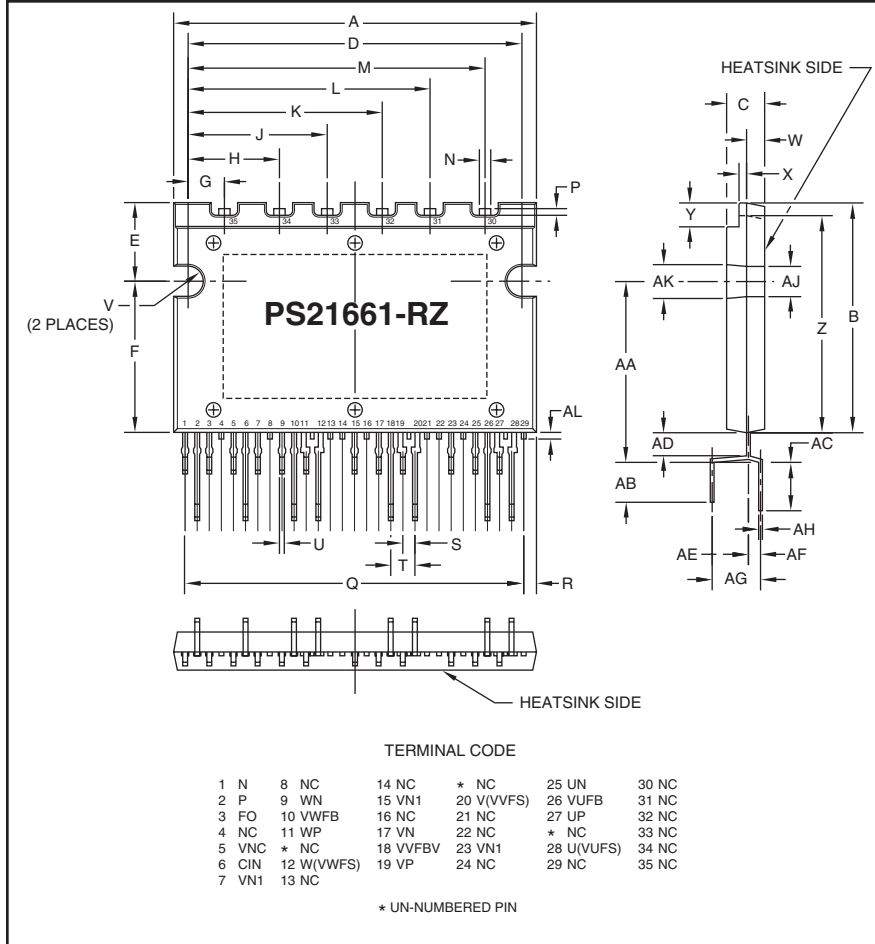


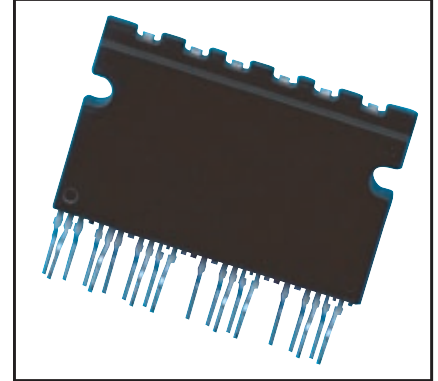
Intellimod™ Module Single-In-Line Intelligent Power Module 3 Amperes/600 Volts



Outline Drawing and Circuit Diagram

| Dimensions | Inches | Millimeters |
|------------|--------|-------------|
| A | 1.50 | 38.0 |
| B | 0.94 | 24.0 |
| C | 0.16 | 4.0 |
| D | 1.38 | 35.0 |
| E | 0.33 | 8.5 |
| F | 0.61 | 15.5 |
| G | 0.15 | 3.8 |
| H | 0.38 | 9.6 |
| J | 0.57 | 14.6 |
| K | 0.80 | 20.4 |
| L | 1.00 | 25.4 |
| M | 1.23 | 31.2 |
| N | 0.047 | 1.2 |
| P | 0.028 | 0.7 |
| Q | 1.39 | 35.28 |
| R | 0.048 | 1.22 |
| S | 0.05 | 1.27 |
| T | 0.10 | 2.54 |

| Dimensions | Inches | Millimeters |
|------------|--------|-------------|
| U | 0.02 | 0.5 |
| V | 0.06 | 1.6 |
| W | 0.07 | 1.9 |
| X | 0.03 | 0.8 |
| Y | 0.11 | 2.7 |
| Z | 0.90 | 22.8 |
| AA | 0.75 | 19.0 |
| AB | 0.17 | 4.2 |
| AC | 0.20 | 5.2 |
| AD | 0.09 | 2.4 |
| AE | 0.15 | 3.81 |
| AF | 0.05 | 1.27 |
| AG | 0.20 | 5.08 |
| AH | 0.016 | 0.4 |
| AJ | 0.13 | 3.3 |
| AK | 0.14 | 3.6 |
| AL | 0.28 | 0.7 |



Description:

SIP-IPMs are intelligent power modules that integrate power devices, drivers, and protection circuitry in an ultra compact single-in-line transfer-mold package for use in driving small three phase motors. Use of 5th generation IGBTs, SIP 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

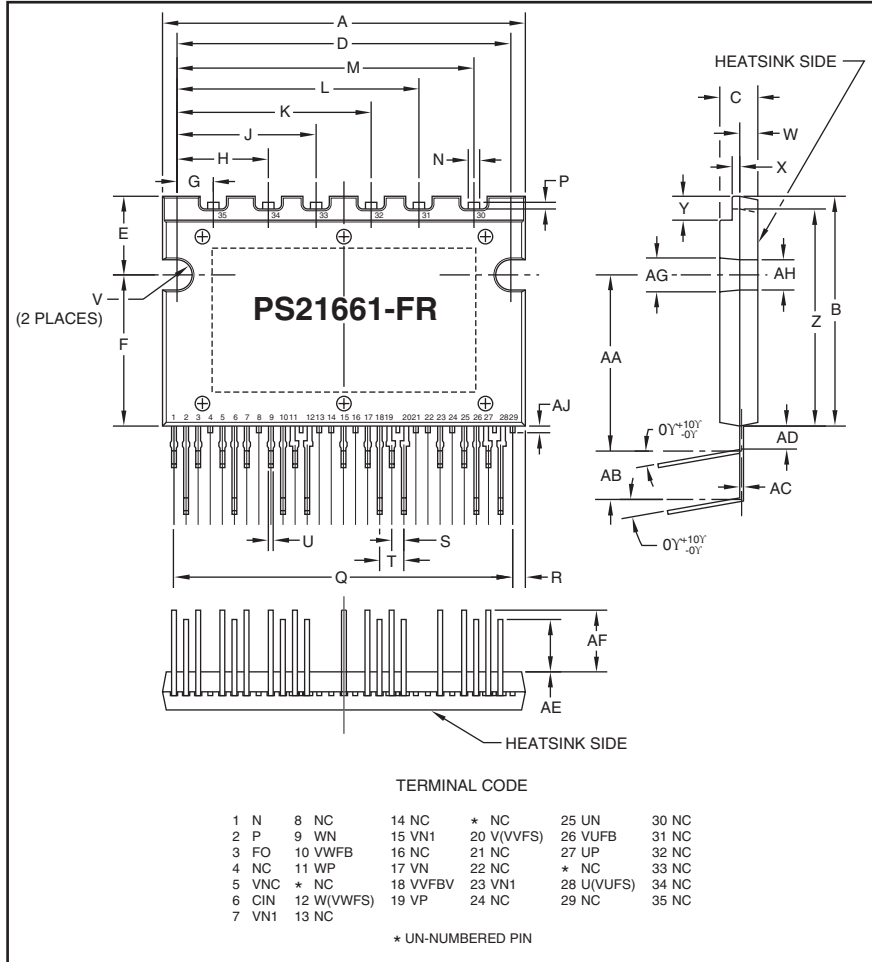
Applications:

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

Ordering Information:

PS21661-RZ is a 600V, 3 Ampere SIP Intelligent Power Module.

PS21661-RZ/-FR
Intellimod™ Module
Single-In-Line Intelligent Power Module
 3 Amperes/600 Volts



Outline Drawing and Circuit Diagram

| Dimensions | Inches | Millimeters |
|------------|--------|-------------|
| A | 1.50 | 38.0 |
| B | 0.94 | 24.0 |
| C | 0.16 | 4.0 |
| D | 1.38 | 35.0 |
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| F | 0.61 | 15.5 |
| G | 0.15 | 3.8 |
| H | 0.38 | 9.6 |
| J | 0.57 | 14.6 |
| K | 0.80 | 20.4 |
| L | 1.00 | 25.4 |
| M | 1.23 | 31.2 |
| N | 0.047 | 1.2 |
| P | 0.028 | 0.7 |
| Q | 1.39 | 35.28 |
| R | 0.048 | 1.22 |
| S | 0.05 | 1.27 |

| Dimensions | Inches | Millimeters |
|------------|--------|-------------|
| T | 0.10 | 2.54 |
| U | 0.02 | 0.5 |
| V | 0.06 | 1.6 |
| W | 0.07 | 1.9 |
| X | 0.03 | 0.8 |
| Y | 0.11 | 2.7 |
| Z | 0.90 | 22.8 |
| AA | 0.71 | 18.1 |
| AB | 0.20 | 5.08 |
| AC | 0.016 | 0.4 |
| AD | 0.09 | 2.4 |
| AE | 0.22 | 5.5 |
| AF | 0.26 | 6.5 |
| AG | 0.14 | 3.6 |
| AH | 0.13 | 3.3 |
| AJ | 0.028 | 0.7 |

PS21661-RZ/-FR
Intellimod™ Module
Single-In-Line Intelligent Power Module
 3 Amperes/600 Volts

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

| Characteristics | Symbol | PS21661-RZ/-FR | Units |
|--|-----------------|----------------|------------------|
| Power Device Junction Temperature* | T_j | -20 to 125 | $^\circ\text{C}$ |
| Heatsink 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 | — | 7 | in-lb |
| Module Weight (Typical) | — | 10 | 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 SIP-IPM is 150°C ($@T_f \leq 100^\circ\text{C}$). However, to ensure safe operation of the SIP-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 $2\mu\text{s}$

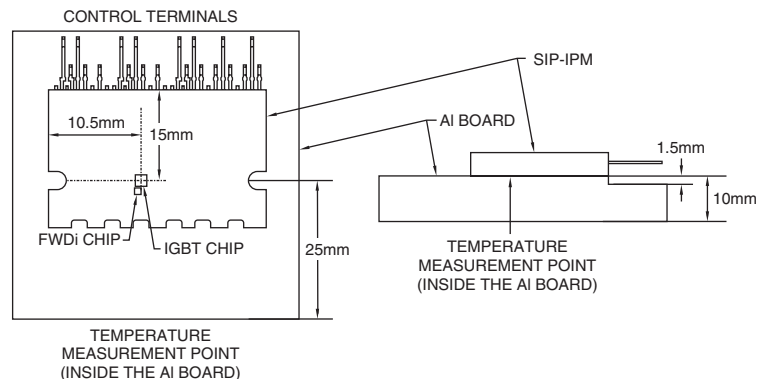
IGBT Inverter Sector

| | | | |
|---|-----------------|------|---------|
| Collector-Emitter Voltage | V_{CES} | 600 | Volts |
| Collector Current ($T_f = 25^\circ\text{C}$) | $\pm I_C$ | 3 | Amperes |
| Peak Collector Current ($T_f = 25^\circ\text{C}$, $t_w \leq 1\text{ms}$) | $\pm I_{CP}$ | 6 | 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 | 11.1 | Watts |

Control Sector

| | | | |
|--|----------|--------------|-------|
| Supply Voltage (Applied between V_{N1} - V_{NC}) | V_D | 20 | Volts |
| Supply Voltage (Applied between V_{UFB} - $U(V_{UFS})$, V_{VFB} - $V(V_{VFS})$, V_{WFB} - $W(V_{WFS})$) | V_{DB} | 20 | Volts |
| Input Voltage (Applied between U_B , V_B , W_P - V_{NC} , U_N , V_N , W_N - V_{NC}) | V_{IN} | -0.5 ~ V_D | Volts |
| Fault Output Supply Voltage (Applied between F_O - V_{NC}) | V_{FO} | -0.5 ~ V_D | Volts |
| Fault Output Current (Sink Current at F_O Terminal) | I_{FO} | 10 | mA |
| Current Sensing Input Voltage (Applied between C_{IN} - V_{NC}) | V_{SC} | -0.5 ~ V_D | Volts |

T_f Measurement Point



PS21661-RZ-FR
 Intellimod™ Module
 Single-In-Line Intelligent Power Module
 3 Amperes/600 Volts

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

| Characteristics | Symbol | Test Conditions | Min. | Typ. | Max. | Units |
|--------------------------------------|---------------|---|------|------|------|---------------|
| IGBT Inverter Sector | | | | | | |
| Collector 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} | $T_j = 25^\circ\text{C}, -I_C = 3\text{A}, V_{IN} = 0\text{V}$ | — | 1.55 | 2.00 | Volts |
| Collector-Emitter Saturation Voltage | $V_{CE(sat)}$ | $I_C = 3\text{A}, T_j = 25^\circ\text{C}, V_D = V_{DB} = 15\text{V}, V_{IN} = 5\text{V}$ | — | 1.60 | 2.15 | Volts |
| | | $I_C = 3\text{A}, T_j = 125^\circ\text{C}, V_D = V_{DB} = 15\text{V}, V_{IN} = 5\text{V}$ | — | 1.70 | 2.30 | Volts |
| Inductive Load Switching Times | t_{on} | | 0.50 | 0.85 | 1.25 | μs |
| | t_{rr} | $V_{CC} = 300\text{V}, V_D = V_{DB} = 15\text{V},$ | — | 0.20 | — | μs |
| | $t_{C(on)}$ | $I_C = 3\text{A}, T_j = 125^\circ\text{C}, V_{IN} = 0 \Leftrightarrow 5\text{V},$ | — | 0.35 | 0.55 | μs |
| | t_{off} | Inductive Load (Upper-Lower Arm) | — | 1.00 | 1.50 | μs |
| | $t_{C(off)}$ | | — | 0.55 | 1.10 | μs |

Control Sector

| | | | | | | |
|-----------------------------|---------------|--|------|------|------|---------------|
| Supply Voltage | V_D | Applied between $V_{N1}-V_{NC}$ | 13.5 | 15.0 | 16.5 | Volts |
| | V_{DB} | Applied between $V_{UFB}-V_{UFS},$ $V_{VFB}-V_{VFS}, V_{WFB}-V_{WFS}$ | 13.0 | 15.0 | 18.5 | Volts |
| Circuit Current | I_D | $V_D = 15\text{V}, V_{IN} = 0\text{V},$ Total of $V_{N1}-V_{NC}$ (U, V, W) | — | — | 3.60 | mA |
| | | $V_D = 15\text{V}, V_{IN} = 5\text{V},$ Total of $V_{N1}-V_{NC}$ (U, V, W) | — | — | 3.60 | mA |
| | I_{DB} | $V_{DB} = 15\text{V}, V_{IN} = 0\text{V},$ $V_{UFB}-U(V_{UFS}), V_{VFB}-V(V_{VFS}), V_{WFB}-W(V_{WFS})$ | — | — | 0.35 | mA |
| | | $V_{DB} = 15\text{V}, V_{IN} = 5\text{V},$ $V_{UFB}-U(V_{UFS}), V_{VFB}-V(V_{VFS}), V_{WFB}-W(V_{WFS})$ | — | — | 0.35 | mA |
| Fault Output Voltage | V_{FOH} | $V_{SC} = 0\text{V}, F_O$ Circuit: 1k Ω to 5V Pull-up | 4.9 | — | — | Volts |
| | V_{FOL} | $V_{SC} = 1\text{V}, I_{FO} = -10\text{mA}$ | — | — | 0.95 | Volts |
| Input Current | I_{IN} | $V_{IN} = 5\text{V}$ | 0.70 | 1.06 | 1.50 | mA |
| Short-Circuit Trip Level* | $V_{SC(ref)}$ | $T_j = 25^\circ\text{C}, V_D = 15\text{V}$ | 0.43 | 0.48 | 0.53 | Volts |
| Supply Circuit Undervoltage | 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} | | 20 | 40 | — | μs |
| ON Threshold Voltage | $V_{th(on)}$ | Applied between $U_P, V_P, W_P-V_{NC},$ | 2.10 | 2.35 | 2.60 | Volts |
| OFF Threshold Voltage | $V_{th(off)}$ | U_N, V_N, W_N-V_{NC} | 1.10 | 1.40 | 1.80 | Volts |

Thermal Characteristics

| Characteristic | Symbol | Condition | Min. | Typ. | Max. | Units |
|--------------------|----------------|----------------------------|------|------|------|-----------------------|
| Junction to Fin | $R_{th(j-f)Q}$ | IGBT Part (Per 1/6 Module) | — | — | 9.0 | $^\circ\text{C/Watt}$ |
| Thermal Resistance | $R_{th(j-f)D}$ | FWDi Part (Per 1/6 Module) | — | — | 9.0 | $^\circ\text{C/Watt}$ |

* 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 5.1A.

**FO signal is only asserted when the SC or UV protection is activated on the low side.



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

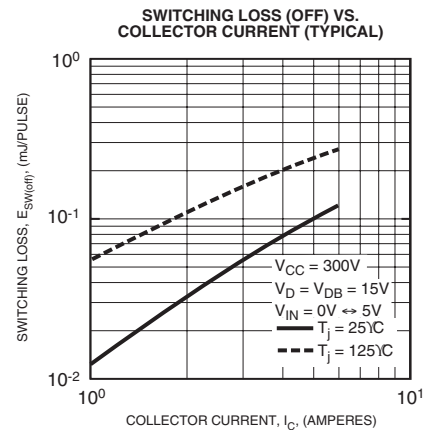
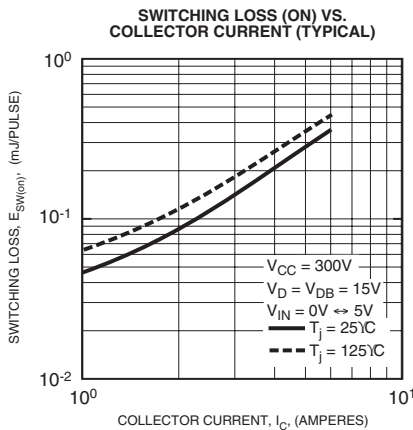
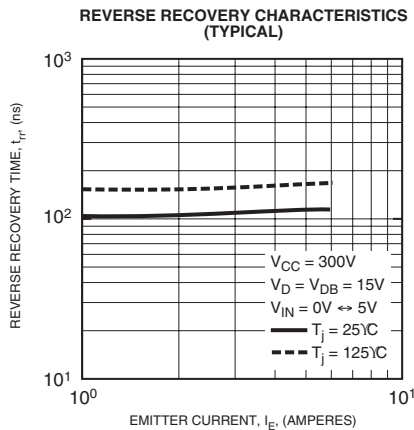
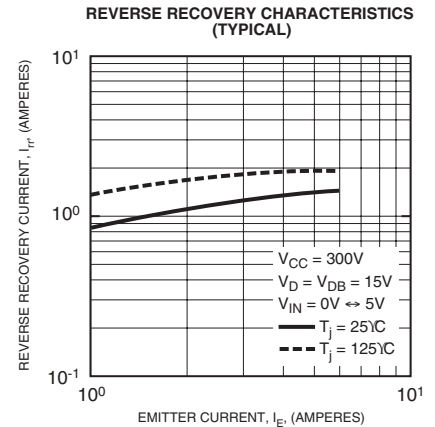
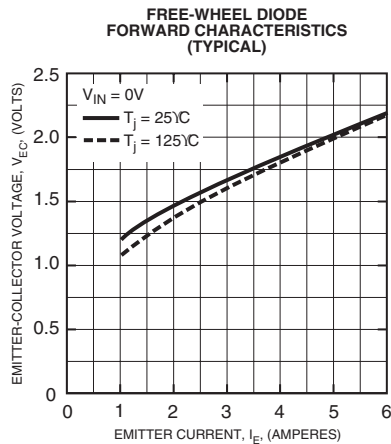
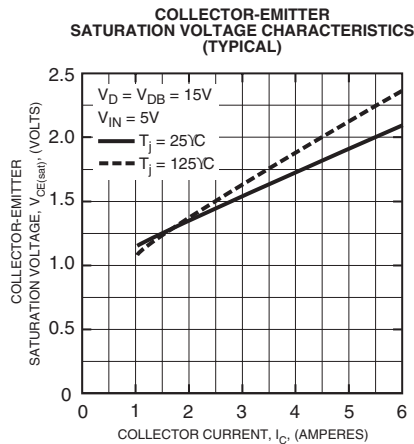
PS21661-RZ-FR
Intellimod™ Module
Single-In-Line Intelligent Power Module
3 Amperes/600 Volts

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_{N1} - V_{NC} | 13.5 | 15.0 | 16.5 | Volts |
| | V_{DB} | Applied between $V_{UFB-U}(V_{UFS}), V_{VFB-V}(V_{VFS}), V_{WFB-W}(V_{WFS})$ | 13.0 | 15.0 | 18.5 | Volts |
| Control Supply Variation | $\Delta V_D, \Delta V_{DB}$ | | -1 | — | 1 | V/ μ s |
| PWM Input Frequency | f_{PWM} | $T_f \leq 100^\circ\text{C}, T_j \leq 125^\circ\text{C}$ | — | 15 | — | kHz |
| Allowable RMS Current* | I_O | $V_{CC} = 300\text{V}, V_D = 15\text{V}, f_c = 5\text{kHz},$ $P_F = 0.8$ Sinusoidal, $T_j \leq 125^\circ\text{C}, T_f \leq 100^\circ\text{C}$ | — | — | 3.0 | Arms |
| | | $V_{CC} = 300\text{V}, V_D = 15\text{V}, f_c = 15\text{kHz},$ $P_F = 0.8$ Sinusoidal, $T_j \leq 125^\circ\text{C}, T_f \leq 100^\circ\text{C}$ | — | — | 2.1 | Arms |
| | | $V_{CC} = 300\text{V}, V_D = 15\text{V}, f_c = 15\text{kHz},$ $P_F = 0.8$ Sinusoidal, $T_j \leq 125^\circ\text{C}, T_f \leq 100^\circ\text{C}$ | — | — | — | — |
| V_{NC} Terminal Voltage | V_{NC} | Applied between V_{NC} -N (Include Surge Voltage) | -5 | — | 5 | Volts |
| Minimum Input Pulse Width** | P_{WIN} | ON/OFF | 0.3 | — | — | μ s |
| Arm Shoot-through Blocking Time | t_{DEAD} | For Each Input Signal | 2.0 | — | — | μ s |

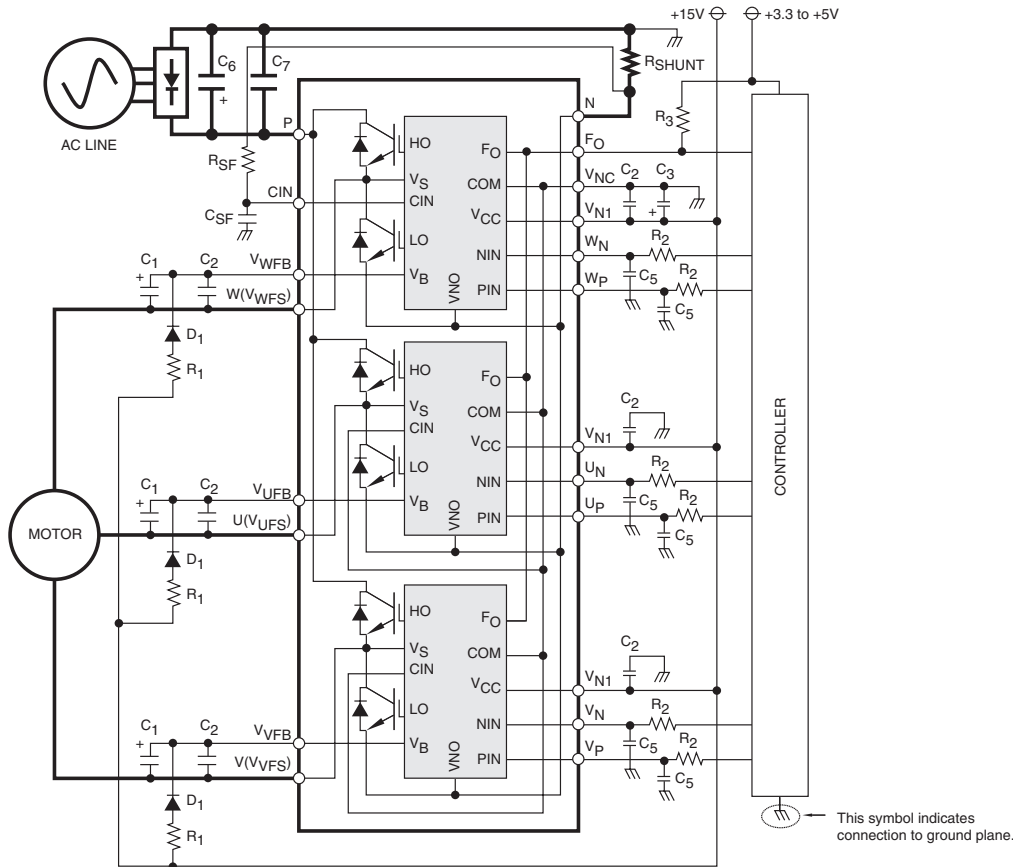
* The allowable RMS current value depends on the actual application conditions.

**There might be no output when the input signal width is less than P_{WIN} .



PS21661-RZ-FR
Intellimod™ Module
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 3 Amperes/600 Volts

SIP-IPM Application Circuit



Component Selection:

| Dsgn. | Typ. Value | Description |
|--------------------|------------------|---|
| D1 | 1A, 600V | Boot strap supply diode – Ultra fast recovery |
| C1 | 10-100µF, 50V | Boot strap supply reservoir – Electrolytic, long life, low Impedance, 105°C (Note 5) |
| C2 | 0.22-2.0µF, 50V | Local decoupling/High frequency noise filters – Multilayer ceramic (Note 8) |
| C3 | 10-100µF, 50V | Control power supply filter – Electrolytic, long life, low Impedance, 105°C |
| C5 | 100pF, 50V | Optional Input signal noise filter – Multilayer ceramic (Note 1) |
| C6 | 200-2000µF, 450V | Main DC bus filter capacitor – Electrolytic, long life, high ripple current, 105°C |
| C7 | 0.1-0.22µF, 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} | 5-100 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 | 1k 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 module.
- 4) Boot strap supply component values must be adjusted depending on the PWM frequency and technique.
- 5) Wiring length associated with R_{SHUNT}, R_{SF}, C_{SF} must be minimized to avoid improper operation of the SC function.
- 6) R_{SF}, C_{SF} set short circuit protection trip time. Recommend time constant is 1.5µs-2.0µs. See application notes.
- 7) Local decoupling/high frequency filter capacitors must be connected as close as possible to the modules pins.
- 8) 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.
- 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.