■ Description

IPS050 is the specific SPXO IC for achieving low power kHz and low MHz range output by divide. The power consumption of IPS050 is quite low, and comparable with tuning fork solution.

■ Features

- Power consumption : 10uA typical with 1/512 divide
- Divide function : 1/256~1/1024 for kHz out, 1/1~1/16 for MHz out
- Output frequency : 13.6kHz~105.469kHz / 0.31MHz~34MHz
- Operation temperature : -40℃~125℃ (85℃ with IPS0503M2, M3, M4 and MA)
- Power supply voltage : 1.6V~3.63V
- Standby function : Oscillation stop
- Output : CMOS
- Small chip size : 0.56mm × 0.52mm
- Frequency stability to V_{DD} : Within ±1ppm

1. Part number rule

IPS 050 3 M z B X －W 0

- IPS: Series Name For SPXO
- 050: Product Series
- 3: Frequency Range

x	Frequency Range
	Fund.
3	5~34MHz

- M: V_{DD} 1.6V ~5.5V
- z: X'tal Mode & Divide Function
  - 0 : Fund. & 1/1
  - 1 : Fund. & 1/2
  - 2 : Fund. & 1/4
  - 3 : Fund. & 1/8
  - 4 : Fund. & 1/16
  - 8 : Fund. & 1/256
  - 9 : Fund. & 1/512
  - A : Fund. & 1/1024
- B: Blank : Lower IDD, B : Deeper NR
- X: Pad Layout
  - X : Cross
  - F : Flip
- －W / 0

IC Form	Thickness	Definition
－W	0	Wafer 100um
	3	Wafer 130um
Blank or －C	Blank	Chip 130um

2. Series

2-1 kHz Output

Part Number	Crystal Frequency f (MHz)		Divide	Output Frequency F0 (kHz)		Pad Layout	Remarks
	Min.	Max.		Min.	Max.		
IPS050 3 M 8 X	8.388		1/256	32.768		Cross	Lower Idd
IPS050 3 M 9 X	16.777		1/512				
IPS050 3 M A X	33.554		1/1024				
IPS050 3 M 8 B X	8.000	27.000	1/256	31.250	105.469		Deeper NR
IPS050 3 M 9 B X	14.000	27.000	1/512	27.344	52.734		
IPS050 3 M A B X	14.000	34.000	1/1024	13.672	33.203		
IPS050 3 M 9 F	16.777		1/512	32.768		Flip	Lower Idd
IPS050 3 M A F	33.554		1/1024				
IPS050 3 M 9 B F	14.000	27.000	1/512	27.344	52.734		Deeper NR
IPS050 3 M A B F	14.000	34.000	1/1024	13.672	33.203		

2-2 MHz Output

Part Number	Crystal Frequency f (MHz)		Divide	Output Frequency F0 (MHz)		Pad Layout	Remarks
	Min.	Max.		Min.	Max.		
IPS050 3 M 0 X	5.00	34.00	1/1	5.00	34.00	Cross	
IPS050 3 M 1 X			1/2	2.50	17.00		
IPS050 3 M 2 X			1/4	1.25	8.50		
IPS050 3 M 3 X			1/8	0.63	4.25		
IPS050 3 M 4 X			1/16	0.31	2.13		

3. Absolute Maximum Ratings

Unless otherwise stated, V_{SS}=0V, Ta=25℃±2℃

Parameter	Symbol	Condition	Ratings		
			Min	Max	Unit
Supply Voltage	V_{DD}		V_{SS}-0.5	5.0	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

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

Parameter	Symbol	Condition	Min	Typ	Max	Unit	Note
Supply Voltage	V_{DD}		1.60		3.63	V	V_{DD}
“H” Input Voltage	V_{IH}		V_{DD}×0.7			V	CE
“L” Input Voltage	V_{IL}				V_{DD}×0.3	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	℃	
		IPS0503M2 IPS0503M3 IPS0503M4 IPS0503MA	-40		85		

5. Electrical Specification

5-1 kHz output

Unless otherwise stated, V_{DD}=3.3V, V_{SS}=0V, CL=15pF, Ta=※1

Parameter	Symbol	Condition		Specification Min	Specification Typ	Specification Max	Unit
Out put Leak current	Iz	CE=0V, X1=1.6V or Vss Vout=Vss~V_{DD}				10	μA
"H" input current	I_{IH}	CE pad, V_{IH}=V_{DD}				1.0	μA
"L" input current	I_{IL}	CE pad, V_{IL}=0V		-3.0			
Output Disable Time	Tplz	OUT pad				0.1	μs
Output Enable Time	Tpzl	OUT pad	Except below			20	ms
			IPS0503M8			25	
Oscillation start up time	Tstart	V_{DD}>1.6V	Except below			20	ms
			IPS0503M8			25	
"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}	
Current consumption ※2	I_{DD}	IPS0503M8				15	μA
		IPS0503M9				15	
		IPS0503MA				27	
		IPS0503M8B, f=27MHz				20	
		IPS0503M9B, f=27MHz				30	
		IPS0503MAB, f=34MHz				42	
Current consumption at oscillation disable	I_{DDD}	V_{DD}=3.3V, CE≦0.3V				3.0	μA
Freq. V_{DD} deviation	Fvst	V_{DD}=3.3±10%				±1.0	ppm
Output Duty Ratio	Duty	1/2V_{DD} point		45		55	%
Rise/Fall time	Tr/Tf	CL=15pF, 10%~90%V_{DD}				15.0	ns

※1 IPS0503MA : Ta=-40℃~85℃, Other Models : Ta=-40℃~125℃
※2 Condition : CL=15pF, V_{DD}=3.3V, CE≧V_{DD}-0.3V

5-2 MHz output

Unless otherwise stated, V_{DD}=3.3V, Vss=0V, CL=15pF, Ta=※1

Parameter	Symbol	Condition		Specification			Unit
				Min	Typ	Max	
Out put Leak current	Iz	CE＝0V, X1=1.6V or Vss Vout=Vss~V_{DD}				10	μA
“H” input current	I_{IH}	CE pad, V_{IH}=V_{DD}				1.0	μA
“L” input current	I_{IL}	CE pad, V_{IL}=0V		-3.0			
Output Disable Time	Tplz	OUT pad				0.1	μs
Output Enable Time	Tpzl	OUT pad	IPS0503M0 IPS0503M1			10	ms
			IPS0503M2 IPS0503M3 IPS0503M4			20	
Oscillation start up time	Tstart	V_{DD}>1.6V	IPS0503M0 IPS0503M1			10	ms
			IPS0503M2 IPS0503M3 IPS0503M4			20	
“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}	
Current consumption ※2	I_{DD}	IPS0503M0, f=24MHz				2400	μA
		IPS0503M1, f=24MHz				1200	
		IPS0503M2, f=12MHz				250	
		IPS0503M3, f=19.2MHz				200	
		IPS0503M4, f=33MHz				220	
Current consumption at oscillation disable	I_{DDD}	V_{DD}=3.3V, CE≦0.3V				3.0	μA
Freq. V_{DD} deviation	Fvst	V_{DD}=3.3±10%				±1.0	ppm
Output Duty Ratio	Duty	1/2V_{DD} point	IPS0503M0, ~30MHz	45		55	%
			IPS0503M0, 30~34MHz	40		60	
			IPS0503M1	45		55	
			IPS0503M2 IPS0503M3 IPS0503M4	40		60	
Rise/Fall time	Tr/Tf	V_{DD}=1.8V, 10%~90%V_{DD}				15.0	ns
		V_{DD}=3.3V, 10%~90%V_{DD}				12.0	

※1 IPS0503M0 & IPS0503M1 : Ta=-40℃~125℃, Other Models : Ta=-40℃~85℃
※2 Condition : CL=15pF, V_{DD}=3.3V, CE≧V_{DD} -0.3V

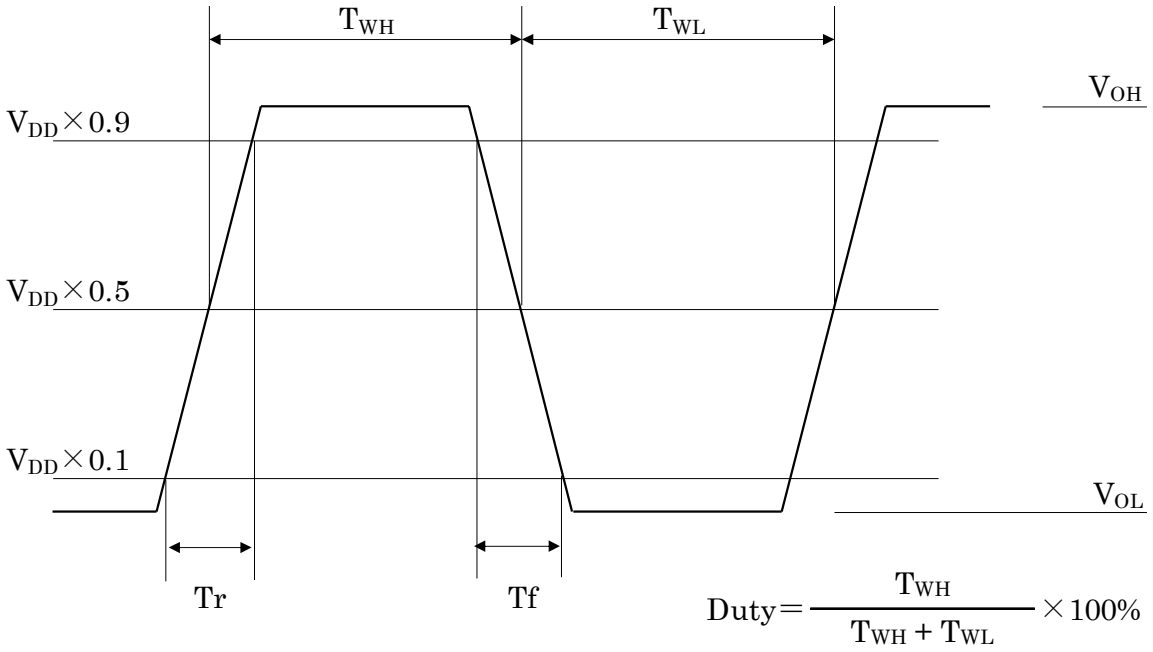
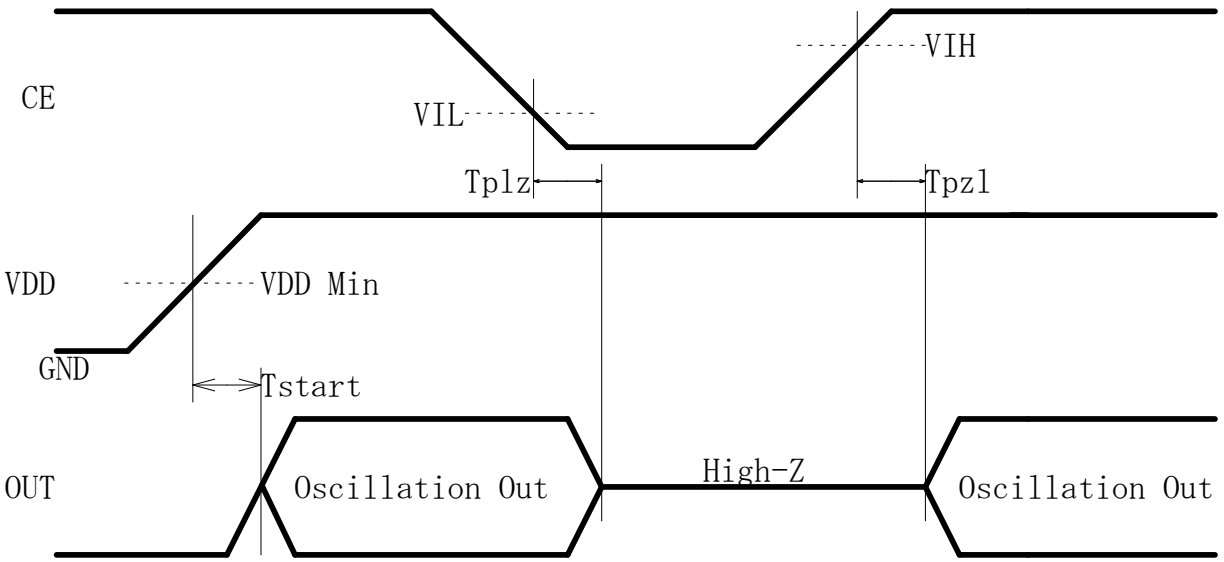


Fig. 5-1 Output wave form (Duty, Tr, Tf, V_{OH}, V_{OL})



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		Typical value	Unit
Constant voltage output	Vreg	V_{DD}=1.60V~3.63V		0.78	V
Feedback Resistor	Rf			348	kΩ
Driving Resistor	Rd			1000	Ω
Oscllation Capacitor	Cg	Gate side	IPS0503M8 IPS0503M9	5.0	pF
			Others	2.0	pF
	Cd	Drain side		2.0	pF

Negative resistance(Ω) : V_{DD}=1.8V, C0=1.5pF, Cst=1.0pF

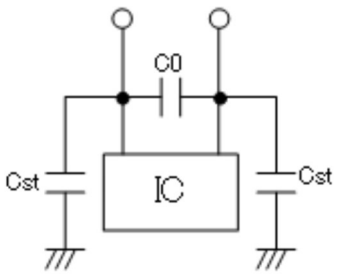
Part Number	Frequency	25℃	85℃	105℃	125℃
IPS0503M9	17MHz	-228	-179	-156	-125
IPS0503M9B	27MHz	-227	-176	-152	-127
IPS0503MA	34MHz	-108	-86	-73	-61
IPS0503MAB	34MHz	-199	-159	-144	-125

Negative resistance(Ω) : V_{DD}=3.3V, C0=1.5pF, Cst=1.0pF

Part Number	Frequency	25℃	85℃	105℃	125℃
IPS0503M8B	17MHz	-578			
IPS0503M0, M1	5MHz	-5073	-5037	-5003	-4772
IPS0503M0, M1	34MHz	-251	-204	-186	-165
IPS0503M2, M3, M4	5MHz	-4744			
IPS0503M2, M3, M4	34MHz	-145			

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

※ Negative resistance was calculated using S-parameters determined by network measurement under the estimation of crystal C0=1.5pF and Cst=1.0pF (Stray capacitance of SMD package). Refer the right side drawing as for C0 and Cst.



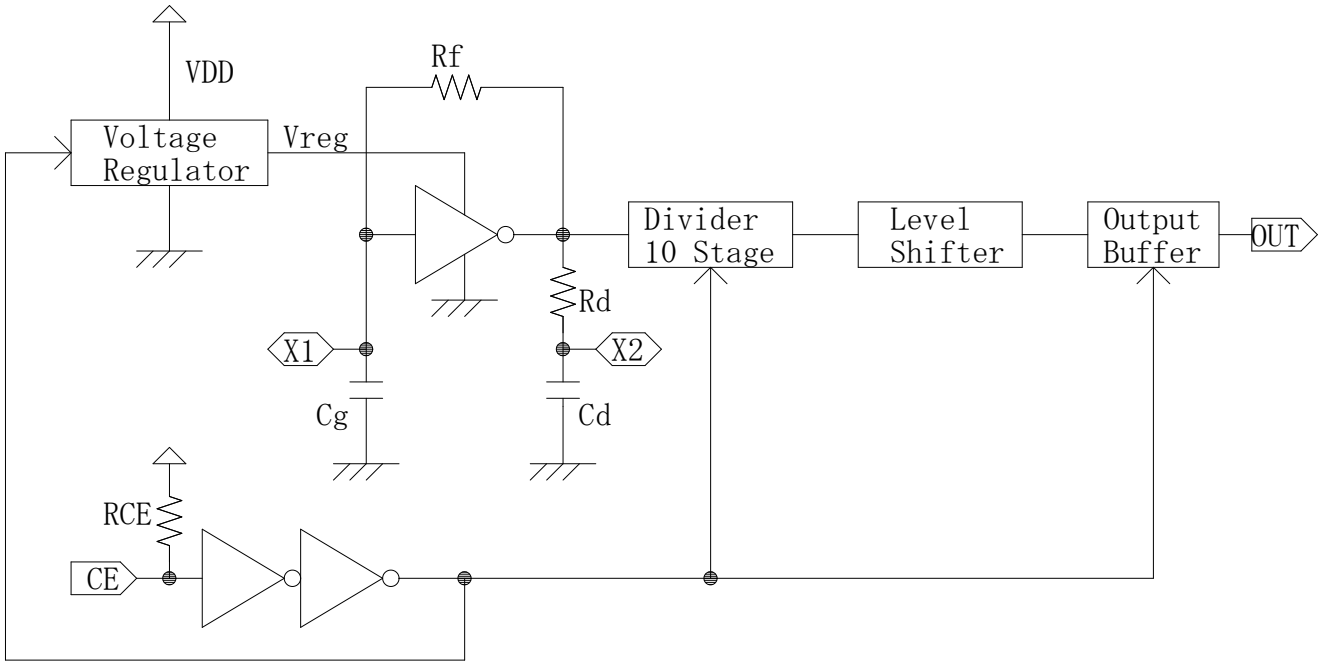
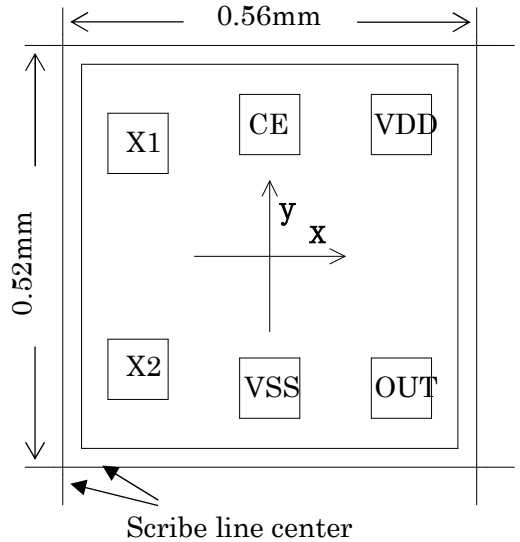


Fig. 6 Block Diagram

7. Pad Layout

7-1 Cross Type

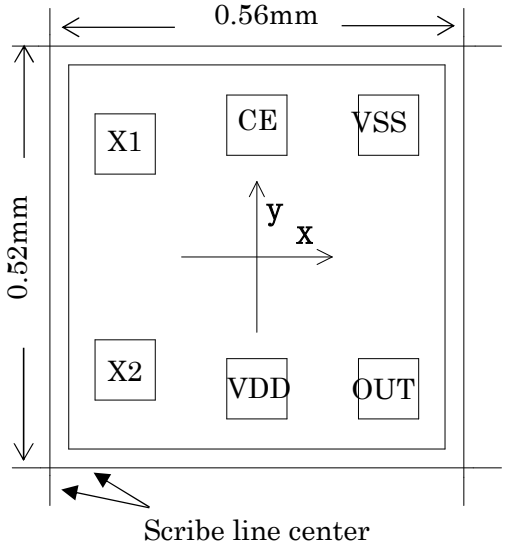


- Die Size: 0.56mm × 0.52mm
- Pad Size: 80um □
- Thickness: 130um±10um
- Scribe Line: 80um
- IC Backside: Gnd or Open

Pad Name	Function	Location (μm)	
		x	y
VDD	(+) Power Supply	175	155
OUT(Q)	Frequency Output	175	-155
VSS	(−) Ground	12	-155
X2	Crystal Drive	-175	-93
X1	Crystal Feedback	-175	93
CE	Oscillation stop "L": High-Impedance	12	155
Chip Center		0	0

Fig. 7-1 Pad Layout of IPS050 (Cross Type)

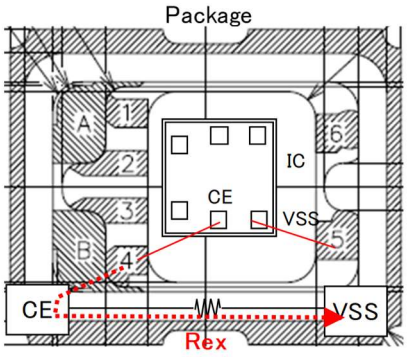
7-2 Flip Type



- Die Size : 0.56mm × 0.52mm
- Pad Size : 80um □
- Thickness : 130um±10um
- Scribe Line : 80um
- IC Backside : Gnd or Open

Pad Name	Function	Location (μm)	
		x	y
VSS	(−) Ground	175	155
OUT(Q)	Frequency Output	175	-155
VDD	(+) Power Supply	12	-155
X2	Crystal Drive	-175	-93
X1	Crystal Feedback	-175	93
CE	Oscillation stop "L": High-Impedance	12	155
Chip Center		0	0

Fig. 7-2 Pad Layout of IPS050 (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