May 2015

FSB43004A
Motion SPM® 45 Series

Features

- UL Certified No.E209204(UL-1557)
- 40 V, $R_{DS(ON)}$=3.0 mΩ(max.) 3-phase MOSFET Inverter Module Including Control IC for Gate Drive and Protection.
- Ceramic Substrate.
- Three Separate Open-Emitter Pins from Low-Side MOSFETs for Three-Leg Current Sensing.
- Single-Grounded Power Supply for Built-in HVIC.
- Isolation Rating of 800 Vrms/min.

Applications

Motion Control - Home Appliance / Industrial Motor.

General Description

FSB43004A is a Motion SPM® 45 series that Fairchild developed based on low-loss Power Trench MOSFET technology as a compact motor drive inverter solution for small power applications supplied by low voltage battery.

Figure 1. Packing Overview

Package Marking and Ordering Information

Device	Device Marking	Package	Packing Type	Quantity
FSB43004A	FSB43304A	SPMAA-A22	Rail	14

Integrated Power Functions

- 40 V $R_{DS(ON)}$= 2.1 mΩ(typ.) inverter for three-phase DC / AC power conversion (please refer to Figure 3)

Integrated Drive, Protection, and System Control Functions

- For inverter high-side MOSFETs: gate drive circuit, high-voltage isolated high-speed level shifting, Under-Voltage Protection.
- For inverter low-side IGBTs: gate drive circuit, Under-Voltage Protection.
- Fault signaling: Corresponding to UV (low-side supply).
- Input interface: Active-HIGH interface, works with 3.3 / 5 V Logic, Schmitt-trigger input

Pin Configuration

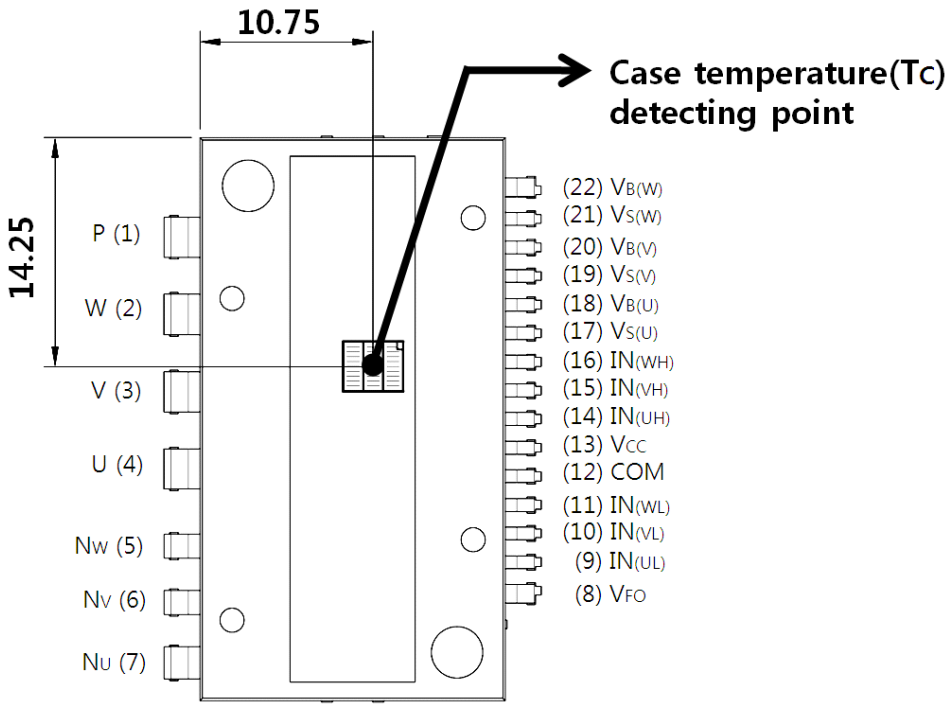


Figure 2.Top View

Pin Descriptions

Pin Number	Pin Name	Pin Description
1	P	Positive DC-Link Input
2	W	W Phase Output
3	V	V Phase Output
4	U	U Phase Output
5	N_W	Negative DC-Link Input
6	N_V	Negative DC-Link Input
7	N_U	Negative DC-Link Input
8	V_{FO}	Fault Output
9	$IN_{(UL)}$	PWM Input for Low-Side U Phase MOSFET Drive
10	$IN_{(VL)}$	PWM Input for Low-Side V Phase MOSFET Drive
11	$IN_{(WL)}$	PWM Input for Low-Side W Phase MOSFET Drive
12	COM	Common Supply Ground
13	Vcc	Common Supply Voltage for IC and Low-side MOSFET Drive
14	$IN_{(UH)}$	PWM Input for High-Side U Phase MOSFET Drive
15	$IN_{(VH)}$	PWM Input for High-Side V Phase MOSFET Drive
16	$IN_{(WH)}$	PWM Input for High-Side W Phase MOSFET Drive
17	$V_{B(U)}$	Supply Voltage for High-Side U Phase MOSFET Drive
18	$V_{S(U)}$	Supply Ground for High-Side U Phase MOSFET Drive
19	$V_{B(V)}$	Supply Voltage for High-Side V Phase MOSFET Drive
20	$V_{S(V)}$	Supply Ground for High-Side V Phase MOSFET Drive
21	$V_{B(W)}$	Supply Voltage for High-Side W Phase MOSFET Drive
22	$V_{S(W)}$	Supply Ground for High-Side W Phase MOSFET Drive

Internal Equivalent Circuit and Input/Output Pins

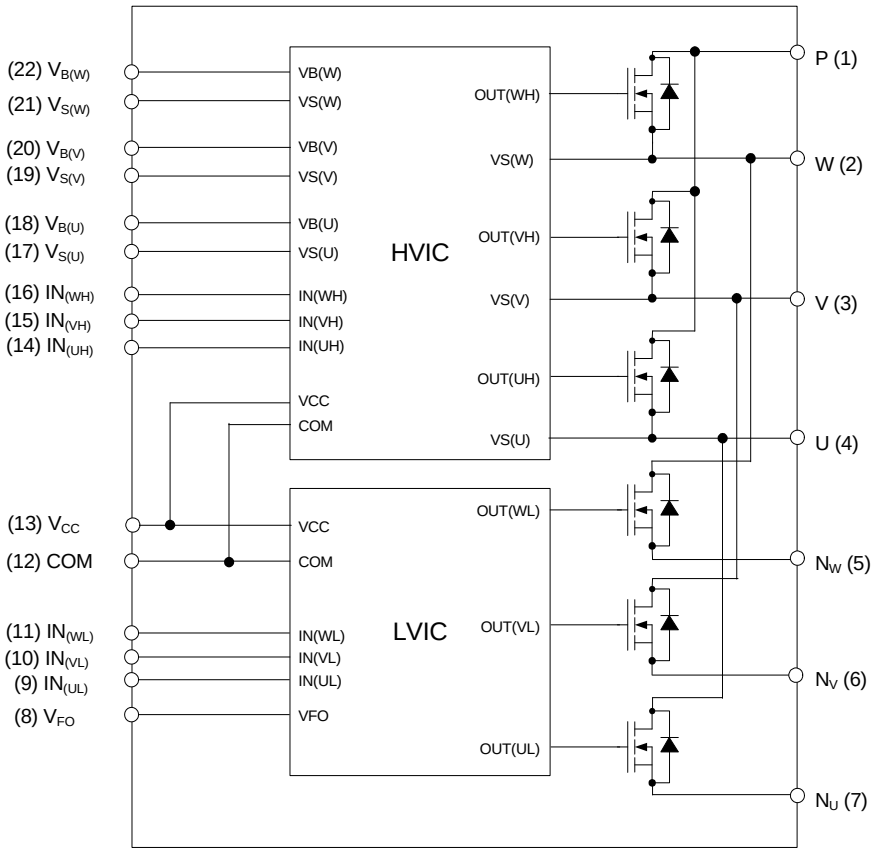


Figure 3. Internal Block Diagram

Absolute Maximum Ratings (T_J = 25°C, unless otherwise specified.)

Inverter Part

Symbol	Parameter	Conditions	Rating	unit
V_{PN}	DC Link Input Voltage Drain-Source Voltage	Applied between P - $N_{(U)}$, $N_{(V)}$, $N_{(W)}$	40	V
* ± I_D	Drain Current	T_C = 25°C, $T_J \leq$ 150°C	71	A
		T_C = 100°C, $T_J \leq$ 150°C	47	A
* ± I_{DP}	Peak Drain Current	T_C = 25°C, under 1ms Pulse Width, $T_J \leq$ 150°C	180	A
* P_D	Maximum Power Dissipation	T_C = 25°C, per Chip, $T_J \leq$ 150°C	31	W
T_J	Operating Junction Temperature		-40 ~ 150	°C

1st Note:

1. Rating value of marking "*" is calculation value or design factor.

Control Part

Symbol	Parameter	Conditions	Rating	unit
V_{CC}	Supply Voltage	Applied between V_{CC} - COM	20	V
V_{BS}	Supply 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}	PWM 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

Total System

Symbol	Parameter	Conditions	Rating	unit
T_{STG}	Storage Temperature		-40 ~ 150	°C
V_{ISO}	Isolation Voltage	60 Hz, Sinusoidal, AC 1 Minute, Connect Pins to DBC Substrate	800	V_{rms}

Thermal Characteristics

Symbol	Parameter	Condition	Max.	unit
$R_{th(j-c)}$	Junction to Case Thermal Resistance	Package center (per MOSFET)	3.92	°C/W

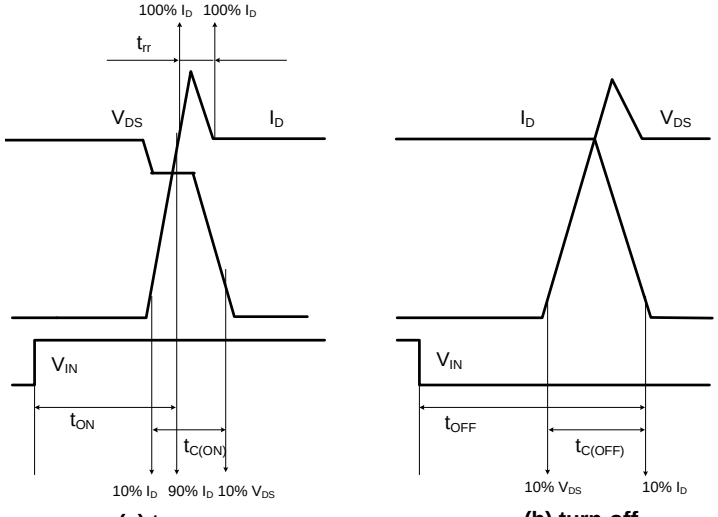
Electrical Characteristics (T_J = 25°C, unless otherwise specified.)

Inverter Part

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
BV_{DSS}	Drain-Source Breakdown Voltage	V_{IN}=0 V, I_D=250 μA (2nd Notes 1)	40	-	-	V
$R_{DS(ON)}$	Drain-Source ON Resistance	V_{CC} = V_{BS} = 15 V, V_{IN} = 5 V, I_D = 40 A	-	2.1	3.0	mΩ
V_{SD}	Source-Drain Diode Forward Voltage	V_{CC} = V_{BS} = 15 V, V_{IN} = 0 V, I_{SD} = 40 A	-	0.8	-	V
t_{ON}	Switching Characteristic	V_{PN} = 20 V, V_{CC} = V_{BS} = 15 V, I_D = 40 A, V_{IN} = 0 V ↔ 5 V, High side, Inductive Load (2nd Notes 2)	-	1750	-	ns
$t_{C(ON)}$			-	900	-	ns
t_{OFF}			-	2600	-	ns
$t_{C(OFF)}$			-	800	-	ns
t_{rr}			-	60	-	ns
I_{rr}			-	3	-	A
t_{ON}		V_{PN} = 20 V, V_{CC} = V_{BS} = 15 V, I_D = 40 A, V_{IN} = 0 V ↔ 5 V, Low side, Inductive Load (2nd Notes 2)	-	1900	-	ns
$t_{C(ON)}$			-	850	-	ns
t_{OFF}			-	2600	-	ns
$t_{C(OFF)}$			-	850	-	ns
t_{rr}			-	60	-	ns
I_{rr}			-	6	-	A
I_{DSS}	Drain-Source Leakage Current	V_{DS} = V_{DSS}	-	-	250	μA

2nd Notes:

1. BV_{DSS} is the absolute maximum voltage rating between drain and source terminal of each MOSFET. V_{PN} should be sufficiently lees than this vale considering the effect of the stray inductance so that V_{DS} should not exceed BV_{DSS} in any case.
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 MOSFET itself under the given gate driving condition internally. For the detailed information, please see Figure 4.



(a) turn-on **(b) turn-off**

Figure 4. Switching Time Definition

Control Part

Symbol	Parameter	Conditions		Min.	Typ.	Max.	Unit
I_{QCC}	Quiescent V_{CC} Supply Current	V_{CC} = 15 V, V_{IN} = 0 V	V_{CC} - COM	-	-	2.75	mA
I_{QBS}	Quiescent V_{BS} Supply Current	V_{BS} = 15 V, V_{IN} = 0 V	$V_{B(U)}$ - $V_{S(U)}$, $V_{B(V)}$ -$V_{S(V)}$, $V_{B(W)}$ - $V_{S(W)}$	-	-	0.3	mA
V_{FOH}	Fault Output Voltage	10 kΩ to 5 V Pull-up	Normal	4.5	-	-	V
V_{FOL}			Fault	-	-	0.5	V
UV_{CCD}	Supply Circuit Under-Voltage Protection	Detection Level		7.0	8.2	10.0	V
UV_{CCR}		Reset Level		8.0	9.4	11.0	V
UV_{BSD}		Detection Level		7.0	8.0	9.5	V
UV_{BSR}		Reset Level		8.0	9.0	10.5	V
t_{FOD}	Fault-Out Pulse Width			30	-	-	µs
$V_{IN(ON)}$	ON Threshold Voltage	Applied between $IN_{(UH)}$, $IN_{(VH)}$, $IN_{(WH)}$, $IN_{(UL)}$, $IN_{(VL)}$, $IN_{(WL)}$ - COM		-	-	2.6	V
$V_{IN(OFF)}$	OFF Threshold Voltage			0.8	-	-	V

Recommended Operating Conditions

Symbol	Parameter	Conditions	Value			Unit
			Min.	Typ.	Max.	
V_{PN}	Supply Voltage	Applied between P - $N_{(U)}$, $N_{(V)}$, $N_{(W)}$	-	20	-	V
V_{CC}	Control Supply Voltage	Applied between V_{CC} - COM	13.5	15	16.5	V
V_{BS}	Control Supply 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/µs
V_{SEN}	Voltage for Current Sensing	Applied between N_U, N_V, N_W - COM (Including surge voltage)	-4	-	4	V

Mechanical Characteristics and Ratings

Parameter	Conditions		Limits			Units
			Min.	Typ.	Max.	
Mounting Torque	Mounting Screw: - M3		0.51	0.62	0.72	N•m
Device Flatness		See Figure 5	-	-	120	μm
Weight			-	8.4	-	g

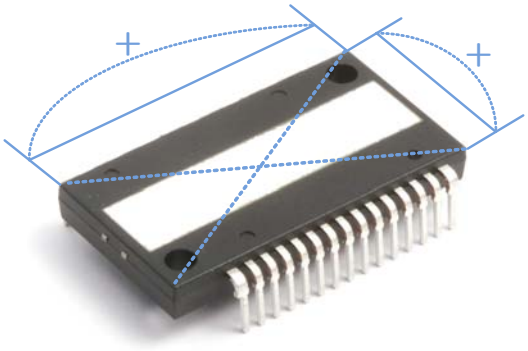
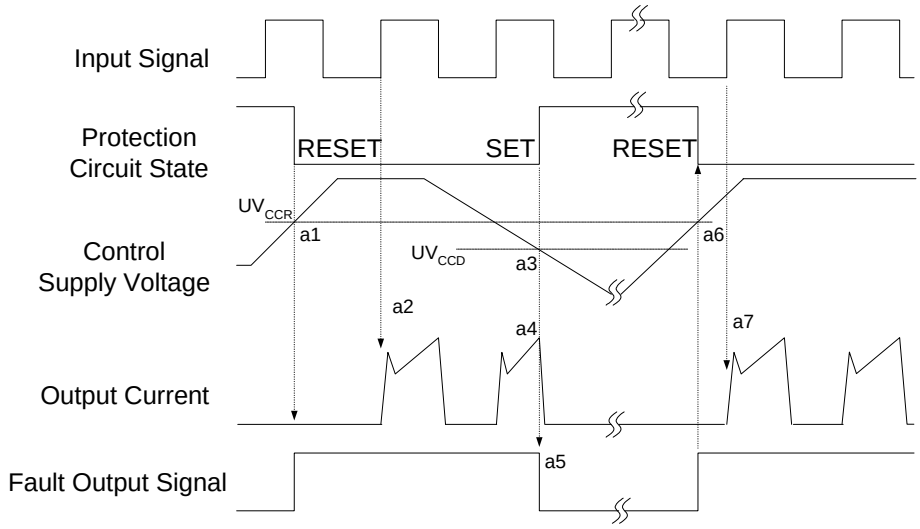


Figure 5. Flatness Measurement Position

Time Charts of Protective Function



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

a2 : Normal operation: MOSFET ON and carrying current.

a3 : Under-Voltage detection (UV_{CCD}).

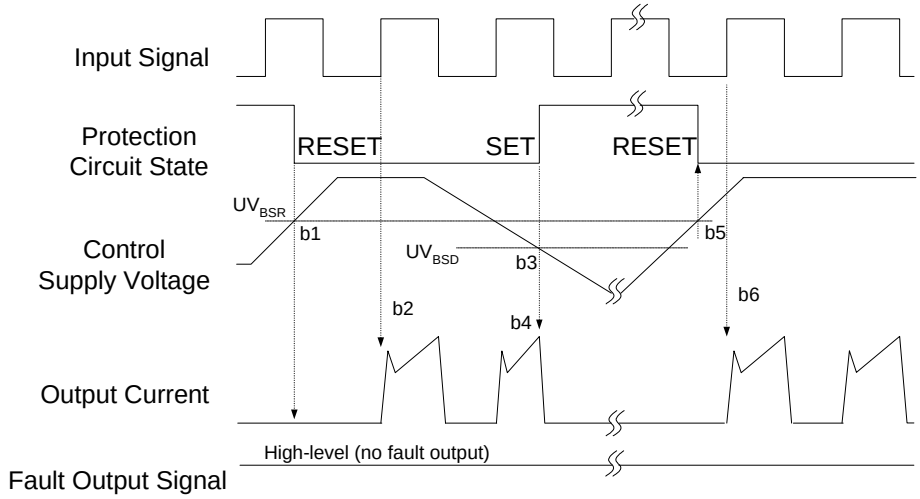
a4 : MOSFET OFF in spite of control input condition.

a5 : Fault output operation starts.

a6 : Under-Voltage reset (UV_{CCR}).

a7 : Normal operation: MOSFET ON and carrying current.

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



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

b2 : Normal operation: MOSFET ON and carrying current.

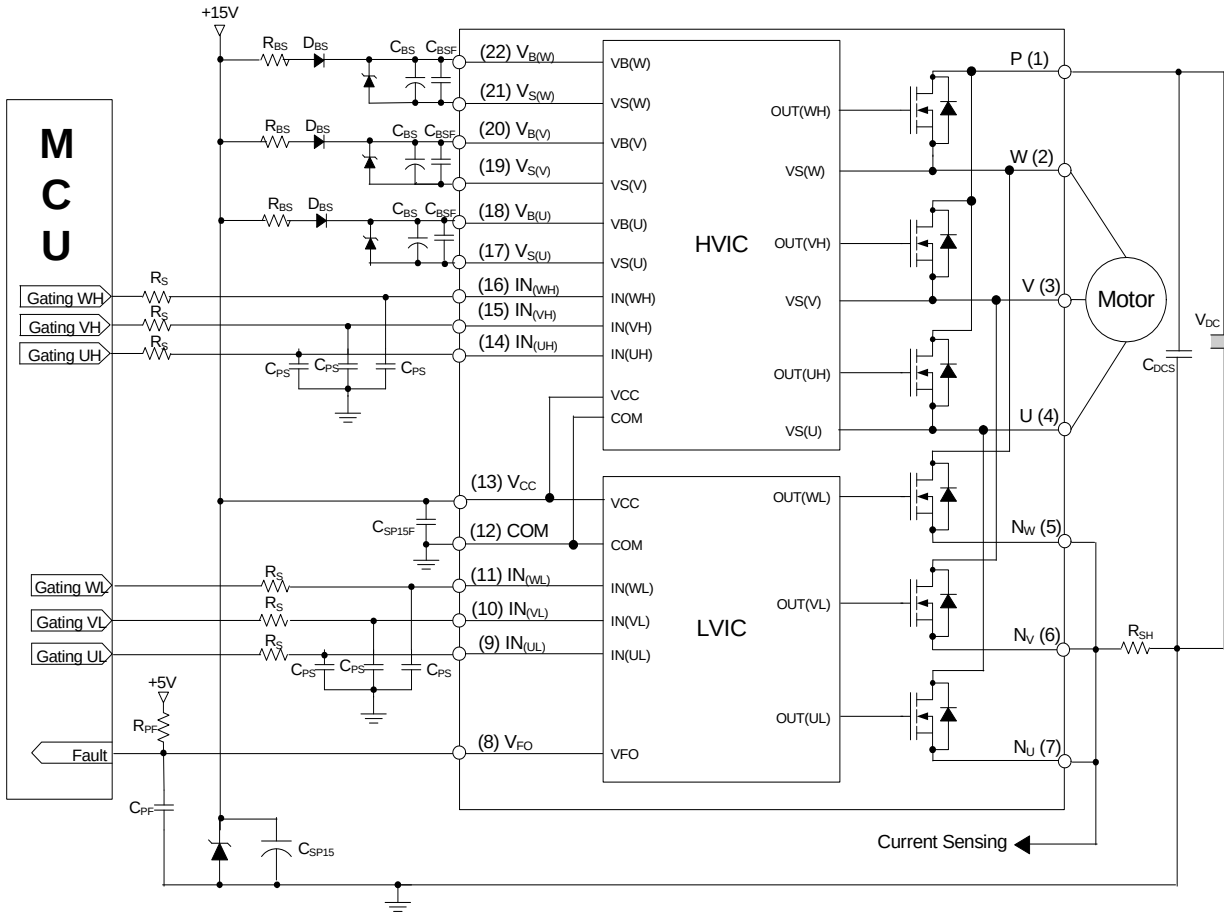
b3 : Under-Voltage detection (UV_{BSD}).

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

b5 : Under-Voltage reset (UV_{BSR}).

b6 : Normal operation: MOSFET ON and carrying current

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

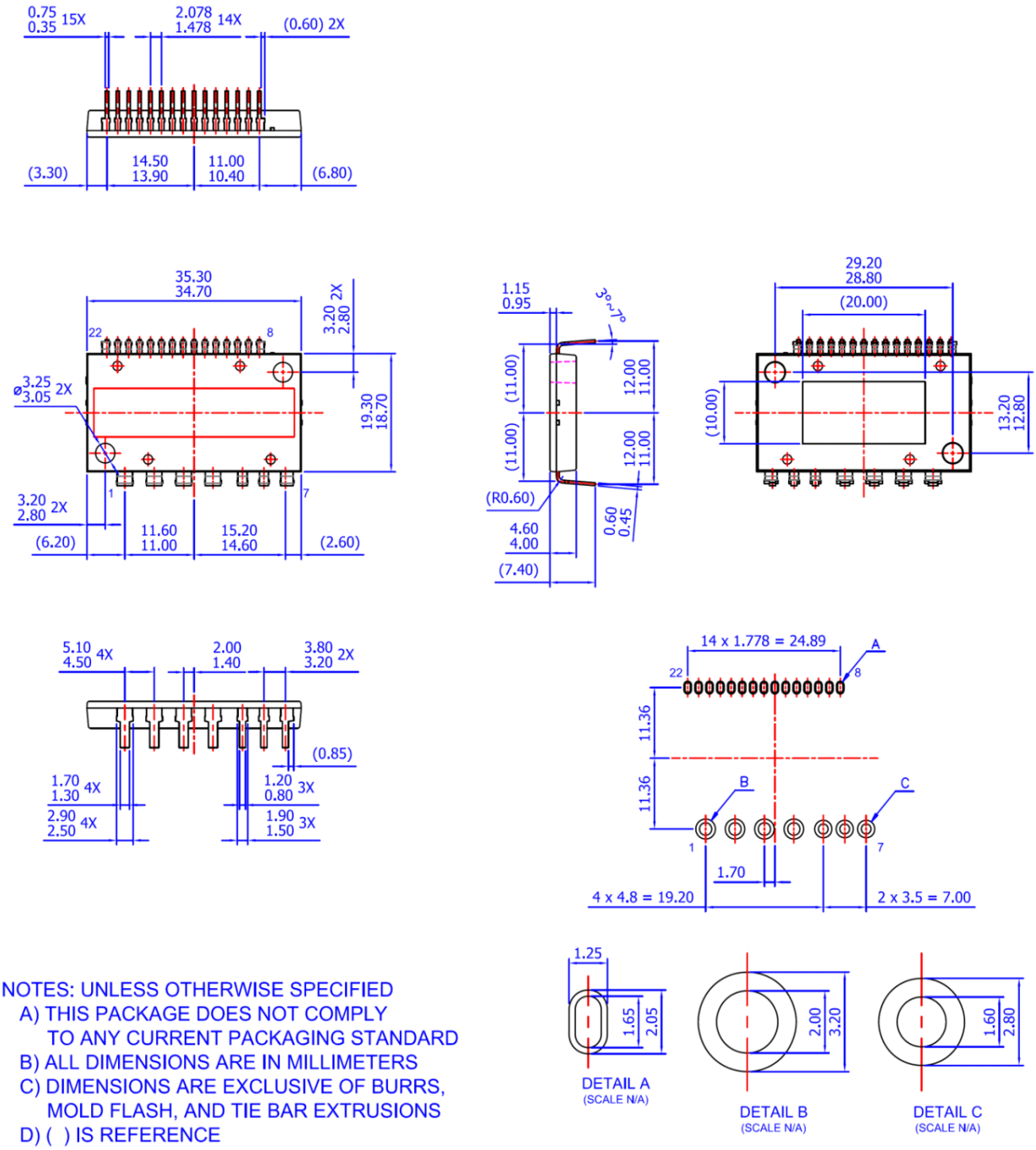


3rd Notes:

1. To avoid malfunction, the wiring of each input should be as short as possible. (less than 2~3 cm)
2. V_{FO} output is open drain type. This signal line should be pulled up to the positive side of the MCU or control power supply with a resistor that makes I_{FO} up to 1 mA.
3. Input signal is High-Active type. There is a 5 kΩ resistor inside the IC to pull down each input signal line to GND. RC coupling circuits is recommended for the prevention of input signal oscillation. $R_F C_F$ constant should be selected in the range 50~150ns. (Recommended R_S=100 Ω , C_{PS}=1 nF)
4. Each capacitors should be mounted as close to the SPM® pins as possible.
5. Relays are used at almost every systems of electrical equipment of home appliances. In these cases, there should be sufficient distance between the CPU and the relays.
6. The zener diode should be adopted for the protection of ICs from the surge destruction between each pair of control supply terminals. (Recommended zener diode=24 / 1 W)

Figure 8. Typical Application Circuit

Detailed Package Outline Drawings



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