XO5009ALx-K Series
High Performance
Fundamental Crystal Oscillator IC
Rev. A.0 - Dec. 2022

Features

- Wide range of operating supply voltage: 2.2V to 5.5V
- Optimized low crystal drive current oscillation for miniature crystal units
- XO5009ALx series: for Wire Bonding
- Recommended oscillation frequency range
- Low frequency Fundamental: 10MHz to 60MHz
- Multi-stage frequency divider for low-frequency output support
- ***High Performance(Low Phase Noise/Low Jitter)***
- ***High Frequency VS Vdd Stability <+/-1ppm***
- ***Ultra-Low Drive Level***
- ***Ultra-low Power Current***
- Frequency divider built-in:
  -Selectable by version: f0, f0/2, f0/4, f0/8, f0/16
- ***-55 to 125°C operating temperature range***
- ***50pF output drive capability***
- Standby function
- High impedance in standby mode, oscillator stops
- CMOS output duty level(1/2VDD)
  -50±5% output duty
- Die form or Wafer form

Description

The XO5009ALx series are miniature crystal oscillator module ICs. The oscillator circuit stage has voltage regulator drive, significantly reducing current consumption and crystal current, compared with existing devices, and significantly reducing the oscillator characteristics supply voltage dependency.

Application

- Used for crystal oscillator
- 7050, 5032 Crystal Oscillator(XO5009ALx-2DE)
- 3225, 2520,Crystal Oscillator(XO5009ALx-3/5DE)

Ordering Information

Part no.	Package type
XO5009ALx-zWF	Wafer form
XO5009ALx-zDE	Die form

Note: 1.Below is the detailed definition of part no.
Note: 2. xx:1/2/3/4 , z: -2(220um) or -3(130um)， -4(100um), -5(150um), -8(180um)

XO 5009 AL 1- X

Device Type
Clock Series

XO 5009 Series

Pad layout type

Oscillation frequency range, frequency divider function

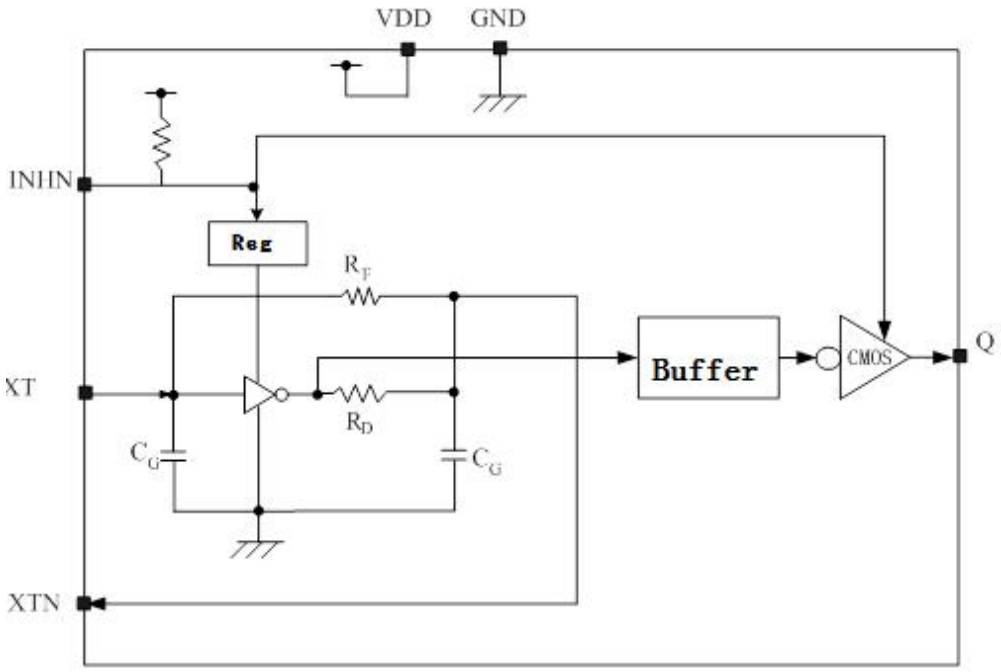
Suffix	f_{output}	Frequency range
1	f_O	10 to 50MHz
2	$f_O/2$	
3	$f_O/4$	
4	$f_O/8$	
5	$f_O/16$	
6	$f_O/32$	
7	$f_O/64$	

X: 2 Stand for 220um die thickness
3 Stand for 130um die thickness
4 Stand for 100um die thickness
5 Stand for 150um die thickness
8 Stand for 180um die thickness

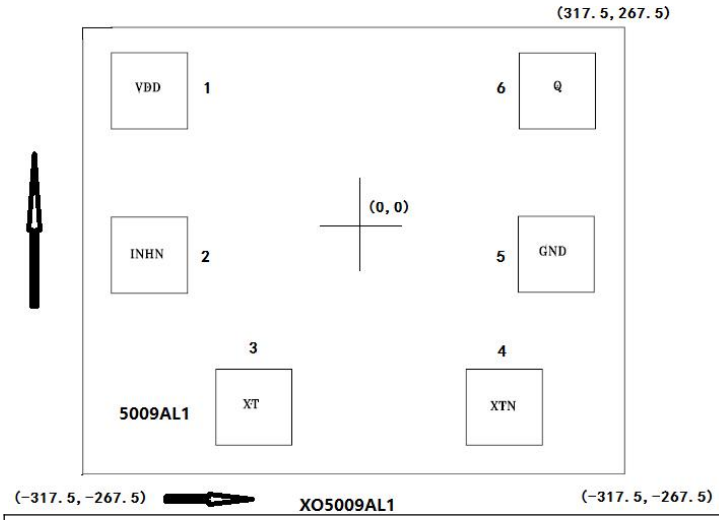
Series Configuration

Part No.	Output frequency	Operating supply voltage range(V)	Oscillation mode	Recommended oscillation frequency ragne*1(MHz)	Output drive capability(mA)	Standby mode	
						Oscillator stop function	Output state
XO5009AL1*2	f0*2	2.2~5.5	Fundamental	10 to 50	16	Yes	Hi-Z
XO5009AL2*2	f0/2						
XO5009AL3*2	f0/4						
XO5009AL4*2	f0/8						
XO5009AL5*2	f0/16						
XO5009AL6*2	f0/32						
XO5009AL7*2	f0/64						

Block Diagram



Pad Configuration



Pad Coordinate File					
Pad Name	X Coordinate	Y Coordinate	Pad Name	X Coordinate	Y Coordinate
1	-214.85	168	4	158.35	-164.6
2	-214.85	-4.65	5	213.15	-3.85
3	-105.1	-164.6	6	214.2	167.9
Note: Substrate is connected to GND or floating.					
Die Size: 630μm*530μm (Including scribe line , Scribe Line Width 60um) **Die Thickness:** 130μm±15μm(-3) or 220um±20um(-2), 100um±15um(-4) **Pad Size:** 80μm*80μm **Substrate Level:** GND or Floating					

Pad Description

Sym.	Type	Description	
XTN	O	Amplifier output.	Crystal connected between XT and XTN
XT	I	Amplifier input.	
INHN	I	Output state control input. High impedance when LOW. Power-saving pull-up resistor built in.	
V_{DD}	P	Supply voltage	
GND	P	Ground	
Q	O	Output. Output frequency determined by internal circuit to one of f0,f0/2,f0/4,f0/8,f0/16,f0/32,f0/64	

Function Description

Standby Function

When INHN goes LOW, the oscillator stops and the output on Q becomes high impedance.

INHN	Q	Oscillator
HIGH (or open)	fo output frequency	Normal operation
Low	High impedance	Stopped

Power-saving Pull-up Resistor

The INHN pin pull-up resistance RUP1 or RUP2 changes in response to the input level(HIGH or LOW). When INHN is tied LOW level, the pull-up resistance is large(RUP1),reducing the current consumed by the resistance. When INHN is left open circuit, the pull-up resistance is small(RUP2),which increases the input susceptibility to external noise. However, the pull-up resistance ties the INHN pin HIGH level to prevent external noise from unexpectedly stopping the output.

Oscillation Detector Function

The XO5009Lx series also feature an oscillation detector circuit. This circuit functions make the outputs disable until the oscillator circuit starts and oscillation becomes stable. This alleviates the danger of abnormal oscillator output at oscillator start-up when power is applied or when INHN is switched

Maximum Ratings

Storage Temperature..... -65°C to +150°C
Supply Voltage to Ground Potential (V_{DD} to GND)..... -0.5V to +7.0V
DC Input (All Other Inputs except V_{DD} & GND).... -0.5V to V_{DD} +0.5V
DC Output..... -0.5V to V_{DD} +0.5V
DC Output Current (all outputs)..... 20mA

Note:

Stresses greater than those listed under MAXIMUM RATINGS may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other condi-tions above those indicated in the operational sec-tions of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect reliability.

Recommended Operating Conditions

(GND=0V, unless otherwise noted.)

Sym.	Parameter	Series	Conditions	Min	Typ	Max	Unit
V_{DD}	Supply voltage	All series	C_L = 15pF	2.2	-	5.5	V
V_{IN}	Input voltage	All series	-	GND	-	VDD	V
T_A	Operating temperature	All series	-	-55	-	+125	°C
f0	Oscillation frequency*1	5009x1-5009x9	V_{DD} =2.2V~5.5V -	10	-	50	MHz
f_{OUT}	Output frequency	5009x1-5009x9	V_{DD} =2.2V~5.5V		- -	50	MHz

Reliability Data

Sym.	Parameter	Series	Conditions	Min	Typ	Max	Unit
ESD	Human Body Model	All series	MIL-STD-883H Method 3015.8	+/-3000	+/-6500		V

Note：Industrial Standard ESD：HBM Model +/-2000V

DC Electrical Characteristics/

XO5009AL1 to XO5009AL6 (V_{DD} = 2.5 to 5.5V, T_A = -40 to 85°C, unless otherwise noted.)

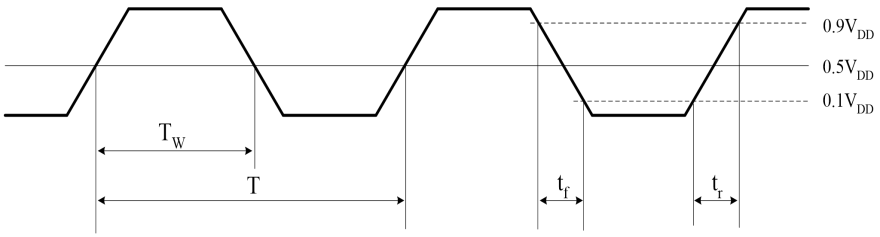
Sym.	Parameter	Condition		Rating			Unit
				min	typ	max	
V_{OH}	HIGH-level output voltage	Q: Measurement cct3, I_{OH}=8mA		V_{DD}-0.4	-	-	V
V_{OL}	LOW-level output voltage	Q: Measurement cct3, I_{OL}=8mA		-	-	0.4	V
V_{IH}	HIGH-level input voltage	INHN, Measurement cct4		0.7V_{DD}	-	-	V
V_{IL}	LOW-level input voltage	INHN, Measurement cct4		-	-	0.3V_{DD}	V
I_Z	Output leakage current	Q: Measurement cct5, IHNH=LOW	V_{OH} =V_{DD}	-	-	10	uA
			V_{OL}=GND	-	-	10	uA
I_{DD}	Current consumption	Measurement cct 1, 5009AL1(f0),no load INHN=open,f0=24MHz	V_{DD} =2.5V	-	0.8	1.6	mA
			V_{DD} =3.3V	-	1.1	2.0	mA
			V_{DD} =5.0V		1.4	2.8	mA
		Measurement cct 1, 5009AL2(f0/2),no load INHN=open,f0=24MHz f_{OUT}=12MHz	V_{DD} =2.5V	-	0.6	1.2	mA
			V_{DD} =3.3V	-	0.8	1.6	mA
			V_{DD} =5.0V		1.0	2.0	mA
		Measurement cct 1, 5009AL3(f0/4),no load INHN=open,f0=24MHz f_{OUT}=6MHz	V_{DD} =2.5V	-	0.6	1.3	mA
			V_{DD} =3.3V	-	0.7	1.5	mA
			V_{DD} =5.0V		0.8	1.6	mA
		Measurement cct 1, 5009AL4(f0/8),no load INHN=open,f0=24MHz f_{OUT}=3MHz	V_{DD} =2.5V	-	0.4	0.8	mA
			V_{DD} =3.3V	-	0.5	1.0	mA
			V_{DD} =5.0V		0.6	1.2	mA
		Measurement cct 1, 5009AL5(f0/16),no load INHN=open,f0=24MHz f_{OUT}=1.5MHz	V_{DD} =2.5V	-	0.4	0.8	mA
			V_{DD} =3.3V	-	0.4	0.8	mA
			V_{DD} =5.0V		0.5	1.0	mA
		Measurement cct 1, 5009AL6(f0/32),no load INHN=open,f0=24MHz f_{OUT}=0.75MHz	V_{DD} =2.5V	-	0.4	0.8	mA
			V_{DD} =3.3V	-	0.4	0.8	mA
			V_{DD} =5.0V		0.5	1.0	mA
		Measurement cct 1, 5009AL6(f0/32),no load INHN=open,f0=24MHz f_{OUT}=0.375MHz	V_{DD} =2.5V	-	0.4	0.8	mA
			V_{DD} =3.3V	-	0.4	0.8	mA
			V_{DD} =5.0V		0.5	1.0	mA
I_{ST}	Standby current	Measurement cct1, INHN=LOW		-	-	10	uA
R_{UP1}	INHN pull-up resistance	Measurement cct6		0.4	1.5	8	M Ω
R_{UP2}				30	70	150	K Ω
R_f	Oscillator feedback resistance	-		70	100	140	K Ω
C_G	Oscillator capacitance	Design value(a monitor pattern on a wafer is tested),Excluding parasitic capacitance		4.8	6	7.2	pF
C_D				8	10	12	pF

AC Electrical Characteristics

XO5009AL Series(V_{DD}=2.2 to 5.5, Ta=-45 to 85℃ unless otherwise noted)

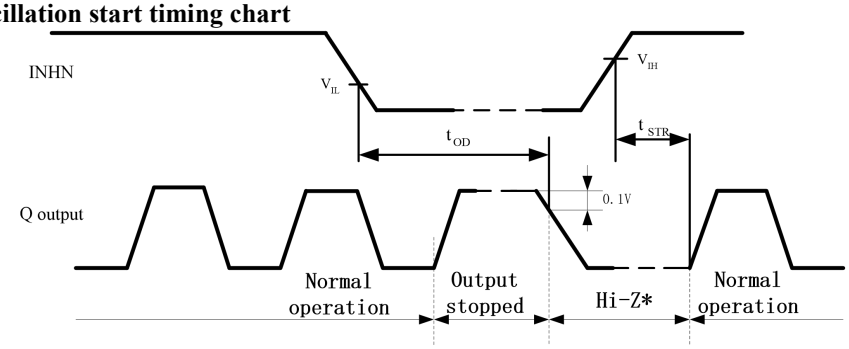
Parameter	Symbol	Condition		Min	Type	Max	Unit
Output rise time	t_{r1}	Measurement cct1,CL=15pf, 0.1V_{DD} to 0.9V_{DD}	V_{DD}=2.97 to 3.63 V	-	3.0	5.0	ns
	t_{r2}		V_{DD}=4.5 to 5.5V	-	2.0	3.0	ns
Output fall time	t_{f1}	Measurement cct1,CL=15pf, 0.1V_{DD} to 0.9V_{DD}	V_{DD}=2.97 to 3.63V	-	3.0	5.0	ns
	t_{f2}		V_{DD}=4.5 to 5.5V	-	2.0	3.0	ns
Output rise time	t_{r1}	Measurement cct1,CL=50pf, 0.1V_{DD} to 0.9V_{DD}	V_{DD}=2.97 to 3.63V	-	5.0	10	ns
	t_{r2}		V_{DD}=4.5 to 5.5V	-	4.0	8	ns
Output fall time	t_{f1}	Measurement cct1,CL=50pf, 0.1V_{DD} to 0.9V_{DD}	V_{DD}=2.97 to 3.63V	-	5.0	10	ns
	t_{f2}		V_{DD}=4.5 to 5.5 V	-	4.0	8	ns
Output duty cycle	Duty	Measurement cct 1, T_A=25℃,C_L=15pF		45	50	55	%
Output disable delay time	t_{OD}	Measurement cct 1, T_A=25℃,C_L≤15pF		-	-	50	us

Output switching waveform



DUTY=Tw/T×100(%)

Output disable and oscillation start timing chart

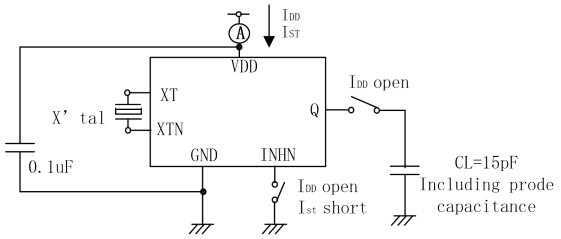


When INHN goes HIGH to LOW, the Q output goes HIGH once and then becomes high impedance.
When INHN goes LOW to HIGH, the Q output from high impedance to normal output operation when the oscillation starts (oscillation is detected)
*: the high –impedance interval in the figure is shown as a LOW level due to the 1KΩ pull-down resistor connected to the Q pin(see "Measurement circuit 2" in the "Measurement circuits" section)

Measurement Circuit

Measurement cct1

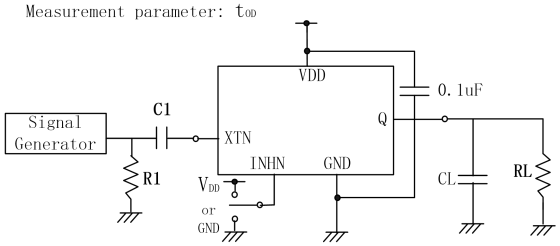
Measurement parameter: I_{DD}, I_{ST}, Duty, t_r, t_f



Note:The AC characteristics are observed using an oscilloscope on pin Q

Measurement cct2

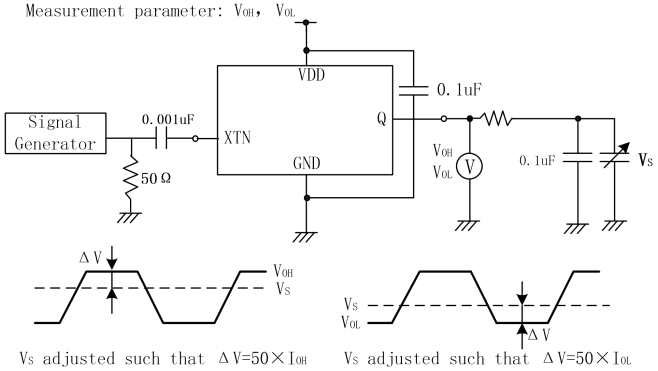
Measurement parameter: t_{OD}



XTN input signal:1Vp-p, sina wave
C1: 0.001uF CL:15pF
R1:50Ω RL: 1KΩ

Measurement cct3

Measurement parameter: V_{OH}, V_{OL}

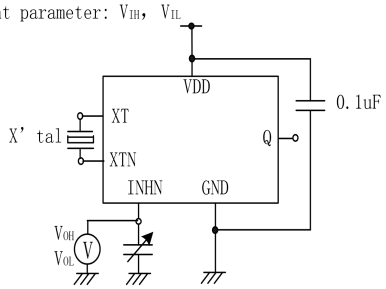


V_S adjusted such that $\Delta V=50\times I_{OH}$ V_S adjusted such that $\Delta V=50\times I_{OL}$

XTN input signal:1Vp-p, sina wave

Measurement cct4

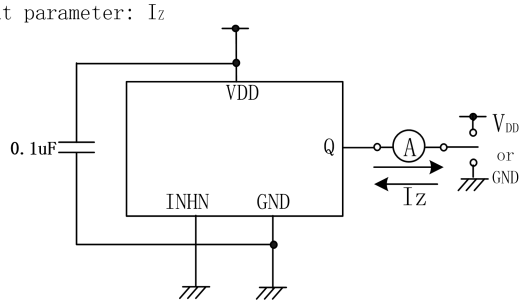
Measurement parameter: V_{IH}, V_{IL}



V_{IH}:Voltage is 0V to V_{DD} transition that changes the output state.
V_{IL}:Voltage is V_{DD} to 0V transition that changes the output state.
INHN has an oscillation stop function

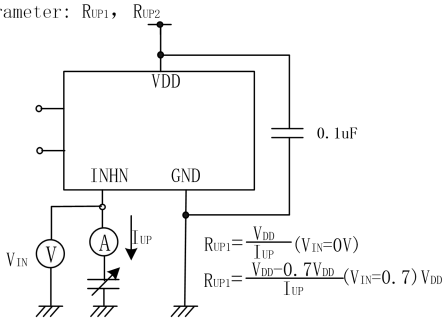
Measurement cct5

Measurement parameter: I_Z



Measurement cct6

Measurement parameter: R_{UP1}, R_{UP2}



Rev #	DCN NO.	REVISION HISTORY	DATE
A.0	220165	Initial release	2022/12/14