

FNA41560 / FNA41560B2

Motion SPM® 45 Series

Features

- UL Certified No. E209204
- 600 V, 15 A 3 - Phase IGBT Inverter Including Control ICs for Gate Drive and Protections
- Easy PCB Layout Thanks to The Built - In Bootstrap Diodes and The Dedicated Vs Pins
- Three Separate Open - Emitter Pins from Low Side IGBTs for Three Leg Current Sensing
- Single - Grounded Power Supply with Bootstrap Operations
- Built - In NTC Thermistor for Over Temperature Monitoring
- Isolation Rating of 2000 Vrms / min.

General Description

FNA41560 Is A Motion SPM 45 Series that Fairchild Has Newly Developed to Provide A Very Compact and High Performance Inverter Solution for AC Motor Drives in Low - Power Applications Such as Air Conditioners and Refrigerators. It Combines Low - Loss Short - Circuit Rated IGBTs and Optimized Gate Drivers in A Fully Isolated Package to Deliver A Simple and Robust Design. The System Reliability Is Further Enhanced by The Built - In NTC for Temperature Monitoring, Integrated Under - Voltage Lock - Out Function for Both High and Low Side, and An Over - Current Protection Input. Three Separate Open - Emitter Pins for Low Side IGBTs Make Three Leg Current Sensing Possible. Built - In Bootstrap Diodes and Dedicated VS Pins Make PCB Layout Easy.

Applications

- Motion Control - Home Appliance / Industrial Motor

Related Resources

[AN - 9070 Motion SPM® 45 Series Users Guide](#)

[AN - 9071 Motion SPM® 45 Series Thermal Performance Information](#)

[AN - 9072 Motion SPM® 45 Series Mounting Guidance](#)

[RD - 344 Reference Design \(Three Shunt Solution\)](#)

[RD - 345 Reference Design \(One Shunt Solution\)](#)

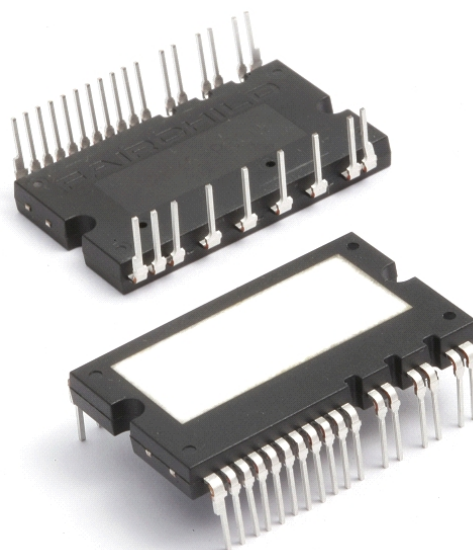


Figure 1. Package Overview

Package Marking and Ordering Information

Device Marking	Device	Package	Packing Type	Reel Size	Tape Width	Quantity
FNA41560	FNA41560	SPMAA-A26	RAIL	-	-	12
FNA41560B2	FNA41560B2	SPMAA-C26	RAIL	-	-	12

Integrated Power Functions

- 600 V - 15 A IGBT inverter for three - phase DC / AC power conversion (Please refer to Figure 3)

Integrated Drive, Protection and System Control Functions

- For inverter high - side IGBTs: Gate drive circuit, High voltage isolated high - speed level shifting
Control circuit under - voltage (UV) protection
- For inverter low - side IGBTs: Gate drive circuit, Short circuit protection (SC)
Control supply circuit under - voltage (UV) protection
- Fault signaling: Corresponding to UV (low - side supply) and SC faults
- Input interface: Active - high interface, can work with 3.3 / 5 V logic

Pin Configuration

Top View

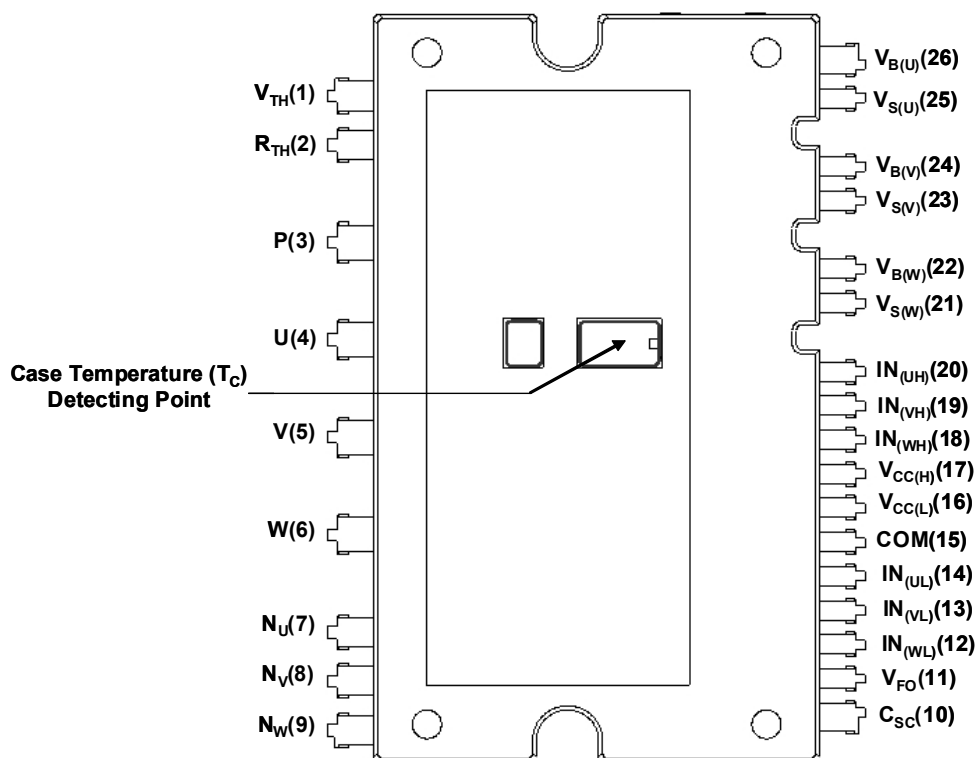
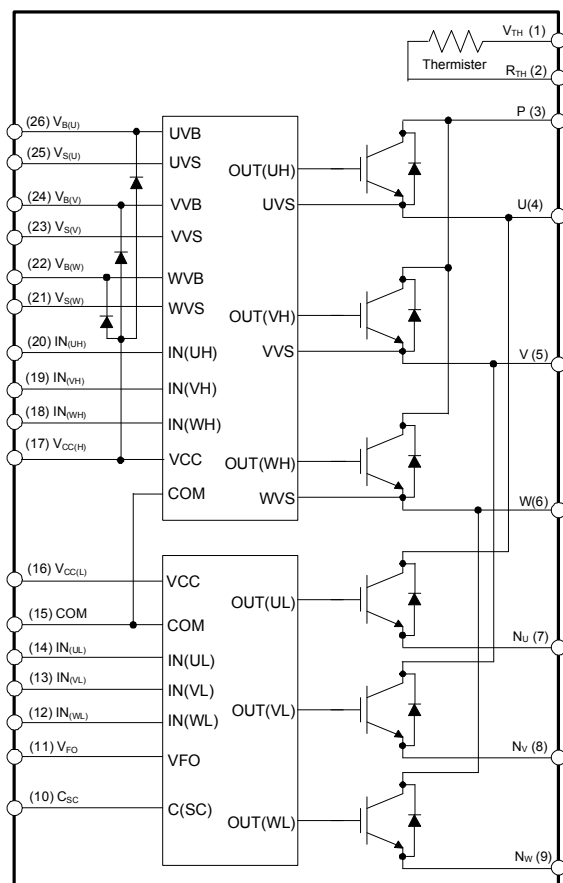


Figure 2.

Pin Descriptions

Pin Number	Pin Name	Pin Description
1	V_{TH}	Thermistor Bias Voltage
2	R_{TH}	Series Resistor for the Use of Thermistor (Temperature Detection)
3	P	Positive DC - Link Input
4	U	Output for U Phase
5	V	Output for V Phase
6	W	Output for W Phase
7	N_U	Negative DC - Link Input for U Phase
8	N_V	Negative DC - Link Input for V Phase
9	N_W	Negative DC - Link Input for W Phase
10	C_{SC}	Capacitor (Low - Pass Filter) for Short - Current Detection Input
11	V_{FO}	Fault Output
12	$IN_{(WL)}$	Signal Input for Low - Side W Phase
13	$IN_{(VL)}$	Signal Input for Low - Side V Phase
14	$IN_{(UL)}$	Signal Input for Low - Side U Phase
15	COM	Common Supply Ground
16	$V_{CC(L)}$	Low - Side Common Bias Voltage for IC and IGBTs Driving
17	$V_{CC(H)}$	High - Side Common Bias Voltage for IC and IGBTs Driving
18	$IN_{(WH)}$	Signal Input for High - Side W Phase
19	$IN_{(VH)}$	Signal Input for High - Side V Phase
20	$IN_{(UH)}$	Signal Input for High - Side U Phase
21	$V_{S(W)}$	High - Side Bias Voltage Ground for W Phase IGBT Driving
22	$V_{B(W)}$	High - Side Bias Voltage for W Phase IGBT Driving
23	$V_{S(V)}$	High - Side Bias Voltage Ground for V Phase IGBT Driving
24	$V_{B(V)}$	High - Side Bias Voltage for V Phase IGBT Driving
25	$V_{S(U)}$	High - Side Bias Voltage Ground for U Phase IGBT Driving
26	$V_{B(U)}$	High - Side Bias Voltage for U Phase IGBT Driving

Internal Equivalent Circuit and Input/Output Pins



Note:

- 1) Inverter high - side is composed of three IGBTs, freewheeling diodes and one control IC for each IGBT.
- 2) Inverter low - side is composed of three IGBTs, freewheeling diodes and one control IC for each IGBT. It has gate drive and protection functions.
- 3) Inverter power side is composed of four inverter dc - link input terminals and three inverter output terminals.

Figure 3.

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

Symbol	Parameter	Conditions	Rating	Unit
V_{PN}	Supply Voltage	Applied between P - N_U , N_V , N_W	450	V
$V_{PN(\text{Surge})}$	Supply Voltage (Surge)	Applied between P - N_U , N_V , N_W	500	V
V_{CES}	Collector - Emitter Voltage		600	V
$\pm I_C$	Each IGBT Collector Current	$T_C = 25^\circ\text{C}$, $T_J < 150^\circ\text{C}$	15	A
$\pm I_{CP}$	Each IGBT Collector Current (Peak)	$T_C = 25^\circ\text{C}$, $T_J < 150^\circ\text{C}$, Under 1ms Pulse Width	30	A
P_C	Collector Dissipation	$T_C = 25^\circ\text{C}$ per One Chip	41	W
T_J	Operating Junction Temperature	(Note 1)	- 40 ~ 150	$^\circ\text{C}$

Note:

1. The maximum junction temperature rating of the power chips integrated within the Motion SPM 45 product is 150°C .

Control Part

Symbol	Parameter	Conditions	Rating	Unit
V_{CC}	Control Supply Voltage	Applied between $V_{CC(H)}$, $V_{CC(L)}$ - COM	20	V
V_{BS}	High - Side Control Bias Voltage	Applied between $V_{B(U)}$ - $V_{S(U)}$, $V_{B(V)}$ - $V_{S(V)}$, $V_{B(W)}$ - $V_{S(W)}$	20	V
V_{IN}	Input Signal Voltage	Applied between $IN_{(UH)}$, $IN_{(VH)}$, $IN_{(WH)}$, $IN_{(UL)}$, $IN_{(VL)}$, $IN_{(WL)}$ - COM	- 0.3 ~ $V_{CC} + 0.3$	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	1	mA
V_{SC}	Current Sensing Input Voltage	Applied between C_{SC} - COM	- 0.3 ~ $V_{CC} + 0.3$	V

Bootstrap Diode Part

Symbol	Parameter	Conditions	Rating	Unit
V_{RRM}	Maximum Repetitive Reverse Voltage		600	V
I_F	Forward Current	$T_C = 25^\circ\text{C}$, $T_J < 150^\circ\text{C}$	0.50	A
I_{FP}	Forward Current (Peak)	$T_C = 25^\circ\text{C}$, $T_J < 150^\circ\text{C}$, Under 1ms Pulse Width	1.50	A
T_J	Operating Junction Temperature		- 40 ~ 150	$^\circ\text{C}$

Total System

Symbol	Parameter	Conditions	Rating	Unit
$V_{PN(\text{PROT})}$	Self Protection Supply Voltage Limit (Short Circuit Protection Capability)	$V_{CC} = V_{BS} = 13.5 \sim 16.5 \text{ V}$ $T_J = 150^\circ\text{C}$, Non-repetitive, less than 2 μs	400	V
T_{STG}	Storage Temperature		- 40 ~ 125	$^\circ\text{C}$
V_{ISO}	Isolation Voltage	60 Hz, Sinusoidal, AC 1 minute, Connection pins to heat sink plate	2000	V_{rms}

Thermal Resistance

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
$R_{th(j-c)Q}$	Junction to Case Thermal Resistance	Inverter IGBT part (per 1 / 6 module)	-	-	3.0	$^\circ\text{C} / \text{W}$
$R_{th(j-c)F}$		Inverter FWD part (per 1 / 6 module)	-	-	4.3	$^\circ\text{C} / \text{W}$

Note:

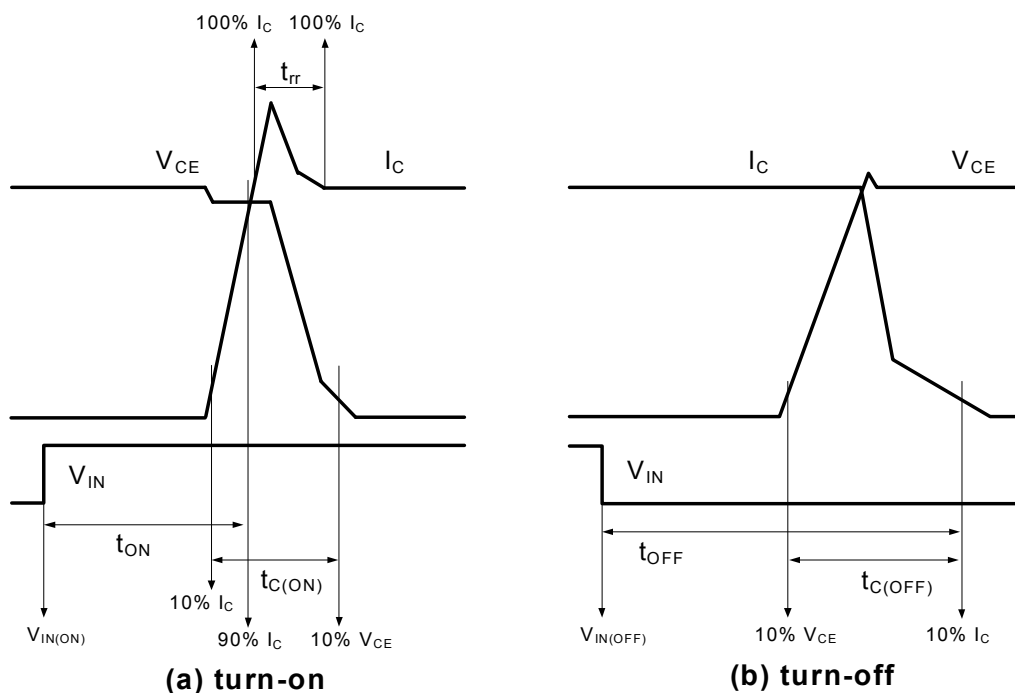
2. For the measurement point of case temperature (T_C), please refer to Figure 2.

Electrical Characteristics ($T_J = 25^\circ\text{C}$, Unless Otherwise Specified)**Inverter Part**

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
$V_{CE(SAT)}$	Collector - Emitter Saturation Voltage	$V_{CC} = V_{BS} = 15\text{ V}$ $V_{IN} = 5\text{ V}$ $I_C = 15\text{ A}$, $T_J = 25^\circ\text{C}$	-	1.8	2.3	V
V_F	FWD Forward Voltage	$V_{IN} = 0\text{ V}$ $I_F = 15\text{ A}$, $T_J = 25^\circ\text{C}$	-	1.8	2.3	V
HS	t_{ON}	$V_{PN} = 300\text{ V}$, $V_{CC} = V_{BS} = 15\text{ V}$, $I_C = 15\text{ A}$ $T_J = 25^\circ\text{C}$ $V_{IN} = 0\text{ V} \leftrightarrow 5\text{ V}$, Inductive load (Note 3)	0.45	0.75	1.25	μs
	$t_{C(ON)}$		-	0.25	0.50	μs
	t_{OFF}		-	0.75	1.25	μs
	$t_{C(OFF)}$		-	0.25	0.50	μs
	t_{rr}		-	0.15	-	μs
LS	t_{ON}	$V_{PN} = 300\text{ V}$, $V_{CC} = V_{BS} = 15\text{ V}$, $I_C = 15\text{ A}$ $T_J = 25^\circ\text{C}$ $V_{IN} = 0\text{ V} \leftrightarrow 5\text{ V}$, Inductive load (Note 3)	0.45	0.75	1.25	μs
	$t_{C(ON)}$		-	0.25	0.50	μs
	t_{OFF}		-	0.75	1.25	μs
	$t_{C(OFF)}$		-	0.25	0.50	μs
	t_{rr}		-	0.15	-	μs
I_{CES}	Collector - Emitter Leakage Current	$V_{CE} = V_{CES}$	-	-	1	mA

Note:

3. 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**

Switching Loss (Typical)

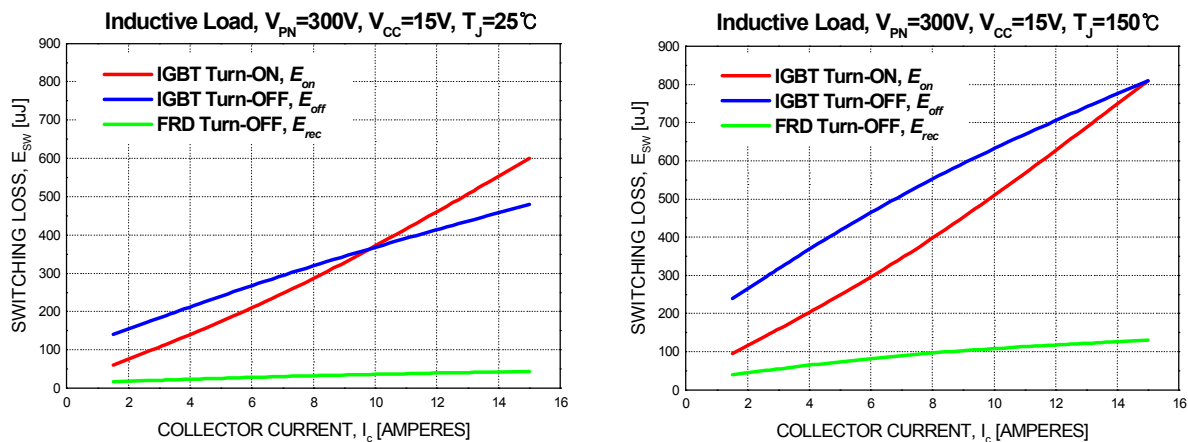


Figure 5. Switching Loss Characteristics

Control Part

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
I_{QCCH}	Quiescent V_{CC} Supply Current	$V_{CC(H)} = 15 V$, $I_{N(UH, VH, WH)} = 0 V$	$V_{CC(H)} - COM$	-	-	0.10 mA
I_{QCCL}		$V_{CC(L)} = 15 V$, $I_{N(UL, VL, WL)} = 0 V$	$V_{CC(L)} - COM$	-	-	2.65 mA
I_{PCCH}	Operating V_{CC} Supply Current	$V_{CC(H)} = 15 V$, $f_{PWM} = 20 kHz$, duty = 50%, applied to one PWM signal input for high - side	$V_{CC(H)} - COM$	-	-	0.15 mA
I_{PCCL}		$V_{CC(L)} = 15 V$, $f_{PWM} = 20 kHz$, duty = 50%, applied to one PWM signal input for low - side	$V_{CC(L)} - COM$	-	-	3.65 mA
I_{QBS}	Quiescent V_{BS} Supply Current	$V_{BS} = 15 V$, $I_{N(UH, VH, WH)} = 0 V$	$V_{B(U)} - V_{S(U)}$, $V_{B(V)} - V_{S(V)}$, $V_{B(W)} - V_{S(W)}$	-	-	0.30 mA
I_{PBS}	Operating V_{BS} Supply Current	$V_{CC} = V_{BS} = 15 V$, $f_{PWM} = 20 kHz$, duty = 50%, applied to one PWM signal input for high - side	$V_{B(U)} - V_{S(U)}$, $V_{B(V)} - V_{S(V)}$, $V_{B(W)} - V_{S(W)}$	-	-	2.00 mA
V_{FOH}	Fault Output Voltage	$V_{SC} = 0 V$, V_{FO} Circuit: 10 k Ω to 5 V Pull - up	4.5	-	-	V
V_{FOL}		$V_{SC} = 1 V$, V_{FO} Circuit: 10 k Ω to 5 V Pull - up	-	-	0.5	V
$V_{SC(ref)}$	Short Circuit Trip Level	$V_{CC} = 15 V$ (Note 4)	0.45	0.5	0.55	V
UV_{CCD}	Supply Circuit Under - Voltage Protection	Detection level	10.5	-	13.0	V
UV_{CCR}		Reset level	11.0	-	13.5	V
UV_{BSD}		Detection level	10.0	-	12.5	V
UV_{BSR}		Reset level	10.5	-	13.0	V
t_{FOD}	Fault - Out Pulse Width		30	-	-	μs
$V_{IN(ON)}$	ON Threshold Voltage	Applied between $I_{N(UH)}$, $I_{N(VH)}$, $I_{N(WH)}$, $I_{N(UL)}$, $I_{N(VL)}$, $I_{N(WL)} - COM$	-	-	2.6	V
$V_{IN(OFF)}$	OFF Threshold Voltage		0.8	-	-	V
R_{TH}	Resistance of Thermister	@ $T_{TH} = 25^\circ C$, (Note 5)	-	47	-	k Ω
		@ $T_{TH} = 100^\circ C$	-	2.9	-	k Ω

Note:

- Short - circuit current protection is functioning only at the low - sides.
- T_{TH} is the temperature of thermister itself. To know case temperature (T_C), please make the experiment considering your application.

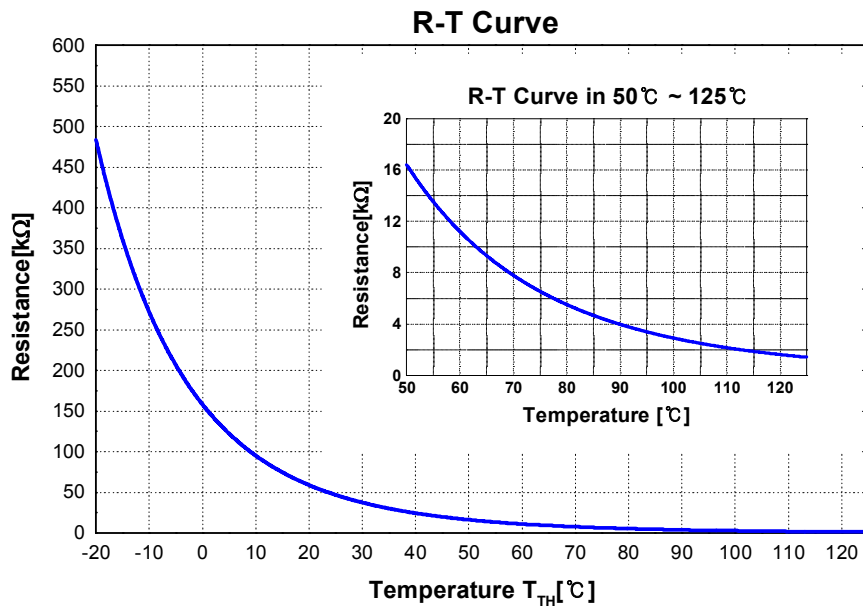
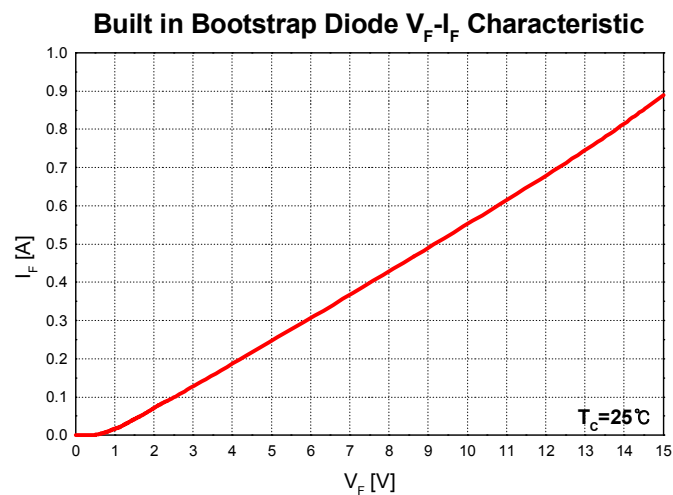


Figure. 6. R-T Curve of The Built-in Thermistor

Bootstrap Diode Part

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
V_F	Forward Voltage	$I_F = 0.1 \text{ A}$, $T_C = 25^\circ\text{C}$	-	2.5	-	V
t_{rr}	Reverse Recovery Time	$I_F = 0.1 \text{ A}$, $T_C = 25^\circ\text{C}$	-	80	-	ns



Note:

6. Built in bootstrap diode includes around 15 Ω resistance characteristic.

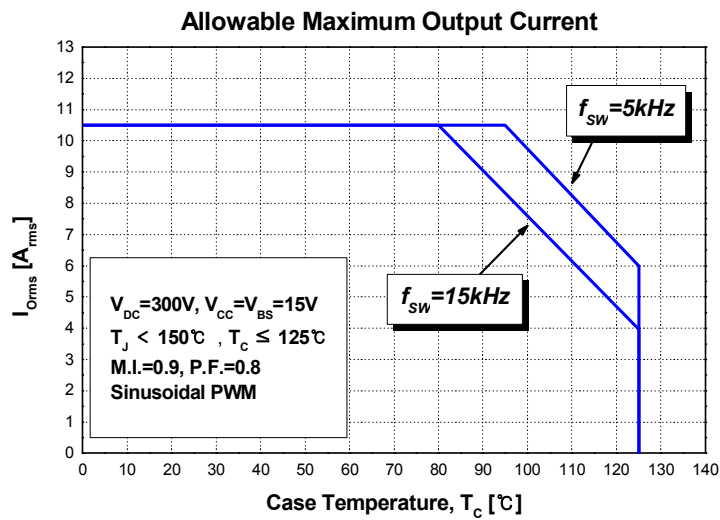
Figure 7. Built in Bootstrap Diode Characteristic

Recommended Operating Conditions

Symbol	Parameter	Conditions	Value			Unit
			Min.	Typ.	Max.	
V_{PN}	Supply Voltage	Applied between P - N_U , N_V , N_W	-	300	400	V
V_{CC}	Control Supply Voltage	Applied between $V_{CC(H)}$, $V_{CC(L)}$ - COM	13.5	15	16.5	V
V_{BS}	High - Side Bias Voltage	Applied between $V_{B(U)}$ - $V_{S(U)}$, $V_{B(V)}$ - $V_{S(V)}$, $V_{B(W)}$ - $V_{S(W)}$	13.0	15	18.5	V
dV_{CC}/dt , dV_{BS}/dt	Control Supply Variation		- 1	-	1	V / μ s
t_{dead}	Blanking Time for Preventing Arm - Short	For each input signal	1.5	-	-	μ s
f_{PWM}	PWM Input Signal	- 40°C < T_J < 150°C	-	-	20	kHz
V_{SEN}	Voltage for Current Sensing	Applied between N_U , N_V , N_W - COM (Including surge voltage)	- 4		4	V
$P_{WIN(ON)}$	Minimum Input Pulse Width	(Note 7)	0.5	-	-	μ s
$P_{WIN(OFF)}$			0.5	-	-	

Note:

7. This product might not make response if input pulse width is less than the recommended value.



Note:

8. This allowable output current value is the reference data for the safe operation of this product. This may be different from the actual application and operating condition.

Figure 8. Allowable Maximum Output Current

Mechanical Characteristics and Ratings

Parameter	Conditions	Limits			Unit
		Min.	Typ.	Max.	
Device Flatness	Note Figure 9	0	-	+ 120	μm
Mounting Torque	Mounting Screw: - M3	Recommended 0.7 N • m			N • m
	Note Figure 10	Recommended 7.1 kg • cm			kg • cm
Weight		-	11	-	g

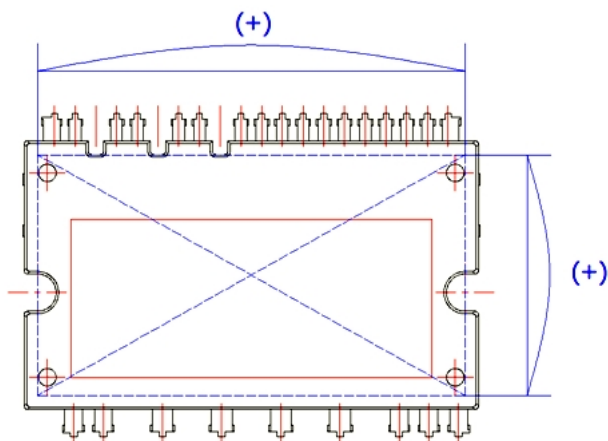
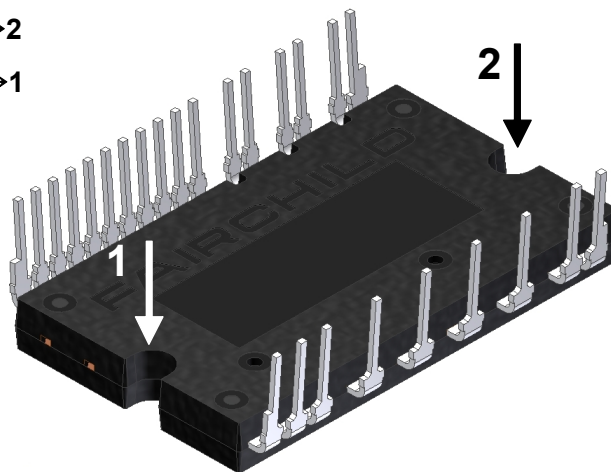


Figure 9. Flatness Measurement Position

Pre - Screwing : 1→2

Final Screwing : 2→1

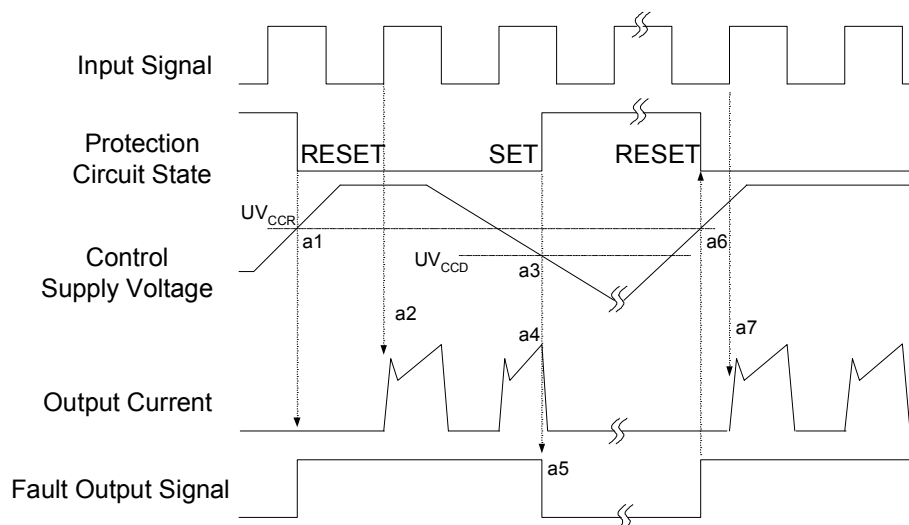


Note:

9. Do not make over torque when mounting screws. Much mounting torque may cause ceramic cracks, as well as bolts and Al heat - sink destruction.
10. Avoid one side tightening stress. Figure 10 shows the recommended torque order for mounting screws. Uneven mounting can cause the ceramic substrate of the Motion SPM 45 product to be damaged. The Pre - Screwing torque is set to 20 ~ 30% of maximum torque rating.

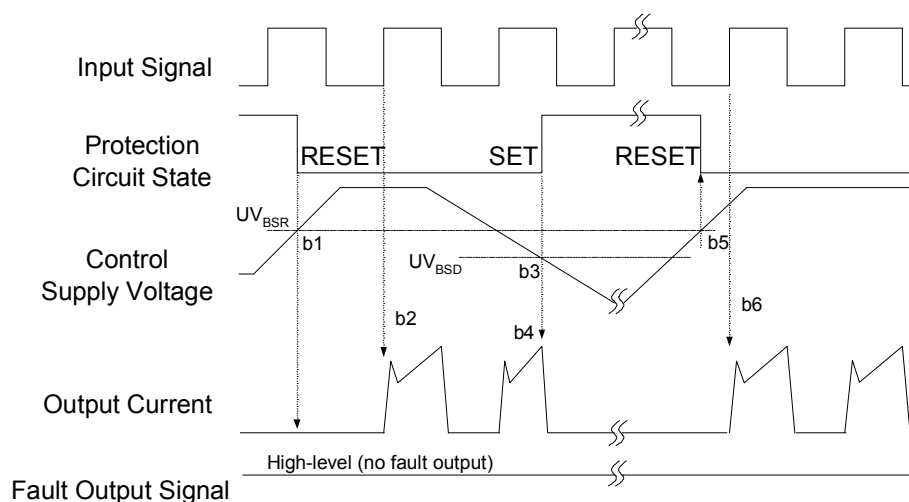
Figure 10. Mounting Screws Torque Order

Time Charts of SPMs Protective Function



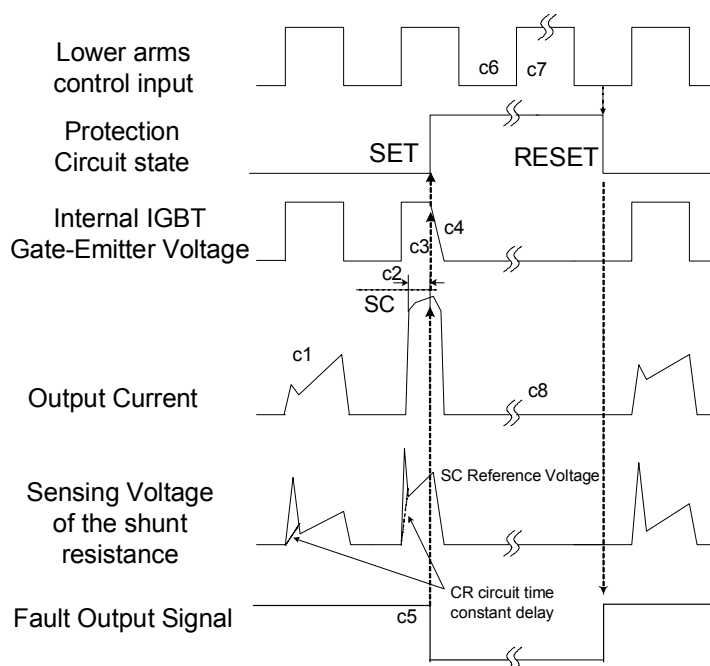
- a1 : Control supply voltage rises: After the voltage rises UV_{CCR} , the circuits start to operate when next input is applied.
- a2 : Normal operation: IGBT ON and carrying current.
- a3 : Under voltage detection (UV_{CCD}).
- a4 : IGBT OFF in spite of control input condition.
- a5 : Fault output operation starts.
- a6 : Under voltage reset (UV_{CCR}).
- a7 : Normal operation: IGBT ON and carrying current.

Figure 11. 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

Figure 12. 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.

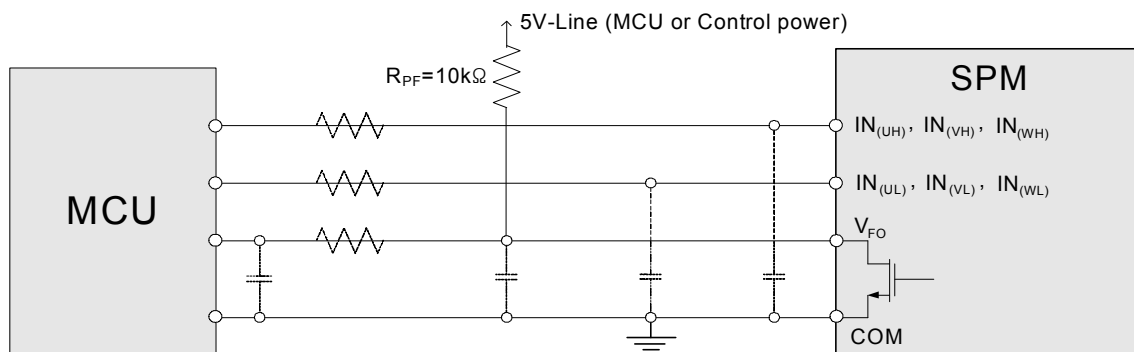
c5 : Input "L" : IGBT OFF state.

c6 : Input "H" : IGBT ON state, but during the active period of fault output the IGBT doesn't turn ON.

c7 : IGBT OFF state

Figure 13. Short-Circuit Current Protection (Low-side Operation only)

Input/Output Interface Circuit



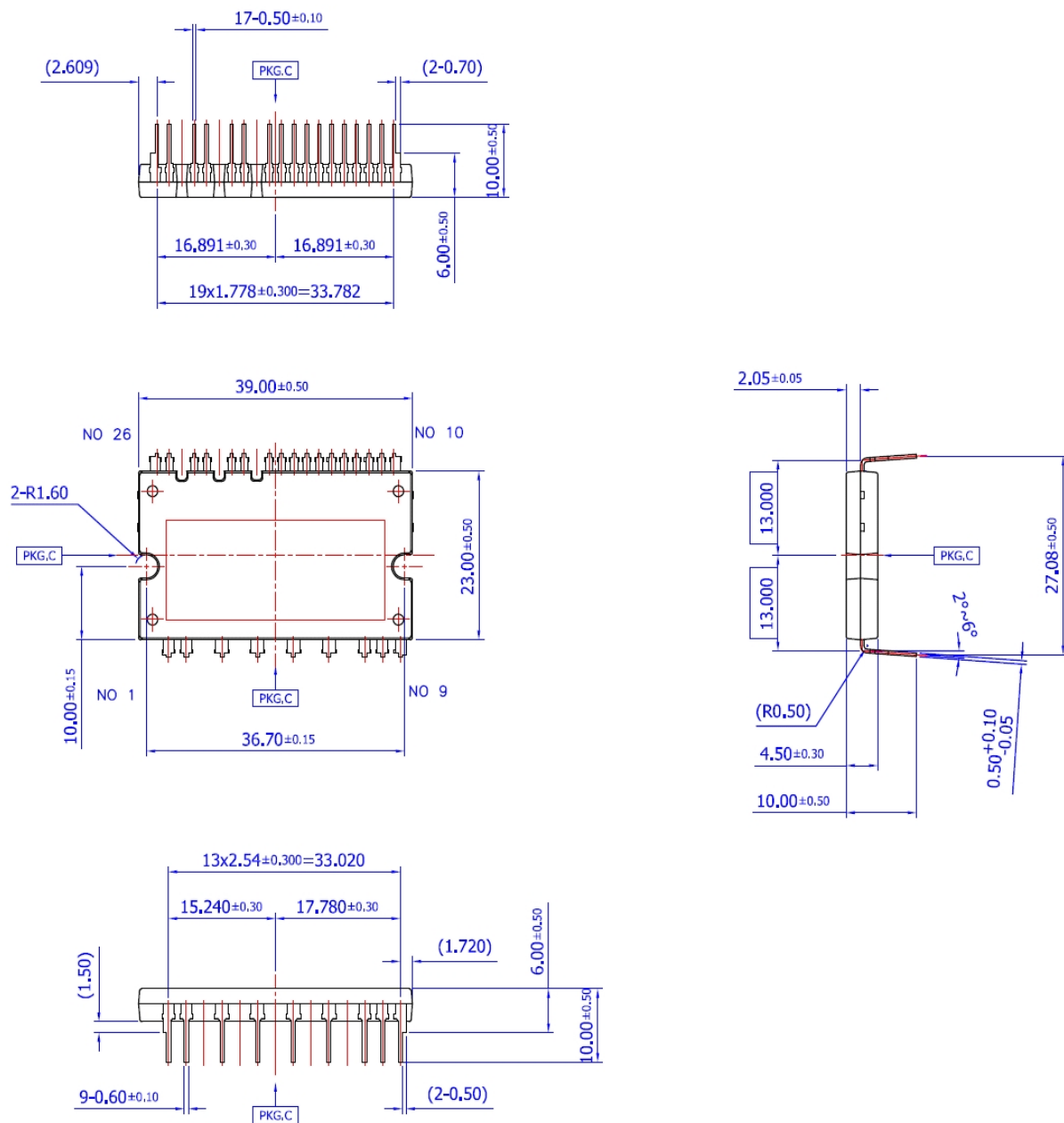
Note:

- 1) 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 of the Motion SPM 45 product 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.
- 2) The logic input is compatible with standard CMOS outputs.

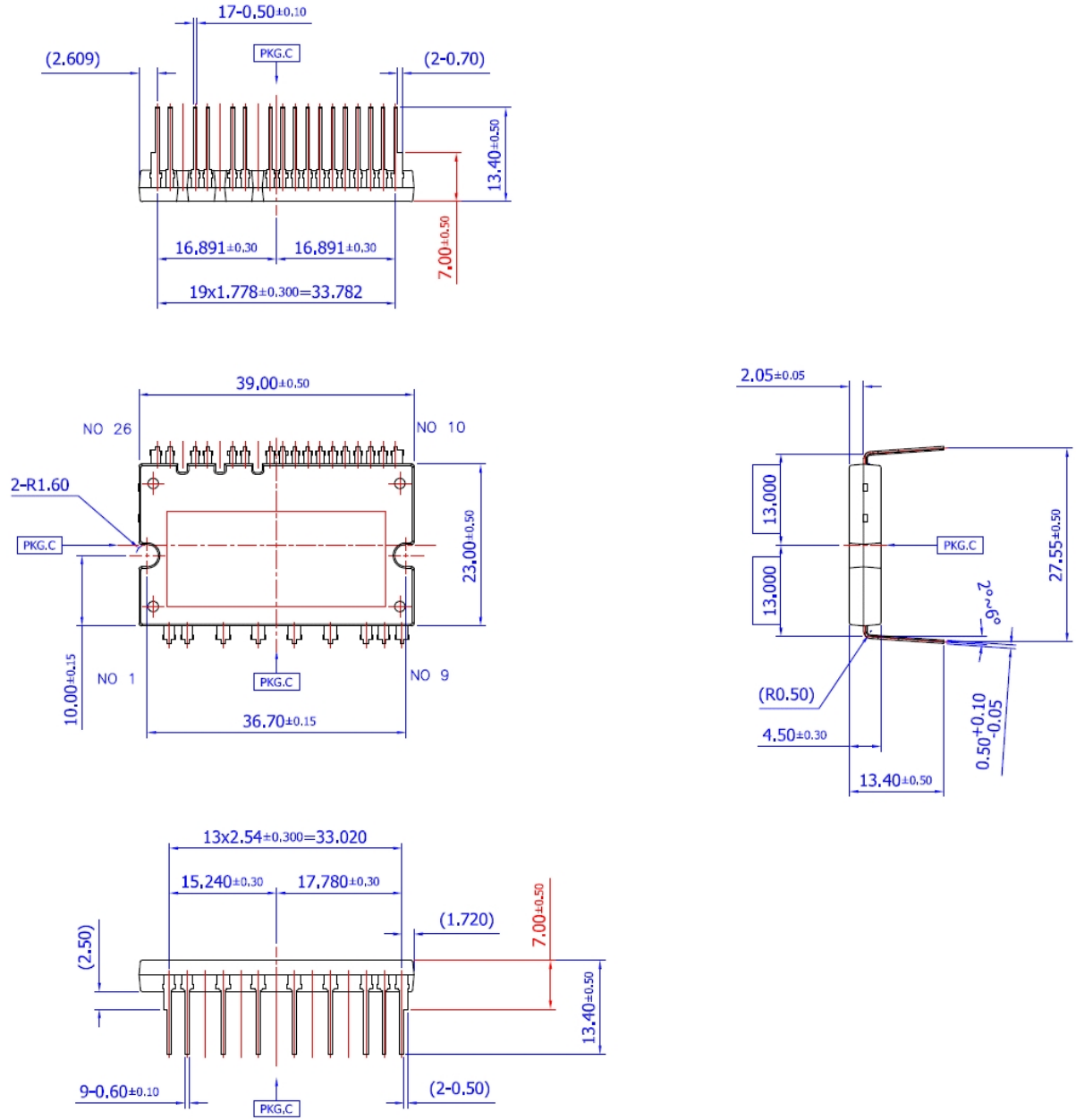
Figure 14. Recommended CPU I/O Interface Circuit

13) For the detailed information, please refer to the AN - 9070, AN - 9071, AN - 9072, RD - 344, and RD - 345.

Detailed Package Outline Drawings(FNA41560)

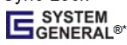


Detailed Package Outline Drawings(FNA41560B2, Long Terminal Type)



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ANTI-COUNTERFEITING POLICY

Fairchild Semiconductor Corporation's Anti-Counterfeiting Policy. Fairchild's Anti-Counterfeiting Policy is also stated on our external website, www.fairchildsemi.com, under Sales Support.

Counterfeiting of semiconductor parts is a growing problem in the industry. All manufacturers of semiconductor products are experiencing counterfeiting of their parts. Customers who inadvertently purchase counterfeit parts experience many problems such as loss of brand reputation, substandard performance, failed applications, and increased cost of production and manufacturing delays. Fairchild is taking strong measures to protect ourselves and our customers from the proliferation of counterfeit parts. Fairchild strongly encourages customers to purchase Fairchild parts either directly from Fairchild or from Authorized Fairchild Distributors who are listed by country on our web page cited above. Products customers buy either from Fairchild directly or from Authorized Fairchild Distributors are genuine parts, have full traceability, meet Fairchild's quality standards for handling and storage and provide access to Fairchild's full range of up-to-date technical and product information. Fairchild and our Authorized Distributors will stand behind all warranties and will appropriately address any warranty issues that may arise. Fairchild will not provide any warranty coverage or other assistance for parts bought from Unauthorized Sources. Fairchild is committed to combat this global problem and encourage our customers to do their part in stopping this practice by buying direct or from authorized distributors.

PRODUCT STATUS DEFINITIONS

Definition of Terms

Datasheet Identification	Product Status	Definition
Advance Information	Formative / In Design	Datasheet contains the design specifications for product development. Specifications may change in any manner without notice.
Preliminary	First Production	Datasheet contains preliminary data; supplementary data will be published at a later date. Fairchild Semiconductor reserves the right to make changes at any time without notice to improve design.
No Identification Needed	Full Production	Datasheet contains final specifications. Fairchild Semiconductor reserves the right to make changes at any time without notice to improve the design.
Obsolete	Not In Production	Datasheet contains specifications on a product that is discontinued by Fairchild Semiconductor. The datasheet is for reference information only.

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Компания «ЭлектроПласт» предлагает заключение долгосрочных отношений при поставках импортных электронных компонентов на взаимовыгодных условиях!

Наши преимущества:

- Оперативные поставки широкого спектра электронных компонентов отечественного и импортного производства напрямую от производителей и с крупнейших мировых складов;
- Поставка более 17-ти миллионов наименований электронных компонентов;
- Поставка сложных, дефицитных, либо снятых с производства позиций;
- Оперативные сроки поставки под заказ (от 5 рабочих дней);
- Экспресс доставка в любую точку России;
- Техническая поддержка проекта, помощь в подборе аналогов, поставка прототипов;
- Система менеджмента качества сертифицирована по Международному стандарту ISO 9001;
- Лицензия ФСБ на осуществление работ с использованием сведений, составляющих государственную тайну;
- Поставка специализированных компонентов (Xilinx, Altera, Analog Devices, Intersil, Interpoint, Microsemi, Aeroflex, Peregrine, Syfer, Eurofarad, Texas Instrument, Miteq, Cobham, E2V, MA-COM, Hittite, Mini-Circuits, General Dynamics и др.);

Помимо этого, одним из направлений компании «ЭлектроПласт» является направление «Источники питания». Мы предлагаем Вам помощь Конструкторского отдела:

- Подбор оптимального решения, техническое обоснование при выборе компонента;
- Подбор аналогов;
- Консультации по применению компонента;
- Поставка образцов и прототипов;
- Техническая поддержка проекта;
- Защита от снятия компонента с производства.



Как с нами связаться

Телефон: 8 (812) 309 58 32 (многоканальный)

Факс: 8 (812) 320-02-42

Электронная почта: org@eplast1.ru

Адрес: 198099, г. Санкт-Петербург, ул. Калинина, дом 2, корпус 4, литера А.