

## OVERVIEW

The SM5005 series are crystal oscillator module ICs, that incorporate high-frequency, low current consumption oscillator and output buffer circuits. Highly accurate thin-film feedback resistors and high-frequency capacitors are built-in, eliminating the need for external components to make a stable 3rd-harmonic oscillator.

## FEATURES

- High-frequency operation
- 3rd-harmonic oscillation
- Capacitors  $C_G$ ,  $C_D$  built-in
- Standby function (oscillator stops)
- Power-save pull-up resistor built-in
- Inverter amplifier feedback resistor built-in
- CMOS input level
- 8 mA ( $V_{DD} = 2.7$  V) drive capability
- CMOS output duty level
- Output three-state function
- 2.25 to 3.6 V supply voltage
- Oscillator frequency output
- 8-pin VSOP (SM5005xxxV)
- Chip form (CF5005xxx)

## SERIES CONFIGURATION

Version <sup>1</sup>	Recommended operating frequency (MHz)		gm ratio	Output duty level	Output current (mA)	Built-in capacitance (pF)		$R_f$ (k $\Omega$ )
	$V_{DD} = 2.25$ to 2.75 V	$V_{DD} = 2.7$ to 3.6 V				$C_G$	$C_D$	
SM5005ALAV	60 to 70	70 to 100	1.0	CMOS	8	8	10	2.2
SM5005ALBV	-	90 to 110	1.5	CMOS	8	6	6	3.3
SM5005ALCV <sup>2</sup>	-	107 to 125	1.5	CMOS	8	3	3	4.6
CF5005ALD <sup>3</sup>	50 to 60	60 to 80	1.0	CMOS	8	8	10	3.5

1. Chip form devices have designation CF5005xxx.
2. Based on Preliminary Constants Data from Crystal MFG.
3. Chip form only.

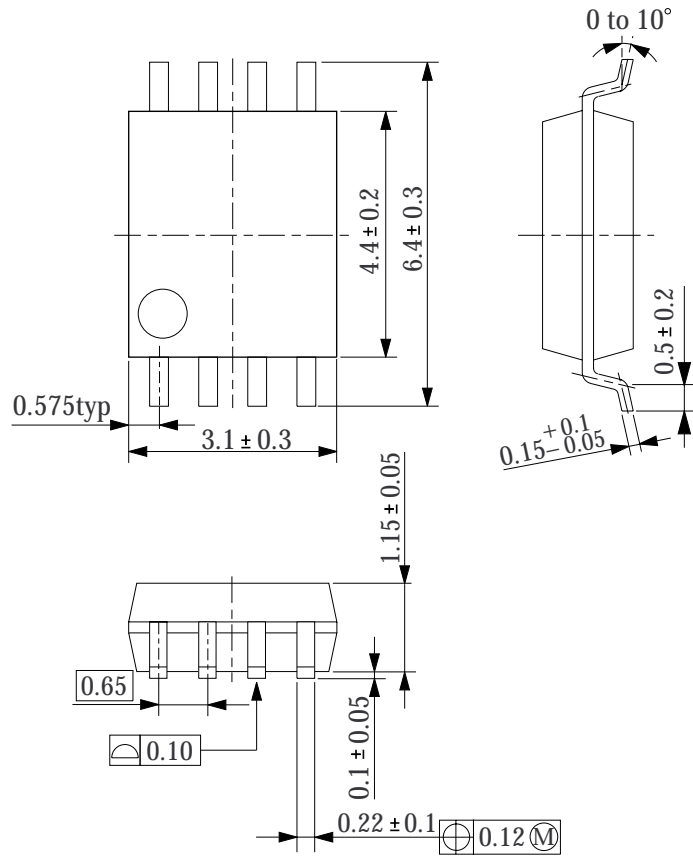
## ORDERING INFORMATION

Device	Package
SM5005xxxV	8-pin VSOP
CF5005xxx-1	Chip form

**PACKAGE DIMENSIONS**

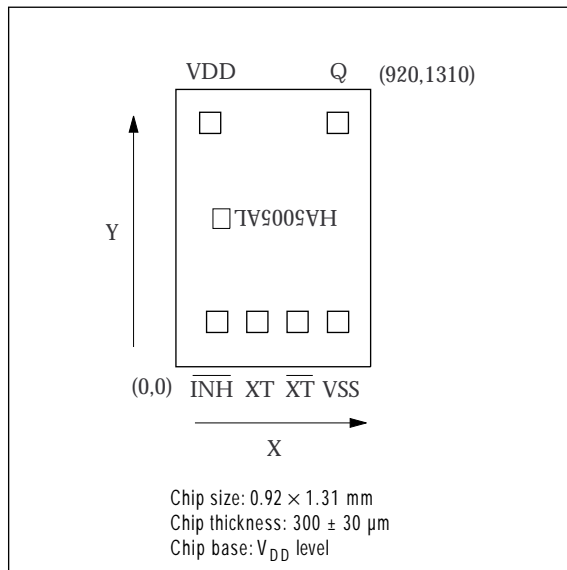
(UNIT : mm)

- 8-pin VSOP



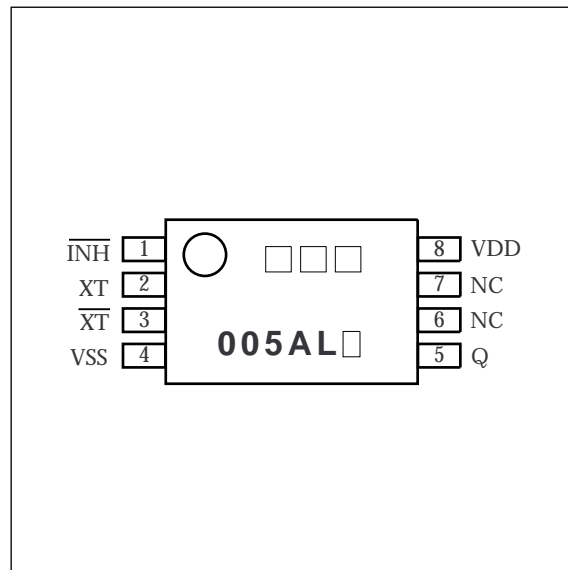
**PAD LAYOUT**

(Unit :  $\mu\text{m}$ )



**PINOUT**

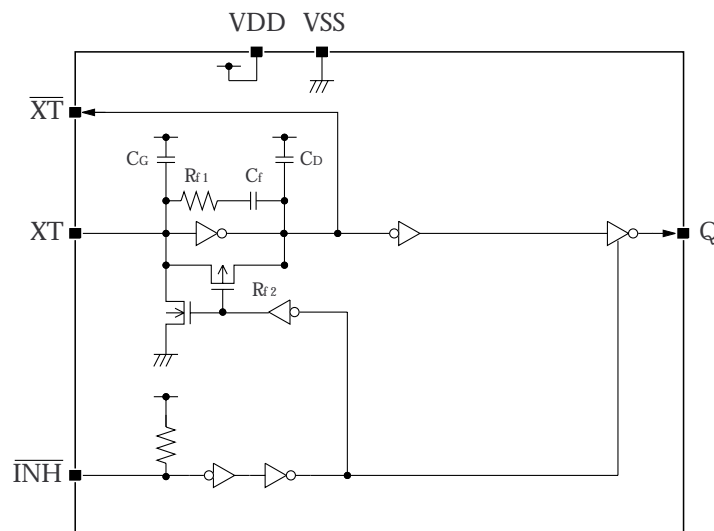
(Top View)



**PIN DESCRIPTION and PAD DIMENSIONS**

Number	Name	I/O	Description	Pad dimensions [ $\mu\text{m}$ ]	
				X	Y
1	$\overline{\text{INH}}$	I	Output state control input. Oscillator stopped when LOW. Power-saving pull-up resistor built in	195	212
2	XT	I	Amplifier input.	385	212
3	$\overline{\text{XT}}$	O	Amplifier output.	575	212
4	VSS	-	Ground	766	212
5	Q	O	Output. Output frequency ( $f_0$ )	765	1152
6	NC	-	No connection	-	-
7	NC	-	No connection	-	-
8	VDD	-	Supply voltage	162	1152

**BLOCK DIAGRAM**



## SPECIFICATIONS

### Absolute Maximum Ratings

$V_{SS} = 0\text{ V}$

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	$T_{stg}$	Chip form	-65 to 150	°C
		8-pin VSOP	-40 to 125	
Output current	$I_{OUT}$		25	mA
Power dissipation	$P_D$	8-pin VSOP	300	mW

### Recommended Operating Conditions

#### CF5005AL×

$V_{SS} = 0\text{ V}$ ,  $f \leq 125\text{MHz}$  unless otherwise noted.

Parameter	Symbol	Condition	Rating			Unit
			min	typ	max	
Supply voltage	$V_{DD}$	$C_L \leq 15\text{pF}$	2.7	-	3.6	V
		$C_L \leq 30\text{pF}$	3.0	-	3.6	
Input voltage	$V_{IN}$		$V_{SS}$	-	$V_{DD}$	V
Operating temperature	$T_{OPR}$		-20	-	80	°C

#### CF5005ALA/CF5005ALD

$V_{SS} = 0\text{ V}$ ,  $f \leq 70\text{MHz}$  unless otherwise noted.

Parameter	Symbol	Condition	Rating			Unit
			min	typ	max	
Supply voltage	$V_{DD}$	$C_L \leq 30\text{pF}$	2.25	-	2.75	V
Input voltage	$V_{IN}$		$V_{SS}$	-	$V_{DD}$	V
Operating temperature	$T_{OPR}$		-20	-	80	°C

#### SM5005AL×V

$V_{SS} = 0\text{ V}$ ,  $f \leq 125\text{MHz}$  unless otherwise noted.

Parameter	Symbol	Condition	Rating			Unit
			min	typ	max	
Supply voltage	$V_{DD}$	$C_L \leq 15\text{pF}$	2.7	-	3.6	V
Input voltage	$V_{IN}$		$V_{SS}$	-	$V_{DD}$	V
Operating temperature	$T_{OPR}$		-20	-	80	°C

SM5005 series

**Electrical Characteristics**

$V_{DD} = 2.7$  to  $3.6$  V,  $V_{SS} = 0$  V,  $T_a = -20$  to  $80$  °C unless otherwise noted.

Parameter	Symbol	Condition		Rating			Unit	
				min	typ	max		
HIGH-level output voltage	$V_{OH}$	Q: Measurement cct 1, $V_{DD} = 2.7$ V, $I_{OH} = 8$ mA		2.2	2.4	–	V	
LOW-level output voltage	$V_{OL}$	Q: Measurement cct 2, $V_{DD} = 2.7$ V, $I_{OL} = 8$ mA		–	0.3	0.4	V	
Output leakage current	$I_Z$	Q: Measurement cct 2, $\overline{INH} = \text{LOW}$ , $V_{DD} = 3.6$ V	$V_{OH} = V_{DD}$	–	–	10	$\mu\text{A}$	
			$V_{OL} = V_{SS}$	–	–	10		
HIGH-level input voltage	$V_{IH}$	$\overline{INH}$		$0.7V_{DD}$	–	–	V	
LOW-level input voltage	$V_{IL}$	$\overline{INH}$		–	–	$0.3V_{DD}$	V	
Current consumption	$I_{DD}$	$\overline{INH} = \text{open}$ , Measurement cct 3, load cct 1, $V_{DD} = 3.0$ V to $3.6$ V $f = 125$ MHz	$C_L = 30$ pF	CF5005AL×	–	40	100	mA
			$C_L = 15$ pF	SM5005AL×V CF5005AL×	–	25	60	
Standby current	$I_{ST}$	$\overline{INH} = \text{LOW}$ , Measurement cct 3		–	–	10	$\mu\text{A}$	
$\overline{INH}$ pull-up resistance	$R_{UP1}$	Measurement cct 4, $\overline{INH} = \text{LOW}$		0.4	–	4	M $\Omega$	
	$R_{UP2}$	Measurement cct 4, $\overline{INH} = 0.7V_{DD}$		50	–	150	k $\Omega$	
AC feedback resistance	$R_{f1}$	Design value, determined by the internal wafer pattern	SM5005ALAV CF5005ALA	1.76	2.2	2.64	k $\Omega$	
			SM5005ALBV CF5005ALB	2.64	3.3	3.96		
			SM5005ALCV CF5005ALC	3.68	4.6	5.52		
			CF5005ALD	2.80	3.5	4.20		
DC feedback resistance	$R_{f2}$	Measurement cct 5		50	–	150	k $\Omega$	
AC feedback capacitance	$C_f$	Design value, determined by the internal wafer pattern		9.3	10	10.7	pF	
Built-in capacitance	$C_G$	Design value, determined by the internal wafer pattern	SM5005ALAV CF5005ALA CF5005ALD	7.44	8	8.56	pF	
			SM5005ALBV CF5005ALB	5.58	6	6.42		
			SM5005ALCV CF5005ALC	2.79	3	3.21		
	$C_D$	Design value, determined by the internal wafer pattern	SM5005ALAV CF5005ALA CF5005ALD	9.3	10	10.7	pF	
			SM5005ALBV CF5005ALB	5.58	6	6.42		
			SM5005ALCV CF5005ALC	2.79	3	3.21		

## Switching Characteristics

### 3V operation

$V_{SS} = 0\text{ V}$ ,  $T_a = -20\text{ to }80\text{ }^\circ\text{C}$  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 $0.9V_{DD}$	$C_L = 15\text{ pF}$ , $V_{DD} = 2.7\text{V to }3.6\text{V}$	SM5005AL×V CF5005AL×	-	1	3	ns
	$t_{r2}$		$C_L = 30\text{ pF}$ , $V_{DD} = 3.0\text{V to }3.6\text{V}$	CF5005AL×	-	1.5	4	
Output fall time	$t_{f1}$	Measurement cct 3, load cct 1, $0.9V_{DD}$ to $0.1V_{DD}$	$C_L = 15\text{ pF}$ , $V_{DD} = 2.7\text{V to }3.6\text{V}$	SM5005AL×V CF5005AL×	-	1	3	ns
	$t_{f2}$		$C_L = 30\text{ pF}$ , $V_{DD} = 3.0\text{V to }3.6\text{V}$	CF5005AL×	-	1.5	4	
Output duty cycle <sup>1</sup>	Duty	Measurement cct 3, load cct 1, $T_a = 25\text{ }^\circ\text{C}$ , $V_{DD} = 3.0\text{ V}$	$C_L = 30\text{ pF}$ , $f \leq 125\text{ MHz}$	CF5005AL×	45	-	55	%
			$C_L = 15\text{ pF}$ , $f \leq 107\text{ MHz}$	SM5005AL×V	45	-	55	
			$C_L = 15\text{ pF}$ , $107\text{ MHz} < f < 125\text{ MHz}$		40	-	60	
Output disable delay time <sup>2</sup>	$t_{PLZ}$	Measurement cct 6, $T_a = 25\text{ }^\circ\text{C}$ , $V_{DD} = 2.7\text{ V}$ , $C_L \leq 15\text{ pF}$			-	-	100	ns
Output enable delay time <sup>2</sup>	$t_{PZL}$	Measurement cct 6, $T_a = 25\text{ }^\circ\text{C}$ , $V_{DD} = 2.7\text{ V}$ , $C_L \leq 15\text{ pF}$			-	-	100	ns

1. Monitored in sample lots.

2. Oscillator stop function is built-in. When  $\overline{\text{INH}}$  goes LOW, normal output stops. When  $\overline{\text{INH}}$  goes HIGH, normal output is not resumed until after the oscillator start-up time has elapsed.

### 2.5V operation

$V_{SS} = 0\text{ V}$ ,  $T_a = -20\text{ to }80\text{ }^\circ\text{C}$  unless otherwise noted.

Parameter	Symbol	Condition	Rating			Unit		
			min	typ	max			
Output rise time	$t_{r3}$	Measurement cct 3, load cct 1, $0.1V_{DD}$ to $0.9V_{DD}$	$C_L = 30\text{ pF}$ , $V_{DD} = 2.25\text{V to }2.75\text{V}$	CF5005ALA CF5005ALD	-	2	6	ns
Output fall time	$t_{f3}$	Measurement cct 3, load cct 1, $0.9V_{DD}$ to $0.1V_{DD}$	$C_L = 30\text{ pF}$ , $V_{DD} = 2.25\text{V to }2.75\text{V}$	CF5005ALA CF5005ALD	-	2	6	ns
Output duty cycle <sup>1</sup>	Duty	Measurement cct 3, load cct 1, $T_a = 25\text{ }^\circ\text{C}$ , $V_{DD} = 2.5\text{ V}$	$C_L = 30\text{ pF}$ , $f \leq 70\text{ MHz}$	CF5005ALA CF5005ALD	40	-	60	%
Output disable delay time <sup>2</sup>	$t_{PLZ}$	Measurement cct 6, $T_a = 25\text{ }^\circ\text{C}$ , $V_{DD} = 2.25\text{ V}$ , $C_L \leq 15\text{ pF}$			-	-	300	ns
Output enable delay time <sup>2</sup>	$t_{PZL}$	Measurement cct 6, $T_a = 25\text{ }^\circ\text{C}$ , $V_{DD} = 2.25\text{ V}$ , $C_L \leq 15\text{ pF}$			-	-	300	ns

1. Monitored in sample lots.

2. Oscillator stop function is built-in. When  $\overline{\text{INH}}$  goes LOW, normal output stops. When  $\overline{\text{INH}}$  goes HIGH, normal output is not resumed until after the oscillator start-up time has elapsed.

## FUNCTIONAL DESCRIPTION

### Standby Function

The oscillator stops when  $\overline{\text{INH}}$  goes LOW. When the oscillator stops, the oscillator output on Q goes high impedance.

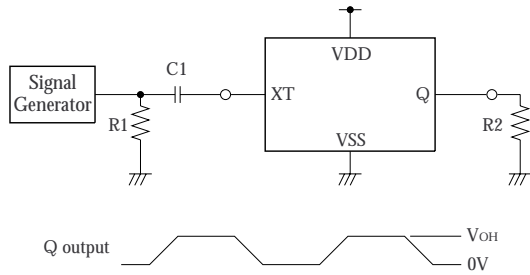
$\overline{\text{INH}}$	Q	Oscillator
HIGH (or open)	$f_0$ output frequency	Normal operation
LOW	High impedance	Stopped

### Power-save Pull-up Resistance

The  $\overline{\text{INH}}$  pull-up resistance changes in response to the input level (HIGH or LOW). When  $\overline{\text{INH}}$  goes LOW (standby state), the pull-up resistance becomes large to reduce the current consumption during standby.

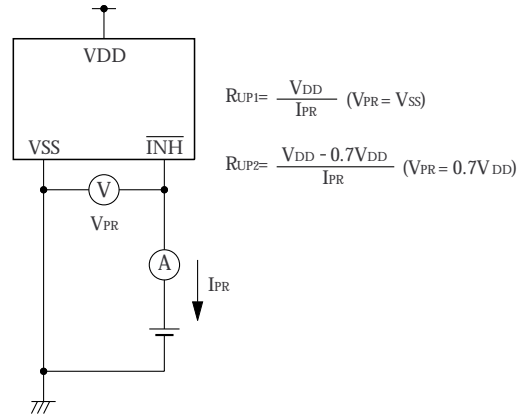
## MEASUREMENT CIRCUITS

Measurement cct 1



2.5V<sub>p-p</sub>, 10MHz sine wave input signal  
 C1 : 0.001μF  
 R1 : 50Ω  
 R2 : 275Ω

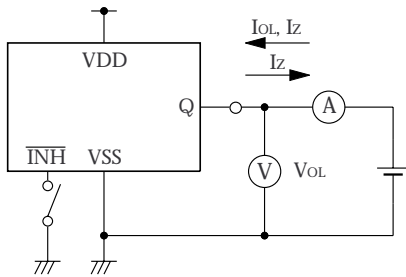
Measurement cct 4



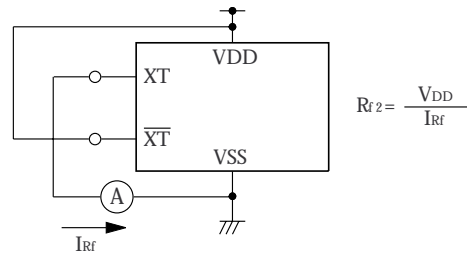
$$R_{UP1} = \frac{V_{DD}}{I_{PR}} \quad (V_{PR} = V_{SS})$$

$$R_{UP2} = \frac{V_{DD} - 0.7V_{DD}}{I_{PR}} \quad (V_{PR} = 0.7V_{DD})$$

Measurement cct 2

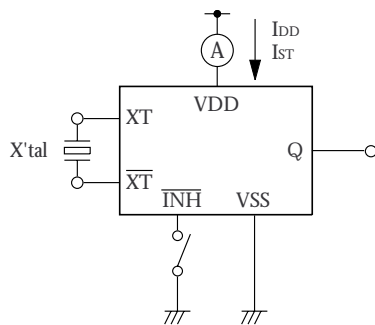


Measurement cct 5

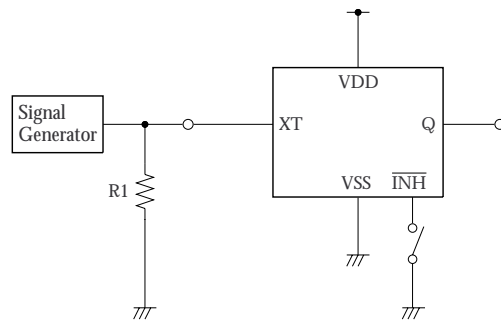


$$R_f 2 = \frac{V_{DD}}{I_{Rf}}$$

Measurement cct 3



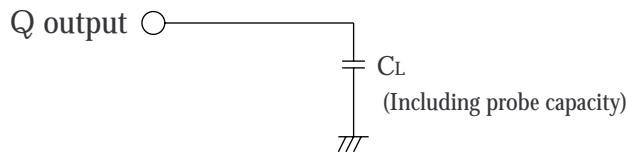
Measurement cct 6



R1 : 50Ω



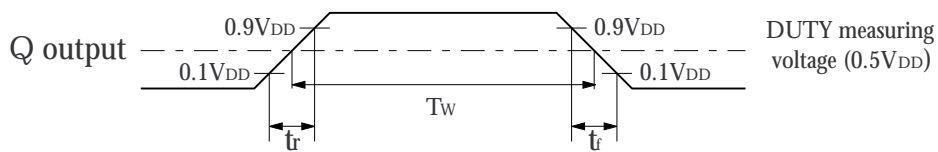
**Load cct 1**



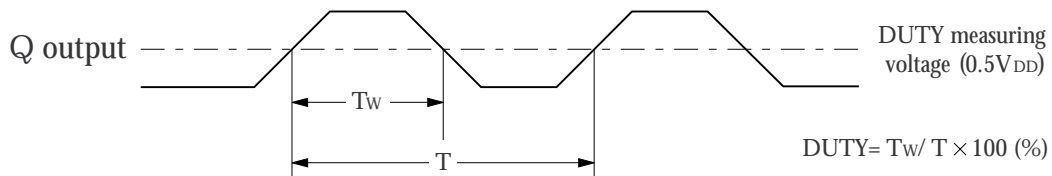
$C_L = 15\text{pF}: t_{r1}, t_{f1}, I_{DD}$  (SM5005AL×V, CF5005AL×)  
 $C_L = 30\text{pF}: t_{r2}, t_{f2}, t_{r3}, t_{f3}, I_{DD}$  (CF5005AL×)

**Switching Time Measurement Waveform**

**Output duty level (CMOS)**

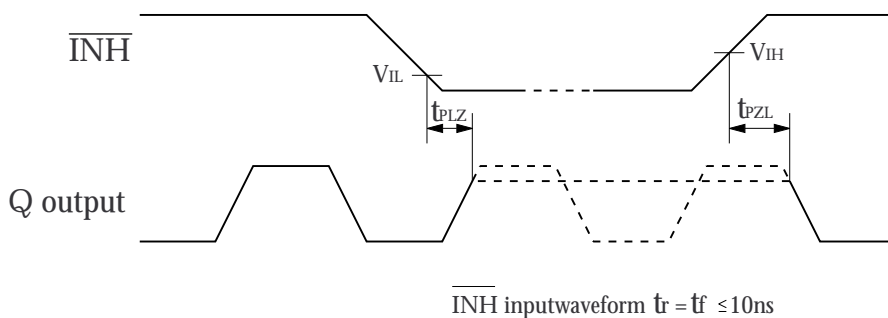


**Output duty cycle (CMOS)**



**Output Enable/Disable Delay**

The following figure shows the oscillator timing during normal operation. Note that 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.



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NIPPON PRECISION CIRCUITS INC.

4-3, Fukuzumi 2-chome  
Koto-ku, Tokyo 135-8430, Japan  
Telephone: 03-3642-6661  
Facsimile: 03-3642-6698

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