

Preliminary

RSN34007F / RSN34007FT

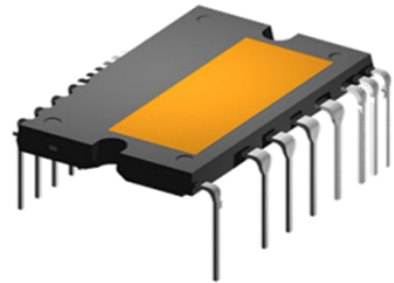


Green Power Module (GPM)

650V 40A Inverter

Features

- 650V / 40A 3-Phase IGBT Inverter
- Low-Losses & Short-Circuit-Rated IGBTs
- Soft Reverse Recovery Diodes
- Built-In Bootstrap Diodes
- DBC Substrate
- Under-Voltage Lock-Out for high side and low side
- Short-Circuit Protection (SC)
- Over Temperature Protection (RSN3**07FT only)
- LVIC Temperature Output (RSN3**07F only)
- 3.3 V and 5V Input Logic Compatible : Active High
- Fault Signaling : LVIC UVLO and Short-circuit Protection
- Isolation Rating of 1500 Vrms/1 min
- UL 1557 Certified



Typical Applications

- Air-conditioner, Washing machine etc.
- Motor Control – Industrial Motor (AC 200 V Class)

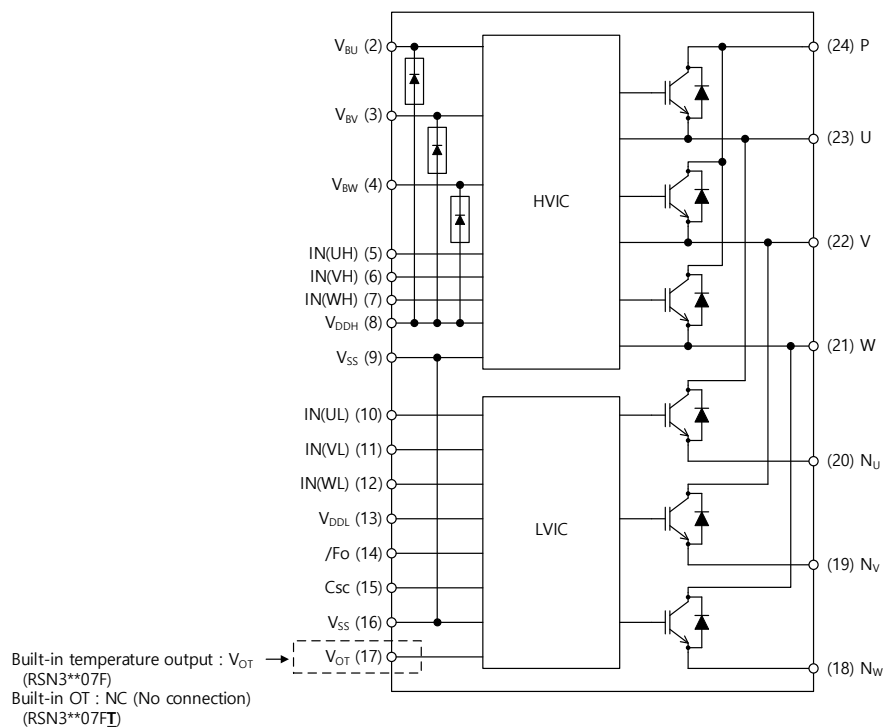


Figure 1. Internal Circuit

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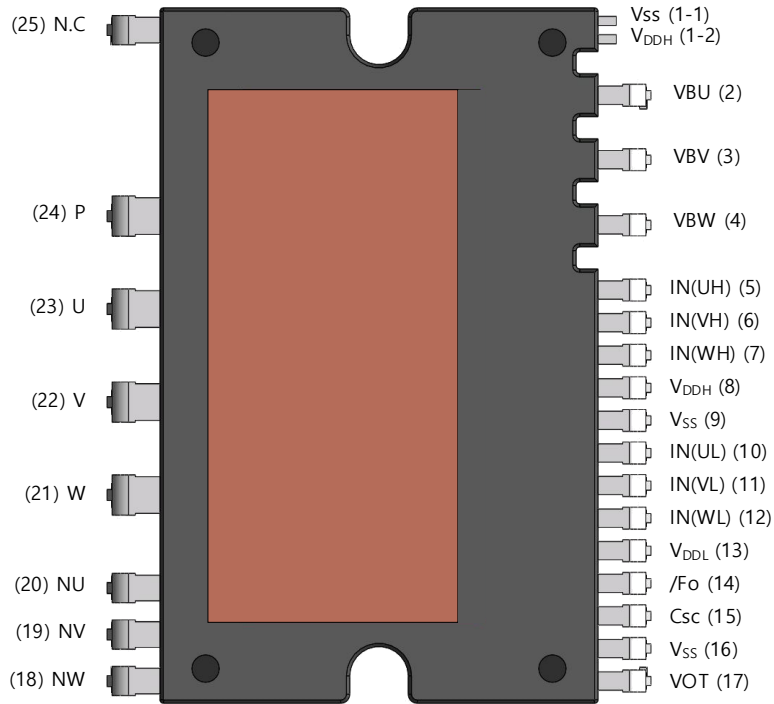


Figure 2. Pin Configuration – Top View

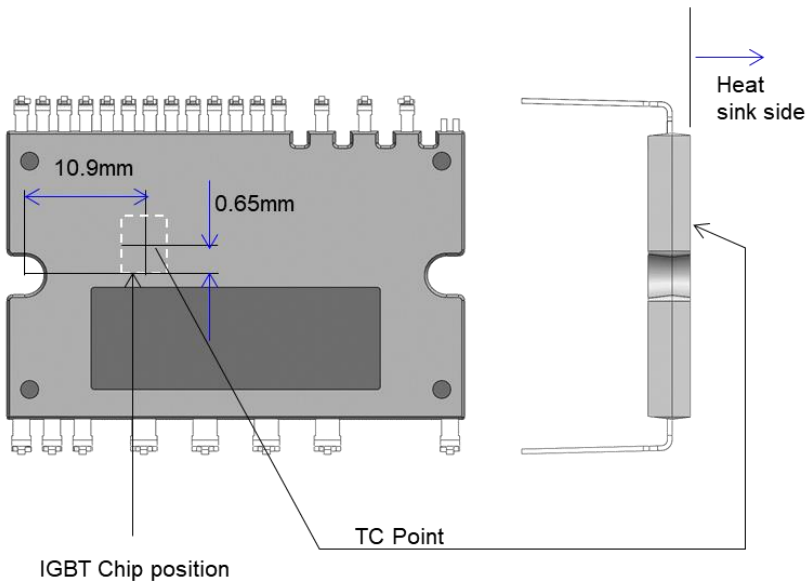


Figure 3. Tc Measurement Point

PIN DESCRIPTION

Pin Number	Pin Name	Pin Description
(1-1)	V _{SS}	Common Supply Ground, connected to HVIC
(1-2)	V _{DDH}	High-Side Bias Voltage for U Phase IC
2	V _{BU}	High-Side Bias Voltage for U Phase IGBT Driving
3	V _{BV}	High-Side Bias Voltage for V Phase IGBT Driving
4	V _{BW}	High-Side Bias Voltage for W Phase IGBT Driving
5	IN(UH)	Signal Input for High-Side U Phase
6	IN(VH)	Signal Input for High-Side V Phase
7	IN(WH)	Signal Input for High-Side W Phase
8	V _{DDH}	High-Side Bias Voltage for U Phase IC
9	V _{SS}	Common Supply Ground, connected to HVIC
10	IN(UL)	Signal Input for Low-Side U Phase
11	IN(VL)	Signal Input for Low-Side V Phase
12	IN(WL)	Signal Input for Low-Side W Phase
13	V _{DDL}	Low-Side Bias Voltage for IC and IGBTs Driving
14	/FO	Fault Output
15	Csc	Input for Current Protection
16	V _{SS}	Common Supply Ground, connected to LVIC
17	V _{OT}	Voltage Output for LVIC Temperature
18	N _W	Negative DC-Link Input for W Phase
19	N _V	Negative DC-Link Input for V Phase
20	N _U	Negative DC-Link Input for U Phase
21	W	Output for W Phase
22	V	Output for V Phase
23	U	Output for U Phase
24	P	Positive DC-Link Input
25	NC	Not Connected

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ABSOLUTE MAXIMUM RATINGS (T_j = 25°C unless otherwise noted)

Symbol	Rating	Conditions	Rating	Unit
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INVERTER PART

V _{PN}	Supply Voltage	Applied between P-N _U , N _V , N _W	450	V
V _{PN(surge)}	Supply Voltage (Surge)	Applied between P-N _U , N _V , N _W	500	V
V _{ces}	Collector-Emitter Voltage		650	V
I _c	Each IGBT Collector Current	T _c =25°C, T _j ≤150°C	40	A
I _{cp}	Each IGBT Collector Current (Peak)	T _c =25°C, T _j ≤150°C, Under 1ms Pulse Width (Note 1)	80	A
P _c	Collector Dissipation	T _c =25°C per One Chip (Note 1)	139	W
T _j	Operating Junction Temperature		-40~150	°C

CONTROL PART

V _{DD}	Control Supply Voltage	Applied between V _{DDH} , V _{DDL} -V _{SS}	20	V
V _{BS}	High-Side Control Bias Voltage	Applied between V _{BU} -V _{SU} , V _{BV} -V _{SV} , V _{BW} -V _{SW}	20	V
V _{IN}	Input Signal Voltage	Applied between IN(UH), IN(VH), IN(WH), IN(UL), IN(VL), IN(WL) - V _{SS}	-0.5-V _{DD} +0.5	V
V _{FO}	Fault Output Supply Voltage	Applied between F _O -V _{SS}	-0.5-V _{DD} +0.5	V
I _{FO}	Fault Output Current	Sink Current at F _O pin	5	mA
V _{sc}	Current Sensing Input Voltage	Applied between C _{sc} -V _{SS}	-0.5-V _{DD} +0.5	V
T _j	Operating Junction Temperature		-40~150	°C

BOOSTSTRAP DIODE PART

V _{RRM}	Maximum Repetitive Reverse Voltage		650	V
T _j	Operating Junction Temperature		-40~150	°C

TOTAL SYSTEM

V _{PN(PROT)}	Self-Protection Supply Voltage Limit (Short-Circuit Protection Capability)	V _{DD} =V _{BS} =13.5~16.5V, T _j =150°C, Non-Repetitive, < 2 μs	400	V
T _c	Module Case Operation Temperature	See Figure 2	-40~125	°C
T _{stg}	Storage Temperature		-40~125	°C
V _{iso}	Isolation Voltage	60 Hz, Sinusoidal, AC 1 Minute, Connection Pins to Heat Sink Plate	1500	V _{rms}

1. These values had been made an acquisition by the calculation considered to design factor.

THERMAL RESISTANCE

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
R _{th(j-c)Q}	Junction-to-Case Thermal Resistance (Note 2)	Inverter IGBT Part (per 1/6 module)	-	-	0.9	°C/W
R _{th(j-c)F}		Inverter FWDi Part (per 1/6 module)	-	-	1.8	°C/W

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

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

Symbol	Parameter	Conditions	Min	Typ	Max	Unit		
INVERTER PART								
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	$V_{DD}=V_{BS}=15\text{V}$ $V_{IN}=5\text{V}$	$I_c=40\text{A}$, $T_j=25^\circ\text{C}$	-	1.6	1.9	V	
V_F	FWDi Forward Voltage	$V_{IN}=0\text{V}$	$I_c=-40\text{A}$, $T_j=25^\circ\text{C}$	-	1.7	2.2	V	
HS	Switching Times	$V_{PN}=300\text{V}$, $V_{DD}=15\text{V}$, $I_c=40\text{A}$ $T_j=25^\circ\text{C}$ $V_{IN}=0\text{V} \leftrightarrow 5\text{V}$, Inductive Load, See Figure 3 (Note 3)	t_{on}	-	1.5	-	μs	
			$t_{c(on)}$	-	0.2	-	μs	
			t_{off}	-	1.5	-	μs	
			$t_{c(off)}$	-	0.1	-	μs	
			t_{rr}	-	0.1	-	μs	
LS	Switching Times		$V_{PN}=300\text{V}$, $V_{DD}=15\text{V}$, $I_c=40\text{A}$ $T_j=25^\circ\text{C}$ $V_{IN}=0\text{V} \leftrightarrow 5\text{V}$, Inductive Load, See Figure 3 (Note 3)	t_{on}	-	1.4	-	μs
				$t_{c(on)}$	-	0.2	-	μs
				t_{off}	-	1.4	-	μs
				$t_{c(off)}$	-	0.1	-	μs
				t_{rr}	-	0.1	-	μs
I_{ces}	Collector-Emitter Leakage Current	$V_{ce} = V_{ces}$		-	-	1	mA	

3. t_{on} and t_{off} include the propagation delay of the internal drive IC. $t_{c(on)}$ and $t_{c(off)}$ are the switching times of IGBT under the given gate-driving condition internally. For the detailed information, please see Figure 3.

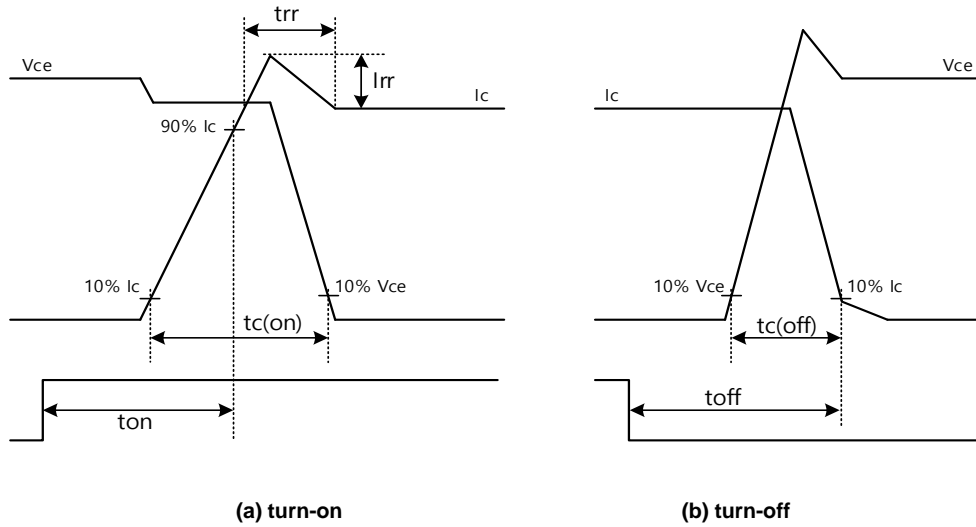


Figure 3. Switching Time Definition

Symbol	Parameter	Conditions	Min	Typ	Max	Unit	
CONTROL PART							
I_{QDDH}	Quiescent V_{DD} Supply Current	$V_{DDH}=15\text{V}$, $V_{IN(UH,VH,WH)}=0\text{V}$	$V_{DDH}-V_{SS}$	-	-	0.10	mA
I_{QDDL}		$V_{DDL}=15\text{V}$, $V_{IN(UL,VL,WL)}=0\text{V}$	$V_{DDL}-V_{SS}$	-	-	1.50	mA
I_{QBS}	Quiescent VBS Supply Current	$V_{DD}=V_{BS}=15\text{V}$, $V_{IN(UH,VH,WH)}=0\text{V}$	$V_{BU}-V_{SU}$, $V_{BV}-V_{SV}$, $V_{BW}-V_{SW}$	-	-	0.10	mA
V_{FOH}	Fault Output Voltage	$V_{DD}=15\text{V}$, $V_{sc}=0\text{V}$, V_{FO} Circuit: 10k Ω to 5V Pull-up	4.90	-	-	V	
V_{FOL}		$V_{DD}=15\text{V}$, $V_{sc}=1\text{V}$, $I_{FO}=1\text{mA}$	-	-	0.95	V	
$V_{SC(ref)}$	Short Circuit Trip Level	$V_{DDH}=V_{DDL}=15\text{V}$	$C_{sc}-V_{SS}$	0.455	0.48	0.505	V

ELECTRICAL CHARACTERISTICS (Tj = 25°C unless otherwise specified.) (continued)

Symbol	Parameter	Conditions	Min	Typ	Max	Unit	
CONTROL PART							
U _{VDDD}	Supply Circuit Under-Voltage Protection	Detection Level	10.3	-	12.5	V	
U _{VDDR}		Reset Level	10.8	-	13.0	V	
U _{VBSD}		Detection Level	10.0	-	12.0	V	
U _{VBSR}		Reset Level	10.5	-	12.5	V	
V _{IN(ON)}	ON Threshold Voltage	Applied between V _{IN(UH,VH,WH)} -V _{SS} , V _{IN(UL,VL,WL)} -V _{SS}	-	-	2.6	V	
V _{IN(OFF)}	OFF Threshold Voltage		0.8	-	-	V	
OT _{trip}	Over temperature protection (RSN3**07FI)	V _{DDL} =15V Detect LVIC temperature	Trip level	130	140	150	°C
OT _{hys}		Hysteresis of trip-reset	-	10	-	°C	
V _{OT}	Voltage Output for LVIC Temperature Sensing Unit	V _{DDL} =15V, T _{LVIC} =25°C See Figure 4 and 5 (Note 5)	0.88	1.13	1.39	V	
t _{FOD}	Fault-Out Pulse Width		20	-	-	us	

- Short-circuit current protection functions only at the low-sides because the sense current is divided from main current at low-side IGBTs. Inserting the shunt resistor for monitoring the phase current at NU, NV, NW terminal, the trip level of the short-circuit current is changed.
- T_{LVIC} is LVIC temperature and VOT is only for sensing temperature of LVIC and cannot shutdown IGBTs automatically. The relationship between VOT voltage output and LVIC temperature is described in Figure 5. It is recommended to add a ceramic capacitor of 10 nF or more between VOT and VSS (Signal Ground) to make the VOT more stable. Refer to the application note for this products about usage of VOT.

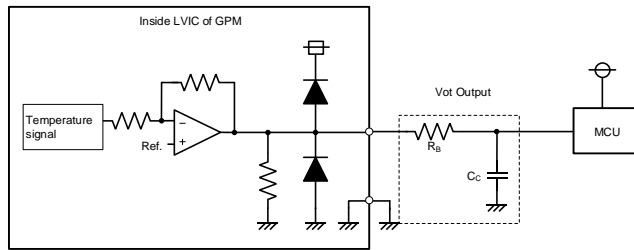


Figure 4. Internal Block Diagram and Interface Circuit of VOT

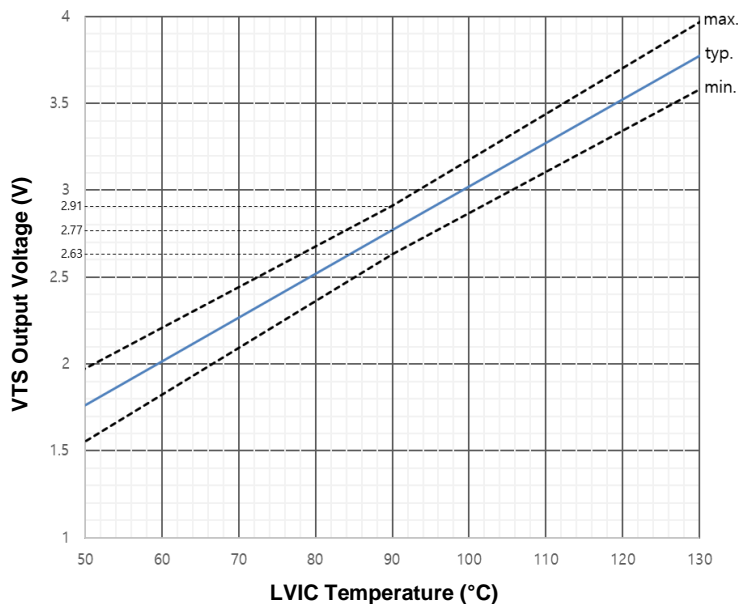


Figure 5. Temperature Profile of VOT

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ELECTRICAL CHARACTERISTICS (T_j = 25°C unless otherwise specified.) (continued)

BOOTSTRAP DIODE/RESISTOR PART

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
V _F	Forward Voltage	I _F =0.1A, T _j =25°C	See Figure 6	-	1.6	-	V

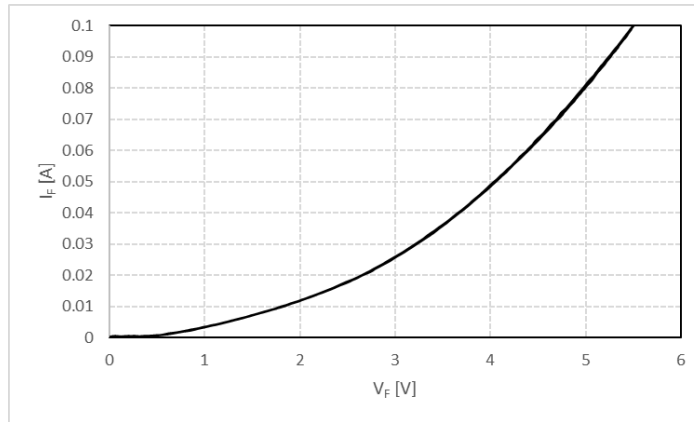


Figure 6. Characteristics of Bootstrap Diode

RECOMMENDED OPERATING RANGES

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V _{PN}	Supply Voltage	Applied between P-N _U , N _V , N _W	-	300	400	V
V _{DD}	Control Supply Voltage	Applied between V _{DDH} -V _{SS} , V _{DDL} -V _{SS}	13.5	15.0	16.5	V
V _{BS}	High-Side Control Bias Voltage	Applied between V _{BU} -V _{SU} , V _{BV} -V _{SV} , V _{BW} -V _{SW}	13.0	15.0	18.5	V
dV _{DD} /dt, dV _{BS} /dt	Control Supply Variation		-1	-	+1	V/μs
t _{dead}	Blanking Time for Preventing Arm - Short	For Each Input Signal	1.0	-	-	μs
f _{PWM}	PWM Input Signal	-40°C ≤ T _C ≤ 125°C, -40°C ≤ T _j ≤ 150°C	-	-	20	kHz
PWIN(ON)	Minimum Input Pulse Width	(Note 6)	0.7	-	-	μs
PWIN(OFF)			0.7	-	-	
T _j	Junction Temperature		-40	-	+150	°C

6. This product might not make output response if input pulse width is less than the recommended value.
7. RC coupling at each input 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 5 kΩ (typ.) pull-down resistor. Therefore, when using an external filtering resistor, please pay attention to the signal voltage drop at input terminal.

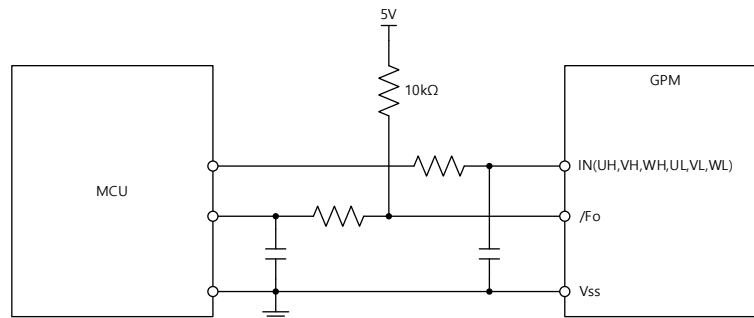


Figure 7. Recommended MCU I/O Interface Circuit

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PACKAGE MARKING AND ORDERING INFORMATION

Device	Device Marking	Package	Shipping
RSN34007F(T)	RSN34007F(T)	GPM24-AA	480 ea/box

MECHANICAL CHARACTERISTICS AND RATINGS

Parameter	Conditions	Min	Typ	Max	Unit
Device Flatness	See Figure 8	-50	-	120	μm
Mounting Torque	Mounting Screw: M3 Recommended 1.18 N·m	0.59	0.69	0.78	N·m
Terminal Pulling Strength	Control terminal : Load 5N Power terminal : Load 10N	10	-	-	s
Terminal Bending Strength	Control terminal : Load 5N Power terminal : Load 10N 90 degree Bend	2	-	-	times
Weight		-	9.6	-	g

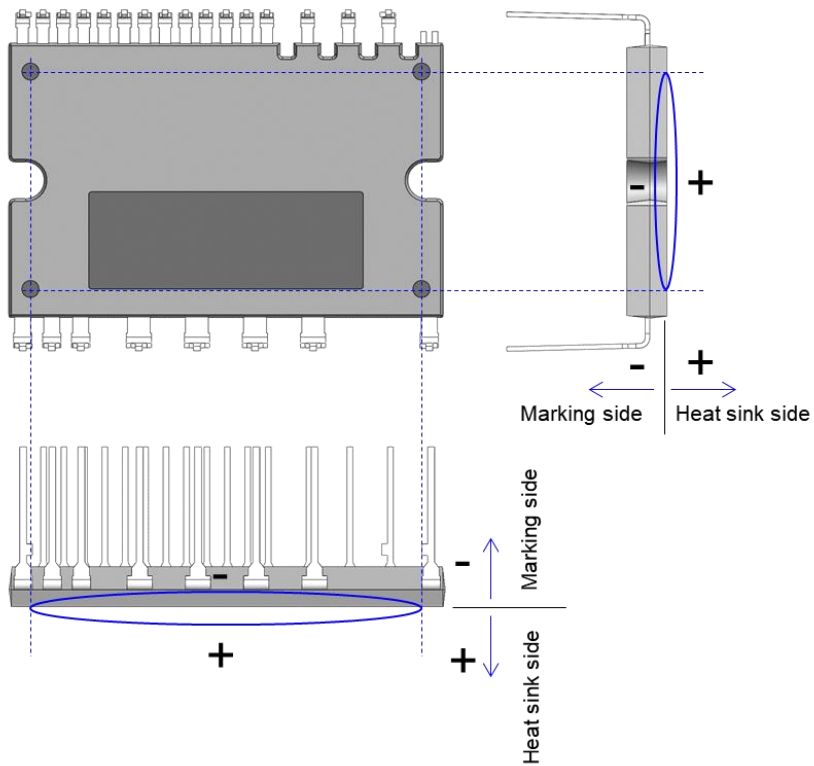
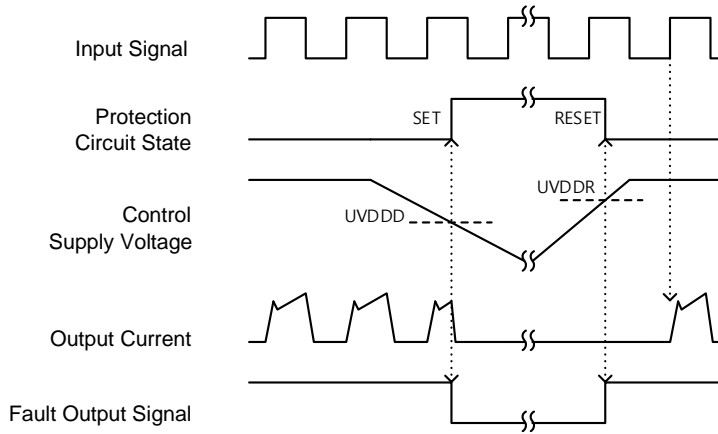


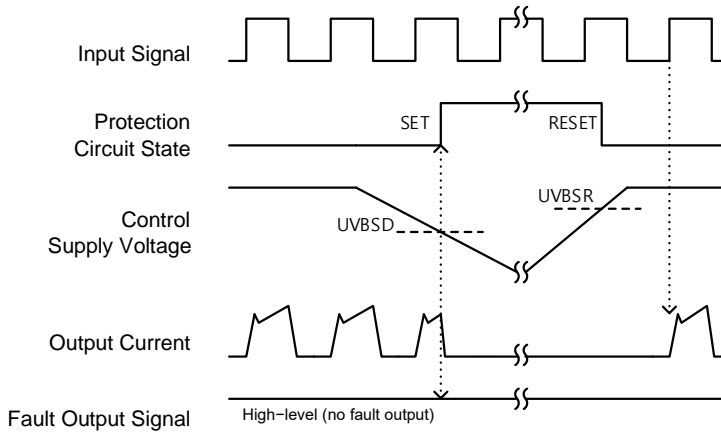
Figure 8. Flatness Measurement Position

TIME CHARTS OF GPMs PROTECTIVE FUNCTION



- 1: Normal operation: IGBT ON and carrying current.
- 2: Under-voltage detection (UVDDD).
- 3: All low-side IGBT OFF in spite of control input condition.
- 4: Fault output operation starts with a fixed pulse width.
- 5: Under-voltage reset (UVDDR).
- 6: Normal operation: IGBT ON and carrying current by triggering next signal from LOW to HIGH.

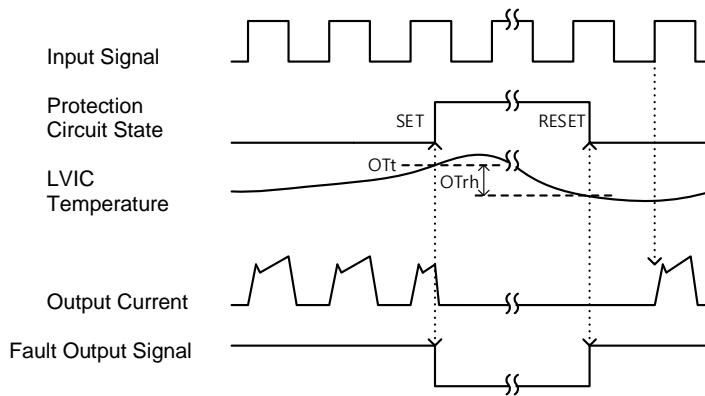
Figure 9. Under-voltage Protection (Low-side)



- 1: Normal operation: IGBT ON and carrying current.
- 2: Under-voltage detection (UVBSD).
- 3: IGBT OFF in spite of control input condition, but there is no fault output signal.
- 4: Under-voltage reset (UVBSR).
- 5: Normal operation: IGBT ON and carrying current by triggering next signal from LOW to HIGH.

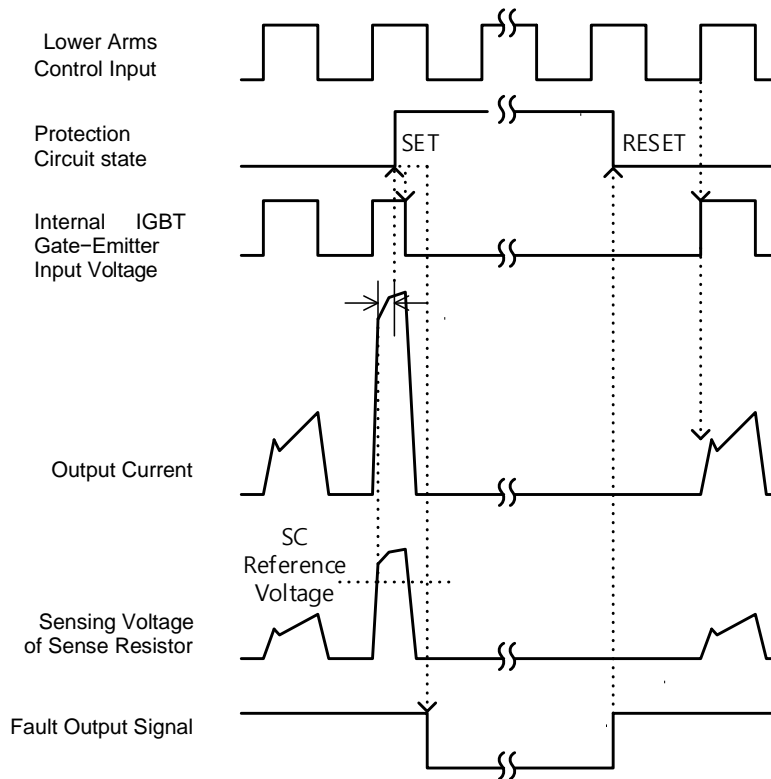
Figure 10. Under-voltage Protection (High-side)

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- 1: Normal operation: IGBT ON and carrying current.
- 2: LVIC temperature exceed OT trip level (OT_t).
- 3: All low-side IGBTs OFF in spite of control input condition.
- 4: Fault output operation starts with a fixed pulse width (min. 20us).
- 5: LVIC temperature drop to OT reset level.
- 6: Normal operation: IGBT ON and carrying current by triggering next signal from LOW to HIGH.

Figure 11. Over-temperature Protection (RSN307FI only)**



(With the external sense resistance and RC filter connection)

- 1: Normal operation: IGBT ON and carrying current.
- 2: Short-circuit current detection (SC trigger).
- 3: All low-side IGBTs gate are hard interrupted.
- 4: All low-side IGBTs turn OFF.
- 5: Fault output operation starts with a fixed pulse width (min. 20us).
- 6: Input HIGH – IGBT ON state, but during the active period of fault output, the IGBT doesn't turn ON.
- 7: Fault output operation finishes, but IGBT doesn't turn on until triggering the next signal from LOW to HIGH.
- 8: Normal operation: IGBT ON and carrying current.

Figure 12. Short-circuit Current Protection (Low-side Operation Only)

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