Is Now Part of

ON Semiconductor®

To learn more about ON Semiconductor, please visit our website at
www.onsemi.com

December 2015

FSB70325
Motion SPM® 7 Series

Features

- UL Certified No. E209204 (UL1557)
- High Performance PQFN Package
- 250 V $R_{DS(on)}$ = 1.4 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 FSB70325 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
FSB70325	FSB70325	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		250	V
$*I_{D\ 25}$	Each MOSFET Drain Current, Continuous	T_{CB} = 25°C (1st Notes 1)	4.1	A
$*I_{D\ 80}$	Each MOSFET Drain Current, Continuous	T_{CB} = 80°C	3.1	A
$*I_{DP}$	Each MOSFET Drain Current, Peak	T_{CB} = 25°C, PW < 100 μs	8.2	A
$*P_D$	Maximum Power Dissipation	T_{CB} = 25°C, For Each MOSFET	49	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 Mosfet driving
24 (24a)	$V_{S(U)}$	High-side Bias Voltage Ground for U phase Mosfet driving
25	$V_{B(U)}$	High-side Bias Voltage for U phase Mosfet driving
26	$V_{B(V)}$	High-side Bias Voltage for V phase Mosfet driving
27	$V_{B(W)}$	High-side Bias Voltage for W phase Mosfet driving

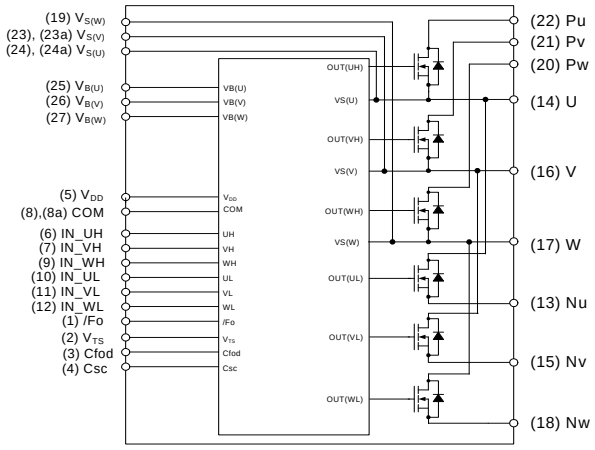


Figure 1. Pin Configuration and Internal Block Diagram

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)	250	-	-	V
I_{DSS}	Zero Gate Voltage Drain Current	V_{IN} = 0 V, V_{DS} = 250 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	-	1.1	1.4	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} = 150 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)	-	460	-	ns
$t_{D(ON)}$			-	405	-	ns
t_{OFF}			-	340	-	ns
$t_{D(OFF)}$			-	280	-	ns
I_{rr}			-	1.3	-	A
t_{rr}			-	72	-	ns
E_{ON}			-	25	-	μJ
E_{OFF}			-	22	-	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	-	150	200	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)	-	2.0	-	°C/W

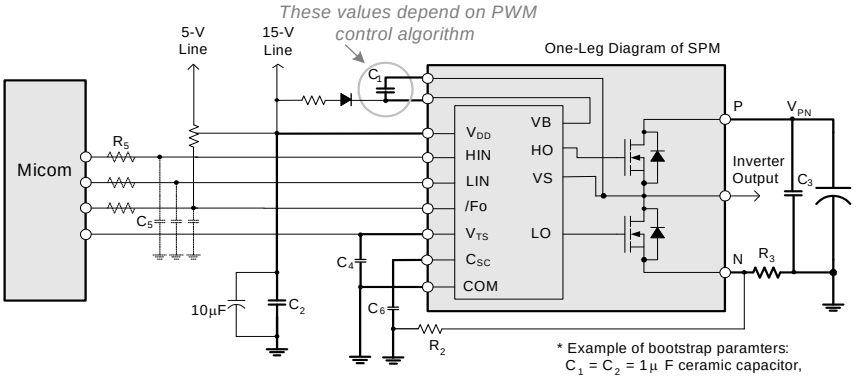


Figure 2. Recommended MCU Interface and Bootstrap Circuit with Parameters

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_S and C_S) 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.

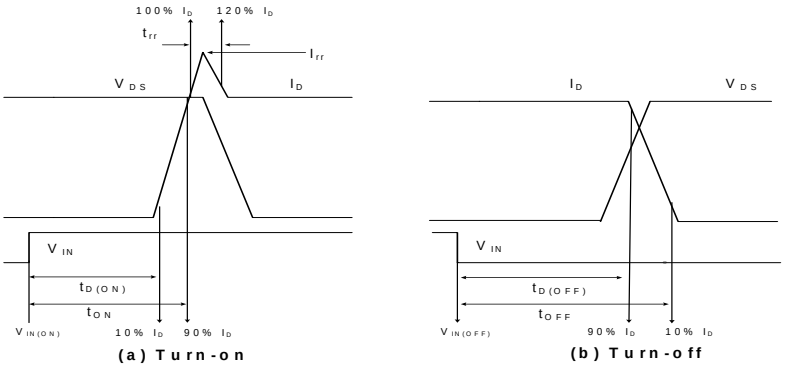


Figure 3. Switching Time Definition

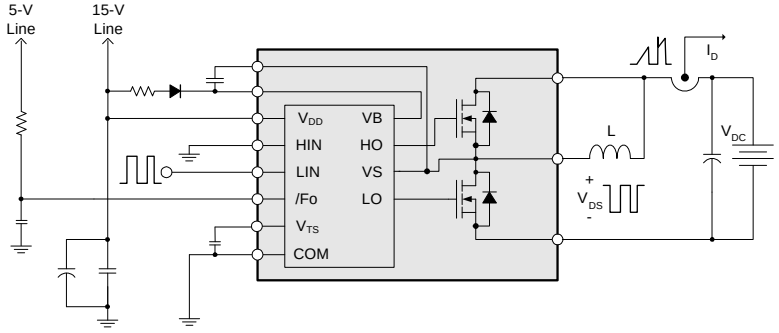


Figure 4. Switching Test Circuit (Low-side)

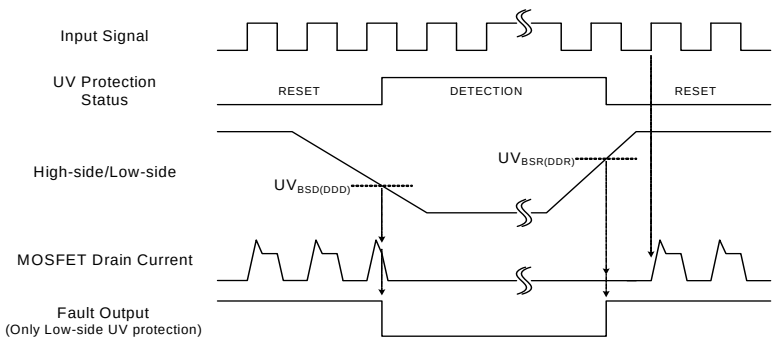


Figure 5. Under Voltage Protection

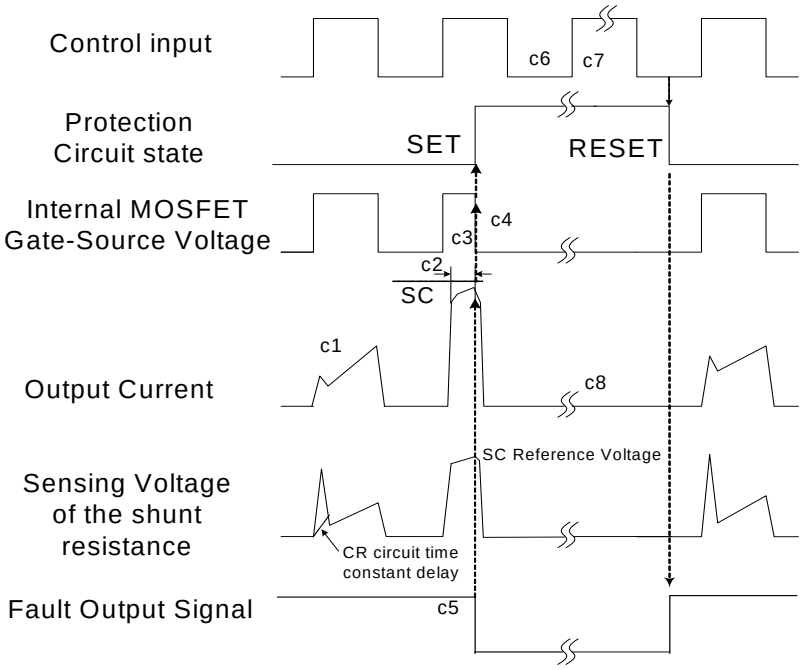


Figure 6. Short-Circuit Current Protection

(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

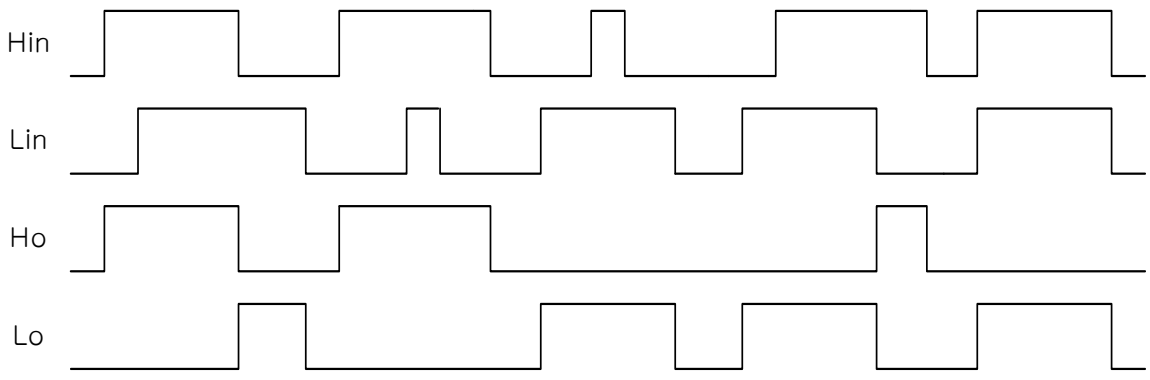


Figure 7. Timing Chart of Interlock Function

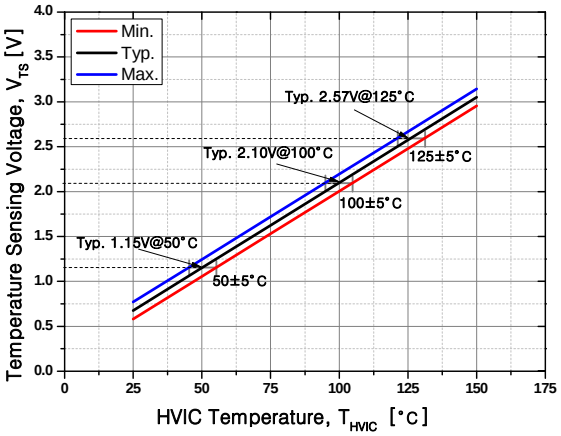


Figure 8. Temperature profile V_{TS} vs. T_{HVIC}

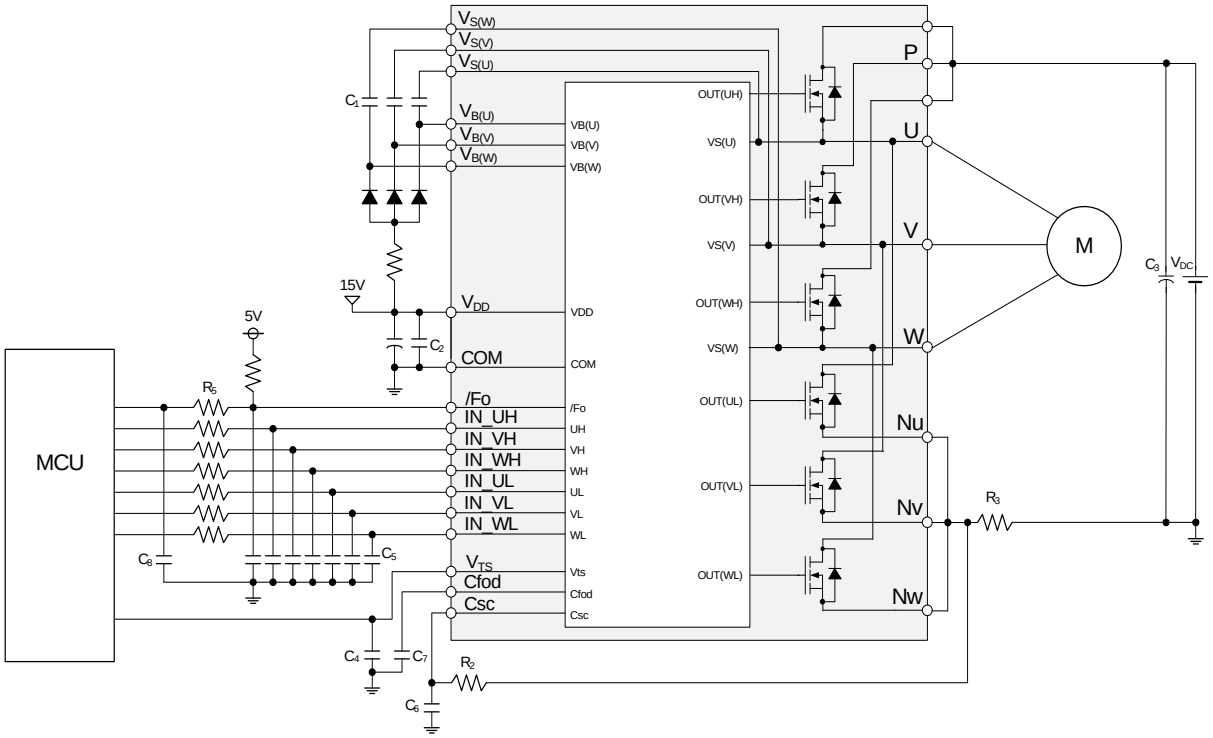
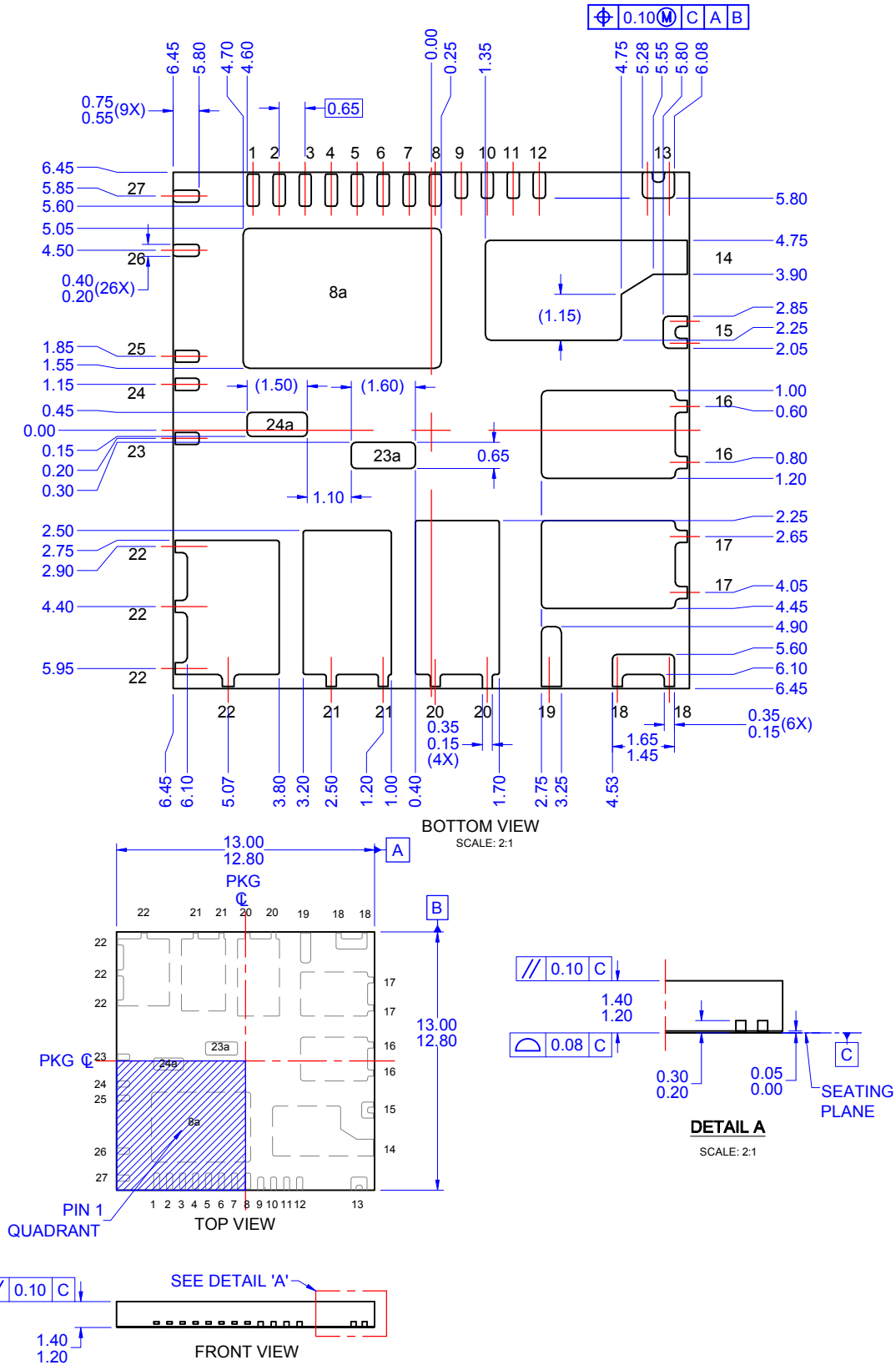
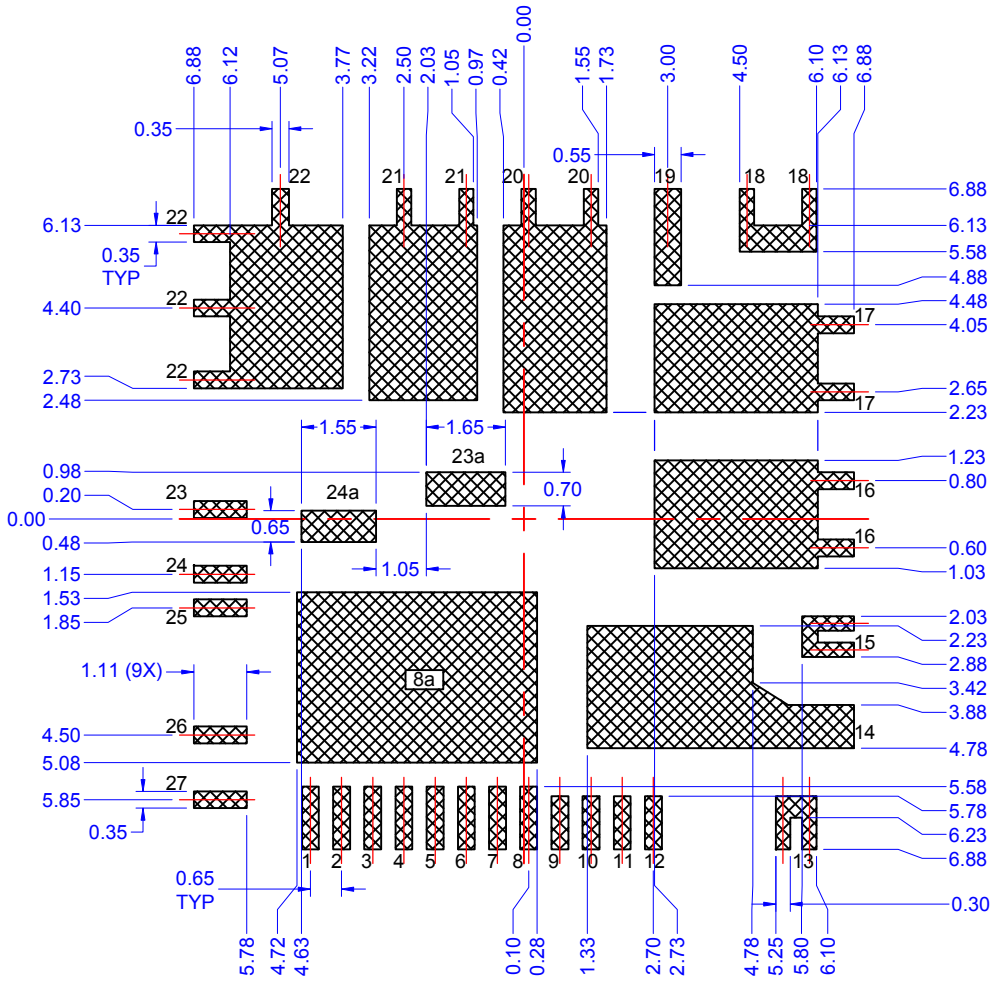


Figure 9. Example of Application Circuit

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

NOTES: UNLESS OTHERWISE SPECIFIED

A) THIS PACKAGE IS NOT PRESENTLY REGISTERED TO ANY STANDARD COMMITTEE.

B) DIMENSIONS DO NOT INCLUDE BURRS OR MOLD FLASH. MOLD FLASH OR BURRS DOES NOT EXCEED 0.10MM.

C) ALL DIMENSIONS ARE IN MILLIMETERS.

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

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

F) DRAWING FILE NAME: MKT-PQFN27AREV3.

G) IT IS NOT NECESSARY TO SOLDER 23a AND 24a, AND CAN BE OMITTED FROM THE FOOTPRINT

H) FAIRCHILD SEMICONDUCTOR

TRADEMARKS

The following includes registered and unregistered trademarks and service marks, owned by Fairchild Semiconductor and/or its global subsidiaries, and is not intended to be an exhaustive list of all such trademarks.

AccuPower™
AttitudeEngine™
Awinda®
AX-CAP®*
BitSiC™
Build it Now™
CorePLUS™
CorePOWER™
CROSSVOLT™
CTL™
Current Transfer Logic™
DEUXPEED®
Dual Cool™
EcoSPARK®
EfficientMax™
ESBC™
Fairchild®
Fairchild Semiconductor®
FACT Quiet Series™
FACT®
FastvCore™
FETBench™
FPS™
F-PFS™
FRFET®
Global Power Resource SM
GreenBridge™
Green FPS™
Green FPS™ e-Series™
G*max*™
GTO™
IntelliMAX™
ISOPLANAR™
Making Small Speakers Sound Louder and Better™
MegaBuck™
MICROCOUPLER™
MicroFET™
MicroPak™
MicroPak2™
MillerDrive™
MotionMax™
MotionGrid®
MTi®
MTx®
MVN®
mWSaver®
OptoHiT™
OPTOLOGIC®
OPTOPLANAR®
®
Power Supply WebDesigner™
PowerTrench®
PowerXS™
Programmable Active Droop™
QFET®
QS™
Quiet Series™
RapidConfigure™
™
Saving our world, 1mW/W/kW at a time™
SignalWise™
SmartMax™
SMART START™
Solutions for Your Success™
SPM®
STEALTH™
SuperFET®
SuperSOT™-3
SuperSOT™-6
SuperSOT™-8
SupreMOS®
SyncFET™
Sync-Lock™
SYSTEM GENERAL®*
TinyBoost®
TinyBuck®
TinyCalc™
TinyLogic®
TINYOPTO™
TinyPower™
TinyPWM™
TinyWire™
TranSiC™
TriFault Detect™
TRUECURRENT®*
µSerDes™
SerDes™
UHC®
Ultra FRFET™
UniFET™
VCX™
VisualMax™
VoltagePlus™
XS™
Xsens™
仙童®

* Trademarks of System General Corporation, used under license by Fairchild Semiconductor.

DISCLAIMER

FAIRCHILD SEMICONDUCTOR RESERVES THE RIGHT TO MAKE CHANGES WITHOUT FURTHER NOTICE TO ANY PRODUCTS HEREIN TO IMPROVE RELIABILITY, FUNCTION, OR DESIGN. TO OBTAIN THE LATEST, MOST UP-TO-DATE DATASHEET AND PRODUCT INFORMATION, VISIT OUR WEBSITE AT HTTP://WWW.FAIRCHILDSEMI.COM. FAIRCHILD DOES NOT ASSUME ANY LIABILITY ARISING OUT OF THE APPLICATION OR USE OF ANY PRODUCT OR CIRCUIT DESCRIBED HEREIN; NEITHER DOES IT CONVEY ANY LICENSE UNDER ITS PATENT RIGHTS, NOR THE RIGHTS OF OTHERS. THESE SPECIFICATIONS DO NOT EXPAND THE TERMS OF FAIRCHILD'S WORLDWIDE TERMS AND CONDITIONS, SPECIFICALLY THE WARRANTY THEREIN, WHICH COVERS THESE PRODUCTS.

AUTHORIZED USE

Unless otherwise specified in this data sheet, this product is a standard commercial product and is not intended for use in applications that require extraordinary levels of quality and reliability. This product may not be used in the following applications, unless specifically approved in writing by a Fairchild officer: (1) automotive or other transportation, (2) military/aerospace, (3) any safety critical application – including life critical medical equipment – where the failure of the Fairchild product reasonably would be expected to result in personal injury, death or property damage. Customer's use of this product is subject to agreement of this Authorized Use policy. In the event of an unauthorized use of Fairchild's product, Fairchild accepts no liability in the event of product failure. In other respects, this product shall be subject to Fairchild's Worldwide Terms and Conditions of Sale, unless a separate agreement has been signed by both Parties.

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 Terms of Use

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.

Rev. I77

Mouser Electronics

Authorized Distributor

Click to View Pricing, Inventory, Delivery & Lifecycle Information:

Fairchild Semiconductor:

FSB70325