OVERVIEW

The 5087 series are LVDS output oscillator ICs that operate with 300MHz to 700MHz SAW resonators. The series includes devices with $f_0/4$ frequency output (mask option), making them ideal for low frequency SAW oscillators as low as 75MHz. They are specialized for SAW oscillators, realizing smaller chip size compared to existing products. They feature low jitter, miniature LVDS output oscillator to use in high-speed serial interface applications.

FEATURES

- 2.375 to 3.6V operating supply voltage range
- Recommended oscillation frequency range:
  300MHz to 700MHz (varies with version)
- Output frequency range: 75MHz to 700MHz
  f_0,$f_0/2$,$f_0/4$ output frequency, determined by internal connection
- Output rise time/Output fall time: 400ps (max)
- -40 to +85°C operating temperature range
- LVDS output
- Standby function
  Outputs are high impedance when OE is LOW. (oscillator stops)
- Power-saving pull-up resistor built-in (OE pin)
- BiCMOS process
- Wafer form (WF5087xx)
- Chip form (CF5087xx)

SERIES CONFIGURATION

Version[*1]	Recommended crystal unit/resonator	Recommended oscillation frequency range[*2][MHz]	Built-in capacitance[*3][pF]		Output frequency
			C_{XIN}	C_{XOUT}	
5087A1	SAW	300 to 500	6	8	f_0
5087A2					$f_0/2$
5087A3					$f_0/4$
5087B1		500 to 700	5	5	f_0
5087B2					$f_0/2$
5087B3					$f_0/4$

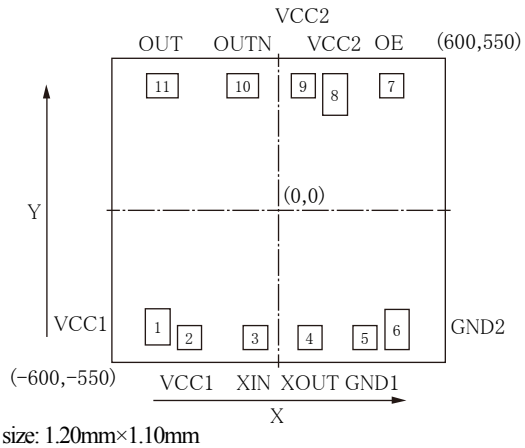
*1. It becomes WF5087xx in case of the wafer form and CF5087xx in case of the chip form.
*2. The recommended oscillation frequency is a yardstick value derived from the resonator used for NPC characteristics authentication. However, the oscillation frequency range is not guaranteed. Specifically, the characteristics can vary greatly due to resonator characteristics and mounting conditions, so the oscillation characteristics of components must be carefully evaluated.
*3. The built-in oscillation capacitance contains parasitic capacitance.

ORDERING INFORMATION

Device	Package	Version name
WF5087xx-x	Wafer form	WF5087□□-□ Form WF: Wafer form CF: Chip (Die) form Wafer/Chip thickness 1: 300µm 3:180µm Frequency divider function Oscillation frequency range
CF5087xx-x	Chip form	

PAD LAYOUT

(Unit: μm)



Chip size: 1.20mm×1.10mm

Chip thickness: 180μm , 300μm

PAD size: 80μm×80μm(PAD No.2, 3, 4, 5, 7, 9 pins)

80μm×150μm(PAD No.6, 8 pins)

110μm×80μm(PAD No.10, 11 pins)

80μm×134μm(PAD No.1 pin)

Chip base: GND potential

PIN DESCRIPTION and PAD COORDINATES

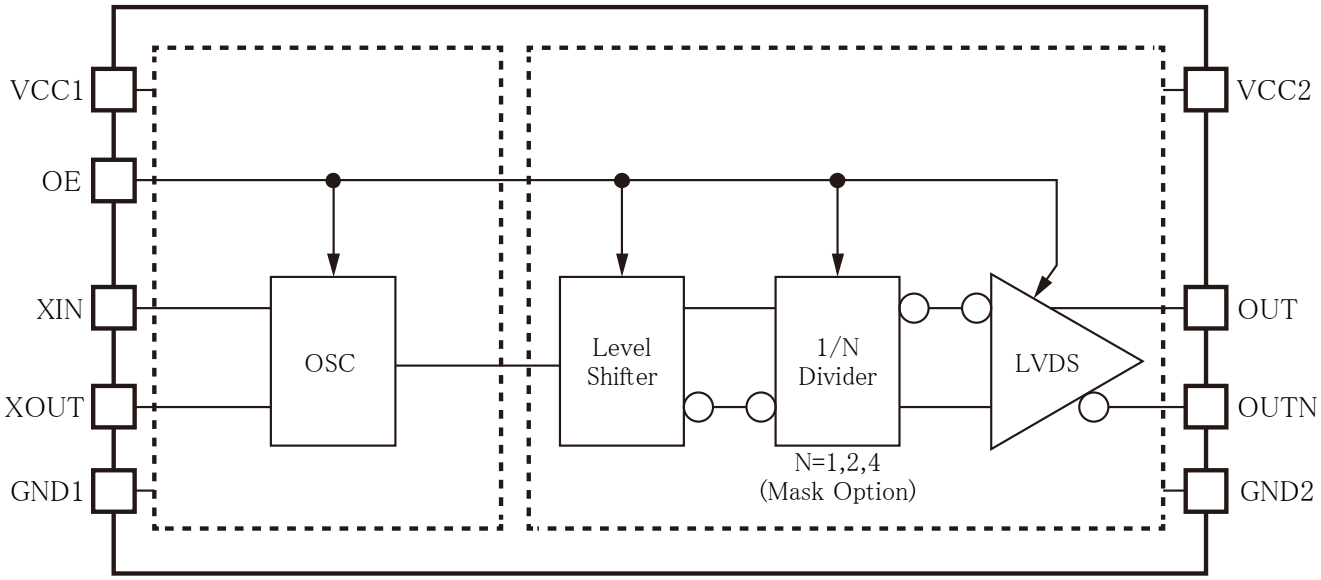
No.	Name	i/o*1	Function	PAD coordinate [μm]	
				X	Y
1	VCC1*2	-	(+) supply pin（for oscillation circuit）	-395	-424
2	VCC1*2	-		-290	-440
3	XIN	i	Oscillator input pin	-72	-440
4	XOUT	o	Oscillator output pin	107	-440
5	GND1*3	-	(-) ground pin（for oscillation circuit）	290	-440
6	GND2*3	-	(-) ground pin（for all circuits excluding oscillation circuit）	395	-440
7	OE	i	Output enable pin. Outputs are high impedance when LOW (oscillator stopped). Power-saving pull-up resistor built-in.	377	440
8	VCC2*2	-	(+) supply pin（for all circuits excluding oscillation circuit）	190	440
9	VCC2*2	-		85	440
10	OUTN	o	LVDS complementary output pin. Disable: High impedance	-114	440
11	OUT	o	LVDS output pin. Disable: High impedance	-380	440

*1. i: input, o: output

*2. Connect both of pins by wire-bonding for good characteristics.

*3. GND1 and GND2 pins should be connected by wire-bonding since they are disconnected.

BLOCK DIAGRAM



SPECIFICATIONS

Absolute Maximum Ratings

V_{SS}=0V

Parameter	Symbol	Condition	Rating	Unit
Supply voltage range*1	V_{CC}	VCC1, VCC2 pins	-0.3 to +5.0	V
Input voltage range*1*2	V_{IN}	XIN, OE pins	-0.3 to V_{CC}+0.3	V
Output voltage range*1*2	V_{OUT}	XOUT, OUT/OUTN pins	-0.3 to V_{CC}+0.3	V
Junction temperature*3	T_j		+125	°C
Storage temperature range*4	T_{STG}	Chip form, Wafer form	-55 to +125	°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_{CC} is a V_{CC} 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	Conditions	Rating			Unit
			MIN	TYP	MAX	
Operating supply voltage	V_{CC}	Between VCC1 and GND pins Between VCC2 and GND pins	2.375		3.6	V
Operating supply voltage difference	ΔV_{CC}	Voltage difference between VCC1 and VCC2 pins	-0.1		+0.1	V
Input voltage	V_{IN}	XIN, OE pins	0		V_{CC}	V
Operating temperature	T_a		-40		+85	°C
Output load	R_L	Between OUT and OUTN pins	99	100	101	Ω
Oscillation frequency range*1	f_0	5087Ax	300		500	MHz
		5087Bx	500		700	
Output frequency range	f_{OUT}	5087A1	300		500	MHz
		5087A2	150		250	
		5087A3	75		125	
		5087B1	500		700	
		5087B2	250		350	
		5087B3	125		175	

*1. The oscillation frequency is a yardstick value derived from the resonator 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.

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

3.3V operation

V_{CC}=3.0 to 3.6V, GND=0V, T_a= -40 to +85°C unless otherwise noted.

Parameter	Symbol	Conditions		Rating			Unit
				MIN	TYP	MAX	
Current consumption	I_{CC}	Measurement circuit 1, OE=Open			49	70	mA
Standby current	I_{STB}	Measurement circuit 1, OE=Low				30	µA
High-level output voltage	V_{OH}	Measurement circuit 2, OE=Open, R_L=100Ω OUT/OUTN pins			1.43	1.6	V
Low-level output voltage	V_{OL}			0.9	1.1		V
Differential output voltage	V_{OD}	Measurement circuit 2, OE=Open, R_L=100Ω OUT/OUTN pins		247	330	454	mV
Differential output voltage error	ΔV_{OD}					50	mV
Offset voltage	V_{OS}	Measurement circuit 2, OE=Open, R_L=100Ω OUT/OUTN pins		1.125	1.25	1.375	V
Offset voltage error	ΔV_{OS}					50	mV
Output leakage current	I_Z	Measurement circuit 3, SW=High or Low OE=Low, OUT/OUTN pins				10	µA
High-level input voltage	V_{IH}	Measurement circuit 1, OE pin		0.7V_{CC}			V
Low-level input voltage	V_{IL}	Measurement circuit 1, OE pin				0.3V_{CC}	V
High-level input current	I_{IH}*1	Measurement circuit 1, V_{IN}=0.7Vcc, OE pin		-10		-70	µA
Low-level input current	I_{IL}*1	Measurement circuit 1, V_{IN}=0V, OE pin		-1		-15	µA
Oscillation capacitors	C_{IN}	Design value (a monitor pattern on a wafer is tested), Excluding parasitic capacitance.	5087Ax	1.70	2.00	2.30	pF
			5087Bx	0.85	1.00	1.15	
	C_{OUT}		5087Ax	3.40	4.00	4.60	
			5087Bx	0.85	1.00	1.15	

*1. A sign means the direction of current flows and the MAX value is defined as the largest absolute value.

2.5V operation

V_{DD}=2.375 to 2.625V, GND=0V, T_a= -40 to +85°C unless otherwise noted.

Parameter	Symbol	Conditions		Rating			Unit
				MIN	TYP	MAX	
Current consumption	I_{CC}	Measurement circuit 1, OE=Open			47	68	mA
Standby current	I_{STB}	Measurement circuit 1, OE=Low				30	µA
High-level output voltage	V_{OH}	Measurement circuit 2, OE=Open, R_L=100Ω OUT/OUTN pins			1.43	1.6	V
Low-level output voltage	V_{OL}			0.9	1.1		V
Differential output voltage	V_{OD}	Measurement circuit 2, OE=Open, R_L=100Ω OUT/OUTN pins		247	330	454	mV
Differential output voltage error	ΔV_{OD}					50	mV
Offset voltage	V_{OS}	Measurement circuit 2, OE=Open, R_L=100Ω OUT/OUTN pins		1.125	1.25	1.375	V
Offset voltage error	ΔV_{OS}					50	mV
Output leakage current	I_Z	Measurement circuit 3, SW=High or Low OE=Low, OUT/OUTN pins				10	µA
High-level input voltage	V_{IH}	Measurement circuit 1, OE pin		0.7V_{CC}			V
Low-level input voltage	V_{IL}	Measurement circuit 1, OE pin				0.3V_{CC}	V
High-level input current	I_{IH} *1	Measurement circuit 1, V_{IN}=0.7Vcc, OE pin		-10		-70	µA
Low-level input current	I_{IL} *1	Measurement circuit 1, V_{IN}=0V, OE pin		-1		-15	µA
Oscillation capacitors	C_{IN}	Design value (a monitor pattern on a wafer is tested), Excluding parasitic capacitance.	5087Ax	1.70	2.00	2.30	pF
			5087Bx	0.85	1.00	1.15	
	C_{OUT}		5087Ax	3.40	4.00	4.60	
			5087Bx	0.85	1.00	1.15	

*1. A sign means the direction of current flows and the MAX value is defined as the largest absolute value.

Switching Characteristics

3.3V operation

V_{DD} = 3.0 to 3.6V, GND= 0V, T_a = -40 to +85°C unless otherwise noted

Parameter	Symbol	Conditions	Rating			Unit
			MIN	TYP	MAX	
Output duty cycle	Duty	Measurement circuit 4 T_a=+25°C, V_{CC}=3.3V Measured at differential output is 0V (cross point)	45		55	%
Output swing	V_{OPP}	Measurement circuit 4, Peak to peak of differential output waveform	0.35			V
Output rise time	t_r	Measurement circuit 4 20% to 80% of differential output swing		290	400	ps
Output fall time	t_f	Measurement circuit 4 80% to 20% of differential output swing		290	400	ps
Output disable time	t_{OD}	Measurement circuit 5, T_a=+25°C Time to becoming output Hi-Z at OE(fall)=V_{IL} (Refer to the timing chart for details.)			200	ns

Note. 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: A version: R1≤20Ω, C0≤3pF
B version: R1≤20Ω, C0≤2pF

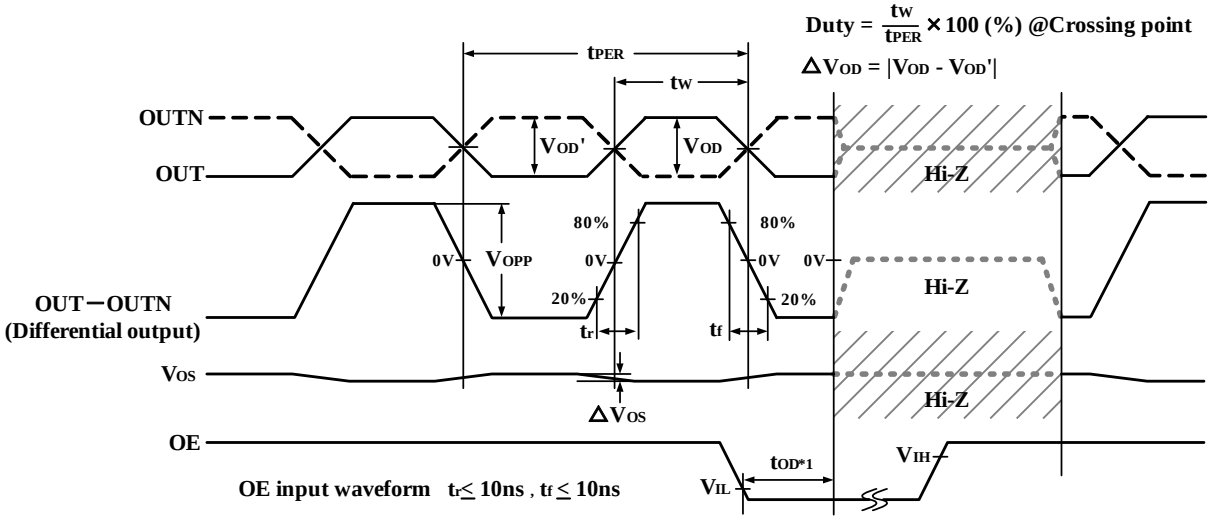
2.5V operation

V_{DD} = 2.375 to 2.625V, GND= 0V, T_a = -40 to +85°C unless otherwise noted

Parameter	Symbol	Conditions	Rating			Unit
			MIN	TYP	MAX	
Output duty cycle	Duty	Measurement circuit 4 T_a=+25°C, V_{CC}=2.5V Measured at differential output is 0V (cross point)	45		55	%
Output swing	V_{OPP}	Measurement circuit 4, Peak to peak of differential output waveform	0.25			V
Output rise time	t_r	Measurement circuit 4 20% to 80% of differential output swing		290	400	ps
Output fall time	t_f	Measurement circuit 4 80% to 20% of differential output swing		290	400	ps
Output disable time	t_{OD}	Measurement circuit 5, T_a=+25°C Time to becoming output Hi-Z at OE(fall)=V_{IL} (Refer to the timing chart for details.)			200	ns

Note. 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: A version: R1≤20Ω, C0≤3pF
B version: R1≤20Ω, C0≤2pF

Timing chart



*1. The OUT/OUTN output goes high impedance after the OE is fallen and then the output disable time "t_{OD}" has elapsed.

Figure 1. Timing chart

MEASUREMENT CIRCUITS

These are measurement circuits for electrical characteristics and switching characteristics.

■ Note: Bypass capacitors specified in each measurement circuit below should be connected between VCC and GND. Load resistance specified in each measurement circuit below should be connected to OUT and OUTN pins (excluding measurement circuit 3). Circuit wiring of bypass capacitors and load resistance should be connected as short as possible. If the circuit wiring is long, the required characteristics may not be realized. Also, if the values of bypass capacitors and load resistance differ from the description in this document or are not connected, the required characteristics may not be realized.

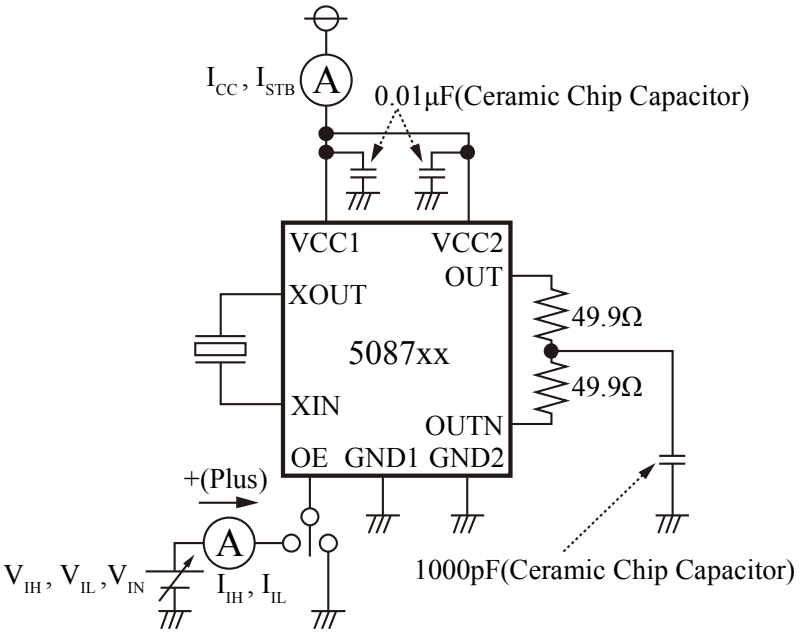
* The capacitor and resistor used in measurement circuits below;

GRM155F11H103Z (MURATA)	0.01μF
GRM1552C1H102JA01 (MURATA)	1000pF
RN732ATTD49R9B25 (KOA)	49.9Ω

The differential probe spec used for measurement recommends >5GHz analog bandwidth, >50kΩ impedance, and <1pF load.
If common-mode noise becomes a problem, connect a capacitor between the center tap of 49.9Ω resistance and GND.
The capacitor should choose value so that impedance becomes low on the frequency of the noise which is attenuated.

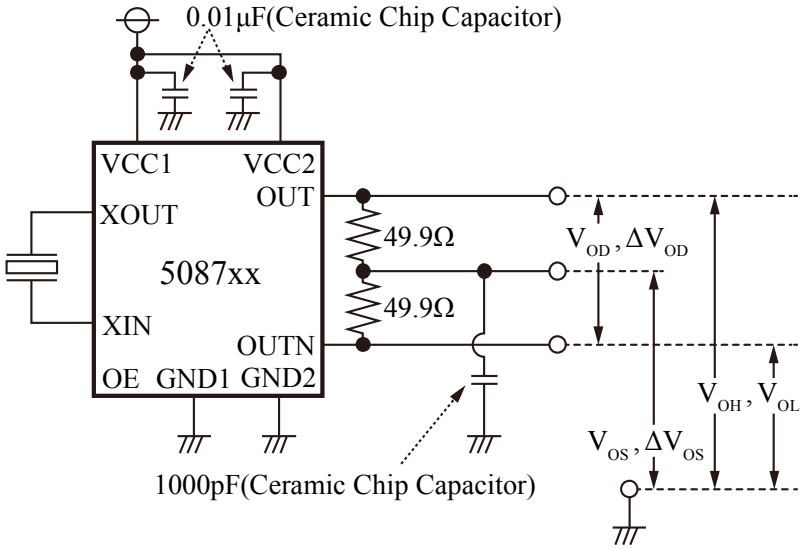
MEASUREMENT CIRCUIT 1

Measurement Parameter: I_{CC}, I_{STB}, V_{IH}, V_{IL}, I_{IH}, I_{IL}



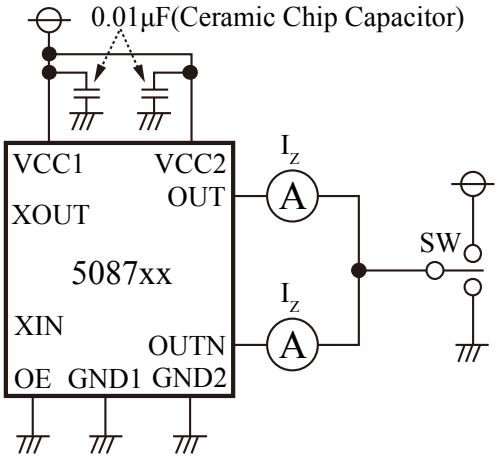
MEASUREMENT CIRCUIT 2

Measurement Parameter: V_{OH}, V_{OL}, V_{OD}, ΔV_{OD}, V_{OS}, ΔV_{OS}



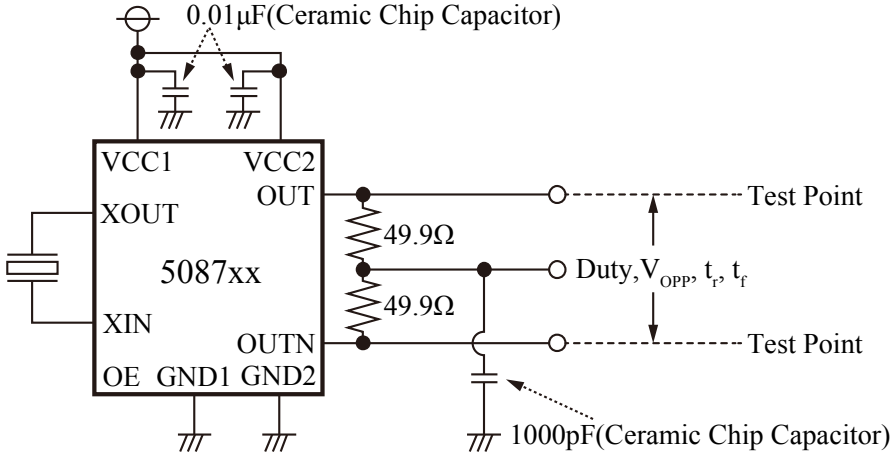
MEASUREMENT CIRCUIT 3

Measurement Parameter: I_Z



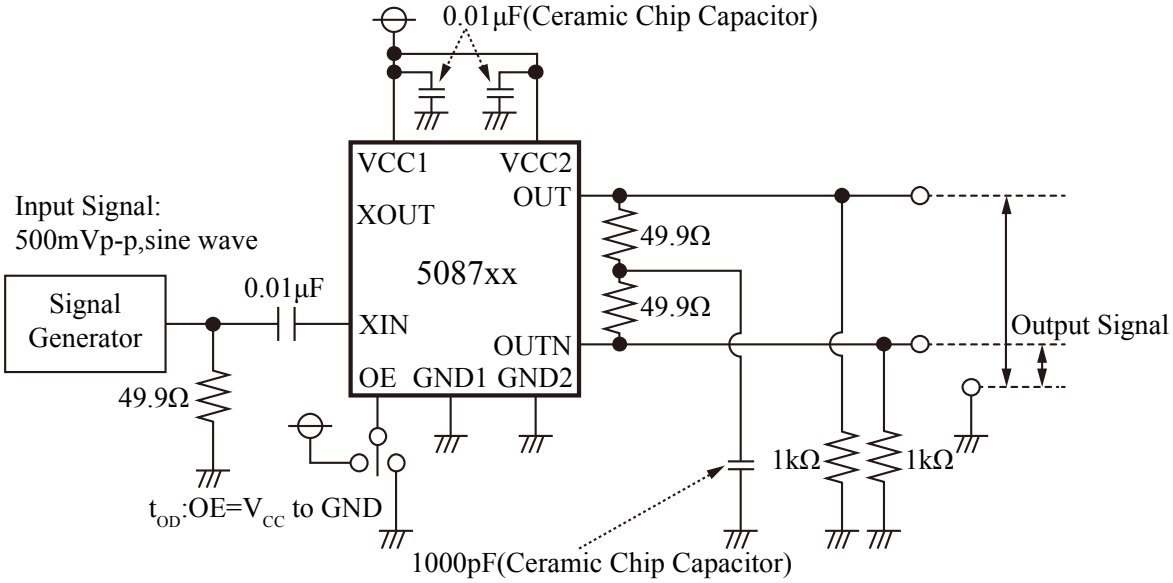
MEASUREMENT CIRCUIT 4

Measurement Parameter: Duty, V_{OPP}, t_r, t_f



MEASUREMENT CIRCUIT 5

Measurement Parameter: t_{OD}



FUNCTIONAL DESCRIPTION

Standby Function

When OE goes LOW, the oscillator stops and the output pins (OUT, OUTN) become high impedance.

OE	OUT, OUTN	Oscillator
HIGH (Open)	Any f_0, $f_0/2$, $f_0/4$ output frequency	Operating
LOW	Hi-Z	Stopped

Power Saving Pull-up Resistor

The OE pin pull-up resistance changes in response to the input level (HIGH or LOW). When OE is tied LOW (standby state), the pull-up resistance becomes large, reducing the current consumed by the resistance. When OE is open circuit, the pull-up resistance becomes small, decreasing the susceptibility to the effects of external noise.

Oscillation Detection Function

The 5087 series also feature an oscillation detector circuit. This circuit functions to disable the outputs until the oscillator circuit starts and the oscillation becomes stable. This alleviates the danger of abnormal oscillator output at oscillator start-up when power is applied or when OE is switched.

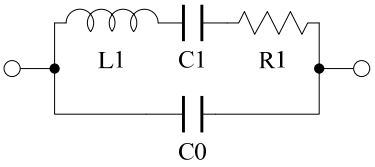
TYPICAL PERFORMANCE

The following characteristics measured using the NPC's standard jig and SAW resonator. Note that the characteristics will vary with the resonator used or measurement condition.

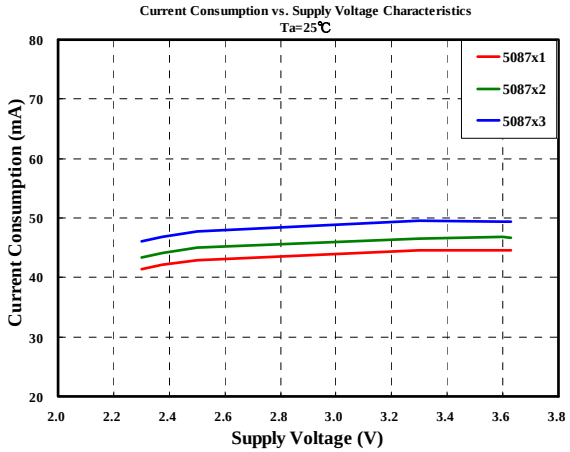
SAW resonator used for measurement

Parameter	f_0=315MHz
C0 (pF)	2.8
R1 (Ω)	18

SAW resonator parameters

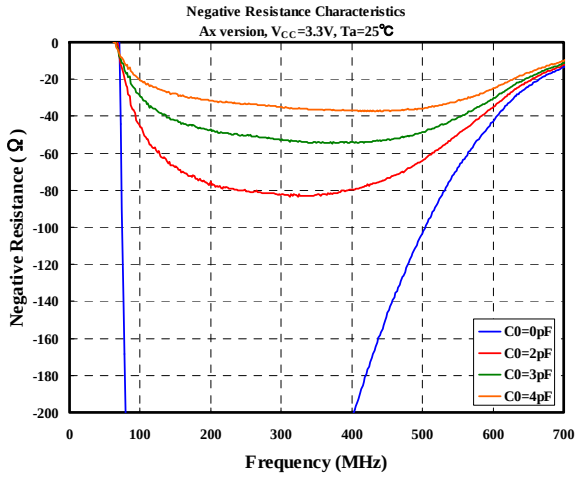


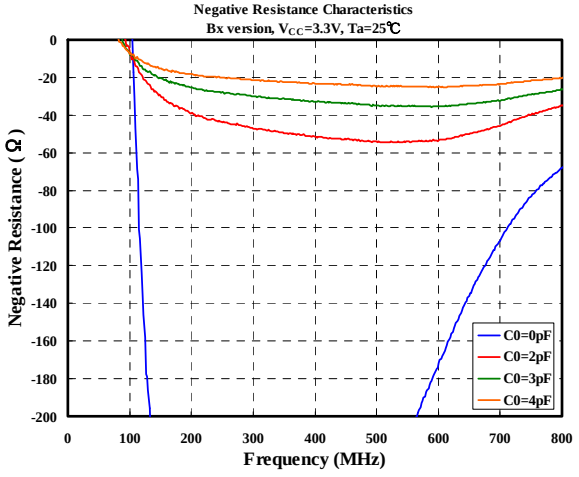
Current Consumption



Negative Resistance

Measurement equipment: Agilent 4396B Network Analyzer, Agilent 85046A S-parameter Test Set

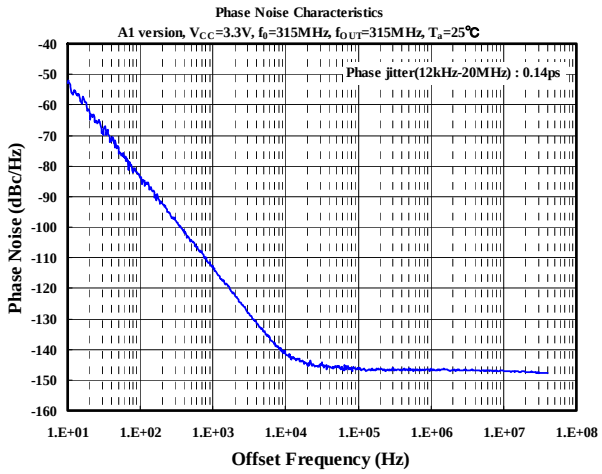


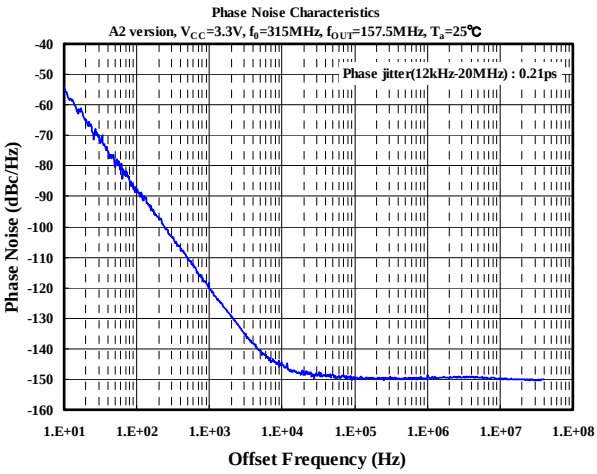


Characteristics are measured with a capacitance C0, representing the resonator equivalent circuit C0 capacitance, connected between the XIN and XOUT pins. Measurement are performed with Agilent 4396B, 85046A using the NPC test jig. Characteristics may vary with measurement jig and measurement conditions.

Phase Noise

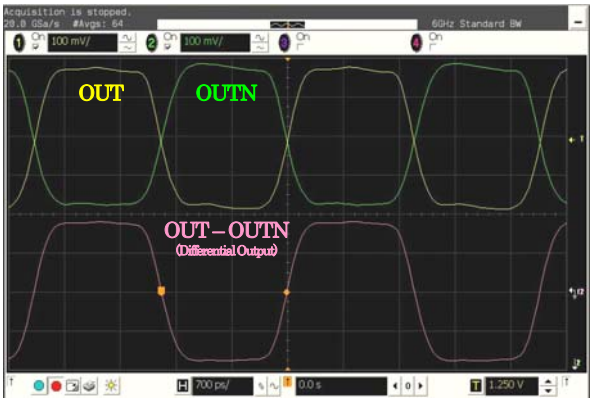
Measurement equipment: Agilent E5052B Signal Source Analyzer



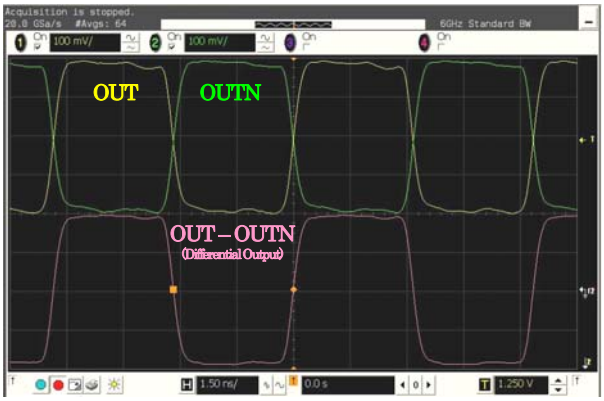


Output Waveform

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



A1 version, V_{CC}=3.3V, T_a=25°C
f_0=315MHz, f_{OUT}=315MHz



A2 version, V_{CC}=3.3V, T_a=25°C
f_0=315MHz, f_{OUT}=157.5MHz

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.
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