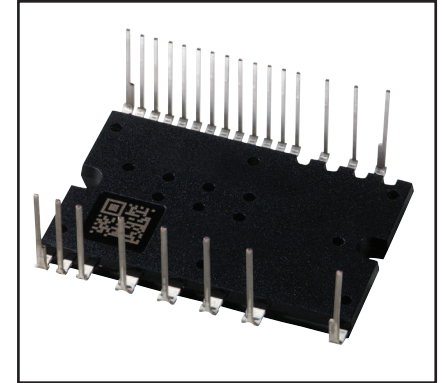
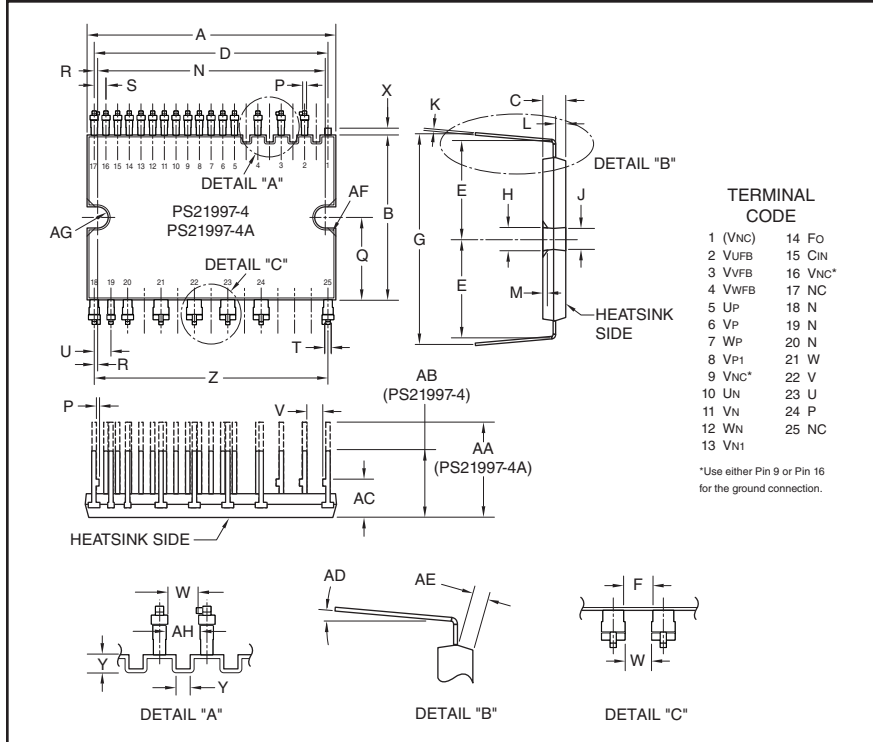


### Intellimod™ Module Dual In-line Intelligent Power Module 30 Amperes/600 Volts



**Description:**  
DIPIMs 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

#### 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.  |

**PS21997-4, PS21997-4A**  
**Intellimod™ Module**  
**Dual In-line Intelligent Power Module**  
 30 Amperes/600 Volts

## Absolute Maximum Ratings, $T_j = 25^\circ\text{C}$ unless otherwise specified

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

\*The maximum junction temperature rating of the power chips integrated within the DIPIPM is  $150^\circ\text{C}$  ( $@T_C \leq 100^\circ\text{C}$ ). However, to ensure safe operation of the DIPIPM, the average junction temperature should be limited to  $T_{j(\text{avg})} \leq 125^\circ\text{C}$  ( $@T_C \leq 100^\circ\text{C}$ ).

\*\* $V_D = 13.5 - 16.5\text{V}$ , Inverter Part,  $T_j = 125^\circ\text{C}$ , Non-repetitive, Less than  $2\mu\text{s}$

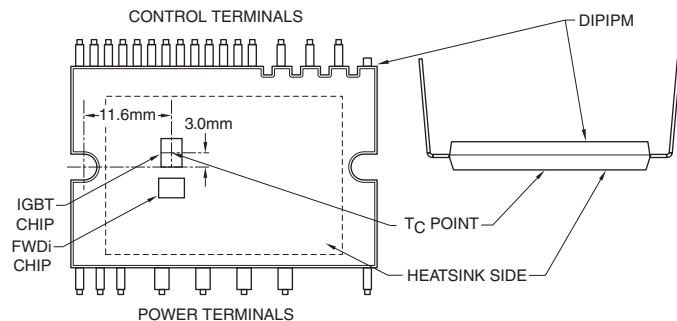
## IGBT Inverter Sector

|   |                        |      |         |
|---|------------------------|------|---------|
| Supply Voltage (Applied between P - N)  | $V_{\text{CC}}$        | 450  | Volts   |
| Supply Voltage, Surge (Applied between P - N)                                       | $V_{\text{CC(surge)}}$ | 500  | Volts   |
| Collector-Emitter Voltage   | $V_{\text{CES}}$       | 600  | Volts   |
| Each IGBT Collector Current, $\pm$ ( $T_C = 25^\circ\text{C}$ )                     | $I_C$                  | 30   | Amperes |
| Each IGBT Peak Collector Current, $\pm$ ( $T_C = 25^\circ\text{C}$ , Less than 1ms) | $I_{\text{CP}}$        | 60   | Amperes |
| Collector Dissipation ( $T_C = 25^\circ\text{C}$ , per 1 Chip)                      | $P_C$                  | 47.6 | Watts   |

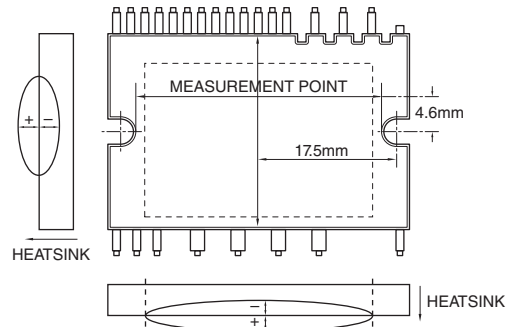
## Control Sector

|   |                 |                  |       |
|---|-----------------|------------------|-------|
| Supply Voltage (Applied between $V_{P1-V_{NC}}$ , $V_{N1-V_{NC}}$ )                   | $V_D$           | 20               | Volts |
| Supply Voltage (Applied between $V_{UFB-U}$ , $V_{VFB-V}$ , $V_{WFB-W}$ )             | $V_{\text{DB}}$ | 20               | Volts |
| Input Voltage (Applied between $U_B$ , $V_B$ , $W_B$ , $U_N$ , $V_N$ , $W_N-V_{NC}$ ) | $V_{\text{IN}}$ | -0.5 ~ $V_D+0.5$ | Volts |
| Fault Output Supply Voltage (Applied between $F_O-V_{NC}$ )                           | $V_{\text{FO}}$ | -0.5 ~ $V_D+0.5$ | Volts |
| Fault Output Current (Sink Current at $F_O$ Terminal)                                 | $I_{\text{FO}}$ | 1                | mA    |
| Current Sensing Input Voltage (Applied between $C_{\text{IN}}-V_{NC}$ )               | $V_{\text{SC}}$ | -0.5 ~ $V_D+0.5$ | Volts |

Note 1 –  $T_C$  Measure Point



Note 2 – Flatness Measurement Position



PS21997-4, PS21997-4A  
**Intellimod™ Module**  
**Dual In-line Intelligent Power Module**  
 30 Amperes/600 Volts

## Electrical and Mechanical Characteristics, $T_j = 25^\circ\text{C}$ unless otherwise specified

| Characteristics                      | Symbol        | Test Conditions  | Min. | Typ. | Max. | Units         |
|--------------------------------------|---------------|--|------|------|------|---------------|
| <b>IGBT Inverter Sector</b>          |               |  |      |      |      |               |
| Collector-Emitter Saturation Voltage | $V_{CE(sat)}$ | $V_D = V_{DB} = 15\text{V}, I_C = 30\text{A}, V_{IN} = 5\text{V}, T_j = 25^\circ\text{C}$  | —    | 1.90 | 2.50 | Volts         |
|                                      |               | $V_D = V_{DB} = 15\text{V}, I_C = 30\text{A}, V_{IN} = 5\text{V}, T_j = 125^\circ\text{C}$ | —    | 2.00 | 2.60 | Volts         |
| Diode Forward Voltage                | $V_{EC}$      | $T_j = 25^\circ\text{C}, -I_C = 30\text{A}, V_{IN} = 0\text{V}$                            | —    | 1.70 | 2.20 | Volts         |
| Switching Times                      | $t_{on}$      | $V_{CC} = 300\text{V},$  | 0.70 | 1.30 | 1.90 | $\mu\text{s}$ |
|                                      | $t_{rr}$      | $V_D = V_{DB} = 15\text{V},$   | —    | 0.30 | —    | $\mu\text{s}$ |
|                                      | $t_{C(on)}$   | $I_C = 30\text{A}, T_j = 125^\circ\text{C},$   | —    | 0.40 | 0.60 | $\mu\text{s}$ |
|                                      | $t_{off}$     | $V_{IN} = 0 \leftrightarrow 5\text{V},$  | —    | 1.70 | 2.65 | $\mu\text{s}$ |
|                                      | $t_{C(off)}$  | Inductive Load (Upper and Lower Arm)   | —    | 0.40 | 1.00 | $\mu\text{s}$ |
| Collector-Emitter Cutoff Current     | $I_{CES}$     | $V_{CE} = V_{CES}, T_j = 25^\circ\text{C}$   | —    | —    | 1.0  | mA            |
|                                      |               | $V_{CE} = V_{CES}, T_j = 125^\circ\text{C}$  | —    | —    | 10   | mA            |

## Control Sector

|   |               |  |   |      |      |               |    |
|---|---------------|--|---|------|------|---------------|----|
| Circuit Current                         | $I_D$         | $V_{IN} = 5\text{V}$   | 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 |
|   |               | $V_{IN} = 0\text{V}$   | 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                    | $V_{FOH}$     | $V_{SC} = 0\text{V}, F_O$ Terminal Pull-up to 5V by 10k $\Omega$ | 4.9                                     | —    | —    | Volts         |    |
|   |               | $V_{SC} = 1\text{V}, I_{FO} = 1\text{mA}$                        | —                                       | —    | 0.95 | Volts         |    |
| Short Circuit Trip Level*               | $V_{SC(ref)}$ | $V_D = 15\text{V}$   | 0.43                                    | 0.48 | 0.53 | Volts         |    |
| Input Current                           | $I_{IN}$      | $V_{IN} = 5\text{V}$   | 0.70                                    | 1.00 | 1.50 | mA            |    |
| Supply Circuit Under-voltage Protection | $UV_{DBt}$    | Trip Level, $T_j \leq 125^\circ\text{C}$                         | 10.0                                    | —    | 12.0 | Volts         |    |
|   |               | Reset Level, $T_j \leq 125^\circ\text{C}$                        | 10.5                                    | —    | 12.5 | Volts         |    |
|   |               | Trip Level, $T_j \leq 125^\circ\text{C}$                         | 10.3                                    | —    | 12.5 | Volts         |    |
|   |               | Reset Level, $T_j \leq 125^\circ\text{C}$                        | 10.8                                    | —    | 13.0 | Volts         |    |
| Fault Output Pulse Width**              | $t_{FO}$      |  | 40                                      | —    | —    | $\mu\text{s}$ |    |
| 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  $UV$  or  $SC$  condition on the low side. On a  $SC$  fault the  $F_O$  duration will be 40 $\mu\text{sec}$ . On a  $UV$  condition the fault signal will be asserted as long as the  $UV$  condition exists or for 40 $\mu\text{sec}$ , whichever is longer.



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

PS21997-4, PS21997-4A  
 Intellimod™ Module  
 Dual In-line Intelligent Power Module  
 30 Amperes/600 Volts

### 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 $V_{UFB-U}$ ,<br>$V_{VFB-V}$ , $V_{WFB-W}$  | 13.0                           | 15.0 | 18.5  | Volts      |
| Control Supply Variation        | $dV_D$ , $dV_{DB}$   |   | -1                             | —    | 1     | V/ $\mu$ s |
| Arm Shoot-through Blocking Time | $t_{DEAD}$           | For Each Input Signal, $T_C \leq 100^\circ\text{C}$         | 2.0                            | —    | —     | $\mu$ s    |
| PWM Input Frequency             | $f_{PWM}$            | $T_C \leq 100^\circ\text{C}$ , $T_j \leq 125^\circ\text{C}$ | —                              | —    | 20    | kHz        |
| Allowable Minimum Input         | $P_{WIN(on)}^{**}$   | $200\text{V} \leq V_{CC} \leq 350\text{V}$ ,                | 0.5                            | —    | —     | $\mu$ s    |
| Pulse Width                     | $P_{WIN(off)}^{***}$ | $13.5\text{V} \leq V_D \leq 16.5\text{V}$ ,                 | Below Rated Current            | 1.5  | —     | $\mu$ s    |
|                                 |                      | $13.0\text{V} \leq V_{DB} \leq 18.5\text{V}$                | Between Rated Current          | 3.0  | —     | $\mu$ s    |
|                                 |                      | $-20^\circ\text{C} \leq T_C \leq 100^\circ\text{C}$ ,       | and 1.7 Times<br>Rated Current |      |       |            |
|                                 |                      | N-line Wiring Inductance<br>Less than 10nH                  |                                |      |       |            |
| $V_{NC}$ Voltage Variation      | $V_{NC}$             | Between $V_{NC-N}$ (Including Surge)                        | -5.0                           | —    | 5.0   | Volts      |

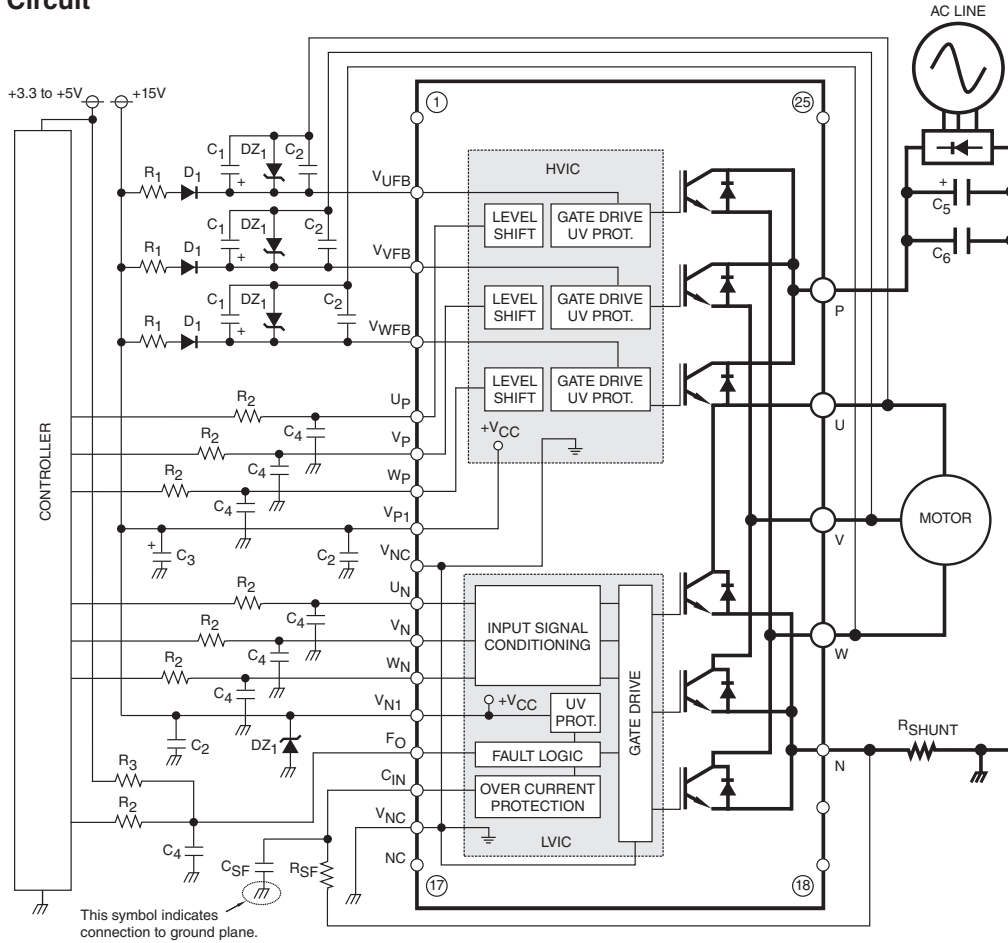
\*The allowable rms current value depends on the actual application conditions.

\*\*Input signal with ON pulse width less than  $P_{WIN(on)}$  may not respond.

\*\*\*Input signal with OFF pulse width less than  $P_{WIN(off)}$  may make no response or may have a delayed response to P-side input only. The delay is less than 4 $\mu$ s.

**PS21997-4, PS21997-4A**  
**Intellimod™ Module**  
**Dual In-line Intelligent Power Module**  
**30 Amperes/600 Volts**

### Application Circuit



#### Component Selection:

| Dsgn.              | Typ. Value       | Description   |
|--------------------|------------------|---|
| D <sub>1</sub>     | 1A, 600V         | Boot strap supply diode – Ultra fast recovery   |
| DZ <sub>1</sub>    | 24V, 1.0W        | Control and boot strap supply over voltage suppression                                  |
| C <sub>1</sub>     | 10-100uF, 50V    | Boot strap supply reservoir – Electrolytic, long life, low Impedance, 105°C (Note 5)    |
| C <sub>2</sub>     | 0.22-2.0uF, 50V  | Local decoupling/High frequency noise filters – Multilayer ceramic (Note 8)             |
| C <sub>3</sub>     | 10-100uF, 50V    | Control power supply filter – Electrolytic, long life, low Impedance, 105°C             |
| C <sub>4</sub>     | 100pF, 50V       | Optional Input signal noise filter – Multilayer ceramic (Note 1)                        |
| C <sub>5</sub>     | 200-2000uF, 450V | Main DC bus filter capacitor – Electrolytic, long life, high ripple current, 105°C      |
| C <sub>6</sub>     | 0.1-0.22uF, 450V | Surge voltage suppression capacitor – Polyester/Polypropylene film (Note 9)             |
| C <sub>SF</sub>    | 1000pF, 50V      | Short circuit detection filter capacitor – Multilayer Ceramic (Note 6, Note 7)          |
| R <sub>SF</sub>    | 1.8k ohm         | Short circuit detection filter resistor (Note 6, Note 7)                                |
| R <sub>SHUNT</sub> | 5-100mohm        | Current sensing resistor – Non-inductive, temperature stable, tight tolerance (Note 10) |
| R <sub>1</sub>     | 10 ohm           | Boot strap supply inrush limiting resistor (Note 5)                                     |
| R <sub>2</sub>     | 330 ohm          | Optional control input noise filter (Note 1, Note 2)                                    |
| R <sub>3</sub>     | 10k ohm          | Fault output signal pull-up resistor (Note 3)   |

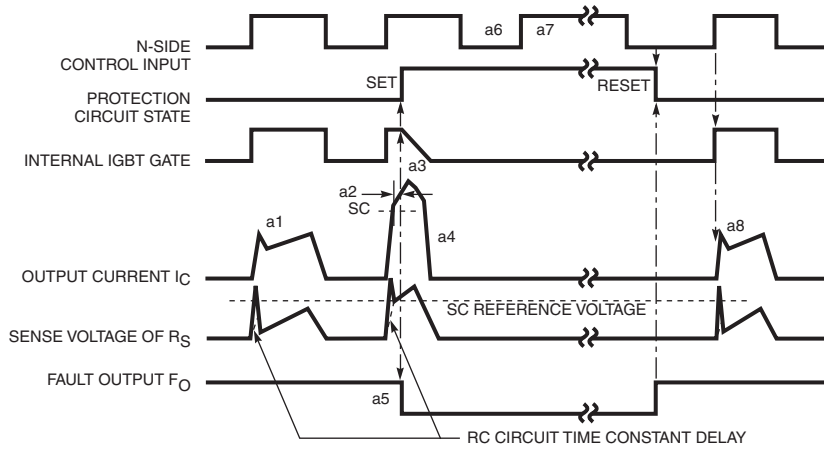
#### Notes:

- To prevent input signal oscillations minimize wiring length to controller (~2cm). Additional RC filtering (C<sub>5</sub> etc.) may be required. If filtering is added be careful to maintain proper dead time and voltage levels. See application notes for details.
- Internal HVIC provides high voltage level shifting allowing direct connection of all six driving signals to the controller.
- F<sub>O</sub> output is an open collector type. Pull up resistor (R<sub>3</sub>) should be adjusted to current sink capability of the controller.
- Use only one V<sub>NC</sub> Pin (either 9 or 16) and leave the other open.
- Boot strap supply component values must be adjusted depending on the PWM frequency and technique.
- Wiring length associated with R<sub>SHUNT</sub>, R<sub>SF</sub>, C<sub>SF</sub> must be minimized to avoid improper operation of the OC function.
- R<sub>SF</sub>, C<sub>SF</sub> set over current protection trip time. Recommend time constant is 1.5µs-2.0µs. See application notes.
- Local decoupling/high frequency filter capacitors must be connected as close as possible to the modules pins.
- The length of the DC link wiring between C<sub>5</sub>, C<sub>6</sub>, the DIP's P terminal and the shunt must be minimized to prevent excessive transient voltages. In particular C<sub>6</sub> should be mounted as close to the DIP as possible.
- 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.

PS21997-4, PS21997-4A  
 Intellimod™ Module  
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 30 Amperes/600 Volts

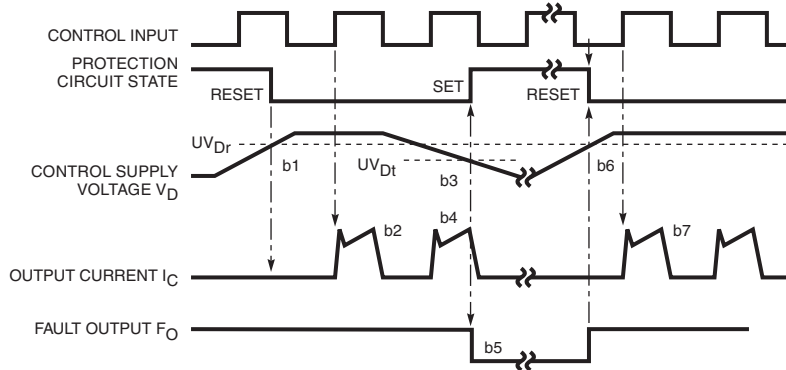
## Protection Function Timing Diagrams

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 with 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 period the IGBT will not turn on.
- a8: IGBT turns on when L→H signal is input after  $F_O$  is reset.

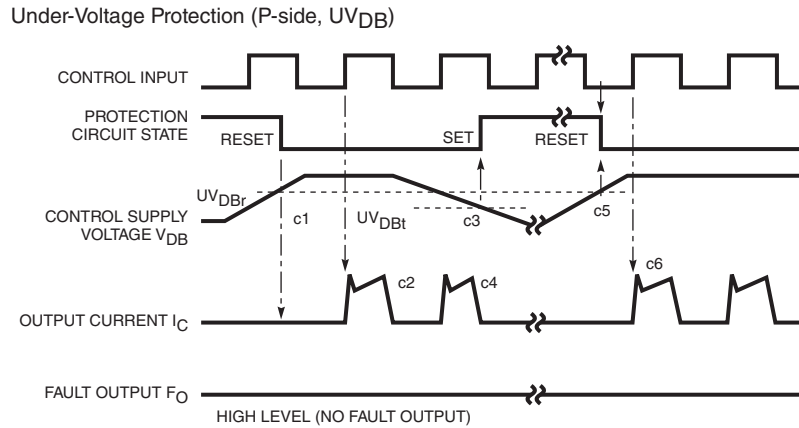
Under-Voltage Protection (N-side , UV<sub>D</sub>)



- 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.

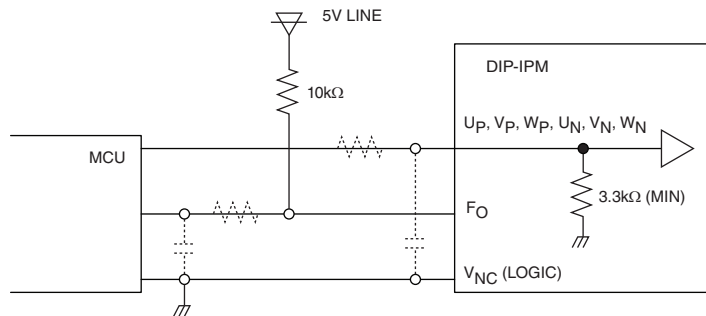
PS21997-4, PS21997-4A  
 Intellimod™ Module  
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 30 Amperes/600 Volts

## Protection Function Timing Diagrams



- 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 DIP-IPM 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

