1. OVERVIEW

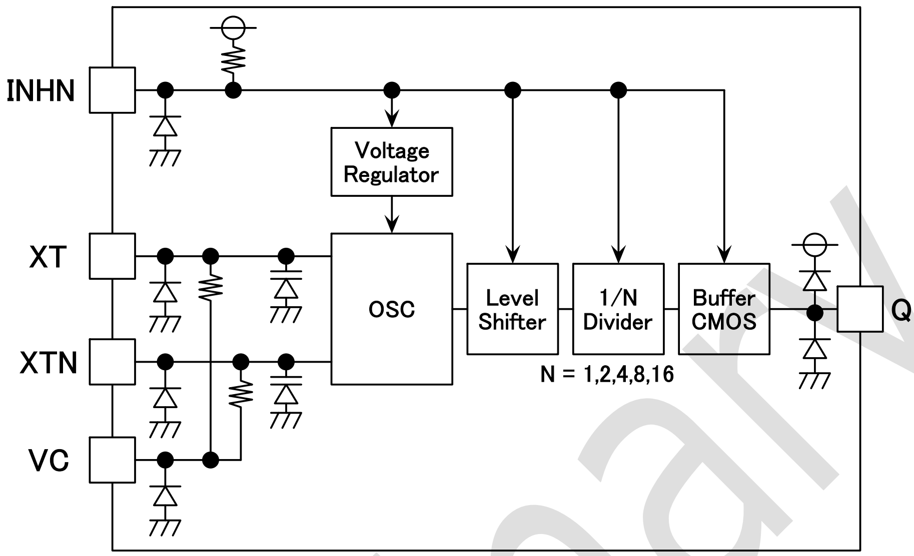
The CF7310xx/WF7310xx series are 20 to 170 MHz fundamental oscillation, VCXO module ICs.

They incorporate a proprietary varicap diode, integrated in epitaxial layer, targeted for fixed telecommunications applications. It provides a low phase noise characteristic and a wide frequency pulling range, without any external components.

2. FEATURES

- Varicap diode built-in
- Output interface :CMOS output
- Standby Function (Standby : Output is high impedance)
- Oscillator: Fundamental-frequency mode oscillation
- Recommended oscillator frequency
  : 20 to 40MHz xAx xLx version
  : 40 to 62MHz xBx version
  : 60 to 100MHz xCx version
  : 100 to 170MHz xDx version
- Output frequency
  f_{OSC}, xx1 version
  f_{OSC}, /2 xx2 version
  f_{OSC}, /4 xx3 version
  f_{OSC}, /8 xx4 version
  f_{OSC}, /16 xx5 version
- Operating supply voltage
  :2.25V to 3.63V xAx version
  :2.97V to 3.63V xBx,xCx,xDx version
  :1.6V to 2.0V xLx version
- Operating temperature range :-40°C to 105°C
- Phase Noise
  : -135dBc/Hz @ xA1 version, 1kHz Offset, f=40MHz (γ=330, C0=1.3pF)
  : -160dBc/Hz @ xA1 version, 10MHz Offset, f=40MHz
  : -126dBc/Hz @ xB1 version, 1kHz Offset, f=61.44MHz (γ=350, C0=3.2pF)
  : -160dBc/Hz @ xB1 version, 10MHz Offset, f=61.44MHz
  : -126dBc/Hz @ xC1 version, 1kHz Offset, f=77.76MHz (γ=290, C0=2.4pF)
  : -160dBc/Hz @ xC1 version, 10MHz Offset, f=77.76MHz
  : -125dBc/Hz @ xD1 version, 1kHz Offset, f=155.52MHz (γ=330, C0=1.5pF)
  : -162dBc/Hz @ xD1 version, 10MHz Offset, f=155.52MHz
- Frequency pulling range
  : ±150ppm @xA1 version, VC=1.65±1.65V, f=40MHz (γ=330, C0=1.3pF)
  : ±140ppm @xB1 version, VC=1.65±1.65V, f=61.44MHz (γ=350, C0=3.2pF)
  : ±140ppm @xC1 version, VC=1.65±1.65V, f=77.76MHz (γ=290, C0=2.4pF)
  : ±130ppm @xD1 version, VC=1.65±1.65V, f=155.52MHz (γ=330, C0=1.5pF)
- Operating current consumption: 1.6mA @xA1 version, f=40MHz, CL_{OUT}=No Load
  : 2.7mA @xB1 version, f=61.44MHz, CL_{OUT}=No Load
  : 5.2mA @xC1 version, f=77.76MHz, CL_{OUT}=No Load
  : 10.0mA @xD1 version, f=155.52MHz, CL_{OUT}=No Load
- Applications : Communications

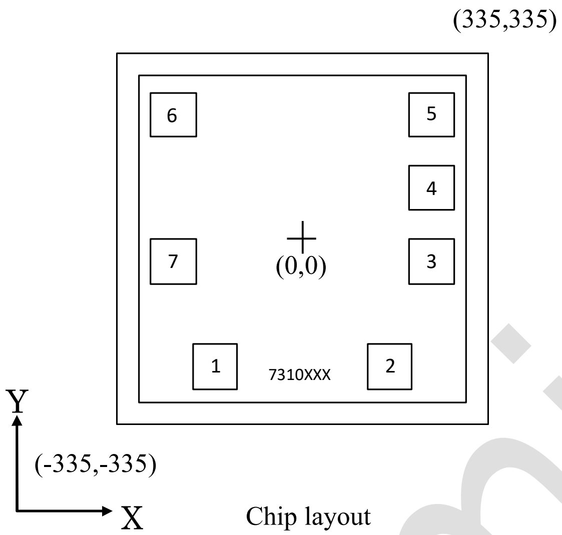
3. BLOCK DIAGRAM



4. PAD DIMENSIONS

(1) Chip size*1 : X=0.67mm, Y=0.67mm
(2) Chip base : V_{SS} potential
(3) Pad size : 80µm×80µm
(4) Scribe line width : 80µm
(5) Chip layout and pad dimensions

*1. The chip size is the value measured between scribe line centers.



Chip layout

PAD dimensions (Unit: µm)

No.	Wxx version	Fxx version	PAD coordinate (µm)	
			X	Y
1	XTN	XT	-158	-231
2	XT	XTN	158	-231
3	VC	VDD	233	-41
4	INHN	NC*1	233	92
5	VSS	Q	233	225
6	Q	VSS	-233	225
7	VDD	VC	-233	-41

*1 Don't use it because it is a terminal for IC testing.

Wxx ：Wire Bonding
Fxx ：Flip Chip Bonding

5. PIN DESCRIPTION

No.		Name	I/O *	Function
Wxx	Fxx			
1	2	XTN	O	Crystal element connection terminals.
2	1	XT	I	Crystal element connection terminals.
3	7	VC	I	Control voltage input. (positive polarity)
4	4	INHN / NC	I	Output state control input (Inhibit) pin. (NC when not in use: OPEN) Oscillator is stopped in standby mode when LOW. Pull-up resistor built-in.
5	6	VSS	-	Negative (-) supply voltage
6	5	Q	O	Output frequency (f_0, $f_0/2$, $f_0/4$, $f_0/8$, or $f_0/16$) High-impedance output in standby mode
7	3	VDD	-	Positive (+) supply voltage

*I: Input, O: Output

6. SERIES CONFIGURATION (TBD)

Power-supply voltage [V]	Pad layout	Oscillator frequency f0[MHz]※1	Output frequency and Version name ※2				
			f_0	$f_0/2$	$f_0/4$	$f_0/8$	$f_0/16$
2.25~3.63	Wire Bonding	20~40	WA1	WA2	WA3	WA4	WA5
	Flip Chip Bonding		FA1	FA2	FA3	FA4	−
2.97~3.63	Wire Bonding	40~62	WB1	−	−	−	−
		62~100	WC1	−	−	−	−
		100~170	WD1	−	−	−	−
	Flip Chip Bonding	40~62	FB1	−	−	−	−
		62~100	FC1	−	−	−	−
1.60~2.00	Wire Bonding	20~40	WL1	−	−	−	−
	Flip Chip Bonding		FL1	FL2	−	−	−

∗1. The recommended oscillation frequency is a yardstick value derived from the resonator used for NPC characteristics authentication. However, the oscillator frequency band is not guaranteed.
Specifically, the characteristics can vary greatly due to resonator characteristics and mounting conditions, So the oscillation characteristics of components must be carefully evaluated.

∗2. "−" is not developed. Please contact us for details.

7. ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Conditions		Rating	Unit
Supply voltage range *1	V_{DD}	Voltage between VDD and VSS		-0.3 to +4.5	V
Input voltage range *1, *2	V_{IN}	VC,INHN,XT Input pins		-0.3 to V_{DD}+0.3	V
Output voltage range *1, *2	V_{OUT}	Q output pin		-0.3 to V_{DD}+0.3	V
		XTN output pin		-0.3 ~ 2.5	V
Junction temperature *3	T_j			+125	°C
Storage temperature range *4	T_{STG}	Chip form wafer form		-65 to +125	°C
Output current *3	I_{OUT}	Q output	T_a = -40 ~ +85°C	±20	mA
			T_a = -40 ~ +105°C	±10	mA

*1. Absolute maximum ratings are the values that must never exceed even for a moment. This product may suffer breakdown if any one of these parameter ratings is exceeded. Operation and characteristics are guaranteed only when the product is operated at recommended supply voltage range.

*2. V_{DD} is a V_{DD} value of recommended operating conditions.

*3. Do not exceed the absolute maximum ratings. If they are exceeded, characteristic and reliability may be degraded.

*4. When stored alone in nitrogen or vacuum atmosphere.

8. RECOMMENDED OPERATING CONDITIONS

Parameter	Symbol	Conditions	MIN	TYP	MAX	Unit
Oscillator frequency *1	f_{OSC}	xA1 to 5, xL to 5 version	20		40	MHz
		xB1 version	40		62	
		xC1 version	62		100	
		xD1 version	100		170	
Output frequency	f_{OUT}	xA1 to 5, xL to 5 version	2.5		40	MHz
		xB1 version	40		62	
		xC1 version	62		100	
		xD1 version	100		170	
Operating supply voltage	V_{DD}	Voltage between VDD and VSS *2 xA1 to 5 version	2.25		3.63	V
Operating supply voltage	V_{DD}	Voltage between VDD and VSS *2 xB1, xC1, xD1 version	2.97		3.63	V
Operating supply voltage	V_{DD}	Voltage between VDD and VSS *2 xL to 5 version	1.60		2.00	V
Input voltage range	V_{IN}	VC input, INHN input	V_{SS}		V_{DD}	V
Operating temperature range	T_a	xA1~5, xB1,xC1,xD1 version	-40		+105	°C
		xL1~5 version	-40		+85	°C
Output load capacitance	C_L	Q output			15	pF

*1. The oscillation frequency is a yardstick value and the oscillation frequency range is not guaranteed. Specifically, the characteristics can vary greatly due to crystal characteristics and mounting conditions, so the oscillation characteristics of components must be carefully evaluated.

*2. For stable operation of this product, please mount ceramic chip capacitor that is more than 0.1uF between VDD and VSS in close proximity to IC (within 3mm). Wiring pattern between IC and capacitor should be as thick as possible.

* Since it may influence the reliability if it is used out of the recommended operating conditions range, this product should be used within this range.

9. ELECTRICAL CHARACTERISTICS

9.1. 7310xA1～7310xA5 version

V_{DD} = 2.25V to 3.63V, V_C = 0.5V_{DD}, V_{SS} = 0V, T_a = -40 to +105°C unless otherwise noted

Parameter	Symbol	Conditions	MIN	TYP	MAX	Unit
Current consumption (xA1 version: f_{OSC} output)	I_{DD}	Measurement circuit 1, INHN=OPEN, no load, V_{DD} = 3.3V, f_{OSC} = 40MHz, f_{OUT} = 40MHz		(1.6)	(3.0)	mA
Current consumption (xA2 version: f_{OSC}/2 output)	I_{DD}	Measurement circuit 1, INHN=OPEN, no load, V_{DD} = 3.3V, f_{OSC} = 40MHz, f_{OUT}= 20MHz		(1.2)	(1.8)	mA
Current consumption (xA3 version: f_{OSC}/4 output)	I_{DD}	Measurement circuit 1, INHN=OPEN, no load, V_{DD} = 3.3V, f_{OSC} = 40MHz, f_{OUT} = 10MHz		(1.1)	(1.6)	mA
Current consumption (xA4 version: f_{OSC}/8 output)	I_{DD}	Measurement circuit 1, INHN=OPEN, no load, V_{DD} = 3.3V, f_{OSC} = 40MHz, f_{OUT} = 5MHz		(1.0)	(1.5)	mA
Current consumption (xA5 version: f_{OSC}/16 output)	I_{DD}	Measurement circuit 1, INHN=OPEN, no load, V_{DD} = 3.3V, f_{OSC} = 40MHz, f_{OUT} = 2.5MHz		(0.9)	(1.4)	mA
Standby current	I_{STB}	Measurement circuit 1 INHN=LOW, T_a = -40 ~ +85°C		10	20	μA
		T_a = -40 ~ +105°C		10	100	μA
HIGH-level output voltage	V_{OH}	Measurement circuit 2, I_{OH}=-2.8mA, Q pin	V_{DD} - 0.4			V
LOW-level output voltage	V_{OL}	Measurement circuit 2, I_{OL}=2.8mA, Q pin			0.4	V
HIGH-level input voltage	V_{IH}	Measurement circuit 3, INHN pin	-1		1	μA
LOW-level input voltage	V_{IL}	Measurement circuit 3, INHN pin	0.7			V_{DD}
Output leakage current	I_Z	Measurement circuit 4, Ta = 25°C, INHN = Low, Q pin			0.3	V_{DD}
Pull-up resistance	R_{PU1}	Measurement circuit 5, INHN pin, V_{INHN} = 0V	0.5	1	2	MΩ
	R_{PU2}	Measurement circuit 5, INHN pin, V_{INHN} = 0.7V_{DD}	25	50	100	kΩ
Oscillator internal capacitance	C_{VC1}	Design value, V_C = 0.3V		(5.6)		pF
		V_C = 1.65V		(3.1)		
		V_C = 3.0V		(1.5)		
	C_{VC2}	Design value, V_C = 0.3V		(8.4)		pF
		V_C = 1.65V		(4.7)		
		V_C = 3.0V		(2.3)		
Input leakage resistance	R_{VIN}	Measurement circuit 7, VC pin, Ta = 25°C	10			MΩ
Max Modulation Frequency	F_M	Measurement circuit 10, -3dB Frequency V_{DD} = 3.3V, V_C = 1.65V ± 1.65V, Ta = 25°C crystal = 40MHz (R1=42Ω, C0=1.3pF)	15	25		kHz

* The ratings are measured by using the NPC standard resonator and jig.
They may vary due to resonator characteristics, so they must be carefully evaluated.

9.2. 7310xB1 version

V_{DD} = 2.97V to 3.63V, V_C = 0.5V_{DD}, V_{SS} = 0V, T_a = -40 to +105°C unless otherwise noted

Parameter	Symbol	Conditions		MIN	TYP	MAX	Unit
Current consumption (xB1 version: f_{OSC} output)	I_{DD}	Measurement circuit 1, INHN=OPEN, no load, V_{DD} = 3.3V, f_{OSC} = 61.44MHz, f_{OUT} = 61.44MHz			(2.7)	(5.0)	mA
Standby current	I_{STB}	Measurement circuit 1, INHN=LOW	T_a = -40 ~ +85°C	10	20	µA	µA
			T_a = -40 ~ +105°C	10	100	µA	µA
HIGH-level output voltage	V_{OH}	Measurement circuit 2, I_{OH}=-2.8mA, Q pin		V_{DD} - 0.4			V
LOW-level output voltage	V_{OL}	Measurement circuit 2, I_{OL}=2.8mA, Q pin				0.4	V
HIGH-level input voltage	V_{IH}	Measurement circuit 3, INHN pin		0.7			V_{DD}
LOW-level input voltage	V_{IL}	Measurement circuit 3, INHN pin				0.3	V_{DD}
Output leakage current	I_Z	Measurement circuit 4, Ta = 25°C INHN = Low, Q pin		-1		1	µA
Pull-up resistance	R_{PU1}	Measurement circuit 5, INHN pin, V_{INHN} = 0V		0.5	1	2	MΩ
	R_{PU2}	Measurement circuit 5, INHN pin, V_{INHN} = 0.7V_{DD}		25	50	100	kΩ
Oscillator internal capacitance	C_{VC1}	Design value	V_C = 0.3V		(5.6)		pF
			V_C = 1.65V		(3.1)		
			V_C = 3.0V		(1.5)		
	C_{VC2}	Design value	V_C = 0.3V		(8.4)		pF
			V_C = 1.65V		(4.7)		
			V_C = 3.0V		(2.3)		
Input leakage resistance	R_{VIN}	Measurement circuit 7, VC pin, Ta = 25°C		10			MΩ
Max Modulation Frequency	F_M	Measurement circuit 10, -3dB Frequency V_{DD} = 3.3V, V_C = 1.65V±1.65V, Ta = 25°C crystal = 61.44MHz(R1=20Ω, C0=3.2pF)		15	25		kHz

* The ratings are measured by using the NPC standard resonator and jig.
They may vary due to resonator characteristics, so they must be carefully evaluated.

9.3. 7310xC1 version

V_{DD} = 2.97V to 3.63V, V_C = 0.5V_{DD}, V_{SS} = 0V, T_a = -40 to +105°C unless otherwise noted

Parameter	Symbol	Conditions	MIN	TYP	MAX	Unit
Current consumption (xC1 version: f_{OSC} output)	I_{DD}	Measurement circuit 1, INHN=OPEN, no load, V_{DD} = 3.3V, f_{OSC} = 77.76MHz, f_{OUT} = 77.76MHz		(5.2)	(8.0)	mA
Standby current	I_{STB}	Measurement circuit 1, INHN=LOW; T_a = -40 ~ +85°C	10	20	µA	µA
		Measurement circuit 1, INHN=LOW; T_a = -40 ~ +105°C	10	100	µA	µA
HIGH-level output voltage	V_{OH}	Measurement circuit 2, I_{OH}=-4mA, Q pin	V_{DD} - 0.4			V
LOW-level output voltage	V_{OL}	Measurement circuit 2, I_{OL}=4mA, Q pin			0.4	V
HIGH-level input voltage	V_{IH}	Measurement circuit 3, INHN pin	-1		1	µA
LOW-level input voltage	V_{IL}	Measurement circuit 3, INHN pin	0.7			V_{DD}
Output leakage current	I_Z	Measurement circuit 4, Ta = 25°C INHN = Low, Q pin			0.3	V_{DD}
Pull-up resistance	R_{PU1}	Measurement circuit 5, INHN pin, V_{INHN} = 0V	0.5	1	2	MΩ
	R_{PU2}	Measurement circuit 5, INHN pin, V_{INHN} = 0.7V_{DD}	25	50	100	kΩ
Oscillator internal capacitance	C_{VC1}	Design value; V_C = 0.3V		(6.5)		pF
		Design value; V_C = 1.65V		(4.1)		pF
		Design value; V_C = 3.0V		(2.3)		pF
	C_{VC2}	Design value; V_C = 0.3V		(9.8)		pF
		Design value; V_C = 1.65V		(6.2)		pF
		Design value; V_C = 3.0V		(3.4)		pF
Input leakage resistance	R_{VIN}	Measurement circuit 7, VC pin, Ta = 25°C	10			MΩ
Max Modulation Frequency	F_M	Measurement circuit 10, -3dB Frequency V_{DD} = 3.3V, V_C = 1.65V±1.65V, Ta = 25°C crystal = 77.76MHz(R1=7Ω, C0=2.8pF)	15	25		kHz

* The ratings are measured by using the NPC standard resonator and jig.
They may vary due to resonator characteristics, so they must be carefully evaluated.

9.4. 7310xD1 version

V_{DD} = 2.97V to 3.63V, V_C = 0.5V_{DD}, V_{SS} = 0V, T_a = -40 to +105°C unless otherwise noted

Parameter	Symbol	Conditions		MIN	TYP	MAX	Unit
Current consumption (xC1 version: f_{OSC} output)	I_{DD}	Measurement circuit 1, INHN=OPEN, no load, V_{DD} = 3.3V, f_{OSC} =155.52MHz, f_{OUT} = 155.52MHz			(10)	(15)	mA
Standby current	I_{STB}	Measurement circuit 1, INHN=LOW	T_a = -40 ~ +85°C		10	20	μA
			T_a = -40 ~ +105°C		10	100	μA
HIGH-level output voltage	V_{OH}	Measurement circuit 2, I_{OH}=-8mA, Q pin		V_{DD} - 0.4			V
LOW-level output voltage	V_{OL}	Measurement circuit 2, I_{OL}=8mA, Q pin				0.4	V
HIGH-level input voltage	V_{IH}	Measurement circuit 3, INHN pin		-1		1	μA
LOW-level input voltage	V_{IL}	Measurement circuit 3, INHN pin		0.7			V_{DD}
Output leakage current	I_Z	Measurement circuit 4, Ta = 25°C INHN = Low, Q pin				0.3	V_{DD}
Pull-up resistance	R_{PU1}	Measurement circuit 5, INHN pin, V_{INHN} = 0V		0.5	1	2	MΩ
	R_{PU2}	Measurement circuit 5, INHN pin, V_{INHN} = 0.7V_{DD}		25	50	100	kΩ
Oscillator internal capacitance	C_{VC1}	Design value	V_C = 0.3V		(4.9)		pF
			V_C = 1.65V		(3.1)		
			V_C = 3.0V		(1.7)		
	C_{VC2}	Design value	V_C = 0.3V		(6.9)		pF
			V_C = 1.65V		(4.4)		
			V_C = 3.0V		(2.4)		
Input leakage resistance	R_{VIN}	Measurement circuit 7, VC pin, Ta = 25°C		10			MΩ
Max Modulation Frequency	F_M	Measurement circuit 10, -3dB Frequency V_{DD} = 3.3V, V_C = 1.65V±1.65V, Ta = 25°C crystal = 155.52MHz(R1=7Ω, C0=2.8pF)		15	25		kHz

* The ratings are measured by using the NPC standard resonator and jig.
They may vary due to resonator characteristics, so they must be carefully evaluated.

9.5. 7310xL1～7310xL5 version

V_{DD} = 1.6V to 2.0V, V_C = 0.5V_{DD}, V_{SS} = 0V, T_a = -40 to +85°C unless otherwise noted

Parameter	Symbol	Conditions	MIN	TYP	MAX	Unit
Current consumption (xL1 version: f_{OSC} output)	I_{DD}	Measurement circuit 1, INHN=OPEN, no load, V_{DD} = 1.8V, f_{OSC} = 27MHz, f_{OUT} = 27MHz		(0.5)	(1.0)	mA
Current consumption (xL2 version: f_{OSC}/2 output)	I_{DD}	Measurement circuit 1, INHN=OPEN, no load, V_{DD} = 1.8V, f_{OSC} = 27MHz, f_{OUT}= 13.5MHz		(0.4)	(0.8)	mA
Current consumption (xL3 version: f_{OSC}/4 output)	I_{DD}	Measurement circuit 1, INHN=OPEN, no load, V_{DD} = 1.8V, f_{OSC} = 27MHz, f_{OUT} = 6.75MHz		(0.3)	(0.6)	mA
Current consumption (xL4 version: f_{OSC}/8 output)	I_{DD}	Measurement circuit 1, INHN=OPEN, no load, V_{DD} = 1.8V, f_{OSC} = 27MHz, f_{OUT} = 3.38MHz		(0.3)	(0.6)	mA
Current consumption (xL5 version: f_{OSC}/16 output)	I_{DD}	Measurement circuit 1, INHN=OPEN, no load, V_{DD} = 1.8V, f_{OSC} = 27MHz, f_{OUT} = 1.69MHz		(0.3)	(0.6)	mA
Standby current	I_{STB}	Measurement circuit 1, INHN=LOW		10	20	μA
HIGH-level output voltage	V_{OH}	Measurement circuit 2, I_{OH}=-2.0mA, Q pin	V_{DD} - 0.4			V
LOW-level output voltage	V_{OL}	Measurement circuit 2, I_{OL}=2.0mA, Q pin			0.4	V
HIGH-level input voltage	V_{IH}	Measurement circuit 3, INHN pin	-1		1	μA
LOW-level input voltage	V_{IL}	Measurement circuit 3, INHN pin	0.7			V_{DD}
Output leakage current	I_Z	Measurement circuit 4, Ta = 25°C, INHN = Low, Q pin			0.3	V_{DD}
Pull-up resistance	R_{PU1}	Measurement circuit 5, INHN pin, V_{INHN} = 0V	0.5	1	2	MΩ
	R_{PU2}	Measurement circuit 5, INHN pin, V_{INHN} = 0.7V_{DD}	25	50	100	kΩ
Oscillator internal capacitance	C_{VC1}	Design value, V_C = 0.2V		(4.7)		pF
		Design value, V_C = 0.9V		(2.9)		
		Design value, V_C = 1.6V		(1.7)		
	C_{VC2}	Design value, V_C = 0.2V		(4.7)		pF
		Design value, V_C = 0.9V		(2.9)		
		Design value, V_C = 1.6V		(1.7)		
Input leakage resistance	R_{VIN}	Measurement circuit 7, VC pin, Ta = 25°C	10			MΩ
Max Modulation Frequency	F_M	Measurement circuit 10, -3dB Frequency V_{DD} = 1.8V, V_C = 0.9V±0.9V, Ta = 25°C crystal = 27MHz (R1=11Ω, C0=1.1pF)	15	25		kHz

* The ratings are measured by using the NPC standard resonator and jig.
They may vary due to resonator characteristics, so they must be carefully evaluated.

10. SWITCHING CHARACTERISTICS

10.1. 7310xA1 to 7310xA5 version

V_{DD} = 2.25V to 3.63V, V_C = 0.5V_{DD}, V_{SS} = 0V, T_a = -40 to +105°C unless otherwise noted

Parameter	Symbol	Conditions	MIN	TYP	MAX	Unit
AC HIGH-level output voltage	V_{TOP}	Measurement circuit 8, C_L=15pF	0.9 V_{DD}			V
AC LOW-level output voltage	V_{BASE}	Measurement circuit 8, C_L=15pF			0.1 V_{DD}	V
Output rise time	t_r	Measurement circuit 8, C_L=15pF, 0.1V_{DD}→0.9V_{DD}		3.0	6.5	ns
Output fall time	t_f	Measurement circuit 8, C_L=15pF, 0.9V_{DD}→0.1V_{DD}		3.0	6.5	ns
Output duty cycle	DUTY	Measurement circuit 8, C_L=15pF V_{DD}=3.3V, Ta=25°C	45	50	55	%
Output enable delay time	t_{OE}	Measurement circuit 9, Ta=25°C, C_L=15pF			2	ms
Output disable delay time	t_{OD}	Measurement circuit 9, Ta=25°C, C_L=15pF			200	ns

* C_L : Load capacitance connected with Q pin.

* The ratings are measured by using the NPC standard resonator and jig.
They may vary due to resonator characteristics, so they must be carefully evaluated.

10.2. 7310xB1 version

V_{DD} = 2.97V to 3.63V, V_C = 0.5V_{DD}, V_{SS} = 0V, T_a = -40 to +105°C unless otherwise noted

Parameter	Symbol	Conditions	MIN	TYP	MAX	Unit
AC HIGH-level output voltage	V_{TOP}	measurement circuit 8, C_L=15pF	0.9 V_{DD}			V
AC LOW-level output voltage	V_{BASE}	measurement circuit 8, C_L=15pF			0.1 V_{DD}	V
Output rise time	t_r	Measurement circuit 8, C_L=15pF, 0.1V_{DD}→0.9V_{DD}		2.2	5.5	ns
Output fall time	t_f	Measurement circuit 8 C_L=15pF, 0.9V_{DD}→0.1V_{DD}		2.2	5.5	ns
Output duty cycle	DUTY	measurement circuit 8, C_L=15pF V_{DD}=1.8V, Ta=25°C	45	50	55	%
Output enable delay time	t_{OE}	measurement circuit 9, Ta=25°C, C_L=15pF			2	ms
Output disable delay time	t_{OD}	measurement circuit 9, Ta=25°C, C_L=15pF			200	ns

* C_L : Load capacitance connected with Q pin.

* The ratings are measured by using the NPC standard resonator and jig.
They may vary due to resonator characteristics, so they must be carefully evaluated.

10.3. 7310xC1 version

V_{DD} = 2.97V to 3.63V, V_C = 0.5V_{DD}, V_{SS} = 0V, T_a = -40 to +105°C unless otherwise noted

Parameter	Symbol	Conditions	MIN	TYP	MAX	Unit
AC HIGH-level output voltage	V_{TOP}	Measurement circuit 8, C_L=15pF	0.9 V_{DD}			V
AC LOW-level output voltage	V_{BASE}	Measurement circuit 8, C_L=15pF			0.1 V_{DD}	V
Output rise time	t_r	Measurement circuit 8, C_L=15pF, 0.1V_{DD}→0.9V_{DD}		1.5	3.0	ns
Output fall time	t_f	Measurement circuit 8, C_L=15pF, 0.9V_{DD}→0.1V_{DD}		1.5	3.0	ns
Output duty cycle	DUTY	Measurement circuit 8, C_L=15pF V_{DD}=3.3V, Ta=25°C	45	50	55	%
Output enable delay time	t_{OE}	Measurement circuit 9, Ta=25°C, C_L=15pF			2	ms
Output disable delay time	t_{OD}	Measurement circuit 9, Ta=25°C, C_L=15pF			200	ns

* C_L : Load capacitance connected with Q pin.

* The ratings are measured by using the NPC standard resonator and jig.
They may vary due to resonator characteristics, so they must be carefully evaluated.

10.4. 7310xD1 version

V_{DD} = 2.97V to 3.63V, V_C = 0.5V_{DD}, V_{SS} = 0V, T_a = -40 to +105°C unless otherwise noted

Parameter	Symbol	Conditions	MIN	TYP	MAX	Unit
AC HIGH-level output voltage	V_{TOP}	measurement circuit 8, C_L=15pF	0.9 V_{DD}			V
AC LOW-level output voltage	V_{BASE}	measurement circuit 8, C_L=15pF			0.1 V_{DD}	V
Output rise time	t_r	Measurement circuit 8, C_L=15pF, 0.1V_{DD}→0.9V_{DD}		1.2	2.4	ns
Output fall time	t_f	Measurement circuit 8 C_L=15pF, 0.9V_{DD}→0.1V_{DD}		1.2	2.4	ns
Output duty cycle	DUTY	measurement circuit 8, C_L=15pF V_{DD}=1.8V, Ta=25°C	45	50	55	%
Output enable delay time	t_{OE}	measurement circuit 9, Ta=25°C, C_L=15pF			2	ms
Output disable delay time	t_{OD}	measurement circuit 9, Ta=25°C, C_L=15pF			200	ns

* C_L : Load capacitance connected with Q pin.

* The ratings are measured by using the NPC standard resonator and jig.
They may vary due to resonator characteristics, so they must be carefully evaluated.
Recommended resonator characteristics are R1<20Ω and C0<1.5pF.

10.5. 7310xL1 to 7310xL5 version

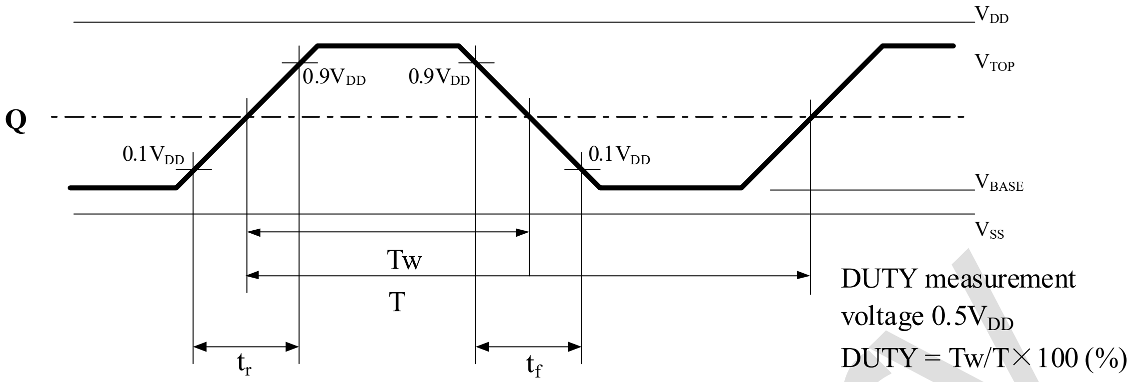
V_{DD} = 1.6V to 2.0V, V_C = 0.5V_{DD}, V_{SS} = 0V, T_a = -40 to +105°C unless otherwise noted

Parameter	Symbol	Conditions	MIN	TYP	MAX	Unit
AC HIGH-level output voltage	V_{TOP}	Measurement circuit 8, C_L=15pF	0.8 V_{DD}			V
AC LOW-level output voltage	V_{BASE}	Measurement circuit 8, C_L=15pF			0.2 V_{DD}	V
Output rise time	t_r	Measurement circuit 8, C_L=15pF, 0.2V_{DD}→0.8V_{DD}		3.0	6.5	ns
Output fall time	t_f	Measurement circuit 8, C_L=15pF, 0.8V_{DD}→0.2V_{DD}		3.0	6.5	ns
Output duty cycle	DUTY	Measurement circuit 8, C_L=15pF V_{DD}=3.3V, Ta=25°C	45	50	55	%
Output enable delay time	t_{OE}	Measurement circuit 9, Ta=25°C, C_L=15pF			2	ms
Output disable delay time	t_{OD}	Measurement circuit 9, Ta=25°C, C_L=15pF			200	ns

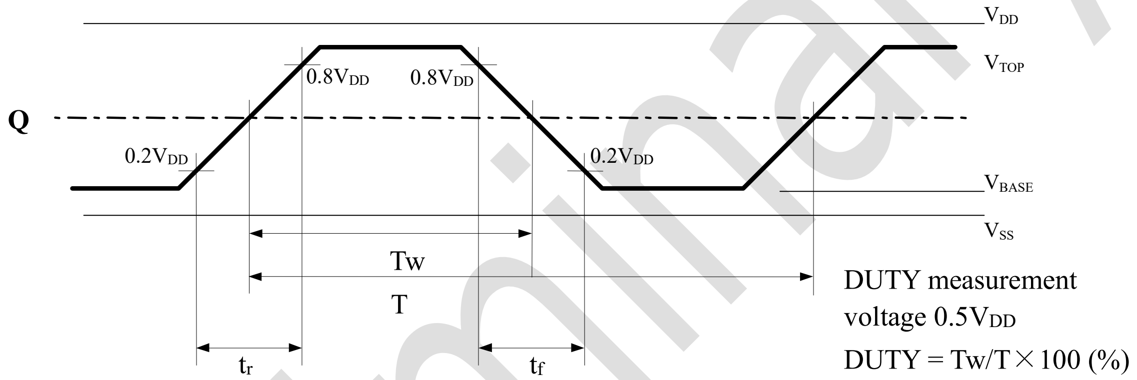
* C_L ：Load capacitance connected with Q pin.

* The ratings are measured by using the NPC standard resonator and jig.
They may vary due to resonator characteristics, so they must be carefully evaluated.

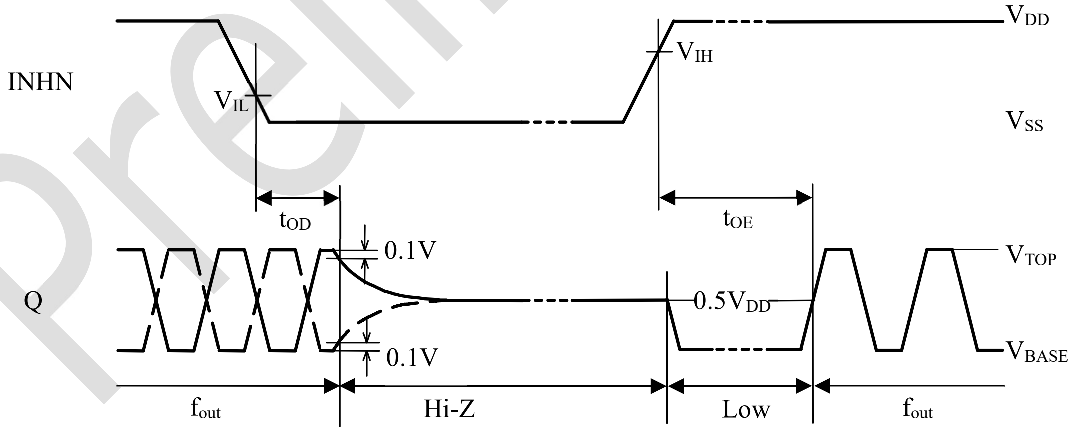
10.6. Switch Timing Measurement Waveform



Q pin Switching Waveform xA1~5, xB1, xC1, xD1 version



Q pin Switching Waveform xL1~5 version



Output state control switching waveform

・When INHN goes HIGH to LOW, the Q output becomes high impedance.

・When INHN goes LOW to HIGH, the Q output goes LOW once and then becomes normal output operation after having detected oscillation signals.

11. FUNCTIONAL DESCRIPTION

11.1. INHN Function

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

(1) INHN Functio

INHN pin (pull-up resistance built-in)	Oscillator (XT-XTN)	Output stage (Q)
High /Open	Active	Active
Low	Stop	HiZ

When INHN pin goes LOW, the Q pin becomes high impedance

11.2. Power Saving Pull-up Resistor

The INHN pin pull-up resistance changes in response to the input level (High or Low). When INHN pin is tied Low (standby state), the pull-up resistance becomes large (R_{PU1}), reducing the current consumed by the resistance. When INHN pin is open circuit, the pull-up resistance becomes small (R_{PU2}), decreasing the susceptibility to the effects of external noise.

11.3. Boot Function

At the time of oscillation starting, XT pin potential is made into the V_{DD} level. It makes negative resistance enlarged and it becomes easy to start oscillation. Beware that a current flows into VC pin until it starts oscillation, when XT pin is V_{DD} level and the voltage below V_{DD} level is being applied to VC pin.

A boot function is canceled after an oscillation start.

11.4. Oscillation Detection Function

The 7310 series incorporate an oscillation detector circuit.

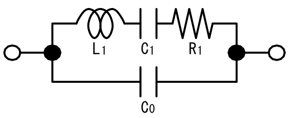
The oscillation detector circuit disables the Q output until crystal oscillation becomes stable when oscillator circuit starts up. This reduces the risk of abnormal oscillator behavior in the initial power up and in a reactivation by INHN. [when the oscillator starts by power apply and reactivation by INHN.]

12. REFERENCE DATA (5410A1, 5410Bx and 5410C1 TYPICAL CHARACTERISTICS)

The following characteristics are measured using the crystal below.
Note that the characteristics will vary with the crystal used.

* Crystal used for measurement

Parameter	7310WA1	7310WB1	7310WC1	7310WD1	7310WL1
f_s(MHz)	40	61.44	77.76	155.52	27
C0(pF)	1.3	3.2	2.4	1.5	1.5
γ(=C0/C1)	330	350	290	330	300
R1(Ω)	42	20	7	9	11



Crystal parameters

12.1. Frequency Pulling Range Characteristics

VDD=3.3V, Ta=25°C, VC=1.65V Standard

【7310WA1】f_{OSC}=40MHz

【7310WB1】f_{OSC}=61.44MHz

【7310WC1】f_{OSC} =77.76MHz

【7310WD1】f_{OSC} =155.52MHz

See Measurement circuit 8 on page 26.

12.2. Phase Noise Characteristics

【7310WA1 f0】
V_{DD}=3.3V,Ta=25°C, f_{OSC} =40MHz, f_{OUT}=40MHz

【7310WA1 f0/2】
V_{DD}=3.3V,Ta=25°C, f_{OSC} =40MHz, f_{OUT}=20MHz

【7310WA1 f0/4】
V_{DD}=3.3V,Ta=25°C, f_{OSC} =40MHz, f_{OUT}=10MHz

【7310WB1】

V_{DD}=3.3V,Ta=25°C, f_{OSC} =61.44MHz, f_{OUT}=61.44MHz

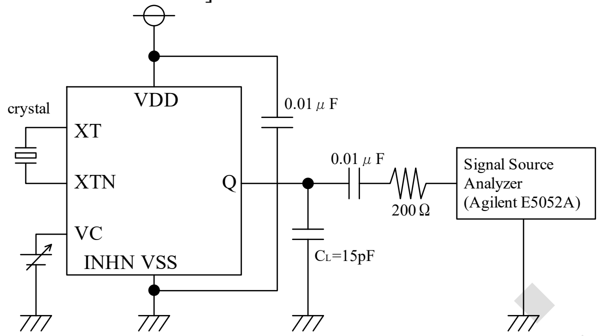
【7310WC1】

V_{DD}=3.3V,Ta=25°C, f_{OSC} =77.76MHz, f_{OUT}=77.76MHz

【7310WD1】

V_{DD}=3.3V,Ta=25°C, f_{OSC} =155.52MHz, f_{OUT}=155.52MHz

[Measurement circuit]



12.3. Negative Resistance Characteristics

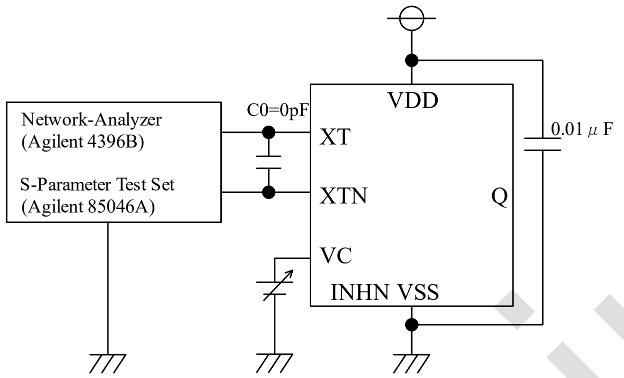
【7310WA1】V_{DD}=3.3V,Ta=25°C,C0=0pF,ブート時

【7310WB1】V_{DD}=3.3V,Ta=25°C,C0=0pF,ブート時

【7310WC1】V_{DD}=3.3V,Ta=25°C,C0=0pF,ブート時

【7310WD1】V_{DD}=3.3V,Ta=25°C,C0=0pF,ブート時

[Measurement circuit]



The NPC measurement jig uses an Agilent 4396B.
The values will vary with the measurement jig and measurement environment.

12.4. Oscillator Equivalent Capacitance (CLosc) Characteristics

【7310WA1】V_{DD}=3.3V,Ta=25°C, f_{OSC} =40MHz

【7310WB1】V_{DD}=3.3V,Ta=25°C, f_{OSC} =61.44MHz

【7310WC1】V_{DD}=3.3V,Ta=25°C, f_{OSC} =77.76MHz

【7310WD1】V_{DD}=3.3V,Ta=25°C, f_{OSC} =155.52MHz

See Measurement Circuit 8 on page 24.

CLosc: Oscillation circuit equivalent capacitance is determined by the oscillator frequency.

$$CLosc = \frac{C1}{\left(\frac{f_{OSC}}{fs}\right)^2 - 1} - C0$$

C1: Crystal equivalent series capacitance
C0: Crystal equivalent parallel capacitance
fs: Crystal series resonant frequency

12.5. Drive Level Characteristics

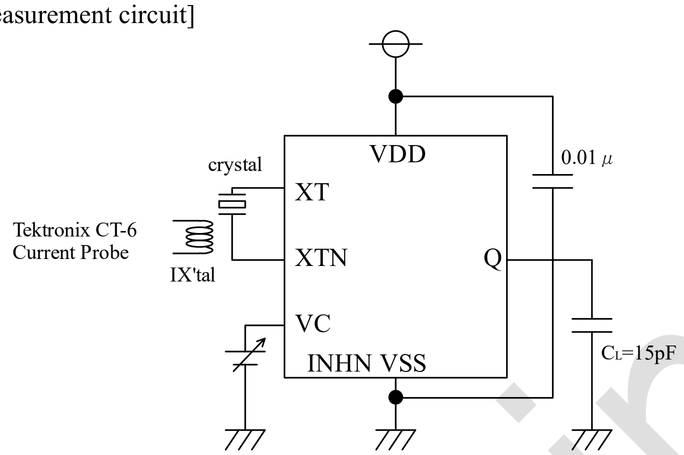
【7310WA1】V_{DD}=3.3V,Ta=25°C, f_{OSC} =40MHz

【7310WB1】V_{DD}=3.3V,Ta=25°C, f_{OSC} =61.44MHz

【7310WC1】V_{DD}=3.3V,Ta=25°C, f_{OSC} =77.76MHz

【7310WD1】V_{DD}=3.3V,Ta=25°C, f_{OSC} =155.52MHz

[Measurement circuit]



12.6. Max Frequency Modulation Characteristics

【7310WA1】V_{DD}=3.3V,Ta=25°C, f_{OSC} =40MHz

【7310WA2,WA3】V_{DD}=3.3V,Ta=25°C, f_{OSC} =40MHz f0/2-4

【7310WB1】V_{DD}=3.3V,Ta=25°C, f_{OSC} =61.44MHz

【7310WC1】V_{DD}=3.3V,Ta=25°C, f_{OSC} =77.76MHz

【7310WD1】V_{DD}=3.3V,Ta=25°C, f_{OSC} =155.52MHz

See Measurement Circuit 10 on page 27.

12.7. Operating Current Consumption

【7310WA1~WA5】V_{DD}=3.3V,Ta=25°C

【7310WB1,WC1,WD1】V_{DD}=3.3V,Ta=25°C

See Measurement Circuit 1 on page 24.

12.8. Frequency Stability by V_{DD}

【7310WA1】V_{DD}=3.3V,Ta=25°C, f_{OSC} =40MHz

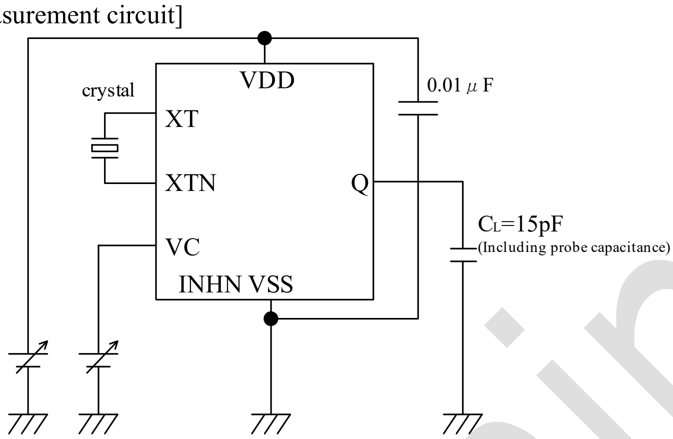
【7310WA2,WA3】V_{DD}=3.3V,Ta=25°C, f_{OSC} =40MHz f0/2-4

【7310WB1】V_{DD}=3.3V,Ta=25°C, f_{OSC} =61.44MHz

【7310WC1】V_{DD}=3.3V,Ta=25°C, f_{OSC} =77.76MHz

【7310WD1】V_{DD}=3.3V,Ta=25°C, f_{OSC} =155.52MHz

[Measurement circuit]



12.9. Output Waveform

V_{DD}=3.3V,V_C=1.65V,Ta=25°C, CL=15pF

【7310WA1】f_{OSC} =40MHz

【7310WB1】f_{OSC} =61.44MHz

【7310WC1】f_{OSC} =77.76MHz

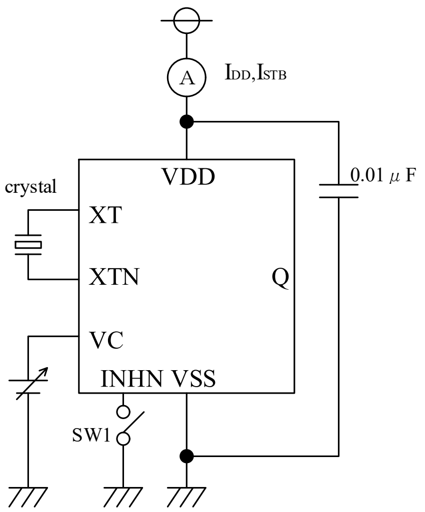
【7310WD1】f_{OSC} =155.52MHz

See Measurement Circuit 8 on page 26.

Measuring equipment: Agilent DSO80604B oscilloscope

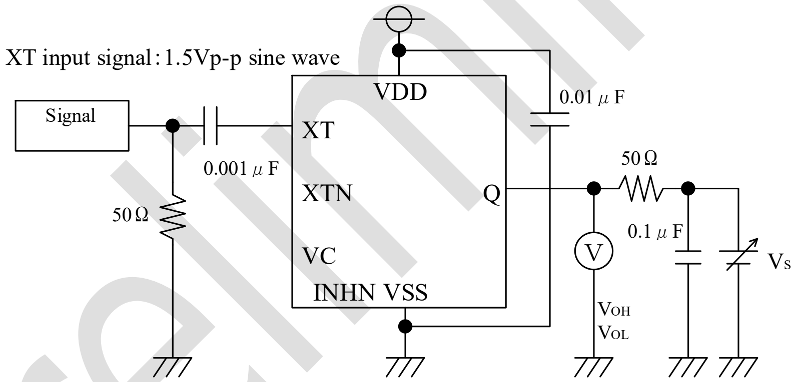
13. MEASUREMENT CIRCUITS

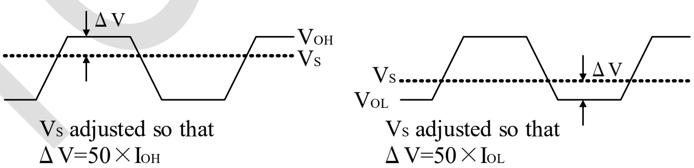
13.1. Measurement circuit 1 ・・・ I_{DD}, I_{STB}



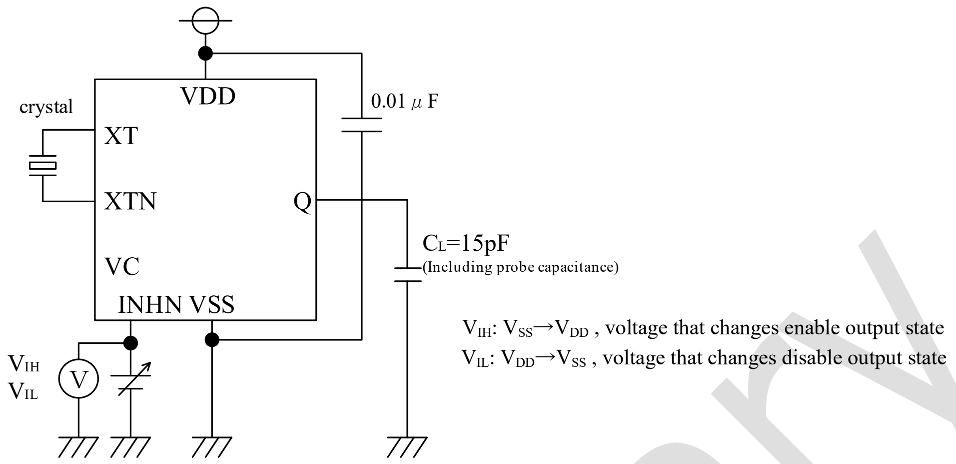
Parameter	**SW1**
I_{DD}	OFF
I_{STB}	ON

13.2. Measurement circuit 2 ・・・ V_{OH}, V_{OL}

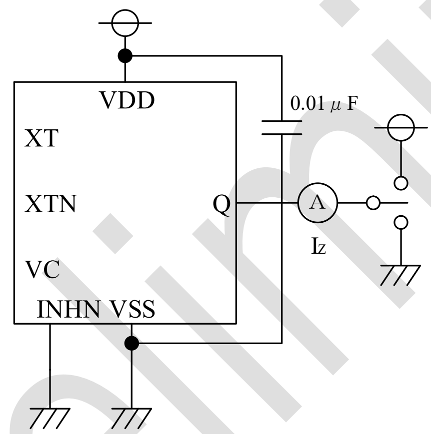




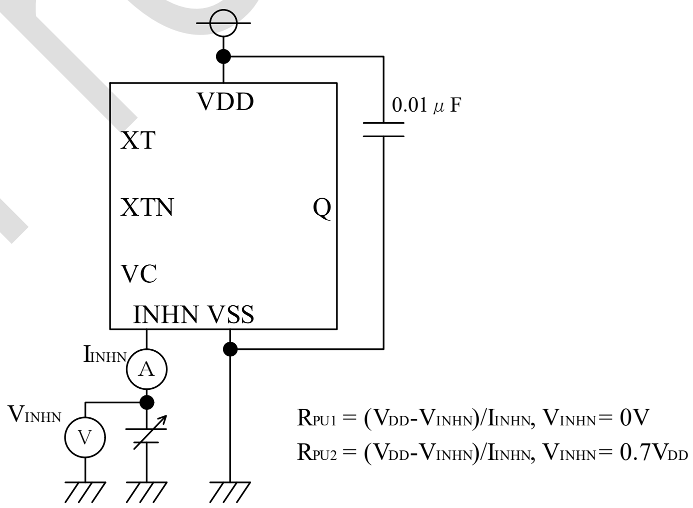
13.3. Measurement circuit 3 ・・・ V_{IH}, V_{IL}



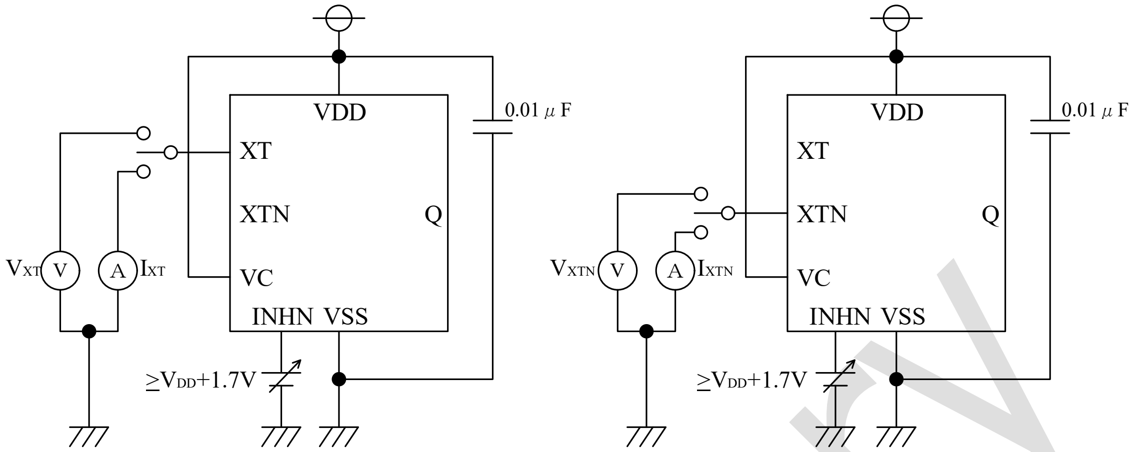
13.4. Measurement circuit 4 ・・・ I_Z



13.5. Measurement circuit 5 ・・・ R_{PU1}, R_{PU2}



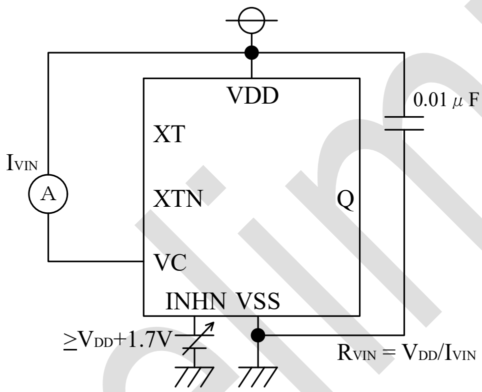
13.6. Measurement circuit 6 ・・・ R_{VC1}, R_{VC2}



$R_{VC1} = V_{XT}/I_{XT}$

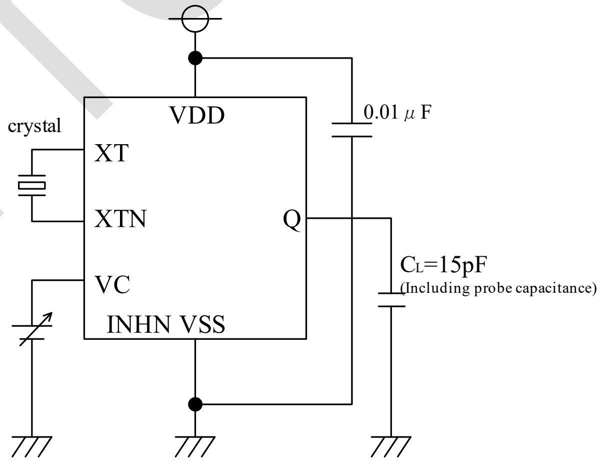
$R_{VC2} = V_{DD}/I_{XTN}$

13.7. Measurement circuit 7 ・・・ R_{VIN}

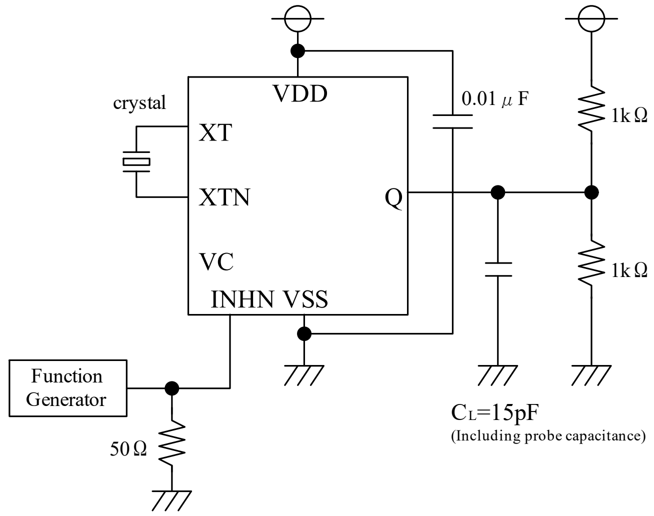


$R_{VIN} = V_{DD}/I_{VIN}$

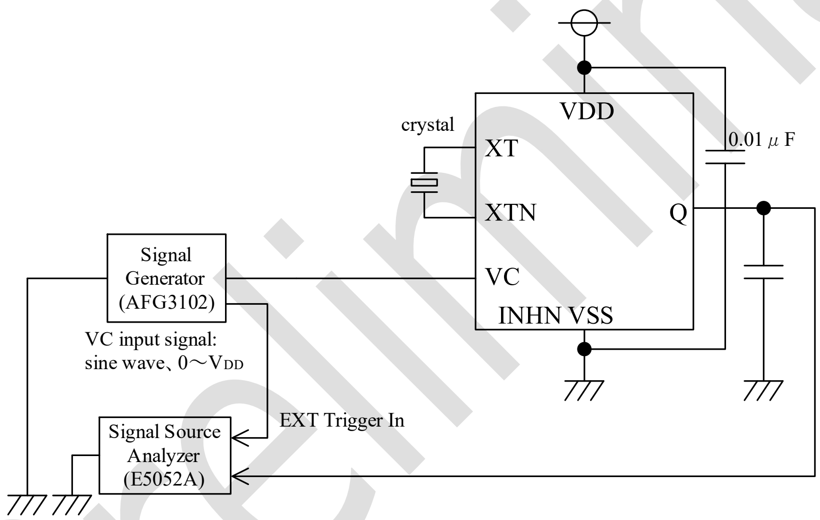
13.8. Measurement circuit 8 ・・・ DUTY , tr , tf , Pulling Range , CL_{OSC} , V_{TOP}, T_{BASE}



13.9. Measurement circuit 9 ･･･ t_{OE}, t_{OD}



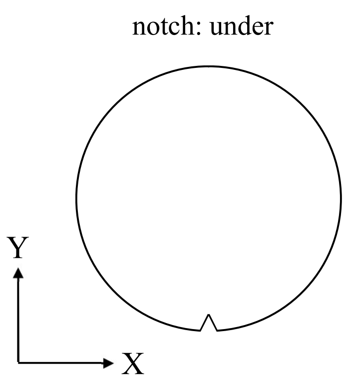
13.10. Measurement circuit 10 ･･･ F_M

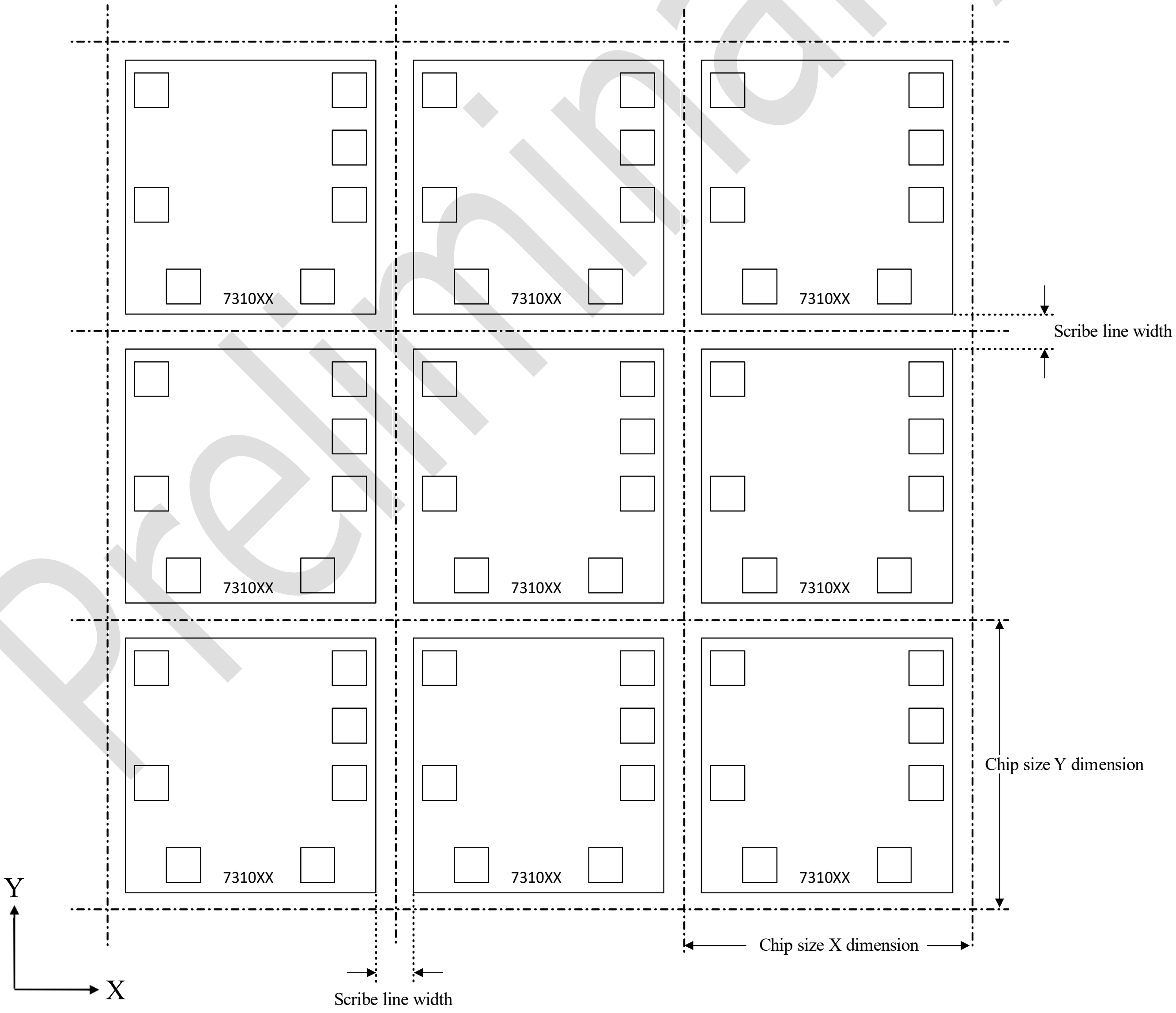


14. **WAFER SURFACE ALIGNMENT DIAGRAM**

Wafer size: 200mm±0.5mm

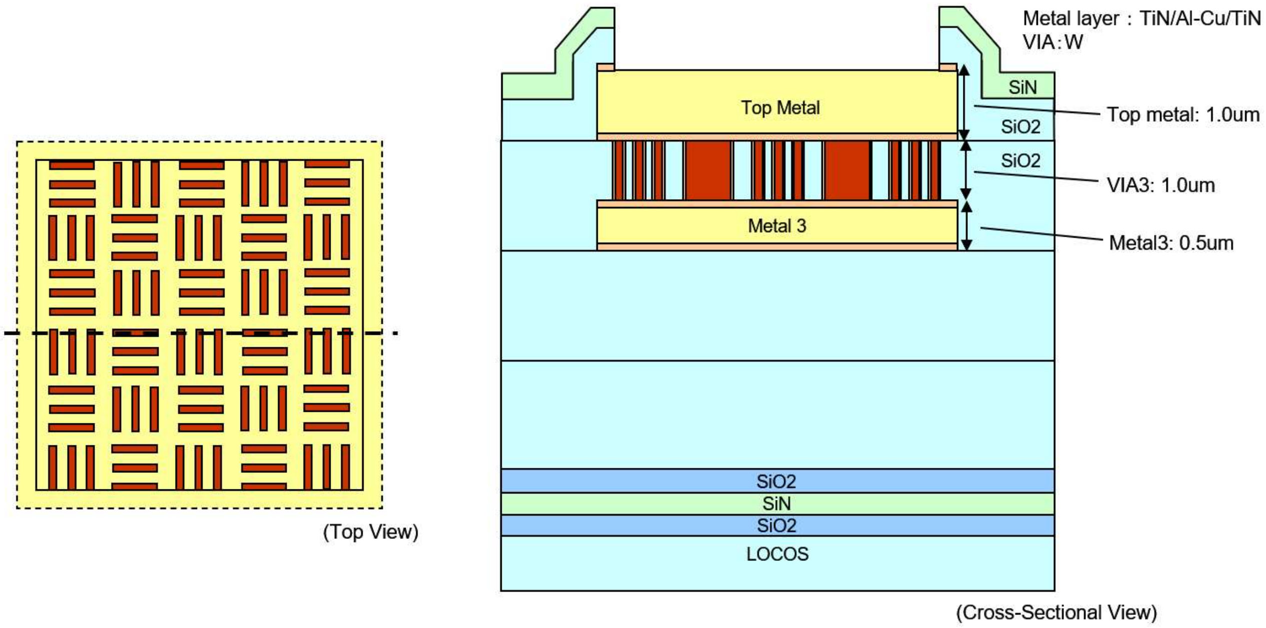
Scribe line width: 80µm





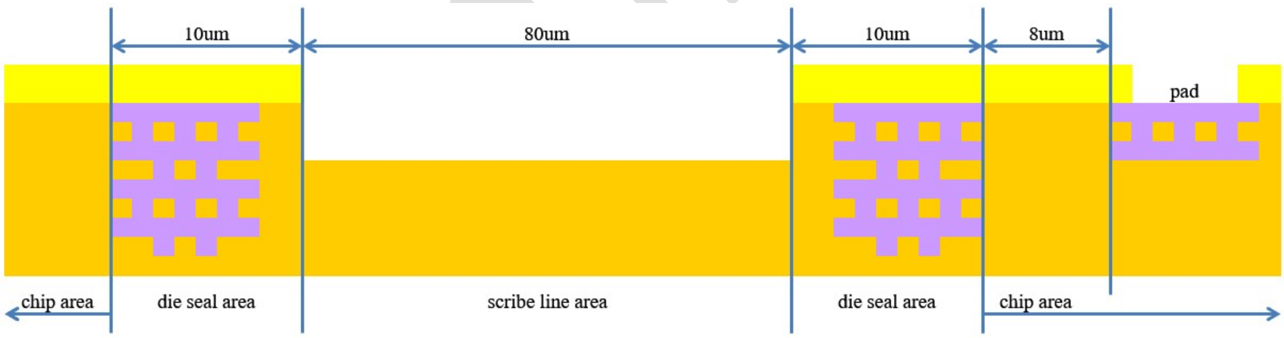
15. CROSS SECTION STRUCTURE

15.1. PAD Cross Section Structure



*Film thicknesses of mention is a value in the designs as above and is not the actual value in the chip.

15.2. Seal Ring And Scribe Line Cross Section Structure



*Film thicknesses of mention is a value in the designs as above and is not the actual value in the chip.

<Notes on UBM formation>

In UBM (Under Bump Metal) formation to the mounting pad electrode by electroless plating, UBM is similarly formed on the scribe line TEG and the metal exposed part of the accessory. So mask process covering the scribe line is required to prevent these effects.

16. USAGE AND PRECAUTIONS

This product is designed and manufactured to the generally accepted standards of reliability as expected for use in general electronic and electrical equipment, such as personal equipment, machine tools, and measurement equipment. This product is not designed and manufactured to be used in any other special equipment requiring extremely high level of reliability and safety, such as aerospace equipment, nuclear power control equipment, medical equipment, transportation equipment, disaster prevention equipment, security equipment.
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This version of 7310 has edit by VC America on page one Overview to correct part number