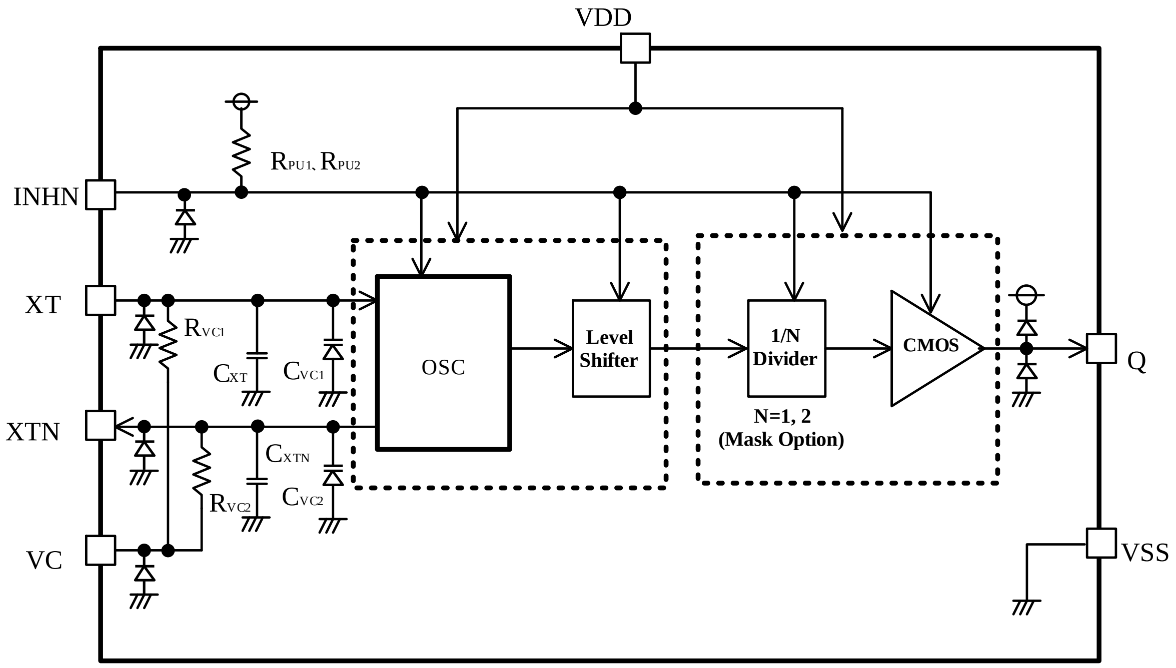
1. OVERVIEW

The CF7321xx/WF7321xx is a 122.88MHz oscillator frequency, CMOS output, VCXO module IC.
It incorporates a bipolar oscillator circuit and varicap diode built-in for low phase noise characteristic and wide frequency pulling range.

2. FEATURES

■ Varicap diode built-in	
■ Oscillator:	Fundamental frequency oscillation
■ Output frequency (f_{OUT}):	30 to 122.88MHz
■ Oscillator frequency:	60 to 122.88MHz (7321Bx versions)
■ Frequency divider output:	Available in fundamental (f_{OSC}) and half frequency ($f_{OSC}/2$) output versions
■ Low standby current	Oscillator stopped, power saving pull-up resistor built-in
■ Output type:	CMOS
■ Operating voltage:	3.135 to 3.465V
■ Phase noise characteristics(typ):	-80dBc/Hz (B1 version, 10Hz offset, f=122.88MHz (γ=300, C0=1.5pF))
	-136dBc/Hz (B1 version, 1kHz offset, f=122.88MHz)
	-161dBc/Hz (B1 version, 10MHz offset, f=122.88MHz)
■ Frequency pulling range(typ):	±40ppm (B1 version, V_C=1.65 ± 1.65V, f=122.88MHz (γ=300, C0=1.5pF))

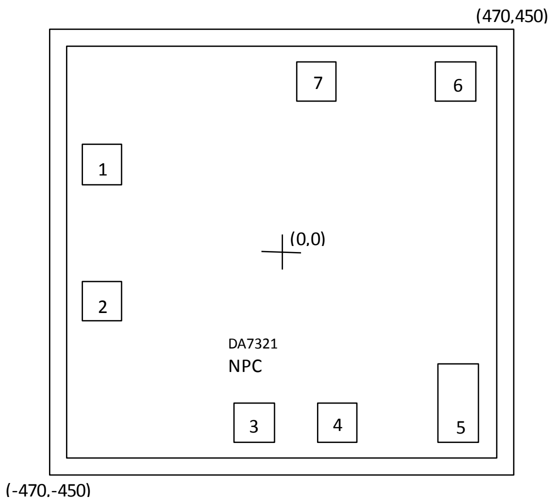
3. BLOCK DIAGRAM



4. PAD LAYOUT

(1) Chip size:*1 X=0.94mm, Y=0.90mm
(2) Rear surface potential: V_{SS}
(3) Pad size: 80μm × 80μm (VSS PAD 80μm × 160μm)
(4) Chip dimensions

*1: Chip size is the distance between the scribe line centers.



Pad coordinates (origin at chip center) Unit: [μm]

No.	Name	X	Y
1	XT	-365.0	177.0
2	XTN	-365.0	-98.0
3	VC	-55.4	-345.0
4	INHN	113.2	-345.0
5	VSS	357.0	-305.0
6	Q	351.9	345.0
7	VDD	70.1	345.0

5. PAD DESCRIPTION

No.	Name	I/O	Function
1	XT	I	Crystal element connection terminals. Connect crystal between XT and XTN
2	XTN	O	
3	VC	I	Control voltage input.
4	INHN	I	Output enable input. Oscillation stopped and the device goes into standby mode when Low. Power saving pull-up resistor built-in.
5	VSS	-	Ground
6	Q	O	Clock output High-impedance when standby mode
7	VDD	-	Supply voltage

*I: Input, O: Output

6. SERIES LINEUP

Device	Recommended oscillation frequency range (f_{OSC})[*1]	Output frequency (f_{OUT})
7321B1	60 to 122.88MHz	f_{OSC}
7321B2	30 to 61.44MHz	f_{OSC} /2

*1: Recommended values based on IC characteristics.
The oscillator characteristics are determined by the combination of crystal element and the IC, hence the actual oscillator is not limited to these values. Always conduct thorough circuit evaluation beforehand.
The recommended characteristics for the crystal element are:
Bx versions: R1 < 20Ω, C0 < 1.5pF

7. ABSOLUTE MAXIMUM RATINGS

V_{SS}=0V

Parameter	Symbol	Conditions		Rating	Unit
Supply voltage range[*1]	V_{DD}	VDD		-0.3 to +5.0	V
Input voltage range[*1,*3]	V_{IN}	XT, INHN, VC		-0.3 to V_{DD}+0.3	V
Output voltage range[*1,*3]	V_{OUT}	XTN, Q		-0.3 to V_{DD}+0.3	V
Junction temperature[*2]	T_j			+125	°C
Storage temperature range[*4]	T_{STG}	Wafers, chips		-55 to +125	°C
Output current[*2]	I_{OUT}	Q	T_a = -40 ~ +85°C	±20	mA
			T_a = -40 ~ +105°C	±10	mA

*1: Parameters must not exceed ratings, not even momentarily. If a rating is exceeded, there is a risk of IC failure, deterioration in characteristics, and decrease in reliability.
*2: Parameters should not exceed ratings. If a rating is exceeded, there is a risk of deterioration in characteristics and decrease in reliability.
*3: Recommended operating voltage V_{DD} value.
*4: Store separately in Nitrogen or vacuum atmosphere.

8. RECOMMENDED OPERATING CONDITIONS

V_{SS}=0V

Parameter	Symbol	Conditions	MIN	TYP	MAX	Unit
Operating supply voltage	V_{DD}	Between VDD and VSS[*2]	3.135	3.3	3.465	V
Input voltage	V_{IN}	INHN, VC	0		V_{DD}	V
Operating temperature	T_a		-40		105	°C
Output load	C_L				15	pF
Oscillator frequency[*1]	f_{OSC}	7321Bx	60		122.88	MHz
Output frequency	f_{OUT}	7321B1	60		122.88	MHz
		7321B2	30		61.44	

*1: The characteristics will vary greatly depending on the crystal element characteristics and mounting conditions. Use only after thorough evaluation of the oscillator characteristics.
*2: For stable device operation, connect 0.01μF or larger ceramic chip capacitors between VDD and VSS, mounted as close as possible to the IC (within approximately 3mm). Also, use as thick a wiring pattern as possible between the IC and the capacitors.
*Operation outside the recommended operating conditions may adversely affect reliability. Use only within specified ratings.

9. ELECTRICAL CHARACTERISTICS

9.1. B1, B2 Versions

V_{DD}=3.135 to 3.465V, 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 B1 version	I_{DD}	Measurement circuit 1, no load INHN=Open f_{OSC}=122.88MHz, f_{OUT}=122.88MHz V_{DD}=3.3V			8.0	14.0	mA
Current consumption B2 version	I_{DD}	Measurement circuit 1, no load INHN=Open f_{OSC}=122.88MHz, f_{OUT}=61.44MHz V_{DD}=3.3V			7.0	12.0	mA
Standby current	I_{STB}	Measurement circuit 1 INHN=LOW	T_a = -40 ~ +85°C			10	μA
			T_a = -40 ~ +105°C			100	
HIGH-level output voltage	V_{OH}	Measurement circuit 2, Q output I_{OH}=-4mA		V_{DD} -0.4			V
LOW-level output voltage	V_{OL}	Measurement circuit 2, Q output I_{OL}=4mA				0.4	V
Output leakage current	I_Z	Measurement circuit 3, Q output INHN=Low, T_a=25°C		-1		1	μA
HIGH-level input voltage	V_{IH}	Measurement circuit 4, INHN input		0.7V_{DD}			V
LOW-level input voltage	V_{IL}	Measurement circuit 4, INHN input				0.3V_{DD}	V
Pull-up resistance1	R_{PU1}	Measurement circuit 5, INHN input INHN=0V		1	4	9	MΩ
Pull-up resistance2	R_{PU2}	Measurement circuit 5, INHN input INHN=0.7V_{DD}		50	100	200	kΩ
Oscillator internal resistance	R_{VC1}	Between VC-XT, measurement circuit 6		70	140	210	kΩ
	R_{VC2}	Between VC-XTN, measurement circuit 6		70	140	210	
Input leakage resistance	R_{VIN}	VC, T_a=25°C, measurement circuit 7		10			MΩ
Oscillator capacitance	C_{VC1}	Confirmed using wafer monitor pattern, design value, excluding parasitic capacitance	V_C=0.3V	4.38	4.86	5.35	pF
			V_C=1.65V	2.62	3.08	3.55	
			V_C=3.0V	1.38	1.72	2.06	
	C_{VC2}		V_C=0.3V	6.24	6.94	7.63	pF
			V_C=1.65V	3.70	4.36	5.01	
			V_C=3.0V	1.89	2.36	2.83	
	C_{XT}	Confirmed using wafer monitor pattern, design value, excluding parasitic capacitance		4	6	8	pF
	C_{XTN}			4	6	8	
Maximum modulation frequency	F_M	-3dB frequency, T_a=25°C, design value, V_{DD}=3.3V, V_C=1.65 ± 1.65V, measurement circuit 8, f_{OSC}=122.88MHz		20	50		kHz

10. SWITCHING CHARACTERISTICS

10.1. B1, B2 Versions

V_{DD}=3.135 to 3.465V, V_C=0.5V_{DD}, V_{SS}=0V, T_a=-40 to +105°C unless otherwise noted

Parameter	Symbol	Conditions	MIN	TYP	MAX	Unit
HIGH-level output voltage	V_{TOP}	C_L=15pF, measurement circuit 9	0.9V_{DD}			V
LOW-level output voltage	V_{BASE}	C_L=15pF, measurement circuit 9			0.1V_{DD}	V
Duty cycle	Duty	T_a =25°C, V_{DD}=3.3V, measurement circuit 9	45	50	55	%
Output rise time	t_r	C_L=15pF, output amplitude, measurement circuit 9, 0.1V_{DD}→0.9V_{DD}		1.5	3.0	ns
Output fall time	t_f	C_L=15pF, output amplitude, measurement circuit 9, 0.9V_{DD}→0.1V_{DD}		1.5	3.0	ns
Output enable propagation delay*1	t_{OE}	T_a=25°C, measurement circuit 10 INHN=”Low”→”High”			2	ms
Output disable propagation delay	t_{OD}	T_a=25°C, measurement circuit 10 INHN=”High”→”Low”			200	ns

*1: Rating may vary depending on the power supply used, values of bypass capacitors, and other factors.

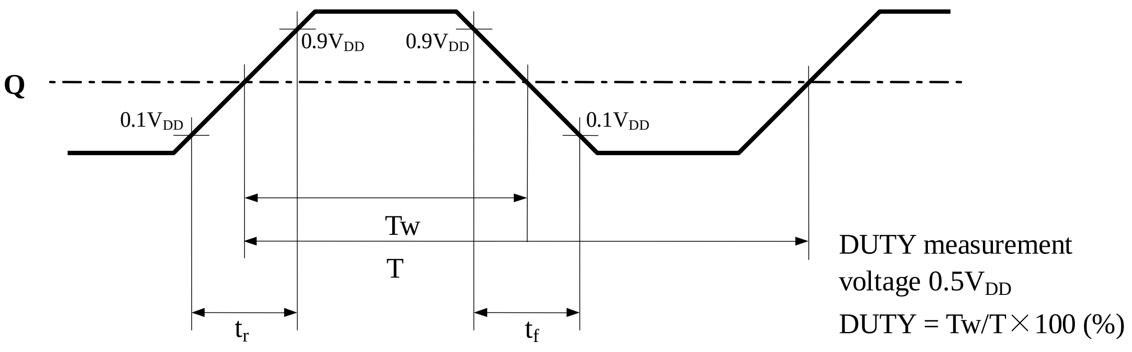
Notes

The ratings above are values obtained by measurements using NPC evaluation standard crystal element on a standards testing jig.

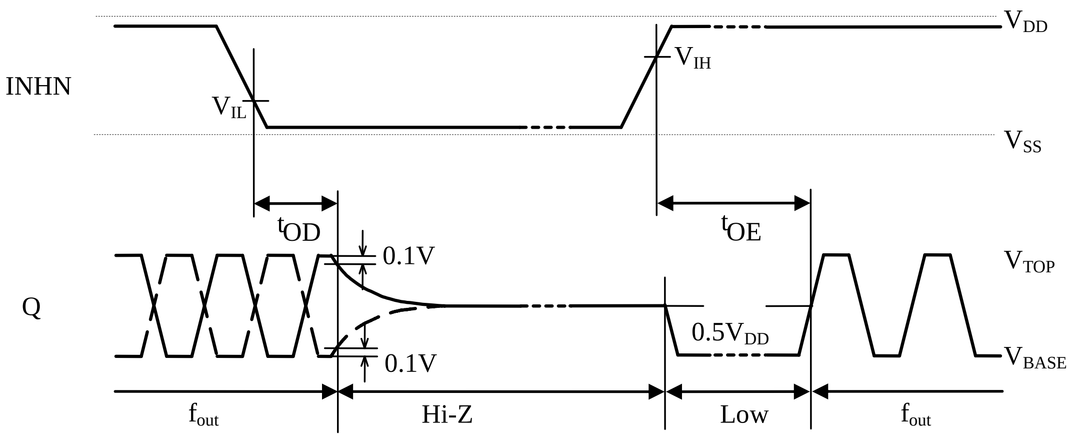
Ratings may have wide tolerances due to crystal element characteristics; thorough evaluation is recommended.

The recommended crystal element characteristics are R1 < 20Ω and C0 < 1.5pF.

Timing Diagrams



Output switching waveform



Output state control switching waveform

11. FUNCTIONAL DESCRIPTION

11.1. INHN Function

When INHN pin goes Low, the Q pin becomes high impedance and the oscillation stops.

INHN	Q	Oscillator
High(Open)	f_{OUT}	Operating
Low	Disabled (Hi-Z)	Disabled

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. Oscillation Detection Function

The 7321 series incorporate an oscillation detector circuit.

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

11.4. Boot Function

At the time of oscillation starting, XTN 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 XTN pin is V_{DD} level and the voltage below V_{DD} level is being applied to VC pin.

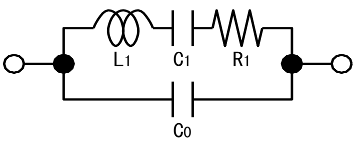
A boot function is canceled after an oscillation start.

12. REFERENCE CHARACTERISTICS EXAMPLE (7321Bx Typical Characteristics)

The characters given below were measured using an NPC standards jig and standard crystal element, and do not represent a guarantee of device characteristics.
Note that the characteristics will vary due to measurement environment and the oscillator element used.

Crystal used for evaluation

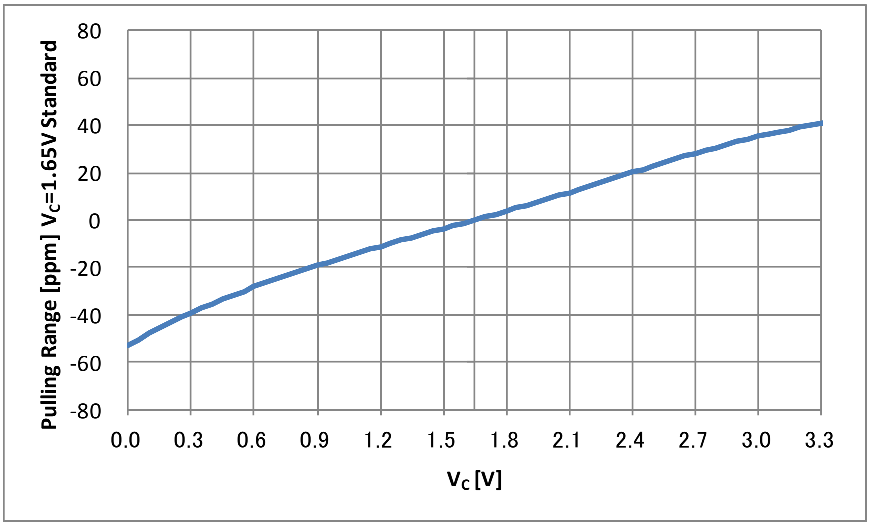
Parameter	B1
f_{OSC} (MHz)	122.88
C0 (pF)	1.8
γ (=C0/C1)	354
R1 (Ω)	8.1



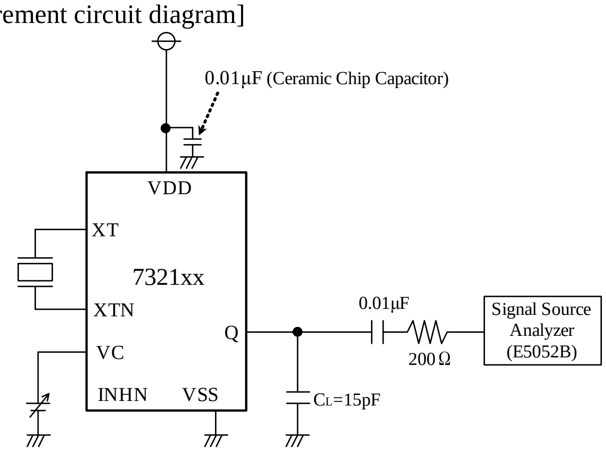
12.1. Pulling Range

[Measurement condition]
V_{DD}=3.3V, V_{SS}=0V, Ta=25℃

【7321Bx】f_{OSC}=122.88MHz



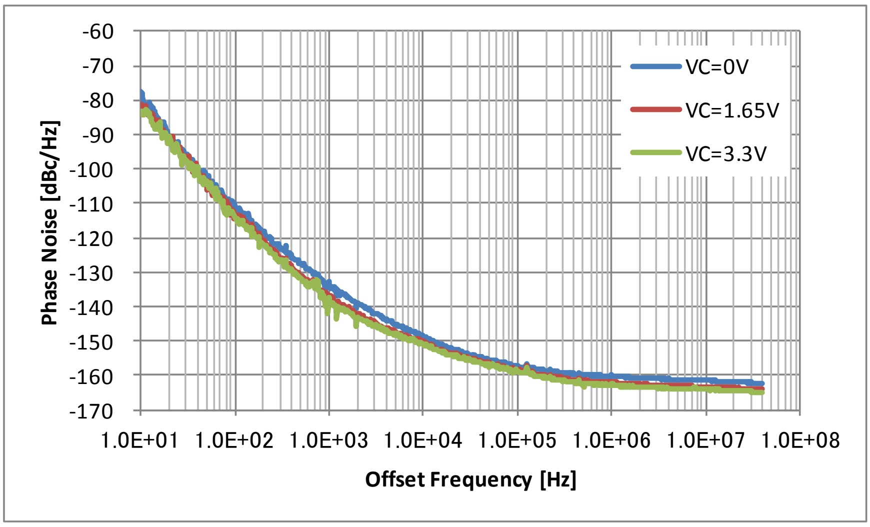
[Measurement circuit diagram]



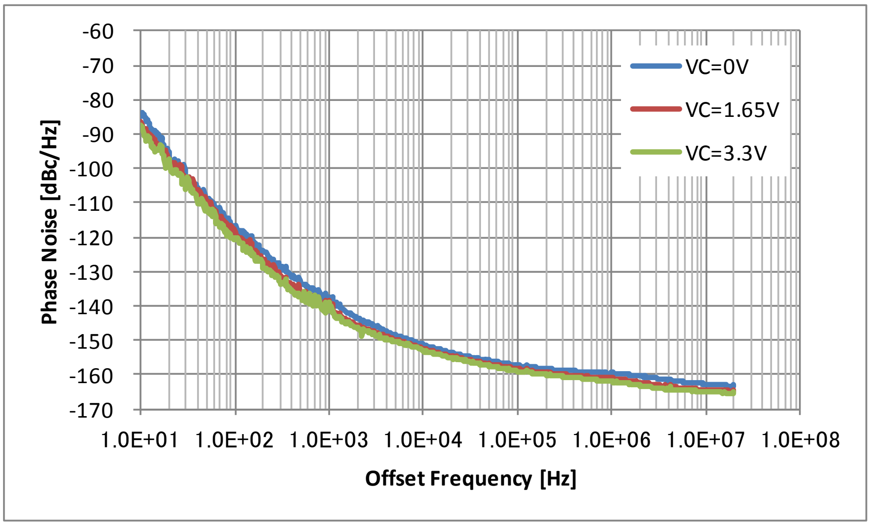
12.2. Phase Noise

[Measurement condition]
V_{DD}=3.3V, V_{SS}=0V, Ta=25℃

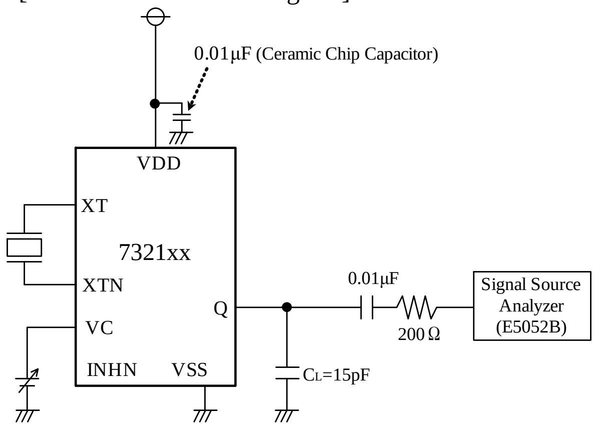
【7321B1】f_{OSC} =122.88MHz, f_{OUT} =122.88MHz



【7321B2】f_{OSC} =122.88MHz, f_{OUT} =61.44MHz



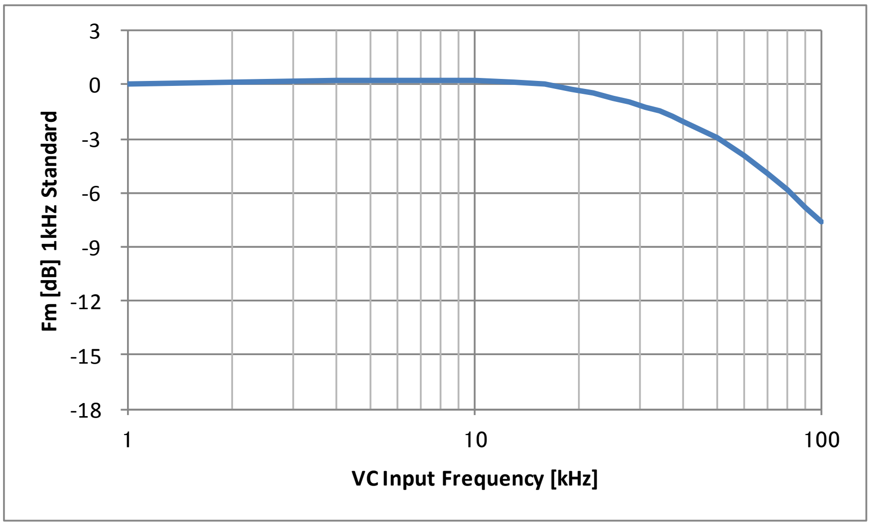
[Measurement circuit diagram]



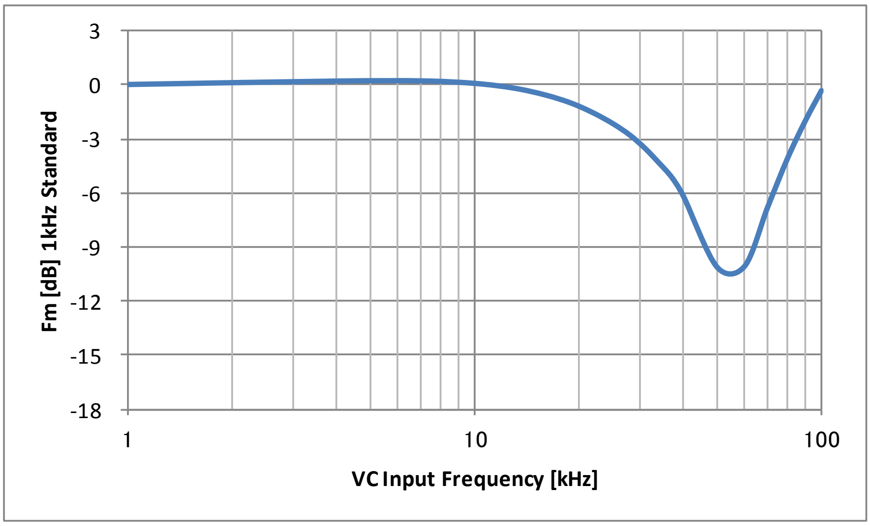
12.3. Modulation Bandwidth

[Measurement condition]
V_{DD}=3.3V, V_{SS}=0V, Ta=25℃

【7321B1】f_{OSC} =122.88MHz, f_{OUT} =122.88MHz



【7321B2】f_{OSC} =122.88MHz, f_{OUT} =61.44MHz

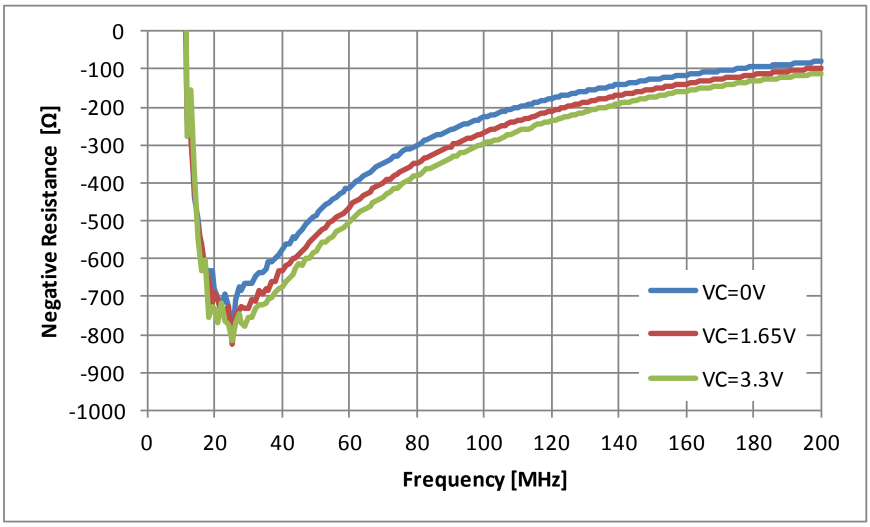


[Measurement circuit diagram] P22. Measurement circuit 8.

12.4. Negative Resistance

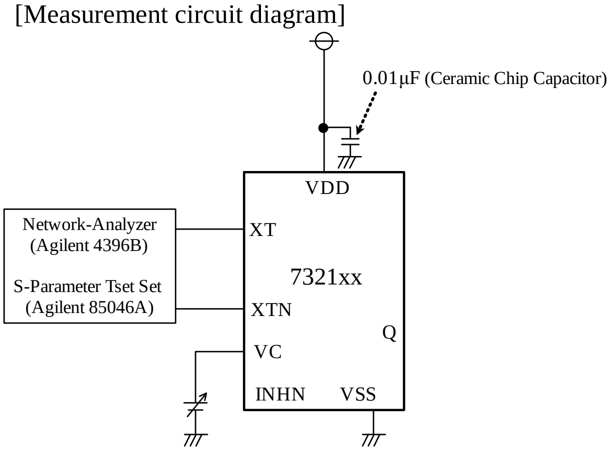
[Measurement condition]
V_{DD}=3.3V, V_{SS}=0V, Ta=25℃, C0=0pF

【7321Bx】 When in "Boot" function



At the time of oscillation starting, negative resistance becomes deep by boot function.
The boot function is released when oscillation is steady, and oscillation output starts.

[Measurement circuit diagram]

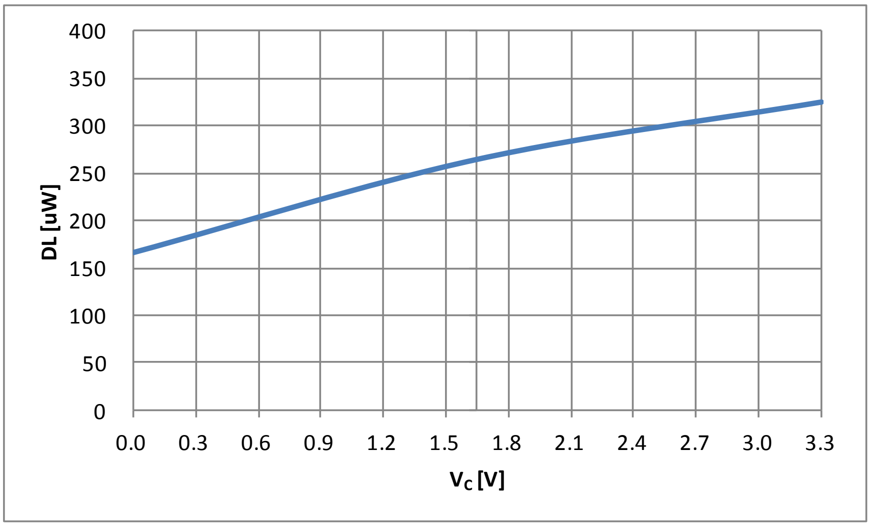


Measurement results using 4396B Agilent analyzer on NPC test jig. Measurements will vary with test jig and measurement environment.

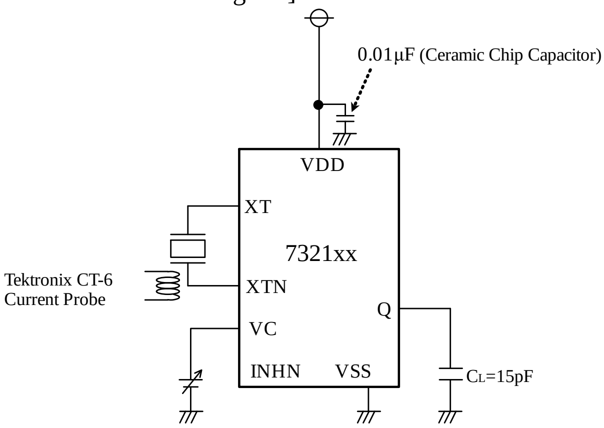
12.5. Drive Level

[Measurement condition]
V_{DD}=3.3V, Ta=25°C

【7321Bx】f_{OSC} =122.88MHz



[Measurement circuit diagram]



$$DL = (IX'tal)^2 \times Re$$

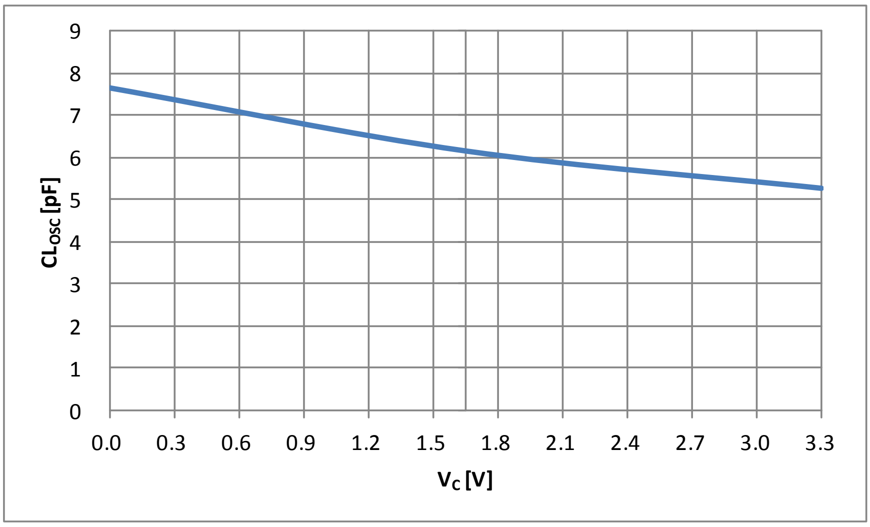
IX'tal：Current though Crystal(RMS)
Re：Crystal's effective resistance

12.6. Oscillator CL Characteristics

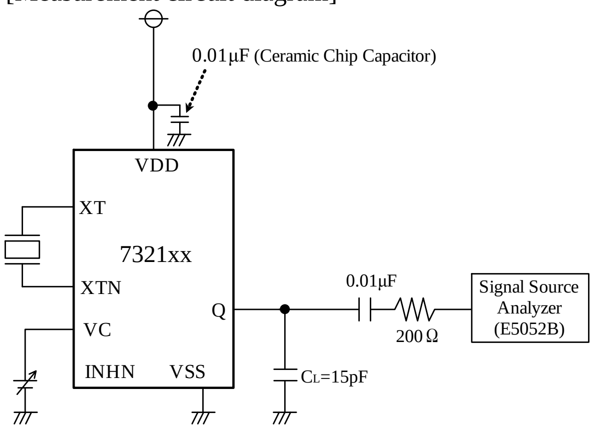
[Measurement condition]

V_{DD}=3.3V, V_{SS}=0V, Ta=25℃

【7321Bx】f_{OSC} =122.88MHz



[Measurement circuit diagram]



CL_{OSC}: Oscillator circuit equivalent capacitance determined by oscillator frequency

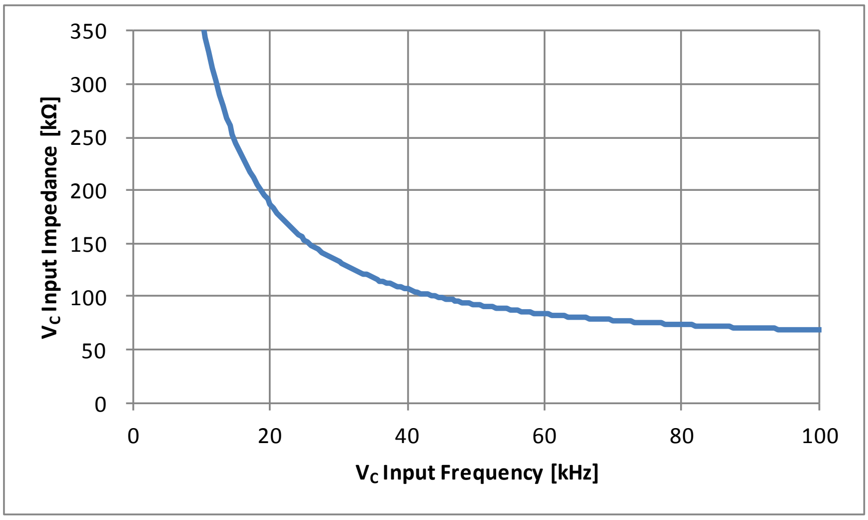
$$CLosc = \frac{C1}{\left(\frac{f_{OSC}}{fs}\right)^2 - 1} - C0$$

C1: Crystal element equivalent series capacitance
C0: Crystal element equivalent parallel capacitance
fs: Crystal element series resonance frequency

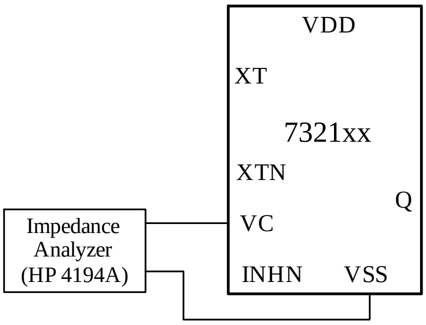
12.7. VC Terminal Input Impedance

[Measurement condition]
Ta=25°C, V_C=0V

【7321Bx】



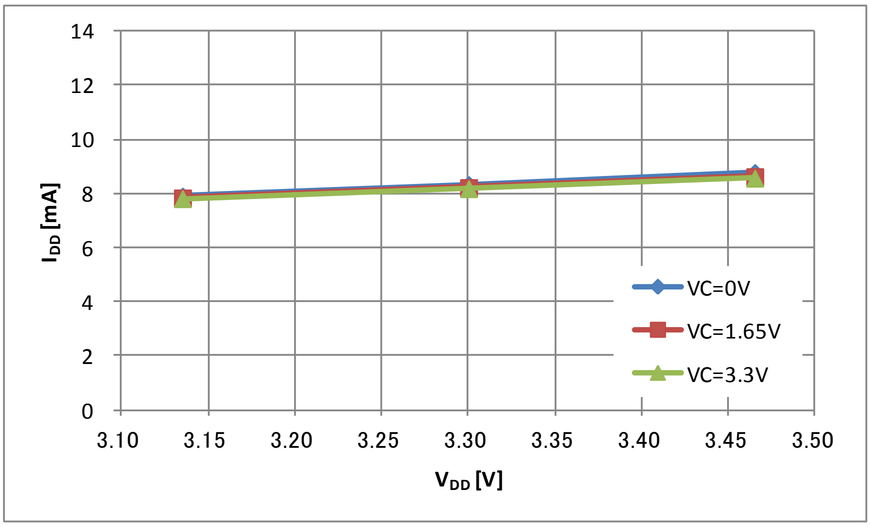
[Measurement circuit diagram]



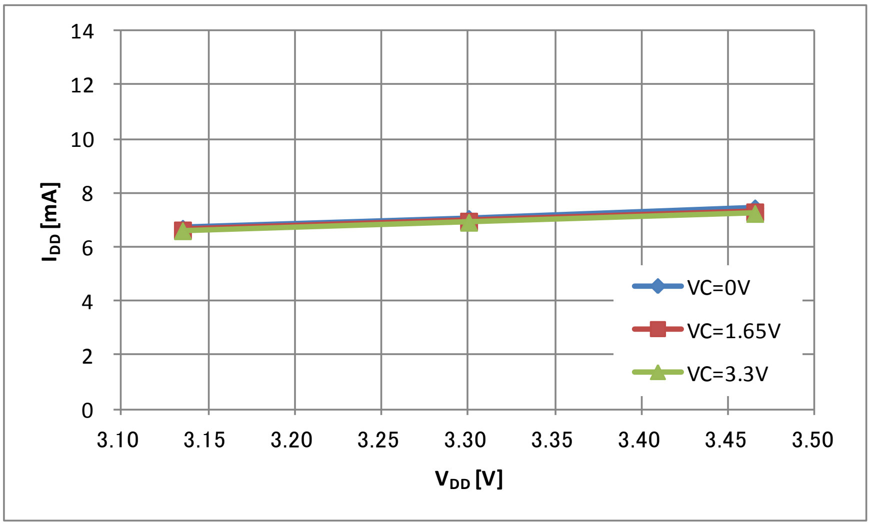
12.8. Current Consumption

[Measurement condition]
Ta=25℃, no load

【7321B1】f_{OSC} =122.88MHz, f_{OUT} =122.88MHz



【7321B2】f_{OSC} =122.88MHz, f_{OUT} =61.44MHz

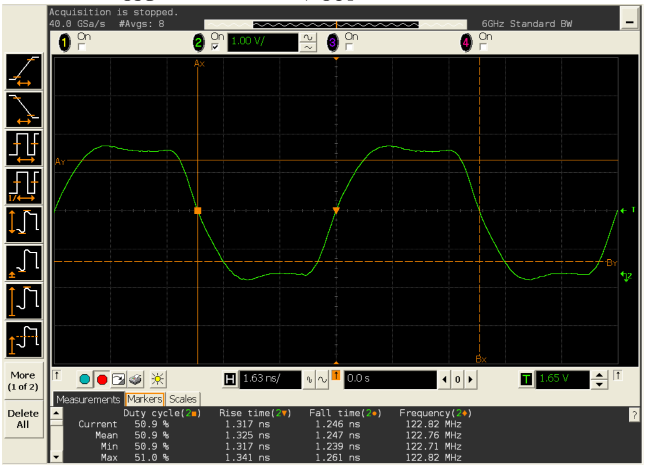


[Measurement circuit diagram] P18. Measurement circuit 1.

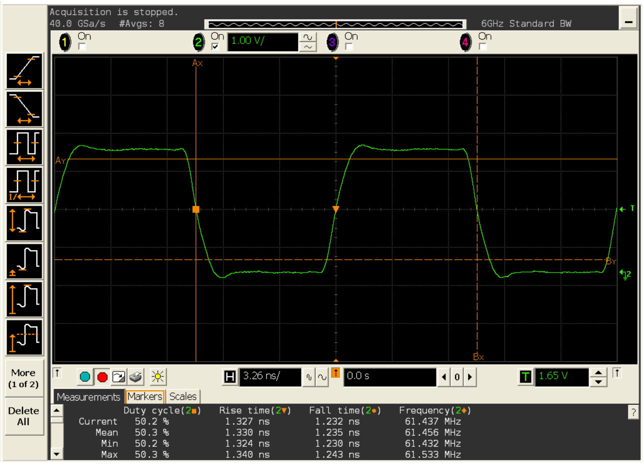
12.9. Output Waveform

[Measurement condition]
V_{DD}=3.3V, V_C=1.65V, Ta=25°C

【7321B1】f_{OSC} =122.88MHz,f_{OUT}=122.88MHz



【7321B2】f_{OSC} =122.88MHz, f_{OUT}=61.44MHz



[Measurement circuit diagram]P22. Measurement circuit 9.

Measurement equipment：Oscilloscope DSO80604B(Agilent), Differential probe 1134A (Probe head E2678A)

13. MEASUREMENT CIRCUITS

These measurement circuits are used for the evaluation of the electrical and switching characteristics.

Notes

Connect the bypass capacitors, specified in the measurement circuits, VDD/-VSS.
Connect the bypass capacitors and load resistors with wiring pattern as short as possible (less than 3mm length). If the wiring pattern is too long, the desired characteristics cannot be obtained.
Note that if bypass capacitors and load resistors other than the specified values are connected, or if the components are not connected at all, the desired characteristics cannot be obtained.

* Capacitor and resistor values used by NPC

- Capacitors: 0.01μF GRM188B11H103K (Murata Manufacturing Co., Ltd.)

13.1. Measurement Circuit 1

Measurement parameter: I_{DD}, I_{STB}

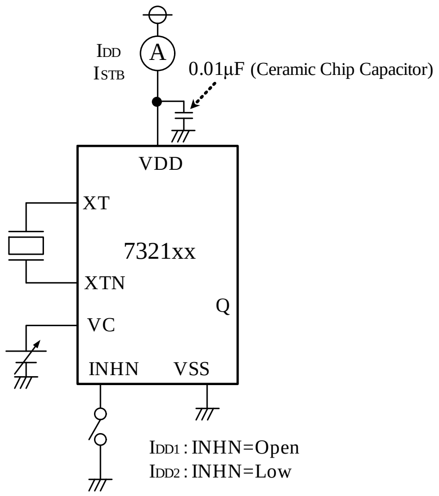


Figure 13-1. Measurement circuit 1

13.2. Measurement Circuit 2

Parameters：V_{OH}，V_{OL}

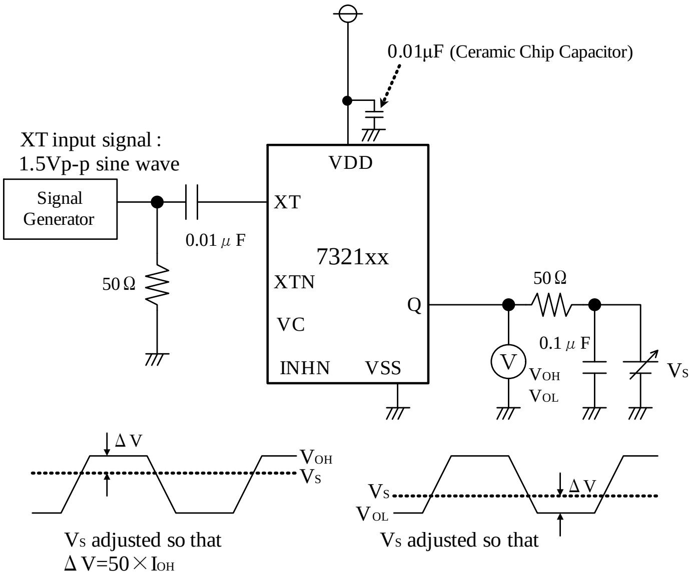


Figure 13-2. Measurement circuit 2

13.3. Measurement Circuit 3

Parameters：I_Z

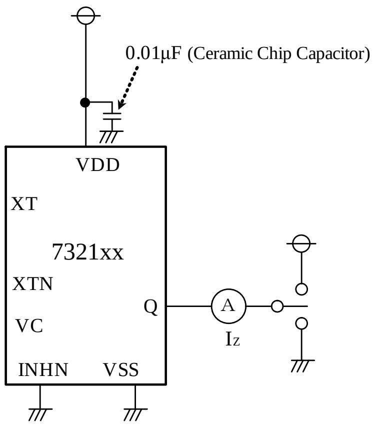
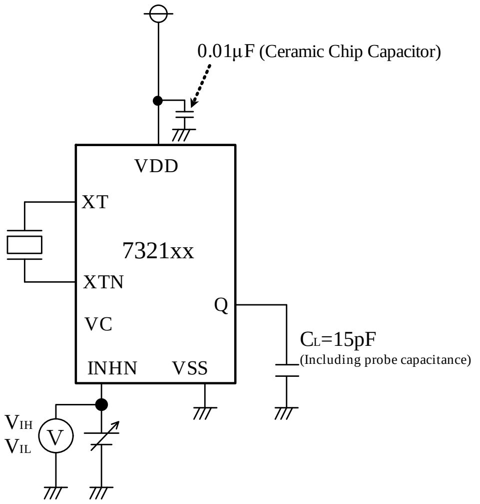


Figure 13-3. Measurement circuit 3

13.4. Measurement Circuit 4

Parameter：V_{IH}，V_{IL}

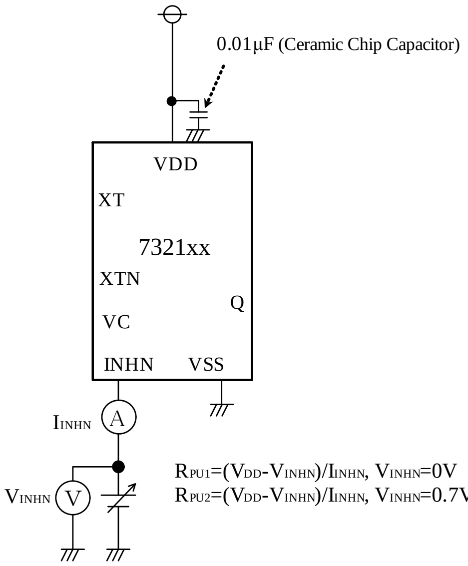


V_{IH}: V_{SS}→V_{DD} , voltage that changes enable output state
V_{IL}: V_{DD}→V_{SS} , voltage that changes disable output state

Figure 13-4. Measurement circuit 4

13.5. Measurement Circuit 5

Parameters：R_{PU1}, R_{PU2}



$R_{PU1}=(V_{DD}-V_{INHN})/I_{INHN}$, $V_{INHN}=0V$
$R_{PU2}=(V_{DD}-V_{INHN})/I_{INHN}$, $V_{INHN}=0.7V_{DD}$

Figure 13-5. Measurement circuit 5

13.6. Measurement Circuit 6

Parameters: R_{VC1}, R_{VC2}

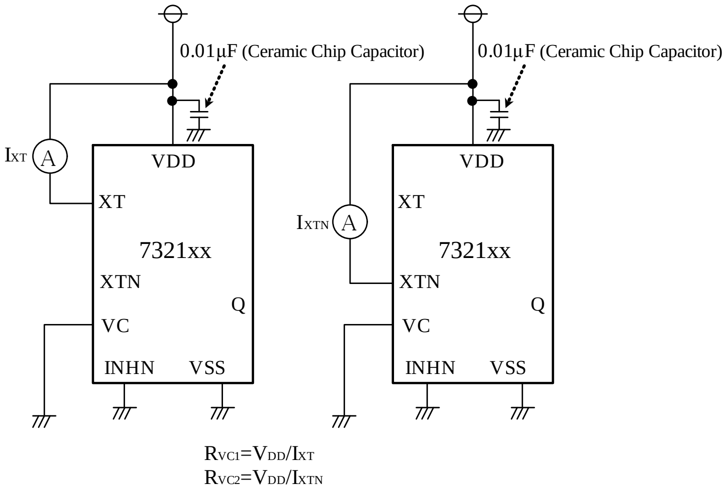


Figure 13-6. Measurement circuit 6

13.7. Measurement Circuit 7

Parameters: R_{VIN}

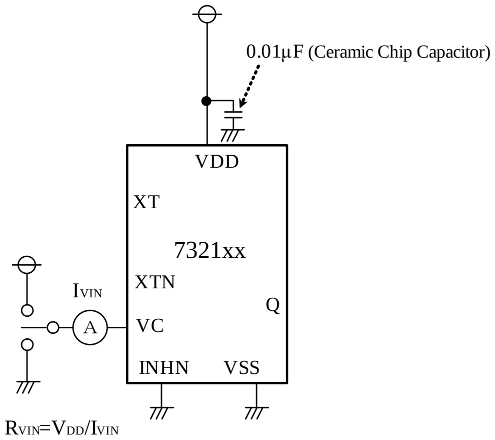


Figure 13-7. Measurement circuit 7

13.8. Measurement Circuit 8

Parameters：F_M

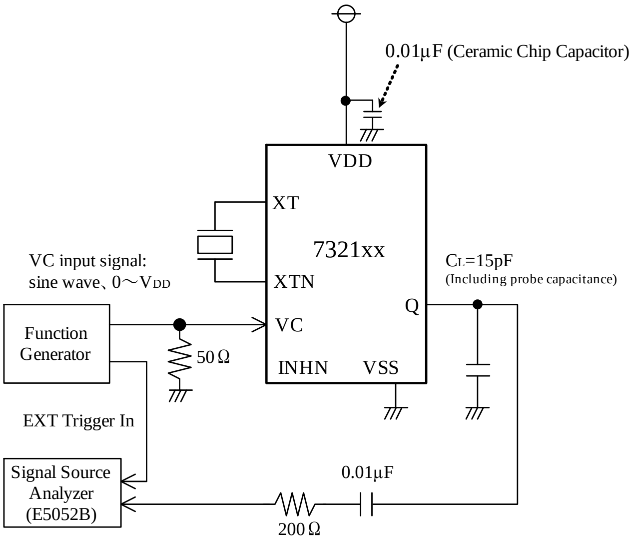


Figure 13-8. Measurement circuit 8

13.9. Measurement Circuit 9

Parameter：Duty, t_r, t_f, V_{TOP}, V_{BASE}

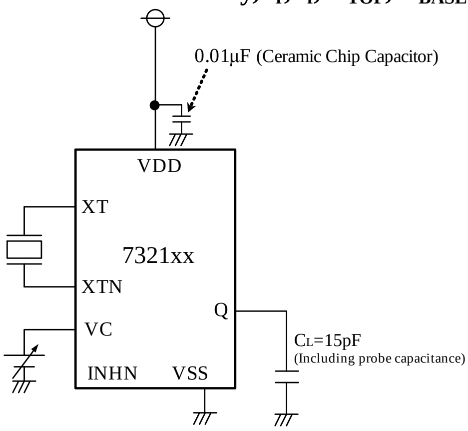


Figure 13-9. Measurement circuit 9

13.10. Measurement Circuit 10

Parameter : t_{OE}, t_{OD}

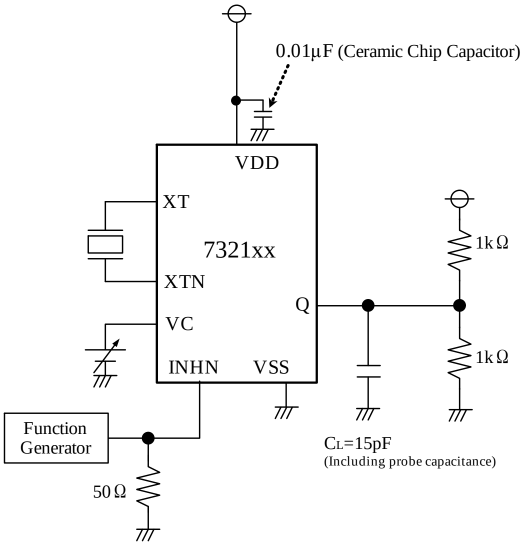
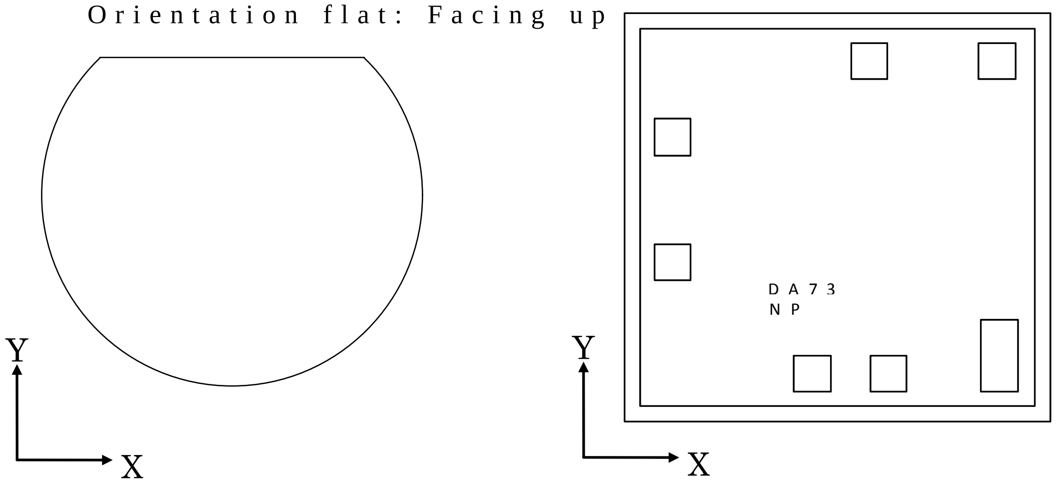


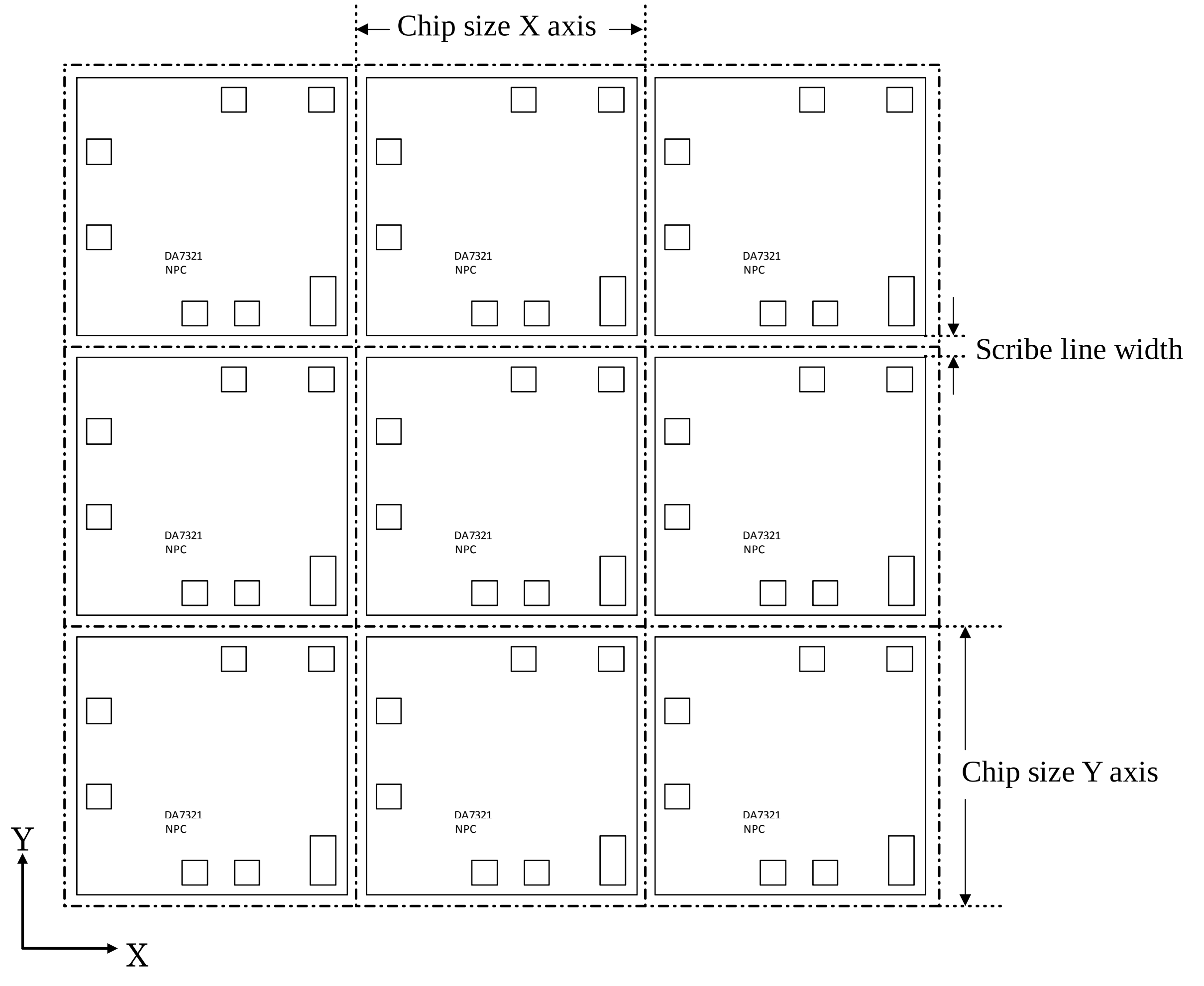
Figure 13-10. Measurement circuit 10

14. WAFER SURFACE ORIENTATION DIAGRAM

Scribe line width：70μm

Unit μm
(940,9





15. 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.
If you wish to use this product in equipment requiring extremely high level of reliability, please contact our sales department or representative in advance.
In the event that this product is used in such equipment, please take scrupulous care and apply fail-safe techniques including redundancy and malfunction prevention in order to prevent damage to life, health, property, or infrastructure etc. in case there is some malfunction in the product.

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