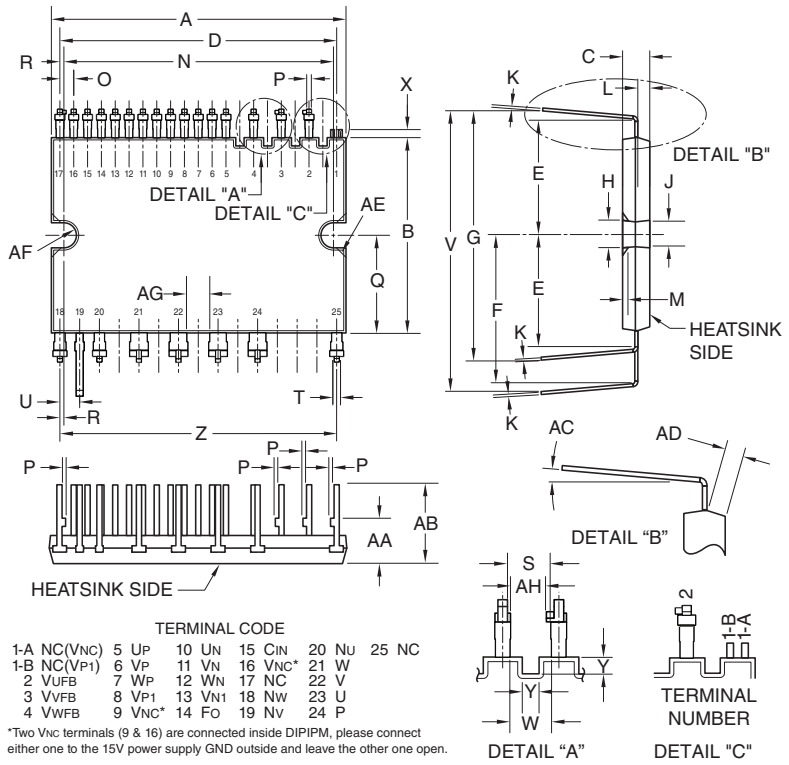
# PS219B4-ST, PS219B4-AST, PS219B4-CST

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

## *Intellimod™ Module*

***Dual-In-Line Intelligent Power Module***
***15 Amperes/600 Volts***

**PS219B4-ST**




TERMINAL CODE

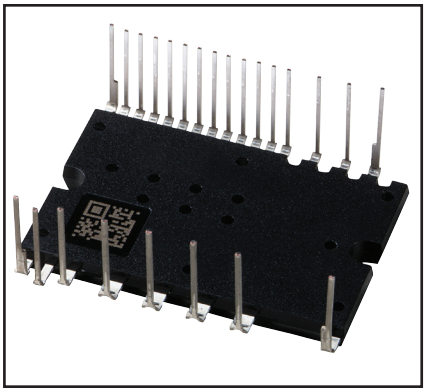
| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 1-A | NC($V_{NC}$) | 5 | $U_P$ | 10 | $U_N$ | 15 | $C_{IN}$ | 20 | $N_U$ | 25 | NC |
| 1-B | NC($V_{P1}$) | 6 | $V_P$ | 11 | $V_N$ | 16 | $V_{NC}$* | 21 | W | | |
| 2 | $V_{UFB}$ | 7 | $W_P$ | 12 | $W_N$ | 17 | NC | 22 | V | | |
| 3 | $V_{VFB}$ | 8 | $V_{P1}$ | 13 | $V_{N1}$ | 18 | $N_W$ | 23 | U | | |
| 4 | $V_{WFB}$ | 9 | $V_{NC}$* | 14 | $F_O$ | 19 | $N_V$ | 24 | P | | |

*Two $V_{NC}$ terminals (9 & 16) are connected inside DIPIPM, please connect either one to the 15V power supply GND outside and leave the other one open.

**Outline Drawing and Circuit Diagram**

| Dim. | 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 | 0.74±0.02 | 18.9±0.5 |
| 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 | 1.38±0.019 | 35.0±0.3 |
| O | 0.07±0.008 | 1.778±0.2 |
| P | 0.02 | 0.5 |
| Q | 0.47 | 12.0 |
| R | 0.011 | 0.28 |

| Dim. | Inches | Millimeters |
|---|---|---|
| S | 0.1046 | 2.656 |
| T | 0.024 | 0.6 |
| U | 0.1±0.008 | 2.54±0.2 |
| V | 1.33±0.02 | 33.7±0.5 |
| W | 0.1085 | 2.756 |
| X | 0.04 | 1.0 |
| Y | 0.05 | 1.2 |
| Z | 1.40 | 35.56 |
| AA | 0.22±0.02 | 5.5±0.5 |
| AB | 0.37±0.02 | 9.5±0.5 |
| AC | 0 ~ 5° | 0 ~ 5° |
| AD | 0.06 Min. | 1.5 Min. |
| AE | 0.05 | 1.2 |
| AF | 0.063 Rad. | 1.6 Rad. |
| AG | 0.118 Min. | 3.0 Min. |
| AH | 0.098 Min. | 2.5 Min. |



**Description:**
DIP-IPMs 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 6th generation CSTBT 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
- ☐ Over-temperature Protection

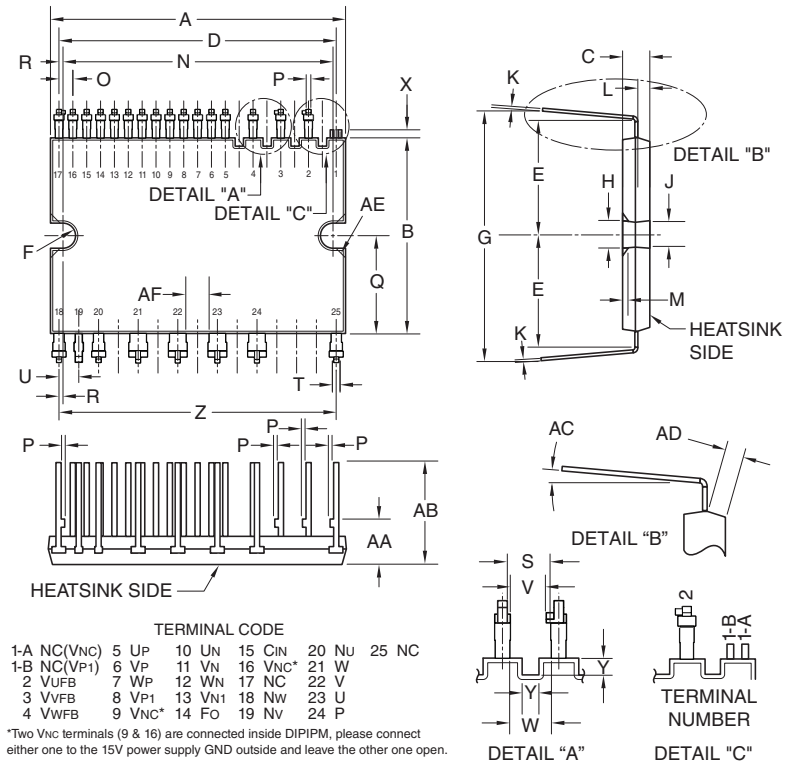
**Applications:**
- ☐ Small Servo Motors
- ☐ Small Motor Control

**Ordering Information:**
PS219B4-ST is a 600V, 15 Ampere short pin DIP Intelligent Power Module.

PS219B4-AST – long pin type
PS219B4-CST – zigzag pin type

***PS219B4-ST, PS219B4-AST, PS219B4-CST***
***Intellimod™ Module***
***Dual-In-Line Intelligent Power Module***
*15 Amperes/600 Volts*

## PS219B4-AST




TERMINAL CODE

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 1-A | NC($V_{NC}$) | 5 | $U_P$ | 10 | $U_N$ | 15 | $C_{IN}$ | 20 | $N_U$ | 25 | NC |
| 1-B | NC($V_{P1}$) | 6 | $V_P$ | 11 | $V_N$ | 16 | $V_{NC}$* | 21 | W | | |
| 2 | $V_{UFB}$ | 7 | $W_P$ | 12 | $W_N$ | 17 | NC | 22 | V | | |
| 3 | $V_{VFB}$ | 8 | $V_{P1}$ | 13 | $V_{N1}$ | 18 | $N_W$ | 23 | U | | |
| 4 | $V_{WFB}$ | 9 | $V_{NC}$* | 14 | $F_O$ | 19 | $N_V$ | 24 | P | | |

*Two $V_{NC}$ terminals (9 & 16) are connected inside DIPIPM, please connect either one to the 15V power supply GND outside and leave the other one open.

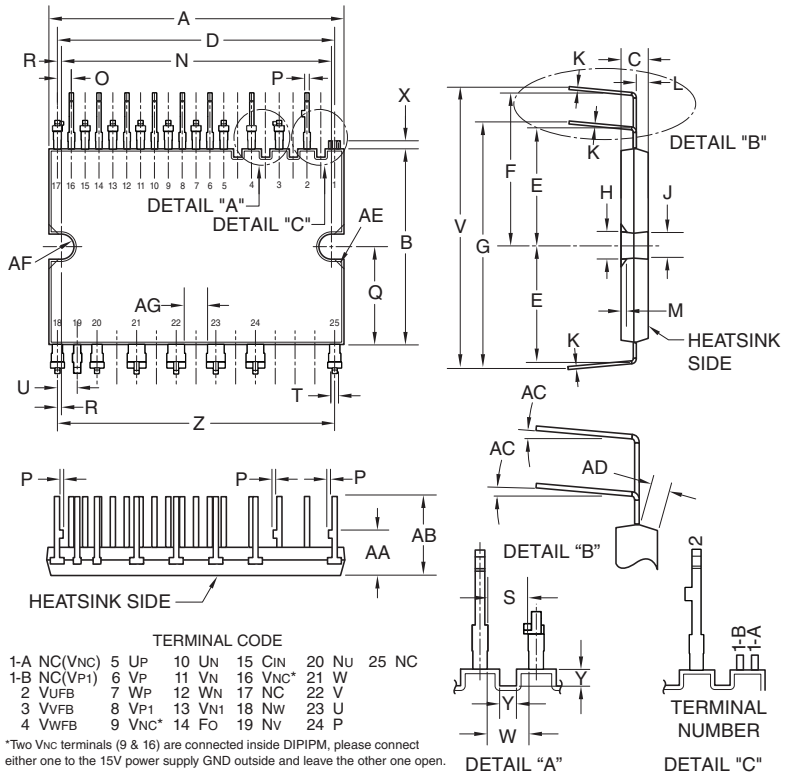
**Outline Drawing and Circuit Diagram**

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| 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 | 0.063 Rad. | 1.6 Rad. |
| G | 1.16±0.02 | 29.4±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 | 1.38±0.019 | 35.0±0.3 |
| O | 0.07±0.008 | 1.778±0.2 |
| P | 0.02 | 0.5 |
| Q | 0.47 | 12.0 |

| Dim. | Inches | Millimeters |
|---|---|---|
| R | 0.011 | 0.28 |
| S | 0.1046 | 2.656 |
| T | 0.024 | 0.6 |
| U | 0.1±0.008 | 2.54±0.2 |
| V | 0.098 Min. | 2.5 Min. |
| W | 0.1085 | 2.756 |
| X | 0.04 | 1.0 |
| Y | 0.05 | 1.2 |
| Z | 1.40 | 35.56 |
| AA | 0.22±0.02 | 5.5±0.5 |
| AB | 0.55±0.02 | 14.0±0.5 |
| AC | 0 ~ 5° | 0 ~ 5° |
| AD | 0.06 Min. | 1.5 Min. |
| AE | 0.05 | 1.2 |
| AF | 0.118 Min. | 3.0 Min. |

***PS219B4-ST, PS219B4-AST, PS219B4-CST***
***Intellimod™ Module***
***Dual-In-Line Intelligent Power Module***
*15 Amperes/600 Volts*

## PS219B4-CST




TERMINAL CODE

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 1-A | NC($V_{NC}$) | 5 | $U_P$ | 10 | $U_N$ | 15 | $C_{IN}$ | 20 | $N_U$ | 25 | NC |
| 1-B | NC($V_{P1}$) | 6 | $V_P$ | 11 | $V_N$ | 16 | $V_{NC}$* | 21 | W | | |
| 2 | $V_{UFB}$ | 7 | $W_P$ | 12 | $W_N$ | 17 | NC | 22 | V | | |
| 3 | $V_{VFB}$ | 8 | $V_{P1}$ | 13 | $V_{N1}$ | 18 | $N_W$ | 23 | U | | |
| 4 | $V_{WFB}$ | 9 | $V_{NC}$* | 14 | $F_O$ | 19 | $N_V$ | 24 | P | | |

*Two $V_{NC}$ terminals (9 & 16) are connected inside DIPIPM, please connect either one to the 15V power supply GND outside and leave the other one open.

**Outline Drawing and Circuit Diagram**

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| C | 0.14 | 3.5 |
| D | 1.40 | 35.56 |
| E | 0.57±0.02 | 14.4±0.5 |
| F | 0.74±0.02 | 18.9±0.5 |
| 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 | 1.38±0.019 | 35.0±0.3 |
| O | 0.07±0.008 | 1.778±0.2 |
| P | 0.02 | 0.5 |
| Q | 0.47 | 12.0 |

| Dim. | Inches | Millimeters |
|---|---|---|
| R | 0.011 | 0.28 |
| S | 0.1046 | 2.656 |
| T | 0.024 | 0.6 |
| U | 0.1±0.008 | 2.54±0.2 |
| V | 1.33±0.02 | 33.7±0.5 |
| W | 0.1085 | 2.756 |
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| Y | 0.05 | 1.2 |
| Z | 1.40 | 35.56 |
| AA | 0.22±0.02 | 5.5±0.5 |
| AB | 0.37±0.02 | 9.5±0.5 |
| AC | 0 ~ 5° | 0 ~ 5° |
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| AF | 0.063 Rad. | 1.6 Rad. |
| AG | 0.118 Min. | 3.0 Min. |

***PS219B4-ST, PS219B4-AST, PS219B4-CST***
***Intellimod™ Module***
***Dual-In-Line Intelligent Power Module***
*15 Amperes/600 Volts*

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

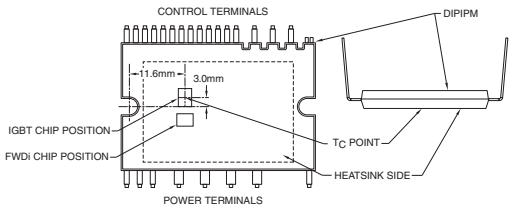
| Characteristics | Symbol | PS219B4-ST, PS219B4-AST, PS219B4-CST | Units |
|---|---|---|---|
| **Inverter Part** | | | |
| Supply Voltage (Applied between P-NU, NV, NW) | $V_{CC}$ | 450 | Volts |
| Supply Voltage, Surge (Applied between P-NU, NV, NW) | $V_{CC(surge)}$ | 500 | Volts |
| Collector-Emitter Voltage | $V_{CES}$ | 600 | Volts |
| Each IGBT Collector Current ($T_C$ = 25°C) | $\pm I_C$ | 15 | Amperes |
| Each Peak Collector Current ($T_C$ = 25°C, Less than 1ms) | $\pm I_{CP}$ | 30 | Amperes |
| Collector Dissipation ($T_C$ = 25°C, per 1 Chip) | $P_C$ | 33.3 | Watts |
| Power Device Junction Temperature*1 | $T_j$ | -20 ~ +150 | °C |
| **Control (Protection) Part** | | | |
| Control Supply Voltage (Applied between $V_{P1}$-$V_{NC}$, $V_{N1}$-$V_{NC}$) | $V_D$ | 20 | Volts |
| Control Supply Voltage (Applied between $V_{UFB}$-U, $V_{VFB}$-V, $V_{WFB}$-W) | $V_{DB}$ | 20 | Volts |
| Input Voltage (Applied between $U_P$, $V_P$, $W_P$-$V_{NC}$, $U_N$, $V_N$, $W_N$-$V_{NC}$) | $V_{IN}$ | -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 |
| **Total System** | | | |
| 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 2µs) | $V_{CC(prot.)}$ | 400 | Volts |
| Module Case Operating Temperature*2 | $T_C$ | -20 ~ +100 | °C |
| Storage Temperature | $T_{stg}$ | -40 ~ +125 | °C |
| Isolation Voltage, 60Hz, Sinusoidal 1 Minute, All Connected Pins to Heatsink Plate | $V_{ISO}$ | 1500 | $V_{rms}$ |

## Thermal Resistance

| | | | | | | |
|---|---|---|---|---|---|---|
| Junction to Case*3 | $R_{th(j-c)Q}$ | Inverter IGBT Part (Per 1/6 Module) | — | — | 3.0 | °C/Watt |
| | $R_{th(j-c)D}$ | Inverter FWDi Part (Per 1/6 Module) | — | — | 3.9 | °C/Watt |

*1 The maximum junction temperature rating of the power chips integrated within the DIPIPM is 150°C (@$T_C$ ≤ 100°C). However, to ensure safe operation of the DIPIPM, the average junction temperature should be limited to $T_{j(avg)}$ ≤ 25°C (@$T_C$ ≤ 100°C).

*2 TC measurement point




*3 Good thermal grease with long-term quality should be applied evenly with +100µm ~ +200µm on the contacting surface of the DIPIPM and heatsink. The contacting thermal resistance between DIPIPM case and heatsink ($R_{th(c-f)}$) is determined by the thickness and the thermal conductivity of the applied grease. For reference, $R_{th(c-f)}$ (per 1/6 module) is about 0.3°C/W when the grease thickness is 20µm and the thermal conductivity is 1.0W/mK.

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***Intellimod™ Module***
***Dual-In-Line Intelligent Power Module***
*15 Amperes/600 Volts*

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

| Characteristics | Symbol | Test Conditions | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|---|
| **Inverter Part** | | | | | | |
| Collector-Emitter Saturation Voltage | $V_{CE(sat)}$ | $V_D = V_{DB}$ = 15V, $I_C$ = 15A, $V_{IN}$ = 5V, $T_j$ = 25°C | — | 1.50 | 2.00 | Volts |
| | | $V_D = V_{DB}$ = 15V, $I_C$ = 15A, $V_{IN}$ = 5V, $T_j$ = 125°C | — | 1.60 | 2.10 | Volts |
| Diode Forward Voltage | $V_{EC}$ | $-I_C$ = 15A, $V_{IN}$ = 0V | — | 1.70 | 2.20 | Volts |
| Switching Times | $t_{on}$ | $V_{CC}$ = 300V, $V_D = V_{DB}$ = 15V, $I_C$ = 15A, $T_j$ = 125°C, $V_{IN}$ = 0 ⇔ 5V, Inductive Load | 0.85 | 1.45 | 2.05 | µs |
| | $t_{rr}$ | | — | 0.30 | — | µs |
| | $t_{C(on)}$ | | — | 0.45 | 0.70 | µs |
| | $t_{off}$ | | — | 1.50 | 2.10 | µs |
| | $t_{C(off)}$ | | — | 0.35 | 0.60 | 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 (Protection) Part** | | | | | | |
| Circuit Current | $I_D$ | $V_{IN}$ = 0V, $V_D$ = 15V, Total of $V_{P1}$-$V_{NC}$, $V_{N1}$-$V_{NC}$ | — | — | 2.80 | mA |
| | | $V_{IN}$ = 5V, $V_D$ = 15V, Total of $V_{P1}$-$V_{NC}$, $V_{N1}$-$V_{NC}$ | — | — | 2.80 | mA |
| | $I_{DB}$ | $V_{IN}$ = 0V, $V_D = V_{DB}$ = 15V, Each Part of $V_{UFB}$-U, $V_{VFB}$-V, $V_{WFB}$-W | — | — | 0.10 | mA |
| | | $V_{IN}$ = 5V, $V_D = V_{DB}$ = 15V, Each Part of $V_{UFB}$-U, $V_{VFB}$-V, $V_{WFB}$-W | — | — | 0.10 | 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 |
| Input Current | $I_{IN}$ | $V_{IN}$ = 5V | 0.70 | 1.00 | 1.50 | mA |
| Short Circuit Trip Level | $V_{SC(ref)}$ | $V_D$ = 15V*4 | 0.43 | 0.48 | 0.53 | Volts |
| Over-Temperature Protection | $OT_t$ | Trip Level | 100 | 120 | 140 | °C |
| ($V_D$ = 15V, At Temperatue of LVIC)*6 | $OT_{rh}$ | Trip/Reset Hysteresis | — | 10 | — | °C |
| Control Supply | $UV_{DBt}$ | Trip Level, $T_j$ ≤ 125°C | 7.0 | 10.0 | 12.0 | Volts |
| Under-voltage Protection | $UV_{DBr}$ | Reset Level, $T_j$ ≤ 125°C | 7.0 | 10.0 | 12.0 | Volts |
| | $UV_{Dt}$ | Trip Level, $T_j$ ≤ 125°C | 10.3 | — | 12.5 | Volts |
| | $UV_{Dr}$ | Reset Level, $T_j$ ≤ 125°C | 10.8 | — | 13.0 | Volts |
| Fault Output Pulse Width*5 | $t_{FO}$ | | 20 | — | — | µs |
| ON Threshold Voltage | $V_{th(on)}$ | Applied between $U_P$, $V_P$, $W_P$-$V_{NC}$, $U_N$, $V_N$, $W_N$-$V_{NC}$ | — | 2.1 | 2.6 | Volts |
| OFF Threshold Voltage | $V_{th(off)}$ | | 0.8 | 1.3 | — | Volts |
| ON/OFF Threshold Hysteresis Voltage | $V_{th(hys)}$ | | 0.35 | 0.65 | — | Volts |
| Bootstrap Diode Forward Voltage*7 | $V_F$ | $I_F$ = 10mA, Including Voltage Drop by Limiting Resistor | 1.1 | 1.7 | 2.3 | Volts |
| Built-in Limiting Resistance | R | For Bootstrap Circuit | 80 | 100 | 120 | Ω |

*4 Short Circuit protection is functioning only for N-side IGBTs. 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.

*5 Fault signal, $F_O$, outputs when $S_C$ or $U_V$ protection works. $F_O$ pulse width is different for each protection mode. At $S_C$ failure, $F_O$ pulse width is a fixed width (=min. 20µs), however, at $U_V$ failure, $F_O$ outputs continuously until recovering from $U_V$ state. Minimum $F_O$ pulse width is 20µs.

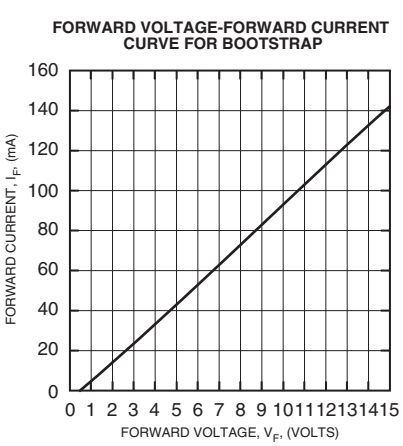
*6 When the LVIC temperature exceeds OT trip temperature level ($OT_t$), OT protection works and $F_O$ outputs. In that case if the heatsink dropped off or is loosely fitted, do not use the DIPIPM. There is a possiblity that the junction temperature of the power chips has exceeded maximum $T_j$ (150°C).

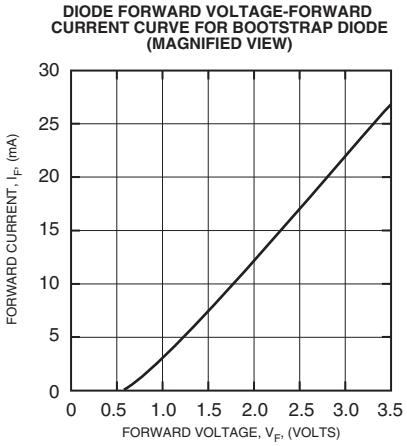
***PS219B4-ST, PS219B4-AST, PS219B4-CST***
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## Mechanical Characteristics and Ratings

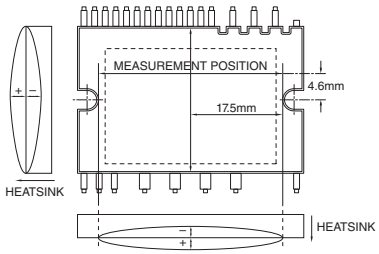
| Characteristic | Symbol | Condition | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|---|
| Mounting Torque | | M3 Mounting Screws*8 | 5.2 | 6.1 | 6.9 | in-lb |
| Terminal Pulling Strength | | Control Terminal: Weight 4.9N | 10 | — | — | s |
| | | Power Terminal: Weight 9.8N | | | | |
| Terminal Bending Strength | | Control Terminal: Weight 2.45N | 2 | — | — | times |
| | | Power Terminal: Weight 4.9N | | | | |
| | | 90 Degree Bend | | | | |
| Module Weight (Typical) | | | — | 8.5 | — | Grams |
| Heatsink Flatness*9 | | | -50 | — | +100 | µm |

*7 Bootstrap Diode (@$T_a$ = 25°C) Characteristics




*8 Plain washers (ISO 7089-7094) are recommended.
*9 Flatness measurement position.



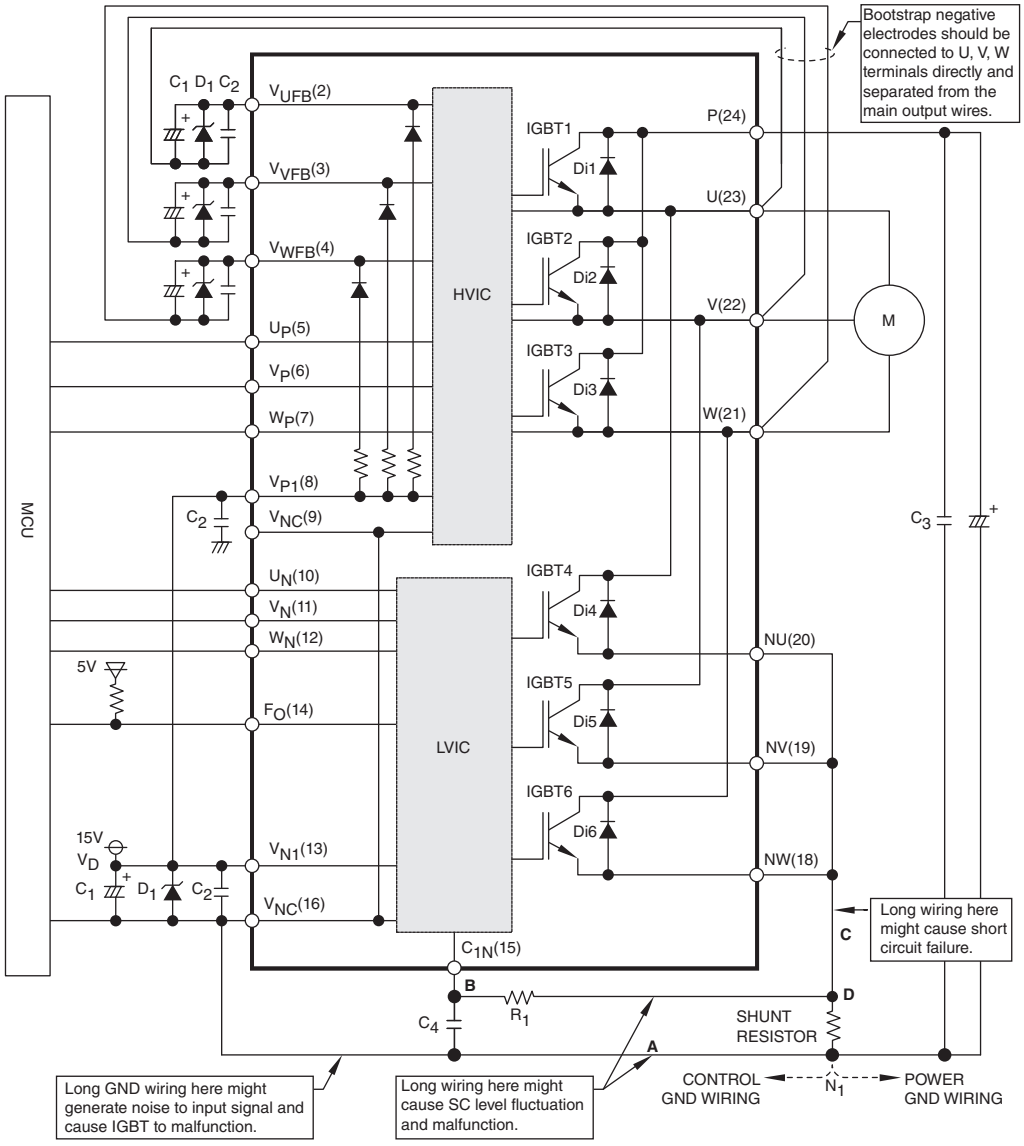
## Recommended Conditions for Use

| Characteristic | Symbol | Condition | Min. | Typ. | Max. | 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 | $\Delta V_D$, $\Delta V_{DB}$ | | -1 | — | 1 | V/μs |
| Arm Shoot-through Blocking Time | $t_{DEAD}$ | For Each Input Signal, $T_C \leq 100°C$ | 1.0 | — | — | μs |
| Allowable Minimum Input Pulse Width*11 | $P_{WIN(on)}$ | | 0.7 | — | — | μs |
| | $P_{WIN(off)}$ | | 0.7 | — | — | μs |
| $V_{NC}$ Voltage Variation | $V_{NC}$ | Between $V_{NC}$-NU, NV, NW (Including Surge) | -5.0 | — | 5.0 | Volts |
| Junction Temperature | $T_j$ | | -20 | — | 125 | °C |

*11 DIPIPM may not respond if the input signal pulse is less than $P_{WIN(on)}$, $P_{WIN(off)}$.

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*15 Amperes/600 Volts*

## Application Circuit

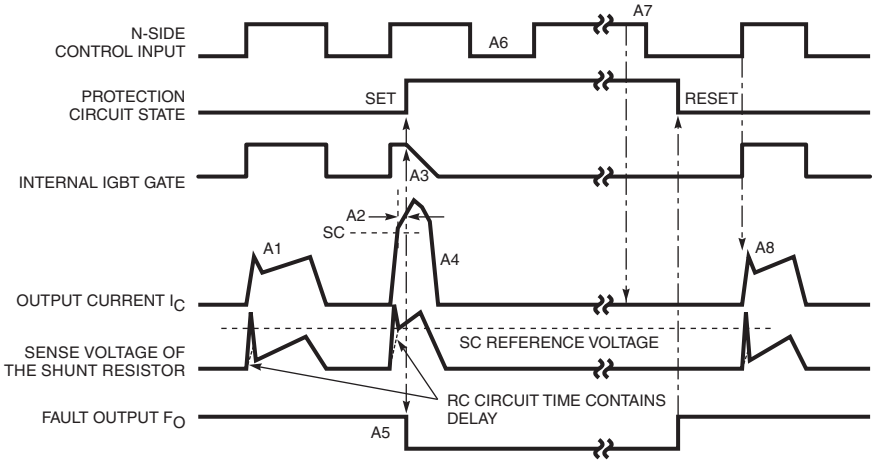



Notes:
1) It is recommended to connect Control GND wiring and Power GND wiring only at point $N_1$ (near terminal of shunt resistor) to prevent a malfunction by Power GND fluctuations.
2) It is recommended to insert a Zener diode D1 (24V/1W) between each pair of control supply terminals to prevent surge destruction.
3) To prevent surge destruction, the wiring between the DC bus smoothing capacitor and the P, $N_1$ terminals should be as short as possible. Generally a 0.1-0.22μF snubber capacitor C3 between the P-$N_1$ terminals is recommended.
4) Time constant of $R_1$, $C_4$ for SC protection circuit should be selected so that protection works within 2μs. (Recommended value: ≤2μs) SC interrupting time might vary with the wiring pattern. Tight tolerance, temp-compensated type, is recommended for $R_1$, $C_4$.
5) To prevent malfunction, the wiring of A, B, C should be as short as possible.
6) The point D at which the wiring to $C_{IN}$ filter is divided should be near the terminal of shunt resistor. NU, NV, NW terminals should be connected at near NU, NV, NW terminals.
7) All capacitors should be mounted as close to the terminals as possible. (C1: good temperature, frequency characteristic electrolytic type and C2: 0.22μ-2μF, good temperature, frequency and DC bias characteristic ceramic types recommended.)
8) Input drive is active-high type. There is a 3.3kΩ (Min.) pull-down resistor in the input circuit of IC. 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.
9) $F_O$ output is open drain type. It should be pulled up to MCU or control power supple (e.g. 5V) by resistor makes $I_{FO}$ up to 1mA.
10) Direct coupling to the MCU without any opto-coupler or transformer isolation is possible because the HVIC is inside the module.
11) Two $V_{NC}$ terminals (9 & 16 pin) are connected inside the DIPIPM. Be sure to connect either one to the 15V power supply GND outside and leave the other one open.
12) IC malfunction can occur and cause the DIPIPM to operate erroneously when high frequency noise is superimposed on the control supply line. To avoid such problem, the line ripple voltage should meet dV/dt ≤ ±1V/μs and $V_{ripple}$ ≤ 2Vp-p.

***PS219B4-ST, PS219B4-AST, PS219B4-CST***
***Intellimod™ Module***
***Dual-In-Line Intelligent Power Module***
*15 Amperes/600 Volts*

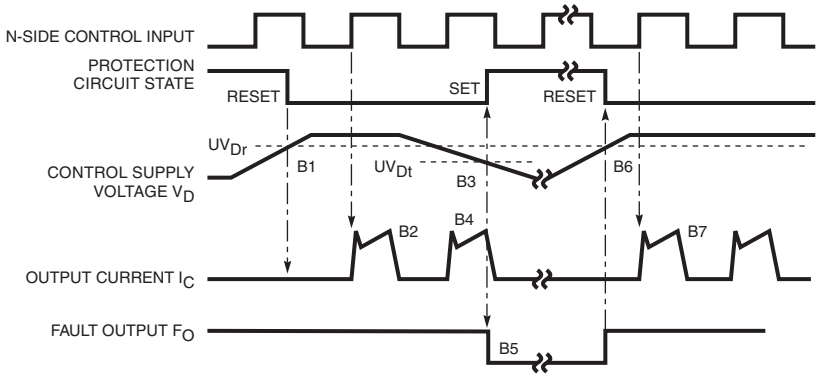
## Protection Function Timing Diagrams

Short-Circuit Protection (N-side only with the external shunt resistor and RC filter)




A1: Normal operation – IGBT turn on and conducting current.
A2: Short-circuit current detected (SC trigger).
A3: All N-side IGBT gate hard interrupted.
A4: All N-side IGBTs turn off.
A5: $F_O$ output with a fixed pulse width of $t_{FO(min)}$ = 20µs.
A6: Input "L" – IGBT off.
A7: Input "H" – IGBT off in spite of "H" input.
A8: Normal operation – IGBT on and conducting current.

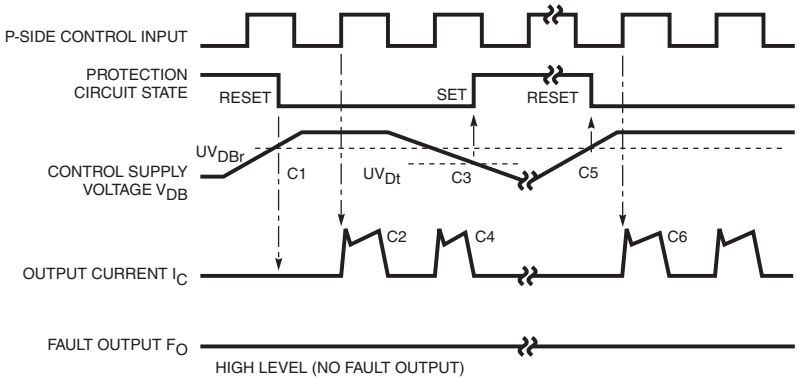
Under-Voltage Protection (N-side, $UV_D$)




B1: Control supply voltage rise – After the voltage level reaches $UV_{Dr}$, the drive circuit begins to work at the rising edge of the next input signal.
B2 : Normal operation – IGBT turn on and conducting current.
B3: Under-voltage trip ($UV_{Dt}$).
B4: All N-side IGBTs turn off regardless of the control input level.
B5: $F_O$ output during under-voltage period, however, the minimum pulse width is 20µs.
B6: Under-voltage reset ($UV_{Dr}$).
B7: Normal operation – IGBT turn on and conducting current.

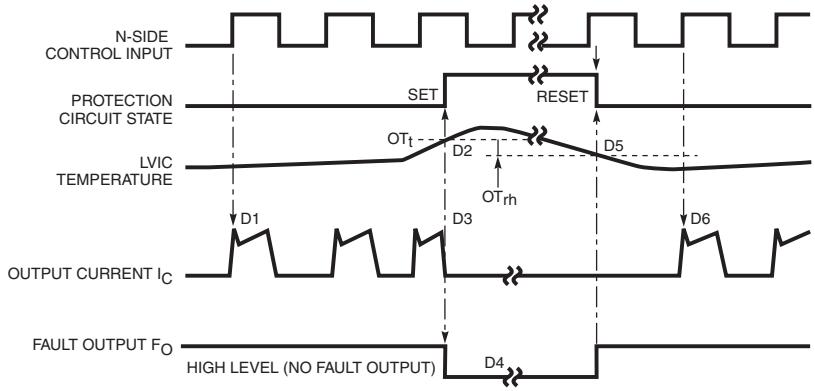
## Protection Function Timing Diagrams

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




C1: Control supply voltage rises – After the voltage level reaches $UV_{DBr}$, the drive circuit begins to work at the rising edge of the next input signal.
C2: Normal operation – IGBT turn on and conducting current.
C3: Under-voltage trip ($UV_{DBt}$).
C4: IGBT stays off regardless of the control input level, but there is no $F_O$ signal output.
C5: Under-voltage reset ($UV_{Dr}$).
C6: Normal operation – IGBT turn on and conducting current.

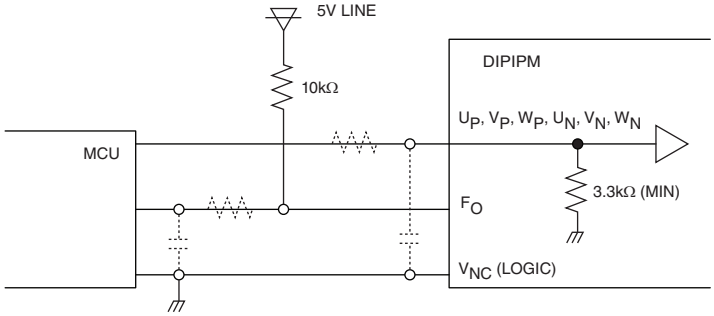
Over-Temperature Protection (N-side, OT)




D1: Normal operation – IGBT turn on and conducting current.
D2: LVIC temperature exceeds over-temperature tril level ($OT_t$).
D3: All N-side IGBTs turn OFF iin spite of control input condition.
D4: $F_O$ outputs during over-temperature period, however, the minimum pulse width is 20µs.
D5: LVIC temperature is lower than over-temperature reset level.
D6: Circuits start to operate normally when next input is applied.

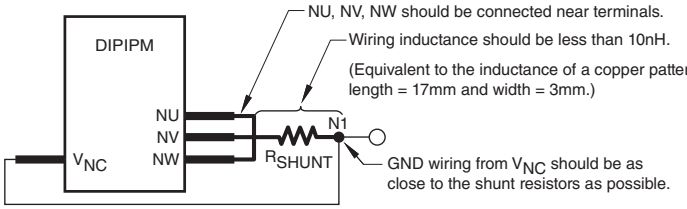
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## Typical Interface Circuit

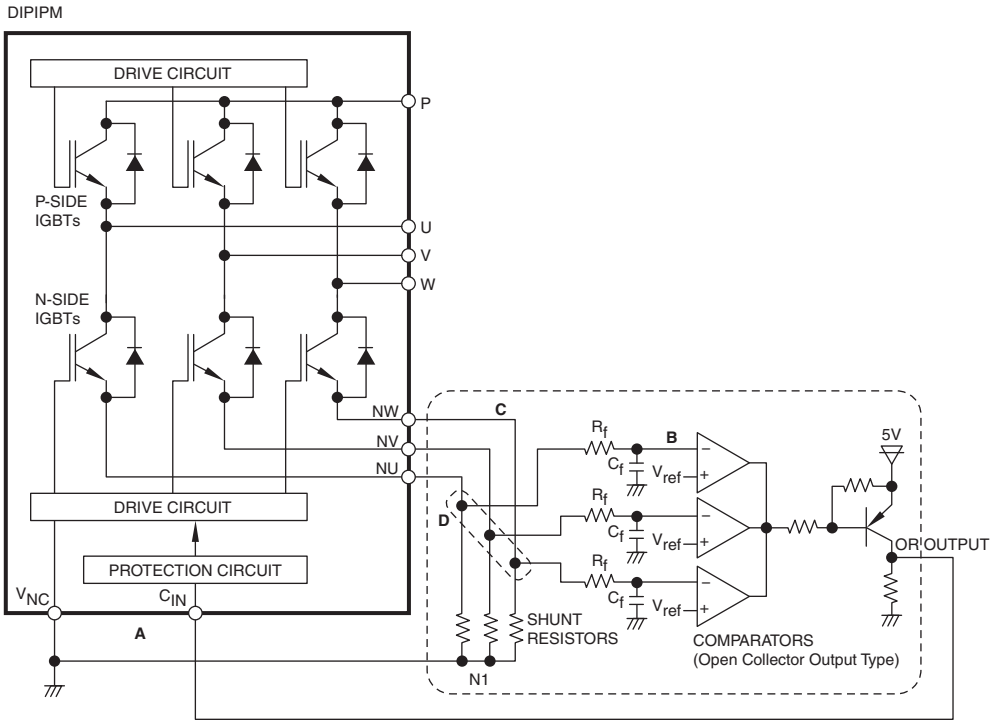



NOTE: RC coupling at each input (parts shown dotted) may change depending on the PWM control scheme used in the application and the wiring impedance of the printed circuit board. The DIPIPM input signal section integrates a 3.3kΩ (min) pull-down resistor. Therefore, when using an external filtering resistor,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

## Pattern Wiring Around Shunt Resistor




## External $S_C$ Protection Circuit Using Three Shunt Resistors




Notes:
1) It is necessary to set the time constraint $R_f$, $C_f$ of external comparator input so that the IGBT stops within 2µs when short circuit occurs. SC interrupting time can vary with the wiring pattern, comparator speed and so on.
2) The threshold voltage $V_{ref}$ should be set up as the same rating as the short circuit trip level ($V_{SC(ref)}$, typically 0.48V).
3) Select the external shunt resistance so that the SC trip-level is less than specified value (≤1.7 times current rating).
4) Wiring A, B, and C should be as short as possible to avoid a malfunction.
5) Where the wiring to the comparator is divided, point D, should be near the shunt resistor terminal.
6) OR output high level should be over 0.53V (= maximum $V_{SC(ref)}$).