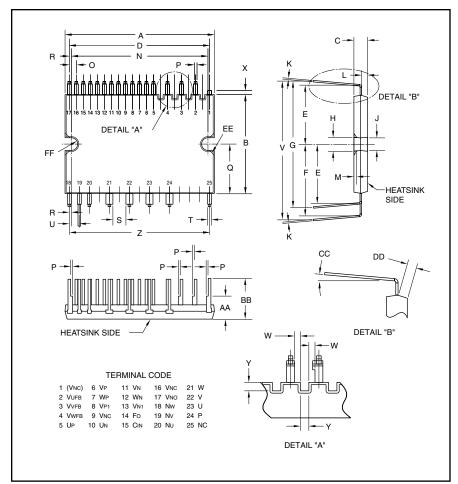


IntellimodTM Module Dual-In-Line Intelligent Power Module 20 Amperes/600 Volts



Outline Drawing and Circuit Diagram

Dimensions	Inches	Millimeters
Α	1.50±0.02	38.0±0.5
В	0.94±0.02	24.0±0.5
С	0.14	3.5
D	1.40	35.56
Е	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
Н	0.14	3.5
J	0.13	3.3
K	0.016	0.4
L	0.06±0.02	1.5±0.05
М	0.031	0.8
N	1.39±0.019	35.0±0.3
0	0.07±0.008	1.778±0.2
Р	0.02	0.5
Q	0.47	12.0

Dimensions	Inches	Millimeters
R	0.011	0.28
S	0.12	3.08
Т	0.024	0.6
U	0.1±0.008	2.54±0.2
V	1.33±0.02	33.7±0.5
W	0.03	0.678
Χ	0.04	1.0
Υ	0.05	1.2
Z	1.40	35.56
AA	0.22±0.02	5.5±0.5
BB	0.37±0.02	9.5±0.5
CC	0 ~ 5°	0 ~ 5°
DD	0.06 MIN.	1.5 Min.
EE	0.05	1.2
FF	0.063 Rad.	1.6 Rad.



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 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 Rth

Applications:

- □ Refrigerators
- ☐ Air Conditioners
- ☐ Small Servo Motors
- ☐ Small Motor Control

Ordering Information:

PS21965-S is a 600V, 20 Ampere short pin DIP Intelligent Power Module.



PS21965-S Intellimod™ Module Dual-In-Line Intelligent Power Module 20 Amperes/600 Volts

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

Characteristics	Symbol	PS21965-S	Units
Power Device Junction Temperature*	Тј	-20 to 150	°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	Volts

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

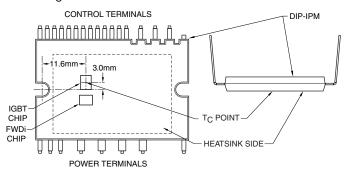
IGBT Inverter Sector

Collector-Emitter Voltage	V _{CES}	600	Volts
Each Collector Current, ± (T _C = 25°C)	Ic	20	Amperes
Each Peak Collector Current, ± (T _C = 25°C, Less than 1ms)	l _{CP}	40	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 _C = 25°C, per 1 Chip)	P _C	35.7	Watts

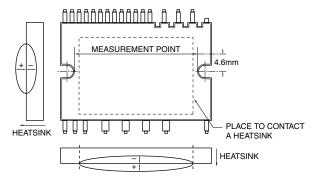
Control Sector

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_{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

Note 1 – T_C Measure Point



Note 2 - Flatness Measurement Position



^{**}V_D = 13.5 ~ 16.5V, Inverter Part, T_j = 125°C, Non-repetitive, Less than 2µs



PS21965-S Intellimod™ Module Dual-In-Line Intelligent Power Module 20 Amperes/600 Volts

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

Characteristics	Syn	nbol Test Conditions	Min.	Тур.	Max.	Units
IGBT Inverter Sector						
Collector-Emitter Saturation Voltage	e V _{CE(sat)}	$V_D = V_{DB} = 15V$, $I_C = 20A$, $V_{IN} = 5V$, $T_j = 25$ °C	_	1.70	2.20	Volts
	, ,	$V_D = V_{DB} = 15V$, $I_C = 20A$, $V_{IN} = 5V$, $T_j = 125$ °C	_	1.80	2.30	Volts
Diode Forward Voltage	V _{EC}	-I _C = 20A, V _{IN} = 0V	_	1.90	2.40	Volts
Inductive Load Switching Times	t _{on}		0.70	1.30	1.90	μS
	t _{rr}	$V_{CC} = 300V, V_D = V_{DB} = 15V,$	_	0.30		μS
	t _{C(on)}	I _C = 20A, T _j = 125°C,	_	0.50	0.75	μS
	t _{off}	V _{IN} = 0 ⇔ 5V, Inductive Load,	_	1.60	2.20	μS
	t _{C(off)}		_	0.40	0.75	μS
Collector Cutoff Current	I _{CES}	$V_{CE} = V_{CES}, T_j = 25^{\circ}C$	_	_	1.0	mA
		V _{CE} = V _{CES} , T _i = 125°C	_	_	10	mA
Control Sector	I- V	Total of Very Very Very			0.00	A
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 $10k\Omega$	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)}	$V_{D} = 15V^{*}$	0.43	0.48	0.53	Volts
Supply Circuit Under-voltage	UV _{DBt}	Trip Level, T _j ≤ 125°C	10.0	_	12.0	Volts
	UV _{DBr}	Reset Level, T _j ≤ 125°C	10.5	_	12.5	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**	t _{FO}		20	_	_	μs
ON Threshold Voltage	V _{th(on)}	Applied between	_	2.1	2.6	Volts
OFF Threshold Voltage	V _{th(off)}	U _B V _B W _P -V _{NC,}	0.8	1.3	_	Volts
ON/OFF Threshold Hysteresis Volta		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 20µsec. On a U_V condition the fault signal will be asserted as long as the U_V condition exists or for 20µsec, whichever is longer.

Rev. 04/06 3



PS21965-S Intellimod™ Module Dual-In-Line Intelligent Power Module 20 Amperes/600 Volts

Thermal Characteristics

Characteristic	Symbol	Condition	Min.	Тур.	Max.	Units
Junction to Case	R _{th(j-c)Q}	Inverter IGBT (Per 1/6 Module)	_	_	2.8	°C/Watt
	R _{th(i-c)D}	Inverter FWDi (Per 1/6 Module)	_	_	3.9	°C/Watt

Recommended	Conditions for	موا ا

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,	13.0	15.0	18.5	Volts
			V_{VFB} - V , V_{WFB} - W				
Control Supply Variation		dV_D , dV_{DB}		-1	_	1	V/µs
Arm Shoot-through Blocking Time		t _{DEAD}	For Each Input Signal, T _C ≤ 100°C	1.5	_	_	μs
Output r.m.s. Current*	ΙO	$f_{PWM} = 5kHZ$	$V_{CC} = 300V, V_D = V_{DB} = 15V,$	_	_	10.0	A _{rms}
	Io	f _{PWM} = 15kHZ	P.F. = 0.8, Sinusoidal PWM,	_	_	6.0	A _{rms}
			$T_j \le 125^{\circ}C, T_C \le 100^{\circ}C$				
Allowable Minimum Input		P _{WIN(on)}		0.5	_	_	μs
Pulse Width**		P _{WIN(off)}		0.5	_	_	μs
V _{NC} Voltage Variation		V _{NC}	Between V _{NC} -N (Including Surge)	-5.0	_	5.0	Volts

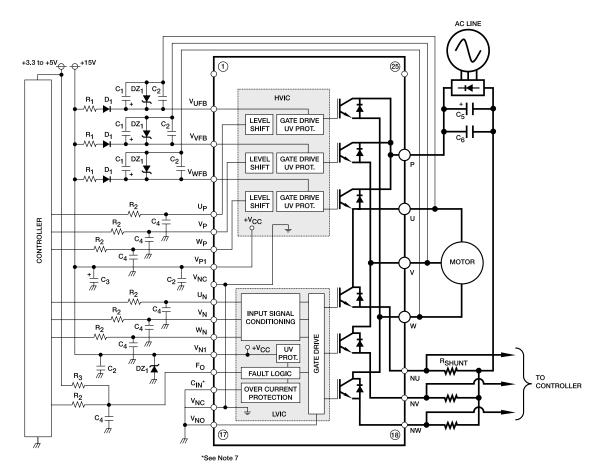
^{*}The allowable r.m.s. current also depends on the actual application conditions.

**DIP-IPM might not make response or work properly if the input signal pulse width is less than the recommended minimum value.



PS21965-S Intellimod™ Module Dual-In-Line Intelligent Power Module 20 Amperes/600 Volts

Application Circuit



Component	Selection:
Component	Selection

Compon	ent Selection.	
Dsgn.	Typ. Value	Description
D ₁	1A, 600V	Boot strap supply diode - Ultra fast recovery
DZ ₁	16V, 0.25W	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)
RSHUNT	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)

- 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.
- Internal HVIC provides high voltage level shifting allowing direct connection of all six driving signals to the controller.
 F_O output is an open collector type. Pull up resistor (R3) should be adjusted to current sink capability of the controller.
 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.

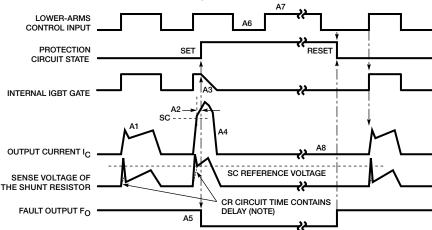
 (6) Wiring length associated with R_{SHUNT}, must be minimized to avoid improper operation of the OC function.
- 7) Shows short circuit protection disabled. See application notes for use of short circuit protection.
 8) Local decoupling/high frequency filter capacitors must be connected as close as possible 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.



PS21965-S Intellimod™ Module Dual-In-Line Intelligent Power Module 20 Amperes/600 Volts

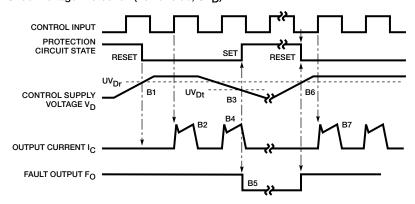
Protection Function Timing Diagrams

Short-Circuit Protection (Lower-arms 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: IGBT gate hard interrupted.
- A4: IGBT turn off.
- A5: F_O output with a fixed pulse width of $t_{FO(min)} = 20\mu s$.
- A6: Input "L" IGBT off.
- A7: Input "H" IGBT on is blocked during the F_O output period.
- A8: IGBT stays in off state.

Under-Voltage Protection (Lower-side, UVD)



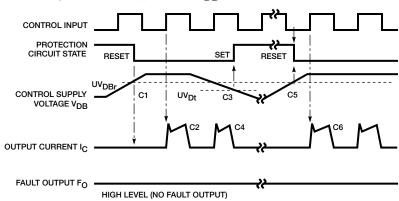
- B1: Control supply voltage rise After the voltage level reaches UV_{Dr}, the drive circuit begins to work at the rising edge of the next input signal.
- B2: Normal operation IGBT turn on and conducting current.
- B3: Under-voltage trip (UV_{Dt}).
- B4: IGBT turn off regardless of the control input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



PS21965-S Intellimod™ Module Dual-In-Line Intelligent Power Module 20 Amperes/600 Volts

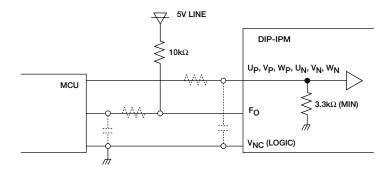
Protection Function Timing Diagrams

Under-Voltage Protection (Upper-side, UVDB)



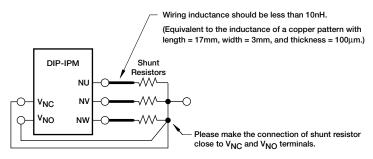
- C1: Control supply voltage rises After the voltage level reaches UV_{DBr}, the drive circuit begins to work at the rising edge of the next input signal.
- C2: Normal operation IGBT turn on and conducting current.
- C3: Under-voltage trip (UV_{DBt}).
- C4: IGBT stays off regardless of the control input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

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 $3.3 \mathrm{k}\Omega$ (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



Rev. 04/06 7