



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 optocoupler-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.

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

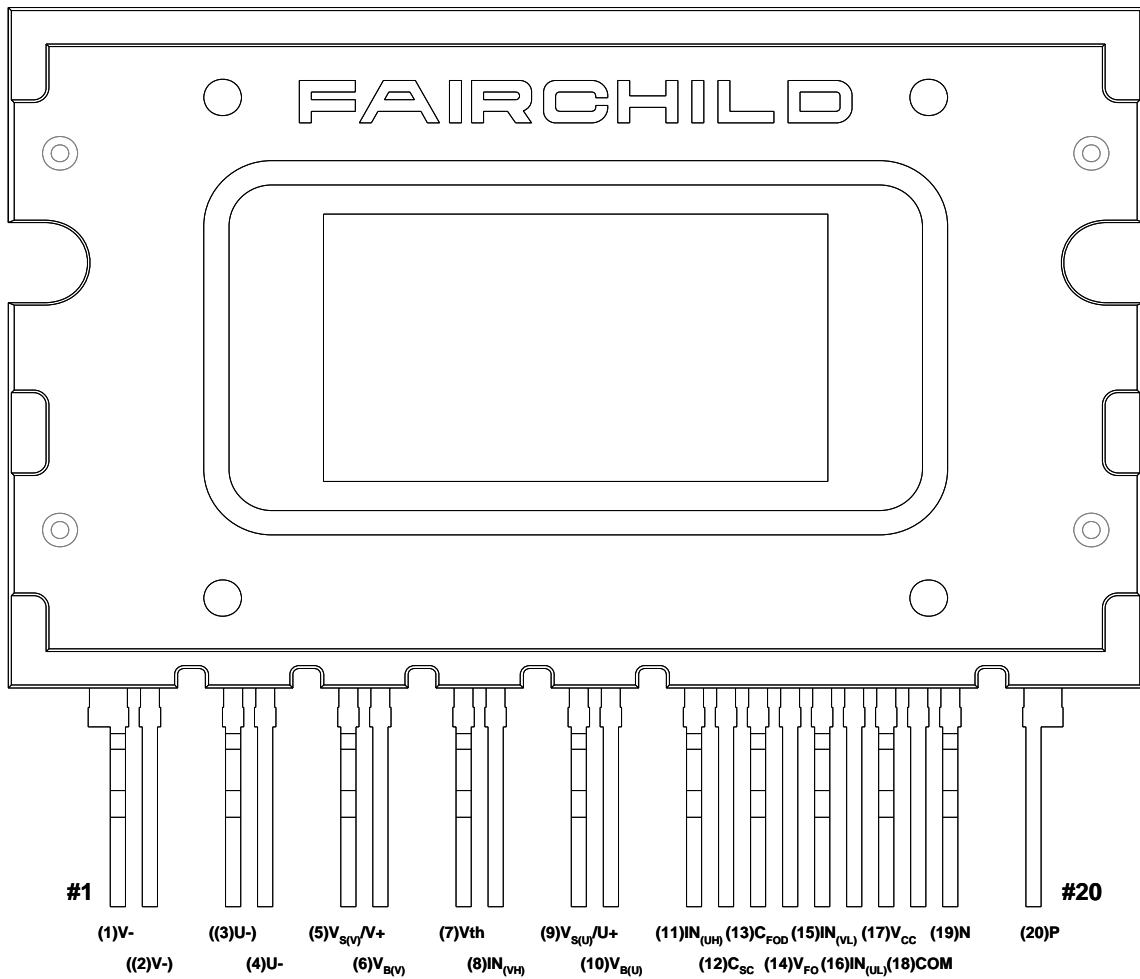


Figure 2.

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

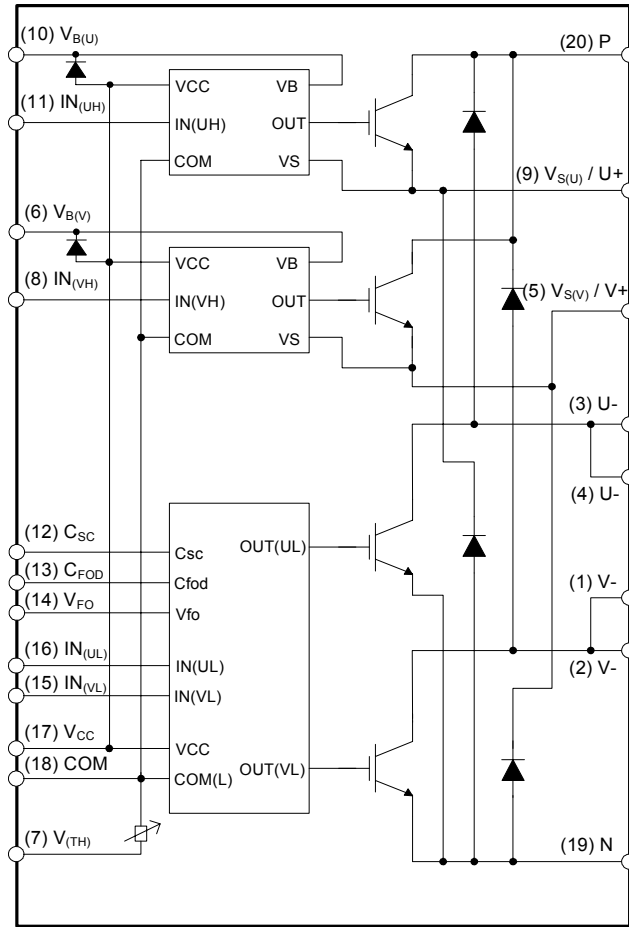


Figure 3.

Absolute Maximum Ratings ($T_J = 25^\circ\text{C}$, Unless Otherwise Specified)

Inverter Part

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

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 |
|-----------------------|--|--|-----------|------------------|
| $V_{PN(\text{PROT})}$ | Self Protection Supply Voltage Limit (Short Circuit Protection Capability) | $V_{CC} = V_{BS} = 13.5 \sim 16.5\text{V}$ $T_J = 125^\circ\text{C}$, Non-repetitive, less than $2\mu\text{s}$ | 400 | V |
| T_{STG} | Storage Temperature | | -40 ~ 125 | $^\circ\text{C}$ |
| 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 | $^\circ\text{C/W}$ |
| $R_{th(j-c)F}$ | | Each FWDi under Operating Condition | - | - | 9.4 | $^\circ\text{C/W}$ |

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.

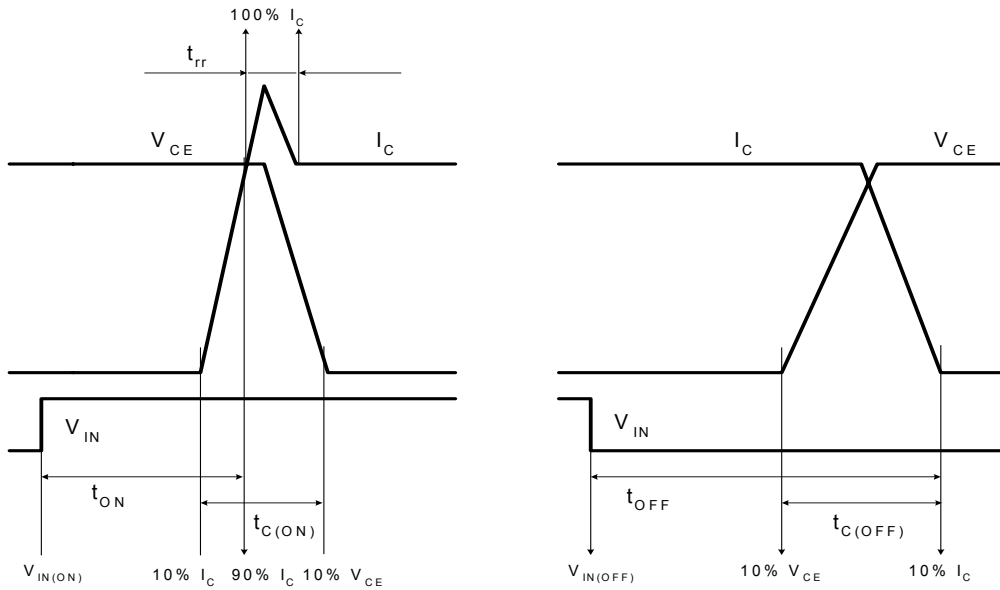


Figure 4. Switching Time Definition

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 I _{N(L)} = 0V | V _{CC} - COM | - | - | 24 | mA |
| I _{QBS} | Quiescent V _{BS} Supply Current | V _{BS} = 15V I _{N(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 I _{N(H)} , I _{N(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 x 10⁻⁶ x 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 ≤ 100°C, T _J ≤ 125°C | - | 3 | - | kHz |
| V _{IN(ON)} | Input ON Voltage | Applied between I _{N(H)} , I _{N(L)} - COM | 4 ~ 5.5 | | | V |
| V _{IN(OFF)} | Input OFF Voltage | Applied between I _{N(H)} , I _{N(L)} - COM | 0 ~ 0.65 | | | V |

Bootstrap Diode Part

| Symbol | Parameter | Conditions | Rating | Units |
|------------------|------------------------------------|--|---------|-------|
| V _{RRM} | Maximum Repetitive Reverse 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 |

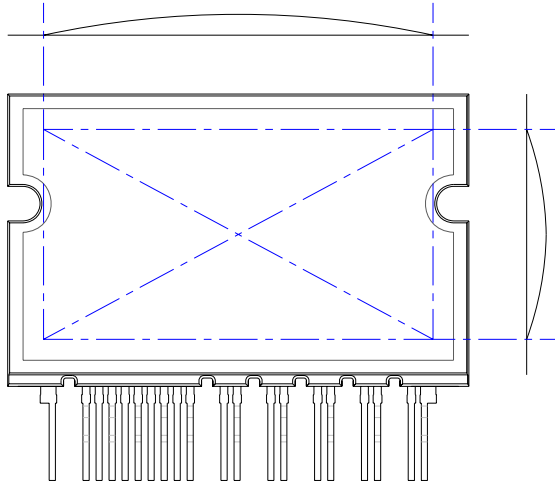
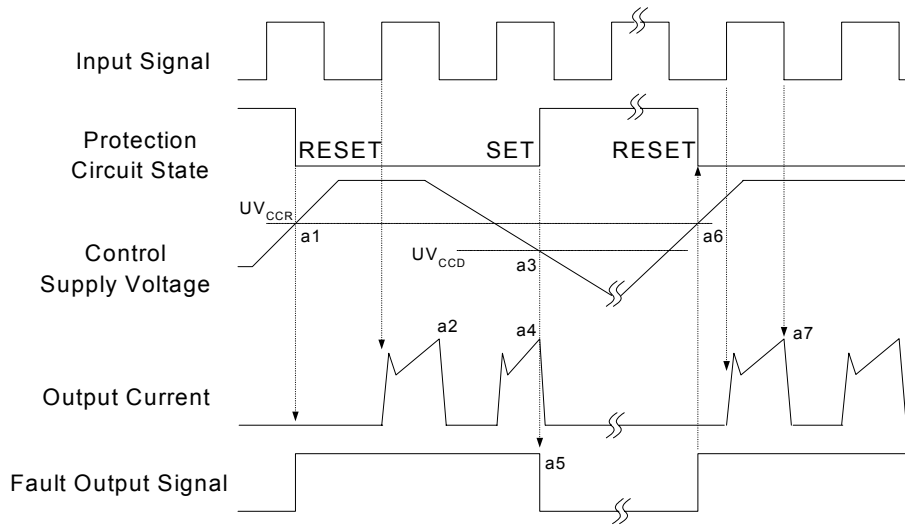


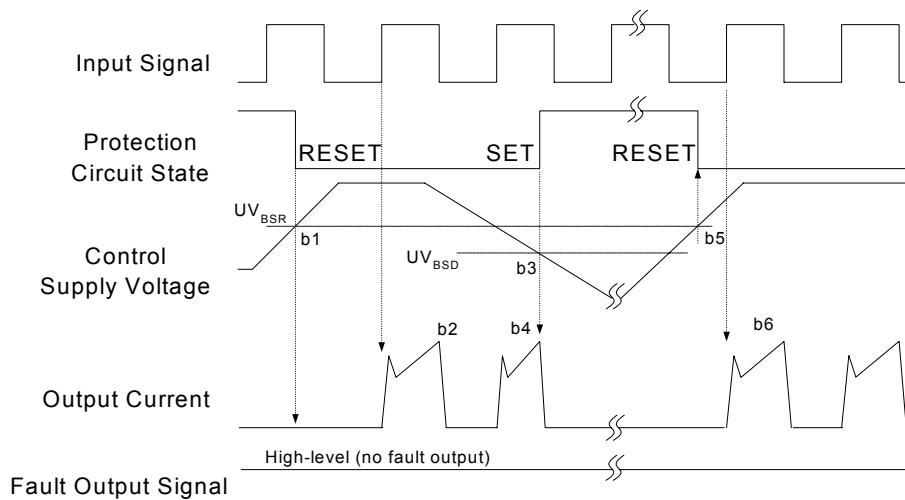
Figure 5. Flatness Measurement Position

Time Charts of Protective Function



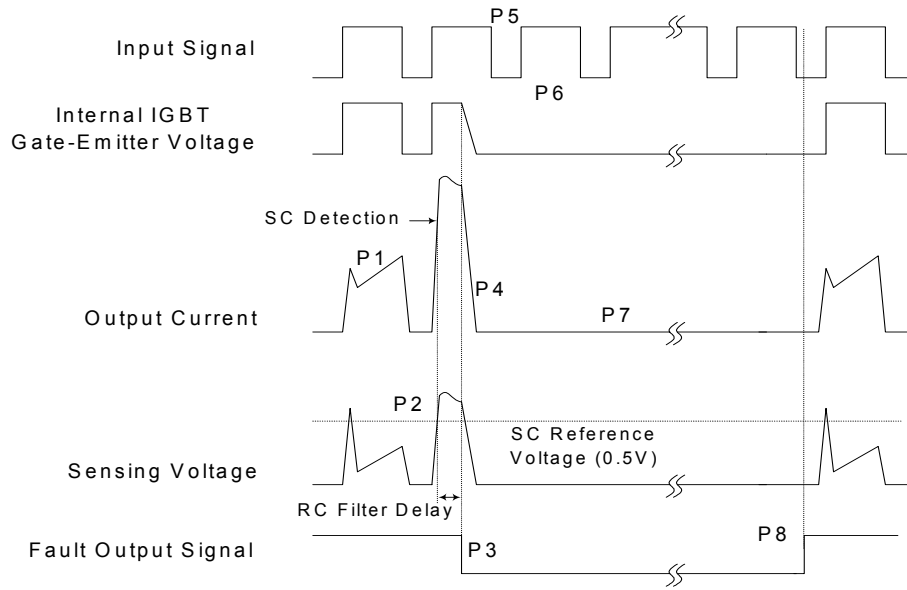
- a1 : Control supply voltage rises: After the voltage rises UV_{CCR} , the circuits start to operate when next input is applied.
- a2 : Normal operation: IGBT ON and carrying current.
- a3 : Under voltage detection (UV_{CCD}).
- a4 : IGBT OFF in spite of control input condition.
- a5 : Fault output 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)

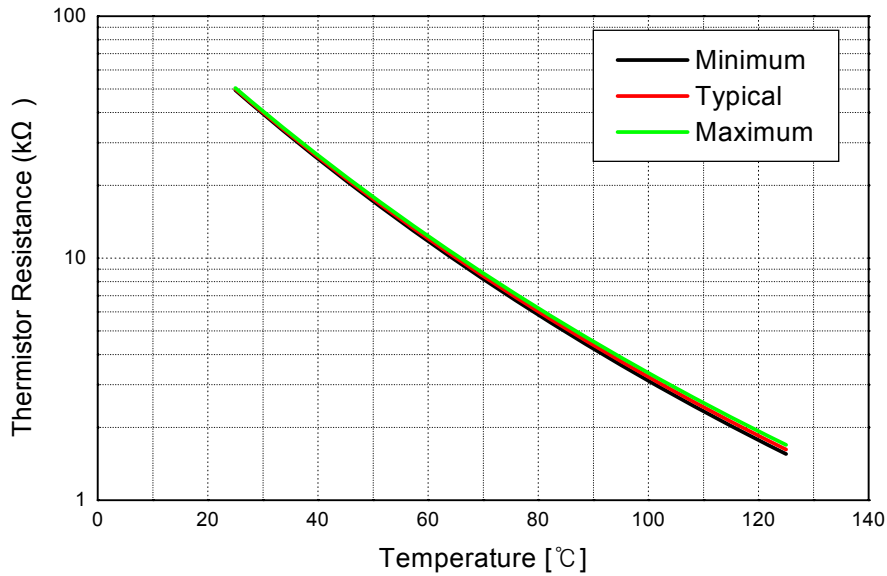
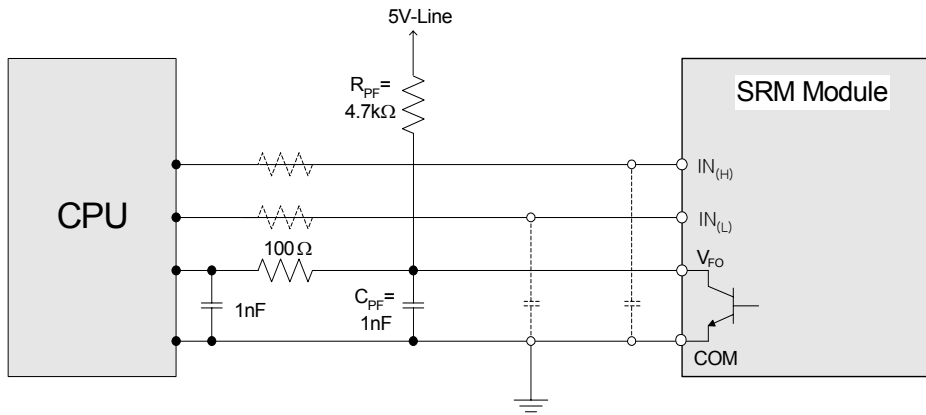


Fig. 9. R-T Curve of the Built-in Thermistor

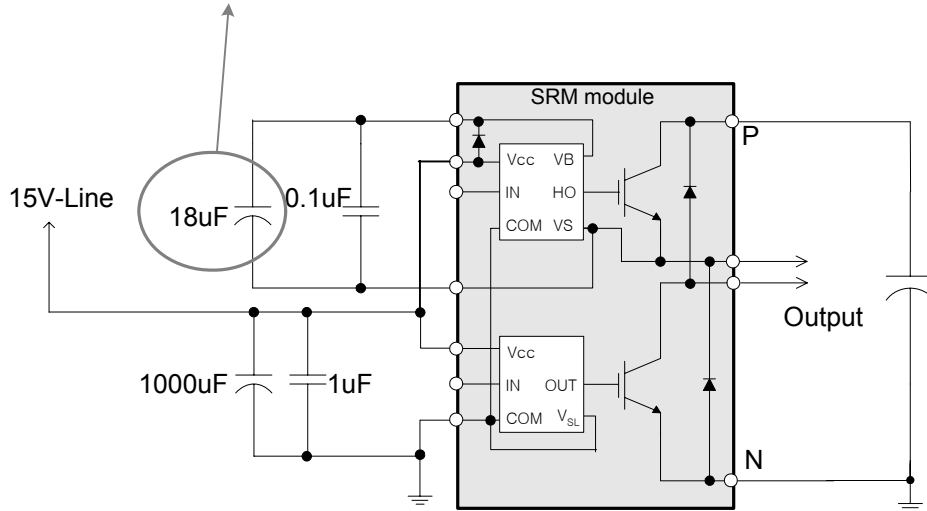


Note:

- 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

This Value depend on PWM Control Algorithm



Note:

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

Figure 11. Recommended Bootstrap Operation Circuit and Parameters

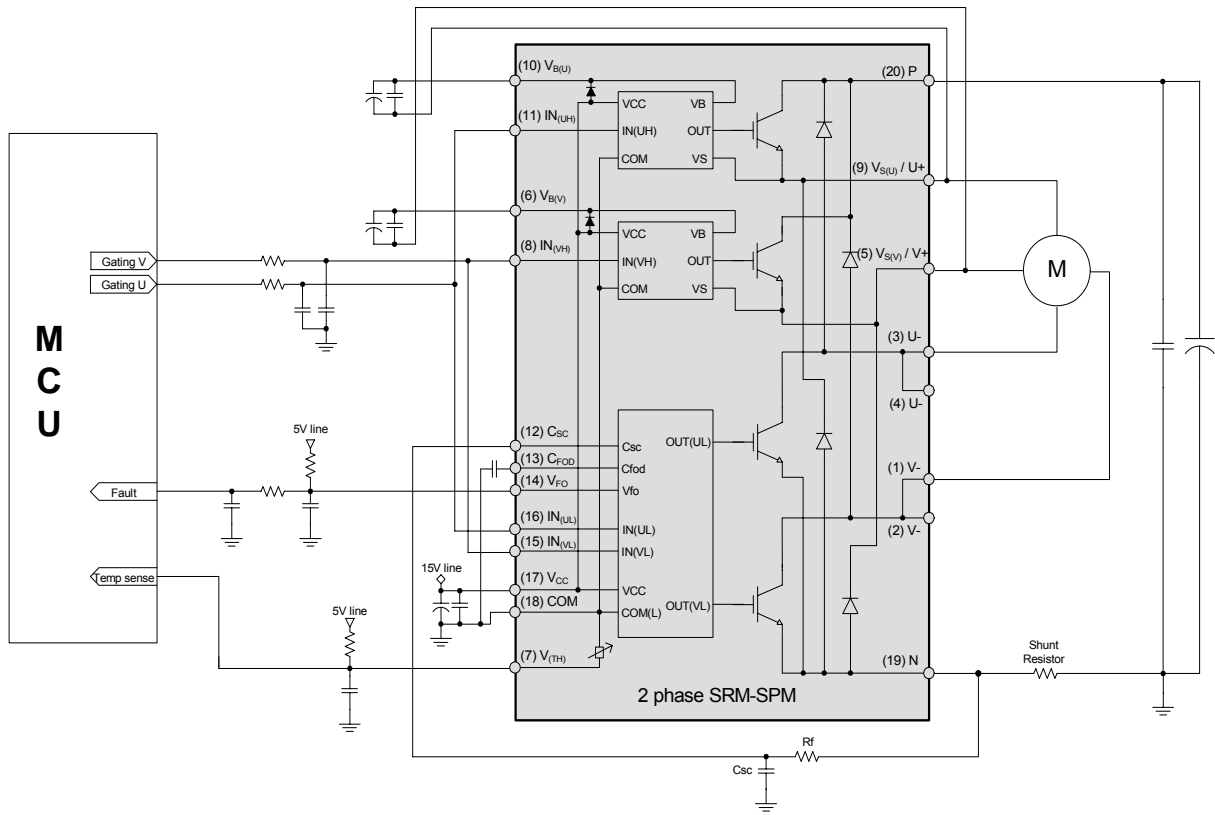




Figure 12. Typical Application Circuit



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