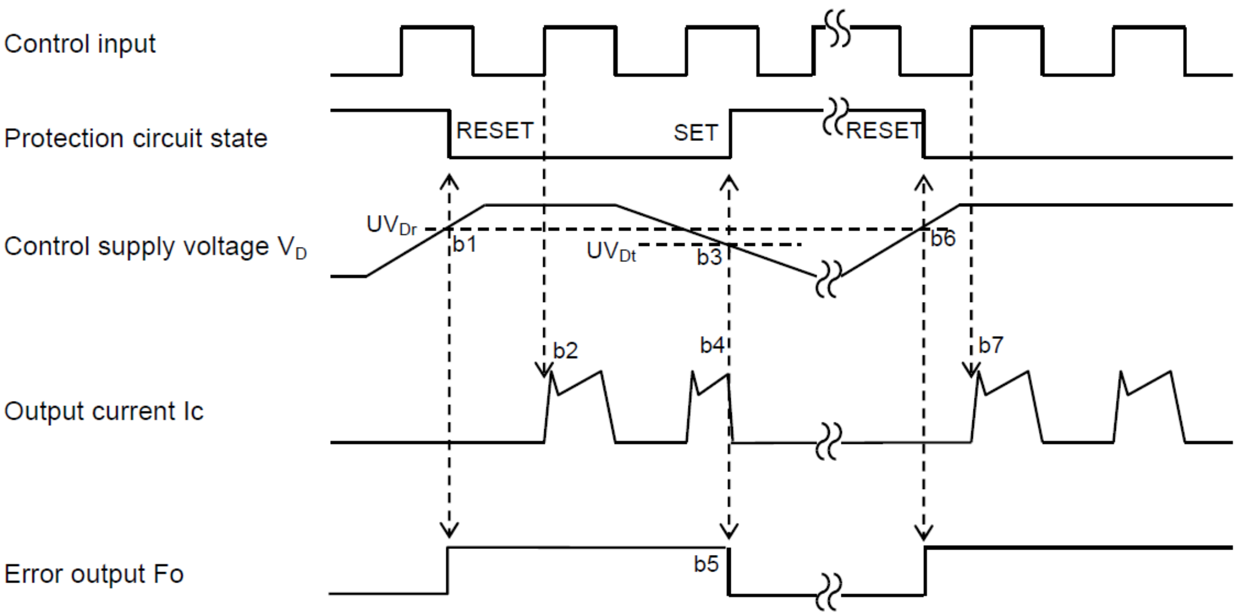
Symbol	Parameter	Condition		Limits			Unit
				Min.	Typ.	Max.	
V_{PN}	Supply voltage	Applied between P-NU, NV, NW		0	300	400	V
V_{CC}	Control supply voltage	Applied between VCCH-COM,VCCL-COM		13.5	15.0	16.5	V
V_{BS}	Control supply voltage	Applied between VBU-U, VBV-V,VBW-W		13.0	15.0	18.5	V
dV_{CC}/dt, dV_{BS}/dt	Control supply variation			-1	-	+1	V/μs
t_{dead}	Arm shoot-through blocking time	For each input signal,		1.0	-	-	μs
f_{PWM}	PWM input frequency	TC ≤ 100°C, Tj ≤ 125°C		-	-	20	kHz
I_O	Allowable r.m.s. current	V_{PN}=300V, V_{CC}=V_{BS}=15V, P.F = 0.8,Sinusoidal PWM TC ≤ 100°C, Tj ≤ 125°C	f_{PWM}= 5kHz	-	-	15	Arms
			f_{PWM}= 15kHz	-	-	10	
$PW_{IN(on)}$	Minimum input pulse width			0.7	-	-	μs
$PW_{IN(off)}$				0.7	-	-	
V_{COM}	COM variation	Between COM-NU, NV, NW (including surge)		-5.0	-	+5.0	V
Tj	Junction temperature			-20	-	+125	°C

Fig. 5 Timing Charts of the DIPIPM Protective Functions

[A] Short-Circuit Protection(N-side only with the external shunt resistor and RC filter)
a1: Normal operation, Low-Side output.
a2: Short circuit current detection (ITRIP trigger).
(It is recommended to set RC time constant 1.5-2.0us so that IGBT shunt down within 2.0us when ITRIP be triggered.)
a3: All low-side outputs are hard interrupted.
a4: All low-side outputs turn off.
a5: FO outputs for tFO=40us (min).
a6: Input is low, outputs turn off.
a7: FO rise to high, but outputs don't turn on until input signal change low to high.
a8: Normal operation, outputs on.

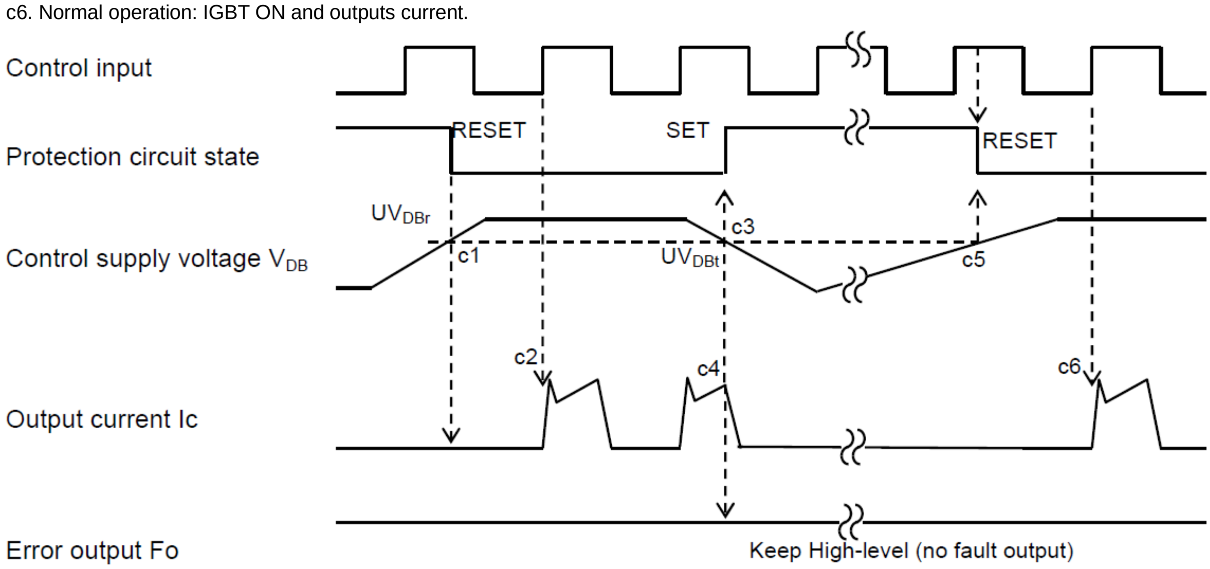


[B] Under-Voltage Protection (LOW-side, UV_{CC})
b1: Control supply voltage VCC exceeds under voltage reset level (UVCCR), but output turns on until next high level signal.
b2: Normal operation, outputs turn on.
b3: VCC level drops to under voltage trip level. (UVCCT)
b4: All low side outputs turn off in spite of control input condition.
b5: FO outputs for t_{FO}=40us (Min), but output is extended during VCC keeps below UVCCR.
b6: VCC level reaches UVCCR.
b7: Normal operation, outputs turn on.



[C] Under-Voltage Protection (HIGH-side, UV_{BS})

c1. Control supply voltage V_{DB} rises. After the voltage reaches under voltage reset level UV_{DBr}, IGBT turns on by next ON signal (L H).
c2. Normal operation: IGBT ON and outputs current.
c3. V_{DB} level drops to under voltage trip level (UV_{DBt}).
c4. IGBT of the corresponding phase only turns OFF in spite of control input signal level, but there is no F_O signal output.
c5. V_{DB} level reaches UV_{DBr}.
c6. Normal operation: IGBT ON and outputs current.



[D] Over Temperature Protection (N-side, Detecting LVIC temperature)

d1: Normal operation, low side outputs turn on.
d2: LVIC temperature exceeds over temperature trip level (OTt).
d3: All low side outputs turn off in spite of control input condition.
d4: FO outputs for tFO=40us (Min), but output is extended during LVIC temperature higher than OTt.
d5: LVIC temperature drops to over temperature reset level.
d6: Normal operation, low side outputs turn on by next high level signal.

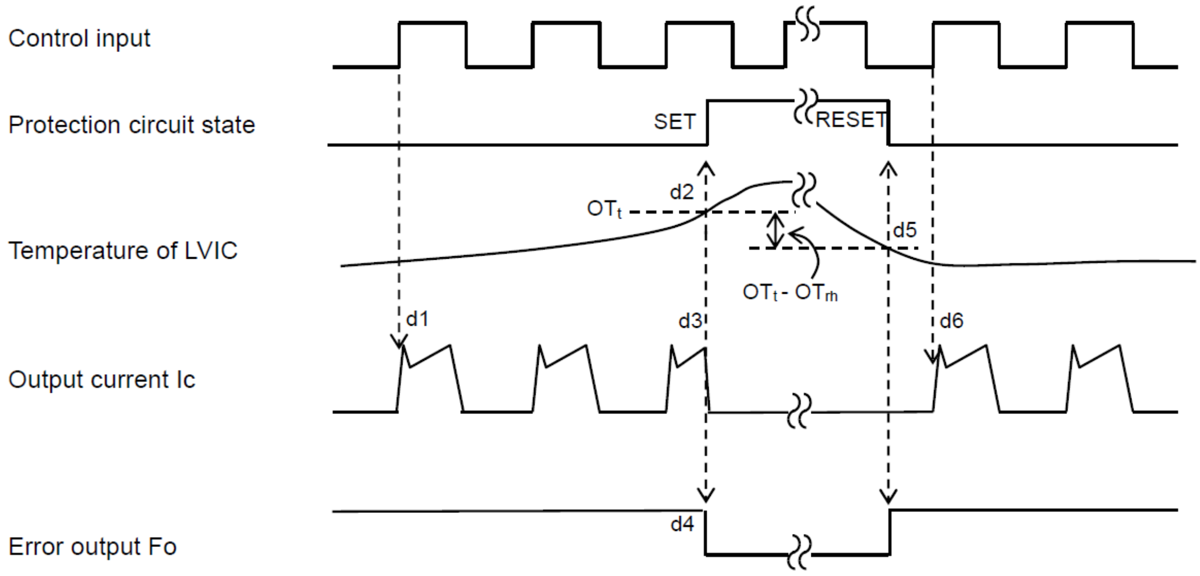
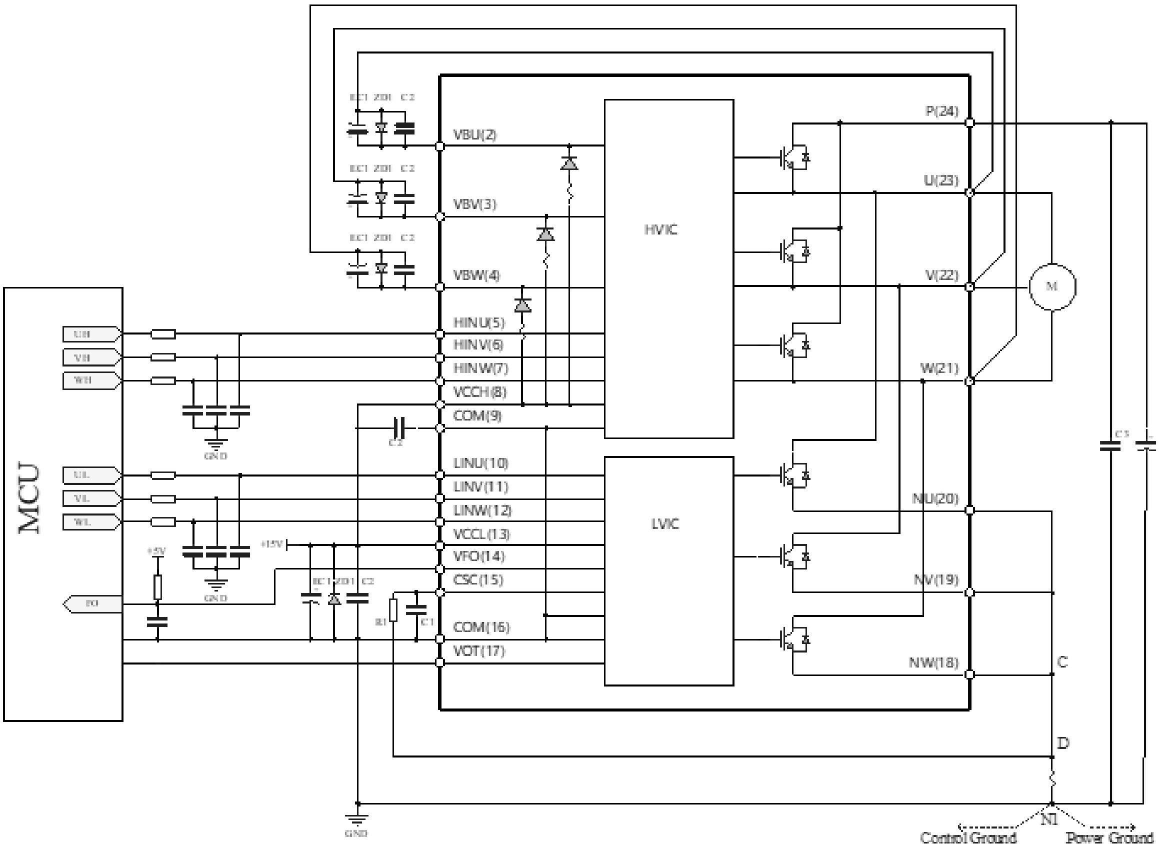

Control input
Protection circuit state
SET
RESET
Temperature of LVIC
OT_t
d2
d5
$OT_t - OT_{rh}$
d1
d3
d6
Output current Ic
Error output Fo
d4

Fig. 6 Example of Application Circuit



(1) If control GND is connected with power GND by common broad pattern, it may cause malfunction by power GND fluctuation. It is recommended to connect control GND and power GND at only a point N1 (near the terminal of shunt resistor).
(2) It is recommended to insert a Zener diode ZD1 (24V/1W) between each pair of control supply terminals to prevent surge destruction.
(3) To prevent surge destruction, the wiring between the smoothing capacitor and the P, N1 terminals should be as short as possible. Generally a 0.1-0.22µF snubber capacitor C3 between the P-N1 terminals is recommended.
(4) R1, C1 of RC filter for preventing protection circuit malfunction is recommended to select tight tolerance, temp-compensated type. The time constant R1C1should be set so that SC current is shut down within 2µs. (1.5µs~2µs is general value.) SC interrupting time might vary with the wiring pattern, so the enough evaluation on the real system is necessary.
(5) The point D at which the wiring to CIN filter is divided should be near the terminal of shunt resistor. NU, NV, NW terminals should be connected at near NU, NV, NW terminals.
(6) All capacitors should be mounted as close to the terminals as possible.
(7) Input drive is High-active type. There is a 3.3kΩ pull-down resistor integrates in the input circuit of IC.
(8) Fo output is open drain type. It should be pulled up to MCU or control power supply (e.g. 5V, 15V) by a resistor that makes I_{Fo} up to 1mA. (I_{FO} is estimated roughly by the formula of control power supply voltage divided by pull-up resistance. In the case of pulled up to 5V, 10kΩ (5kΩ or more) is recommended.)
(9) Two COM terminals are connected inside IPM, please connect either one to the 15V power supply GND outside and leave another one open.
(10) If high frequency noise superimposed to the control supply line, IC malfunction might happen and cause IPM erroneous operation. To avoid such problem, line ripple voltage should meet dV/dt ≤+/-1V/µs, Vripple≤2Vp-p.

Package Information

Ref.	Dimensions (mm)		
	Min.	Typ.	Max.
A	37.900	38.000	38.100
A1	34.900	35.000	35.100
A2	1.400	1.500	1.600
e	1.728	1.778	1.828
e1	3.506	3.556	3.606
e2	10.110	10.160	10.210
e3	5.030	5.080	5.130
e4	2.490	2.540	2.590
F	0.450	0.500	0.550
F1	0.550	0.600	0.650
f	0.750	0.800	0.850
f1	1.950	2.000	2.050
f2	1.150	1.200	1.250
f3	0.950	1.000	1.050
E	12.600	13.000	13.400
E1	0.900	1.000	1.100
E2	7.900	8.000	8.100
E3	1.100	1.200	1.300
D	28.600	29.000	29.400
D1	7.900	8.000	8.100
D2	2.706	2.756	2.806
D3	1.100	1.200	1.300
B	23.900	24.000	24.100
B1	11.900	12.000	12.100
B2	14.000	14.400	14.800
B3	28.900	29.400	29.900
R	1.200	1.600	2.000
C	3.450	3.500	3.550
C1	1.450	1.500	1.550
C2	0.900	1.000	1.100
C3	12.350	12.500	12.650
C4	13.800	14.000	14.200
C5	5.400	5.500	5.600
T	0.350	0.400	0.450
V	0-8°