■ Description

IPS009BM is the specific SPXO IC for achieving low Phase Noise, corresponding to the fundamental crystal from 14MHz to 60MHz.

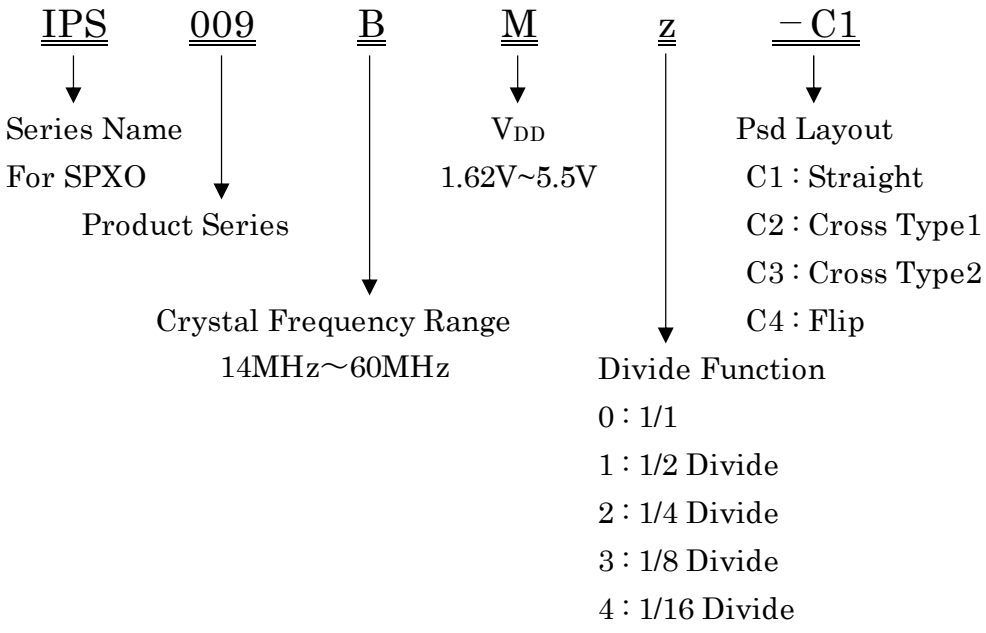
Both the operation temperature (-40℃~125℃) and V_{DD} range(1.62V~5.5V) is wide, so IPS009BM makes the selection of application wider. If slightly poor phase noise performance is allowed, even 1.8V is applicable.

■ Features

- Phase Noise ※ : -162dBc/Hz @ 1MHz, V_{DD}=3.3V, F0=27MHz
- Phase Jitter : 150fs @ 12kHz~20MHz, V_{DD}=3.3V, F0=27MHz
- Operation temperature : -40℃~125℃ (Except V_{DD}=1.62~1.98V, 50MHz~60MHz)
- Power supply voltage ※ : 1.62V~2.25V~5.5V
- Standby function : Oscillation stop
- Crystal frequency : 60MHz maximum
- Output : CMOS
- Divide function : 1/2, 1/4, 1/8 and 1/16
- Small chip size : 0.70mm × 0.75mm
- Frequency stability to V_{DD} : Within ±1ppm
- Duty cycle : Within 50%±5%

※Phase noise performance becomes slightly poor below 2.25V operation.

1. Part number rule



2. Series

Part Number	Crystal Frequency f (MHz)		Divide	Output Frequency F0 (MHz)		Pad Layout	Remarks
	Min.	Max.		Min.	Max.		
IPS009 B M 0 -C1	14.00	60.00	1/1	14.00	60.00	Straight	Low Phase Noise Wide V_{DD} V_{DD}=1.62V~5.5V
IPS009 B M 1 -C1			1/2	7.00	30.00		
IPS009 B M 2 -C1			1/4	3.50	15.00		
IPS009 B M 3 -C1			1/8	1.75	7.50		
IPS009 B M 0 -C2	14.00	60.00	1/1	14.00	60.00	Cross Type1	
IPS009 B M 1 -C2			1/2	7.00	30.00		
IPS009 B M 2 -C2			1/4	3.50	15.00		
IPS009 B M 3 -C2			1/8	1.75	7.50		
IPS009 B M 0 -C3	14.00	60.00	1/1	14.00	60.00	Cross Type2	
IPS009 B M 1 -C3			1/2	7.00	30.00		
IPS009 B M 2 -C3			1/4	3.50	15.00		
IPS009 B M 3 -C3			1/8	1.75	7.50		
IPS009 B M 0 -C4	14.00	60.00	1/1	14.00	60.00	Flip	
IPS009 B M 1 -C4			1/2	7.00	30.00		
IPS009 B M 2 -C4			1/4	3.50	15.00		
IPS009 B M 3 -C4			1/8	1.75	7.50		
IPS009 B M 4 -C4			1/16	0.875	3.75		

3. Absolute Maximum Ratings

V_{SS}=0V, Ta=25℃±2℃

Parameter	Symbol	Condition	Ratings		Unit
			Min	Max	
Supply Voltage	V_{DD}		V_{SS}-0.5	7.0	V
Input Voltage	V_{IN}	All Input Pin	V_{SS}-0.5	V_{DD}+0.5	V
Output Voltage	V_{OUT}		V_{SS}-0.5	V_{DD}+0.5	V
Output Current	I_{OUT}			25	mA
Junction Temperature	Tj		-55	150	℃
Storage Temperature	Tstg		-55	125	℃

4. Recommended Operating Condition

V_{SS}=0V, Ta=-40℃~125℃

Parameter	Symbol	Condition	Min	Typ	Max	Unit	Note
Supply Voltage ※	V_{DD}		1.62	3.3	5.5	V	V_{DD}
"H" Input Voltage	V_{IH}		V_{DD}×0.8			V	CE
"L" Input Voltage	V_{IL}				V_{DD}×0.2	V	CE
Input Voltage	V_{IN}		V_{SS}		V_{DD}	V	CE
Output Load Capacitance	CL	CMOS			15	pF	OUT
Ambient Temperature	Topt	Except below	-40		125	℃	
		V_{DD}=1.62~1.98V f=50MHz~60MHz	-40		85		

※Phase noise performance becomes slightly poor at 1.62~2.25V.
This IC has enough immunity against ESD and Latch-up, but handle with care.

5. Electrical Specification

Unless otherwise stated, V_{DD}=1.62V~5.5V, V_{SS}=0V, Ta=-40℃~125℃

Parameter	Symbol	Condition	Specification			Unit
			Min	Typ	Max	
Out put Leak current	Iz	CE=0V, X1=V_{DD} or Vss Vout=Vss~V_{DD}			15	μA
"H" input current	I_{IH}	CE pad, V_{IN}=V_{DD}	0		0.1	μA
"L" input current	I_{IL}	CE pad, V_{IN}=V_{SS}	-1.0		-0.01	μA
Ootput Disable Time	Tplz	OUT pad			0.1	μs
Oitput Enable Time	Tpzl	OUT pad			2.0	ms
Osc. start up time	Tstart	f=27MHz, V_{DD}≧1.62V			2.0	ms
"H" output voltage	V_{OH}	OUT pad, I_{OH}=-1.0mA	0.9V_{DD}			V
"L" output voltage	V_{OL}	OUT pad, I_{OL}=1.0mA			0.1V_{DD}	V
Current consumption	I_{DD}	CL=15pF, V_{DD}=1.8V CE≧V_{DD} -0.3V, f=27MHz		1.5	2.3	mA
		CL=15pF, V_{DD}=3.3V CE≧V_{DD} -0.3V, f=27MHz		2.8	4.2	
Current consumption at oscillation disable	I_{DDD}	V_{DD}=3.3V, CE≦0.3V		1.0	5.0	μA
Frequency V_{DD} deviation	Fvst	V_{DD}=5.0V±10%			±1.0	ppm
		V_{DD}=3.3V±10%			±1.0	
		V_{DD}=2.5V±10%			±1.0	
Duty Ratio	Duty	IPS009BMz-C1, IPS009BMz-C2 CL=15pF, 1/2V_{DD} point	45		55	%
		IPS009BMz-C3, IPS009BMz-C4 CL=15pF, 1/2V_{DD} point V_{DD}=1.62V~2.97V	40		60	
		IPS009BMz-C3, IPS009BMz-C4 CL=15pF, 1/2V_{DD} point V_{DD}=2.97V~5.5V	45		55	
Rise/Fall time	Tr/Tf	CL=15pF, 10%~90%V_{DD} V_{DD}=1.62V~2.25V			6.5	ns
		CL=15pF, 10%~90%V_{DD} V_{DD}=2.25V~5.5V			4.0	

Phase Noise : F0=27MHz, V_{DD}=3.3V

Offset	IPS009BMx-C1/C2	IPS009BMx-C3	IPS009BMx-C4
10Hz	-106 dBc/Hz	-106 dBc/Hz	-105 dBc/Hz
100Hz	-132 dBc/Hz	-133 dBc/Hz	-133 dBc/Hz
1kHZ	-145 dBc/Hz	-146 dBc/Hz	-147 dBc/Hz
10kHz	-154 dBc/Hz	-157 dBc/Hz	-157 dBc/Hz
100kHz	-160 dBc/Hz	-163 dBc/Hz	-163 dBc/Hz
1MHz	-162 dBc/Hz	-165 dBc/Hz	-164 dBc/Hz
Phase Jitter	143 fs	102 fs	108 fs

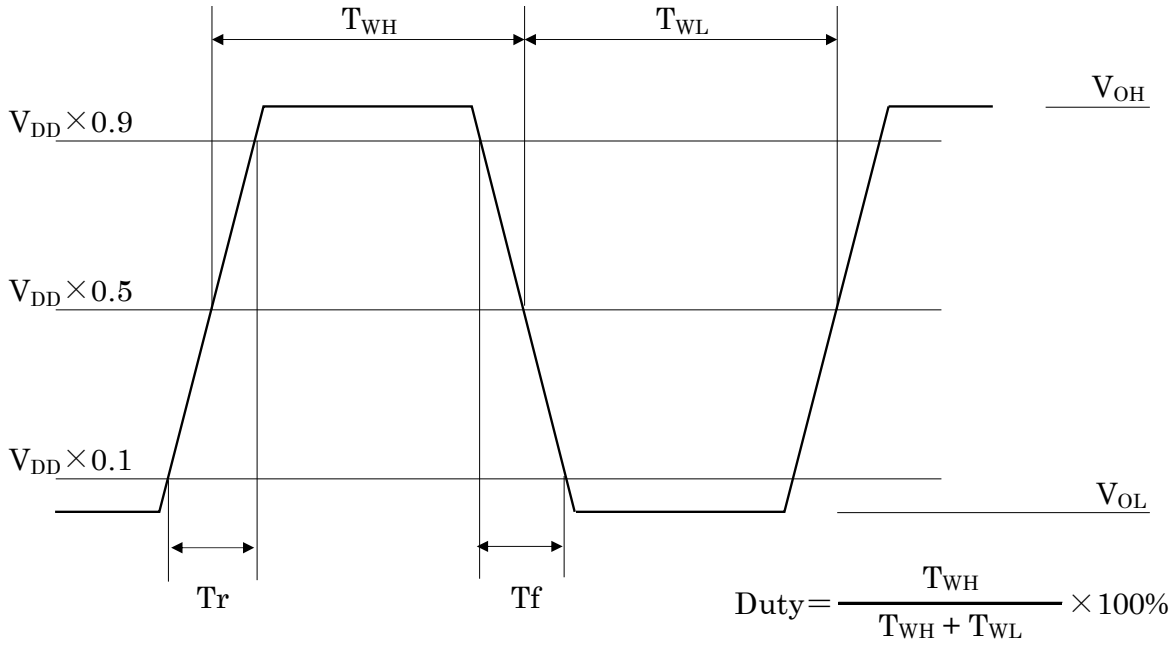
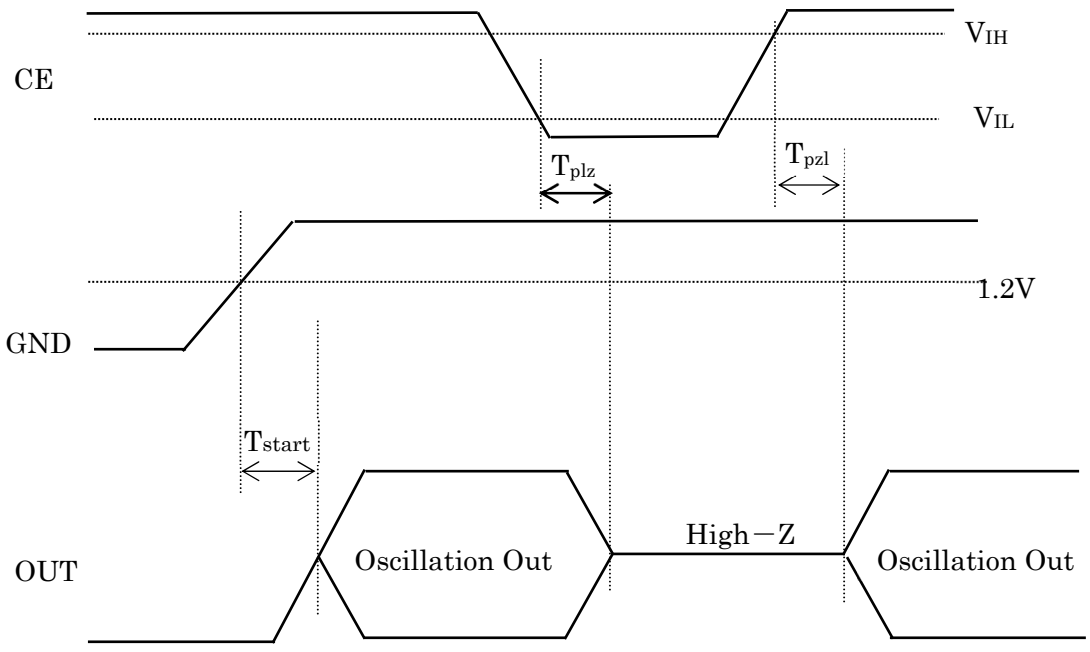


Fig. 5-1 Output wave form (Duty, Tr, Tf, V_{OH}, V_{OL})



V_{IH} : Threshold voltage for Oscillation Start
V_{IL} : Threshold voltage for Oscillation Stop

Fig. 5-2 Input output signal timing

6. Circuit Parameters of Oscillator (Reference Data for Circuit Design)

Ta=25℃

Parameter	Symbol	Condition	Min	Typ	Max	Unit
Equivalent series (Loading) Capacitance	CLxtal	V_{DD}=2.7V, f=27MHz		6.0		pF
Drive Level	DL	V_{DD}=3.3V, f=27MHz		60		μW
Feedback Resistor	Rf			300		kΩ
Driving Resistor	Rd			1000		Ω
Oscillation Capacitor	Cg			8.0		pF
	Cd			12.0		

*The above values are the design values and are not guaranteed by test.

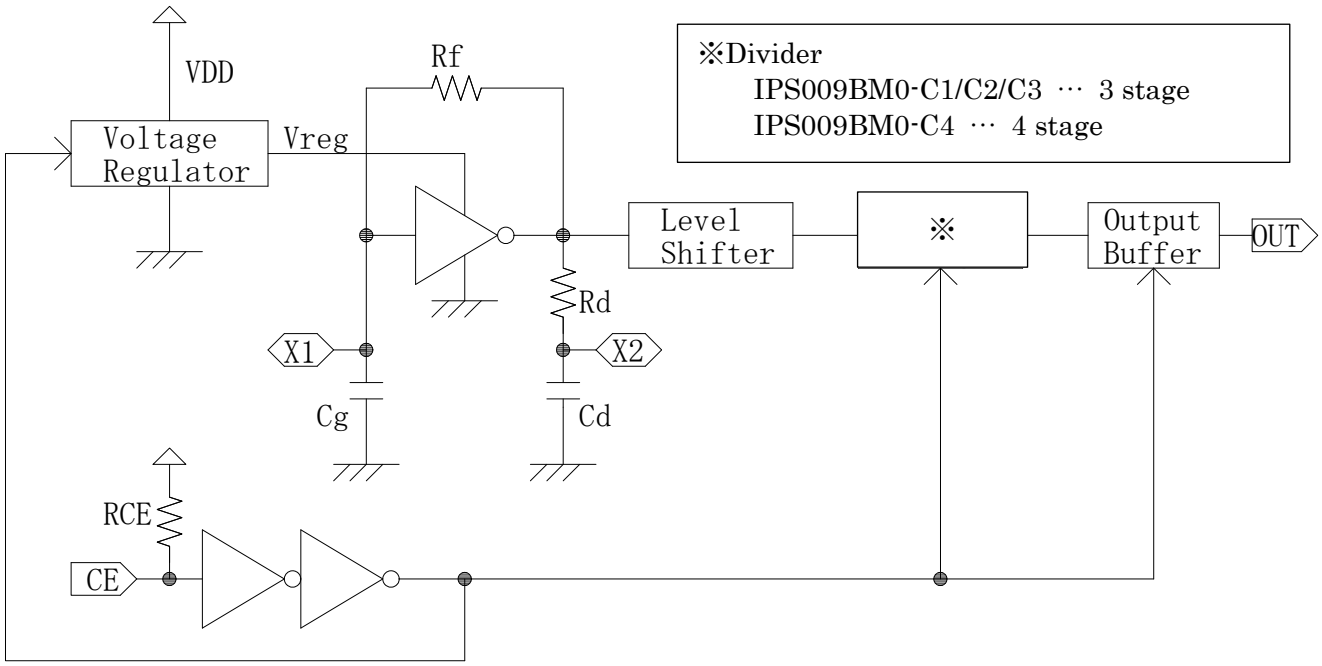
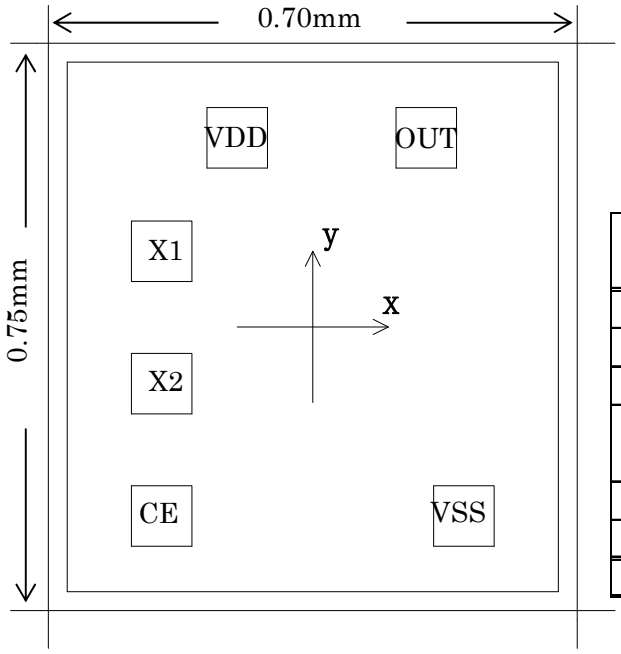


Fig. 6 Block Diagram

7. Pad Layout

7-1 IPS009BM0-C1 (Straight Type)

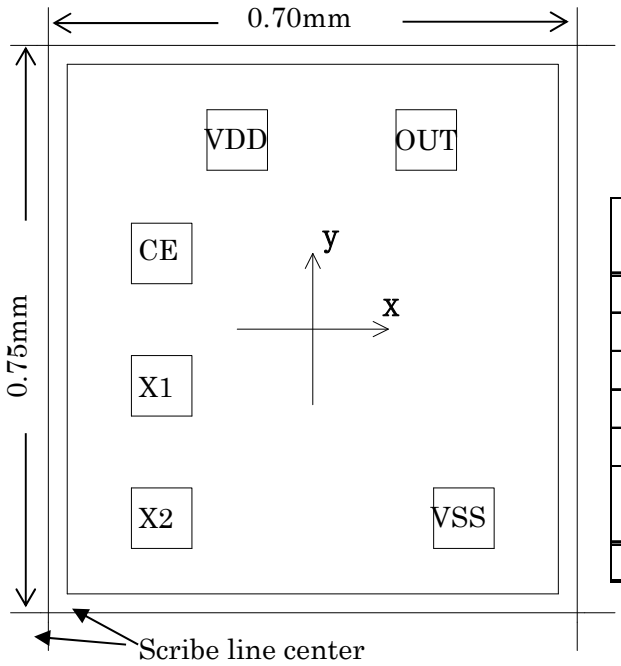


- Die Size: 0.70mm × 0.75mm
- Pad Size: 80um □
- Thickness: 150um±20um
- IC Backside: Gnd or Open

Pad Name	Function	Location (μm)	
		x	y
VDD	(+) Power Supply	-105	244
OUT(Q)	Frequency Output	153	244
VSS	(−) Ground	209	-244
CE	Oscillation stop "L": High-Impedance	-209	-244
X2	Crystal Drive	-209	-74
X1	Crystal Feedback	-209	94
Chip Center		0	0

Fig. 7-1 Pad Layout of IPS009BM-C1 (Straight Type)

7-2 IPS009BM0-C2 (Cross Type1)

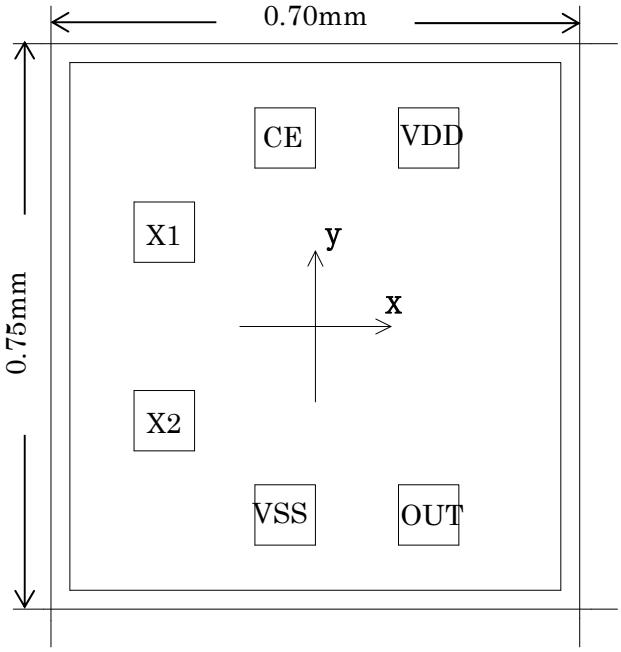


- Die Size: 0.70mm × 0.75mm
- Pad Size: 80um □
- Thickness: 150um±20um
- IC Backside: Gnd or Open

Pad Name	Function	Location (μm)	
		x	y
VDD	(+) Power Supply	-105	244
OUT(Q)	Frequency Output	153	244
VSS	(−) Ground	209	-244
X2	Crystal Drive	-209	-244
X1	Crystal Feedback	-209	-74
CE	Oscillation stop "L": High-Impedance	-209	94
Chip Center		0	0

Fig. 7-2 Pad Layout of IPS009BM-C2 (Cross Type1)

7-3 IPS009BM0-C3 (Cross Type2)

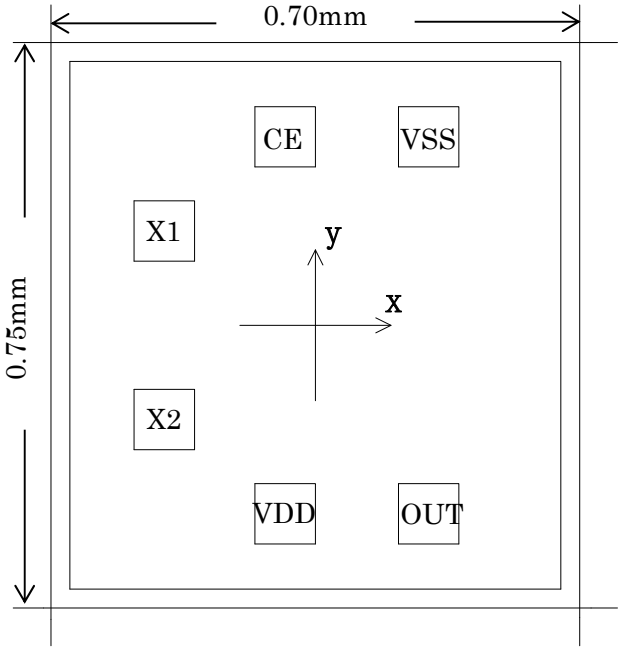


- Die Size: 0.70mm × 0.75mm
- Pad Size: 80um □
- Thickness: 150um±20um
- IC Backside: Gnd or Open

Pad Name	Function	Location (μm)	
		x	y
VDD	(+) Power Supply	152	244
OUT(Q)	Frequency Output	152	-244
VSS	(−) Ground	-39	-244
X2	Crystal Drive	-209	-133
X1	Crystal Feedback	-209	133
CE	Oscillation stop "L": High-Impedance	-39	244
Chip Center		0	0

Fig. 7-3 Pad Layout of IPS009BM-C3 (Cross Type2)

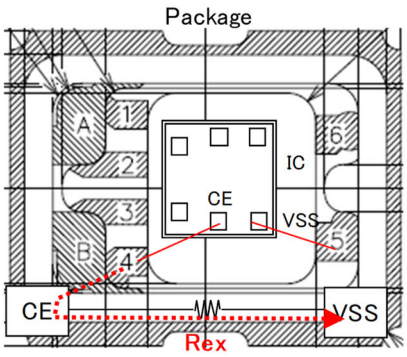
7-4 IPS009BM0-C4 (Flip Type)



- Die Size: 0.70mm × 0.75mm
- Pad Size: 80um □
- Thickness: 150um±20um
- IC Backside: Gnd or Open

Pad Name	Function	Location (μm)	
		x	y
VSS	(−) Ground	152	244
OUT(Q)	Frequency Output	152	-244
VDD	(+) Power Supply	-39	-244
X2	Crystal Drive	-209	-133
X1	Crystal Feedback	-209	133
CE	Oscillation stop "L": High-Impedance	-39	244
Chip Center		0	0

Fig. 7-4 Pad Layout of IPS009BM-C4 (Flip Type)



IMPORTANT Notice for CE function

※ Oscillation will not be activated when CE=Open after CE=Low if Rex is not large.

※ Reference value of Rex is over 10MΩ with CE=Open usage.

※ There is no such issue with CE=VDD usage.

Rex： Resistance value between CE and VSS of package