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# FSB44104A

## Motion SPM® 45 LV Series

### Features

- UL Certified No.E209204 (UL1557)
- 40 V,  $R_{DS(ON)} = 4.1 \text{ m}\Omega(\text{Max.})$  3-Phase MOSFET Inverter Module with Gate Drivers and Protection
- Low Thermal Resistance Using 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: 800  $V_{rms}$  / min.

### Applications

- Motion Control - Home Appliance / Industrial Motor.

### General Description

FSB44104A is a Motion SPM® 45 LV module that Fairchild developed based on low-loss PowerTrench® MOSFET technology as a compact motor drive inverter solution for small power applications supplied by low voltage battery.

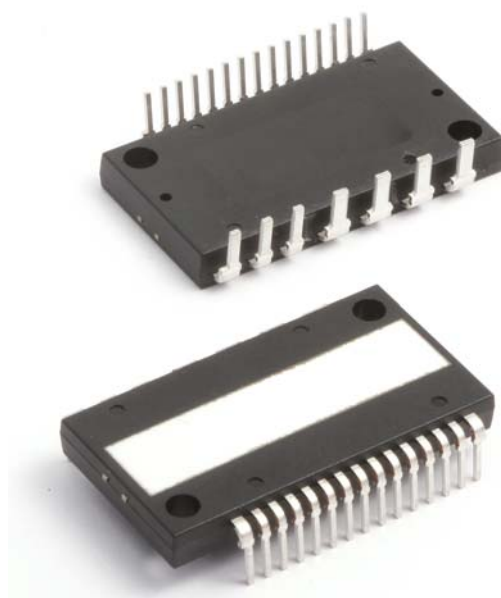


Figure 1. Packing Overview

### Package Marking and Ordering Information

Device	Device Marking	Package	Packing Type	Quantity
FSB44104A	FSB44104A	SPMAA-A22	Rail	14

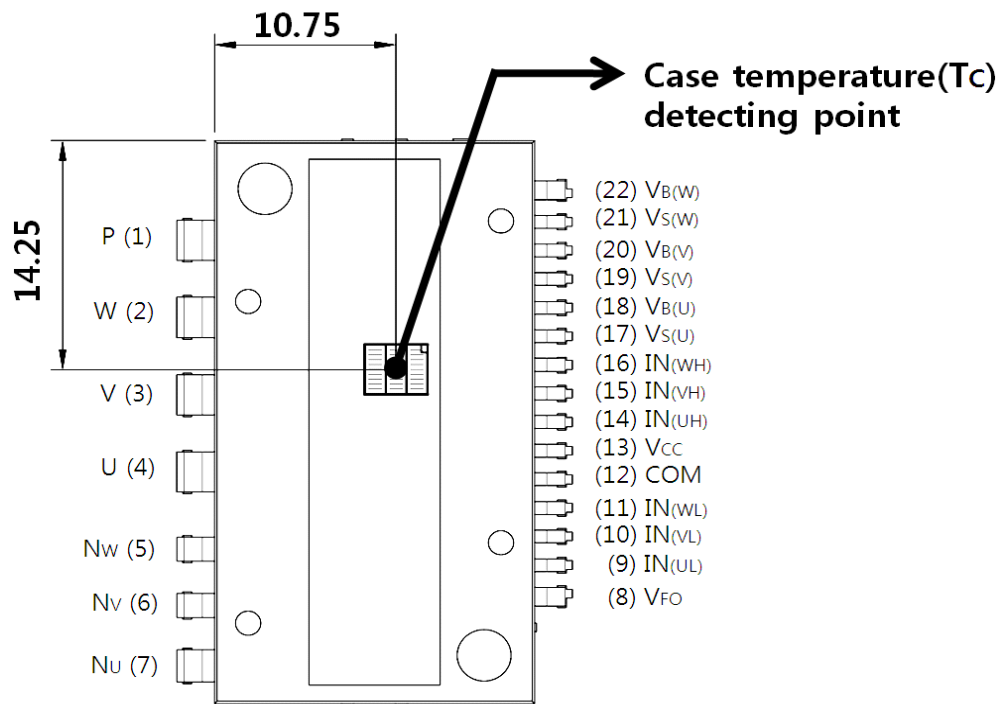
### Integrated Power Functions

- 40 V  $R_{DS(ON)} = 2.5 \text{ m}\Omega$ (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 Lock-Out (UVLO) Protection.
- For inverter low-side IGBTs: gate drive circuit, Under-Voltage Lock-Out (UVLO) 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 <sub>W</sub>	Negative DC-Link Input
6	N <sub>V</sub>	Negative DC-Link Input
7	N <sub>U</sub>	Negative DC-Link Input
8	V <sub>FO</sub>	Fault Output
9	IN <sub>(UL)</sub>	PWM Input for Low-Side U-Phase MOSFET Drive
10	IN <sub>(VL)</sub>	PWM Input for Low-Side V-Phase MOSFET Drive
11	IN <sub>(WL)</sub>	PWM Input for Low-Side W-Phase MOSFET Drive
12	COM	Common Supply Ground
13	V <sub>CC</sub>	Common Supply Voltage for IC and Low-side MOSFET Drive
14	IN <sub>(UH)</sub>	PWM Input for High-Side U-Phase MOSFET Drive
15	IN <sub>(VH)</sub>	PWM Input for High-Side V-Phase MOSFET Drive
16	IN <sub>(WH)</sub>	PWM Input for High-Side W-Phase MOSFET Drive
17	V <sub>B(U)</sub>	Supply Voltage for High-Side U-Phase MOSFET Drive
18	V <sub>S(U)</sub>	Supply Ground for High-Side U-Phase MOSFET Drive
19	V <sub>B(V)</sub>	Supply Voltage for High-Side V-Phase MOSFET Drive
20	V <sub>S(V)</sub>	Supply Ground for High-Side V-Phase MOSFET Drive
21	V <sub>B(W)</sub>	Supply Voltage for High-Side W-Phase MOSFET Drive
22	V <sub>S(W)</sub>	Supply Ground for High-Side W-Phase MOSFET Drive

Internal Equivalent Circuit and Input/Output Pins

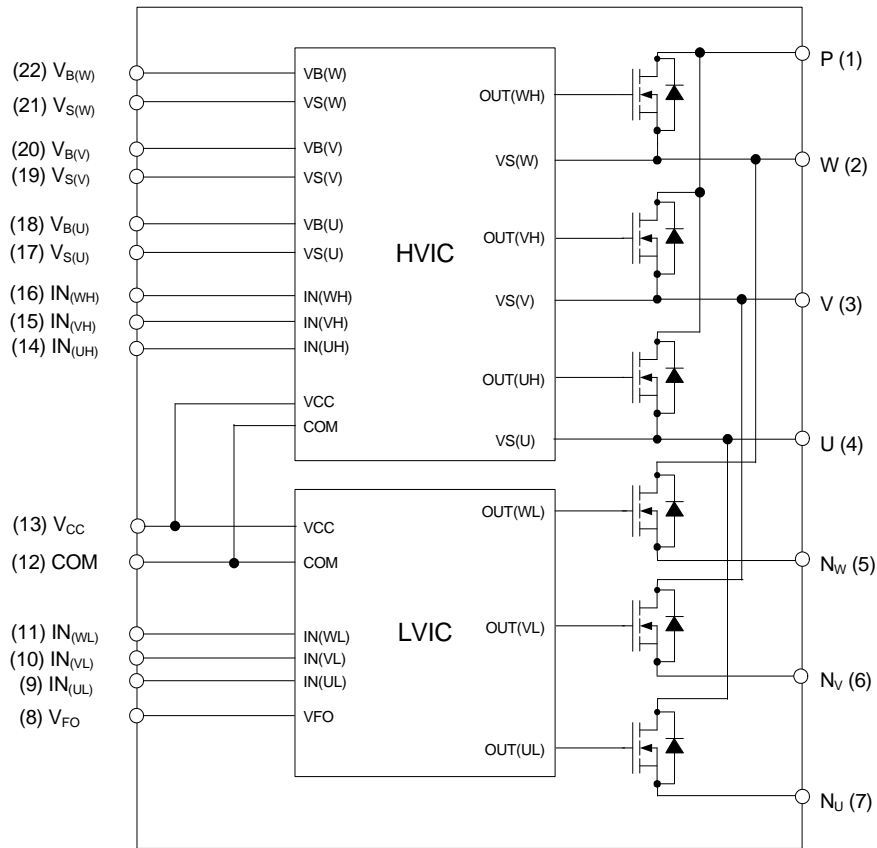


Figure 3. Internal Block Diagram

**Absolute Maximum Ratings** ( $T_J = 25^\circ\text{C}$ , 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
$* \pm I_D$	Drain Current	$T_C = 25^\circ\text{C}$ , $T_J \leq 150^\circ\text{C}$	57	A
		$T_C = 100^\circ\text{C}$ , $T_J \leq 150^\circ\text{C}$	36	A
$* \pm I_{DP}$	Peak Drain Current	$T_C = 25^\circ\text{C}$ , under 1ms Pulse Width, $T_J \leq 150^\circ\text{C}$	110	A
$* P_D$	Maximum Power Dissipation	$T_C = 25^\circ\text{C}$ , per Chip, $T_J \leq 150^\circ\text{C}$	28	W
$T_J$	Operating Junction Temperature		-40 ~ 150	$^\circ\text{C}$

**1st Notes:**

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	$^\circ\text{C}$
$V_{ISO}$	Isolation Voltage	60 Hz, Sinusoidal, AC 1 Minute, Connect Pins to Heat-Sink Plate	800	$V_{rms}$

**Thermal Characteristics**

Symbol	Parameter	Condition	Max.	unit
$R_{th(j-c)}$	Junction to Case Thermal Resistance	Package center (per MOSFET)	4.41	$^\circ\text{C/W}$

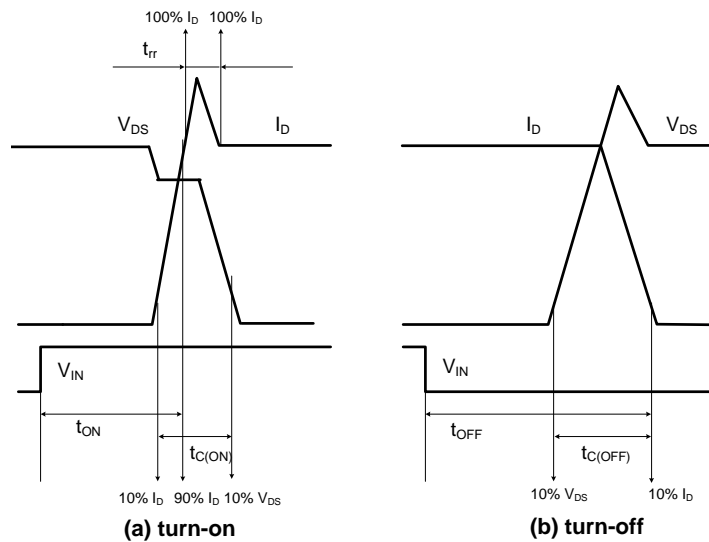
**Electrical Characteristics** ( $T_J = 25^\circ\text{C}$ , unless otherwise specified.)

**Inverter Part**

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit		
$BV_{DSS}$	Drain - Source Breakdown Voltage	$V_{IN} = 0\text{ V}$ , $I_D = 250\ \mu\text{A}$ (2nd Notes 1)	40	-	-	V		
$R_{DS(ON)}$	Drain - Source Turn-On Resistance	$V_{CC} = V_{BS} = 15\text{ V}$ , $V_{IN} = 5\text{ V}$ , $I_D = 40\text{ A}$	-	3.0	4.1	$\text{m}\Omega$		
$V_{SD}$	Source - Drain Diode Forward Voltage	$V_{CC} = V_{BS} = 15\text{ V}$ , $V_{IN} = 0\text{ V}$ , $I_{SD} = 40\text{ A}$	-	0.8	1.1	V		
$t_{ON}$	Switching Characteristic	$V_{PN} = 20\text{ V}$ , $V_{CC} = V_{BS} = 15\text{ V}$ , $I_D = 40\text{ A}$ , $V_{IN} = 0\text{ V} \leftrightarrow 5\text{ V}$ , High-side, Inductive Load (1st Note 3)	-	1200	-	ns		
$t_{C(ON)}$			-	1140	-	ns		
$t_{OFF}$			-	1700	-	ns		
$t_{C(OFF)}$			-	500	-	ns		
$t_{rr}$			-	70	-	ns		
$I_{rr}$			-	5	-	A		
$t_{ON}$			$V_{PN} = 20\text{ V}$ , $V_{CC} = V_{BS} = 15\text{ V}$ , $I_D = 40\text{ A}$ , $V_{IN} = 0\text{ V} \leftrightarrow 5\text{ V}$ , Low side, Inductive Load (1st Note 3)	-	1370	-	ns	
$t_{C(ON)}$				-	1000	-	ns	
$t_{OFF}$				-	1850	-	ns	
$t_{C(OFF)}$				-	600	-	ns	
$t_{rr}$				-	75	-	ns	
$I_{rr}$				-	4	-	A	
$I_{DSS}$				Drain - Source Leakage Current	$V_{DS} = V_{DSS}$	-	-	250

**1st Notes:**

- $BV_{DSS}$  is the absolute maximum voltage rating between drain and source terminal of each MOSFET.  $V_{PN}$  should be sufficiently less than this value considering the effect of the stray inductance so that  $V_{DS}$  should not exceed  $BV_{DSS}$  in any case.
- $t_{ON}$  and  $t_{OFF}$  include the propagation delay 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.



**Figure 4. Switching Time Definition**

**Control Part**

Symbol	Parameter	Conditions		Min.	Typ.	Max.	Unit
$I_{OCC}$	Quiescent $V_{CC}$ Supply Current	$V_{CC} = 15\text{ V}$ , $V_{IN} = 0\text{ V}$	$V_{CC} - \text{COM}$	-	-	2.75	mA
$I_{OBS}$	Quiescent $V_{BS}$ Supply Current	$V_{BS} = 15\text{ V}$ , $V_{IN} = 0\text{ V}$	$V_{B(U)} - V_{S(U)}$ , $V_{B(V)} - V_{S(V)}$ , $V_{B(W)} - V_{S(W)}$	-	-	0.3	mA
$V_{FOH}$	Fault Output Voltage	10 k $\Omega$ 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	-	-	$\mu\text{s}$
$V_{IN(ON)}$	ON Threshold Voltage	Applied between $IN_{(UH)}$ , $IN_{(VH)}$ , $IN_{(WH)}$ , $IN_{(UL)}$ ,		-	-	2.6	V
$V_{IN(OFF)}$	OFF Threshold Voltage	$IN_{(VL)}$ , $IN_{(WL)} - \text{COM}$		0.8	-	-	V

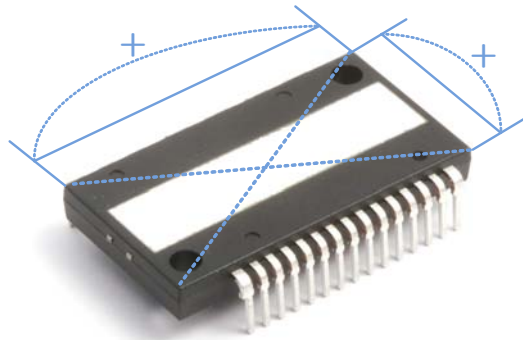
**Recommended Operating Conditions**

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
$V_{PN}$	Supply Voltage	Applied between P - $N_{(U)}$ , $N_{(V)}$ , $N_{(W)}$	-	20	-	V
$V_{CC}$	Control Supply Voltage	Applied between $V_{CC} - \text{COM}$	13.5	15.0	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	15.0	18.5	V
$dV_{CC}/dt$ , $dV_{BS}/dt$	Control Supply Variation		-1	-	1	V / $\mu\text{s}$
$V_{SEN}$	Voltage for Current Sensing	Applied between $N_U$ , $N_V$ , $N_W - \text{COM}$ (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)**

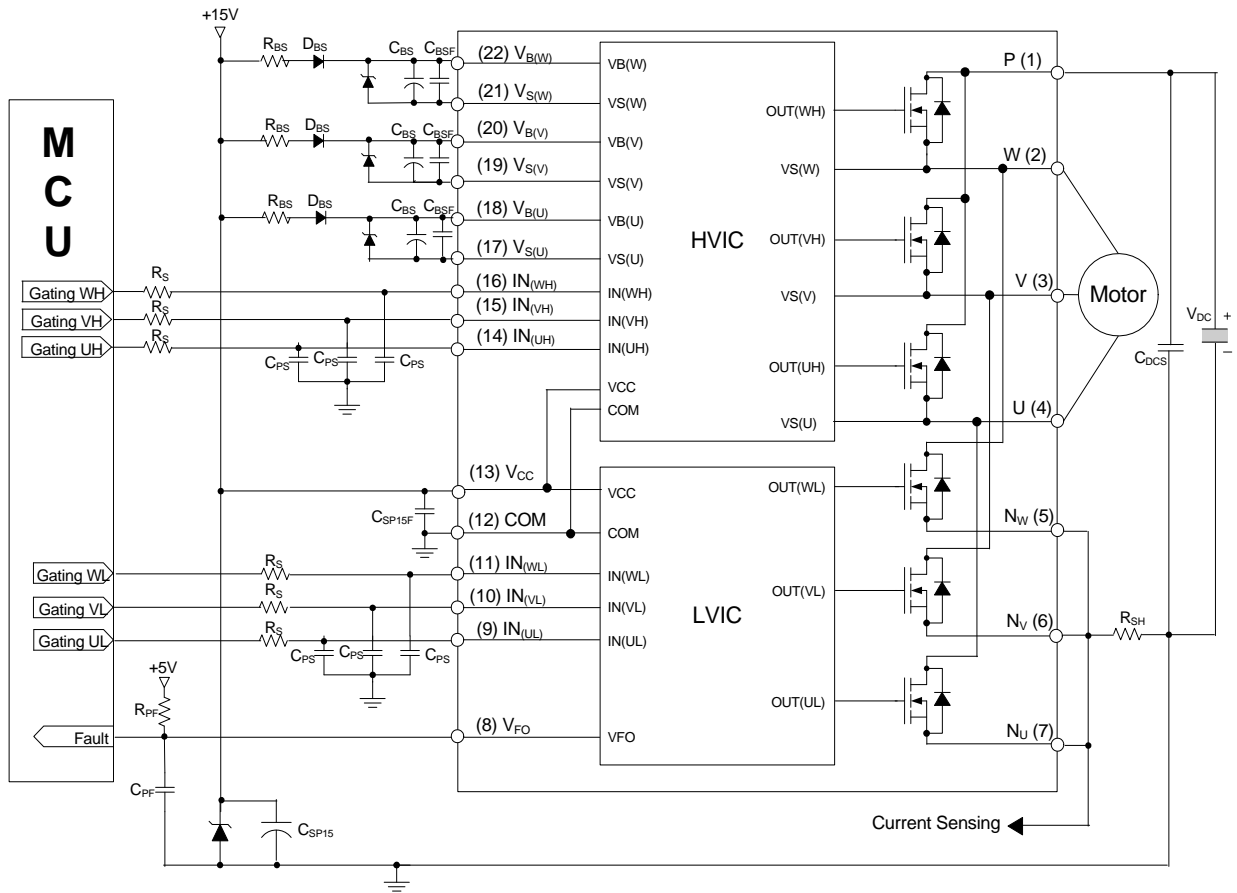
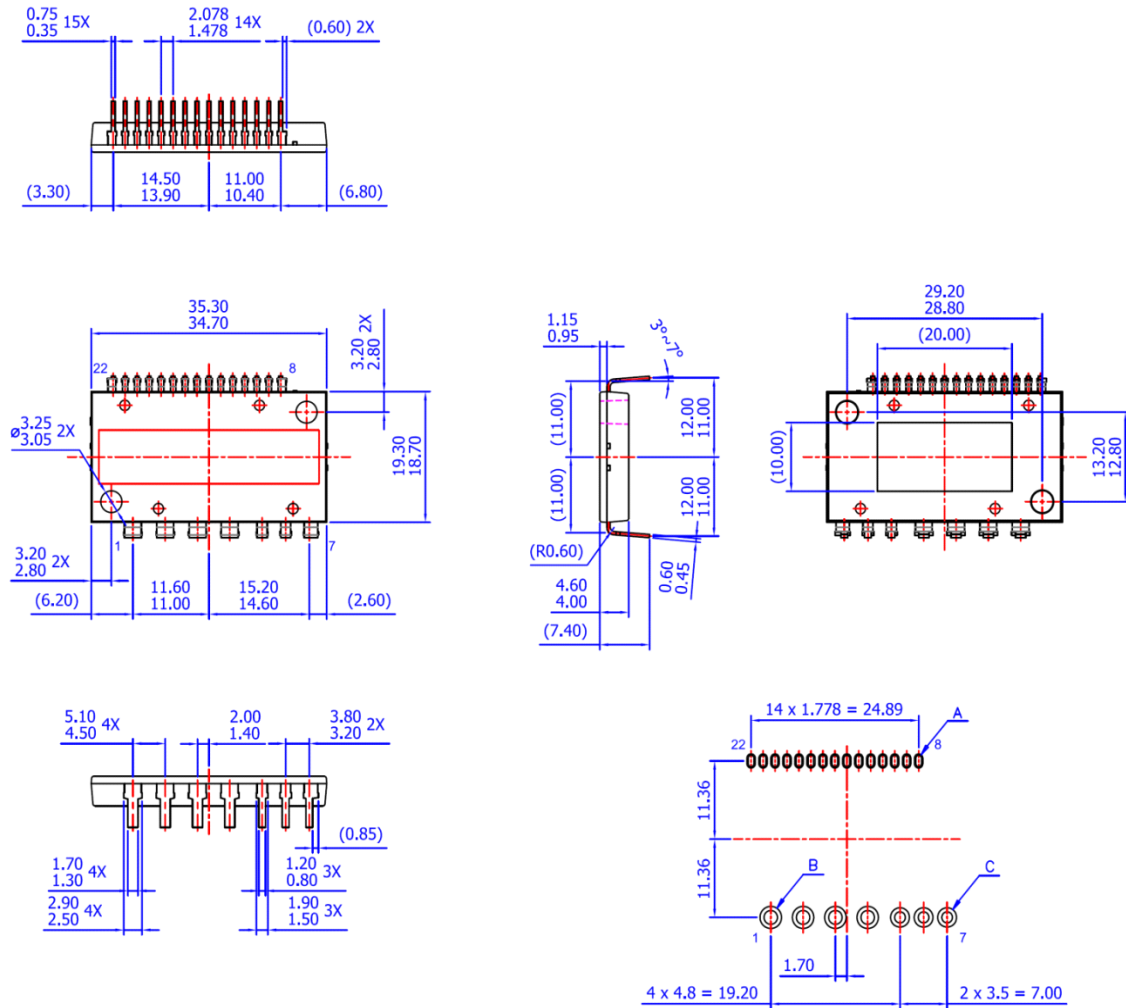


Figure 8. Typical Application Circuit

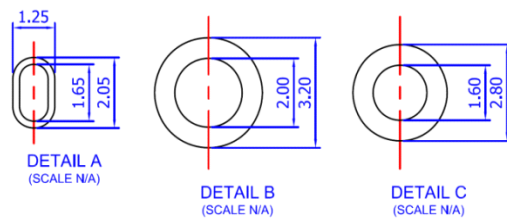
**2nd Notes:**

1. To avoid malfunction, the wiring of each input should be as short as possible (less than 2-3 cm).
2. VFO 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 IFO up to 1 mA.
3. Input signal is active-HIGH 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<sub>F</sub>C<sub>F</sub> constant should be selected in the range 50 ~ 150 ns (recommended R<sub>S</sub> = 100 Ω , C<sub>PS</sub> = 1 nF).
4. Each capacitors should be mounted as close to the Motion SPM® module pins as possible.
5. 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 V / 1 W).

### Detailed Package Outline Drawing



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