GC21765-I

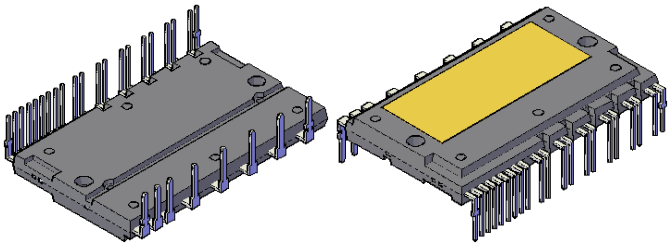


Figure 1

INTEGRATED POWER FUNCTIONS

600V/20A low-loss 6th generation IGBT inverter bridge for three phase DC-to-AC power conversion.

Open emitter type.

INTEGRATED DRIVE, PROTECTION AND SYSTEM CONTROL FUNCTIONS

- For upper-leg IGBTS : Advanced input filter, Shoot through prevention, Drive circuit, High voltage high-speed level shifting, Control supply under-voltage (UV) protection, Short circuit protection (SC), Integrate bootstrap diodes.
- For lower-leg IGBTS : Advanced input filter, Shoot through prevention, Drive circuit, Control supply under-voltage protection (UV), Short circuit protection (SC).
- Fault signaling : Corresponding to an SC fault, a UV fault (Lower-side supply).
- Input interface: 3V, 5V line(High Active).
- Analog temperature output.

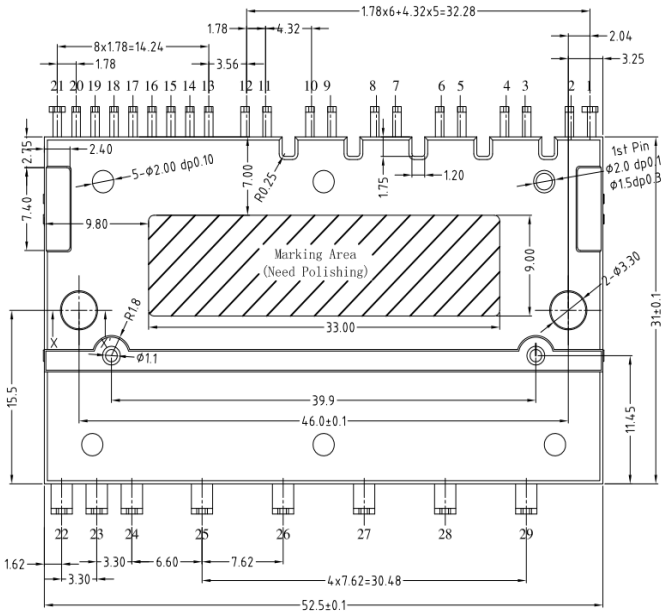
APPLICATION

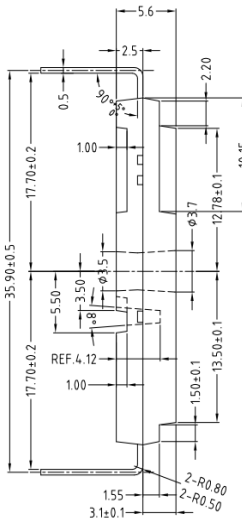
AC100V~220V inverter drive for small power motor control;

such as: Refrigerators、 Inverter air-conditioner、Small Servo Motors Small Motor Control etc.

Detailed Package Outline Drawings:

Dimensions in mm

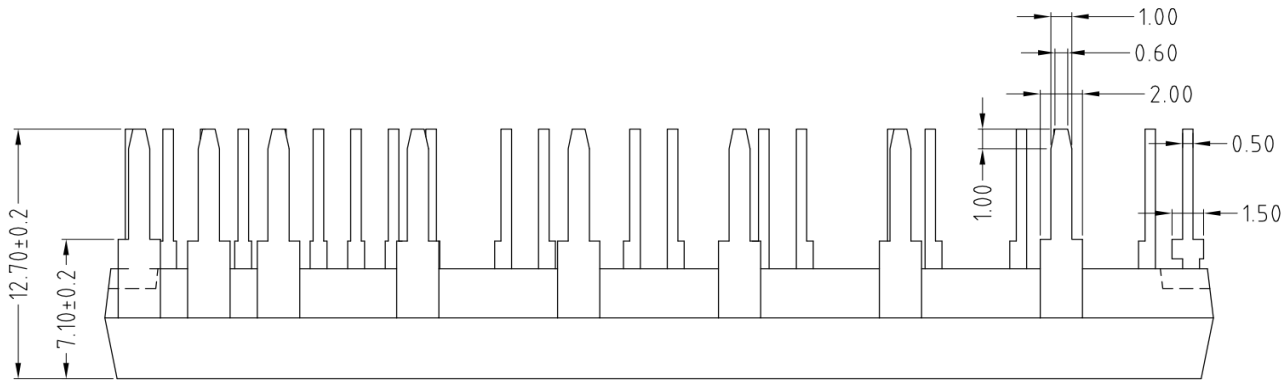


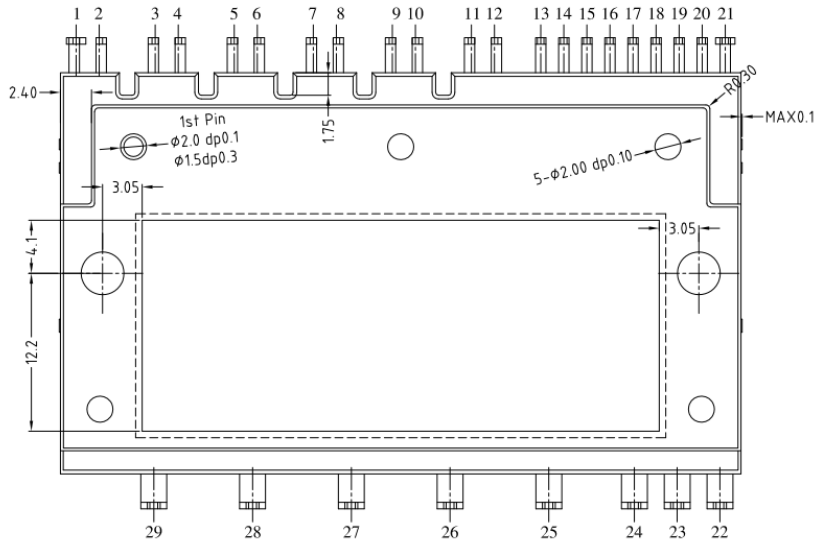


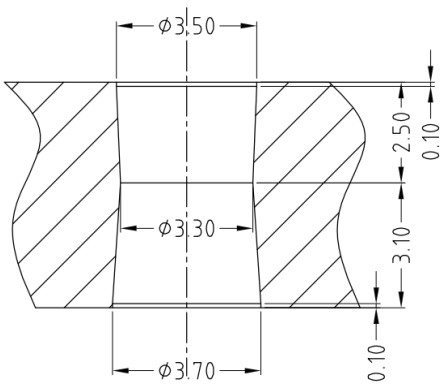
1 VUFS	15VN
2 VUFB	16 WN
3 VP1	17 FO
4UP	18 NC
5 VVFS	19CIN
6VVFB	20 VNC
7 VP1	21 VN1
8 VP	22 NW
9 VWFS	23 NV
10 VWFB	24 NU
11 VP1	25 W
12 WP	26 V
13 VNO	27 U
14 UN	28 P
	29 NC

Detailed Package Outline Drawings:

Dimensions in mm







Pin Configuration

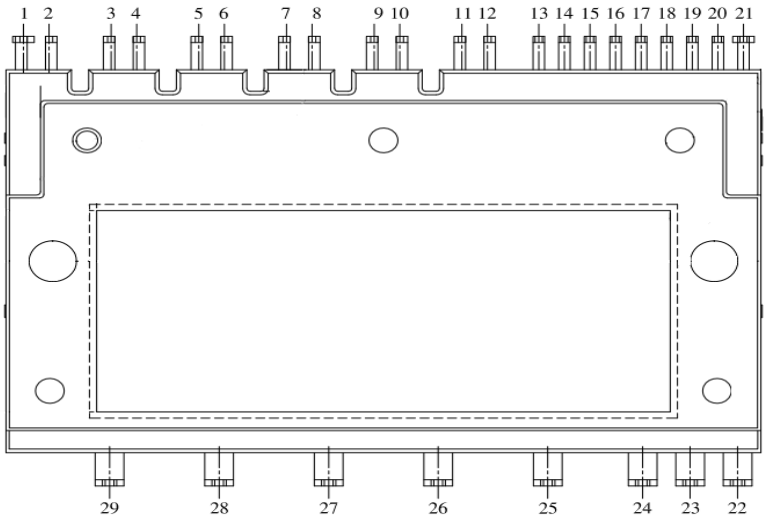


Figure 2 .Pin Configuration

Pin Descriptions

Pin number	Pin name	Pin Description
1	VUFS	U-phase high side floating IC supply offset voltage
2	VUFB	U-phase high side floating IC supply voltage
3	VP1	IC supply voltage
4	UP	U-phase high side gate driver input
5	VVFS	V-phase high side floating IC supply offset voltage
6	VVFB	V-phase high side floating IC supply voltage
7	VP1	IC supply voltage
8	VP	V-phase high side gate driver input
9	VWFS	W-phase high side floating IC supply offset voltage
10	VWFB	W-phase high side floating IC supply voltage
11	VP1	IC supply voltage
12	WP	W-phase high side gate driver input
13	VNO	Supply Ground
14	UN	U-phase low side gate driver input
15	VN	V-phase low side gate driver input
16	WN	W-phase low side gate driver input
17	FO	Fault output
18	NC	No connection
19	CIN	Analog input for over current shutdown
20	VNC	Common Supply Ground
21	VN1	IC supply voltage
22	NW	Negative DC-Link input for W-phase
23	NV	Negative DC-Link input for V-phase
24	NU	Negative DC-Link input for U-phase
25	W	Motor W-phase output
26	V	Motor V-phase output
27	U	Motor U-phase output
28	P	Positive bus input voltage
29	NC	No connection

Internal Function Block Diagram

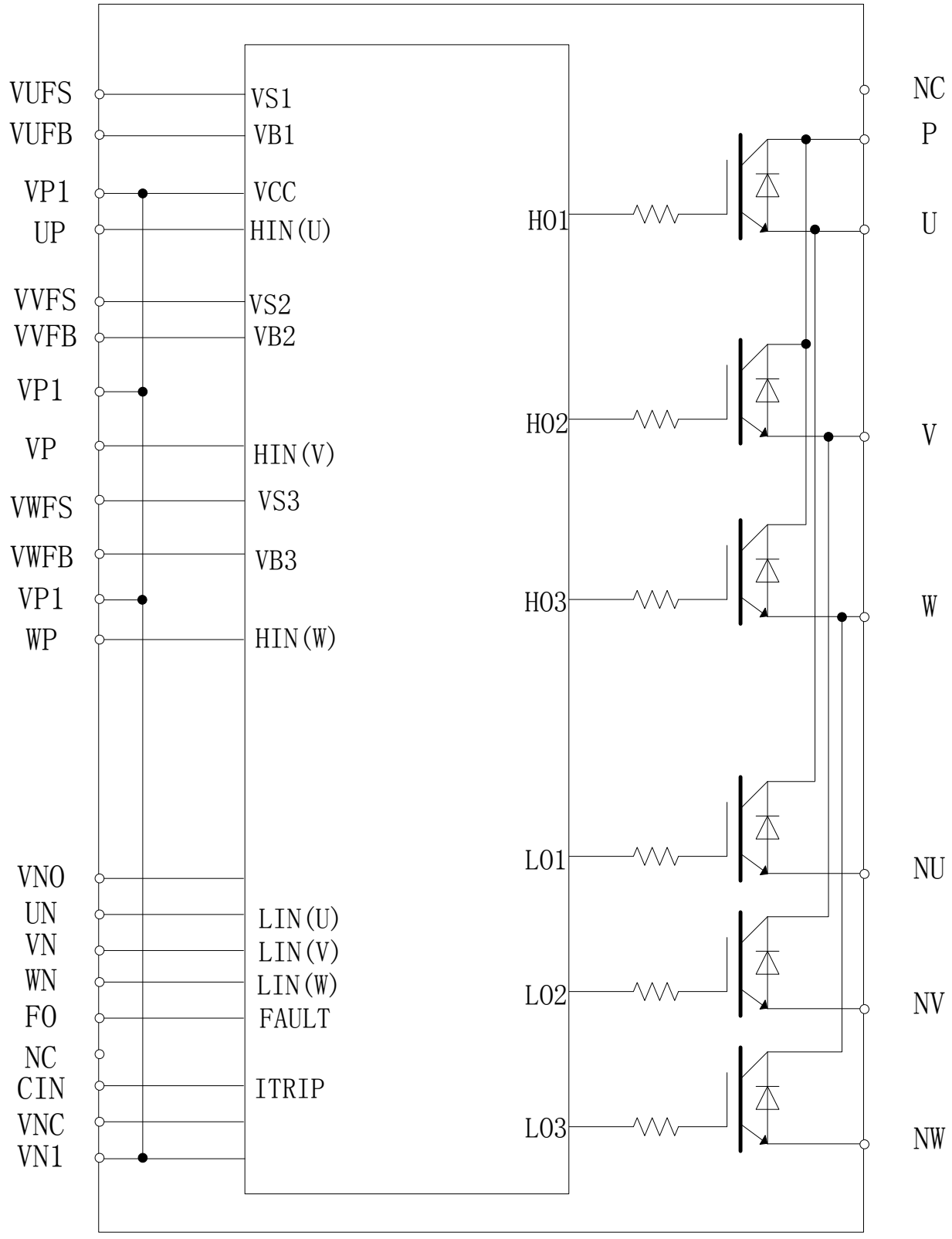


Figure 3 . Function Block Diagram

Absolute Maximum Ratings (Tj= 25°C, Unless Otherwise Specified)

Inverter Part

Symbol	Parameter	Conditions	Ratings	Unit
V_{CC}	Supply Voltage	Applied between P- NU, NV, NW	450	V
$V_{CC(Surge)}$	Supply Voltage (Surge)	Applied between P- NU, NV, NW	500	V
V_{CES}	Collector-emitter Voltage		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 One Chip	78	W
T_j	Operating Junction Temperature	(Note 1)	-40 ~ +150	°C

Note:

1. The maximum junction temperature rating of the power chips integrated within the IPM is 175°C(@Tc ≤ 100°C). However, to insure safe operation of the IPM, the junction temperature should be limited to T_j(av) ≤ 150°C (@Tc ≤ 100°C).

Control Part

Symbol	Parameter	Conditions	Ratings	Unit
V_{DB}	High side floating supply voltage	(Applied between VUFB-UUFS, VVFB-VVFS, VWFB-WWFS)	17.5	V
V_D	Low side supply voltage	Applied between VP1-VNC, VN1-VNC	17.5	V
V_{IN}	Input Signal Voltage	Applied between UP, VP, WP, UN ,VN ,WN - V_{NC}	-1~10	V
V_{FO}	Fault Output Supply Voltage	Applied between FO-VNC	-0.3~VD+0.3	V
I_{FO}	Fault Output Current	Sink Current at F_O Pin	1.5	mA
V_{SC}	Current Sensing Input Voltage	Applied between CIN - V_{NC}	-1~ 10	V

Total System

Symbol	Parameter	Conditions	Ratings	Unit
$V_{CC(PROT)}$	Self Protection Supply Voltage Limit(Short Circuit Protection Capability)	V_D = V_{DB} = 13.5 ~ 16.5V T_j= 150°C, Non-repetitive, less than 2us	400	V
T_C	Module Case Operation Temperature	-20℃≤T_j ≤150°C,	-20 ~ +100	°C
T_{STG}	Storage Temperature		-40 ~ +150	°C
V_{ISO}	Isolation Voltage	60Hz, Sinusoidal, AC 1 minute, between Pins and heat-sink plate	2500	V_{rms}

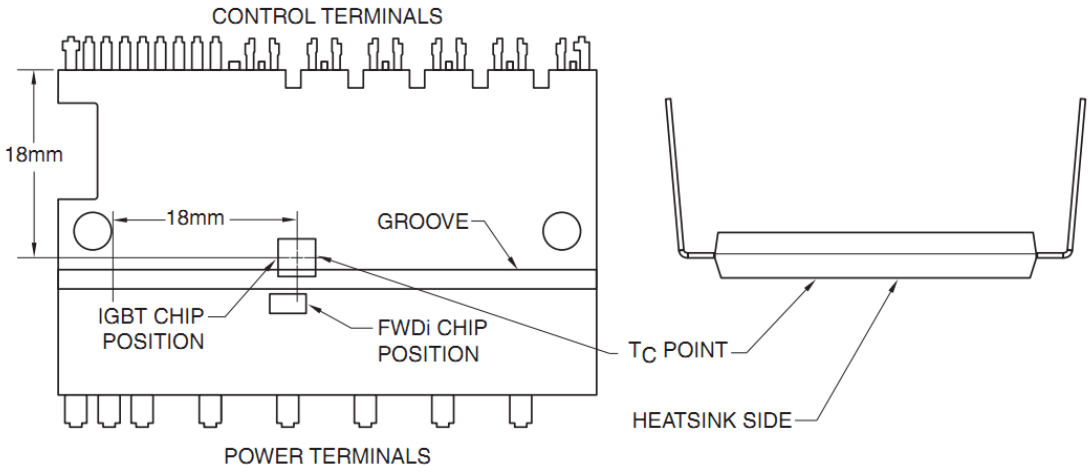


Figure 4. Tc measurement point

Thermal Resistance

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
$R_{th(j-c)Q}$	Junction to Case Thermal Resistance	Inverter IGBT part (per 1/6 module)	-	-	1.6	°C/W
$R_{th(j-c)F}$		Inverter FWD part (per 1/6 module)	-	-	2.8	°C/W

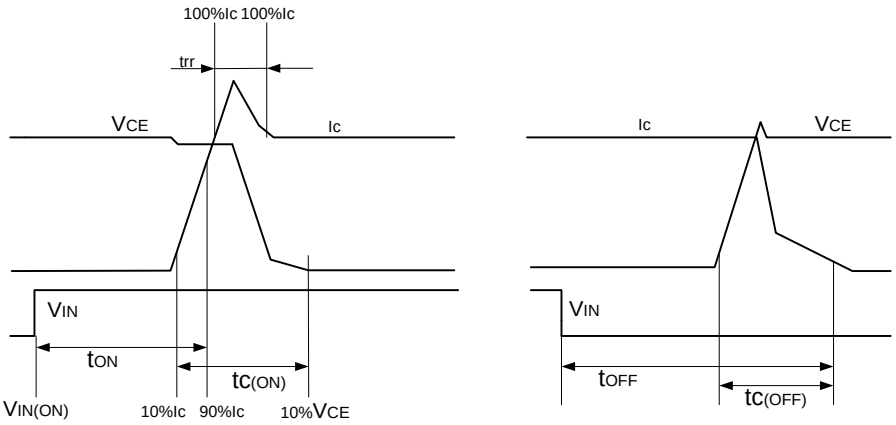
Electrical Characteristics (T_j = 25°C, Unless Otherwise Specified)

Inverter Part

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
$V_{CE(SAT)}$	Collector - Emitter Saturation Voltage	$V_D = V_{DB}$ = 15V V_{IN} = 5V, I_C =20A, T_j= 25°C	-	1.65	-	V
		$V_D = V_{DB}$ = 15V V_{IN} = 5V, I_C =20A, T_j= 125°C	-	2.05	-	V
V_F	FWD Forward Voltage	V_{IN} = 0V， I_C =-20A, T_j = 25°C		1.5	-	V
		V_{IN} = 0V， I_C =-20A, T_j = 125°C	-	1.4	-	V
t_{ON}	Switching Times	V_{PN} = 300V, $V_D = V_{DB}$ = 15V I_C = 20A V_{IN} = 0V –5V, Inductive Load		0.78	-	μs
$t_{C(ON)}$			-	0.3	-	μs
t_{OFF}			-	0.8	-	μs
$t_{C(OFF)}$			-	0.08		μs
t_{rr}			-	0.2	-	μs
I_{CES}	Collector-Emitter Leakage Current	V_{CE}= V_{CES} T_j= 25°C	-	-	75	μA
		V_{CE}= V_{CES} T_j= 125°C	-	-	1	mA

Note:

2. t_{ON} and t_{OFF} include the propagation delay time of the internal drive IC. $t_{C(ON)}$ and $t_{C(OFF)}$ are the switching time of IGBT itself under the given gate driving condition internally. For the detailed information, please see Figure 5.



(a) turn-on (b) turn-off

Figure 5 . Switching Time Definition

Electrical Characteristics (Tj= 25°C, Unless Otherwise Specified)

Control Part

Symbol	Parameter	Condition		Min.	Typ.	Max.	Units
ID	Quiescent VD Supply Current	VD = 15V VIN = 5V	VP1,VN1-VNC	-	0.52	1	mA
IDB	Quiescent VDB Supply Current	VDB = 15V VIN = 5V	VUFB - U, VVFB - V, VWFB - W	-	0.36	0.55	μ A
VFOH	Fault Output Voltage	Vsc = 0V, FO Terminal pull up to 5V by 10kohm		4.9	-	-	V
VFOL		Vsc =1V, IFO=1.0mA		-	-	1.05	V
Vsc,TH+	Short circuit positive going threshold	VD = 15V (Note 3)		0.37	0.46	0.55	V
Vsc,TH-	Short circuit negative going threshold	VD= 15V		-	0.4	-	V
UVDt	Control supply under-voltage protection	Trip Level		9.5	10.4	11.0	V
UVDr		Reset Level		11	12.1	12.8	
UVDBt		Trip Level		9.5	10.4	11.0	
UVDBr		Reset Level		11	12.1	12.8	
Ron,FLT	FLT low on resistance	I=1.5mA			50	90	ohm
tFO	Fault-out Pulse Width	CFO = 22nF		20	-	-	μ s
tFIL,IN	Input filter time (U/V/WP, U/V/WN, CIN)	VIN = 0 V & 5 V		140	290	-	ns
tBL	CIN blanking time	VIN = 0 V or 5 V,VCIN = 5 V		-	400	-	ns
VIN(ON)	ON Threshold Voltage	Applied between UP,VP,WP,UN,VN,WN- VNC		1.7	2.1	2.4	V
VIN(OFF)	OFF Threshold Voltage			0.7	0.85	1.1	
BSD Forward voltage	VF	IF=10mA including voltage		-	1.0	1.3	V
BSD current limiting resistor	R			22	36	50	ohm

Note: 3. Short-circuit current protection is functioning at both low-side and high side.

Recommended Operating Conditions

Symbol	Parameter	Conditions	Values			Unit
			Min.	Typ.	Max.	
V_{CC}	Supply Voltage	Applied between P - NU, NV, NW	-	300	400	V
V_D	Control Supply Voltage	Applied between VP1,VN1 - VNC	13.5	15	16.5	V
V_{DB}	High-side Bias Voltage	Applied between VUFB-VUFS,VVFB-VVFS, VWFB-VWFS	13	15	18.5	V
t_{dead}	Blanking Time for Preventing Arm-short	For Each Input Signal	1.5	-	-	us
f_{PWM}	PWM Input Signal	-20°C≤Tc ≤+100°C, -20°C≤ Tj≤+150°C	-	-	20	kHz
$P_{WIN(ON)}$	Minimum Input Pulse Width		1	-	-	us
$P_{WIN(OFF)}$			1	-	-	us
Tj	Junction temperature		-20	-	125	° C

Internal NTC - Thermistor Characteristics

symbol	parameter	conditions	Values			unit
			Min	Typ	Max	
R_{NTC}	Resistance of Thermistor	T_{NTC} = 25°C see Figure 15.	98	100	102	Kohm
		T_{NTC} = 125°C	3.43	3.58	3.75	Kohm
Temperature Range			-40	-	+125	°C

Mechanical Characteristics and Ratings

Parameter	Conditions	Limits			Unit
		Min.	Typ.	Max.	
Mounting Torque	Mounting Screw: - M3	-	0.69	-	N•m
Device Flatness	see Figure 6.	0	-	+120	um
Weight		-	7	-	g

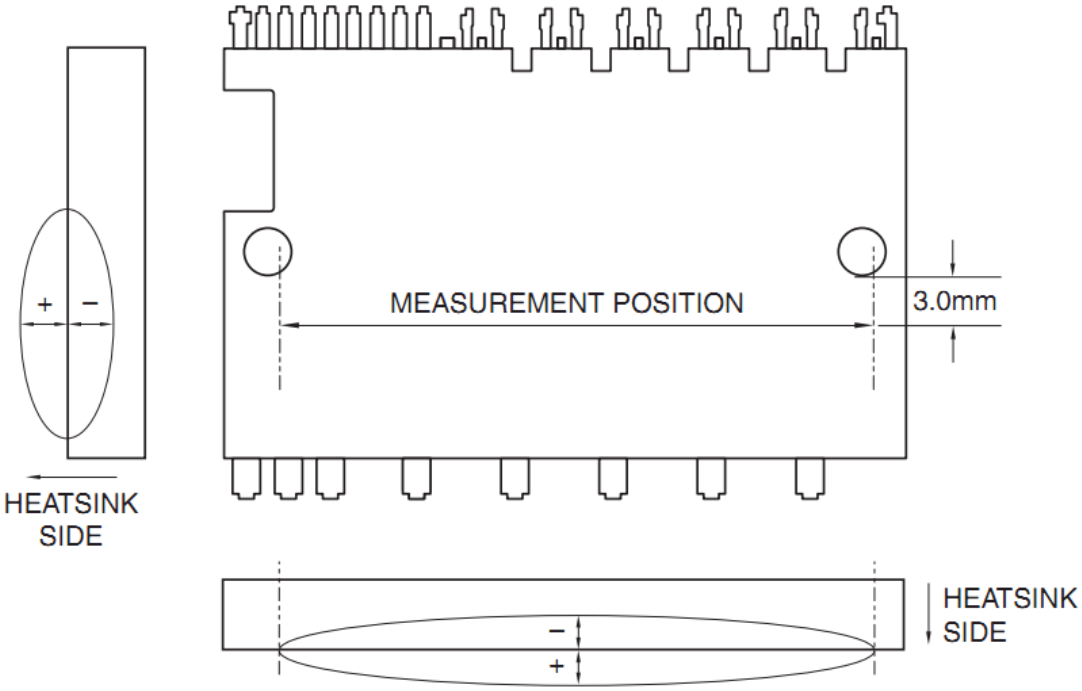


Figure 6. Flatness Measurement Position

Advanced input filter

The advanced input filter allows an improvement in the input/output pulse symmetry of HVIC inside the module and helps to reject noise spikes and short pulses. The advantage of the new filter is shown in Figures 7 and 8.

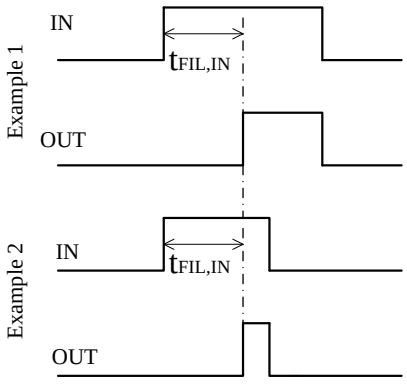


Figure 7. Typical input filter

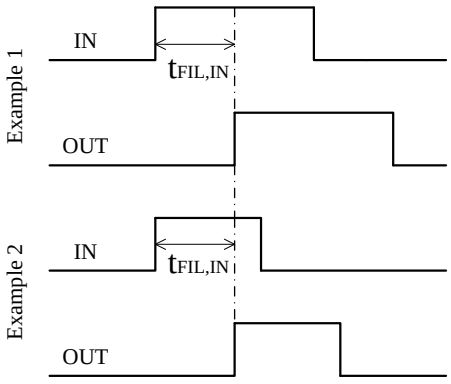
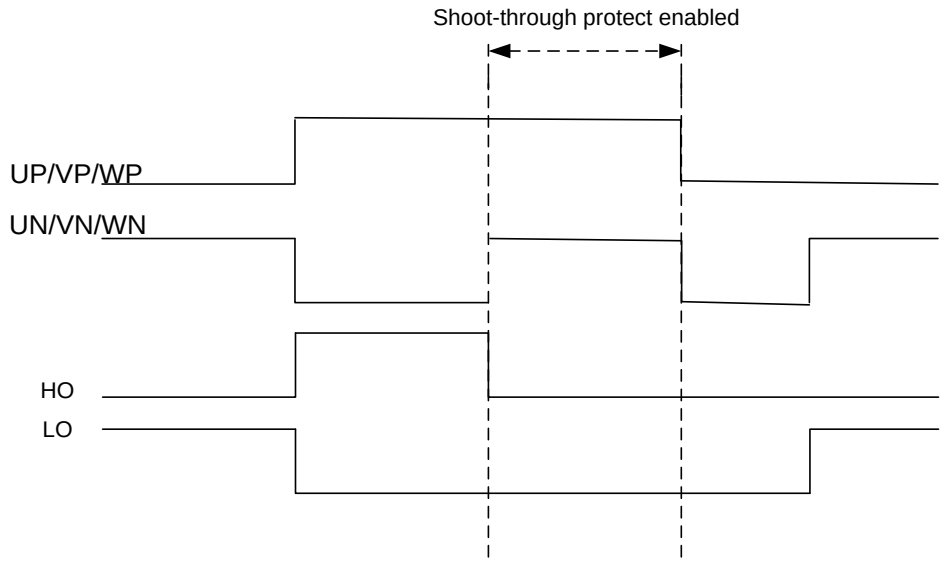


Figure 8. Advanced input filter

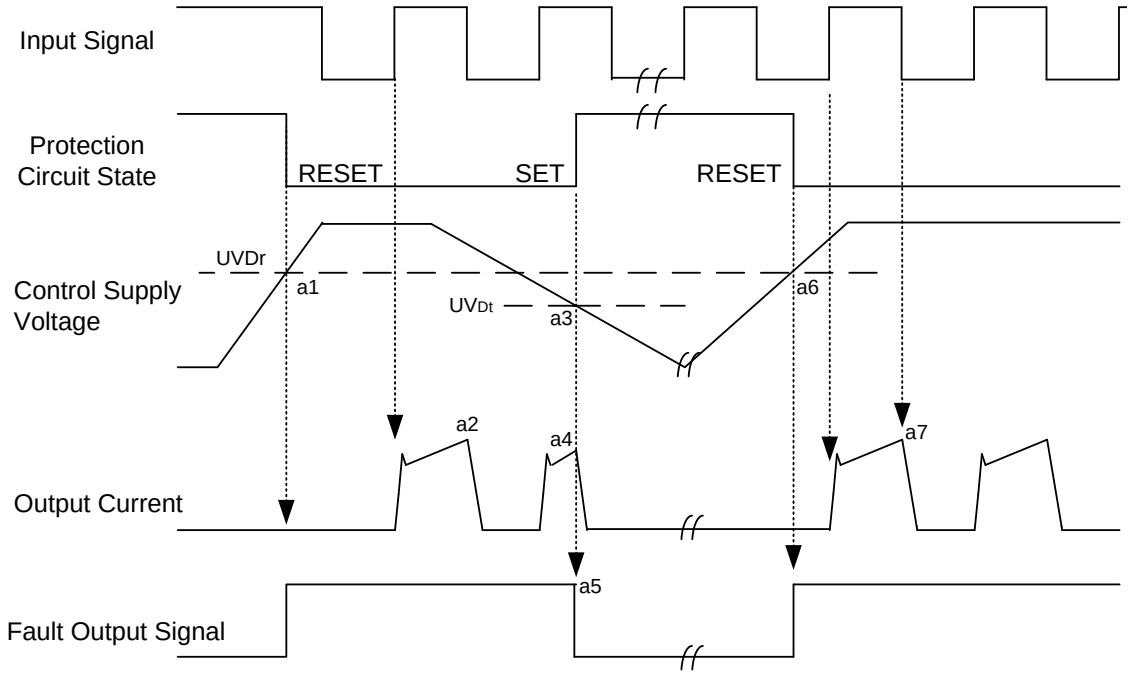
Time Charts of Protective Function



Note:

5. The signal HO and LO are gate output of the internal HVIC.

Figure 9 . Shoot-through（cross-conduction）protection



a1 : Control supply voltage rises: After the voltage rises UV_{Dr}, the circuits start to operate when next input is applied.

a2 : Normal operation: IGBT ON and carrying current.

a3 : Under voltage detection (UV_{Dt}).

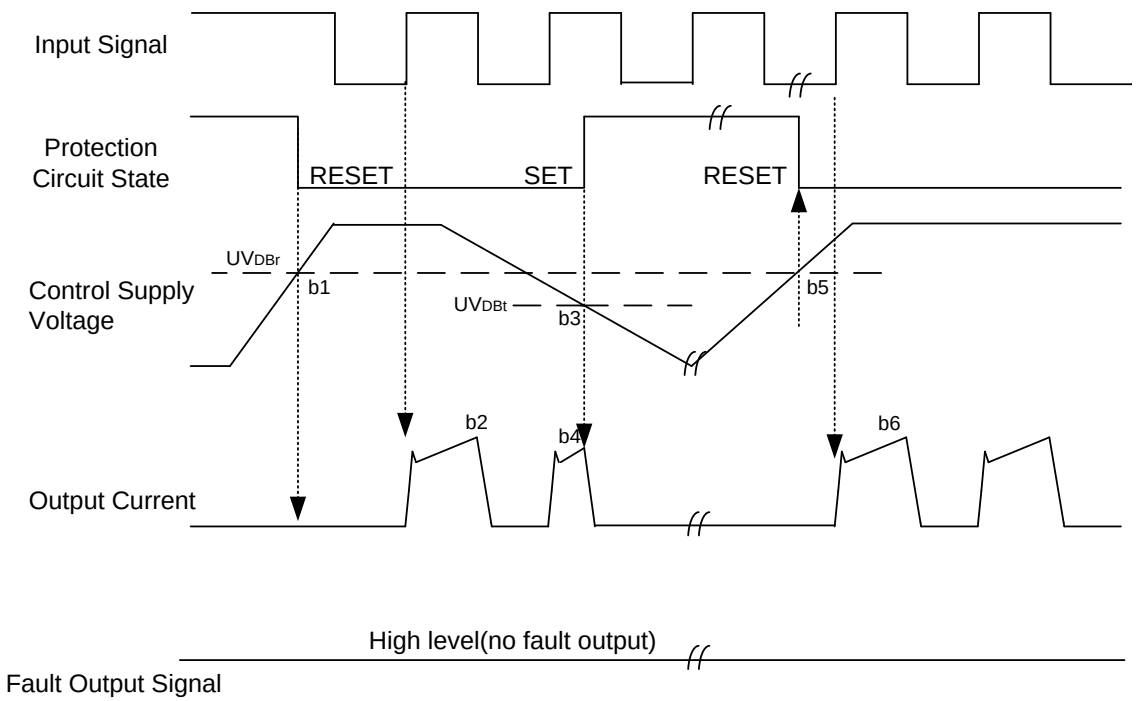
a4 : IGBT OFF in spite of control input condition.

a5 : Fault output operation starts.

a6 : Under voltage reset (UV_{Dr}).

a7 : Normal operation: IGBT ON and carrying current.

Figure 10. Under-Voltage Protection (Low-side Operation)



b1 : Control supply voltage rises: After the voltage reaches UV_{DBr}, the circuits start to operate when next input is applied.

b2 : Normal operation: IGBT ON and carrying current.

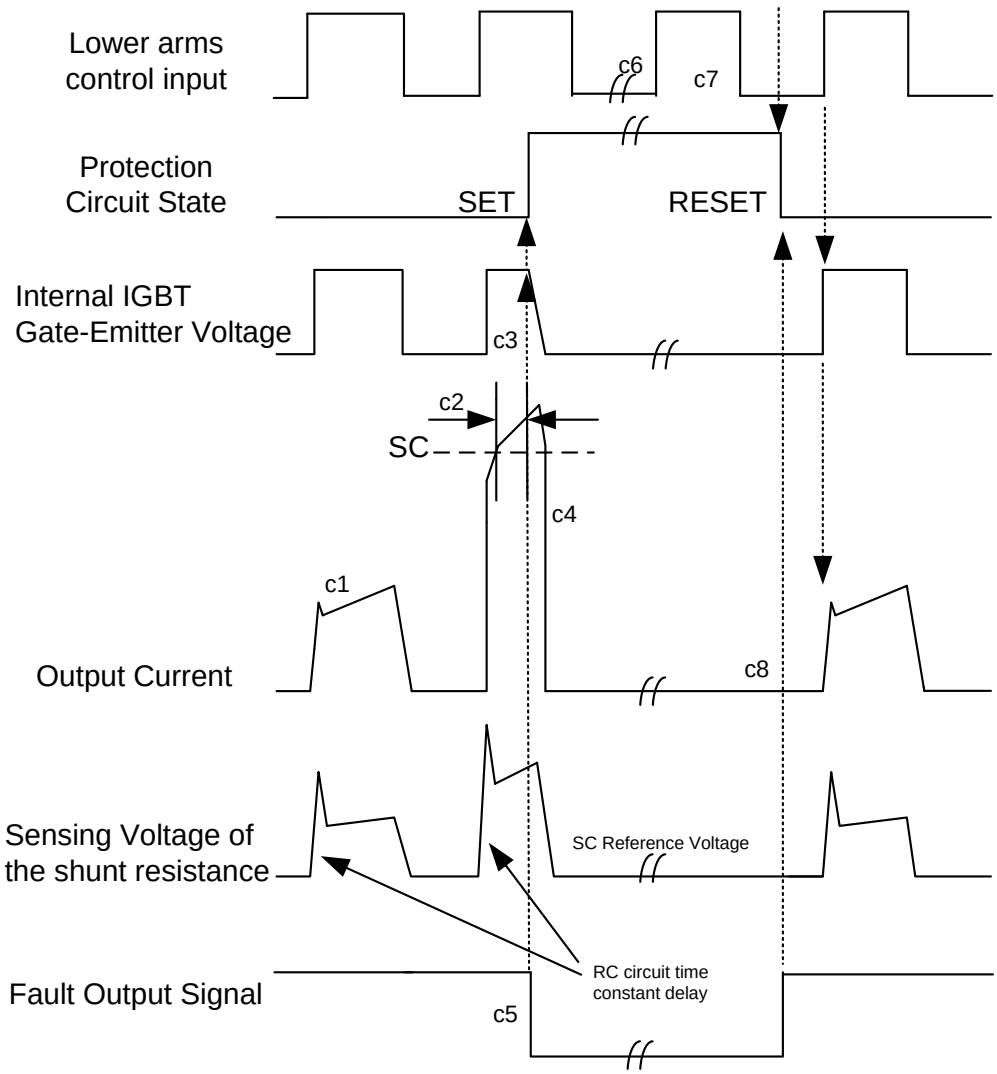
b3 : Under voltage detection (UV_{DBt}).

b4 : IGBT OFF in spite of control input condition, but there is no fault output signal.

b5 : Under voltage reset (UV_{DBr}).

b6 : Normal operation: IGBT ON and carrying current.

Figure 11. Under-Voltage Protection (High-side Operation only)



(with the external shunt resistance connection)

c1 : Normal operation: IGBT ON and carrying current.

c2 : Short circuit current detection (CIN trigger).

c3 : Hard IGBT gate interrupt.

c4 : IGBT turns OFF.

c5 : Fault output timer operation starts: The pulse width of the fault output signal is set by the internal capacitor.

c6 : Input “L” : IGBT OFF state.

c7 : Input “H”: IGBT ON state, but during the active period of fault output the IGBT doesn’t turn ON.

c8 : IGBT OFF state

Figure 12. Short-Circuit Current Protection (Low-side And High-side Operation)

Input/Output Interface Circuit

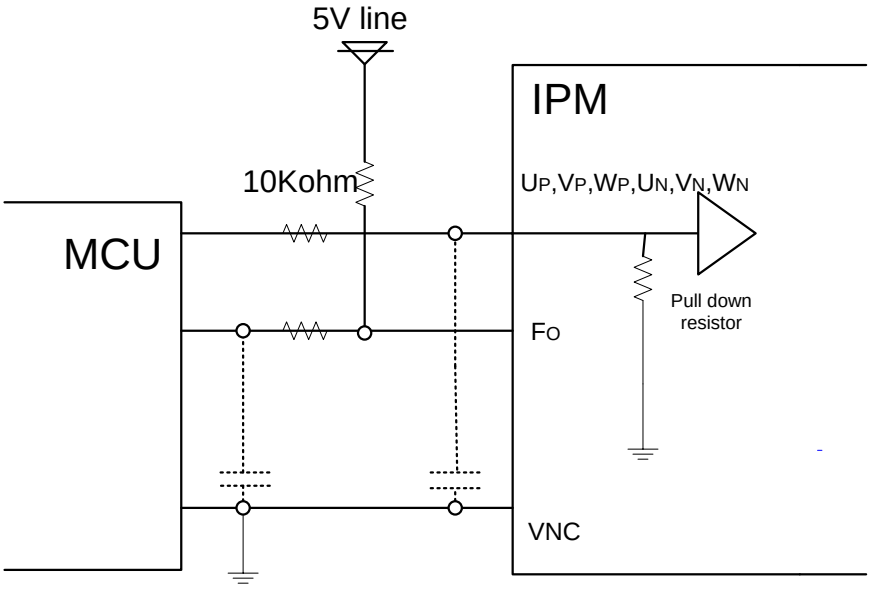


Figure 13. Recommended CPU I/O Interface Circuit

Note:

6. RC coupling at each input (parts shown dotted) might change depending on the PWM control scheme used in the application and the wiring impedance of the application's printed circuit board.
7. The logic input is compatible with standard CMOS or LSTTL outputs

Wiring Around The Shunt Resistor

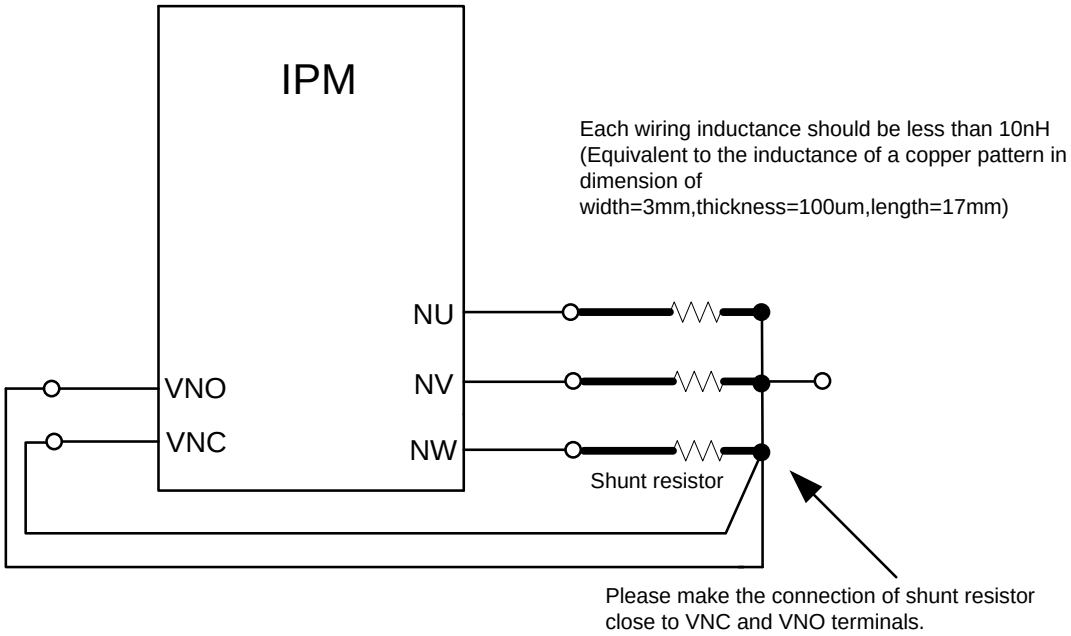
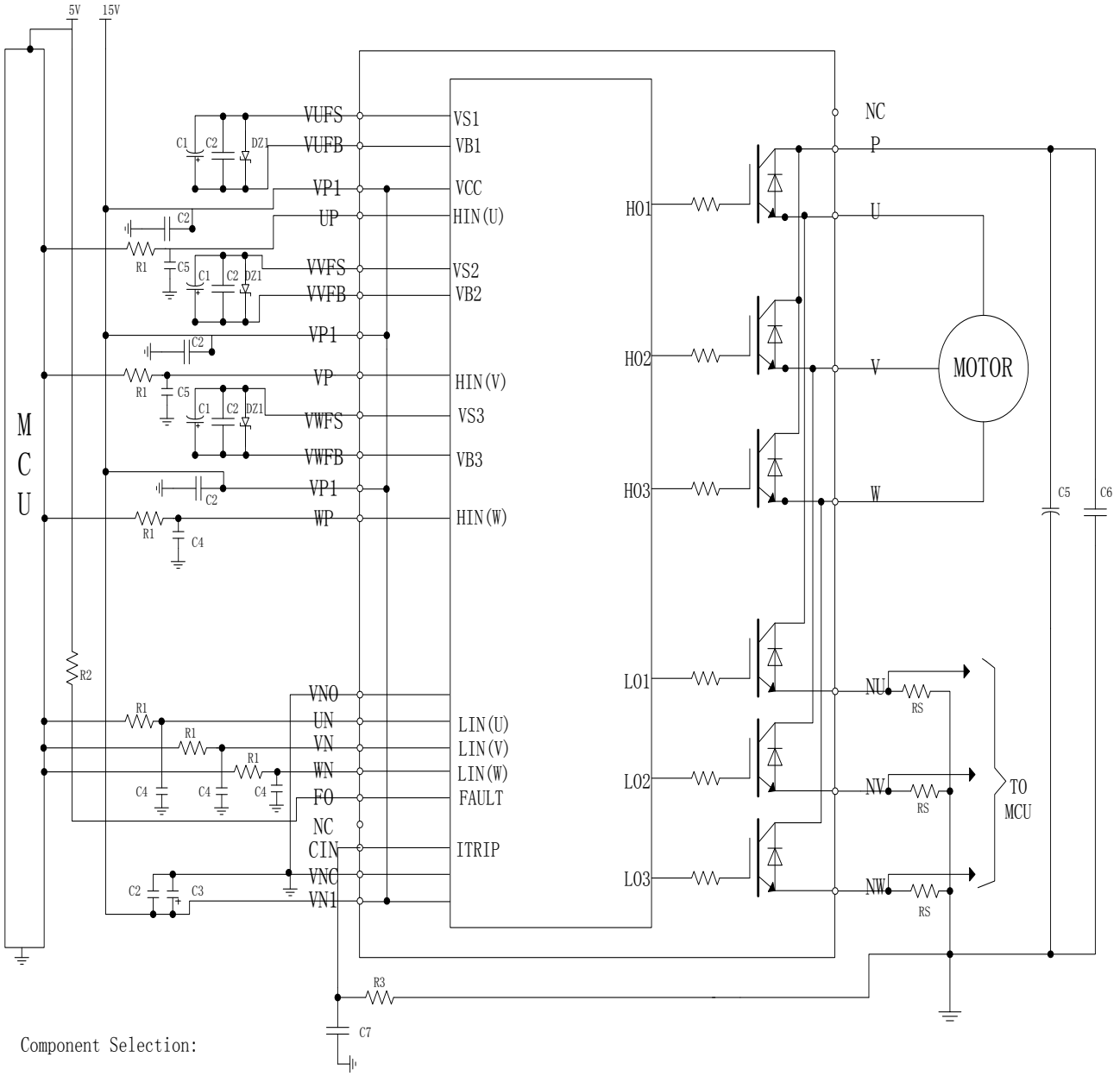


Figure 14. Recommended Wiring Around The Shunt Resistor



Component Selection:

Dsgn.	Typ. Value	Description
DZ1	18V, 0.5W	Control and boot strap supply over voltage suppression
C1	10-47uF, 50V	Boot strap supply reservoir - Electrolytic, long life, low Impedance, 105° C (Note 5)
C2	0.1-1.0uF, 50V	Local decoupling/High frequency noise filters - Multilayer ceramic (Note 5)
C3	100-470uF, 50V	Control power supply filter - Electrolytic, long life, low Impedance, 105° C (Note 5)
C4	100-1000pF, 50V	Optional Input signal noise filter - Multilayer ceramic (Note 1)
C5	200-2000uF,	450V Main DC bus filter capacitor - Electrolytic, long life, high ripple current, 105° C
C6	0.1-0.22uF,	450V Surge voltage suppression capacitor - Polyester/Polypropylene film (Note 8)
R1	100-1000ohm	Optional control input noise filter (Note 1, Note 2)
R2	10k ohm	Fault output signal pull-up resistor (Note 3)
RS	<4 mohm	Current sensing resistor - Non-inductive, temperature stable, tight tolerance (Note 9)
R3, C7	1k, 1000pF	RC filtering for current sense

Figure 15. Typical Application Circuit

Note:

1) Input drive is active-high type. There is a 2.5k7(min.) pull-down resistor integrated in the IC input circuit. To prevent malfunction, the wiring of each input should be as short as possible. When using RC coupling circuit, make sure the input signal level meets the turn-on and turn-off threshold voltage. See application notes for details.
2) Internal HVIC provides high voltage level shifting allowing direct connection of all six driving signals to the controller.
3) FO output is an open collector type. Pull up resistor (R3) should be adjusted to current sink capability of the controller.
4) To prevent input signal oscillations, minimize wire length to controller (~2cm). Additional RC filtering (C5 etc.) may be required. If filtering is added be careful to maintain proper dead time and voltage levels. See application notes for details.
5) All capacitors should be mounted as close to the terminals as possible. (C1: good temperature, frequency characteristic electrolytic type, and C2, C3: good temperature, frequency and DC bias characteristic ceramic type are recommended.)
6) Shows short circuit protection disabled. See application notes for use of short circuit protection.
7) Local decoupling frequency filter capacitors must be connected as close as possible to the module's pins.
8) The length of the DC link wiring between C4, C5, the DIP's P terminal and the shunt must be minimized to prevent excessive transient voltages. In particular C6 should be mounted as close to the DIP as possible.
9) Use high quality, tight tolerance current sensing resistor. Connect resistor as close as possible to the DIP's N terminal. Be careful to check for proper power rating. See application notes for calculation of resistance value.
10) Inserting a Zener diode (24V/1W) between each pair of control supply terminals to prevent surge destruction is recommended.