FAIRCHILD SEMICONDUCTOR®

January 2008

FCAS20DN60BB

Smart Power Module for SRM

Features

- 600V-20A 2-phase asymmetric bridge IGBT converter for SRM drive including control ICs for gate driving and protection
- Single-grounded power supply due to built-in HVIC
- Isolation rating of 1500Vrms/min.
- Embedded bootstrap diode in the package

Applications

- 2-phase SRM drives for home application vacuum cleaner.

General Description

FCAS20DN60BB is an advanced smart power module for SRM drive that Fairchild has newly developed and designed to provide very compact and high performance SRM motor drives mainly targeting low-power SRM application especially for a vacuum air cleaner. It combines optimized circuit protection and drive matched to low-loss IGBTs. System reliability is further enhanced by the integrated under-voltage lock-out and short-circuit protection. The high speed built-in HVIC provides opto-coupler-less IGBT gate driving capability that further reduce the overall size of the system. In addition the incorporated HVIC facilitates the use of single-supply drive topology enabling the FCAS20DN60BB to be driven by only one drive supply voltage without negative bias.



Figure 1.

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Integrated Power Functions

- 600V-20A IGBT asymmetric converter for 2-phase SRM drives (Please refer to Figure 3)

Integrated Drive, Protection and System Control Functions

- For high-side IGBTs: Gate drive circuit, High voltage isolated high-speed level shifting
  Control circuit under-voltage (UV) protection
  Note) Available bootstrap circuit example is given in Figures 11.
- For low-side IGBTs: Gate drive circuit, Short circuit protection (SC)
  Control supply circuit under-voltage (UV) protection
- Fault signaling: Corresponding to a UV fault (Low-side supply)
- Input interface: 5V CMOS/LSTTL compatible, Schmitt trigger input

Pin Configuration

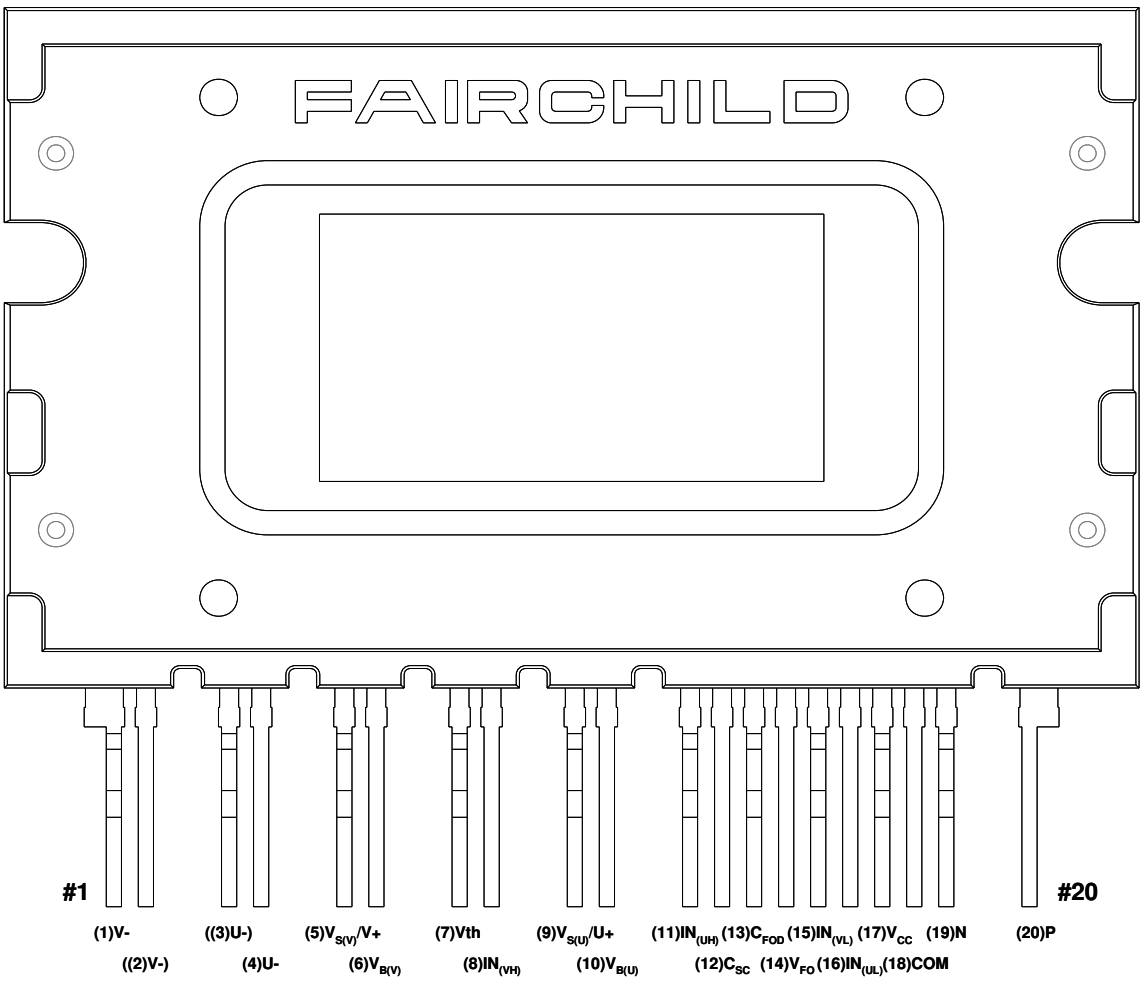


Figure 2.

Pin Descriptions

Pin Number	Pin Name	Pin Description
1	V-	Output for V- Leg
2	(V-)	Output for V- Leg
3	(U-)	Output for U- Leg
4	U-	Output for U- Leg
5	VS(V)/V+	Output for V+ Leg / High-side Bias Voltage Ground for V-phase IGBT Gate Driving
6	VB(V)	High-side Bias Voltage for V-phase IGBT Gate Driving
7	Vth	Thermistor Output
8	IN(VH)	Signal Input for V-phase High-side IGBT
9	VS(U)/U+	Output for U+ Leg / High-side Bias Voltage Ground for U-phase IGBT Gate Driving
10	VB(U)	High-side Bias Voltage for U-phase IGBT Gate Driving
11	IN(UH)	Signal Input for U-phase High-side IGBT
12	C_{SC}	Capacitor (Low-pass Filter) for Short-Current Detection
13	C_{FOD}	Capacitor for Fault Output Duration Time Selection
14	V_{FO}	Fault Output
15	IN(VL)	Signal Input for V-phase Low-side IGBT
16	IN(UL)	Signal Input for U-phase Low-side IGBT
17	V_{CC}	Common Bias Voltage for IC and IGBTs Driving
18	COM	Common Supply Ground
19	N	Negative DC–Link Input
20	P	Positive DC–Link Input

Internal Equivalent Circuit and Input/Output Pins

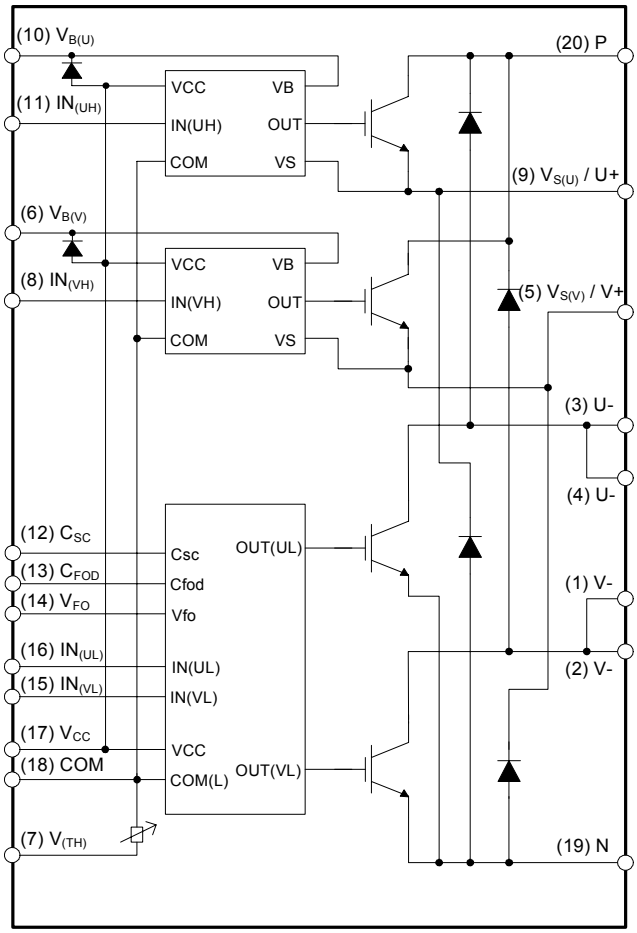


Figure 3.

Absolute Maximum Ratings (T_J = 25°C, Unless Otherwise Specified)

Inverter Part

Symbol	Parameter	Conditions	Rating	Units
$V_{PN(Surge)}$	Supply Voltage (Surge)	Applied between P- N	550	V
V_{CES}	Collector-emitter Voltage		600	V
± I_C	Each IGBT Collector Current	T_C = 25°C	20	A
± I_{CP}	Each IGBT Collector Current (Peak)	T_C = 25°C, Under 1ms Pulse Width	30	A
P_C	Collector Dissipation	T_C = 25°C per One IGBT	22	W
T_J	Operating Junction Temperature	(Note 1)	-20 ~ 125	°C

Control Part

Symbol	Parameter	Conditions	Rating	Units
V_{CC}	Control Supply Voltage	Applied between V_{CC} - COM	20	V
V_{BS}	High-side Control Bias Voltage	Applied between V_B - V_S	20	V
V_{IN}	Input Signal Voltage	Applied between $IN_{(H)}$, $IN_{(L)}$ - COM	-0.3~17	V
V_{FO}	Fault Output Supply Voltage	Applied between V_{FO} - COM	-0.3~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~V_{CC}+0.3	V

Total System

Symbol	Parameter	Conditions	Rating	Units
$V_{PN(PROT)}$	Self Protection Supply Voltage Limit (Short Circuit Protection Capability)	V_{CC} = V_{BS} = 13.5 ~ 16.5V T_J = 125°C, Non-repetitive, less than 2μs	400	V
T_{STG}	Storage Temperature		-40 ~ 125	°C
V_{ISO}	Isolation Voltage	60Hz, Sinusoidal, AC 1 minute, Connection Pins to IMS	1500	V_{rms}

Thermal Resistance

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Units
$R_{th(j-c)Q}$	Junction to Case Thermal Resistance	Each IGBT under Operating Condition	-	-	4.0	°C/W
$R_{th(j-c)F}$		Each FWDi under Operating Condition	-	-	9.4	°C/W

Note:

1. For the measurement point of case temperature (T_C), please refer to Figure 2.

Package Marking & Ordering Information

Device Marking	Device	Package	Reel Size	Tape Width	Quantity
FCAS20DN60BB	FCAS20DN60BB	SPM20-BC	_	_	11

Electrical Characteristics (T_J = 25°C, Unless Otherwise Specified)

Inverter Part

Symbol		Parameter	Conditions		Min.	Typ.	Max.	Units
$V_{CE(SAT)}$		Collector-Emitter Saturation Voltage	V_{CC} = V_{BS} = 15V V_{IN} = 5V	I_C = 15A, T_J = 25°C	-	-	2.05	V
V_{FM}		FWDi Forward Voltage	V_{IN} = 0V	I_C = 15A, T_J = 25°C	-	-	2.8	V
HS	t_{ON}	Switching Times	V_{PN} = 300V, V_{CC} = V_{BS} = 15V I_C = 20A V_{IN} = 0V ↔ 5V, Inductive Load (Note 2)		-	680	-	ns
	$t_{C(ON)}$				-	500	-	ns
	t_{OFF}				-	1130	-	ns
	$t_{C(OFF)}$				-	160	-	ns
	t_{rr}				-	85	-	ns
LS	t_{ON}		V_{PN} = 300V, V_{CC} = V_{BS} = 15V I_C = 20A V_{IN} = 0V ↔ 5V, Inductive Load (Note 2)		-	1000	-	ns
	$t_{C(ON)}$				-	1100	-	ns
	t_{OFF}				-	1050	-	ns
	$t_{C(OFF)}$				-	180	-	ns
	t_{rr}				-	80	-	ns
	I_{CES}	Collector - Emitter Leakage Current	V_{CE} = V_{CES}		-	-	250	μA

Note:

2. 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 time of IGBT itself under the given gate driving condition internally. For the detailed information, please see Figure 4.

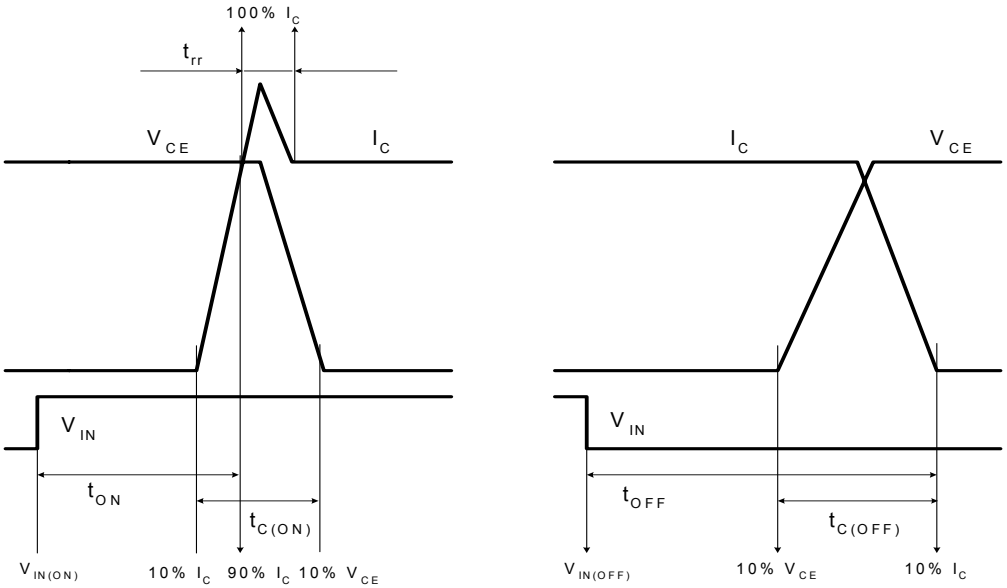


Figure 4. Switching Time Definition

Electrical Characteristics (T_J = 25°C, Unless Otherwise Specified)

Control Part

Symbol	Parameter	Conditions		Min.	Typ.	Max.	Units
I_{QCC}	Quiescent V_{CC} Supply Current	V_{CC} = 15V $IN_{(L)}$ = 0V	V_{CC} - COM	-	-	24	mA
I_{QBS}	Quiescent V_{BS} Supply Current	V_{BS} = 15V $IN_{(H)}$ = 0V	V_B - V_S	-	-	500	μA
V_{FOH}	Fault Output Voltage	V_{SC} = 0V, V_{FO} Circuit: 4.7kΩ to 5V Pull-up		4.5	-	-	V
V_{FOL}		V_{SC} = 1V, V_{FO} Circuit: 4.7kΩ to 5V Pull-up		-	-	0.8	V
$V_{SC(ref)}$	Short Circuit Trip Level	V_{CC} = 15V (Note 3)		0.45	0.5	0.55	V
UV_{CCD}	Supply Circuit Under-Voltage Protection	Detection Level	Applied between V_{CC} - COM	10.7	11.9	13.0	V
UV_{CCR}		Reset Level		11.2	12.4	13.2	V
UV_{BSD}		Detection Level	Applied between V_B - V_S	10.1	11.3	12.5	V
UV_{BSR}		Reset Level		10.5	11.7	12.9	V
t_{FOD}	Fault-out Pulse Width	C_{FOD} = 33nF (Note 4)		1.0	1.8	-	ms
V_{IH}	ON Threshold Voltage	Logic'1' input voltage	Applied between $IN_{(H)}$, $IN_{(L)}$ - COM	3.0	-	-	V
V_{IL}	OFF Threshold Voltage	Logic'0' input voltage		-	-	0.8	V
R_{TH}	Resistance of Thermistor	@ T_C = 25°C (Note Fig. 9)		-	50	-	kΩ
		@ T_C = 80°C (Note Fig. 9)		-	6.021	-	kΩ

Note:

3. Short-circuit current protection is functioning only at the low-sides.

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

Recommended Operating Conditions

Symbol	Parameter	Conditions	Value			Units
			Min.	Typ.	Max.	
V_{PN}	Supply Voltage	Applied between P - N	-	300	450	V
V_{CC}	Control Supply Voltage	Applied between V_{CC} - COM	13.5	15	16.5	V
V_{BS}	High-side Bias Voltage	Applied between V_B - V_S	13.5	15	18.5	V
f_{PWM}	PWM Input Signal	$T_C \leq$ 100°C, $T_J \leq$ 125°C	-	3	-	kHz
$V_{IN(ON)}$	Input ON Voltage	Applied between $IN_{(H)}$, $IN_{(L)}$ - COM	4 ~ 5.5			V
$V_{IN(OFF)}$	Input OFF Voltage	Applied between $IN_{(H)}$, $IN_{(L)}$ - COM	0 ~ 0.65			V

Bootstrap Diode Part

Symbol	Parameter	Conditions	Rating	Units
V_{RRM}	Maixmum Repetitive Reveres Voltage		600	V
I_F	Forward Current	T_C = 25°C	0.5	A
I_{FP}	Forward Current (Peak)	T_C = 25°C, Under 1ms Pulse Width	2	A
T_J	Reverse Recovery Time		-20~125	°C

Mechanical Characteristics and Ratings

Parameter	Conditions	Limits			Units
		Min.	Typ.	Max.	
Mounting Torque	Mounting Screw - M3	5.17	6.29	7.30	Kg•cm
		0.51	0.62	0.72	N•m
Surface Flatness	Note Figure 5.	-	-	-	um
Weight		-	14.5	-	g

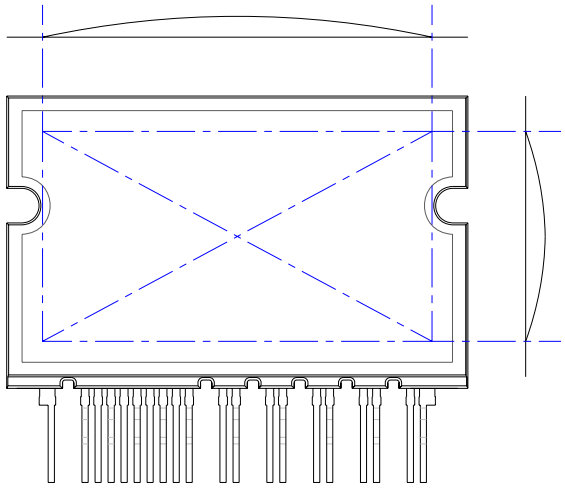
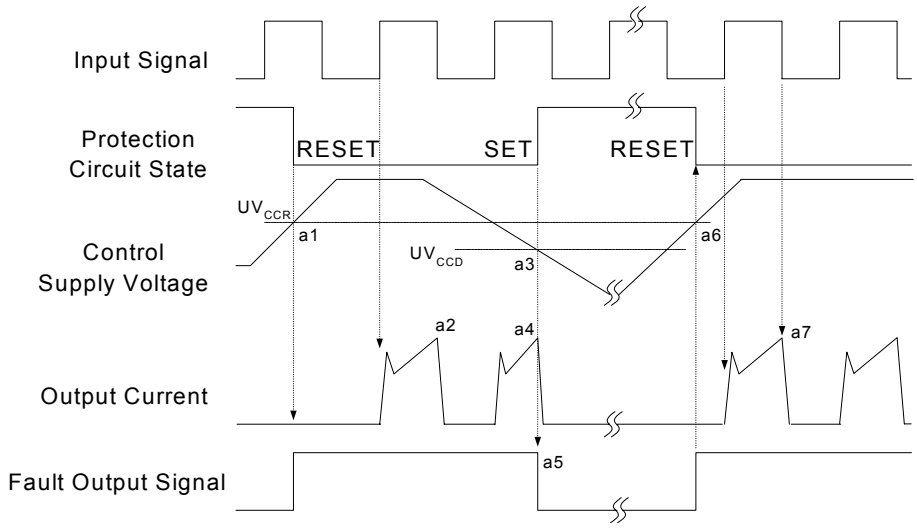


Figure 5. Flatness Measurement Position

Time Charts of Protective Function



a1 : Control supply voltage rises: After the voltage rises UV_{CCR}, the circuits start to operate when next input is applied.

a2 : Normal operation: IGBT ON and carrying current.

a3 : Under voltage detection (UV_{CCD}).

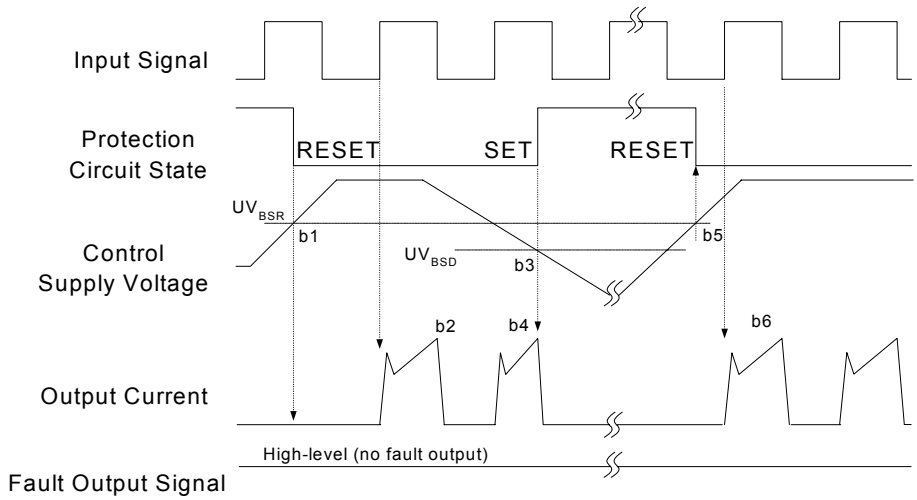
a4 : IGBT OFF in spite of control input condition.

a5 : Fault output operation starts.

a6 : Under voltage reset (UV_{CCR}).

a7 : Normal operation: IGBT ON and carrying current.

Fig. 6. Under-Voltage Protection (Low-side)



b1 : Control supply voltage rises: After the voltage reaches UV_{BSR}, the circuits start to operate when next input is applied.

b2 : Normal operation: IGBT ON and carrying current.

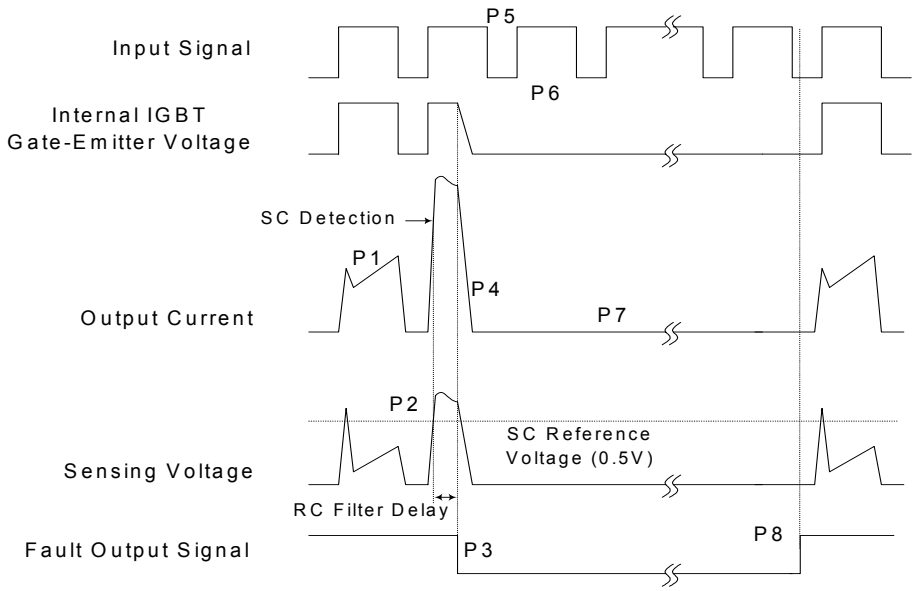
b3 : Under voltage detection (UV_{BSD}).

b4 : IGBT OFF in spite of control input condition, but there is no fault output signal.

b5 : Under voltage reset (UV_{BSR})

b6 : Normal operation: IGBT ON and carrying current

Fig. 7. Under-Voltage Protection (High-side)



(with the external shunt resistance and CR connection)

c1 : Normal operation: IGBT ON and carrying current.

c2 : Short circuit current detection (SC trigger).

c3 : Hard IGBT gate interrupt.

c4 : IGBT turns OFF.

c5 : Fault output timer operation starts: The pulse width of the fault output signal is set by the external capacitor C_{FO}.

c6 : Input “L” : IGBT OFF state.

c7 : Input “H”: IGBT ON state, but during the active period of fault output the IGBT doesn’t turn ON.

c8 : IGBT OFF state

Fig. 8. Short-Circuit Current Protection (Low-side Operation only)

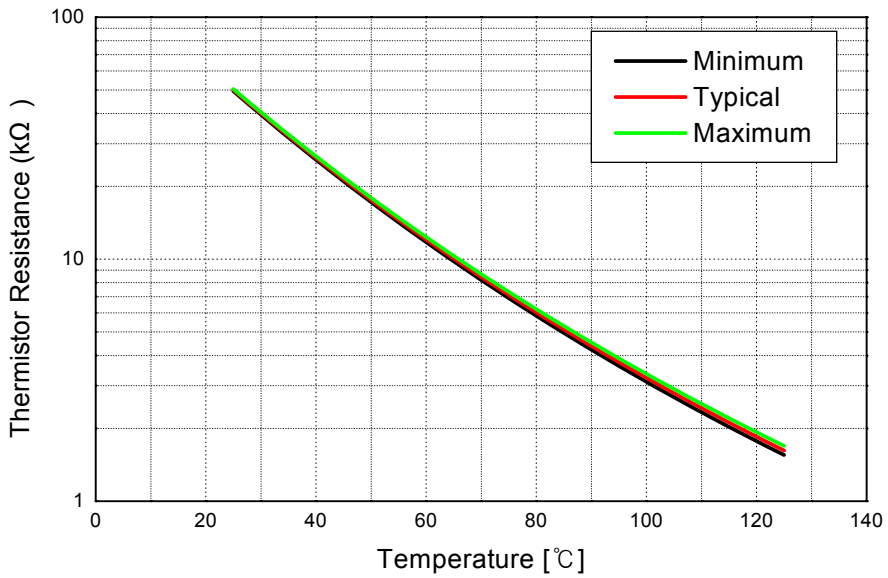
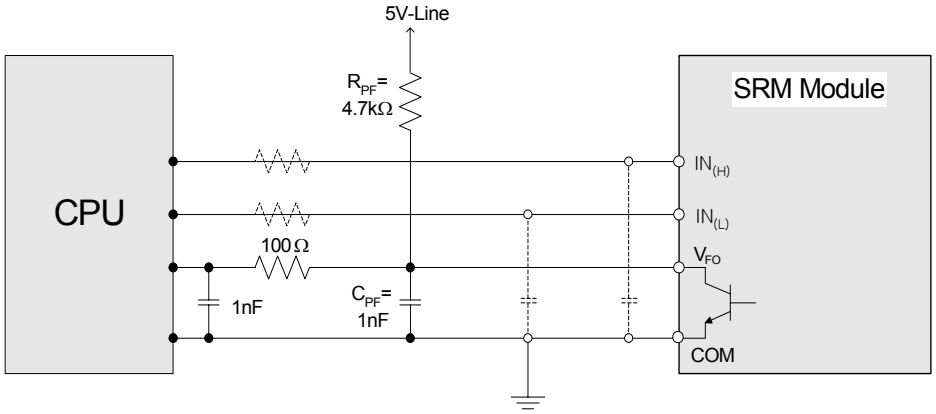


Fig. 9. R-T Curve of the Built-in Thermistor

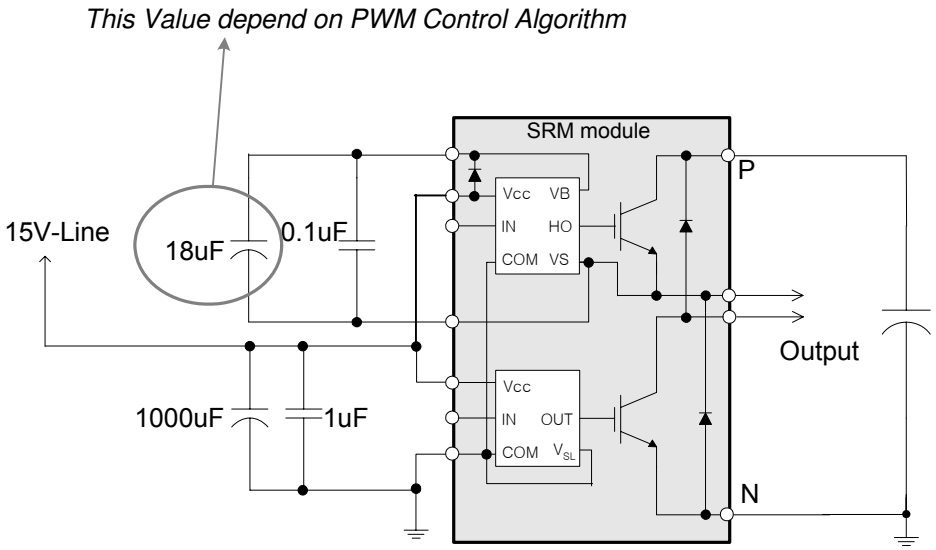


Note:

5. RC coupling at each input (parts shown dotted) might change depending on the PWM control scheme used in the application and the wiring impedance of the application's printed circuit board. The input signal section integrates 3.3kΩ(typ.) pull-down resistor. Therefore, when using an external filtering resistor, please pay attention to the signal voltage drop at input terminal.

6. The logic input is compatible with standard CMOS or LSTTL outputs.

Figure 10. Recommended CPU I/O Interface Circuit



Note:

1) The ceramic capacitor placed between V_{CC}-COM should be over 1uF and mounted as close to the pins of the SPM as possible.

Figure 11. Recommended Bootstrap Operation Circuit and Parameters

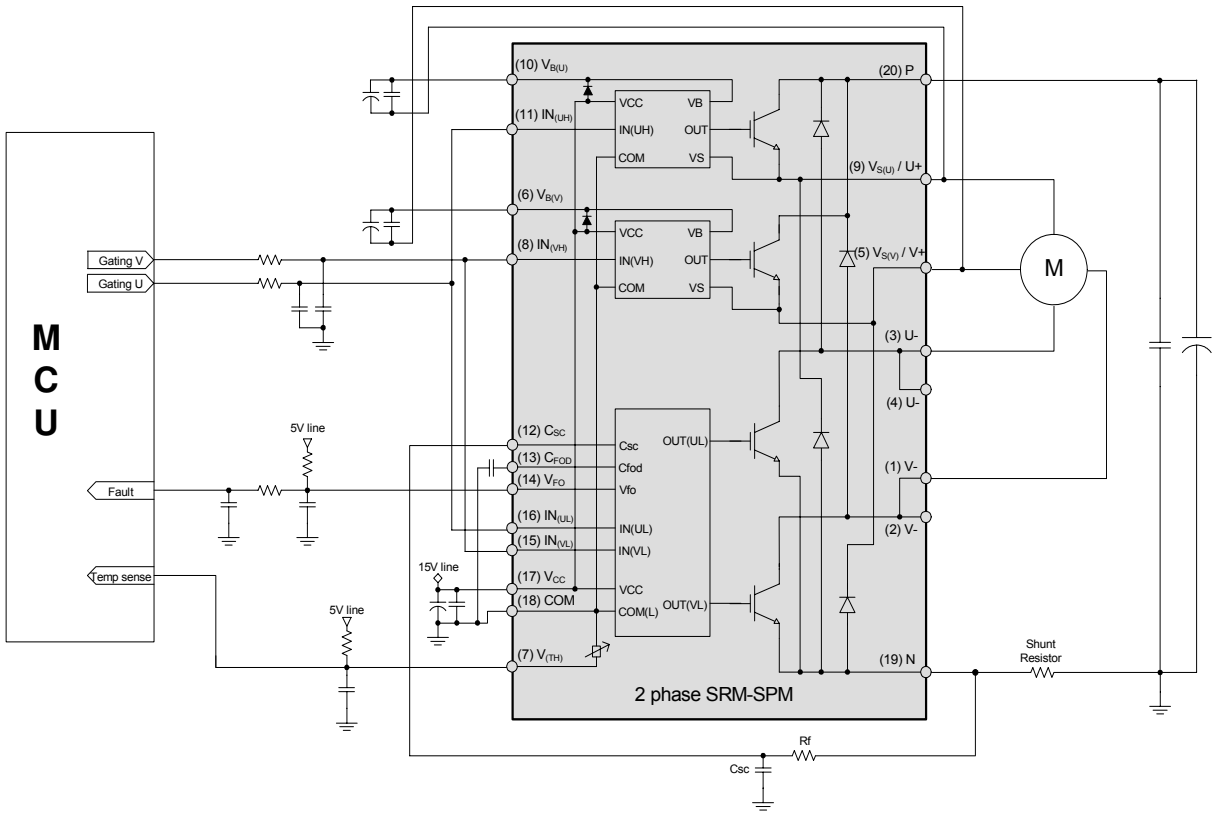
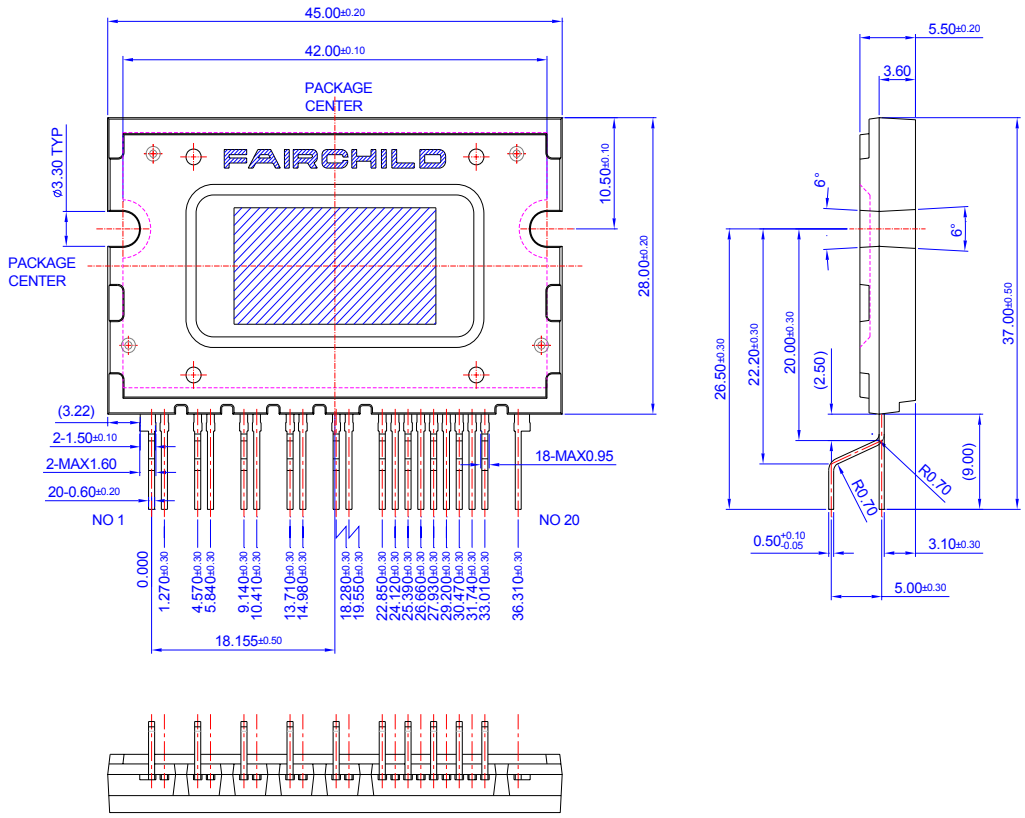


Figure 12. Typical Application Circuit

Detailed Package Outline Drawings



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