POWEREX

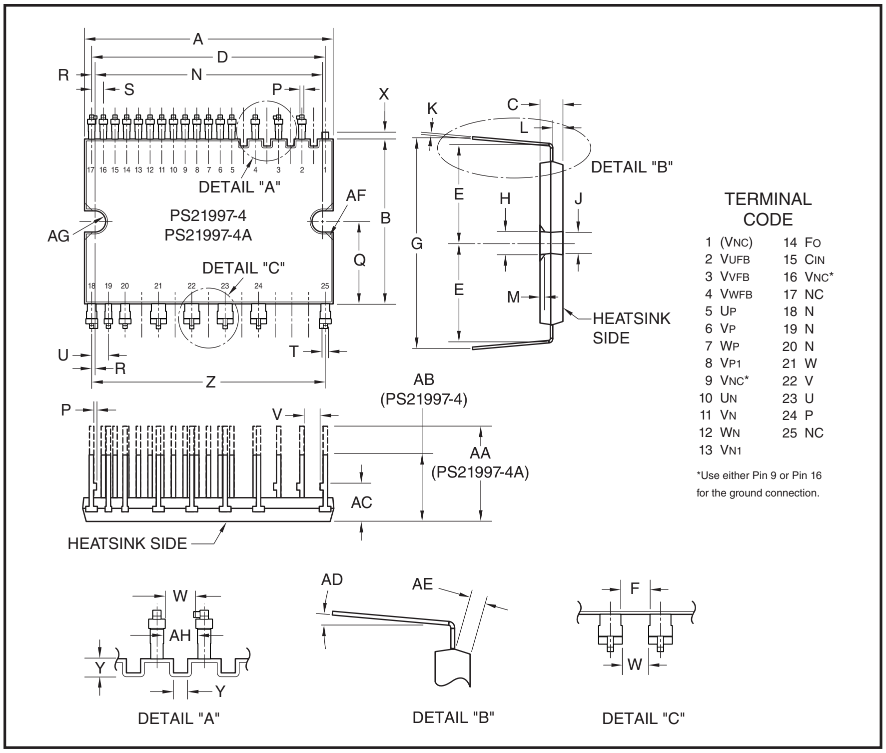
PS21997-4, PS21997-4A

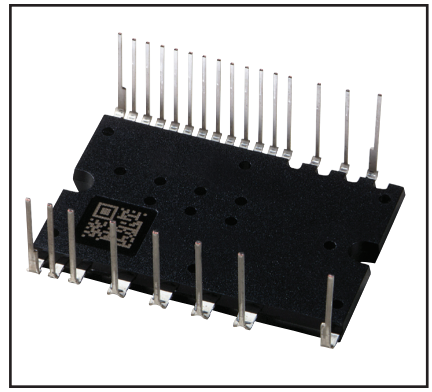
Powerex, Inc., 173 Pavilion Lane, Youngwood, Pennsylvania 15697-1800 (724) 925-7272

Intellimod™ Module

Dual In-line Intelligent Power Module

30 Amperes/600 Volts





Outline Drawing and Circuit Diagram

Dimensions	Inches	Millimeters
A	1.50±0.02	38.0±0.5
B	0.94±0.02	24.0±0.5
C	0.14	3.5
D	1.40	35.56
E	0.57±0.02	14.4±0.5
F	0.118 Min.	3.0 Min.
G	1.15±0.02	29.2±0.5
H	0.14	3.5
J	0.13	3.3
K	0.016	0.4
L	0.06±0.02	1.5±0.05
M	0.031	0.8
N	1.39±0.019	35.0±0.3
P	0.02	0.5
Q	0.47	12.0
R	0.011	0.28

Dimensions	Inches	Millimeters
S	0.07±0.008	1.778±0.2
T	0.024	0.6
U	0.1±0.008	2.54±0.2
V	0.098 Min.	2.5 Min.
W	0.10	2.656
X	0.04	1.0
Y	0.05	1.2
Z	1.40	35.56
AA	0.55±0.02	14.0±0.5
AB	0.37±0.02	9.5±0.5
AC	0.22±0.02	5.5±0.5
AD	0 ~ 5°	0 ~ 5°
AE	0.06 Min.	1.5 Min.
AF	0.05	1.2
AG	0.063 Rad.	1.6 Rad.
AH	0.11 Min.	2.756 Min.

Description:
DIPIPMs are intelligent power modules that integrate power devices, drivers, and protection circuitry in an ultra compact dual-in-line transfer-mold package for use in driving small three phase motors. Use of 5th generation IGBTs, DIP packaging, and application specific HVICs allow the designer to reduce inverter size and overall design time.

Features:
- ☐ Compact Packages
- ☐ Single Power Supply
- ☐ Integrated HVICs
- ☐ Direct Connection to CPU
- ☐ Reduced R_{th}

Applications:
- ☐ Refrigerators
- ☐ Air Conditioners
- ☐ Small Servo Motors
- ☐ Small Motor Control

Ordering Information:
PS21997-4 is a 600V, 30 Ampere short pin DIP Intelligent Power Module.

PS21997-4A – long pin type

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Absolute Maximum Ratings, T_j = 25°C unless otherwise specified

Characteristics	Symbol	PS21997-4, PS21997-4A	Units
Power Device Junction Temperature*	T_j	-20 to 125	°C
Storage Temperature	T_{stg}	-40 to 125	°C
Case Operating Temperature (Note 1)	T_C	-20 to 100	°C
Mounting Torque, M3 Mounting Screws	—	6.9	in-lb
Module Weight (Typical)	—	10	Grams
Heatsink Flatness (Note 2)	—	-50 to 100	µm
Self-protection Supply Voltage Limit (Short Circuit Protection Capability)**	$V_{CC(prot.)}$	400	Volts
Isolation Voltage, AC 1 minute, 60Hz Sinusoidal, Connection Pins to Heatsink Plate	V_{ISO}	1500	V_{rms}

*The maximum junction temperature rating of the power chips integrated within the DIPIPM is 150°C (@$T_C \leq$ 100°C). However, to ensure safe operation of the DIPIPM, the average junction temperature should be limited to $T_{j(avg)} \leq$125°C (@$T_C \leq$ 100°C).
**V_D = 13.5 ~ 16.5V, Inverter Part, T_j = 125°C, Non-repetitive, Less than 2µs

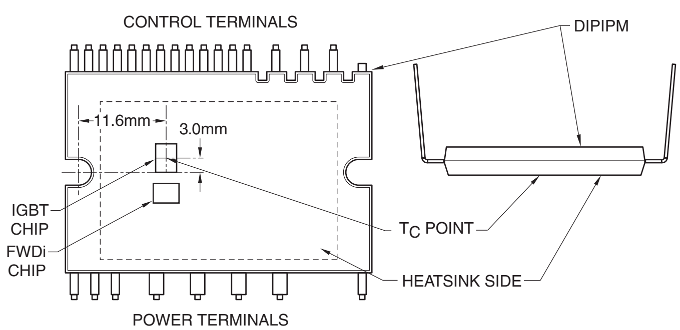
IGBT Inverter Sector

Characteristics	Symbol	PS21997-4, PS21997-4A	Units
Supply Voltage (Applied between P - N)	V_{CC}	450	Volts
Supply Voltage, Surge (Applied between P - N)	$V_{CC(surge)}$	500	Volts
Collector-Emitter Voltage	V_{CES}	600	Volts
Each IGBT Collector Current, ± (T_C = 25°C)	I_C	30	Amperes
Each IGBT Peak Collector Current, ± (T_C = 25°C, Less than 1ms)	I_{CP}	60	Amperes
Collector Dissipation (T_C = 25°C, per 1 Chip)	P_C	47.6	Watts

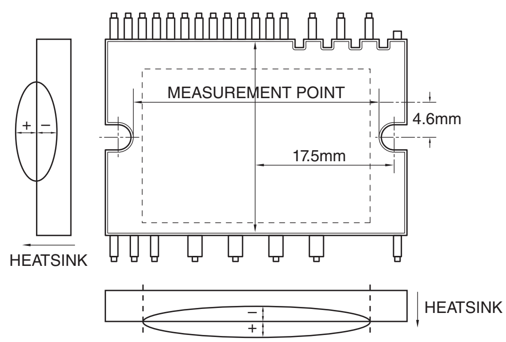
Control Sector

Characteristics	Symbol	PS21997-4, PS21997-4A	Units
Supply Voltage (Applied between V_{P1}-V_{NC}, V_{N1}-V_{NC})	V_D	20	Volts
Supply Voltage (Applied between V_{UFB}-U, V_{VFB}-V, V_{WFB}-W)	V_{DB}	20	Volts
Input Voltage (Applied between U_P, V_P, W_P, U_N, V_N, W_N-V_{NC})	V_{IN}	-0.5 ~ V_D+0.5	Volts
Fault Output Supply Voltage (Applied between F_O-V_{NC})	V_{FO}	-0.5 ~ V_D+0.5	Volts
Fault Output Current (Sink Current at F_O Terminal)	I_{FO}	1	mA
Current Sensing Input Voltage (Applied between C_{IN}-V_{NC})	V_{SC}	-0.5 ~ V_D+0.5	Volts

Note 1 – T_C Measure Point



Note 2 – Flatness Measurement Position



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Electrical and Mechanical Characteristics, T_j = 25°C unless otherwise specified

Characteristics	Symbol	Test Conditions	Min.	Typ.	Max.	Units
IGBT Inverter Sector						
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$V_D = V_{DB}$ = 15V, I_C = 30A, V_{IN} = 5V, T_j = 25°C	—	1.90	2.50	Volts
		$V_D = V_{DB}$ = 15V, I_C = 30A, V_{IN} = 5V, T_j = 125°C	—	2.00	2.60	Volts
Diode Forward Voltage	V_{EC}	T_j = 25°C, -I_C = 30A, V_{IN} = 0V	—	1.70	2.20	Volts
Switching Times	t_{on}	V_{CC} = 300V,	0.70	1.30	1.90	µs
	t_{rr}	$V_D = V_{DB}$ = 15V,	—	0.30	—	µs
	$t_{C(on)}$	I_C = 30A, T_j = 125°C,	—	0.40	0.60	µs
	t_{off}	V_{IN} = 0 ⇔ 5V,	—	1.70	2.65	µs
	$t_{C(off)}$	Inductive Load (Upper and Lower Arm)	—	0.40	1.00	µs
Collector-Emitter Cutoff Current	I_{CES}	$V_{CE} = V_{CES}$, T_j = 25°C	—	—	1.0	mA
		$V_{CE} = V_{CES}$, T_j = 125°C	—	—	10	mA
Control Sector						
Circuit Current I_D	V_{IN} = 5V	Total of V_{P1}-V_{NC}, V_{N1}-V_{NC}	—	—	2.80	mA
$V_D = V_{DB}$ = 15V		V_{UFB}-U, V_{VFB}-V, V_{WFB}-W	—	—	0.55	mA
	V_{IN} = 0V	Total of V_{P1}-V_{NC}, V_{N1}-V_{NC}	—	—	2.80	mA
		V_{UFB}-U, V_{VFB}-V, V_{WFB}-W	—	—	0.55	mA
Fault Output Voltage	V_{FOH}	V_{SC} = 0V, F_O Terminal Pull-up to 5V by 10kΩ	4.9	—	—	Volts
	V_{FOL}	V_{SC} = 1V, I_{FO} = 1mA	—	—	0.95	Volts
Short Circuit Trip Level*	$V_{SC(ref)}$	V_D = 15V	0.43	0.48	0.53	Volts
Input Current	I_{IN}	V_{IN} = 5V	0.70	1.00	1.50	mA
Supply Circuit Under-voltage	UV_{DBt}	Trip Level, $T_j \leq$ 125°C	10.0	—	12.0	Volts
Protection	UV_{DBr}	Reset Level, $T_j \leq$ 125°C	10.5	—	12.5	Volts
	UV_{Dt}	Trip Level, $T_j \leq$ 125°C	10.3	—	12.5	Volts
	UV_{Dr}	Reset Level, $T_j \leq$ 125°C	10.8	—	13.0	Volts
Fault Output Pulse Width**	t_{FO}		40	—	—	µs
ON Threshold Voltage	$V_{th(on)}$	Applied between	—	2.1	2.6	Volts
OFF Threshold Voltage	$V_{th(off)}$	U_P, V_P, W_P,	0.8	1.3	—	Volts
ON/OFF Threshold Hysteresis Voltage	$V_{th(hys)}$	U_N, V_N, W_N-V_{NC}	0.35	0.65	—	Volts

* Short Circuit protection is functioning only for the low-arms. Please select the value of the external shunt resistor such that the S_C trip level is less than 1.7 times the current rating.
**Fault signal is asserted only for a U_V or S_C condition on the low side. On a S_C fault the F_O duration will be 40µsec. On a U_V condition the fault signal will be asserted as long as the U_V condition exists or for 40µsec, whichever is longer.

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Thermal Characteristics

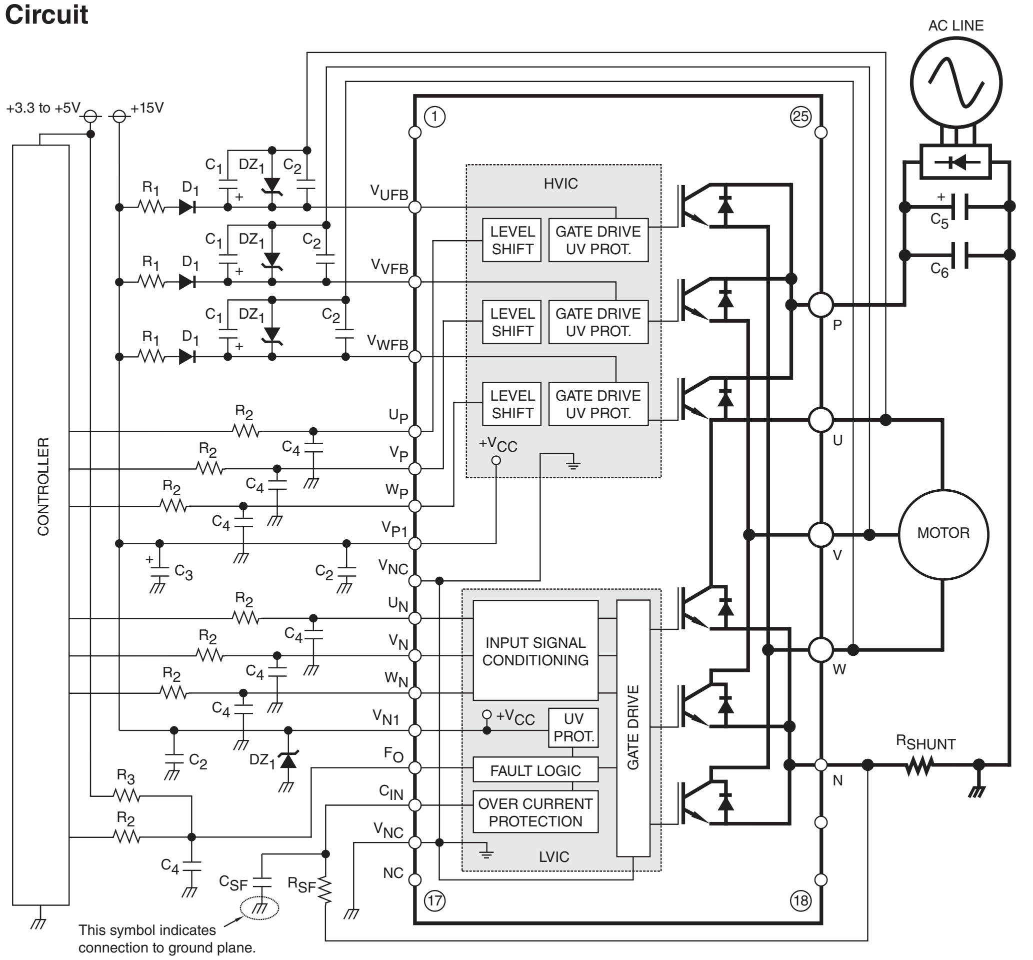
Characteristic	Symbol	Condition	Min.	Typ.	Max.	Units
Junction to Case	$R_{th(j-c)}Q$	Inverter IGBT (Per 1/6 Module)	—	—	2.1	°C/Watt
Junction to Case	$R_{th(j-c)}D$	Inverter FWDi (Per 1/6 Module)	—	—	3.0	°C/Watt

Recommended Conditions for Use

Characteristic	Symbol	Condition		Min.	Typ.	Value	Units
Supply Voltage	V_{CC}	Applied between P-N Terminals		0	300	400	Volts
Control Supply Voltage	V_D	Applied between V_{P1}-V_{NC}, V_{N1}-V_{NC}		13.5	15.0	16.5	Volts
	V_{DB}	Applied between V_{UFB}-U, V_{VFB}-V, V_{WFB}-W		13.0	15.0	18.5	Volts
Control Supply Variation	dV_D, dV_{DB}			-1	—	1	V/μs
Arm Shoot-through Blocking Time	t_{DEAD}	For Each Input Signal, $T_C \leq 100°C$		2.0	—	—	μs
PWM Input Frequency	f_{PWM}	$T_C \leq 100°C$, $T_j \leq 125°C$		—	—	20	kHz
Allowable Minimum Input Pulse Width	$P_{WIN(on)}$**	200V ≤ V_{CC} ≤ 350V, 13.5V ≤ V_D ≤ 16.5V, 13.0V ≤ V_{DB} ≤ 18.5V -20°C ≤ T_C ≤ 100°C, N-line Wiring Inductance Less than 10nH		0.5	—	—	μs
	$P_{WIN(off)}$***		Below Rated Current	1.5	—	—	μs
			Between Rated Current and 1.7 Times Rated Current	3.0	—	—	μs
V_{NC} Voltage Variation	V_{NC}	Between V_{NC}-N (Including Surge)		-5.0	—	5.0	Volts

*The allowable rms current value depends on the actual application conditions.
**Input signal with ON pulse width less than $P_{WIN(on)}$ may not respond.
***Input signal with OFF pulse width less than PWIN(off) may make no resonse or may have a delayed response to P-side input only. The delay is less than 4μs.

Application Circuit



Component Selection:

Dsgn.	Typ. Value	Description
D_1	1A, 600V	Boot strap supply diode – Ultra fast recovery
DZ_1	24V, 1.0W	Control and boot strap supply over voltage suppression
C_1	10-100uF, 50V	Boot strap supply reservoir – Electrolytic, long life, low Impedance, 105°C (Note 5)
C_2	0.22-2.0uF, 50V	Local decoupling/High frequency noise filters – Multilayer ceramic (Note 8)
C_3	10-100uF, 50V	Control power supply filter – Electrolytic, long life, low Impedance, 105°C
C_4	100pF, 50V	Optional Input signal noise filter – Multilayer ceramic (Note 1)
C_5	200-2000uF, 450V	Main DC bus filter capacitor – Electrolytic, long life, high ripple current, 105°C
C_6	0.1-0.22uF, 450V	Surge voltage suppression capacitor – Polyester/Polypropylene film (Note 9)
C_{SF}	1000pF, 50V	Short circuit detection filter capacitor – Multilayer Ceramic (Note 6, Note 7)
R_{SF}	1.8k ohm	Short circuit detection filter resistor (Note 6, Note 7)
R_{SHUNT}	5-100mohm	Current sensing resistor – Non-inductive, temperature stable, tight tolerance (Note 10)
R_1	10 ohm	Boot strap supply inrush limiting resistor (Note 5)
R_2	330 ohm	Optional control input noise filter (Note 1, Note 2)
R_3	10k ohm	Fault output signal pull-up resistor (Note 3)

Notes:

1) To prevent input signal oscillations minimize wiring 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.
2) Internal HVIC provides high voltage level shifting allowing direct connection of all six driving signals to the controller.
3) F_O output is an open collector type. Pull up resistor (R3) should be adjusted to current sink capability of the controller.
4) Use only one V_{NC} Pin (either 9 or 16) and leave the other open.
5) Boot strap supply component values must be adjusted depending on the PWM frequency and technique.
6) Wiring length associated with R_{SHUNT}, R_{SF}, C_{SF} must be minimized to avoid improper operation of the OC function.
7) R_{SF}, C_{SF} set over current protection trip time. Recommend time constant is 1.5µs-2.0µs. See application notes.
8) Local decoupling/high frequency filter capacitors must be connected as close as possible to the modules pins.
9) The length of the DC link wiring between C5, C6, 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.
10) 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.

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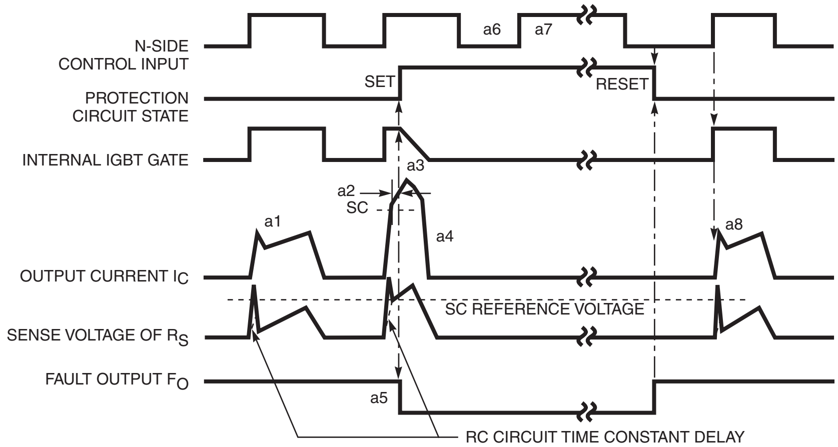
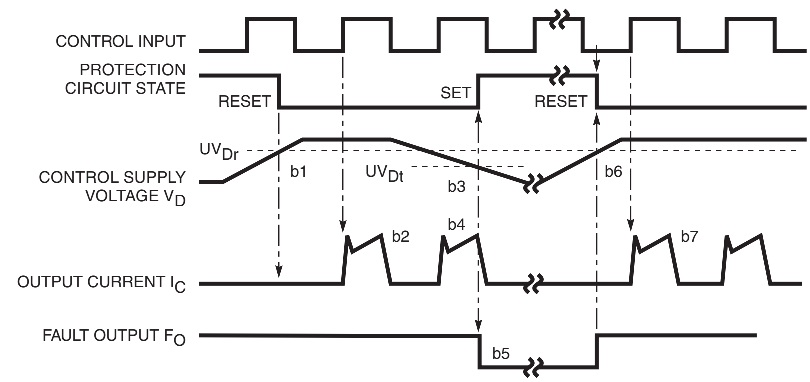
Protection Function Timing Diagrams

Short Circuit Protection (N-side Only with External Shunt Resistor and RC Filter)



a1: Normal operation – IGBT turns on and carries current.
a2: Short circuit current is detected (SC trigger).
a3: All N-side IGBT's gate are hard interrupted.
a4: All N-side IGBT's turn off.
a5: F_O output wirh a fixed pulse width (determined by the external capacitance C_{FO}).
a6: Input "L" – IGBT off.
a7: Input "H" – IGBT on, but during the F_O output perid the IGBT will not turn on.
a8: IGBT turns on when L→H signal is input after F_O is reset.

Under-Voltage Protection (N-side , UV_D)



b1: Control supply voltage V_D rises – After V_D level reaches under voltage reset level (UV_{Dr}), the circuits start to operate when next input is applied.
b2 : Normal operation – IGBT turns on and carries current.
b3: V_D level dips to under voltage trip level (UV_{Dt}).
b4: All N-side IGBT's turn off in spite of control input condition.
b5: F_O is low for a minimum period determined by the capacitance C_{FO} but continuously during UV period.
b6: V_D level reaches UV_{Dr}.
b7: Normal operation – IGBT turns on and carries current.

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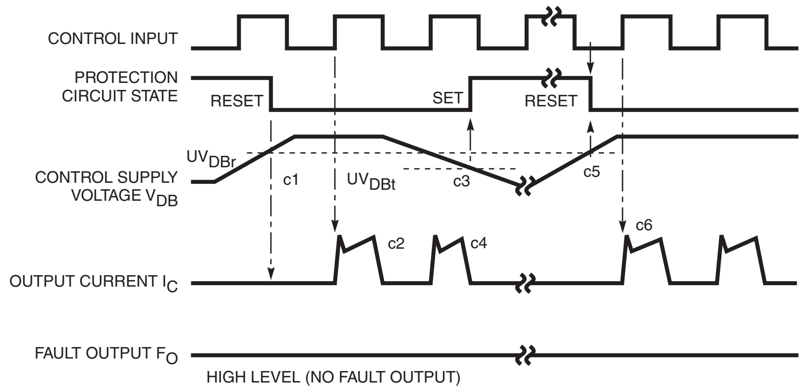
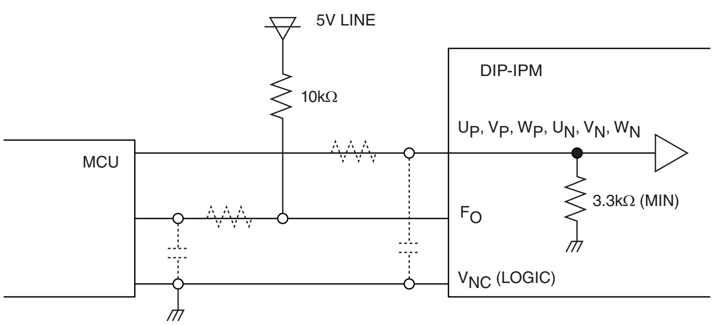
Under-Voltage Protection (P-side, UV_{DB})



c1: Control supply voltage V_{DB} rises – After V_{DB} level reaches under voltage reset level (UV_{DBr}), the circuits starts to operate when next input is applied.
c2: Normal operation – IGBT turns on and carries current.
c3: V_{DB} level dips to under voltage trip level (UV_{DBt}).
c4: P-side IGBT 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 carries current.

Typical Interface Circuit



NOTE: RC coupling at each input (parts shown dotted) may change depending on the PWM control scheme used in the application and the wiring impedance of the printed circuit board. The DIPIPM input signal section integrates a 3.3kΩ (min) pull-down resistor. Therefore, when using an external filtering resistor, care must be taken to satisfy the turn-on threshold voltage requirement.

Wiring Method Around Shunt Resistor