Product Overview

Features

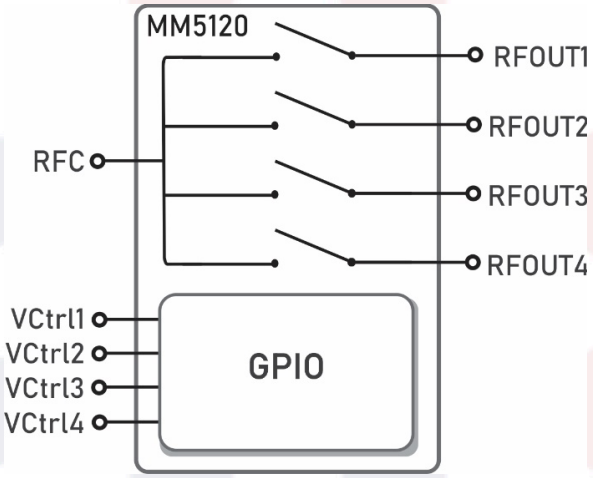
- DC to 12 GHz Frequency Range
- 25 W (CW), 150 W (Pulsed) Power Handling
- Ultra-Low Insertion Loss, 0.35 dB @ 6 GHz
- IP3 > 85 dBm
- 25 dB Isolation @ 6 GHz
- Maximum Voltage (AC or DC): +/-150 V on RF Input
- High Reliability, > 3 Billion Switching Operations
- Integrated Gate Control with HV Boost
- 4 mm x 4 mm Lead-Free RoHS Compliant BGA Package

Markets

- Defense and Aerospace
- Test and Measurement
- Wireless Infrastructure

Applications

- Switched Filter Banks and Tunable Filters
- High Power RF Front-Ends
- Low-Loss Switch Matrices
- RF EM Relay Replacement
- Antenna Tuning
- Antenna Beam Steering
- Digital Step Attenuators



Description

The Menlo Micro MM5120 is the world's first generally available high-power RF SP4T micro-mechanical switch. Menlo Micro has developed a new Digital-Micro-Switch (DMS) fabrication process and applied it to DC and wideband RF/microwave switch applications. This innovative DMS technology enables robust and highly reliable switches capable of greater than 25W CW power handling at 6GHz. The MM5120 provides ultra-low insertion loss and superior linearity from 12 GHz down to DC, with greater than 3 billion switching cycles guaranteed at elevated +85 °C temperatures. An integrated analog gate driver allows the user to provide a low voltage and generate the high voltage gate bias internally. The MM5120 is an ideal solution for replacing large RF electromechanical relays, as well as RF/microwave solid-state switches where linearity and insertion loss are critical parameters.

Functional Block Diagrams

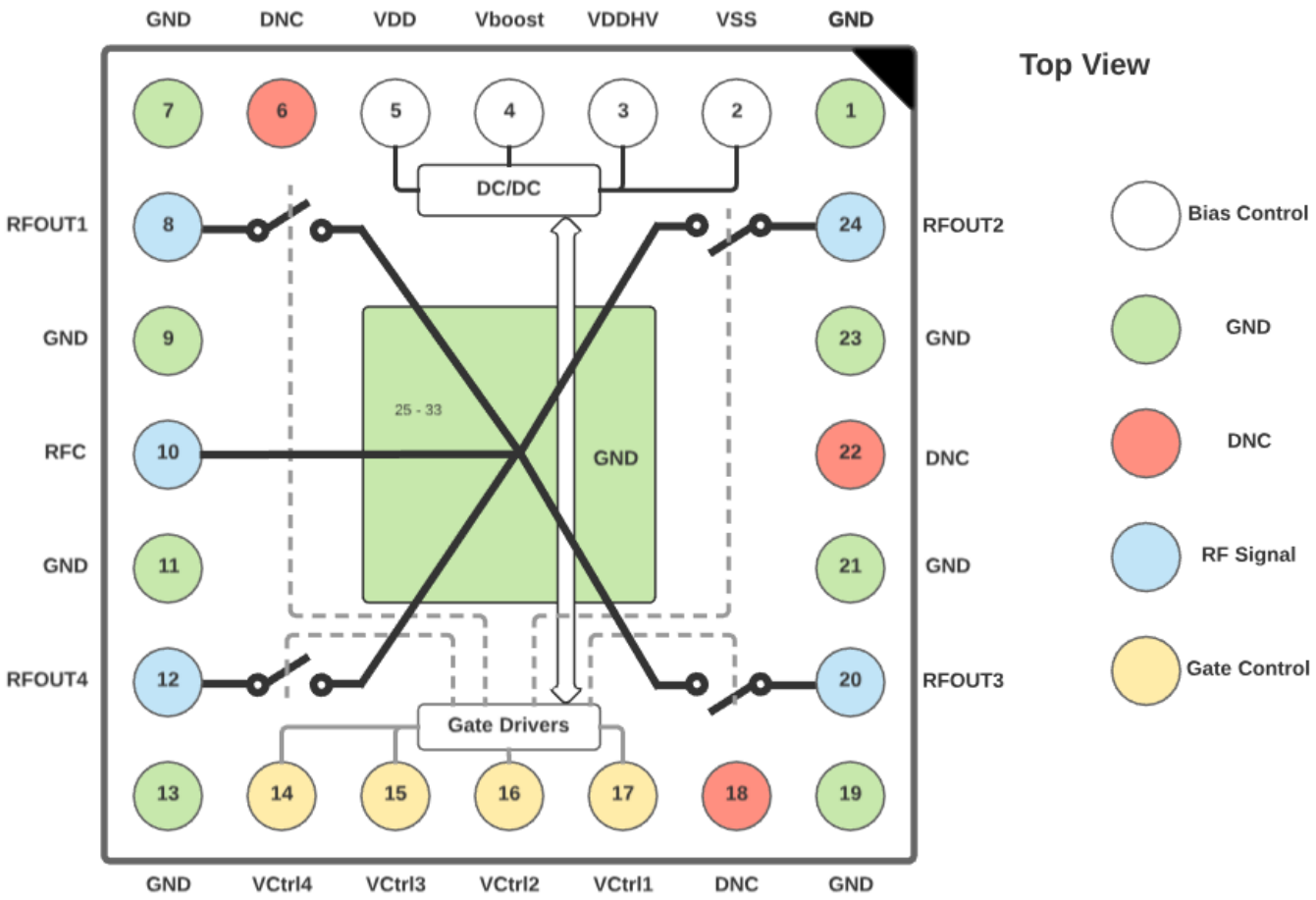


Figure 1.Functional Block Diagram

Electrical Characteristics

Operating Characteristics

Absolute Maximum Ratings

Exceeding the maximum ratings as listed in Table 1 below may reduce the reliability of the device or cause permanent damage. Operation of the MM5120 should be restricted to the limits indicated in Table 2a and 2b recommended operating conditions listed below.

Electrostatic Discharge (ESD) Safeguards

When handling the MM5120, observe the same precautions as with any other ESD sensitive devices. Precautions must be taken to avoid exceeding the ratings specified in Table 1 below.

Susceptibility to Latch-Up

The MM5120 digital micro switch device is not susceptible to switch latch-up condition.

Table 1 Maximum Ratings

Parameter	Minimum	Maximum	Unit
Total CW Power Handling @6GHz		25	W
Open State DC Voltage Rating (RFC to RFOUT)	-150	150	V
DC Current Rating / Switch		500	mA
Operating Temperature Range	-40	+85	°C
Storage Temperature Range	-70	+150	°C
DC Supply Voltage (VDD)	-0.3	4.0	V
Input Control Voltage	-0.3	VDD+0.3	V

Table 2a Recommended Operating Conditions

Operating with V_{SS} connected to system ground and GND pins (0 V). Operating with input frequencies of greater than 10 MHz in a 50 Ω System.

Parameter	Minimum	Typical	Maximum	Unit
Operating Frequency Range			12	GHz
Peak Power @ 10% Duty Cycle[1]			150	W
RF Hot-Switch Power Handling			15	dBm
Insertion Loss @ 6 GHz		0.35	TBD	dB
Insertion Loss @ 12 GHz		0.75	TBD	dB
Return Loss @ 6 GHz		17		dB
Return Loss @ 12 GHz		11		dB
Isolation @ 6 GHz	TBD	30		dB
Isolation @ 12 GHz	TBD	28		dB
Crosstalk @ 6 GHz	TBD	25		dB
Third-Order Output Intercept (IP3)	TBD	> 85		dBm
Second-Order Output Intercept (IP2)	TBD	> 125		dBm
Second Harmonic (H2)			TBD	dBc
Third Harmonic (H3)			TBD	dBc

[1] Duty Cycle based on 10 us period.

Table 2a Recommended Operating Conditions (Continued)

Operating with V_{SS} connected to system ground and GND pins (0 V). Operating with input frequencies of greater than 10 MHz in a 50 Ω System.

Parameter	Minimum	Typical	Maximum	Unit
Hot Switching Current @ 1 V			10	mA
RFC to RFOUT Leakage Current @ 150 V		19		pA
On-State Resistance		2.5		Ω
Current Consumption (I_{DD})		1.0	2.0	mA
Low Voltage Supply (V_{DD})	3.0	3.3	3.6	V_{DC}
Low Voltage Ground (V_{SS})		0		V_{DC}
Input Control Voltage (V_{CTRL}) Logic High	0.7*V_{DD}	V_{DD}		V_{DC}
Input Control Voltage (V_{CTRL}) Logic Low		Vss	0.3*V_{SS}	V_{DC}
Operating Temperature Range	-40		85	°C
Video Feedthrough[2]		16	TBD	mV_{Peak}
Internal Oscillator Frequency		5		MHz
Internal Oscillator Feedthrough[3,4]			-110	dBm

[2] Performed with 1 MΩ termination
[3] The MM5120 has an internal oscillator. This oscillator drives the boost circuitry that provides the actuation voltage for each of the switch gates.

Table 2a Recommended Operating Conditions (Continued)

Operating with V_{SS} connected to system ground and GND pins (0 V). Operating with input frequencies of greater than 10 MHz in a 50 Ω System.

Parameter	Minimum	Typical	Maximum	Unit
Stand Off Voltage RFC to RFOUT	-150		150	$V_{DC/ACrms}$
Full Cycle Frequency			10	kHz
Switching Time		8		us
Switch Cycle Operations / Lifetime[5]	$3x10^9$			Cycles
Steady State Carry Current			500	mA
Package Weight		0.127		g
Moisture Sensitivity Level (Class 3)[6]			168	h

Table 2b Recommended Operating Conditions Less Than 10 MHz

Operating with V_{SS} connected to system ground and GND pins (0 V). Operating with input frequencies of less than 10 MHz in a 50 Ω System. For specifications not called out here, refer to Table 2.

Parameter	Minimum	Typical	Maximum	Unit
CW RF Power			1	W
On / Closed State Switch Rated Voltage (RFC/RFOUT to V_{SS})[7]	-45		45	V_{DC}

[5] Under cold switch conditions.
[6] Time period the device can be exposed to 30 °C at 60% Relative Humidity prior to mounting.
[7] This rating applies for Frequencies below 10MHz. For frequencies above 10MHz, see *CW Power / Channel* and *Peak Power / Channel* specifications.

Pinout Information

Figure 1 MM5120 4mm x 4mm BGA package pinout (Top View)

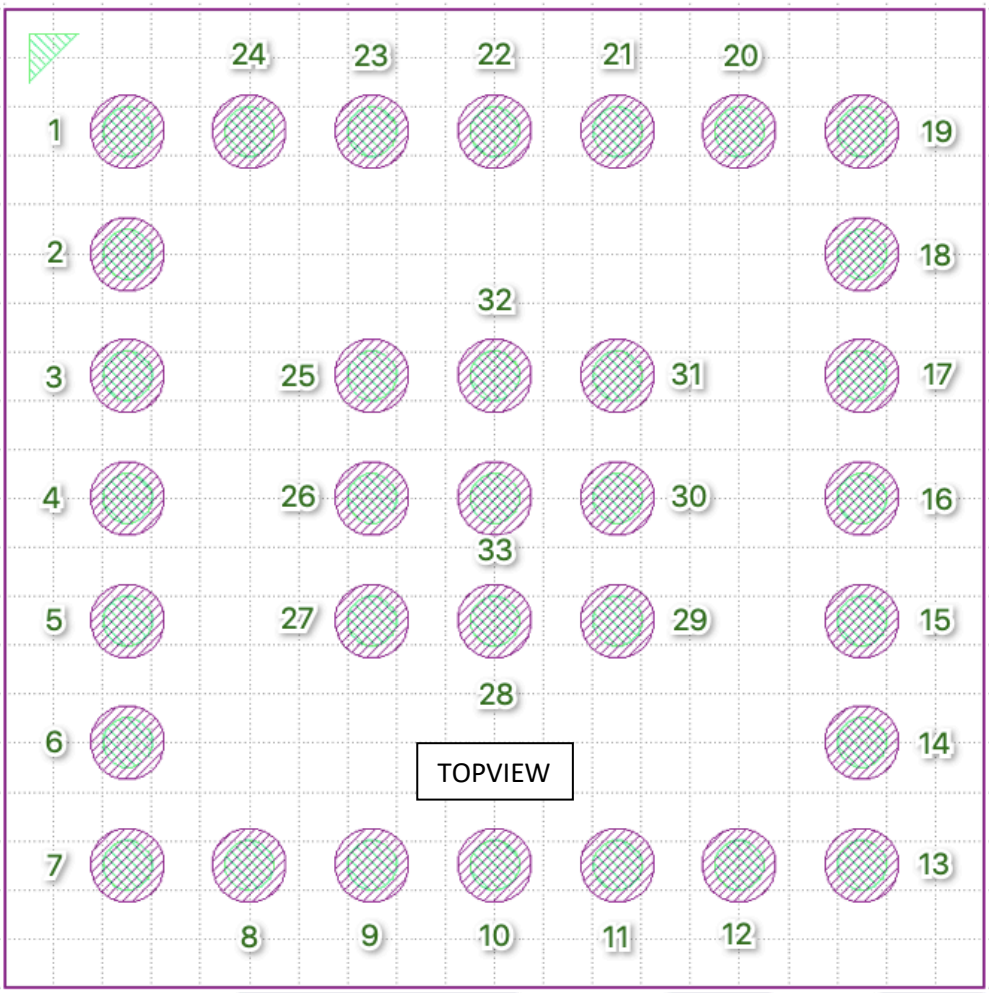


Table 3 Detailed Pin Description

Ball #	Function	Description
6, 18, 22	DNC	Do Not Connect
1,7,9,11,13,19,21,23,25-33	GND	RF Ground
2	VSS	Digital Ground
3	VDDHV	External High Voltage Supply
4	Vboost	Internally Generated High Voltage

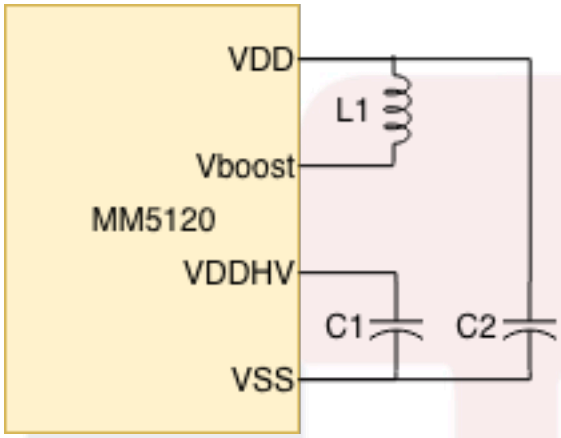
Ball #	Function	Description
5	VDD	Low Voltage Bias Supply
8	RFOUT1	RF Output 1 (Contact)
10	RFC	RF Common Input (Contact)
12	RFOUT4	RF Output 4 (Contact)
14	VCtrl4	Gate Actuation Control RF4
15	VCtrl3	Gate Actuation Control RF3
16	VCtrl2	Gate Actuation Control RF2
17	VCtrl1	Gate Actuation Control RF1
20	RFOUT3	RF Output 3 (Contact)
24	RFOUT2	RF Output 2 (Contact)

Table 4 Voltage Control Truth Table when Logic levels are applied, 1 is High, 0 is Low

VCtrl4	VCtrl3	VCtrl2	VCtrl1	RFC – RF4	RFC – RF3	RFC – RF2	RFC – RF1
0	0	0	**1**	Off	Off	Off	**On**
0	0	**1**	0	Off	Off	**On**	Off
0	**1**	0	0	Off	**On**	Off	Off
1	0	0	0	**On**	Off	Off	Off

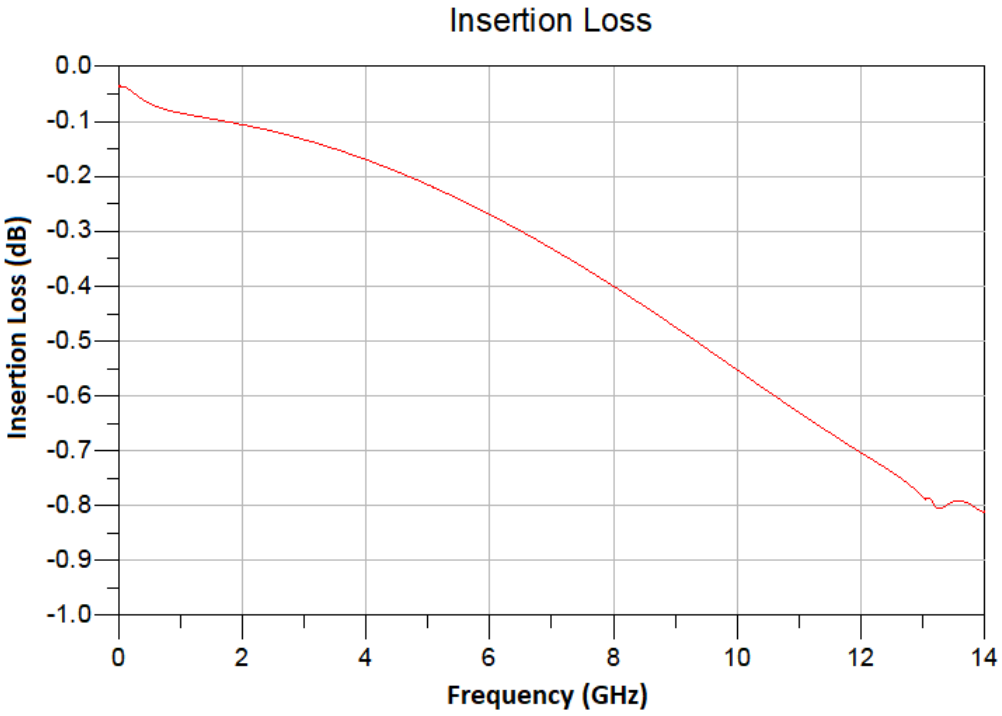
External Circuitry

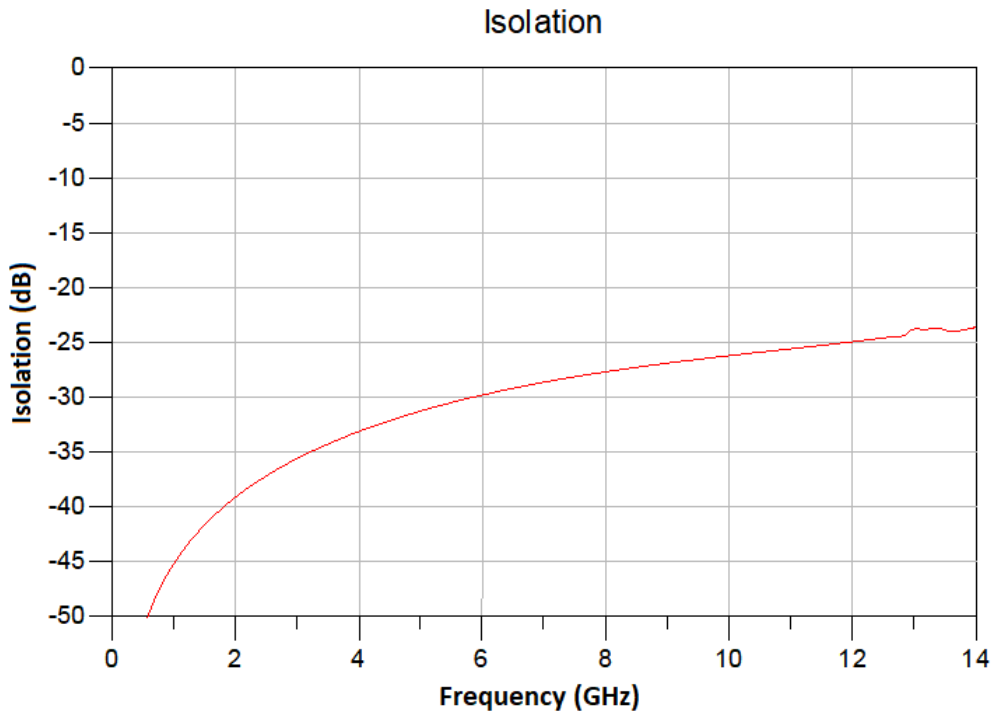
The MM5120's internal driver requires external circuitry to operate its boost converter. The following is suggested components; these suggestions are subject to change.

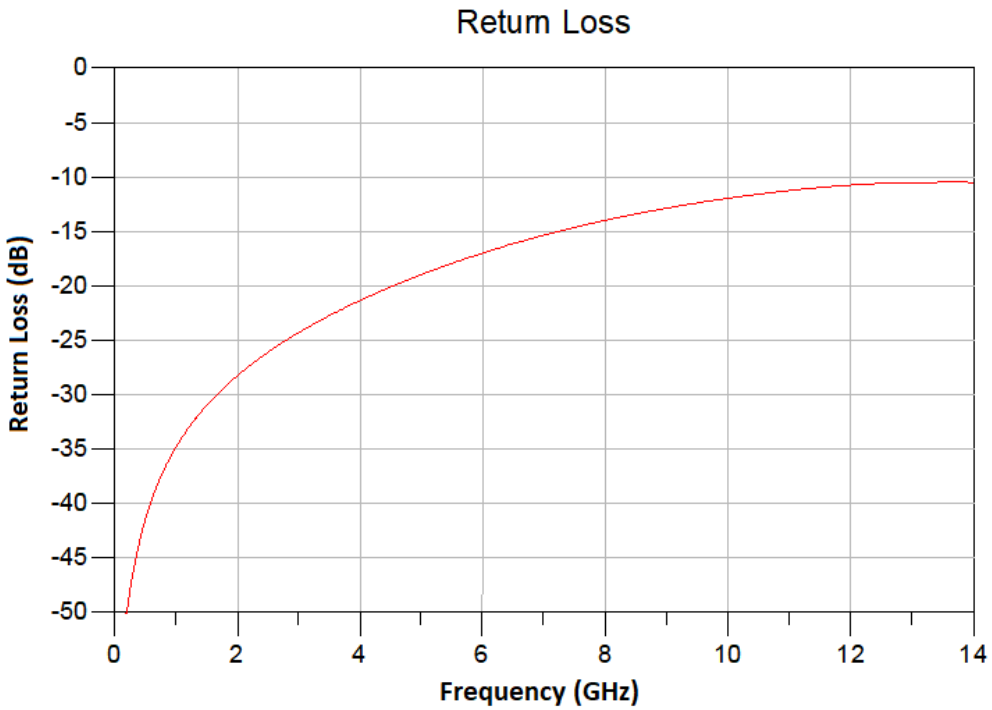


Symbol	Description	Min	Typical	Max	Units
C1	VDDHV Decoupling Capacitor	0.8	1	1.2	nF
C2	VDD Decoupling Capacitor	80	100	120	nF
L1	Boost Regulator Inductor	80	100	120	uH

RF Performance (3D simulated)

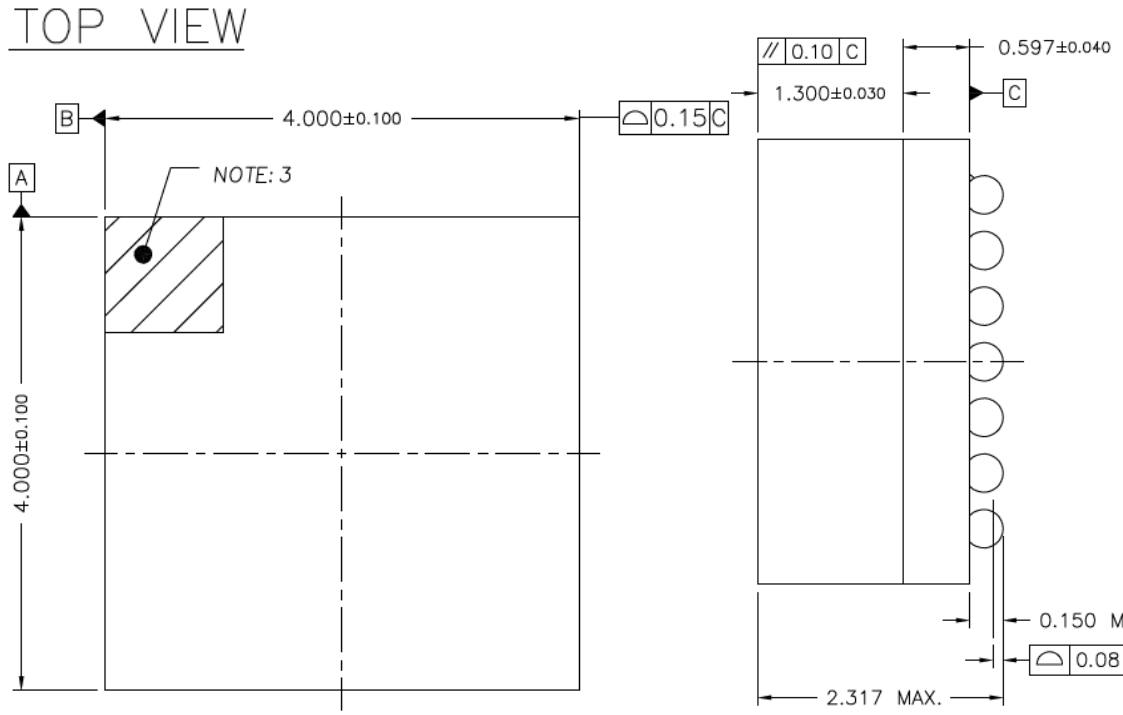


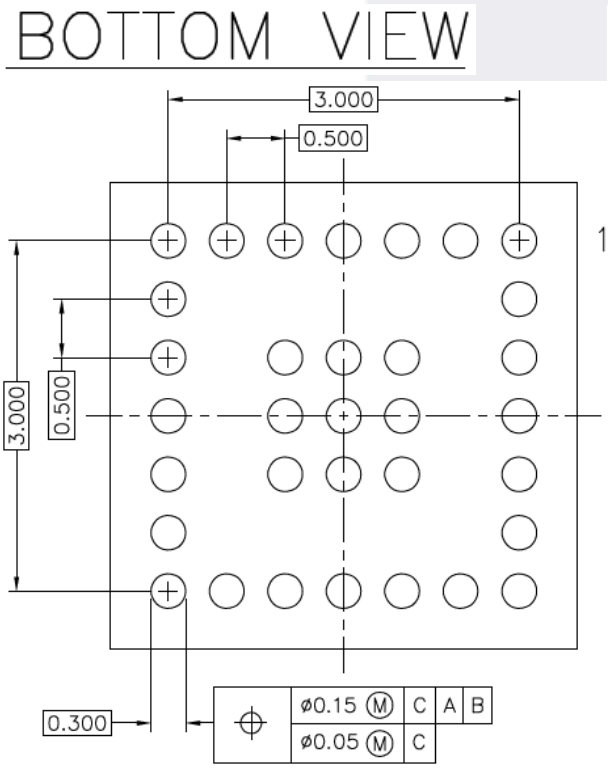




Package Dimensions

33 Ball 4x4 FC BGA Package





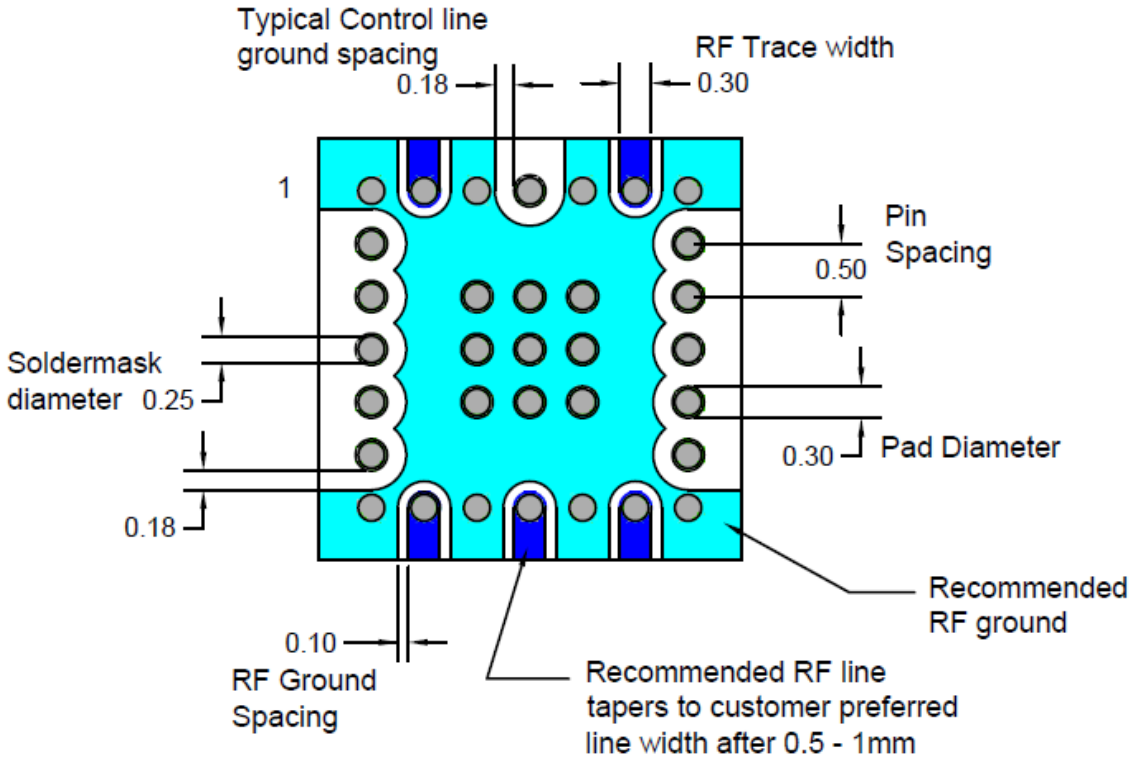
NOTES :
1. DIMENSIONING & TOLERANCING PER ASME Y14.5M – 1994.
2. CONTROLLING DIMENSIONS ARE IN MM.
3. DETAILS OF P1 CORNER ARE OPTIONAL, AND MAY CONSIST OF INK DOT, LASER MARK OR METALIZED MARKING, BUT MUST BE LOCATED WITHIN THE ZONE INDICATED.
4. SOLDER BALLS, ARE LEAD FREE SOLDER.
5. PRIMARY DATUM C AND SEATING PLANE ARE DEFINED BY THE SPHERICAL CROWNS OF THE SOLDER BALLS.
6. REFER TO JEDEC PUBLICATION 95 DESIGN GUIDE 4.5 FINE-PITCH SQUARE BALL GRID ARRAY PACKAGE FOR DATUMS. FEATURES AND DIMENSIONS NOT SHOWN.
7. RELEVANT DRAWING/S:
   7.A. STRIP OUTLINE DRAWING: RA00XXSO-XX
   7.B. SUBSTRATE OUTLINE DRAWING: RA0033ST-XX

UNIT MM — 33 BALL 4x4mm FCBGA PACKAGE OUTLINE DRAWING
PITCH-0.50mm (1.3mm Mold, 0.597mm Sub. thk., 0.30mm BALL)

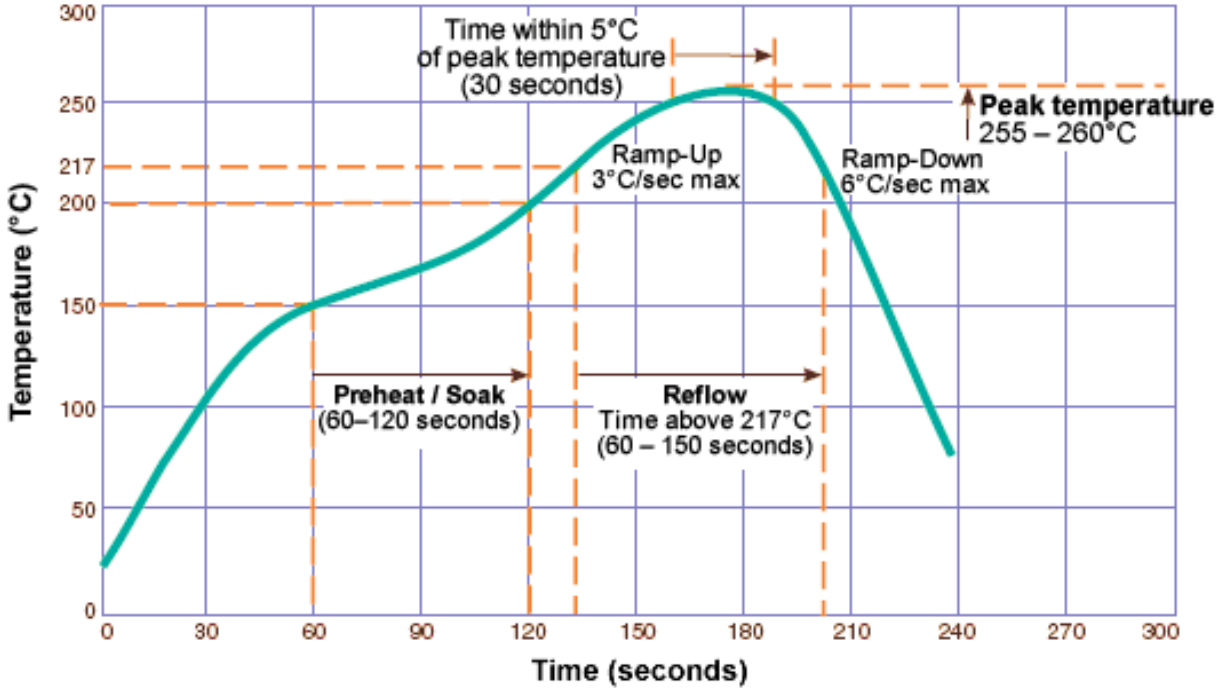
Recommended PCB layout and SMT Parameters

- PCB lands should be as shown in the pad pattern diagram below.
- Open space around the package can have grounded thru holes.
- Use ENIG pad surface finish.
- Use 100 micron thick soldermask.
- Use Type 3 or higher solder paste with no clean flux.
- Component placement force should not exceed 100 grams.

Recommended PCB layout



Recommended Solder Reflow Profile



- *A ROHS compliant Solder Alloy used is SAC alloy: 96.5% Sn, 3.0%Ag, 0.5%Cu. These are the nominal percentages of the components. This alloy is designed to replace SnPb solders to eliminate Lead (Pb) from the process, requiring a higher reflow temperature. Moisture resistance performance may be impacted if not using the Pb-Free reflow conditions.*

Important Information

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