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PFC SPM[®] 3 Series for 2-Phase Bridgeless PFC

FPDB60PH60B

General Description

The FPDB60PH60B is an advanced PFC SPM 3 module providing a fully-featured, high-performance Bridgeless PFC (Power Factor Correction) input power stage for consumer, medical, and industrial applications. These modules integrate optimized gate drive of the built-in IGBTs to minimize EMI and losses, while also providing multiple on-module protection features including under-voltage lockout, over-current shutdown, thermal monitoring, and fault reporting. These modules also feature high-performance output diodes and shunt resistor for additional space savings and mounting convenience.

Features

- UL Certified No. E209204 (UL1557)
- 600 V 60 A 2–Phase Bridgeless PFC with Integral Gate Driver and Protection
- Very Low Thermal Resistance Using AlN DBC Substrate
- Built-in NTC Thermistor for Temperature Monitoring
- Built-in Shunt Resistor for Current Sensing
- Optimized for 20 kHz Switching Frequency
- Isolation Rating: 2500 V_{rms}/ min
- This is a Pb–Free Device

Applications

• 2-Phase Bridgeless PFC Converter

Related Source

 <u>AN-9041 – Bridgeless PFC SPM 3 Series Design</u> <u>Guide</u>

Integrated Drive, Protection and System Control Functions

- For IGBTs: Gate Drive Circuit, Over-Current Protection (OCP), Control Supply Circuit Under-Voltage Lock-Out (UVLO) Protection
- Fault Signal: Corresponding to OC and UV Fault
- Built–in Thermistor: Temperature Monitoring
- Input Interface: Active-HIGH Interface, Works with 3.3 / 5 V Logic, Schmitt-trigger Input



3D Package Drawing (Click to Activate 3D Content)

SPMCA-027 / PDD STD, SPM27-CA, DBC TYPE CASE MODFJ

MARKING DIAGRAM



ORDERING INFORMATION

See detailed ordering and shipping information on page 9 of this data sheet.

PIN CONFIGURATION



Figure 1. Pin Configuration – Top View

PIN DESCRIPTIONS

Pin No.	Pin Name	Pin Description
1	V _{CC}	Common Bias Voltage for IC and IGBTs Driving
2	COM	Common Supply Ground
4	IN _(R)	Signal Input for Low-Side R-Phase IGBT
5	IN _(S)	Signal Input for Low-Side S-Phase IGBT
6	V _{FO}	Fault Output
7	C _{FOD}	Capacitor for Fault Output Duration Selection
8	C _{SC}	Capacitor(Low-Pass Filter) for Over-Current Detection
19	R _(TH)	Series Resistor for The Use of Thermistor
20	V _(TH)	Thermistor Bias Voltage
21	V _{AC-}	Current Sensing Terminal
22	N _{SENSE}	Current Sensing Reference Terminal
24	Ν	Negative Rail of DC-Link
25	R	Output for R-Phase
26	S	Output for S-Phase
27	P _R	Positive Rail of DC-Link
3, 9 ~ 18, 23	NC	No Connection

INTERNAL EQUIVALENT CIRCUIT AND INPUT/OUTPUT PINS



NOTE:

1. Converter is composed of two IGBTs including four diodes and one IC which has gate driving and protection functions.



ABSOLUTE MAXIMUM RATINGS (T_J = 25°C unless otherwise specified)

Symbol	Parameter	Conditions	Rating	Unit
INVERTER PA	ART	-		
Vi	Supply Voltage	Applied between R – S	264	V _{rms}
V _{i(Surge)}	Supply Voltage (Surge)	Applied between R – S	500	V
V _{PN}	Output Voltage	Applied between P – N	450	V
V _{PN(Surge)}	Output Voltage (Surge)	Applied between P – N	500	V
V _{CES}	Collector – Emitter Voltage		600	V
±l _C	Each IGBT Collector Current	$T_{\rm C} = 25^{\circ}{\rm C}$	60	А
±I _{CP}	Each IGBT Collector Current (Peak)	$T_{C} = 25^{\circ}C$, Under 1 ms Pulse Width	90	А
P _C	Collector Dissipation	T _C = 25°C per IGBT	178	W
V _{RRM}	Repetitive Peak Reverse Voltage		600	V
I _{FSM}	Peak Forward Surge Current	Single Half Sine-Wave	350	А
P _{RSH}	Power Rating of Shunt Resistor	T _C < 125°C	2	W
Т _Ј	Operating Junction Temperature	(Note 2)	-40 ~ 150	°C

CONTROL PART

V _{CC}	Control Supply Voltage	Applied between V _{CC} – COM	20	V
V _{IN}	Input Signal Voltage	Applied between IN – COM	-0.3 ~ 17.0	V
V _{FO}	Fault Output Supply Voltage	Applied between V _{FO} – COM	$-0.3 \sim V_{CC} + 0.3$	V
I _{FO}	Fault Output Current	Sink Current at V _{FO} pin	5	mA
V _{SC}	Current-Sensing Input Voltage	Applied between C _{SC} – COM	$-0.3 \sim V_{CC} + 0.3$	V

TOTAL SYSTEM

T _C	Module Case Operation Temperature		-30 ~ 100	°C
T _{STG}	Storage Temperature		-40 ~ 150	°C
V _{ISO}	Isolation Voltage	60 Hz, Sinusoidal, AC 1 Minute, Connect Pins to Heat–Sink Plate	2500	V _{rms}

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected. 2. The maximum junction temperature rating of the power chips integrated within the PFC SPM product is $150^{\circ}C(@T_{C} \le 100^{\circ}C)$.

THERMAL RESISTANCE

Symbol	Parameter	Conditions	Min	Тур	Max	Unit
$R_{\theta(j-c)Q}$	Junction to Case Thermal Resistance	IGBT	-	-	0.7	°C/W
$R_{\theta(j-c)HD}$	(Referenced to PKG Center)	High-Side Diode	-	-	1.5	°C/W
$R_{\theta(j-c)LD}$		Low-Side Diode	-	-	0.85	°C/W

3. For the measurement point of case temperature (T_C), please refer to Figure 1.

ELECTRICAL CHARACTERISTICS ($T_J = 25^{\circ}C$ unless otherwise specified.)

Symbol	Parameter	Conditions	Min	Тур	Max	Unit		
CONVERTE	CONVERTER PART							
V _{CE(SAT)}	IGBT Saturation Voltage	$V_{CC} = 15 \text{ V}, \text{ V}_{IN} = 5 \text{ V}, \text{ I}_{C} = 50 \text{ A}$	-	2.0	2.5	V		
V_{FH}	High-Side Diode Voltage	I _F = 50 A	-	2.4	2.9	V		
V _{FL}	Low-Side Diode Voltage	I _F = 50 A	-	1.2	1.6	V		
t _{ON}	Switching Times	$V_{PN} = 400 \text{ V}, V_{CC} = 15 \text{ V}, I_C = 60 \text{ A},$	-	560	-	ns		
t _{C(ON)}		$V_{\text{IN}} = 0.0 \leftrightarrow 5.0$, inductive load (Note 4)	-	270	-	ns		
t _{OFF}			-	520	-	ns		
t _{C(OFF)}			-	110	-	ns		
t _{rr}			-	44	-	ns		
I _{rr}			-	6.5	-	А		
R _{SENSE}	Current-Sensing Resistor		1.8	2.0	2.2	mΩ		
ICES	Collector – Emitter Leakage Current	VCE = VCES	_	-	250	μA		

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

t_{ON} and t_{OFF} include the propagation delay time of the internal drive IC. t_{C(ON)} and t_{C(OFF)} are the switching times of IGBT itself under the given gate driving condition internally. For the detailed information, please see Figure 3.



Figure 3. Switching Time Definition

ELECTRICAL CHARACTERISTICS (T _J =	= 25°C unless otherwise s	pecified.) (continued)
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Symbol	Parameter	Conditions	Min	Тур	Мах	Unit	
CONTRO	CONTROL PART						
I _{QCCL}	Quiescent V _{CC} Supply Current	$V_{CC} = 15 \text{ V}, \text{ IN} = 0 \text{ V}$ $V_{CC} - \text{COM}$	-	-	26	mA	
V _{FOH}	Fault Output Voltage	V_{SC} = 0 V, V_{FO} Circuit: 4.7 k Ω to 5 V Pull-up	4.5	-	-	V	
V _{FOL}		V_{SC} = 1 V, V_{FO} Circuit: 4.7 k Ω to 5 V Pull-up	-	-	0.8	V	
V _{SC(ref)}	Short Circuit Trip Level	V _{CC} = 15 V	0.45	0.50	0.55	V	
UV _{CCD}	Supply Circuit Under-Voltage	Detection level	10.7	11.9	13.0	V	
UV _{CCR}	FIOLECIION	Reset level	11.2	12.4	13.2	V	
t _{FOD}	Fault-Out Pulse Width	C _{FOD} = 33 nF (Note 5)	1.4	1.8	2.0	ms	
V _{IN(ON)}	ON Threshold Voltage	Applied between IN – COM	3.0	-	-	V	
V _{IN(OFF)}	OFF Threshold Voltage		-	-	0.8	V	
R _{TH}	Resistance of Thermistor	At $T_C = 25^{\circ}C$ (See Figure 4)	-	50	-	kΩ	
		At $T_C = 80^{\circ}C$ (See Figure 4)	-	5.76	-	kΩ	

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

5. The fault-out pulse width t_{FOD} depends on the capacitance value of C_{FOD} according to the following approximate equation: $C_{FOD} = 18.3 \times 10^{-6} t_{FOD}[F]$



Figure 4. R-T Curve of the Built-in Thermistor

RECOMMENDED OPERATING CONDITIONS

Symbol	Parameter	Conditions	Min	Тур	Max	Unit
VI	Input Supply Voltage	Applied between R – S	180	-	264	V _{rms}
V _{PN}	Output Voltage	Applied between P – N	-	280	400	V
V _{CC}	Control Supply Voltage	Applied between V _{CC} – COM	13.5	15	16.5	V
dV _{CC} / dt	Control Supply Variation	Applied between IN – COM	-1	-	1	V/μs
f _{PWM}	PWM Input Signal	$T_C \le 100^{\circ}C$, $T_J \le 125^{\circ}C$, per IGBT	-	20	-	kHz

Functional operation above the stresses listed in the Recommended Operating Ranges is not implied. Extended exposure to stresses beyond the Recommended Operating Ranges limits may affect device reliability.

MECHANICAL CHARACTERISTICS AND RATINGS

ltem	Conditions		Min	Тур	Max	Unit
Mounting Torque	Mounting Screw: M3	Recommended 0.62 N•m	0.51	0.62	0.72	N∙m
Device Flatness	See Figure 5		0	-	+120	μm
Weight			-	15.00	-	g



Figure 5. Flatness Measurement Position

TIME CHARTS OF PROTECTIVE FUNCTION



P1: Normal operation: IGBT ON and conducting current.

P2: Under-voltage detection.

P3: IGBT gate interrupt.

P4: Fault signal generation.

P5: Under-voltage reset.

P6: Normal operation: IGBT ON and conducting current.

Figure 6. Under-Voltage Protection



P1: Normal operation: IGBT ON and conducting current.

P2: Over Current detection.

P3: IGBT gate interrupt / fault signal generation.

P4: IGBT is slowly turned off.

P5: IGBT OFF signal.

P6: IGBT ON signal: but IGBT cannot be turned on during the fault output activation.

P7: IGBT OFF state.

P8: Fault output reset and normal operation start.

Figure 7. Over-Current Protection



NOTE:

6. For the over–current protection, please set time constant in the range 3 \sim 4 $\mu s.$

Figure 8. Application Example

PACKAGE MARKING AND ORDERING INFORMATION

Device	Device Marking	Package	Shipping
FPDB60PH60	FPDB60PH60B	SPMCA-027 / PDD STD, SPM27-CA, DBC TYPE (Pb-Free / Halide Free)	60 Units / Tube

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