NIPPON PRECISION CIRCUITS INC.

CF5020 series

High-Frequency, 3rd Overtone Crystal Oscillator Module ICs

OVERVIEW

The CF5020 series are high-frequency, 3rd overtone crystal oscillator module ICs. They incorporate an oscillator circuit and an output buffer that operate at high frequency on a single chip. The oscillator circuit employs CMOS inverters and a built-in damping resistor R_D, reducing the crystal current compared with existing devices. The damping resistor R_D is fabricated using NPC's unique high-precision thin-film resistor technology, which suppresses oscillator characteristic variations due to changes in temperature and voltage to a minimum. The CF5020 series can be utilized to construct stable, high-frequency, 3rd overtone crystal oscillators.

FEATURES

- R_D built-in to reduce crystal current in the oscillator circuit
- 2.25 to 3.6V operating supply voltage range
- Recommended operating frequency range (varies with version)
  - 2.5V operation: 60 to 155MHz
  - 3.0V operation: 60 to 170MHz
- – 40 to 85°C operating temperature range
- Oscillator capacitors with excellent frequency response built-in
- Feedback resistors with good temperature characteristics built-in
- Standby function
  - High impedance in standby mode, oscillator stops
- Low standby current
  - Power-saving pull-up resistor built-in
- Oscillation detector function
- CMOS output duty level (1/2VDD)
- 50 ± 5% output duty (at 1/2VDD)
- 30pF output load (3.3V operation)
- Molybdenum-gate CMOS process
- Chip form (CF5020AL×)

APPLICATIONS

- Crystal oscillator modules (3rd overtone oscillation)

SERIES CONFIGURATION

Version	Recommended operating frequency range*1 [MHz]		Oscillator circuit constants					INHN input level	Standby mode	
			gm ratio	Built-in capacitance		Feedback resistance	Damping resistance		Oscillator stop function	Output state
	2.5V operation	3.0V operation		C_G [pF]	C_D [pF]	Rf [kΩ]	R_D [Ω]			
CF5020ALA	60 to 80	60 to 90	0.6	4	7	2.5	200	CMOS	Yes	High impedance
CF5020ALB	70 to 115	80 to 125	0.8	3	3	4.5	57			
CF5020ALC	105 to 135	115 to 145	1.0	1	3	3.3	57			
CF5020ALD	110 to 155	135 to 170	1.0	1	5	2.2	57			

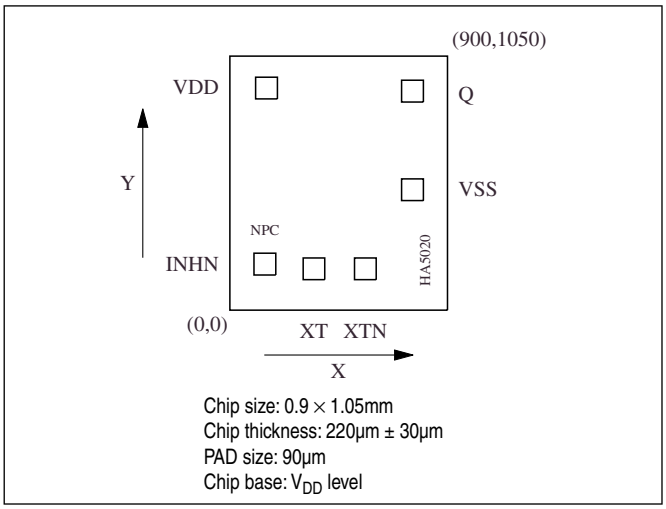
*1. The recommended operating frequency is a yardstick value derived from the crystal used for NPC characteristics authentication. However, the oscillator frequency band is not guaranteed. Specifically, the characteristics can vary greatly due to crystal characteristics and mounting conditions, so the oscillation characteristics of components must be carefully evaluated.

ORDERING INFORMATION

Device	Package
CF5020AL×–2	Chip form

PAD LAYOUT

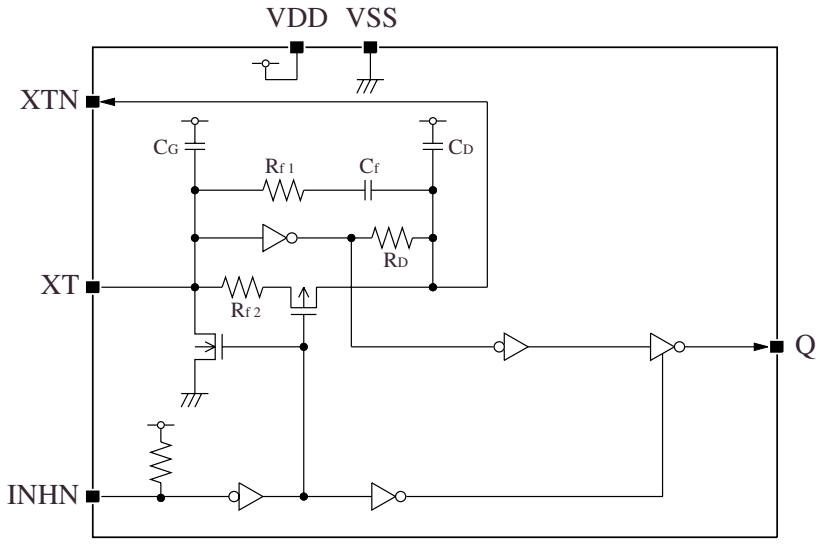
(Unit: µm)



PIN DESCRIPTION and PAD DIMENSIONS

Name	I/O	Description		Pad dimensions [µm]	
				X	Y
INHN	I	Output state control input. High impedance when LOW (oscillator stops). Power-saving pull-up resistor built-in.		144.6	190.6
XT	I	Amplifier input	Crystal connection pins. Crystal is connected between XT and XTN.	347.8	171
XTN	O	Amplifier output		560.6	171
VSS	–	(–) ground		755.4	497.8
Q	O	Output		755.4	905.4
VDD	–	(+) supply voltage		151.4	918.2

BLOCK DIAGRAM



INHN = LOW active

SPECIFICATIONS

Absolute Maximum Ratings

V_{SS} = 0V

Parameter	Symbol	Condition	Rating	Unit
Supply voltage range	V_{DD}		–0.5 to +7.0	V
Input voltage range	V_{IN}		–0.5 to V_{DD} + 0.5	V
Output voltage range	V_{OUT}		–0.5 to V_{DD} + 0.5	V
Operating temperature range	T_{opr}		–40 to +85	°C
Storage temperature range	T_{STG}		–65 to +150	°C
Output current	I_{OUT}		25	mA

Recommended Operating Conditions

CF5020ALA, CF5020ALB

3V Operation

V_{SS} = 0V

Parameter	Symbol	Condition		Rating			Unit
				min	typ	max	
Operating supply voltage range	V_{DD}	f ≤ 125MHz	C_L ≤ 15pF	2.7	–	3.6	V
			C_L ≤ 30pF	3.0	–	3.6	V
				2.7*1	–	3.6*1	V
Input voltage range	V_{IN}			V_{SS}	–	V_{DD}	V
Operating temperature range	T_{OPR}			–40	–	+85	°C

*1. The output duty cycle variability increases than other conditions.

2.5V Operation

V_{SS} = 0V

Parameter	Symbol	Condition		Rating			Unit
				min	typ	max	
Operating supply voltage range	V_{DD}	f ≤ 106MHz	C_L ≤ 15pF	2.25	–	2.75	V
		f ≤ 70MHz	C_L ≤ 30pF	2.25	–	2.75	V
		f ≤ 125MHz	C_L ≤ 15pF	2.25*1	–	2.75*1	V
Input voltage range	V_{IN}			V_{SS}	–	V_{DD}	V
Operating temperature range	T_{OPR}			–40	–	+85	°C

*1. The output duty cycle variability increases than other conditions.

CF5020ALC, CF5020ALD

3V Operation

V_{SS} = 0V

Parameter	Symbol	Condition		Rating			Unit
				min	typ	max	
Operating supply voltage range	V_{DD}	f ≤ 170MHz	C_L ≤ 15pF	2.7	–	3.6	V
		f ≤ 125MHz	C_L ≤ 30pF	2.7	–	3.6	V
Input voltage range	V_{IN}			V_{SS}	–	V_{DD}	V
Operating temperature range	T_{OPR}			–40	–	+85	°C

2.5V Operation

V_{SS} = 0V

Parameter	Symbol	Condition		Rating			Unit
				min	typ	max	
Operating supply voltage range	V_{DD}	f ≤ 155MHz	C_L ≤ 15pF	2.25	–	2.75	V
Input voltage range	V_{IN}			V_{SS}	–	V_{DD}	V
Operating temperature range	T_{OPR}			–40	–	+85	°C

Electrical Characteristics

2.5V operation

V_{DD} = 2.25 to 2.75V, V_{SS} = 0V, Ta = –40 to +85°C unless otherwise noted.

Parameter	Symbol	Condition			Rating min	Rating typ	Rating max	Unit
HIGH-level output voltage	V_{OH}	Q: Measurement cct 1, V_{DD} = 2.25V, I_{OH} = 8mA			1.75	1.95	–	V
LOW-level output voltage	V_{OL}	Q: Measurement cct 2, V_{DD} = 2.25V, I_{OL} = 8mA			–	0.3	0.4	V
HIGH-level input voltage	V_{IH}	INHN			0.7V_{DD}	–	–	V
LOW-level input voltage	V_{IL}	INHN			–	–	0.3V_{DD}	V
Output leakage current	I_Z	Q: Measurement cct 2, INHN = LOW		$V_{OH} = V_{DD}$	–	–	10	µA
				$V_{OL} = V_{SS}$	–	–	10	µA
Current consumption	I_{DD}	Measurement cct 3, load cct 1, INHN = open	CF5020ALA	C_L = 15pF f = 80MHz	–	15	40	mA
				C_L = 30pF f = 70MHz	–	20	50	mA
			CF5020ALB	C_L = 15pF f = 106MHz	–	20	50	mA
				C_L = 30pF f = 70MHz	–	20	50	mA
			CF5020ALC	C_L = 15pF f = 135MHz	–	25	60	mA
			CF5020ALD	C_L = 15pF f = 155MHz	–	30	70	mA
Standby current	I_{ST}	Measurement cct 3, INHN = LOW			–	–	3	µA
INHN pull-up resistance	R_{UP1}	Measurement cct 4			2	6	12	MΩ
	R_{UP2}				50	100	150	kΩ
AC feedback resistance	R_{f1}	Design value. A monitor pattern on a wafer is tested.		CF5020ALA	2.12	2.5	2.88	kΩ
				CF5020ALB	3.82	4.5	5.18	kΩ
				CF5020ALC	2.80	3.3	3.80	kΩ
				CF5020ALD	1.87	2.2	2.53	kΩ
DC feedback resistance	R_{f2}	Measurement cct 5			50	100	150	kΩ
Oscillator amplifier output resistance	R_D	Design value. A monitor pattern on a wafer is tested.		CF5020ALA	170	200	230	Ω
				CF5020ALB	48.4	57	65.6	Ω
				CF5020ALC	48.4	57	65.6	Ω
				CF5020ALD	48.4	57	65.6	Ω
AC feedback capacitance	C_f	Design value. A monitor pattern on a wafer is tested.			8.5	10	11.5	pF
Built-in capacitance	C_G	Design value. A monitor pattern on a wafer is tested.		CF5020ALA	3.40	4	4.60	pF
				CF5020ALB	2.55	3	3.45	pF
				CF5020ALC	0.85	1	1.15	pF
				CF5020ALD	0.85	1	1.15	pF
	C_D	Design value. A monitor pattern on a wafer is tested.		CF5020ALA	5.95	7	8.05	pF
				CF5020ALB	2.55	3	3.45	pF
				CF5020ALC	2.55	3	3.45	pF
				CF5020ALD	4.25	5	5.75	pF

3V operation

V_{DD} = 2.7 to 3.6V, V_{SS} = 0V, Ta = –40 to +85°C unless otherwise noted.

Parameter	Symbol	Condition			Rating min	Rating typ	Rating max	Unit
HIGH-level output voltage	V_{OH}	Q: Measurement cct 1, V_{DD} = 2.7V, I_{OH} = 8mA			2.2	2.4	–	V
LOW-level output voltage	V_{OL}	Q: Measurement cct 2, V_{DD} = 2.7V, I_{OL} = 8mA			–	0.3	0.4	V
HIGH-level input voltage	V_{IH}	INHN			0.7V_{DD}	–	–	V
LOW-level input voltage	V_{IL}	INHN			–	–	0.3V_{DD}	V
Output leakage current	I_Z	Q: Measurement cct 2, INHN = LOW		V_{OH} = V_{DD}	–	–	10	µA
				V_{OL} = V_{SS}	–	–	10	µA
Current consumption	I_{DD}	Measurement cct 3, load cct 1, INHN = open	CF5020ALA	C_L = 15pF f = 90MHz	–	20	50	mA
				C_L = 30pF f = 90MHz	–	25	60	mA
			CF5020ALB	C_L = 15pF f = 125MHz	–	25	60	mA
				C_L = 30pF f = 125MHz	–	40	100	mA
			CF5020ALC	C_L = 15pF f = 135MHz	–	30	70	mA
				C_L = 30pF f = 125MHz	–	40	100	mA
			CF5020ALD	C_L = 15pF f = 170MHz	–	40	100	mA
Standby current	I_{ST}	Measurement cct 3, INHN = LOW			–	–	5	µA
INHN pull-up resistance	R_{UP1}	Measurement cct 4			2	4	8	MΩ
	R_{UP2}				50	100	150	kΩ
AC feedback resistance	R_{f1}	Design value. A monitor pattern on a wafer is tested.		CF5020ALA	2.12	2.5	2.88	kΩ
				CF5020ALB	3.82	4.5	5.18	kΩ
				CF5020ALC	2.80	3.3	3.80	kΩ
				CF5020ALD	1.87	2.2	2.53	kΩ
DC feedback resistance	R_{f2}	Measurement cct 5			50	100	150	kΩ
Oscillator amplifier output resistance	R_D	Design value. A monitor pattern on a wafer is tested.		CF5020ALA	170	200	230	Ω
				CF5020ALB	48.4	57	65.6	Ω
				CF5020ALC	48.4	57	65.6	Ω
				CF5020ALD	48.4	57	65.6	Ω
AC feedback capacitance	C_f	Design value. A monitor pattern on a wafer is tested.			8.5	10	11.5	pF
Built-in capacitance	C_G	Design value. A monitor pattern on a wafer is tested.		CF5020ALA	3.40	4	4.60	pF
				CF5020ALB	2.55	3	3.45	pF
				CF5020ALC	0.85	1	1.15	pF
				CF5020ALD	0.85	1	1.15	pF
	C_D	Design value. A monitor pattern on a wafer is tested.		CF5020ALA	5.95	7	8.05	pF
				CF5020ALB	2.55	3	3.45	pF
				CF5020ALC	2.55	3	3.45	pF
				CF5020ALD	4.25	5	5.75	pF

Switching Characteristics

CF5020ALA, CF5020ALB

2.5V operation

V_{DD} = 2.25 to 2.75V, V_{SS} = 0V, Ta = –40 to +85°C unless otherwise noted.

Parameter	Symbol	Condition		Rating			Unit
				min	typ	max	
Output rise time	t_{r1}	Measurement cct 3, load cct 1, $0.1V_{DD}$ to $0.9V_{DD}$	C_L = 15pF	–	1	3	ns
	t_{r2}		C_L = 30pF	–	2	5.5	ns
Output fall time	t_{f1}	Measurement cct 3, load cct 1, $0.9V_{DD}$ to $0.1V_{DD}$	C_L = 15pF	–	1	3	ns
	t_{f2}		C_L = 30pF	–	2	5.5	ns
Output duty cycle*1	Duty1	Measurement cct 3, load cct 1, V_{DD} = 2.5V, Ta = 25°C	C_L = 15pF, f = 106MHz	45	–	55	%
			C_L = 15pF, f = 125MHz	40	–	60	%
	Duty2		C_L = 30pF, f = 70MHz	45	–	55	%
Output disable delay time*2	t_{PLZ}	Measurement cct 6, load cct 1, V_{DD} = 2.5V, Ta = 25°C, C_L = 15pF		–	–	100	ns
Output enable delay time*2	t_{PZL}			–	–	100	ns

*1. The duty cycle characteristic is checked the sample chips of each production lot.
*2. Oscillator stop function is built-in. When INHN goes LOW, normal output stops. When INHN goes HIGH, normal output is not resumed until after the oscillator start-up time has elapsed.

3V operation

V_{DD} = 2.7 to 3.6V, V_{SS} = 0V, Ta = –40 to +85°C unless otherwise noted.

Parameter	Symbol	Condition		Rating			Unit
				min	typ	max	
Output rise time	t_{r1}	Measurement cct 3, load cct 1, $0.1V_{DD}$ to $0.9V_{DD}$	C_L = 15pF	–	1	2.5	ns
	t_{r2}		V_{DD} = 3.0 to 3.6V, C_L = 30pF	–	1.5	3	ns
Output fall time	t_{f1}	Measurement cct 3, load cct 1, $0.9V_{DD}$ to $0.1V_{DD}$	C_L = 15pF	–	1	2.5	ns
	t_{f2}		V_{DD} = 3.0 to 3.6V, C_L = 30pF	–	1.5	3	ns
Output duty cycle*1	Duty2	Measurement cct 3, load cct 1, V_{DD} = 3.0V, Ta = 25°C, C_L = 30pF, f = 125MHz		45	–	55	%
Output disable delay time*2	t_{PLZ}	Measurement cct 6, load cct 1, V_{DD} = 3.0V, Ta = 25°C, C_L = 15pF		–	–	100	ns
Output enable delay time*2	t_{PZL}			–	–	100	ns

*1. The duty cycle characteristic is checked the sample chips of each production lot.
*2. Oscillator stop function is built-in. When INHN goes LOW, normal output stops. When INHN goes HIGH, normal output is not resumed until after the oscillator start-up time has elapsed.

CF5020ALC, CF5020ALD

2.5V operation

V_{DD} = 2.25 to 2.75V, V_{SS} = 0V, Ta = –40 to +85°C unless otherwise noted.

Parameter	Symbol	Condition	Rating			Unit
			min	typ	max	
Output rise time	t_{r1}	Measurement cct 3, load cct 1, $0.1V_{DD}$ to $0.9V_{DD}$, C_L = 15pF	–	1	3	ns
Output fall time	t_{f1}	Measurement cct 3, load cct 1, $0.9V_{DD}$ to $0.1V_{DD}$, C_L = 15pF	–	1	3	ns
Output duty cycle*1	Duty1	Measurement cct 3, load cct 1, V_{DD} = 2.5V, Ta = 25°C, C_L = 15pF, f = 155MHz	45	–	55	%
Output disable delay time*2	t_{PLZ}	Measurement cct 6, load cct 1, V_{DD} = 2.5V, Ta = 25°C, C_L = 15pF	–	–	100	ns
Output enable delay time*2	t_{PZL}		–	–	100	ns

*1. The duty cycle characteristic is checked the sample chips of each production lot.
*2. Oscillator stop function is built-in. When INHN goes LOW, normal output stops. When INHN goes HIGH, normal output is not resumed until after the oscillator start-up time has elapsed.

3V operation

V_{DD} = 2.7 to 3.6V, V_{SS} = 0V, Ta = –40 to +85°C unless otherwise noted.

Parameter	Symbol	Condition		Rating			Unit
				min	typ	max	
Output rise time	t_{r1}	Measurement cct 3, load cct 1, $0.1V_{DD}$ to $0.9V_{DD}$	C_L = 15pF	–	1	2.5	ns
	t_{r2}		C_L = 30pF	–	1.5	4	ns
Output fall time	t_{f1}	Measurement cct 3, load cct 1, $0.9V_{DD}$ to $0.1V_{DD}$	C_L = 15pF	–	1	2.5	ns
	t_{f2}		C_L = 30pF	–	1.5	4	ns
Output duty cycle*1	Duty1	Measurement cct 3, load cct 1, V_{DD} = 3.0V, Ta = 25°C	C_L = 15pF, f = 170MHz	45	–	55	%
	Duty2		C_L = 30pF, f = 125MHz	45	–	55	%
Output disable delay time*2	t_{PLZ}	Measurement cct 6, load cct 1, V_{DD} = 3.0V, Ta = 25°C, C_L = 15pF		–	–	100	ns
Output enable delay time*2	t_{PZL}			–	–	100	ns

*1. The duty cycle characteristic is checked the sample chips of each production lot.
*2. Oscillator stop function is built-in. When INHN goes LOW, normal output stops. When INHN goes HIGH, normal output is not resumed until after the oscillator start-up time has elapsed.

FUNCTIONAL DESCRIPTION

Standby Function

When INHN goes LOW, the oscillator stops and the oscillator output on Q becomes high impedance.

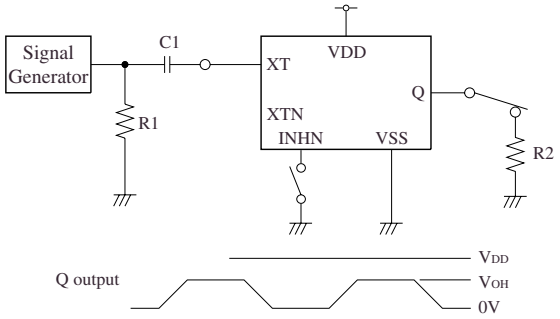
INHN	Q	Oscillator
HIGH (or open)	f_O output frequency	Normal operation
LOW	High impedance	Stopped

Power-saving Pull-up Resistor

The INHN pull-up resistance changes in response to the input level (HIGH or LOW). When INHN goes LOW (standby state), the pull-up resistance becomes large to reduce the current consumption during standby.

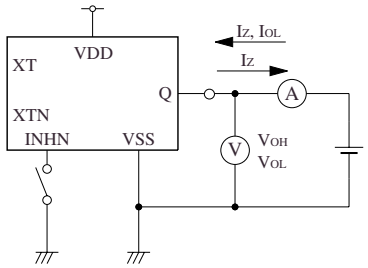
MEASUREMENT CIRCUITS

Measurement cct 1

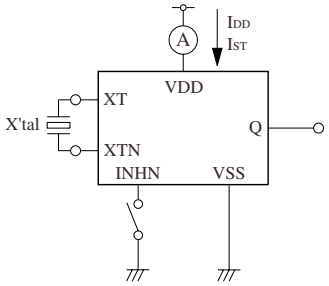


2Vp-p, 10MHz sine wave input signal
C1: 0.001µF
R1: 50Ω
R2: 219Ω (2.5V operation)
275Ω (3.0V operation)

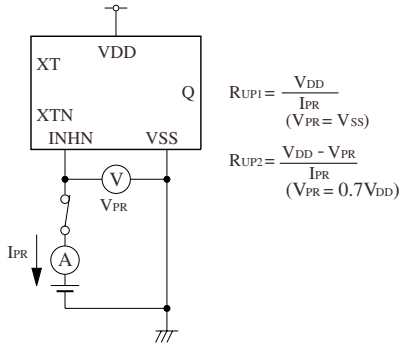
Measurement cct 2



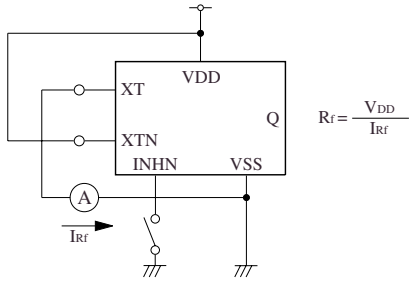
Measurement cct 3



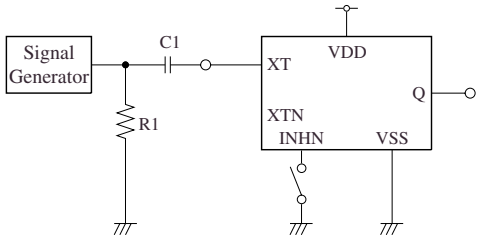
Measurement cct 4



Measurement cct 5

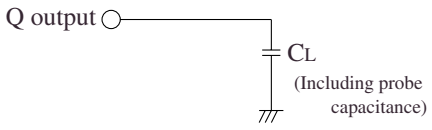


Measurement cct 6



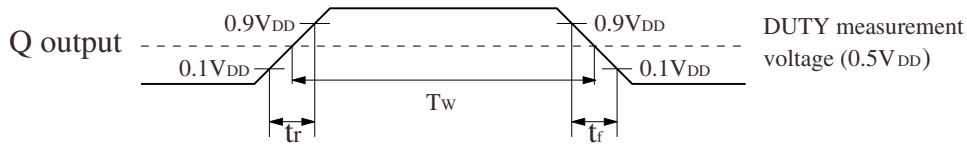
2Vp-p, 10MHz sine wave input signal
C1: 0.001µF
R1: 50Ω

Load cct 1

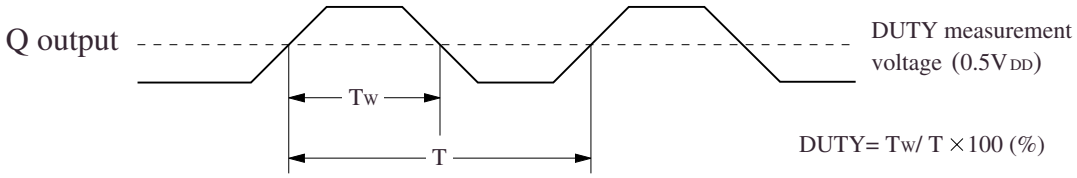


Switching Time Measurement Waveform

Output duty level, t_r, t_f

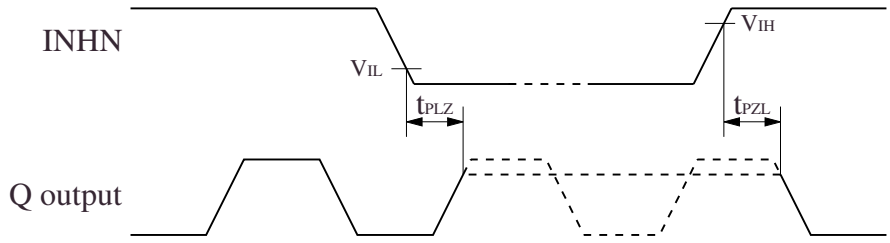


Output duty cycle



Output Enable/Disable Delay

when the device is in standby, the oscillator stops. When standby is released, the oscillator starts and stable oscillator output occurs after a short delay.



INHN input waveform tr = tf ≤ 10ns

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

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