OVERVIEW

The 5059H series are 32.768kHz output and 125°C operation crystal oscillator module ICs with divide-by-512 (or divide-by-1024) frequency, AT-cut crystal 16.777216MHz (or 33.554432MHz) oscillator circuit built-in.
It is possible to generate a 32.768kHz output crystal oscillator with excellent temperature characteristics by using AT-cut crystal.
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: 1.6 to 5.5V
- Oscillation frequency(fundamental oscillator):16.777216MHz or 33.554432MHz
- Output frequency: 32.768kHz (oscillation frequency divided by 512 or 1024)
- -40 to +125°C operating temperature range
- Regulated voltage drive oscillator circuit for reduced power consumption and crystal drive current
- 3 pad layout options for mounting
  5059HAx : for Flip Chip Bonding
  5059HBx : for Wire Bonding(Type I)
  5059HCx : for Wire Bonding(Type II)
- Oscillation capacitors C_G,C_D built-in
- Standby function
  High impedance in standby mode, oscillator stops
- Power-saving pull-up resistor built-in
- ±1mA output drive capability (T_a=-40 to +85°C)
  ±0.8mA output drive capability (T_a=-40 to +125°C)
- 50±5% output duty (1/2VDD)
- Wafer form (WF5059Hxx)
- Chip form (CF5059Hxx)

APPLICATIONS

- 32.768kHz output crystal oscillator modules

SERIES CONFIGURATION

Version*1	Oscillation frequency[MHz] (fundamental oscillator)	Oscillation capacitors*2[pF]		Output frequency[kHz]	PAD layout
		C_G	C_D		
5059HAA	16.777216	3	2	32.768 (f_{OSC}/512)	Flip Chip Bonding
5059HBA					Wire Bonding Type Ⅰ
5059HCA					Wire Bonding Type Ⅱ
5059HAB	33.554432	2	1	32.768 (f_{OSC}/1024)	Flip Chip Bonding
5059HBB					Wire Bonding Type Ⅰ
5059HCB					Wire Bonding Type Ⅱ

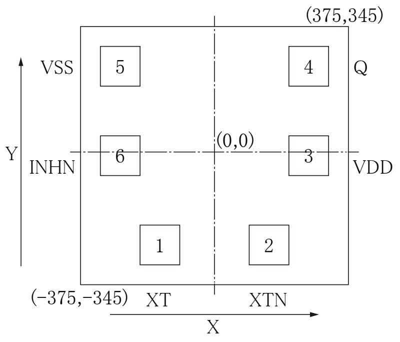
*1. It becomes WF5059Hxx in case of the wafer form and CF5059Hxx in case of the chip form.
*2. The oscillation capacitors do not contain parasitic capacitance.

ORDERING INFORMATION

Device	Package	Version Name
WF5059Hxx-4	Wafer form	WF5059H□□-4 Form WF:Wafer form CF:Chip(Die) form Oscillation frequency A:16.777216MHz B:33.554432MHz PAD layout A:For Flip Chip Bonding B:For Wire Bonding(Type I) C:For Wire Bonding(Type II)
CF5059Hxx-4	Chip form	

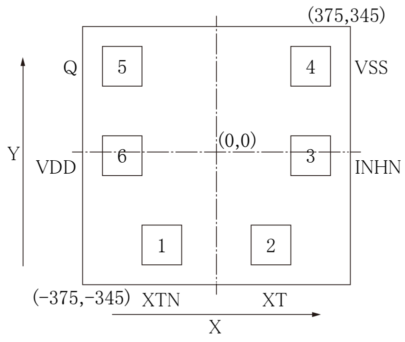
PAD LAYOUT

- WF5059HAx (For Flip Chip Bonding)



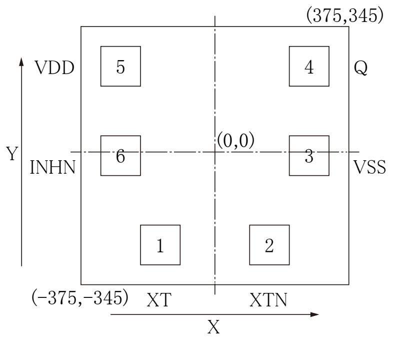
Chip size: 0.75×0.69mm
Chip thickness : 130μm
PAD size : 80μm
Chip base : Vss level

- CF5059HBx (For Wire Bonding (Type I))



Chip size: 0.75×0.69mm
Chip thickness : 130μm
PAD size : 80μm
Chip base : Vss level

- CF5059HCx (For Wire Bonding (Type II))



Chip size: 0.75×0.69mm
Chip thickness : 130μm
PAD size : 80μm
Chip base : Vss level

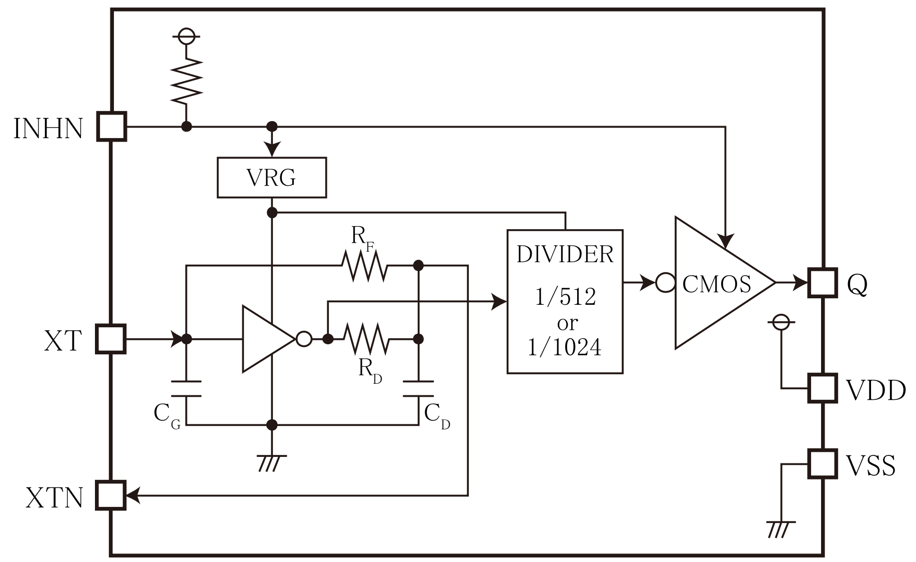
PAD COORDINATES

PAD No.	PAD coordinates[μm]	
	X	Y
1	-146	-235
2	146	-235
3	265	-41
4	265	186
5	-265	186
6	-265	-41

PIN DESCRIPTION

PAD No.			Pin	Function
5059HAx	5059HBx	5059HCx		
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(32.768kHz)
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

BLOCK DIAGRAM



SPECIFICATIONS

Absolute Maximum Ratings

Vss=0V

Parameter	Symbol	Condition	Rating	Unit
Supply voltage range*1	V_{DD}	Between VDD and VSS	-0.3 to +7.0	V
Input voltage range*1*2	V_{IN}	Input pins	-0.3 to VDD+0.3	V
Output voltage range*1*2	V_{OUT}	Output pins	-0.3 to VDD+0.3	V
Output current*3	I_{OUT}	Q pin	±3	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

Vss=0V

Parameter	Symbol	Condition		Rating			Unit
				MIN	TYP	MAX	
Oscillator frequency	f_{OSC}	V_{DD}=1.6 to 5.5V	5059HxA ver.		16.777216		MHz
			5059HxB ver.		33.554432		
Output frequency	f_{OUT}	V_{DD}=1.6 to 5.5V, C_{LOUT}=15pF			32.768		kHz
Operating supply voltage	V_{DD}	Between VDD and VSS*1		1.6		5.5	V
Input voltage	V_{IN}	Input pins		V_{SS}		V_{DD}	V
Operating temperature	T_a			-40		+125	°C
Output load capacitance	C_{LOUT}	Q output				15	pF

*1. 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 5059H 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}=1.6 to 5.5V, V_{SS}=0V, T_a= -40 to +125°C unless otherwise noted.

Parameter	Symbol	Conditions		Rating MIN	Rating TYP	Rating MAX	Unit
Q pin HIGH-level output voltage	V_{OH}	Measurement circuit 3, I_{OH}=-1mA, T_a=-40 to +85°C		V_{DD}-0.4		V_{DD}	V
		Measurement circuit 3, I_{OH}=-0.8mA, T_a=-40 to +125°C					
Q pin LOW-level output voltage	V_{OL}	Measurement circuit 3, I_{OL}=1mA, T_a=-40 to +85°C		0		0.4	V
		Measurement circuit 3, I_{OH}=0.8mA, T_a=-40 to +125°C					
INHN pin HIGH-level input voltage	V_{IH}	Measurement circuit 4		0.7V_{DD}			V
INHN pin LOW-level input voltage	V_{IL}	Measurement circuit 4				0.3V_{DD}	V
Q pin Output leakage current	I_Z	Measurement circuit 5, INHN="Low"	Q=V_{DD}			10	μA
			Q=V_{SS}	-10			
Current consumption (HxA ver. : divide-by-512 frequency output)	I_{DD1}_5.0V	Measurement circuit 1, INHN="OPEN", output load=15pF, f_{OSC}=16.777216MHz, f_{OUT}=32.768kHz, T_a=-40 to +125°C	V_{DD}=5.0V		70	175	μA
	I_{DD1}_3.3V		V_{DD}=3.3V		65	163	
	I_{DD1}_2.5V		V_{DD}=2.5V		63	158	
	I_{DD1}_1.8V		V_{DD}=1.8V		60	150	
	I_{DD2}_5.0V	Measurement circuit 1, INHN="OPEN", output load=15pF, f_{OSC}=16.777216MHz, f_{OUT}=32.768kHz, T_a=-40 to +85°C	V_{DD}=5.0V		70	140	μA
	I_{DD2}_3.3V		V_{DD}=3.3V		65	130	
	I_{DD2}_2.5V		V_{DD}=2.5V		63	126	
	I_{DD2}_1.8V		V_{DD}=1.8V		60	120	
Current consumption (HxB ver. : divide-by-1024 frequency output)	I_{DD3}_5.0V	Measurement circuit 1, INHN="OPEN", output load=15pF, f_{OSC}=33.554432MHz, f_{OUT}=32.768kHz, T_a=-40 to +125°C	V_{DD}=5.0V		140	280	μA
	I_{DD3}_3.3V		V_{DD}=3.3V		130	260	
	I_{DD3}_2.5V		V_{DD}=2.5V		126	252	
	I_{DD3}_1.8V		V_{DD}=1.8V		120	240	
	I_{DD4}_5.0V	Measurement circuit 1, INHN="OPEN", output load=15pF, f_{OSC}=33.554432MHz, f_{OUT}=32.768kHz, T_a=-40 to +85°C	V_{DD}=5.0V		140	245	μA
	I_{DD4}_3.3V		V_{DD}=3.3V		130	228	
	I_{DD4}_2.5V		V_{DD}=2.5V		126	221	
	I_{DD4}_1.8V		V_{DD}=1.8V		120	210	
Standby current	I_{ST}	Measurement circuit 1,INHN="Low",T_a=-40 to +85°C				10	μA
		Measurement circuit 1,INHN="Low",T_a=-40 to +125°C				20	
INHN pin pull-up resistance	R_{PU1}	Measurement circuit 6		0.6	2	20	MΩ
	R_{PU2}	Measurement circuit 6		50	100	200	kΩ
Oscillator feedback resistance	R_f			150	300	600	kΩ
Oscillator capacitance (HxA ver. : divide-by-512 frequency output)	C_G	Design value (a monitor pattern on a wafer is tested), Excluding parasitic capacitance.		2.25	3.00	3.75	pF
	C_D			1.50	2.00	2.50	
Oscillator capacitance (HxB ver. : divide-by-1024 frequency output)	C_G	Design value (a monitor pattern on a wafer is tested), Excluding parasitic capacitance.		1.50	2.00	2.50	pF
	C_D			0.75	1.00	1.25	

AC Characteristics

V_{DD}=1.6 to 5.5V, V_{SS}=0V, T_a=−40 to +125°C unless otherwise noted

Parameter	Symbol	Conditions	Rating			Unit
			MIN	TYP	MAX	
Q pin Output rise time	t_r	Measurement circuit 1, C_{LOUT}=15pF, $0.1V_{DD} \rightarrow 0.9V_{DD}$		50	200	ns
Q pin Output fall time	t_f	Measurement circuit 1, C_{LOUT}=15pF, $0.9V_{DD} \rightarrow 0.1V_{DD}$		50	200	ns
Q pin Output duty cycle	DUTY	Measurement circuit 1, T_a=25°C, C_{LOUT}=15pF	45	50	55	%
Q pin Output disable delay time	t_{OD}	Measurement circuit 2, T_a=25°C, C_{LOUT}≤15pF			1	μs

Timing chart

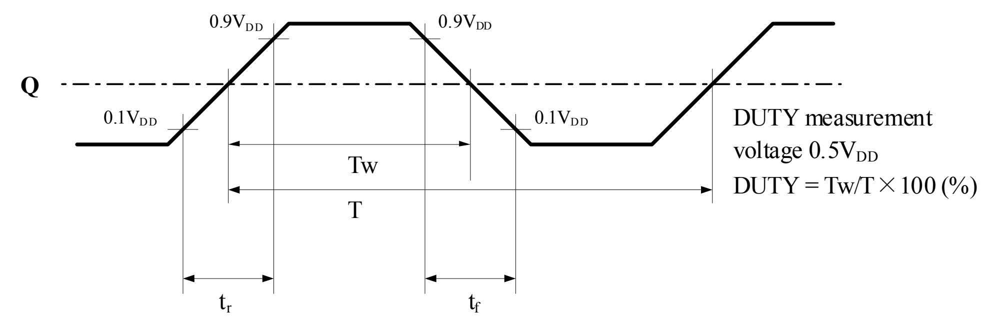
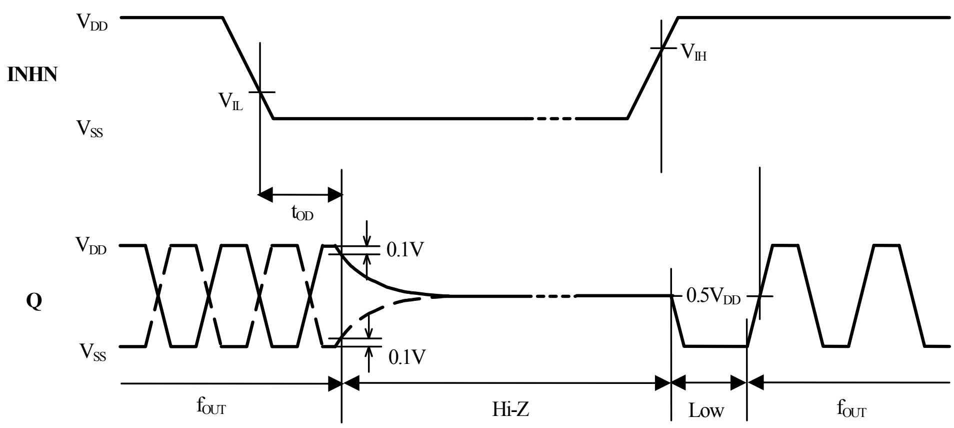


Figure 1.Output switching waveform



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.

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

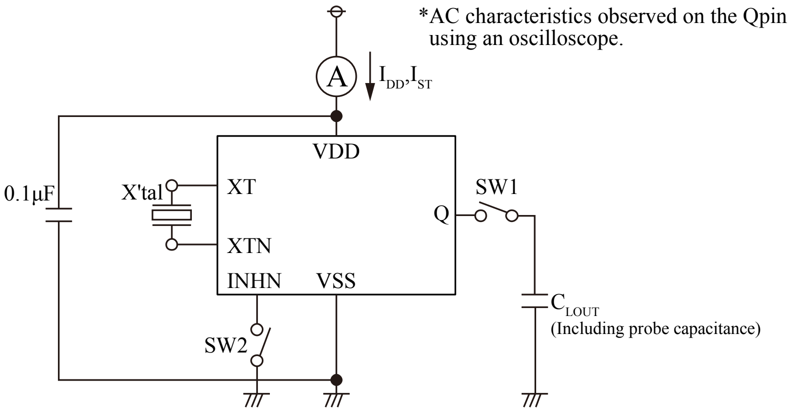
The 5059H series have an oscillation detection circuit.

The oscillation detection circuit disables the output until crystal oscillation becomes stable when oscillation circuit starts up. This function avoids the abnormal oscillation in the initial power up and in a reactivation by INHN.

MEASUREMENT CIRCUITS

MEASUREMENT CIRCUIT 1

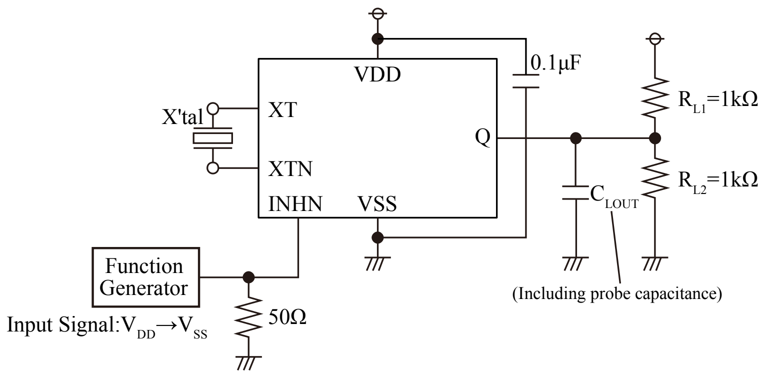
Measurement Parameters : I_{DD}, I_{ST}, DUTY, t_r, t_f



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

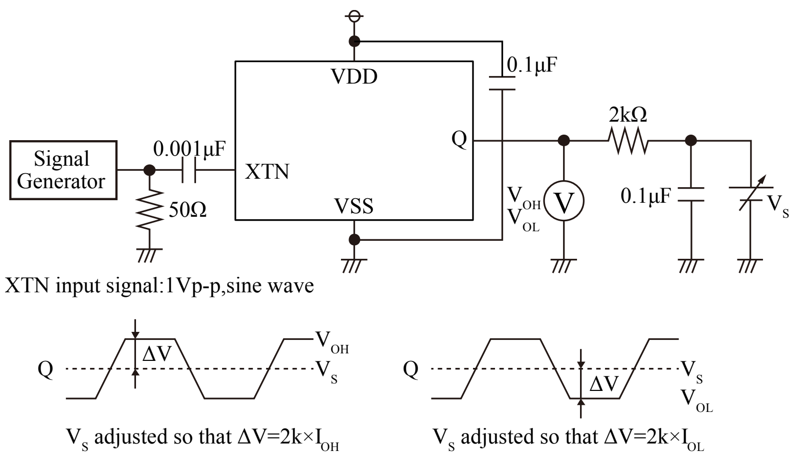
MEASUREMENT CIRCUIT 2

Measurement Parameters : t_{OD}



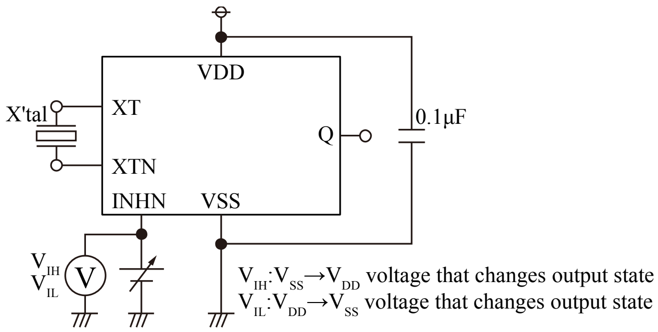
MEASUREMENT CIRCUIT 3

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



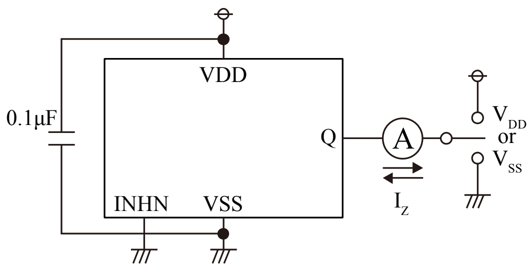
MEASUREMENT CIRCUIT 4

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



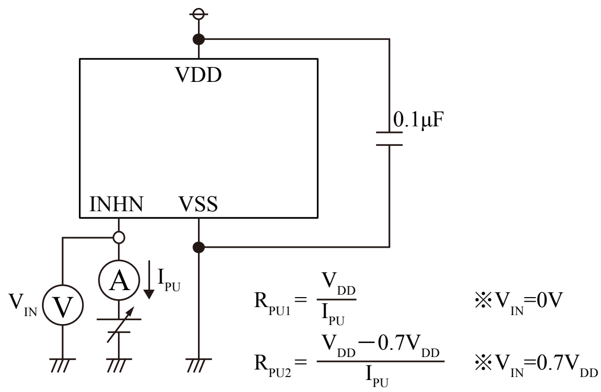
MEASUREMENT CIRCUIT 5

Measurement Parameters : I_Z



MEASUREMENT CIRCUIT 6

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



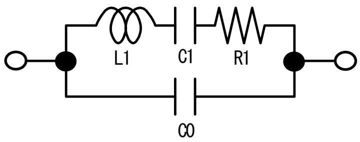
REFERENCE DATA

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

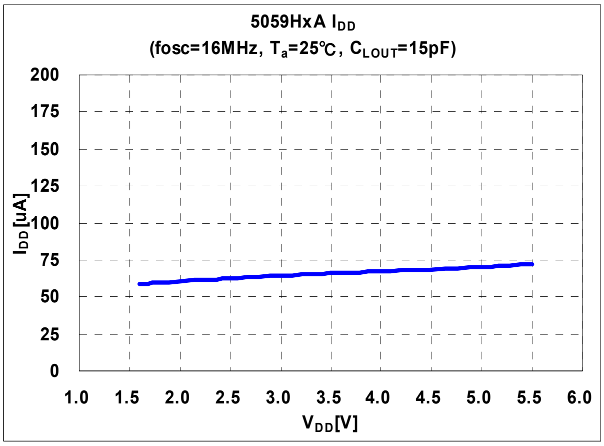
Crystal used for measurement

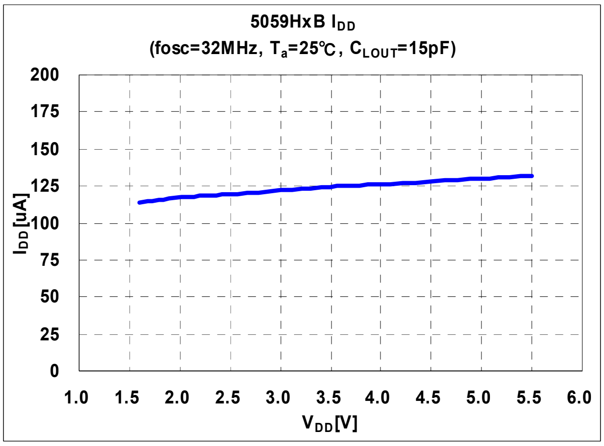
Parameter	f_0=16MHz	f_0=32MHz
C0(pF)	1.1698	1.5927
R1(Ω)	16.824	13.476

Crystal parameters

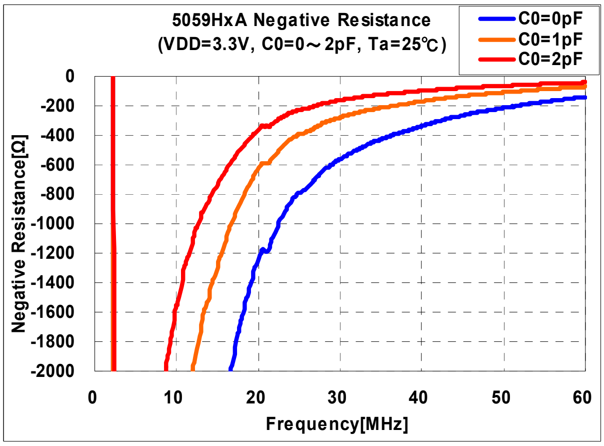


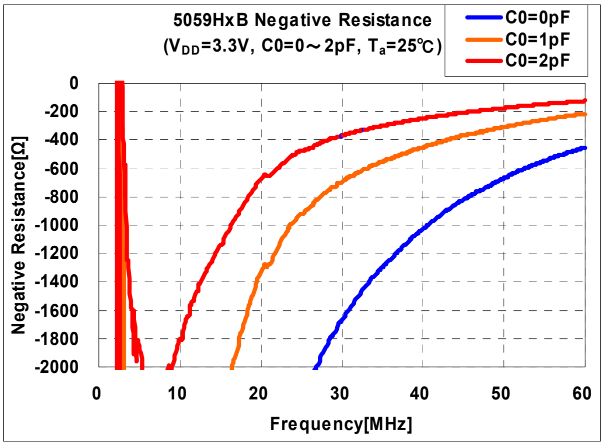
Current Consumption





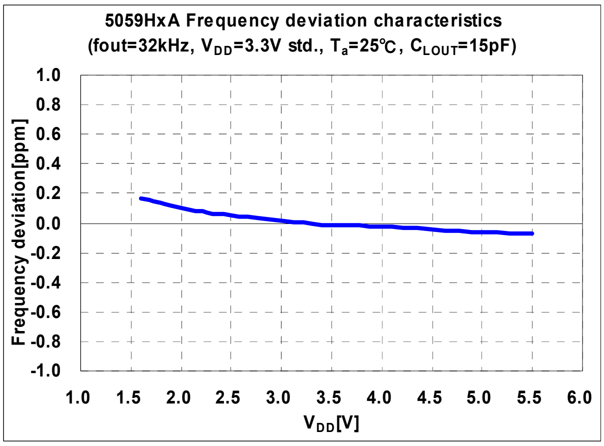
Negative Resistance

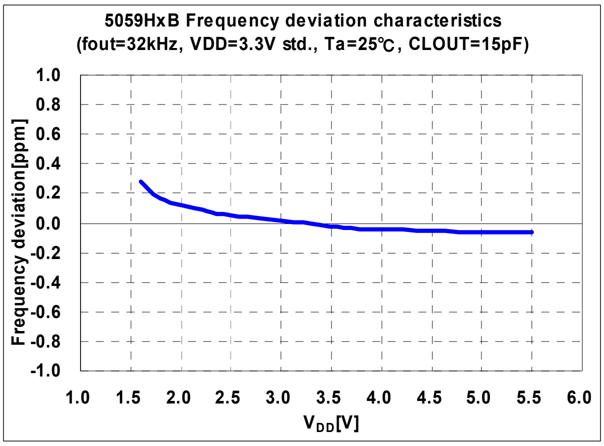




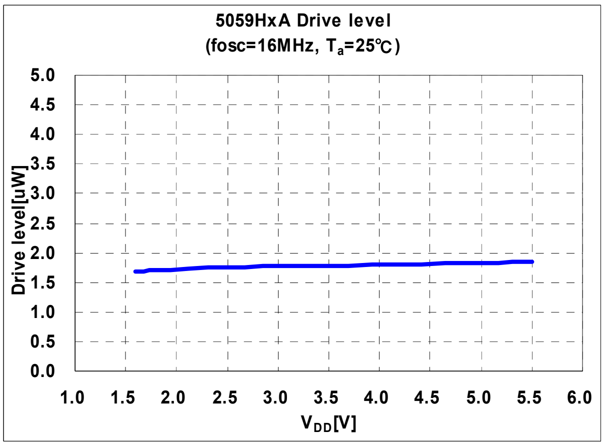
The figures show the measurement result of the crystal equivalent circuit C0 capacitance, connected between the XT and XTN pins. They were performed with Agilent 4396B using the NPC test jig.
They may vary in a measurement jig, and measurement environment.

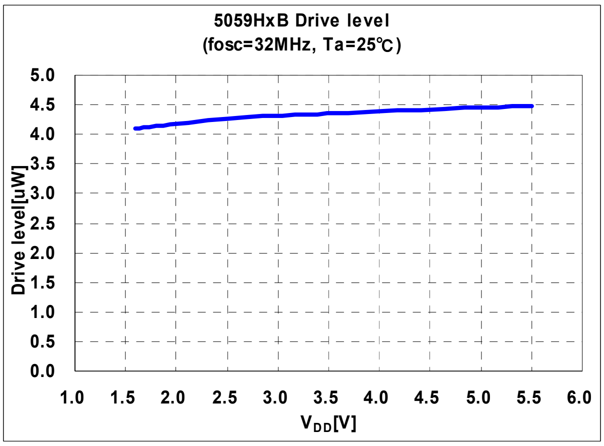
Frequency Deviation by Voltage



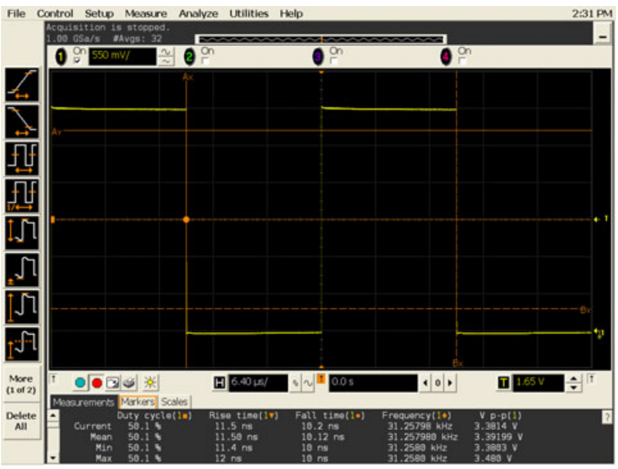


Drive Level

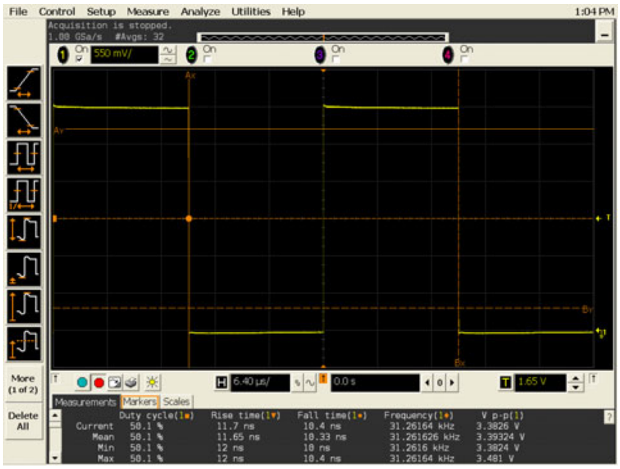




Output Waveform



5059HxA, V_{DD}=3.3V, C_{LOUT}=15pF, T_a=25°C



5059HxB, V_{DD}=3.3V, C_{LOUT}=15pF, T_a=25°C

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