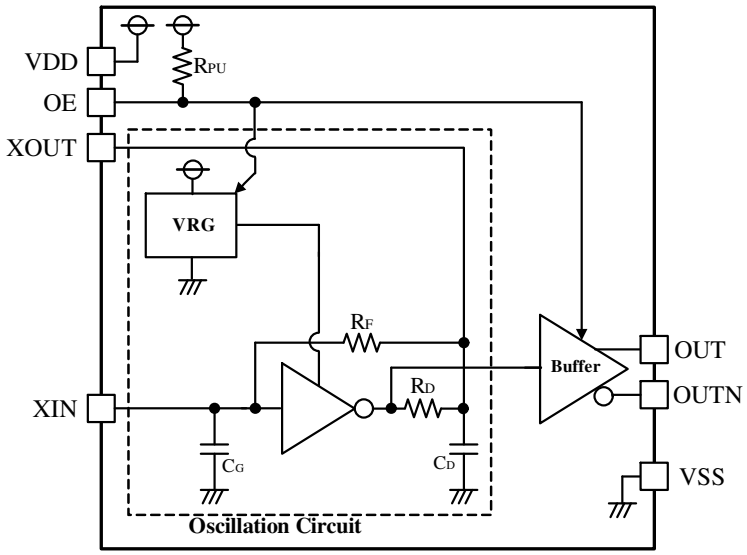
1. OVERVIEW

The CF7060x1S/WF7060x1S series are differential output oscillator ICs of the HCSL output type.
They support 125degree operation and wide range of output frequencies.
They are suitable for high frequency applications such as high speed communication devices.
They use an oscillation circuit suitable for small crystal elements, therefore suitable for a small package oscillation module.

2. FEATURES

■Operating supply voltage:	2.25V to 3.63V	
■Operating temperature:	-40°C to +125°C	
■Recommended oscillation frequency (f_0):	3rd overtone frequency	100MHz to 175MHz, 250MHz to312MHz
	Fundamental frequency	100MHz to 175MHz 250MHz to312MHz
■Output frequency (f_{OUT}):	f_0	
■Oscillator capacitances:	C_G, C_D built-in	
■Output level:	HCSL	
■Standby function:	Oscillator stops, Hi-Z outputs, power saving pull-up resistor built-in (OE output)	
■Oscillation detection circuit built-in		

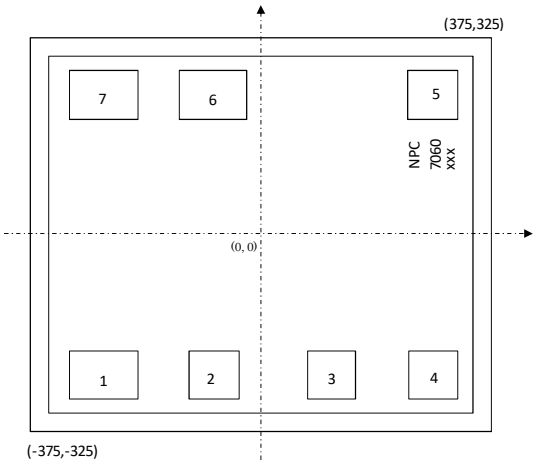
3. BLOCK DIAGRAM



4. PAD LAYOUT

(1) Chip size*1: X=0.75mm, Y=0.65mm
(2) Rear surface potential: V_{SS} level
(3) Pad size: No. 1,6,7:100μm × 80μm
No. 2,3,4,5:80μm × 80μm
(4) Chip dimensions

*1. Chip size is measured between scribe line centers.



Pad Coordinates (Origin in chip center), Unit: [μm]

No.	X	Y	Name
1	-271	-231	VDD
2	-77	-231	XIN
3	115	-231	XOUT
4	281	-231	OE
5	281	231	VSS
6	-93	231	OUTN
7	-271	231	OUT

5. PAD DESCRIPTION

Number	Name	I/O*1	Function
1	VDD	-	(+) Supply voltage
2	XIN	I	Oscillator connections
3	XOUT	O	
4	OE	I	Output enable. Outputs are disabled when OE is V_{SS} level. Disabled state: Oscillator stopped, Hi-Z outputs
5	VSS	-	(-) Supply voltage
6	OUTN	O	output (inverting output) Disabled state: Hi-Z
7	OUT	O	output Disabled state: Hi-Z

*1. I : Input, O : Output

6. VERSION LINEUP

7060xxx
- Output level
- Output freqency
- Oscillation frequency range

(1) Version name 1st character (oscillation frequency range)

Version	Oscillation mode	Recommended C0 value (pF)*1	Oscillator capacitance (pF)*2		Oscillation frequency (reference values) f_0 (MHz)
			C_G	C_D	
D	3rd overtone Fundamental	1.0~ 2.0*3	4	11	100~135
E	3rd overtone Fundamental	1.0~ 2.0*3	4	9	135~175
G	3rd overtone Fundamental	1.0~ 2.0*3	0	1	250~320

∗1. It is the normal recommended range where the value of mention was based on an oscillation circuitry in the upper section.
*2. Values do not include parasitic capacitance.
*3. This version has a C0 cancel circuit to ensure negative resistance at high frequency.
A self-oscillation becomes easy to happen coldly, so please be careful and do initial evaluation.

* Version, recommended C0 value and oscillation frequency are provisional.

(2) Version name 2nd character (output frequency)

Version	Output frequency (f_{OUT})
1	f_0

(3) Version name 3rd character (Output level)

Version	Oscillation frequency range
S	HCSL

7. ABSOLUTE MAXIMUM RATINGS

V_{SS}=0V

Parameter	Symbol	Conditions	Rating	Unit	Notes
Supply voltage range	V_{DD}	Between VDD and VSS	-0.3 to +4.5	V	*1
Input voltage range1	V_{IN1}	OE	-0.3 to V_{DD}+0.3	V	*1,*2
Input voltage range2	V_{IN2}	XIN	-0.3 ~ +2.5	V	*1,*2
Output voltage range1	V_{OUT1}	OUT,OUTN	-0.3 ~ V_{DD}+0.3	V	*1、*2
Output voltage range2	V_{OUT2}	XOUT	-0.3 ~ +2.5	V	*1,*2
Junction temperature	T_j		+150	℃	*3
Storage temperature range	T_{STG}	Chip, wafer form	-55 to +150	℃	*4

*1. Parameters must not exceed ratings, not even momentarily. If the rating is exceeded, it may affect the electrical characteristics and reliability.
*2. V_{DD} indicates the operating supply voltage in "8. RECOMMENDED OPERATING CONDITIONS."
*3. Do not exceed ratings. If a rating is exceeded, there is a risk of deterioration in characteristics and decrease in reliability.
*4. When stored separately in Nitrogen or vacuum atmosphere.

8. RECOMMENDED OPERATING CONDITIONS

V_{SS}=0V

Parameter	Symbol	Conditions	MIN	TYP	MAX	Unit
Oscillation frequency*1	f_0		100	-	320	MHz
Output frequency	f_{OUT}		100	-	320	MHz
Operating supply voltage	V_{DD}	VDD and VSS*2	2.25	-	3.63	V
Input voltage	V_{IN}	OE	0		V_{DD}	V
		XIN	0	-	2.0	V
Operating temperature	T_a		-40		+125	℃
Output load resistance	R_L	Between OUT(Rs) and V_{SS} Between OUTN(Rs) and V_{SS}	49.5	50	50.5	Ω
Damping resistance	R_S	Between OUT and R_L Between OUTN and R_L	0	-	33	Ω

*1. The oscillation frequency range is a target based on evaluation results for the crystal element used for NPC characteristics verification, and does not represent a guarantee of the oscillation frequency band. The oscillation characteristics can vary significantly depending on the characteristics and mounting conditions of the crystal. Accordingly, oscillation characteristics should be thoroughly evaluated for each crystal.
*2. For stable device operation, connect a 0.01μF or larger ceramic chip capacitor between VDD and VSS, mounted close (within approximately 3mm) to the chip. Also, use the thickest wiring possible between the IC and capacitor.
* 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. DC Characteristics

Measurement circuits 1 to 3 in "Conditions" are shown in "12. MEASUREMENT CIRCUITS."

V_{DD}=2.25 to 3.63V, V_{SS}=0V, T_a=-40 to +125°C unless otherwise noted

Parameter	Symbol	Conditions		MIN	TYP	MAX	Unit
Current consumption	I_{DDD}	Measurement circuit 1 OE=Open f_0=125MHz, D1Sver.	V_{DD}=3.3V	-	34	42	mA
	I_{DDE}	Measurement circuit 1 OE=Open f_0=156MHz, E1Sver.	V_{DD}=3.3V	-	36	46	mA
	I_{DDG}	Measurement circuit 1 OE=Open f_0=312MHz, G1Sver.	V_{DD}=3.3V	-	43	53	mA
Standby current	I_{STB}	Measurement circuit 1, OE= V_{SS}		-	-	30	μA
High-level output voltage	V_{OH}	Measurement circuit 2 OUT/OUTN R_S=33ohm		0.6	-	0.9	V
Low-level output voltage	V_{OL}	Measurement circuit 2, OUT/OUTN		-0.15	-	0.15	V
High-level input voltage	V_{IH}	Measurement circuit 1, OE		$0.7V_{DD}$	-	-	V
Low-level input voltage	V_{IL}	Measurement circuit 1, OE		-	-	$0.3V_{DD}$	V
OE pull-up resistance	R_{PU1}	Measurement circuit 1		0.5	1	2	MΩ
	R_{PU2}	Measurement circuit 1		30	70	150	kΩ
Oscillator feedback resistance (D1Sver.)	R_{FD}	Design value		1.8	2.3	2.9	kΩ
Oscillator feedback resistance (E1Sver.)	R_{FE}	Design value		1.8	2.3	2.9	kΩ
Oscillator feedback resistance (G1Sver.)	R_{FG}	Design value		1.5	1.9	2.4	kΩ
Oscillator capacitance (D1S ver.)	C_{GD}	Design value, Excludes parasitic capacitance		3.2	4.0	4.8	pF
	C_{DD}			8.8	11.0	13.2	
Oscillator capacitance (E1S ver.)	C_{GE}	Design value, Excludes parasitic capacitance		3.2	4.0	4.8	pF
	C_{DE}			7.2	9.0	10.8	
Oscillator capacitance (G1S ver.)	C_{GG}	Design value, Excludes parasitic capacitance		0.0	0.0	0.0	pF
	C_{DG}			0.8	1.0	1.2	

9.2. AC Characteristics

Measurement circuits 4 and 5 in "Conditions" are shown in "12. MEASUREMENT CIRCUITS."
The conditions for each parameter assume the timing shown in "9.3 TIMING DIAGRAM."

V_{DD}=2.25 to 3.63V, V_{SS}=0V, T_a=-40 to +125°C unless otherwise noted

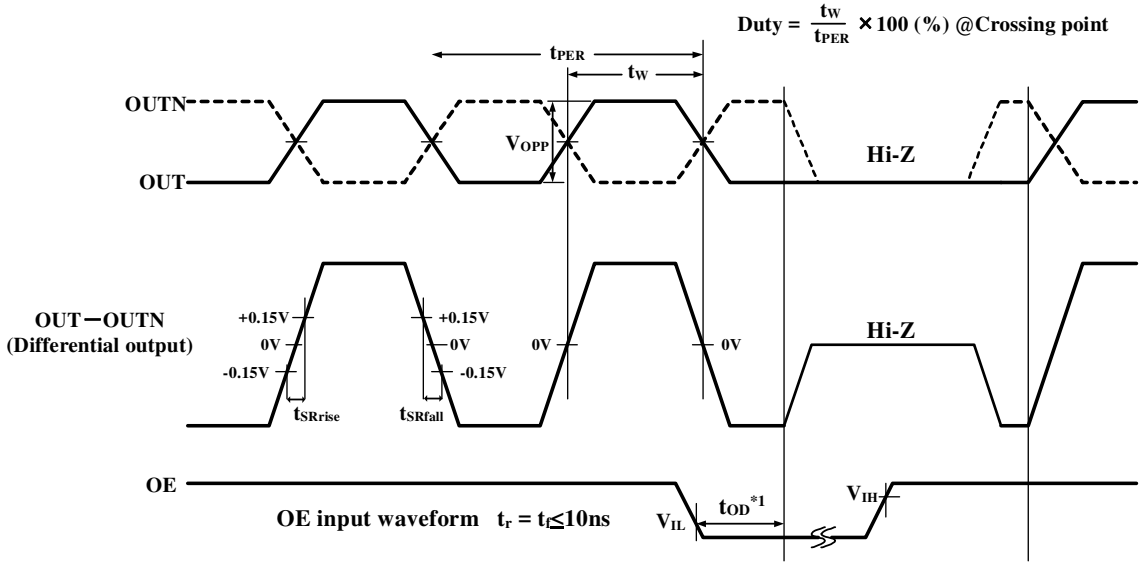
Parameter	Symbol	Conditions		MIN	TYP	MAX	Unit
Output duty cycle	Duty	Measurement circuit 3 Measured at 0V crossover point of differential output signal		45	-	55	%
Output amplitude	V_{OPP}	Measurement circuit 3 Single-ended output signal		0.45	-	-	V
Output rise slew rate *2	t_{SRrise}	Measurement circuit 3 differential output signal Measured at 0V crossover point ±150mV	R_S=33Ω C_L=2pF*1	0.6	-	4	V/ns
Output fall slew rate*2	t_{SRfall}	Measurement circuit 3 differential output signal Measured at 0V crossover point ±150mV	R_S=33Ω C_L=2pF*1	0.6	-	4	V/ns
Output disable time*2	t_{OD}	Measurement circuit 4 Time measured OE=V_{IL} (falling edge) and outputs going Hi-Z (see timing diagram for details)		-	-	200	ns

*1. C_L contains the parasitic capacitance, such as evaluation board, package.
*2. Since shipping inspection is not possible, it is guaranteed by characterization.

* The ratings above are values obtained by measurements using an NPC evaluation standard crystal element, standard testing jig, and evaluation package.
Ratings may have wide tolerances due to crystal element characteristics, evaluation jig, and package parasitic capacitance, so thorough evaluation is recommended.

9.3. Timing Diagram

The timing diagram applies to the "Conditions" in the table in "9.2. AC Characteristics."

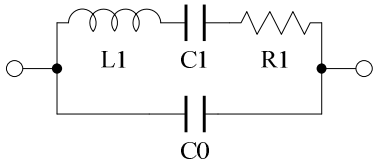


*1. The time, after OE falling edge and the output disable time (t_{OD}) has elapsed, taken until the outputs become high impedance (Hi-Z).

Figure 9. HCSL Timing diagram

10. REFERENCE CHARACTERISTICS (Typical 7060 Characteristics)

The following characteristics assume the use of the following crystal element.
The characteristics will vary depending on the crystal used and the measurement conditions.

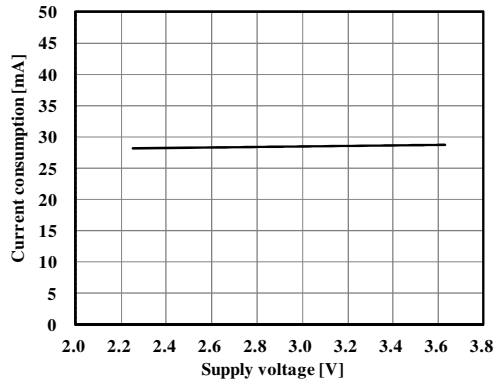


Crystal parameters

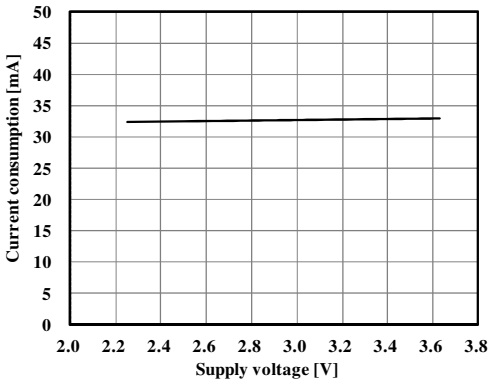
* Crystal oscillator element

Parameter	f_0=100MHz	f_0=155.52MHz	f_0=312.5MHz
C0(pF)	1.8	1.5	1.9
R1(Ω)	7.9	11	18
Oscillation mode	Fundamental	Fundamental	Fundamental

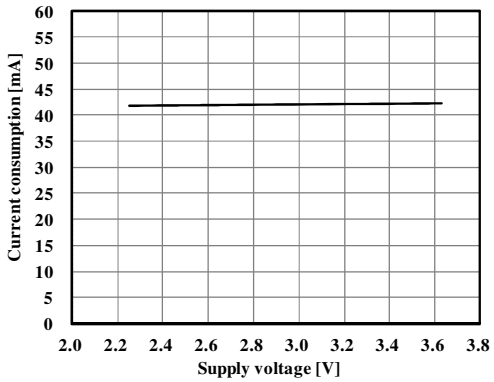
10.1. Current Consumption



7060D1S, f_{OUT}=100MHz, R_S=33Ω, T_a=25°C

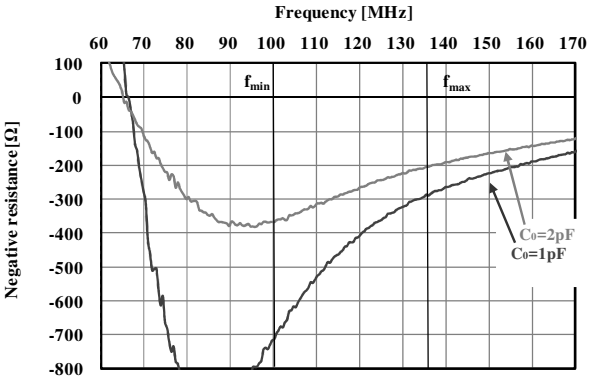


7060E1S, f_{OUT}=155.52MHz, R_S=33Ω, T_a=25°C

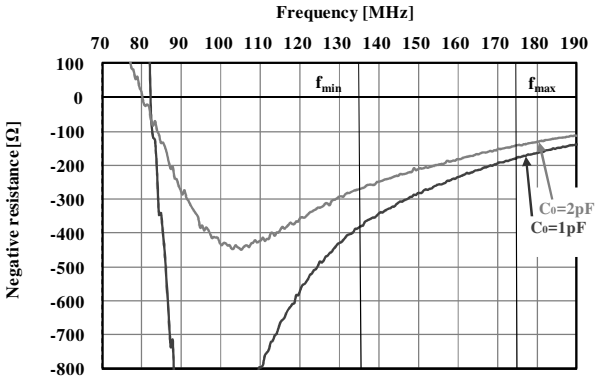


7060G1S, f_{OUT}=312MHz, R_S=33Ω, T_a=25°C

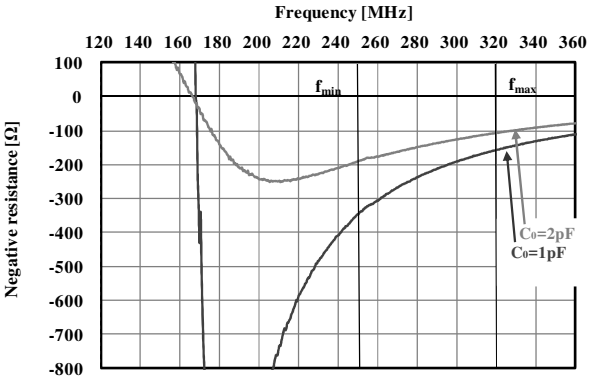
10.2. Negative Resistance



7060D1S, V_{DD}=3.3V, T_a=25°C

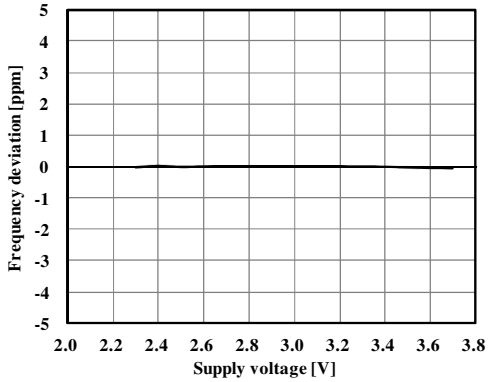


7060E1S, V_{DD}=3.3V, T_a=25°C

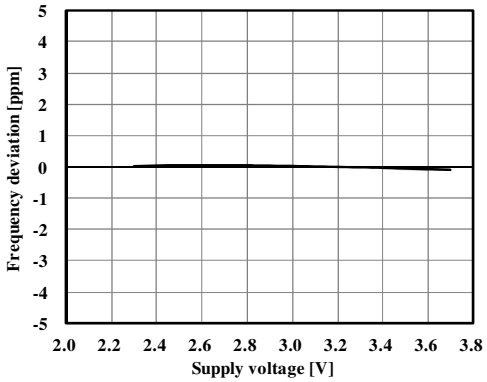


7060G1S, V_{DD}=3.3V, T_a=25°C

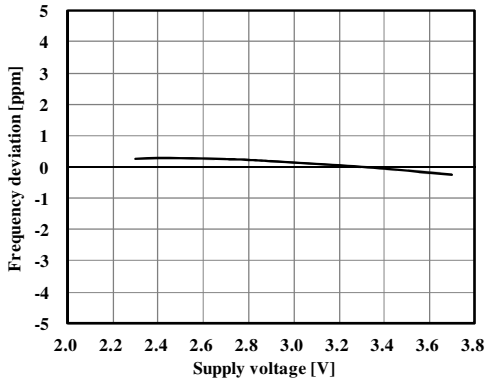
10.3. Frequency Deviation vs. Voltage



7060D1S, f_{OUT}=100MHz, T_a=25°C, 3.3V std.



7060E1S, f_{OUT}=155.52MHz, T_a=25°C, 3.3V std.



7060G1S, f_{OUT}=312MHz, T_a=25°C, 3.3V std.

10.4. Drive Level

7060D1S, f_{OUT}=100MHz, T_a=25°C

V_{DD}[V]	Drive level [uW]
2.5	94.0
3.3	93.9

7060E1S, f_{OUT}=155.52MHz, T_a=25°C

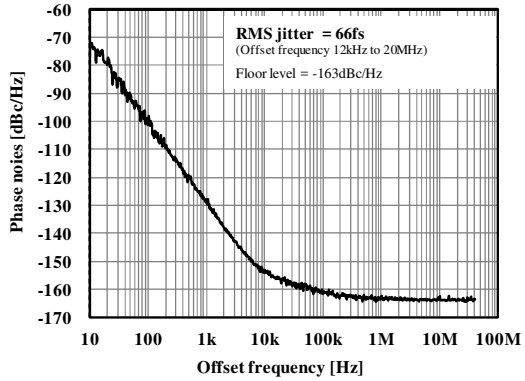
V_{DD}[V]	Drive level [uW]
2.5	131.4
3.3	131.1

7060G1S, f_{OUT}=312MHz, T_a=25°C

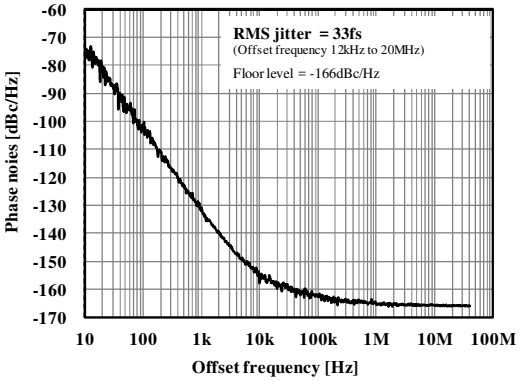
V_{DD}[V]	Drive level [uW]
2.5	638.2
3.3	633.1

10.5. Phase Noise

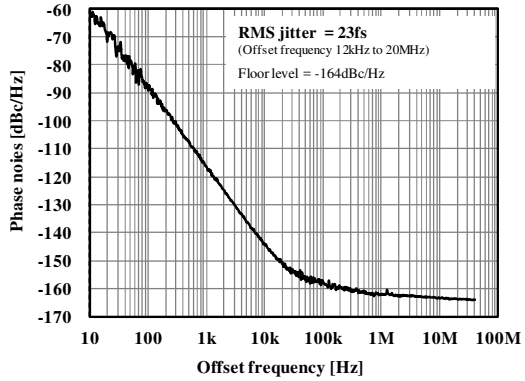
measuring instrument：Signal Source Analyzer E5052B(Agilent)



7060D1S, f_{OUT}=100MHz, V_{DD}=3.3V, T_a=25°C



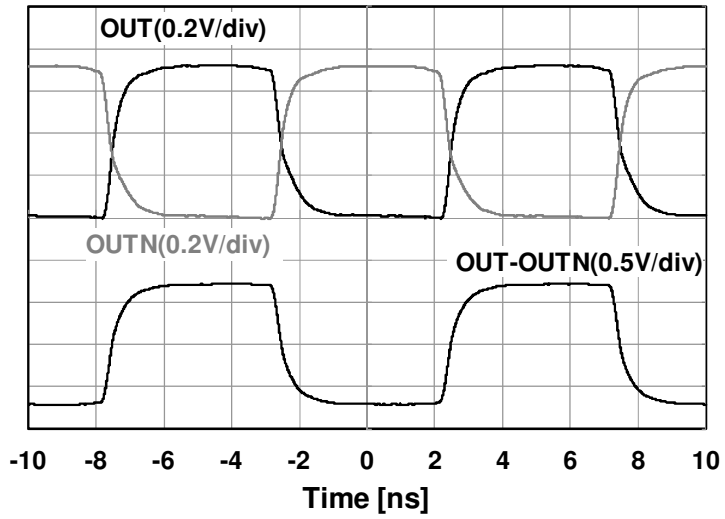
7060E1S, f_{OUT}=155.52MHz, V_{DD}=3.3V, T_a=25°C



7060G1S, f_{OUT}=312MHz, V_{DD}=3.3V, T_a=25°C

10.6. Output Waveforms

measuring instrument：oscilloscope 80604B(Agilent)

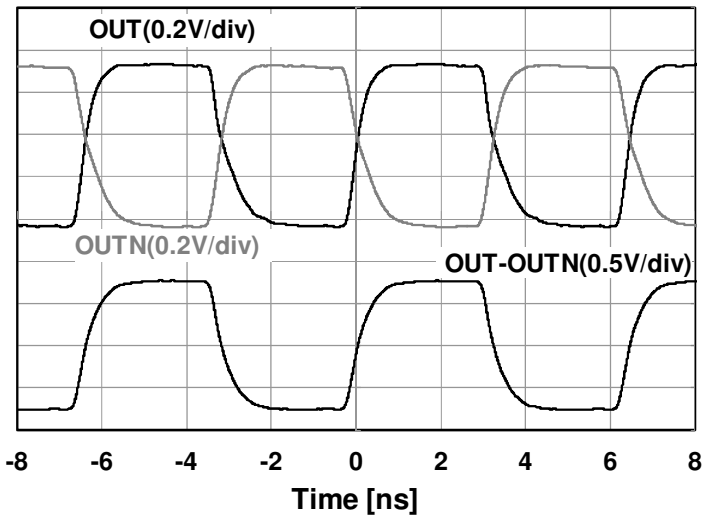


Duty = 50.0%

t_{SRrise} = 2.3 V/ns

t_{SRfall} = 2.3 V/ns

7060D1S, f_{OUT}=100MHz, R_S=33Ω, V_{DD}=3.3V, T_a=25°C, C_L=2pF

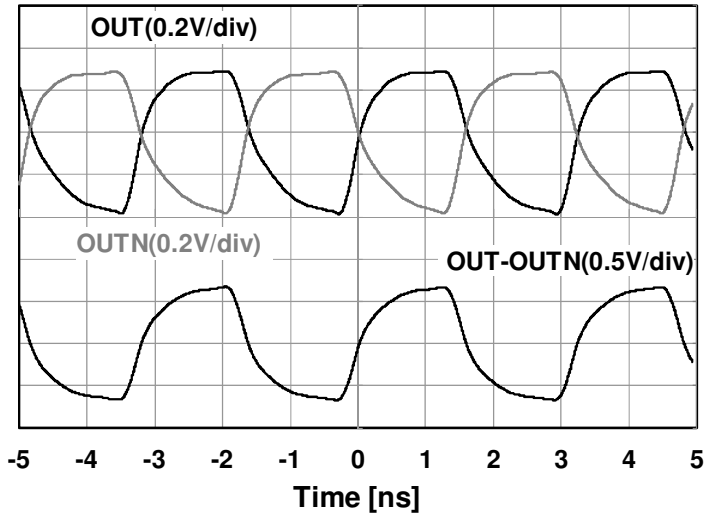


Duty = 49.9%

t_{SRrise} =2.0 V/ns

t_{SRfall} =2.1 V/ns

7060E1S, f_{OUT}=155.52MHz, R_S=33Ω, V_{DD}=3.3V, T_a=25°C, C_L=2pF



Duty = 50.0%

t_{SRrise} = 2.0 V/ns

t_{SRfall} = 2.2 V/ns

7060G1S, f_{OUT}=312MHz, R_S=33Ω, V_{DD}=3.3V, T_a=25°C, C_L=2pF

11. FUNCTIONAL DESCRIPTION

11.1. OE Function

When OE goes V_{SS}, the OUT/OUTN outputs stop and become high impedance. This function is used to disable the operation of the device.

OE input	OUT/OUTN outputs	Oscillator circuit
V_{DD} or Open	f_0 output	Operating
V_{SS}	Hi-Z	Stopped

11.2. Power Saving Pull-up Resistor

The OE terminal pull-up resistance switches between R_{PU1} and R_{PU2}, depending on the input level (V_{DD} or V_{SS}).

When the OE terminal is held V_{SS}, the built-in OE terminal pull-up resistance increases (R_{PU1}), reducing the current consumed by the pull-up resistance when the outputs are disabled.

When the device is operating with the OE terminal V_{DD} or open circuit, the pull-up resistance decreases (R_{PU2}), reducing internal susceptibility to the effects of external noise. The OE terminal is held V_{DD} internally to prevent problems that might otherwise cause the outputs to stop abruptly.

11.3. Oscillation Detection Function

The IC has a built-in oscillation detection circuit.

The oscillation detection circuit disables the output circuit when the oscillator starts until the oscillation becomes stable. This function limits the danger of unstable oscillation when the oscillator starts after power is first applied or the output is enabled.

11.4. 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.

12. MEASUREMENT CIRCUITS

These measurement circuits are used for DC and AC characteristics evaluation.

***** Cautions for output waveform *****

To obtain good waveform characteristics, place a ceramic chip capacitor of 0.01 μF (or more) between the VDD and VSS pins of the IC (within about 3 mm).

12.1. HCSL

- **Measurement circuit 1 Measurement parameters: I_{DD}, I_{STB}, V_{IH}, V_{IL}, R_{PU1}, R_{PU2}**

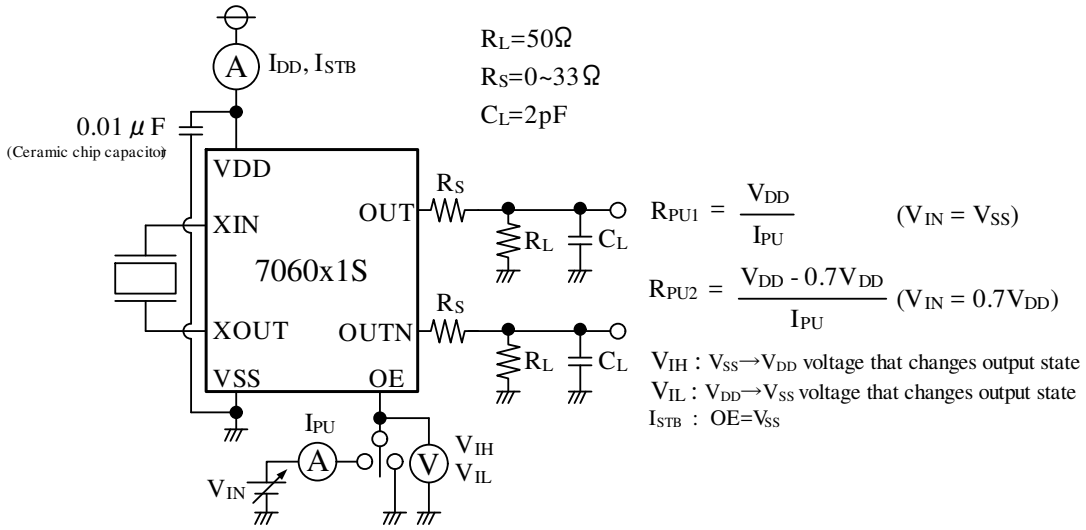


fig12-1. Measurement circuit 1

- **Measurement circuit 2 Measurement parameters: V_{OH}, V_{OL}**

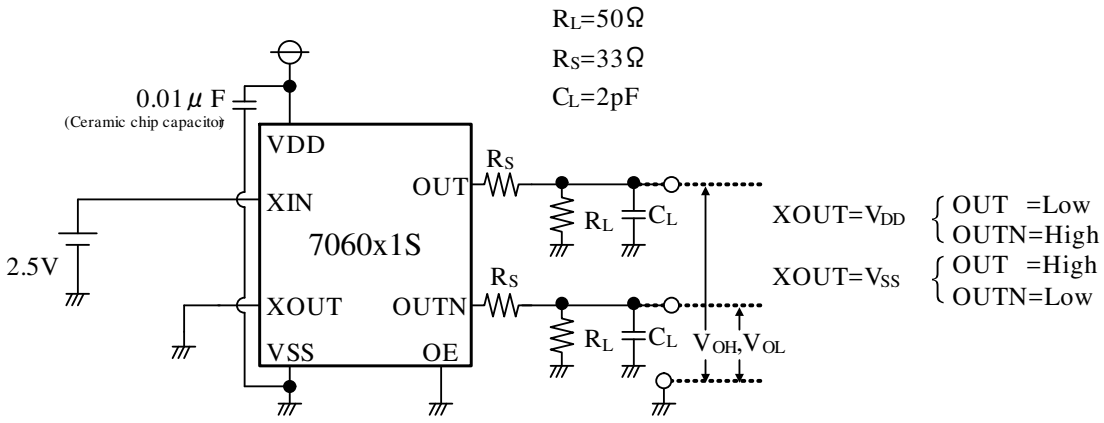


fig12-2. Measurement circuit 2

- **Measurement circuit 3 Measurement parameters: Duty, V_{OPP}, t_{SRrise}, t_{SRfall}**

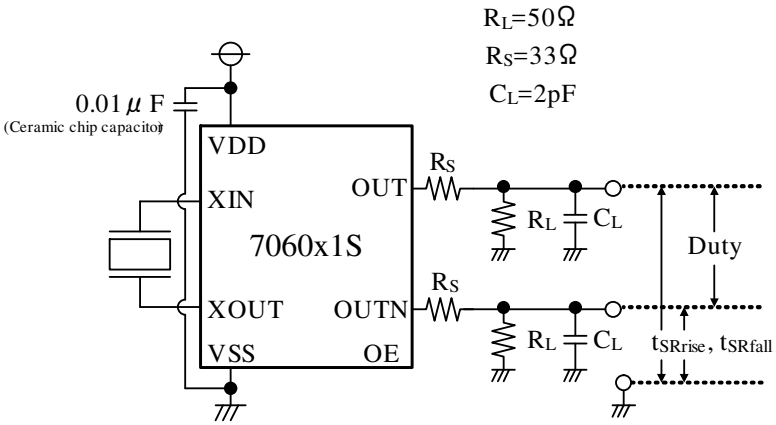


fig12-3. Measurement circuit 3

- **Measurement circuit 4 Measurement parameters: t_{OD}**

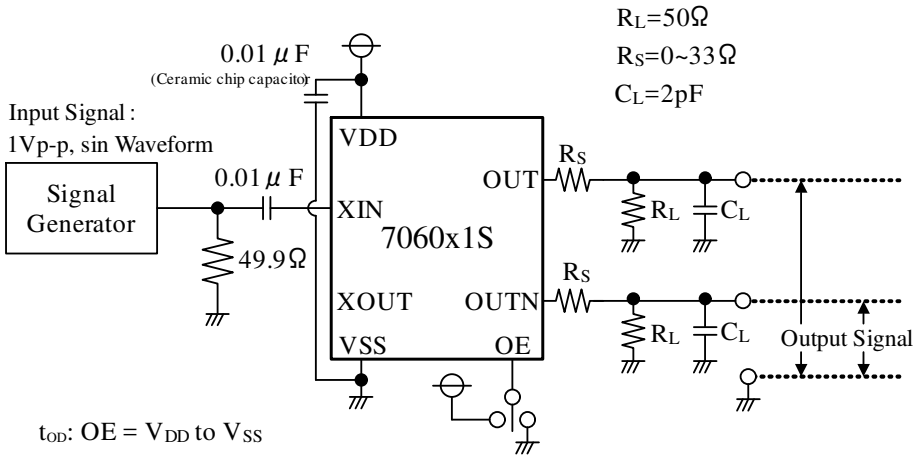
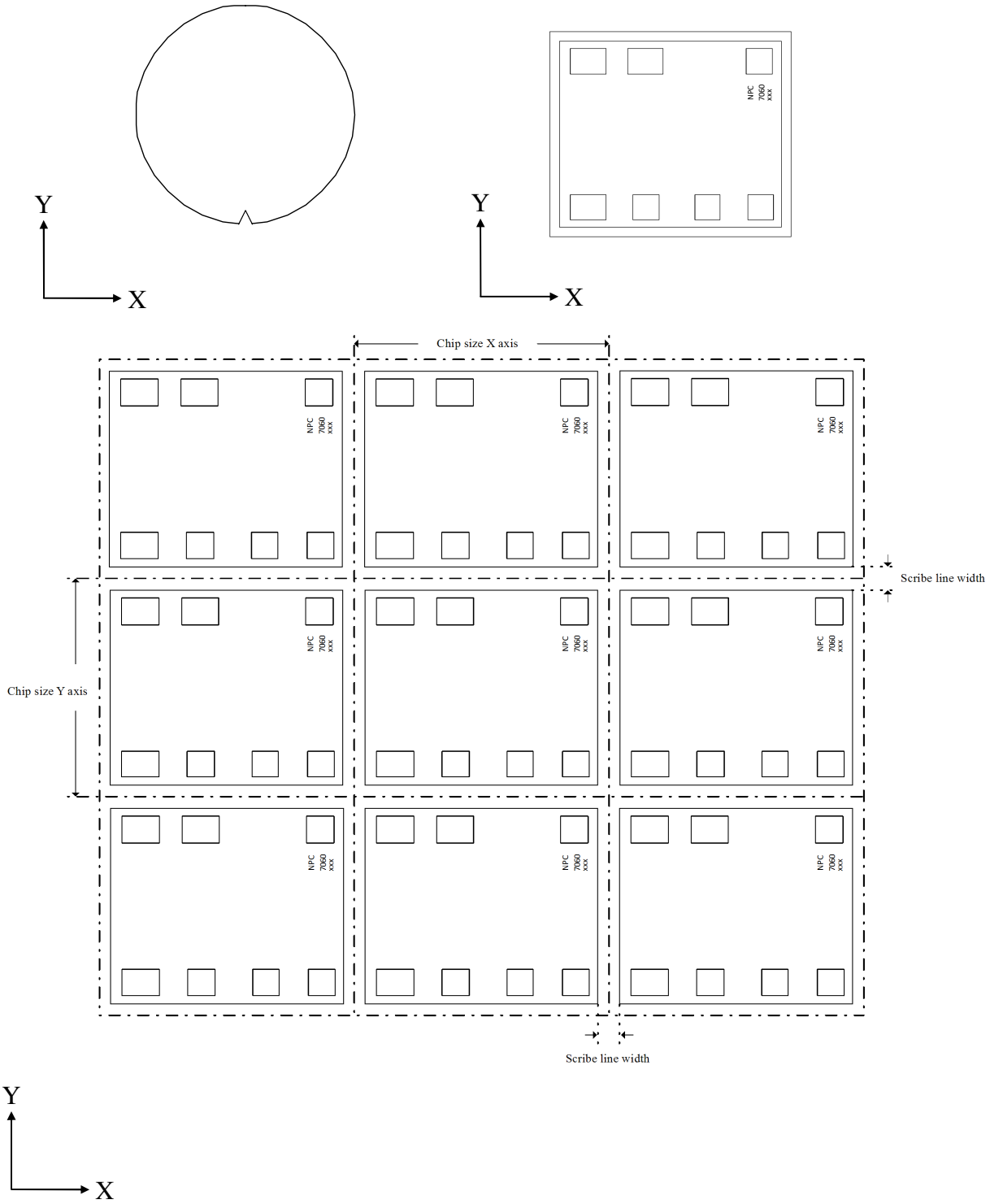


fig12-4. Measurement circuit 4

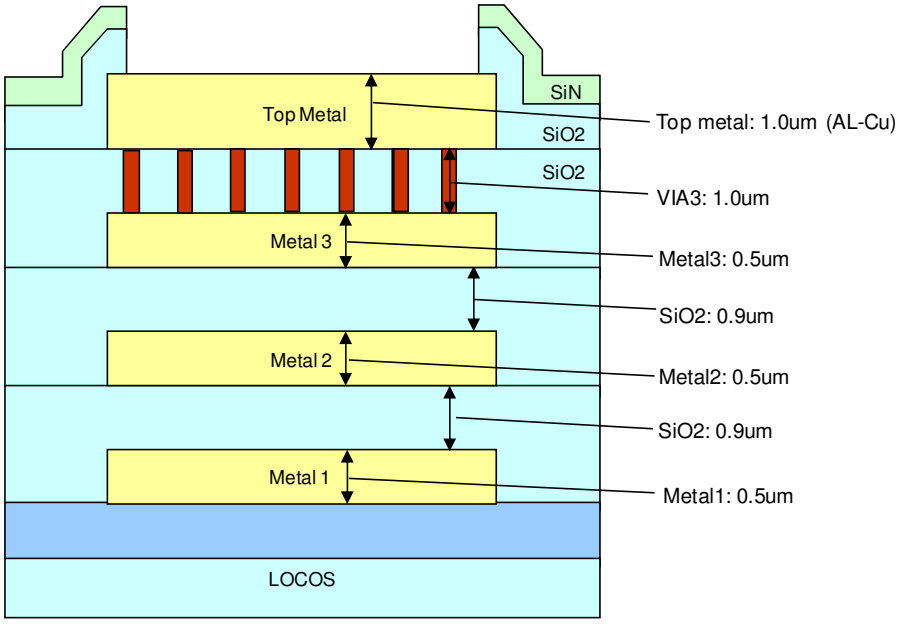
13. WAFER SURFACE DIAGRAM

Wafer size: 200mm±0.5mm
Scribe line width: 60µm



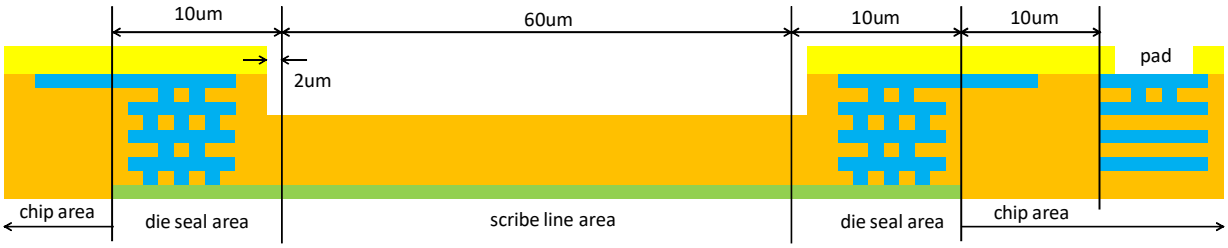
14. CROSS SECTION STRUCTURE

14.1. 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.

14.2. Seal Ring and Scribe Line Cross Section Structure



*Widths 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.

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.

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.
2. NPC reserves the right to change the specifications of the Products in order to improve the characteristics or reliability thereof.
3. The information described in this document is presented only as a guide for using the Products. No responsibility is assumed by us for any infringements of patents or other rights of the third parties which may result from its use. No license is granted by implication or otherwise under any patents or other rights of the third parties. Then, we assume no responsibility whatsoever for any damages resulting from that infringements.
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.

SEIKO NPC CORPORATION

2-9-4, Taito, Taito-ku,
Tokyo 110-0016, Japan
Telephone: +81-3-6747-5300
Facsimile: +81-3-6747-5303
http://www.npc.co.jp/
Email:sales@npc.co.jp

DE200292E 2021.02