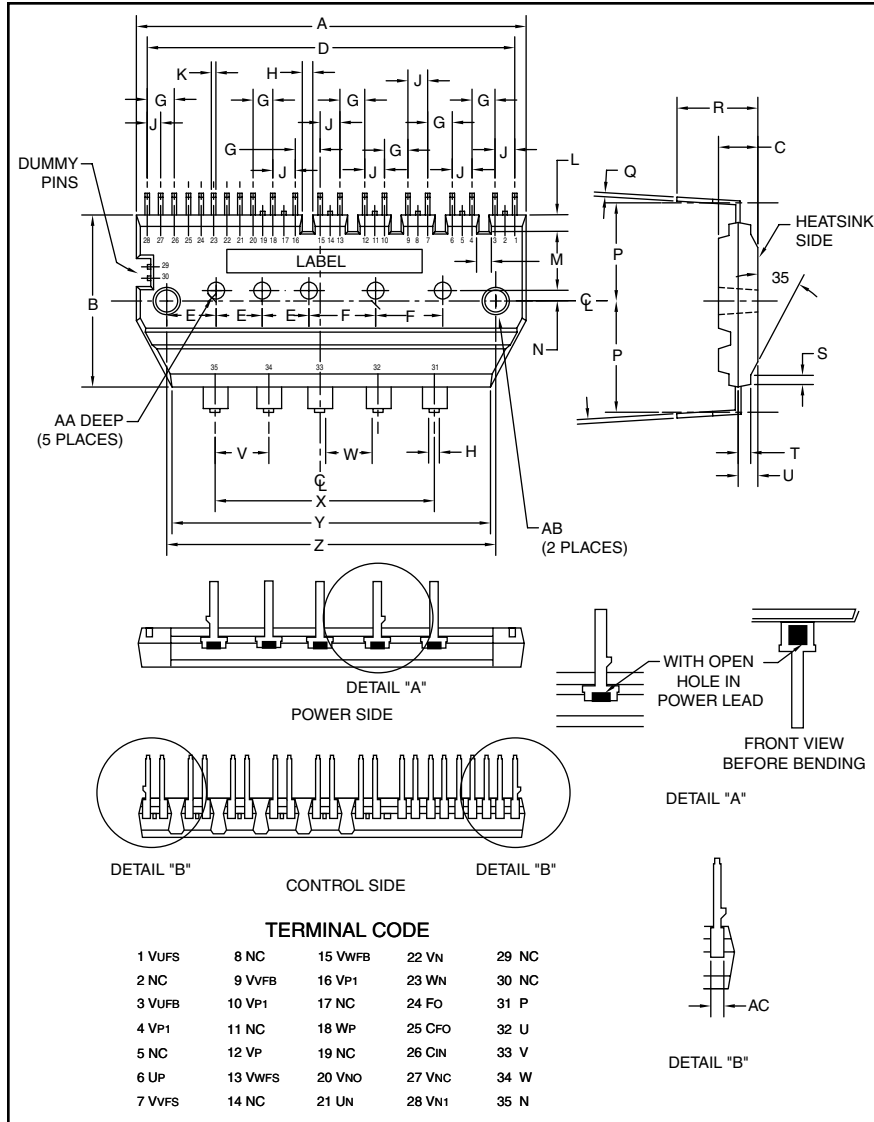


### Intellimod™ Module Dual-In-Line Intelligent Power Module 15 Amperes/600 Volts



#### Outline Drawing and Circuit Diagram

| Dimensions | Inches    | Millimeters |
|------------|-----------|-------------|
| A          | 1.93      | 49.0        |
| B          | 1.20      | 30.5        |
| C          | 0.20      | 5.0         |
| D          | 1.82      | 46.23       |
| E          | 0.25      | 6.25        |
| F          | 0.32      | 8.0         |
| G          | 0.14      | 3.556       |
| H          | 0.04      | 1.0         |
| J          | 0.07      | 1.778       |
| K          | 0.02      | 0.5         |
| L          | 0.06      | 1.5         |
| M          | 0.07 Min. | 1.8 Min.    |
| N          | 0.30      | 0.75        |
| P          | 0.69      | 17.4        |

| Dimensions | Inches    | Millimeters |
|------------|-----------|-------------|
| Q          | 0.02      | 0.5         |
| R          | 0.41      | 10.5        |
| S          | 0.05      | 1.2         |
| T          | 0.05      | 1.25        |
| U          | 0.10      | 2.5         |
| V          | 0.30      | 7.62        |
| W          | 0.16 Min. | 4.0 Min.    |
| X          | 1.20      | 30.48       |
| Y          | 1.61      | 41.0        |
| Z          | 1.65      | 42.0        |
| AA         | 0.08 Dia. | 2.0 Dia.    |
| AB         | 0.13 Dia. | 3.3 Dia.    |
| AC         | 0.05      | 1.25        |



#### Description:

DIP and Mini 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 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

#### Applications:

- ☐ Washing Machines
- ☐ Refrigerators
- ☐ Air Conditioners
- ☐ Small Servo Motors
- ☐ Small Motor Control

#### Ordering Information:

PS21564-P is a 600V, 15 Ampere Mini DIP Intelligent Power Module.

Note: P suffix designates lead-free lead frame.



Powerex, Inc., 200 E. Hillis Street, Youngwood, Pennsylvania 15697-1800 (724) 925-7272

**PS21564-P**

**Intellimod™ Module**

**Dual-In-Line Intelligent Power Module**

15 Amperes/600 Volts

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

| Characteristics                                                                    | Symbol          | PS21564-P  | Units            |
|------------------------------------------------------------------------------------|-----------------|------------|------------------|
| Power Device Junction Temperature*                                                 | $T_j$           | -20 to 125 | $^\circ\text{C}$ |
| Module Case Operation Temperature (See $T_f$ Measurement Point Illustration)       | $T_f$           | -20 to 100 | $^\circ\text{C}$ |
| Storage Temperature                                                                | $T_{stg}$       | -40 to 125 | $^\circ\text{C}$ |
| Mounting Torque, M3 Mounting Screws                                                | —               | 8.5        | in-lb            |
| Module Weight (Typical)                                                            | —               | 20         | Grams            |
| 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 | $V_{ISO}$       | 2500       | Volts            |

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

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

**IGBT Inverter Sector**

|                                                                     |                 |      |         |
|---------------------------------------------------------------------|-----------------|------|---------|
| Collector-Emitter Voltage                                           | $V_{CES}$       | 600  | Volts   |
| Collector Current ( $T_f = 25^\circ\text{C}$ )                      | $\pm I_C$       | 15   | Amperes |
| Peak Collector Current ( $T_f = 25^\circ\text{C}$ , $<1\text{ms}$ ) | $\pm I_{CP}$    | 30   | Amperes |
| Supply Voltage (Applied between P - N)                              | $V_{CC}$        | 450  | Volts   |
| Supply Voltage, Surge (Applied between P - N)                       | $V_{CC(surge)}$ | 500  | Volts   |
| Collector Dissipation ( $T_f = 25^\circ\text{C}$ , per 1 Chip)      | $P_C$           | 22.2 | Watts   |

**Control Sector**

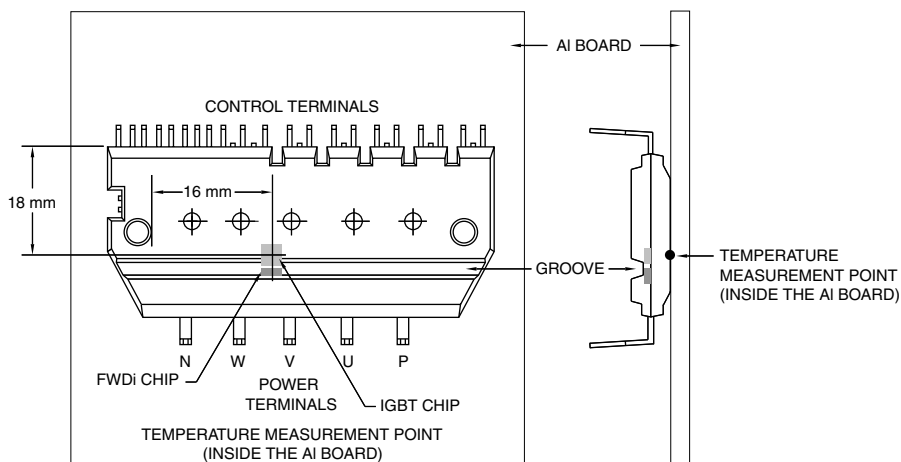
|                                                                                              |          |                     |       |
|----------------------------------------------------------------------------------------------|----------|---------------------|-------|
| Supply Voltage (Applied between $V_{P1}-V_{NC}$ , $V_{N1}-V_{NC}$ )                          | $V_D$    | 20                  | Volts |
| Supply Voltage (Applied between $V_{UFB}-V_{UFS}$ , $V_{VFB}-V_{VFS}$ , $V_{WFB}-V_{WFS}$ )  | $V_{DB}$ | 20                  | Volts |
| Input Voltage (Applied between $U_P$ , $V_P$ , $W_P-V_{NC}$ , $U_N$ , $V_N$ , $W_N-V_{NC}$ ) | $V_{IN}$ | $-0.5 \sim V_D+0.5$ | Volts |
| Fault Output Supply Voltage (Applied between $F_O-V_{NC}$ )                                  | $V_{FO}$ | $-0.5 \sim V_D+0.5$ | Volts |
| Fault Output Current (Sink Current at $F_O$ Terminal)                                        | $I_{FO}$ | 1                   | mA    |
| Current Sensing Input Voltage (Applied between $C_{IN}-V_{NC}$ )                             | $V_{SC}$ | $-0.5 \sim V_D+0.5$ | Volts |

**PS21564-P**  
**Intellimod™ Module**  
**Dual-In-Line Intelligent Power Module**  
 15 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 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            |
| Diode Forward Voltage                | $V_{EC}$      | $T_j = 25^\circ\text{C}, -I_C = 15\text{A}, V_{IN} = 0\text{V}$                                                                                                          | —    | 1.50 | 2.00 | Volts         |
| Collector-Emitter Saturation Voltage | $V_{CE(sat)}$ | $I_C = 15\text{A}, T_j = 25^\circ\text{C}, V_D = V_{DB} = 15\text{V}, V_{IN} = 5\text{V}$                                                                                | —    | 1.45 | 1.95 | Volts         |
|                                      |               | $I_C = 15\text{A}, T_j = 125^\circ\text{C}, V_D = V_{DB} = 15\text{V}, V_{IN} = 5\text{V}$                                                                               | —    | 1.55 | 2.05 | Volts         |
| Inductive Load Switching Times       | $t_{on}$      | $V_{CC} = 300\text{V}, V_D = V_{DB} = 15\text{V},$<br>$I_C = 15\text{A}, T_j = 125^\circ\text{C}, V_{IN} = 5 \Rightarrow 0\text{V},$<br>Inductive Load (Upper-Lower Arm) | 0.60 | 1.20 | 1.80 | $\mu\text{s}$ |
|                                      | $t_{rr}$      |                                                                                                                                                                          | —    | 0.30 | —    | $\mu\text{s}$ |
|                                      | $t_{C(on)}$   |                                                                                                                                                                          | —    | 0.40 | 0.60 | $\mu\text{s}$ |
|                                      | $t_{off}$     |                                                                                                                                                                          | —    | 1.50 | 2.10 | $\mu\text{s}$ |
|                                      | $t_{C(off)}$  |                                                                                                                                                                          | —    | 0.50 | 0.80 | $\mu\text{s}$ |

$T_f$  Measurement Point



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

| Characteristics                        | Symbol               | Test Conditions                                                                                                               | Min. | Typ. | Max. | Units |
|----------------------------------------|----------------------|-------------------------------------------------------------------------------------------------------------------------------|------|------|------|-------|
| <b>Control Sector</b>                  |                      |                                                                                                                               |      |      |      |       |
| 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 $V_{UFB}$ - $V_{UFS}$ ,<br>$V_{VFB}$ - $V_{VFS}$ , $V_{WFB}$ - $V_{WFS}$                                      | 13.0 | 15.0 | 18.5 | Volts |
| Circuit Current                        | $I_D$                | $V_D = V_{DB} = 15\text{V}$ , $V_{IN} = 5\text{V}$ ,<br>Total of $V_{P1}$ - $V_{NC}$ , $V_{N1}$ - $V_{NC}$                    | —    | —    | 5.00 | mA    |
|                                        |                      | $V_D = V_{DB} = 15\text{V}$ , $V_{IN} = 0\text{V}$ ,<br>Total of $V_{P1}$ - $V_{NC}$ , $V_{N1}$ - $V_{NC}$                    | —    | —    | 7.00 | mA    |
|                                        |                      | $V_D = V_{DB} = 15\text{V}$ , $V_{IN} = 5\text{V}$ ,<br>$V_{UFB}$ - $V_{UFS}$ , $V_{VFB}$ - $V_{VFS}$ , $V_{WFB}$ - $V_{WFS}$ | —    | —    | 0.40 | mA    |
|                                        |                      | $V_D = V_{DB} = 15\text{V}$ , $V_{IN} = 0\text{V}$ ,<br>$V_{UFB}$ - $V_{UFS}$ , $V_{VFB}$ - $V_{VFS}$ , $V_{WFB}$ - $V_{WFS}$ | —    | —    | 0.55 | mA    |
| Fault Output Voltage                   | $V_{FOH}$            | $V_{SC} = 0\text{V}$ , $F_O$ Circuit: 10k $\Omega$ to 5V Pull-up                                                              | 4.9  | —    | —    | Volts |
|                                        | $V_{FOL}$            | $V_{SC} = 1\text{V}$ , $I_{FO} = 1\text{mA}$                                                                                  | —    | —    | 0.95 | Volts |
| Input Current                          | $I_{IN}$             | $V_{IN} = 5\text{V}$                                                                                                          | 1.0  | 1.50 | 2.00 | mA    |
| Short-Circuit Trip Level*              | $V_{SC(\text{ref})}$ | $T_j = 25^\circ\text{C}$ , $V_D = 15\text{V}$                                                                                 | 0.43 | 0.48 | 0.53 | Volts |
| Supply Circuit Undervoltage Protection | $UV_{DBt}$           | Trip Level, $T_j \leq 125^\circ\text{C}$                                                                                      | 10.0 | —    | 12.0 | Volts |
|                                        | $UV_{DBr}$           | Reset Level, $T_j \leq 125^\circ\text{C}$                                                                                     | 10.5 | —    | 12.5 | Volts |
|                                        | $UV_{Dt}$            | Trip Level, $T_j \leq 125^\circ\text{C}$                                                                                      | 10.3 | —    | 12.5 | Volts |
|                                        | $UV_{Dr}$            | Reset Level, $T_j \leq 125^\circ\text{C}$                                                                                     | 10.8 | —    | 13.0 | Volts |
| Fault Output Pulse Width**             | $t_{FO}$             | $C_{FO} = 22\text{nF}$                                                                                                        | 1.0  | 1.8  | —    | ms    |
| ON Threshold Voltage                   | $V_{th(\text{on})}$  | Applied between $U_P$ , $V_P$ , $W_P$ - $V_{NC}$ ,                                                                            | 2.1  | 2.3  | 2.6  | Volts |
| OFF Threshold Voltage                  | $V_{th(\text{off})}$ | $U_N$ , $V_N$ , $W_N$ - $V_{NC}$                                                                                              | 0.8  | 1.4  | 2.1  | Volts |

**Thermal Characteristics**

| Characteristic     | Symbol         | Condition                  | Min. | Typ. | Max. | Units                        |
|--------------------|----------------|----------------------------|------|------|------|------------------------------|
| Junction to Fin    | $R_{th(j-f)Q}$ | IGBT Part (Per 1/6 Module) | —    | —    | 4.5  | $^\circ\text{C}/\text{Watt}$ |
| Thermal Resistance | $R_{th(j-f)D}$ | FWDi Part (Per 1/6 Module) | —    | —    | 6.5  | $^\circ\text{C}/\text{Watt}$ |

**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 $V_{UFB}$ - $V_{UFS}$ ,<br>$V_{VFB}$ - $V_{VFS}$ , $V_{WFB}$ - $V_{WFS}$ | 13.0 | 15.0 | 18.5 | Volts            |
| Control Supply Variation | $\Delta V_D$ , $\Delta V_{DB}$ |                                                                                          | -1   | —    | 1    | V/ $\mu\text{s}$ |
| PWM Input Frequency      | $f_{PWM}$                      | $T_f \leq 100^\circ\text{C}$ , $T_j \leq 125^\circ\text{C}$                              | —    | —    | 20   | kHz              |

\* Short-Circuit protection is functioning only at the lower arms. Please select the value of the external shunt resistor such that the SC trip level is less than 25.5A.

\*\*Fault signal is asserted when the lower arm short circuit or control supply under-voltage protective functions operate. The fault output pulse-width  $t_{FO}$  depends on the capacitance value of  $C_{FO}$  according to the following approximate equation:  $C_{FO} = (12.2 \times 10^{-6}) \times t_{FO} \text{ (F)}$ .

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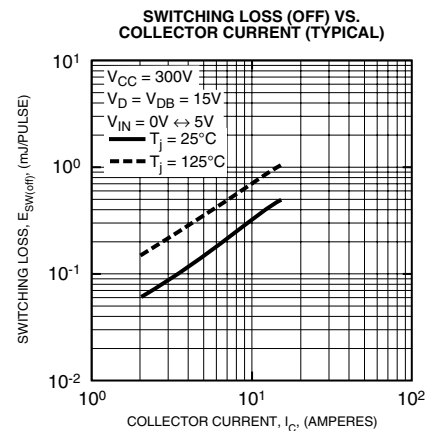
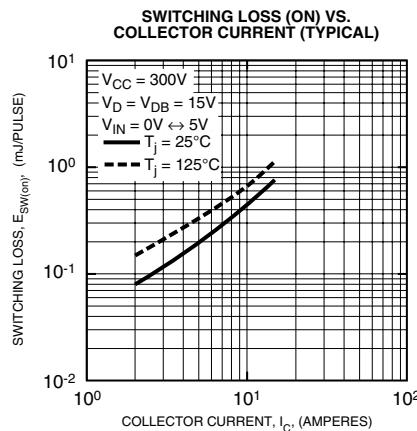
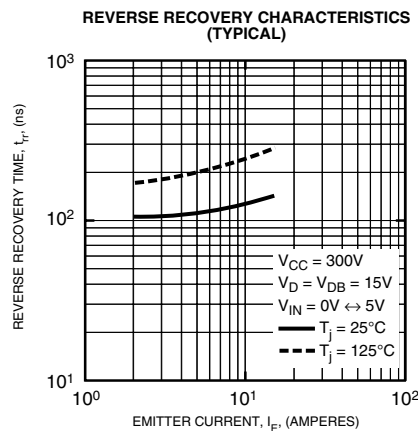
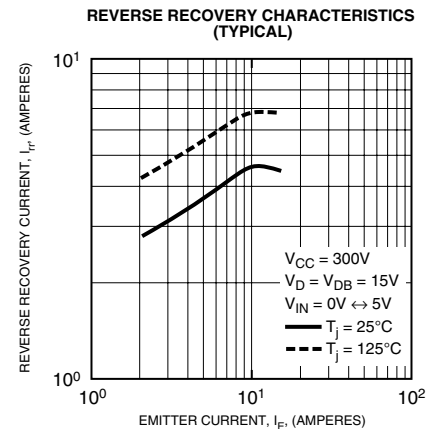
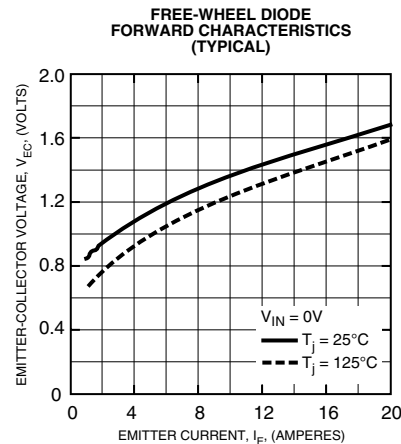
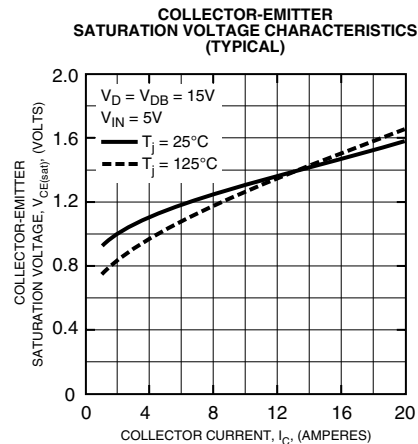
## Recommended Conditions for Use

| Characteristic         | Symbol                                                | Condition                                                                                                                | Min. | Typ. | Max. | Units   |
|------------------------|-------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|------|------|------|---------|
| Allowable rms Current* | $I_O$                                                 | $V_{CC} = 300V$ , $V_D = 15V$ , $f_C = 5kHz$ ,<br>PF = 0.8, Sinusoidal, $T_j \leq 125^\circ C$ , $T_f \leq 100^\circ C$  | —    | —    | 7.4  | Arms    |
|                        |                                                       | $V_{CC} = 300V$ , $V_D = 15V$ , $f_C = 15kHz$ ,<br>PF = 0.8, Sinusoidal, $T_j \leq 125^\circ C$ , $T_f \leq 100^\circ C$ | —    | —    | 4.5  | Arms    |
| Minimum Input          | $P_{WIN(on)}^{**}$                                    |                                                                                                                          | 0.3  | —    | —    | $\mu s$ |
| Pulse Width            | $P_{WIN(off)}^{***}$                                  |                                                                                                                          |      |      |      |         |
|                        | Below Rated Current                                   | $200 \leq V_{CC} \leq 350V$ , $13.5 \leq V_D \leq 16.5V$ ,                                                               | 0.5  | —    | —    | $\mu s$ |
|                        | Between Rated Current<br>& 1.7 Times of rated Current | $13.0 \leq V_{DB} \leq 18.5V$ , $-20^\circ C \leq T_f \leq 100^\circ C$ ,<br>N-line Wiring Inductance Less Than 10nH     | 2.0  | —    | —    | $\mu s$ |
| $V_{NC}$ Variation     | $V_{NC}$                                              | Between $V_{NC-N}$ (Including Surge)                                                                                     | -5.0 | —    | 5.0  | Volts   |
| Arm Shoot-through      | $t_{DEAD}$                                            | For Each Input Signal, $T_f < 100^\circ C$                                                                               | 1.5  | —    | —    | $\mu s$ |
| Blocking Time          |                                                       |                                                                                                                          |      |      |      |         |

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

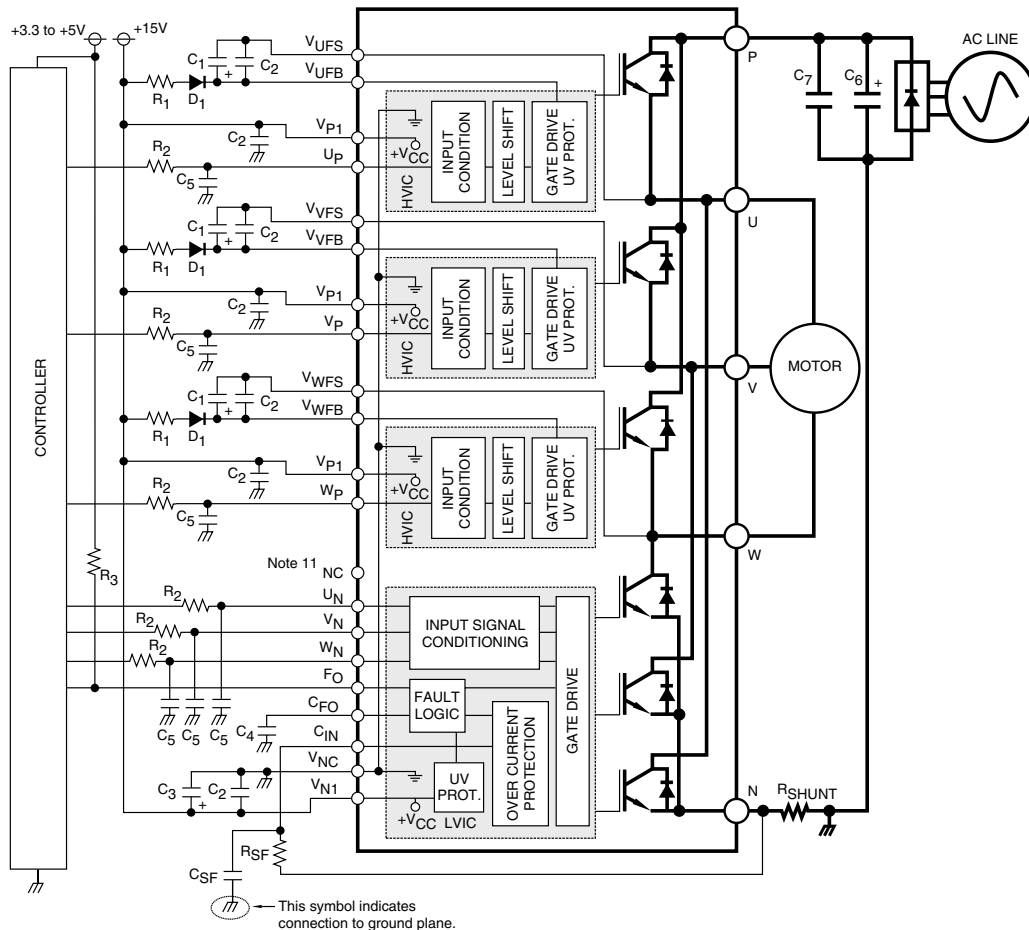
\*\* If input signal ON pulse is less than  $P_{WIN(on)}$ , the device may not respond.

\*\*\* The IPM may fail to respond to an ON pulse if the preceeding OFF pulse is less than  $P_{WIN(off)}$ .



**PS21564-P**  
**Intellimod™ Module**  
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 15 Amperes/600 Volts

**Mini DIP-IPM Application Circuit (Shown Pins Up)**



**Component Selection:**

| Dsgn.  | Typ. Value       | Description                                                                             |
|--------|------------------|-----------------------------------------------------------------------------------------|
| D1     | 1A, 600V         | Boot strap supply diode – Ultra fast recovery                                           |
| C1     | 10-100uF, 50V    | Boot strap supply reservoir – Electrolytic, long life, low Impedance, 105°C (Note 5)    |
| C2     | 0.22-2.0uF, 50V  | Local decoupling/High frequency noise filters – Multilayer ceramic (Note 8)             |
| C3     | 10-100uF, 50V    | Control power supply filter – Electrolytic, long life, low Impedance, 105°C             |
| C4     | 22nF, 50V        | Fault lock-out timing capacitor – Multilayer ceramic (Note 4)                           |
| C5     | 100pF, 50V       | Optional Input signal noise filter – Multilayer ceramic (Note 1)                        |
| C6     | 200-2000uF, 450V | Main DC bus filter capacitor – Electrolytic, long life, high ripple current, 105°C      |
| C7     | 0.1-0.22uF, 450V | Surge voltage suppression capacitor – Polyester/Polypropylene film (Note 9)             |
| CSF    | 1000pF, 50V      | Short circuit detection filter capacitor – Multilayer Ceramic (Note 6, Note 7)          |
| RSF    | 1.8k ohm         | Short circuit detection filter resistor (Note 6, Note 7)                                |
| RSHUNT | 5-100 mohm       | Current sensing resistor - Non-inductive, temperature stable, tight tolerance (Note 10) |
| R1     | 10 ohm           | Boot strap supply inrush limiting resistor (Note 5)                                     |
| R2     | 330 ohm          | Optional control input pull-up resistor (Note 1, Note 2)                                |
| R3     | 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) FO output is an open collector type. Pull-up resistor (R3) should be adjusted to current sink capability of the module.
- 4) C4 sets the fault output duration and lock-out time.  $C4 \approx 12.2E^{-6} \times t_{FO}$ , 22nF gives ~1.8ms
- 5) Boot strap supply component values must be adjusted depending on the PWM frequency and technique.
- 6) Wiring length associated with RSHUNT, RSF, CSF must be minimized to avoid improper operation of the SC function.
- 7) RSF, CSF set short circuit protection trip time. Recommend time constant is 1.5us-2.0us. 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 C6, C7, the DIP's P terminal and the shunt must be minimized to prevent excessive transient voltages. In particular C7 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.
- 11) This pin is connected internally. It must not be connected to any external circuits.