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December 2015

FSB70550
Motion SPM® 7 Series

Features

- UL Certified No. E209204 (UL1557)
- High Performance PQFN Package
- 500 V $R_{DS(on)}$ = 1.85 Ω(Max) FRFET MOSFET 3-Phase Inverter with Gate Drivers and Protection
- Separate Open-Source Pins from Low-Side MOSFETs for Three-Phase Current-Sensing
- Active-HIGH Interface, Works with 3.3 / 5 V Logic, Schmitt-trigger Input
- Optimized for Low Electromagnetic Interference
- HVIC Temperature-Sensing Built-In for Temperature Monitoring
- HVIC for Gate Driving with Under-Voltage Protection and Interlock Function
- Isolation Rating: 1500 V_{rms} / min.
- Moisture Sensitive Level (MSL) 3
- RoHS Compliant

Application

- 3-Phase Inverter Driver for Small Power AC Motor Drives

Related Source

- *AN-9077 - Motion SPM® 7 Series User's Guide*
- *AN-9078 - Surface Mount Guidelines for Motion SPM® 7 Series*

General Description

The FSB70550 is an advanced Motion SPM® 7 module providing a fully-featured, high-performance inverter output stage for AC Induction, BLDC and PMSM motors. These modules integrate optimized gate drive of the built-in MOSFETs (FRFET® technology) to minimize EMI and losses, while also providing multiple on-module protection features including under-voltage lockouts, thermal monitoring, fault reporting and interlock function. The built-in one HVIC translates the incoming logic-level gate inputs to the high-voltage, high-current drive signals required to properly drive the module's internal MOSFETs. Separate open-souce MOSFET terminals are available for each phase to support the widest variety of control algorithms.

3D Package Drawing (Click to Activate 3D Content)

Package Marking & Ordering Information

Device Marking	Device	Package	Reel Size	Tape Width	Quantity
FSB70550	FSB70550	PQFN27A	13"	24 mm	1000 units

Absolute Maximum Ratings

Inverter Part (each MOSFET unless otherwise specified.)

Symbol	Parameter	Conditions	Rating	Unit
V_{DSS}	Drain-Source Voltage of Each MOSFET		500	V
$*I_{D\ 25}$	Each MOSFET Drain Current, Continuous	T_{CB} = 25°C (1st Notes 1)	5.3	A
$*I_{D\ 80}$	Each MOSFET Drain Current, Continuous	T_{CB} = 80°C	3.9	A
$*I_{DP}$	Each MOSFET Drain Current, Peak	T_{CB} = 25°C, PW < 100 μs	10.6	A
$*P_D$	Maximum Power Dissipation	T_{CB} = 25°C, For Each MOSFET	110	W

Control Part (each HVIC unless otherwise specified.)

Symbol	Parameter	Conditions	Rating	Unit
V_{DD}	Control Supply Voltage	Applied Between V_{DD} and COM	20	V
V_{BS}	High-side Bias Voltage	Applied Between V_B and V_S	20	V
V_{IN}	Input Signal Voltage	Applied Between IN and COM	-0.3 ~ V_{DD} + 0.3	V
V_{FO}	Fault Output Supply Voltage	Applied Between FO and COM	-0.3 ~ V_{DD} + 0.3	V
I_{FO}	Fault Output Current	Sink Current FO Pin	5	mA
V_{CSC}	Current Sensing Input Voltage	Applied Between Csc and COM	-0.3 ~ V_{DD} + 0.3	V

Total System

Symbol	Parameter	Conditions	Rating	Unit
T_J	Operating Junction Temperature		-40 ~ 150	°C
T_{STG}	Storage Temperature		-40 ~ 125	°C
V_{ISO}	Isolation Voltage	60 Hz, Sinusoidal, 1 Minute, Connection Pins to Heat Sink Plate	1500	V_{rms}

1st Notes:

1. T_{CB} is pad temperature of case bottom.
2. Marking " * " is calculation value or design factor.

Pin descriptions

Pin Number	Pin Name	Pin Description
1	/FO	Fault Output
2	V_{TS}	Voltage Output of HVIC Temperature
3	Cfod	Capacitor for Duration of Fault Output
4	Csc	Capacitor (Low-pass Filter) for Short-circuit Current Detection Input
5	V_{DD}	Supply Bias Voltage for IC and MOSFETs Driving
6	IN_UH	Signal Input for High-side U Phase
7	IN_VH	Signal Input for High-side V Phase
8 (8a)	COM	Common Supply Ground
9	IN_WH	Signal Input for High-side W Phase
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	Nu	Negative DC-Link Input for U Phase
14	U	Output for U Phase
15	Nv	Negative DC-Link Input for V Phase
16	V	Output for V Phase
17	W	Output for W Phase
18	Nw	Negative DC-Link Input for W Phase
19	$V_{S(W)}$	High-side Bias Voltage Ground for W phase Mosfet driving
20	P_W	Positive DC-Link Input for W Phase
21	P_V	Positive DC-Link Input for V Phase
22	P_U	Positive DC-Link Input for U Phase
23 (23a)	$V_{S(V)}$	High-side Bias Voltage Ground for V Phase MOSFETs Driving
24 (24a)	$V_{S(U)}$	High-side Bias Voltage Ground for U Phase MOSFETs Driving
25	$V_{B(U)}$	High-side Bias Voltage for U Phase MOSFETs Driving
26	$V_{B(V)}$	High-side Bias Voltage for V Phase MOSFETs Driving
27	$V_{B(W)}$	High-side Bias Voltage for W Phase MOSFETs Driving

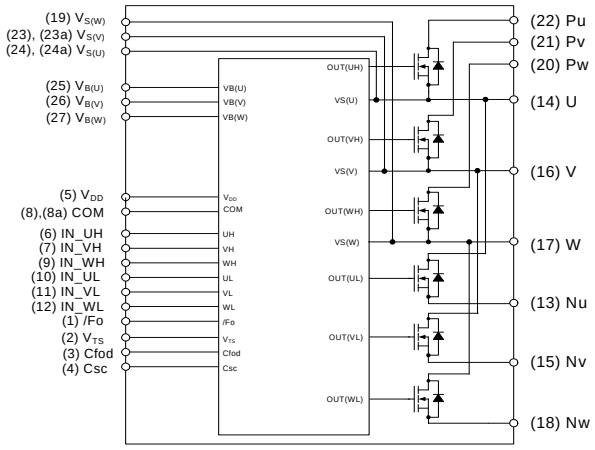


Figure 1. Pin Configuration and Internal Block Diagram

1st Notes:

4. Source terminal of each low-side MOSFET is not connected to supply ground or bias voltage ground inside Motion SPM® 7 product. External connections should be made as indicated in Figure 2.

5. The suffix -a pad is connected with same number pin. ex) 8 and 8a is connected inside.

Electrical Characteristics (T_J = 25°C, V_{DD} = V_{BS} = 15 V unless otherwise specified.)

Inverter Part (each MOSFET unless otherwise specified.)

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
BV_{DSS}	Drain - Source Breakdown Voltage	V_{IN} = 0 V, I_D = 1 mA (2nd Notes 1)	500	-	-	V
I_{DSS}	Zero Gate Voltage Drain Current	V_{IN} = 0 V, V_{DS} = 500 V	-	-	1	mA
$R_{DS(on)}$	Static Drain - Source Turn-On Resistance	V_{DD} = V_{BS} = 15 V, V_{IN} = 5 V, I_D = 1.0 A	-	1.6	1.85	Ω
V_{SD}	Drain - Source Diode Forward Voltage	V_{DD} = V_{BS} = 15V, V_{IN} = 0 V, I_D = -1.0 A	-	0.9	1.2	V
t_{ON}	Switching Times	V_{PN} = 300 V, V_{DD} = V_{BS} = 15 V, I_D = 1.0 A V_{IN} = 0 V ↔ 5 V, Inductive Load L = 3 mH Low-Side MOSFET Switching (2nd Notes 2)	-	600	-	ns
$t_{D(ON)}$			-	540	-	ns
t_{OFF}			-	480	-	ns
$t_{D(OFF)}$			-	410	-	ns
I_{rr}			-	1.4	-	A
t_{rr}			-	90	-	ns
E_{ON}			-	45	-	μJ
E_{OFF}			-	7	-	μJ

Control Part (each HVIC unless otherwise specified.)

Symbol	Parameter	Conditions		Min	Typ	Max	Units
I_{QDD}	Quiescent V_{DD} Current	V_{DD}=15V, V_{IN}=0V	V_{DD} - COM	-	1.7	3.0	mA
I_{QBS}	Quiescent V_{BS} Current	V_{BS}=15V, V_{IN}=0V	$V_{B(X)}$-$V_{S(X)}$,$V_{B(V)}$-$V_{S(V)}$, $V_{B(W)}$-$V_{S(W)}$	-	45	70	μA
I_{PDD}	Operating V_{DD} Current	V_{DD}=15V,F_{PWM}=20kHz, duty=50%, PWM signal input for Low side	V_{DD} - COM	-	1.9	3.2	mA
I_{PBS}	Operating V_{BS} Current	V_{BS}=15V,F_{PWM}=20kHz, duty=50%, PWM signal input for High side	$V_{B(U)}$-$V_{S(U)}$,$V_{B(V)}$-$V_{S(V)}$, $V_{B(W)}$-$V_{S(W)}$	-	300	400	μA
UV_{DDD}	Low-side Undervoltage Protection (Figure 6)	V_{DD} Undervoltage Protection Detection Level		7.4	8.0	9.4	V
UV_{DDR}		V_{DD} Undervoltage Protection Reset Level		8.0	8.9	9.8	V
UV_{BSD}	High-side Undervoltage Protection (Figure 7)	V_{BS} Undervoltage Protection Detection Level		7.4	8.0	9.4	V
UV_{BSR}		V_{BS} Undervoltage Protection Reset Level		8.0	8.9	9.8	V
V_{TS}	HVIC Temperature sensing voltage output	V_{DD}=15V, T_{HVIC}=25°C (2nd Notes 3)		580	675	770	mV
V_{IH}	ON Threshold Voltage	Logic High Level	IN - COM	-	-	2.4	V
V_{IL}	OFF Threshold Voltage	Logic Low Level		0.8	-	-	V
$V_{SC(ref)}$	SC Current Trip Level	V_{DD}=15V	C_{SC} - COM	0.45	0.5	0.55	V
t_{FOD}	Fault-out Pulse Width	C_{FOD}=33nF (2nd Notes 4)		1.0	1.4	1.8	ms

2nd Notes:

1. BV_{DSS} is the absolute maximum voltage rating between drain and source terminal of each MOSFET inside Motion SPM® 7 product. V_{PN} should be sufficiently less than this value considering the effect of the stray inductance so that V_{PN} should not exceed BV_{DSS} in any case.
2. t_{ON} and t_{OFF} include the propagation delay of the internal drive IC. Listed values are measured at the laboratory test condition, and they can be different according to the field applications due to the effect of different printed circuit boards and wirings. Please see Figure 3 for the switching time definition with the switching test circuit of Figure 4.
3. V_{TS} is only for sensing-temperature of module and cannot shutdown MOSFETs automatically.
4. The fault-out pulse width t_{FOD} depends on the capacitance value of C_{FOD} according to the following approximate equation : C_{FOD} = 24 x 10^{-6} x t_{FOD} [F]

Recommended Operating Condition

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
V_{PN}	Supply Voltage	Applied Between P and N	-	300	400	V
V_{DD}	Control Supply Voltage	Applied Between V_{DD} and COM	13.5	15.0	16.5	V
V_{BS}	High-Side Bias Voltage	Applied Between V_B and V_S	13.5	15.0	16.5	V
dV_{DD}/dt, dV_{BS}/dt	Control Supply Variation		-1.0	-	1.0	V/μs
t_{dead}	Blanking Time for Preventing Arm-Short	$V_{DD} = V_{BS} = 13.5 \sim 16.5$ V, $T_J \leq 150°C$	500	-	-	ns
f_{PWM}	PWM Switching Frequency	$T_J \leq 150°C$	-	15	-	kHz

Thermal Resistance

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
$R_{\theta JCB}$	Junction to Case Bottom Thermal Resistance	Single MOSFET Operating Condition (3rd Notes 1)	-	0.9	-	°C/W

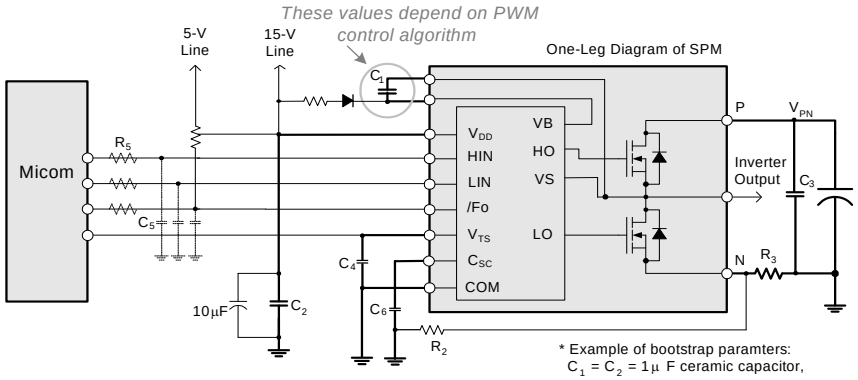


Figure 2. Recommended MCU Interface and Bootstrap Circuit with Parameters

3rd Notes:

1. $R_{\theta JCB}$ is simulation value with application board layout. (Please refer user's guide SPM7 series)
2. Parameters for bootsrap circuit elements are dependent on PWM algorithm. For 15 kHz of switching frequency, typical example of parameters is shown above.
3. RC coupling(R_5 and C_5) at each input (indicated as dotted lines) may be used to prevent improper input signal due to surge noise. Signal input of SPM® is compatible with standard CMOS or LSTTL outptus.
4. Bold lines should be short and thick in PCB pattern to have small stray inductance of circuit, which results in the reduction of surge voltage.

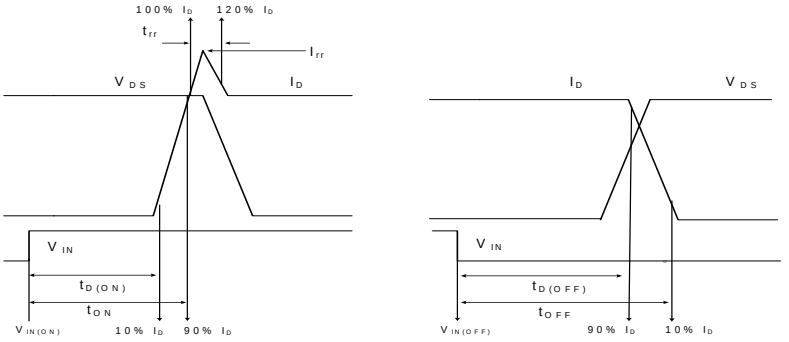


Figure 3. Switching Time Definition

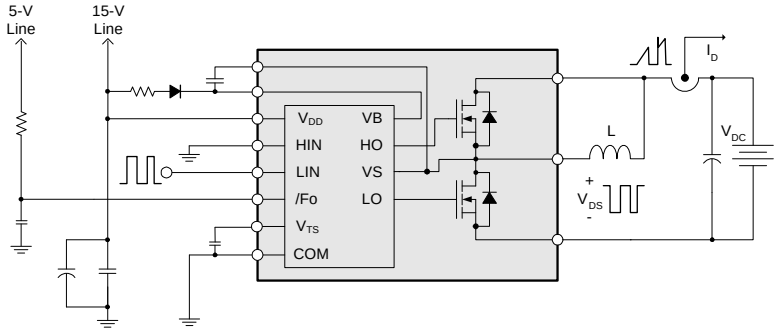


Figure 4. Switching Test Circuit (Low-side)

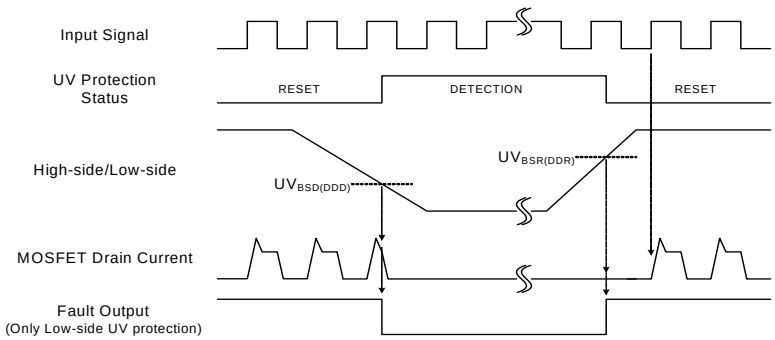


Figure 5. Under Voltage Protection

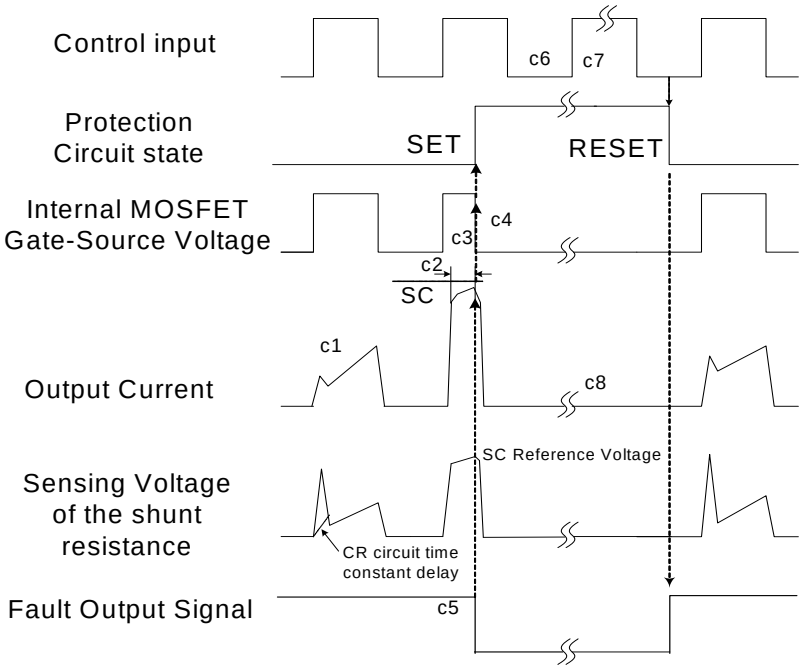


Figure 6. Short-Circuit Current Protection

(with the external shunt resistance and CR connection)

c1 : Normal operation: MOSFET ON and carrying current.

c2 : Short circuit current detection (SC trigger).

c3 : Hard MOSFET gate interrupt.

c4 : MOSFET turns OFF.

c5 : Fault output timer operation start : Fault-out width (t_{FOD})

c6 : Input “L” : MOSFET OFF state.

c7 : Input “H”: MOSFET ON state, but during the active period of fault output the MOSFET doesn’t turn ON.

c8 : MOSFET OFF state

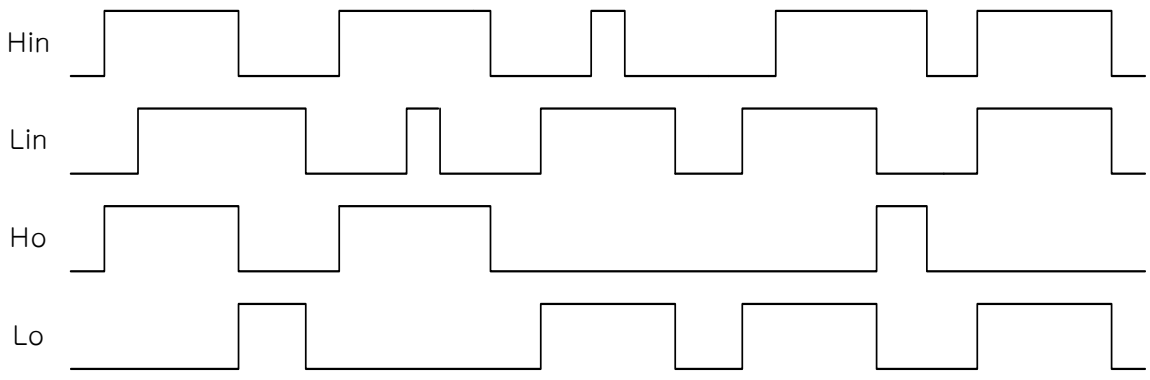


Figure 7. Timing Chart of Interlock Function

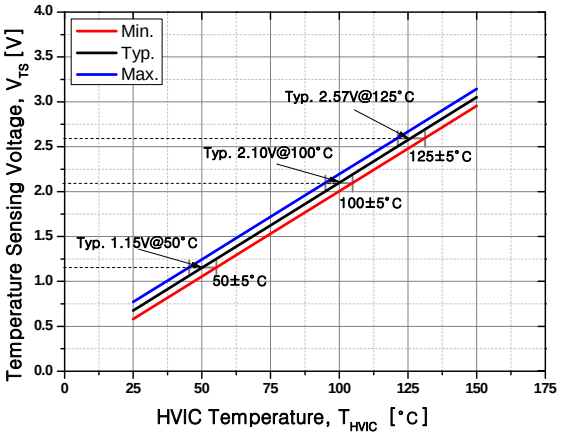


Figure 8. Temperature profile V_{TS} vs. T_{HVIC}

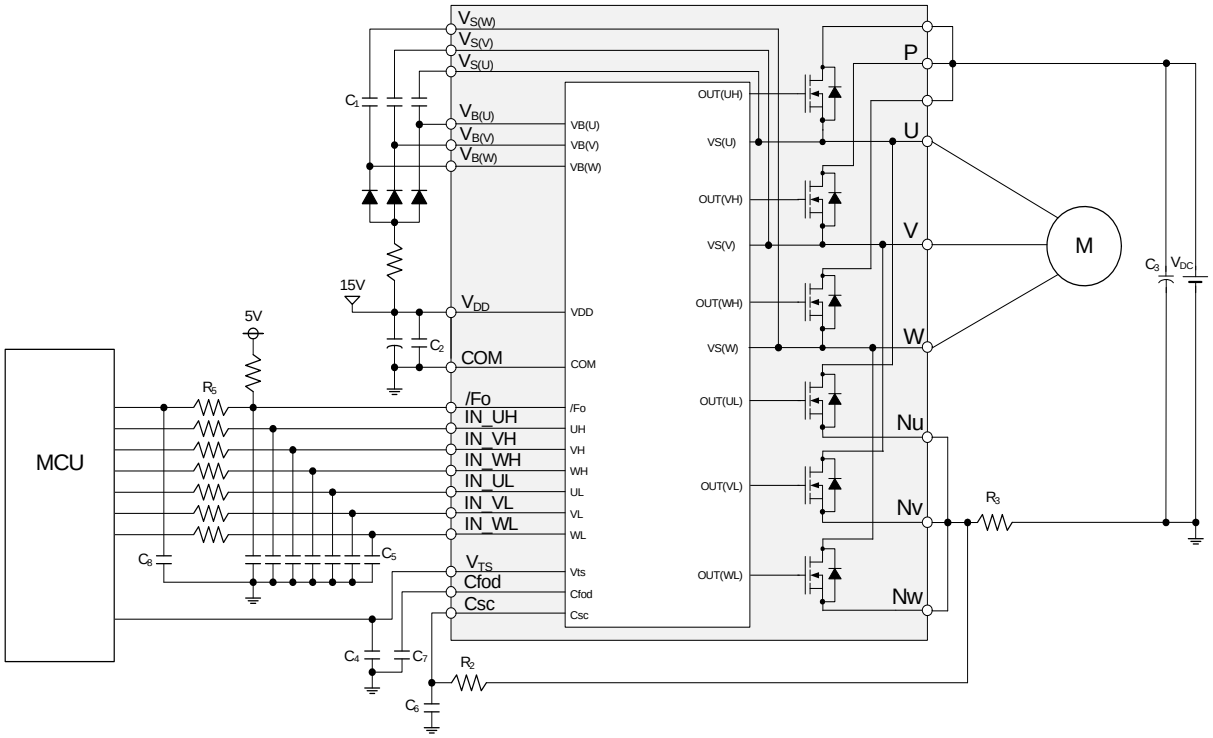
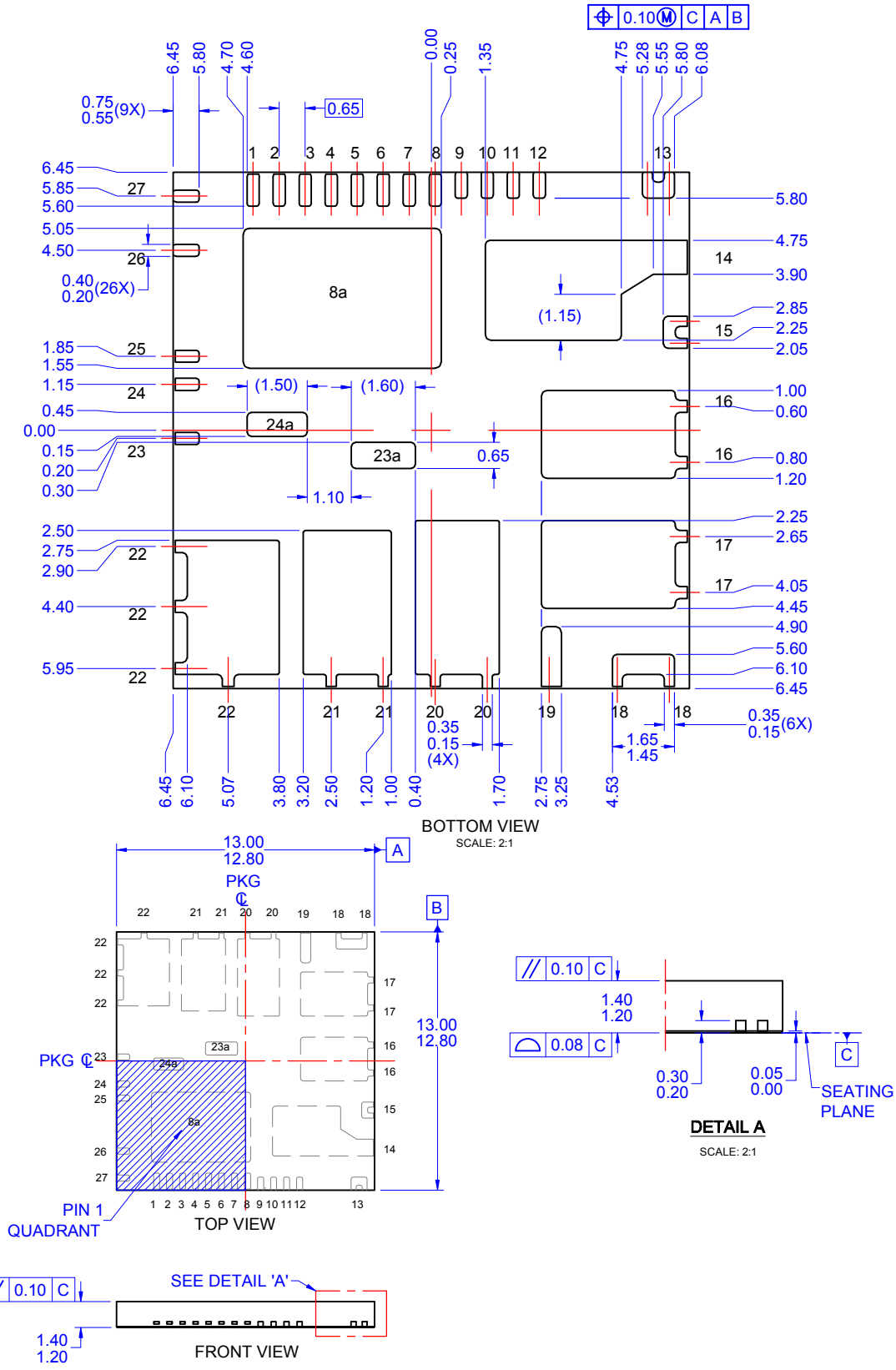
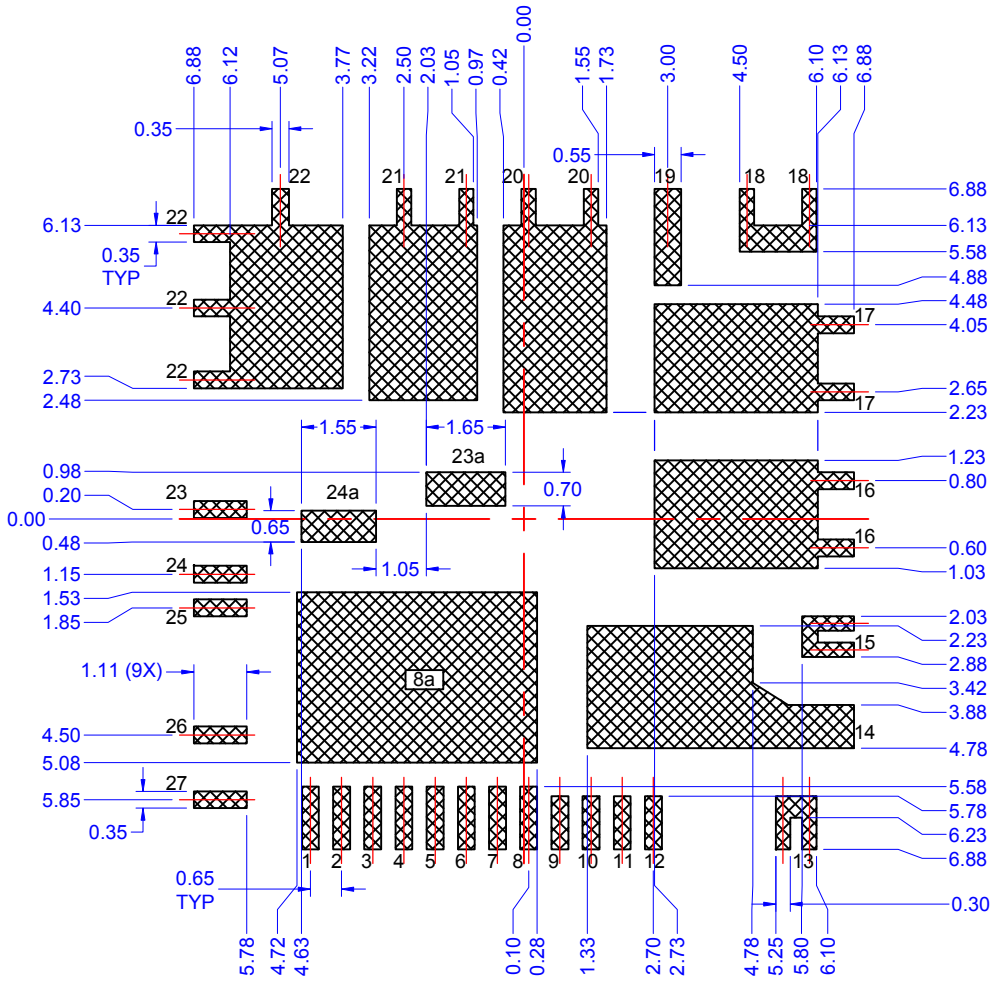


Figure 9. Example of Application Circuit

4th Notes:

1. RC-coupling (R_5 and C_5, R_2 and C_6) and C_1, C_5, C_7, C_8 at each input of Motion SPM® 7 product and MCU are useful to prevent improper input signal caused by surge-noise.
2. Ground-wires and output terminals, should be thick and short in order to avoid surge-voltage and malfunction of HVIC.
3. All the filter capacitors should be connected close to Motion SPM 7 product, and they should have good characteristics for rejecting high-frequency ripple current.


0.10 M C A B
BOTTOM VIEW
SCALE: 2:1
TOP VIEW
PIN 1 QUADRANT
FRONT VIEW
SEE DETAIL 'A'
DETAIL A
SCALE: 2:1
SEATING PLANE
PKG ℄
8a
23a
24a
(1.15)
(1.50)
(1.60)
1.10
0.65
0.35
0.15
(4X)
(6X)
1.65
1.45
13.00
12.80
1.40
1.20
0.30
0.20
0.05
0.00
0.10 C
0.08 C



LAND PATTERN
RECOMMENDATION
SCALE: 2:1

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D) DRAWING CONFORMS TO ASME Y14.5M-1994.

E) LAND PATTERN REFERENCE: QFN65P1290X1290X140-40N-40N

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