OVERVIEW

The 5053 series are miniature crystal oscillator module ICs supported 80MHz to 170MHz fundamental oscillation mode.
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.
There are 3 pad layout package options available for optimized mounting, making these devices ideal for miniature crystal oscillators.

FEATURES

- Wide range of operating supply voltage: 1.60 to 3.63V
- Regulated voltage drive oscillator circuit for reduced power consumption and crystal drive current
- Optimized low crystal drive current oscillation for miniature crystal units
- 3 pad layout options for mounting
  5053Ax: for Flip Chip Bonding
  5053Bx: for Wire Bonding (Type I)
  5053Cx: for Wire Bonding (Type II)
- Recommended oscillation frequency range
  (fundamental oscillator): 80 to 133MHz (x1 ver.)
  100 to 170MHz (xP ver.)
- -40 to 105°C operating temperature range
- Standby function
  High impedance in standby mode, oscillator stops
- CMOS output
- 50±5% output duty ($1/2V_{DD}$)
- ±8mA output drive capability
- 15pF output load capacitance
- Wafer form (WF5053xx)
- Chip form (CF5053xx)

APPLICATIONS

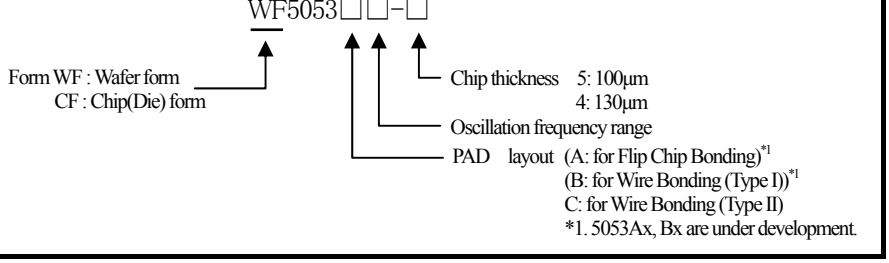
- 3.2×2.5, 2.5×2.0, 2.0×1.6 size miniature crystal oscillator modules

SERIES CONFIGURATION

Version[*1*2]	Operating supply voltage range [V]	Recommended oscillation frequency range[*3] [MHz]	C0 cancellation circuit / Recommended C0 value [pF]	PAD layout
(5053A1)	1.60 to 3.63	80 to 133	Yes/1 to 2	Flip Chip Bonding
(5053B1)				Wire Bonding Type I
5053C1				Wire Bonding Type II
(5053AP)	2.25 to 3.63	100 to 170	Yes/1 to 2	Flip Chip Bonding
(5053BP)				Wire Bonding Type I
5053CP				Wire Bonding Type II

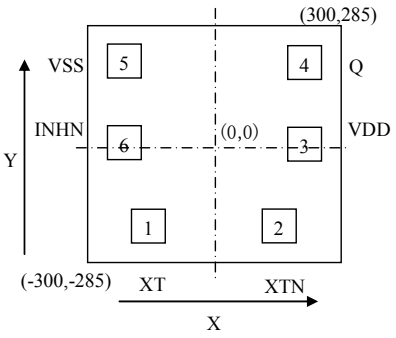
*1. The version name in parentheses is being developed.
*2. It becomes WF5053xx in case of the wafer form and CF5053xx in case of the chip form.
*3. The oscillation frequency is a yardstick value derived from the crystal used for NPC characteristics authentication. However, the oscillation frequency 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.

ORDERING INFORMATION

Device	Package	Version name
WF5053xx-x	Wafer form	
CF5053xx-x	Chip form	

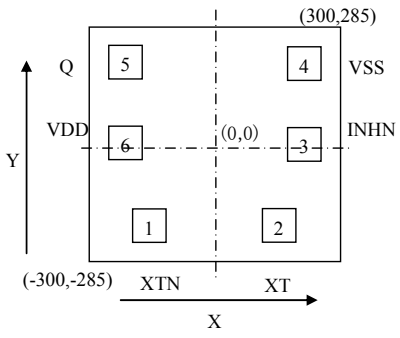
PAD LAYOUT

▪ WF5053Ax
(for Flip Chip Bonding)



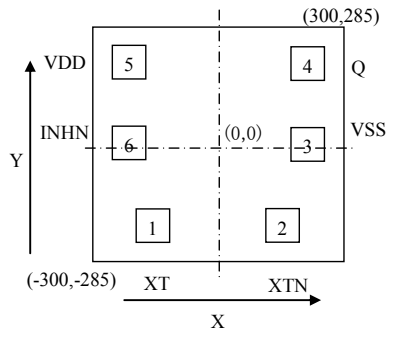
Chip size: 0.60×0.57mm
Chip thickness : 100µm (WF5053Ax-5)
130µm (WF5053Ax-4)
PAD size: 80µm
Chip base: Vss level

▪ CF5053Bx
(for Wire Bonding (Type I))



Chip size: 0.60×0.57mm
Chip thickness : 100µm (CF5053Bx-5)
130µm (CF5053Bx-4)
PAD size: 80µm
Chip base: Vss level

▪ CF5053Cx
(for Wire Bonding (Type II))



Chip size: 0.60×0.57mm
Chip thickness : 100µm (CF5053Cx-5)
130µm (CF5053Cx-4)
PAD size: 80µm
Chip base: Vss level

· Coordinates at the chip center are (0,0). The chip size is the value measured between scribe line centers.

PAD COORDINATES

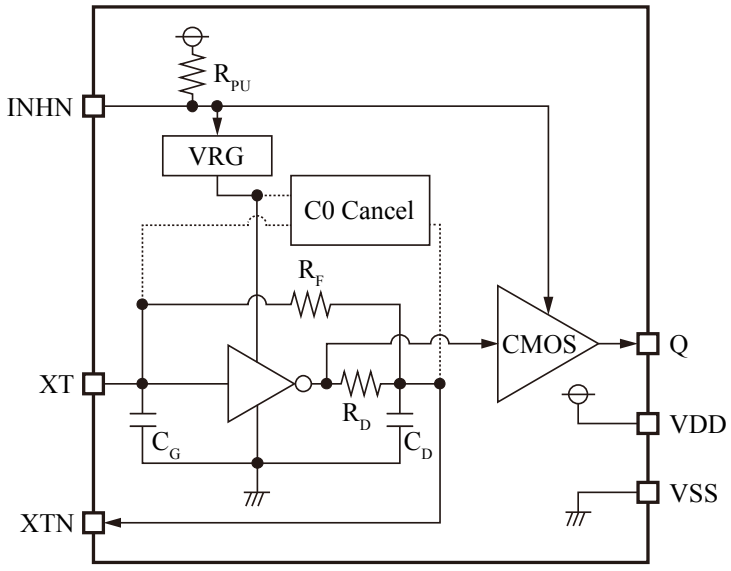
PAD No.	PAD coordinates[µm]	
	X	Y
1	-145.2	-193.5
2	145.2	-193.5
3	208.5	-1.1
4	208.5	193.5
5	-208.5	193.5
6	-208.5	-1.1

PIN DESCRIPTION

PAD No.			Pin	Function
(5053Ax)*1	(5053Bx)*1	5053Cx		
1	2	1	XT	Crystal connection pins.
2	1	2	XTN	Crystal is connected between XT and XTN.
3	6	5	VDD	(+) supply voltage
4	5	4	Q	Output pin
5	4	3	VSS	(-) ground
6	3	6	INHN	Input pin controlled output state (oscillator stops when LOW), Power-saving pull-up resistor built-in

*1. 5053Ax, Bx are under development.

BLOCK DIAGRAM



SPECIFICATIONS

Absolute Maximum Ratings

V_{SS}=0V

Parameter	Symbol	Condition	Rating	Unit
Supply voltage range*1	V_{DD}	Between VDD and VSS	-0.3 to +4.0	V
Input voltage range*1*2	V_{IN}	Input pins	-0.3 to V_{DD}+0.3	V
Output voltage range*1*2	V_{OUT}	Output pins	-0.3 to V_{DD}+0.3	V
Output current*3	I_{OUT}	Q pin	±20	mA
Junction temperature*3	T_j		150	°C
Storage temperature range*4	T_{STG}	Chip form, Wafer form	-55 to +150	°C

*1. This parameter rating is the values that must never exceed even for a moment. This product may suffer breakdown if this parameter rating is exceeded. Operation and characteristics are guaranteed only when the product is operated at recommended operating conditions.

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

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

*4. When stored in nitrogen or vacuum atmosphere applied to IC itself only (excluding packaging materials).

Recommended Operating Conditions

V_{SS}=0V

Parameter	Symbol	Condition		Rating			Unit
				MIN	TYP	MAX	
Oscillator frequency*1	f_{OSC}	V_{DD}=1.60 to 3.63V	5053x1 ver.	80	-	133	MHz
		V_{DD}=2.25 to 3.63V	5053xP ver.	100		170	
Output frequency	f_{OUT}	V_{DD}=1.60 to 3.63V, C_L≤15pF	5053x1 ver.	80	-	133	MHz
		V_{DD}=2.25 to 3.63V, C_L≤15pF	5053xP ver.	100		170	
Operating supply voltage	V_{DD}	Between VDD and VSS*2	5053x1 ver.	1.60	-	3.63	V
			5053xP ver.	2.25			
Input voltage	V_{IN}	Input pins		V_{SS}	-	V_{DD}	V
Operating temperature	T_a			-40	-	+105	°C
Output load capacitance	C_L	Q output		-	-	15	pF

*1. The oscillation frequency is a yardstick value derived from the crystal used for NPC characteristics authentication. However, 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. Mount a ceramic chip capacitor that is larger than 0.01μF proximal to IC (within approximately 3mm) between VDD and VSS in order to obtain stable operation of 5053 series. In addition, the wiring pattern between IC and capacitor should be as wide as possible.

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

Electrical Characteristics
DC Characteristics

V_{DD}=1.60 to 3.63V, V_{SS}=0V, T_a=-40 to +105°C unless otherwise noted.

Parameter	Symbol	Condition		Rating MIN	Rating TYP	Rating MAX	Unit
HIGH-level output voltage	V_{OH}	Q pin, measurement circuit 3, I_{OH}=-8mA, T_a=-40 to +85°C		V_{DD} -0.4	-	V_{DD}	V
		Q pin, measurement circuit 3, I_{OH}=-8mA		V_{DD} -0.45	-	-	
LOW-level output voltage	V_{OL}	Q pin, measurement circuit 3, I_{OL}=8mA, T_a=-40 to +85°C		0	-	0.4	V
		Q pin, measurement circuit 3, I_{OL}=8mA			-	0.45	
HIGH-level input voltage	V_{IH}	INHN pin, measurement circuit 4		0.7V_{DD}	-	-	V
LOW-level input voltage	V_{IL}	INHN pin, measurement circuit 4		-	-	0.3V_{DD}	V
Output leakage current	I_Z	Q pin, measurement circuit 5, INHN="Low", T_a=-40 to +85°C	V_{OH}=V_{DD}	-	-	10	µA
			V_{OL}=V_{SS}	-10	-	-	
		Q pin, measurement circuit 5, INHN="Low"	V_{OH}=V_{DD}	-	-	100	
			V_{OL}=V_{SS}	-100	-	-	
Current consumption*1	I_{DD}	5053x1(f_{OSC}), measurement circuit 1, no load, INHN="OPEN", f_{OSC}=125MHz, f_{OUT}=125MHz	V_{DD}=3.3V	-	6.3	11.0	mA
			V_{DD}=2.5V	-	4.7	8.5	
			V_{DD}=1.8V	-	3.8	7.0	
		5053xP(f_{OSC}), measurement circuit 1, no load, INHN="OPEN", f_{0SC}=155MHz, f_{OUT}=155MHz	V_{DD}=3.3V	-	9.8	17.5	
			V_{DD}=2.5V	-	8	15	
Standby current	I_{ST}	Measurement circuit 1, INHN="Low", T_a=-40 to +85°C		-	-	10	µA
		Measurement circuit 1, INHN="Low"		-	-	100	
INHN pull-up resistance	R_{PU1}	Measurement circuit 6		0.8	3	24	MΩ
	R_{PU2}	Measurement circuit 6		30	70	150	kΩ
Oscillator feedback resistance	R_f	Design value		50	100	200	kΩ
Oscillator capacitance	C_G	5053x1 ver. Design value (a monitor pattern on a wafer is tested), Excluding parasitic capacitance.		0.8	1.0	1.2	pF
	C_D			2.4	3.0	3.6	
	C_G	5053xP ver. Design value (a monitor pattern on a wafer is tested), Excluding parasitic capacitance.		0.8	1.0	1.2	pF
	C_D			2.4	3.0	3.6	

*1. The consumption current $I_{DD}(C_L)$ with a load capacitance(C_L) connected to the Q pin is given by the following equation, where I_{DD} is the no load consumption current and f_{OUT} is the output frequency.

$$I_{DD}(C_L)[mA] = I_{DD}[mA] + C_L[pF] \times V_{DD}[V] \times f_{OUT}[MHz] \times 10^{-3}$$

AC Characteristics

V_{DD}=1.60 to 3.63V, V_{SS}=0V, T_a=-40 to +105°C unless otherwise noted

Parameter	Symbol	Condition	Rating			Unit
			MIN	TYP	MAX	
Output rise time	t_{r1}	Measurement circuit 1, C_L=15pF, $0.1V_{DD} \rightarrow 0.9V_{DD}$, V_{DD}=2.25 to 3.63V	-	1.0	2.0	ns
	t_{r2}	Measurement circuit 1, C_L=15pF, T_a=-40 to +85°C $0.1V_{DD} \rightarrow 0.9V_{DD}$, V_{DD}=1.60 to 2.25V	-	1.5	2.5	
		Measurement circuit 1, C_L=15pF, $0.1V_{DD} \rightarrow 0.9V_{DD}$, V_{DD}=1.60 to 2.25V	-	1.5	3.0	
Output fall time	t_{f1}	Measurement circuit 1, C_L=15pF, $0.9V_{DD} \rightarrow 0.1V_{DD}$, V_{DD}=2.25 to 3.63V	-	1.0	2.0	ns
	t_{f2}	Measurement circuit 1, C_L=15pF, T_a=-40 to +85°C $0.9V_{DD} \rightarrow 0.1V_{DD}$, V_{DD}=1.60 to 2.25V	-	1.5	2.5	
		Measurement circuit 1, C_L=15pF, $0.9V_{DD} \rightarrow 0.1V_{DD}$, V_{DD}=1.60 to 2.25V	-	1.5	3.0	
Output duty cycle	DUTY	5053x1 ver. Measurement circuit 1, T_a=25°C, C_L=15pF, V_{DD}=1.60 to 3.63V	45	50	55	%
		5053xP ver. Measurement circuit 1, T_a=25°C, C_L=15pF, V_{DD}=2.25 to 3.63V	45	50	55	
Output disable delay time	t_{OD}	Measurement circuit 2, T_a=25°C, $C_L \leq$15pF	-	-	200	ns

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.

Timing Chart

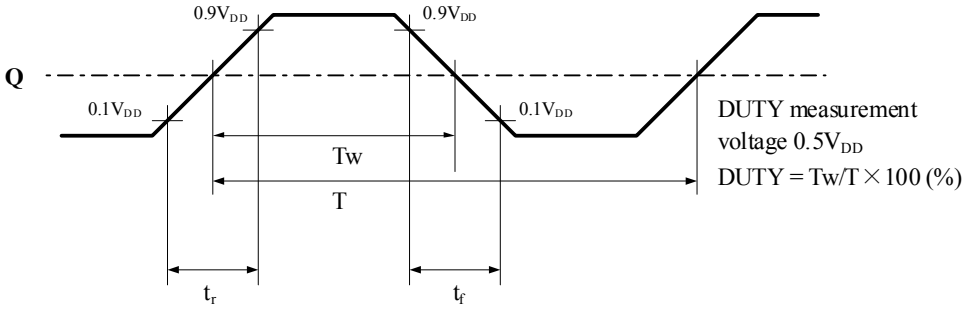


Figure 1.Output switching waveform

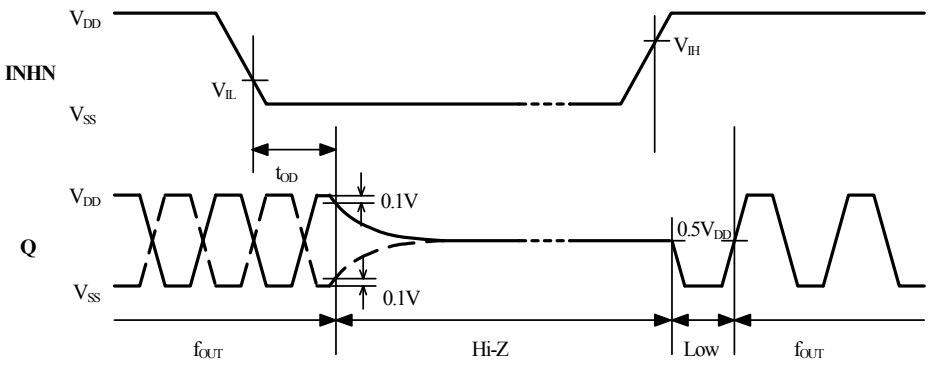


Figure 2.Output disable and oscillation start timing chart

FUNCTIONAL DESCRIPTION

INHN Function

Q output is stopped and becomes high impedance.

INHN	Q	Oscillator
HIGH(Open)	f_{OUT}	Operating
LOW	Hi-Z	Stopped

Power Saving Pull-up Resistor

The INHN pin pull-up resistance changes its value to R_{PU1} or R_{PU2} in response to the input level (HIGH or LOW).

When INHN is tied to LOW level, the pull-up resistance becomes large (R_{PU1}), thus reducing the current consumed by the resistance. When INHN is left open circuit or tied to HIGH level, the pull-up resistance becomes small (R_{PU2}), thus internal circuit of INHN becomes HIGH level.

Consequently, the IC is less susceptible to the effects of noise, helping to avoid problems such as the output stopping suddenly.

Oscillation Detection Function

The 5053 series incorporate an oscillation detection circuit. The oscillation detection circuit disables the output until the oscillator circuit starts up. This function avoids the problem where the oscillator does not start, due to abnormal oscillation conditions, where power is applied or when the oscillator is restarted using INHN.

C0 cancellation circuit

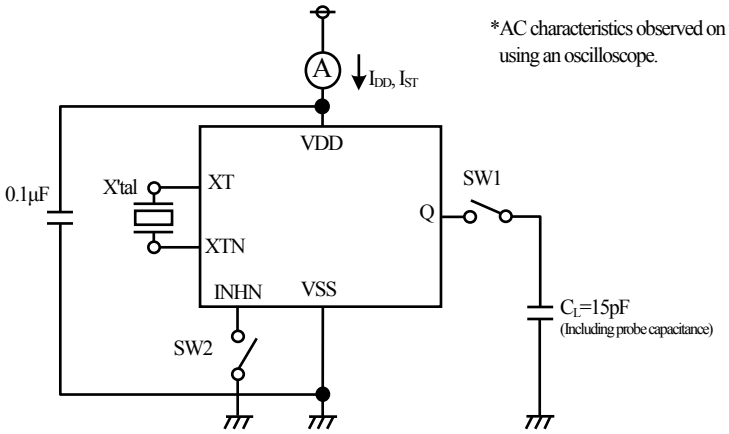
Oscillation circuit with a built-in C0 cancellation circuit provides a fixed compensation amount to cancel the effect of the crystal C0. It reduces the C0 parameter in the equivalent circuit, reducing the shallow negative resistance for increasing values of C0.

This cancellation circuit makes it easier to maintain the oscillation margin.

MEASUREMENT CIRCUITS

MEASUREMENT CIRCUIT 1

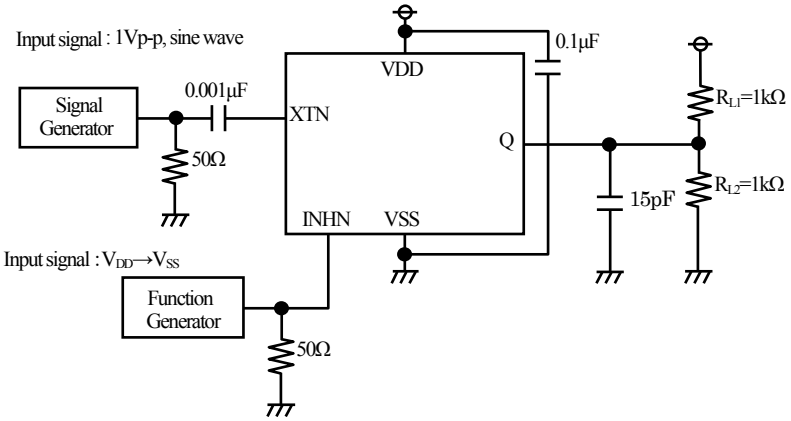
Measurement Parameter: I_{DD}, I_{ST}, DUTY, t_r, t_f



Parameter	SW1	SW2
I_{DD}	OFF	OFF
I_{ST}	ON or OFF	ON
DUTY, t_r, t_f	ON	OFF

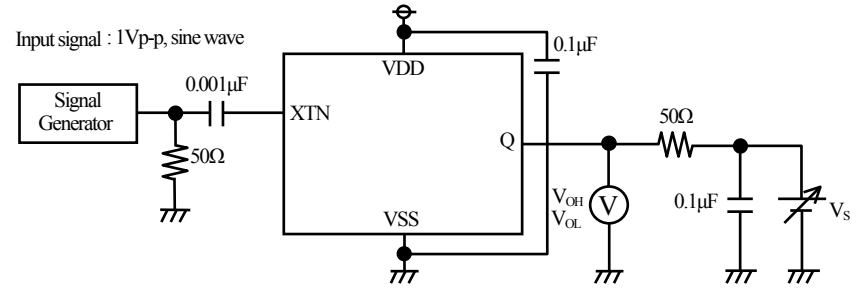
MEASUREMENT CIRCUIT 2

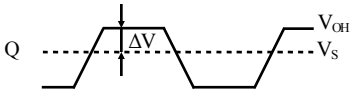
Measurement Parameter: t_{OD}



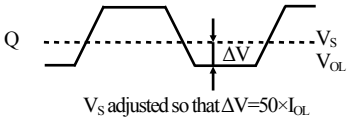
MEASUREMENT CIRCUIT 3

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





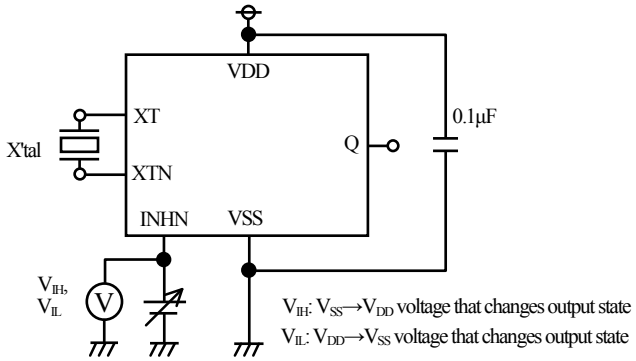
V_S adjusted so that $\Delta V=50\times I_{OH}$



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

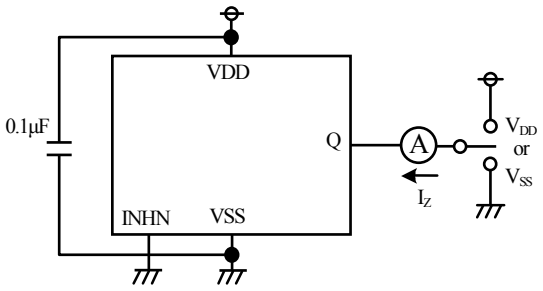
MEASUREMENT CIRCUIT 4

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



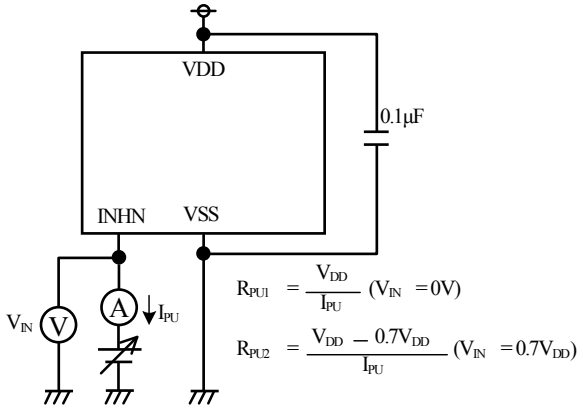
MEASUREMENT CIRCUIT 5

Measurement Parameter: I_Z



MEASUREMENT CIRCUIT 6

Measurement Parameter: R_{PU1}, R_{PU2}



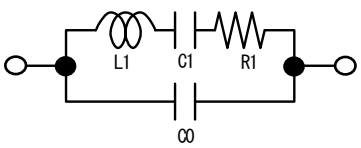
REFERENCE DATA

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

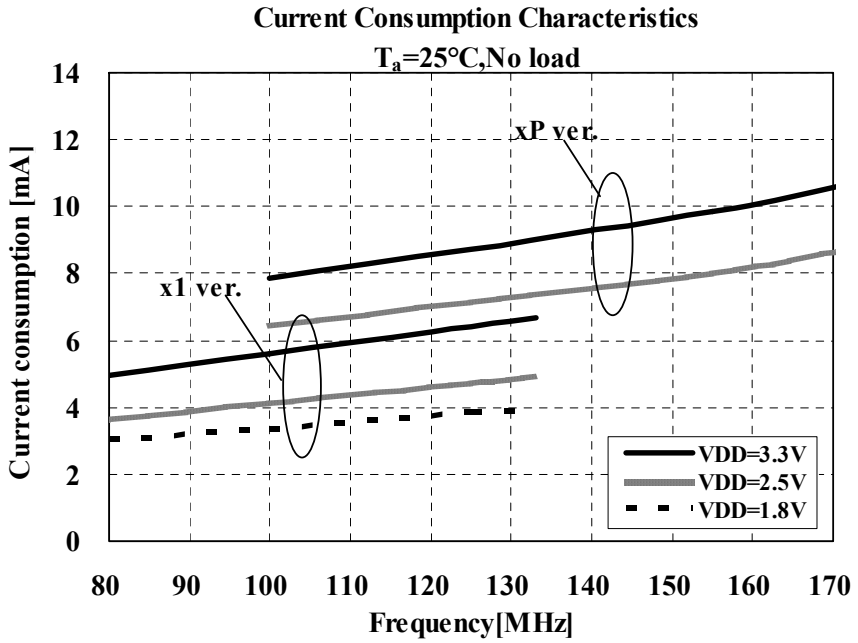
Crystal used for measurement

Parameter	125MHz	155MHz
C0(pF)	2.8	1.7
R1(Ω)	10	10

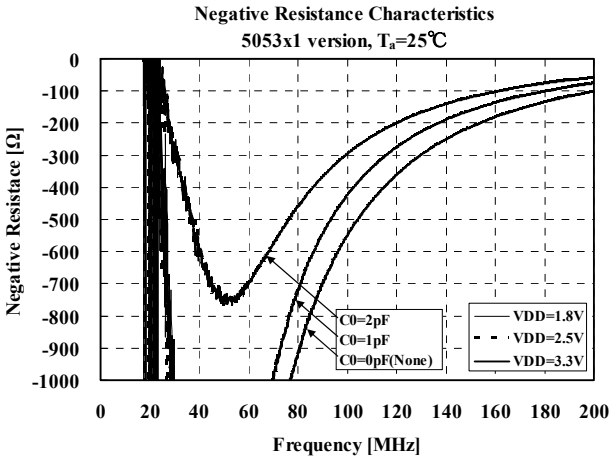
Crystal parameters

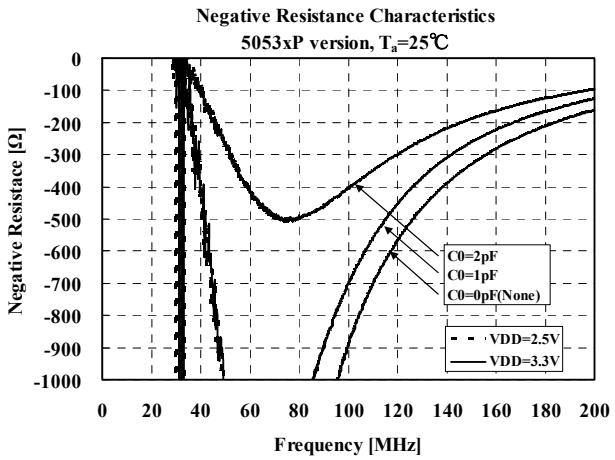


Current Consumption



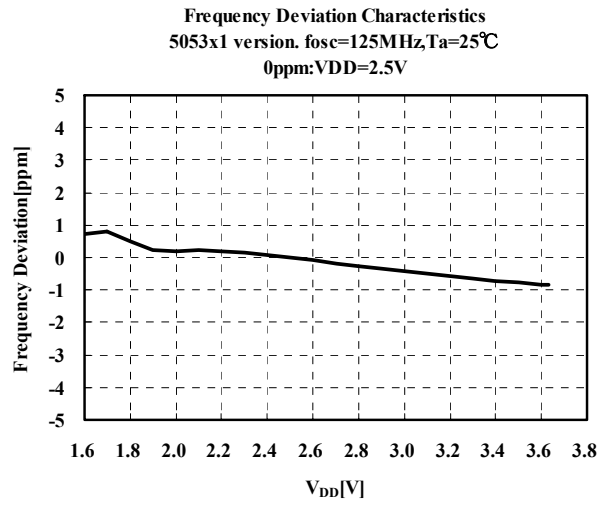
Negative Resistance

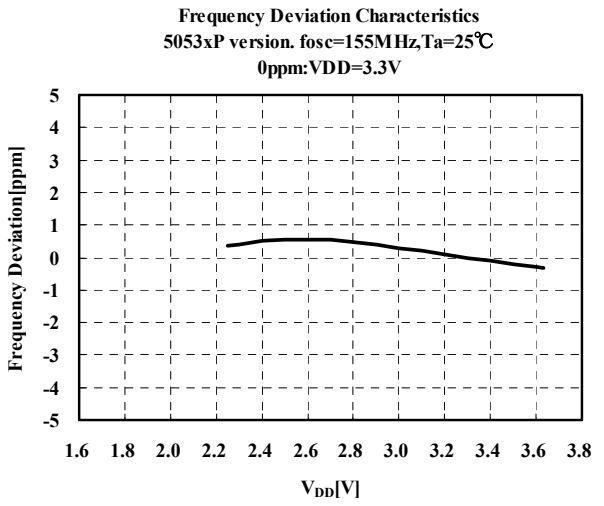




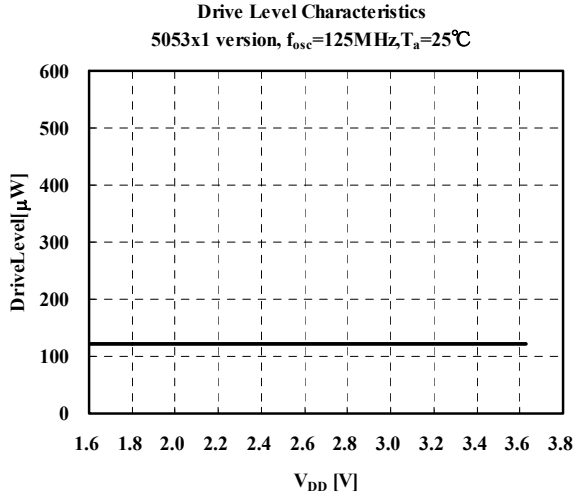
The figures show the measurement result of the crystal equivalent circuit C0 capacitance, connected between the XT and XTN pins.
They were performed with Agilent 4396B using the NPC test jig.
They may vary in a measurement jig, and measurement environment.

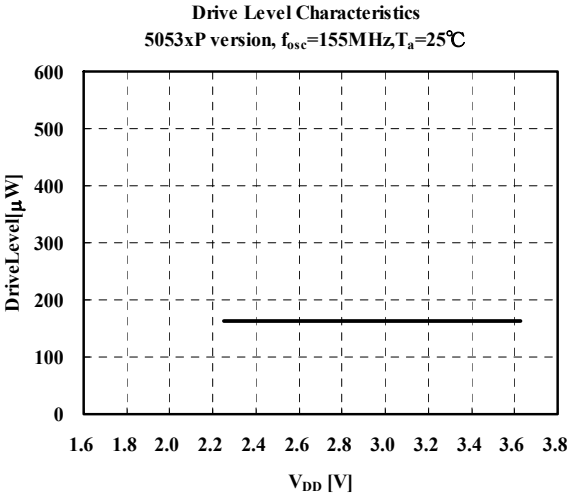
Frequency Deviation by Voltage



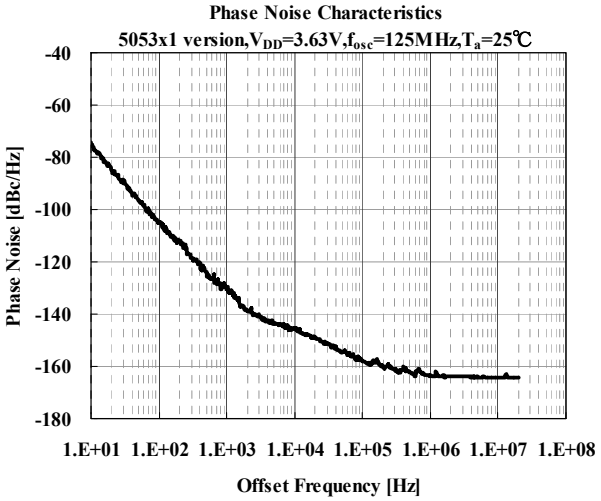


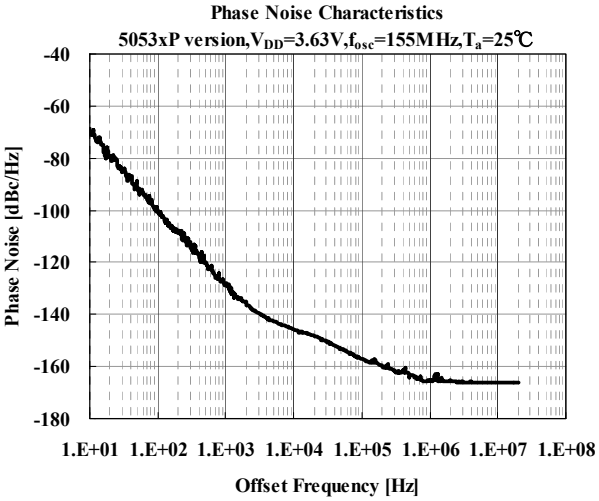
Drive Level





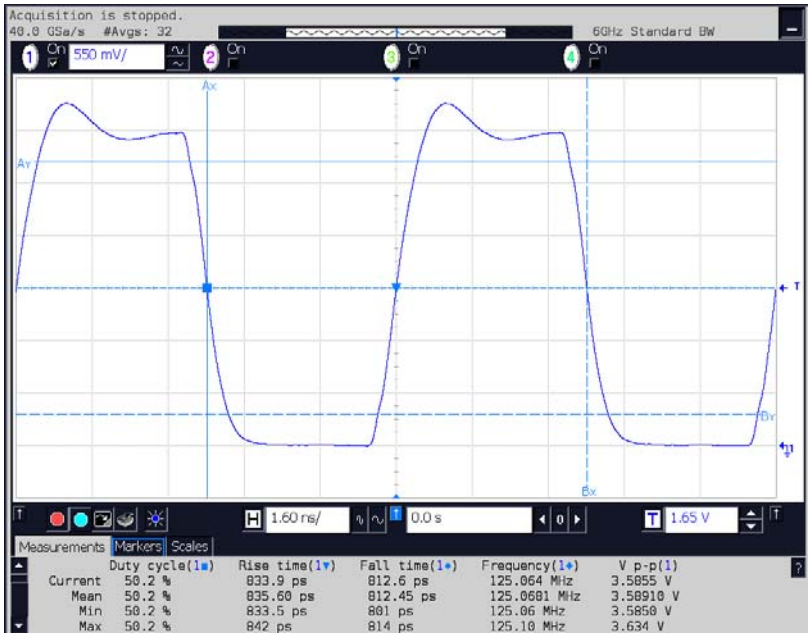
Phase Noise



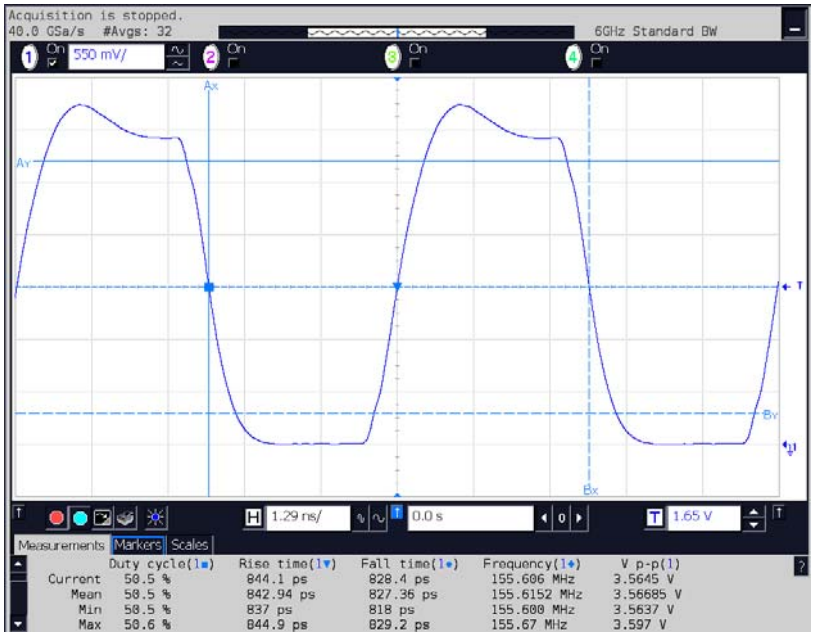


Measurement equipment: Signal Source Analyzer Agilent E5052B

Output Waveform



x1 ver., V_{DD}=3.3V, f_{OUT}=125MHz, C_L=15pF, T_a=R.T.



xP ver., V_{DD}=3.3V, f_{OUT}=155MHz, C_L=15pF, T_a=R.T.

Measurement equipment: Oscilloscope Agilent 54855A

Please pay your attention to the following points at time of using the products shown in this document.

1. The products shown in this document (hereinafter "Products") are 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. The Products are 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. The Products are not designed and manufactured to be used for the apparatus that exerts harmful influence on the human lives due to the defects, failure or malfunction of the Products.
   If you wish to use the Products in that apparatus, please contact our sales section in advance.
   In the event that the Products are used in such apparatus without our prior approval, we assume no responsibility whatsoever for any damages resulting from the use of that apparatus.
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4. The constant of each circuit shown in this document is described as an example, and it is not guaranteed about its value of the mass production products.
5. In the case of that the Products in this document falls under the foreign exchange and foreign trade control law or other applicable laws and regulations, approval of the export to be based on those laws and regulations are necessary. Customers are requested appropriately take steps to obtain required permissions or approvals from appropriate government agencies.

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ND13016-E-01 2014.06