

## OVERVIEW

The SM5007 series are crystal oscillator module ICs, that feature low current consumption. Highly accurate thin-film feedback resistors and high-frequency capacitors are built-in, eliminating the need for external components to make a stable fundamental-harmonic oscillator.

## FEATURES

- Capacitors  $C_G$ ,  $C_D$  built-in
- Standby function (oscillator stops)
- 6  $\mu$ A (typ.) low standby current (5 V operation)
- Power-save pull-up resistor built-in
- Inverter amplifier feedback resistor built-in
- 3.2 mA ( $V_{DD} = 4.5$  V), 1.6 mA ( $V_{DD} = 2.7$  V) drive capability
- 2.7 to 5.5 V supply voltage
- Low current consumption
- Oscillator frequency output ( $f_O$  or  $f_O/2$ , determined by internal connection)
- 8-pin VSOP (SM5007AL $\times$ V)
- Chip form (CF5007A $\times$  $\times$ )

## SERIES CONFIGURATION

Version	Recommended Operating frequency [MHz]		Output frequency	gm ratio	Built-in capacitance [pF]		Input level	Output duty level	Standby output state
	3V	5V			$C_G$	$C_D$			
CF5007AA1	30	30	$f_0$	2	10	10	TTL	CMOS	LOW
CF5007AA2	30	30	$f_0/2$	2	10	10	TTL	CMOS	LOW
SM5007AL1V CF5007AL1	20	30	$f_0$	1	10	10	CMOS	CMOS	High impedance
SM5007AL2V CF5007AL2	20	30	$f_0/2$	1	10	10	CMOS	CMOS	High impedance

Note: Recommended operating frequency is not the guaranteed value but is measured using NPC's standard crystal.  
Since the product feature is targeted at low current consumption, please evaluate oscillation margins seriously before actual use.

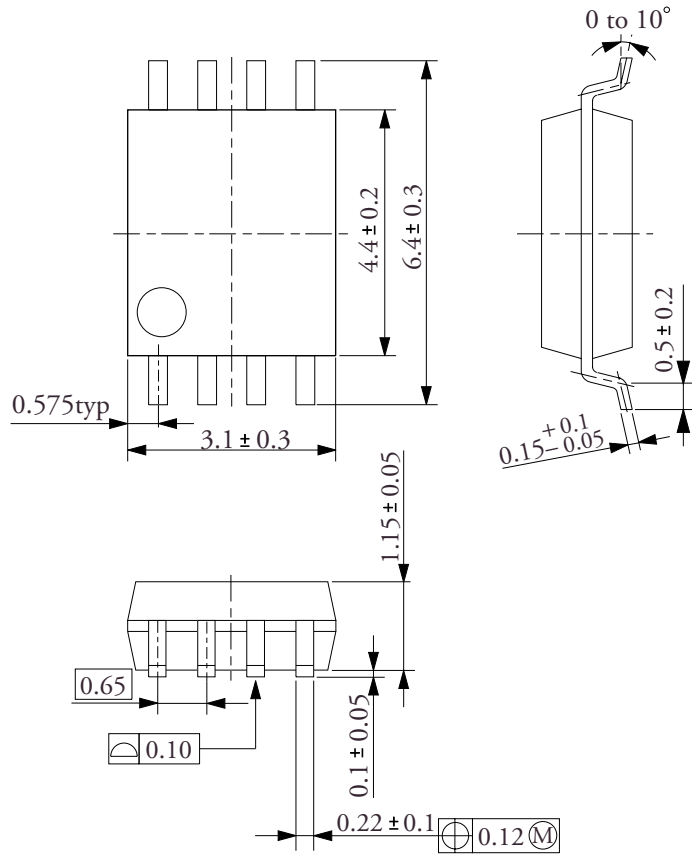
## ORDERING INFORMATION

Device	Package
SM5007AL $\times$ V	8-pin VSOP
CF5007A $\times$ $\times$ -1	Chip form

**PACKAGE DIMENSIONS**

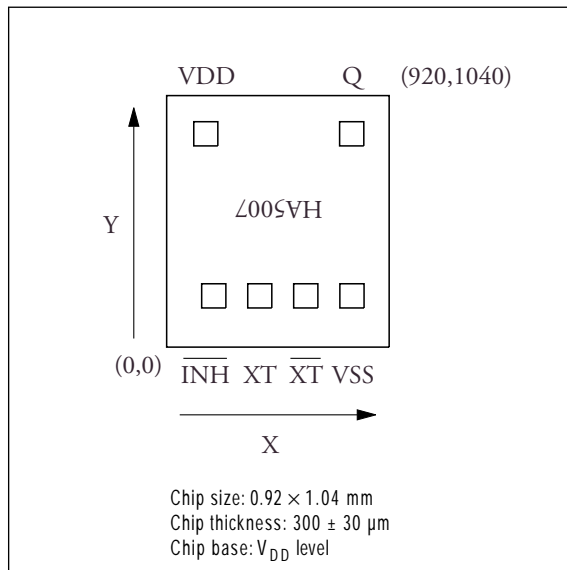
(Unit : mm)

- 8-pin VSOP



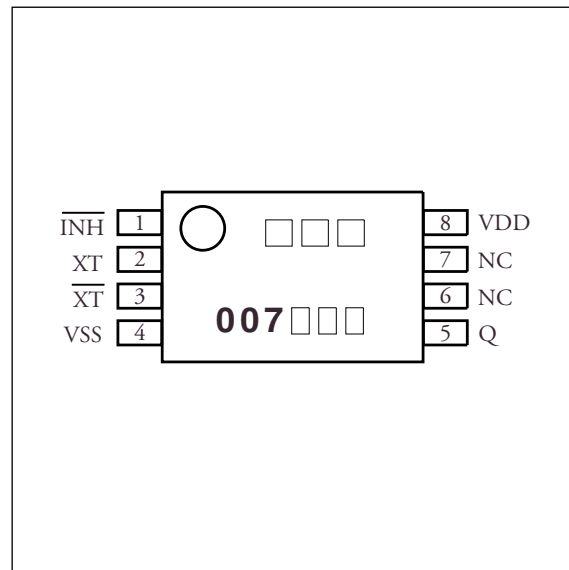
**PAD LAYOUT**

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



**PINOUT**

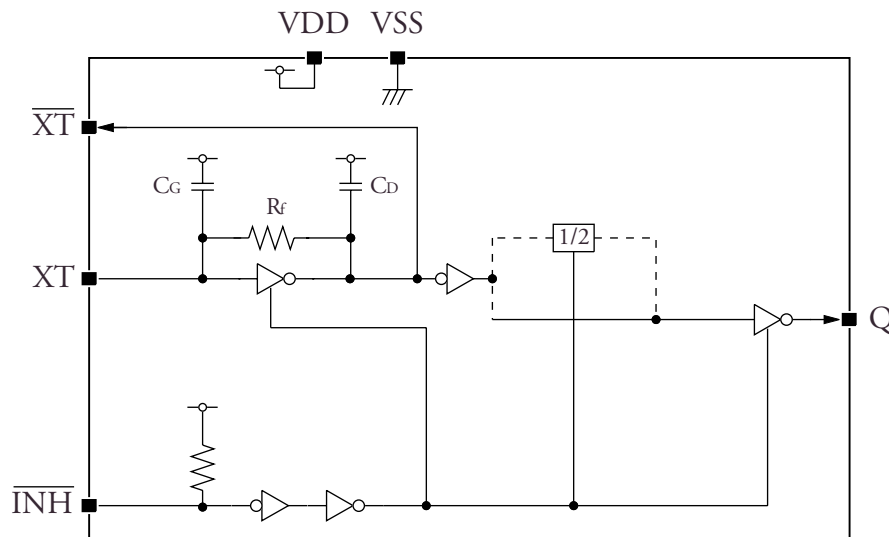
(Top view)



**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 ( $f_0$ or $f_0/2$ ) determined by internal connection	765	882
6	NC	-	No connection	-	-
7	NC	-	No connection	-	-
8	VDD	-	Supply voltage	162	882

**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	-55 to 125	
Output current	$I_{OUT}$		15	mA
Power dissipation	$P_D$	8-pin VSOP	300	mW
Soldering temperature	$T_{sld}$	8-pin VSOP	255	°C
Soldering time	$t_{sld}$	8-pin VSOP	10	s

### Recommended Operating Conditions

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

Parameter	Symbol	Condition	Rating			Unit
			min	typ	max	
Supply voltage	$V_{DD}$		2.7	-	5.5	V
Input voltage	$V_{IN}$		$V_{SS}$	-	$V_{DD}$	V
Operating temperature	$T_{OPR}$		-20	-	80	°C

Note: Since the recommended operating conditions will change in accordance with operating frequency, load capacitance, power dissipation, or crystal characteristics, please evaluate oscillation margins seriously before actual use.

## Electrical Characteristics

3 V operation:  $V_{DD} = 2.7$  to  $3.3$  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, $I_{OH} = 1.6$ mA	2.2	-	-	V	
LOW-level output voltage	$V_{OL}$	Q: Measurement cct 1, $I_{OL} = 1.6$ mA	-	-	0.4	V	
Output leakage current (AL series only)	$I_Z$	Q: Measurement cct 2, $\overline{INH} = LOW$ , $V_{OH} = V_{DD}$	-	-	10	$\mu A$	
		Q: Measurement cct 2, $\overline{INH} = LOW$ , $V_{OL} = V_{SS}$	-	-	10		
HIGH-level input voltage	$V_{IH}$	$\overline{INH}$	SM5007AL×V CF5007AL×	$0.7V_{DD}$	-	-	V
		CF5007AA×	2.0	-	-		
LOW-level input voltage	$V_{IL}$	$\overline{INH}$	SM5007AL×V CF5007AL×	-	-	$0.3V_{DD}$	V
		CF5007AA×	-	-	0.3		
Current consumption	$I_{DD1}$	$\overline{INH} = open$ , Measurement cct 3, No load, $f = 30$ MHz crystal oscillator	CF5007AA1		1.8	4.8	mA
			SM5007AL1V CF5007AL1		1.2	3.2	
			CF5007AA2		1.4	3.6	
			SM5007AL2V CF5007AL2		0.8	2.0	
	$I_{DD2}$	$\overline{INH} = open$ , Measurement cct 3, $C_L = 15$ pF, $f = 30$ MHz crystal oscillator	CF5007AA1		3.4	6.8	
			SM5007AL1V CF5007AL1		2.8	5.2	
			CF5007AA2		2.2	4.6	
			SM5007AL2V CF5007AL2		1.6	3.0	
Standby current	$I_{ST}$	$\overline{INH} = V_{SS}$ , Measurement cct 3	-	2	5	$\mu A$	
$\overline{INH}$ pull-up resistance	$R_{UP1}$	Measurement cct 4, $V_{DD} = 3$ V, $\overline{INH} = V_{SS}$	0.6	-	12	M $\Omega$	
	$R_{UP2}$	Measurement cct 4, $V_{DD} = 3$ V, $\overline{INH} = 2.1$ V	40	-	200	k $\Omega$	
Negative resistance	$-R_L$	$V_{DD} = 3$ V, $T_a = 25$ °C, 30 MHz	CF5007AA×		-140	$\Omega$	
			SM5007AL×V CF5007AL×		-70		
Feedback resistance	$R_f$	Measurement cct 5	50	-	300	k $\Omega$	
Built-in capacitance	$C_G$	Design value	9.3	10	10.7	pF	
	$C_D$		9.3	10	10.7	pF	

SM5007 series

5 V operation:  $V_{DD} = 4.5$  to  $5.5$  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, $I_{OH} = 3.2$ mA	4.0	–	–	V	
LOW-level output voltage	$V_{OL}$	Q: Measurement cct 1, $I_{OL} = 3.2$ mA	–	–	0.4	V	
Output leakage current (AL series only)	$I_z$	Q: Measurement cct 2, $\overline{INH} = \text{LOW}$ , $V_{OH} = V_{DD}$	–	–	10	$\mu\text{A}$	
		Q: Measurement cct 2, $\overline{INH} = \text{LOW}$ , $V_{OL} = V_{SS}$	–	–	10		
HIGH-level input voltage	$V_{IH}$	$\overline{INH}$	SM5007AL×V CF5007AL×	$0.7V_{DD}$	–	–	V
			CF5007AA×	2.0	–	–	
LOW-level input voltage	$V_{IL}$	$\overline{INH}$	SM5007AL×V CF5007AL×	–	–	$0.3V_{DD}$	V
			CF5007AA×	–	–	0.8	
Current consumption	$I_{DD1}$	$\overline{INH} = \text{open}$ , Measurement cct 3, No load, $f = 30$ MHz crystal oscillator	CF5007AA1		3.0	6.8	mA
			SM5007AL1V CF5007AL1		2.2	4.8	
			CF5007AA2		2.2	5.0	
			SM5007AL2V CF5007AL2		1.4	3.0	
	$I_{DD2}$	$\overline{INH} = \text{open}$ , Measurement cct 3, $C_L = 15$ pF, $f = 30$ MHz crystal oscillator	CF5007AA1		5.6	9.8	
			SM5007AL1V CF5007AL1		4.8	7.8	
			CF5007AA2		3.6	6.6	
			SM5007AL2V CF5007AL2		2.8	4.6	
Standby current	$I_{ST}$	$\overline{INH} = V_{SS}$ , Measurement cct 3	–	6	15	$\mu\text{A}$	
$\overline{INH}$ pull-up resistance	$R_{UP1}$	Measurement cct 4, $V_{DD} = 5$ V, $\overline{INH} = V_{SS}$	0.3	–	6	$\text{M}\Omega$	
	$R_{UP2}$	Measurement cct 4, $V_{DD} = 5$ V, $\overline{INH} = 3.5$ V	40	–	200	$\text{k}\Omega$	
Negative resistance	$-R_L$	$V_{DD} = 5$ V, $T_a = 25$ °C, 30 MHz	CF5007AA×		–360	$\Omega$	
			SM5007AL×V CF5007AL×		–190		
Feedback resistance	$R_f$	Measurement cct 5	50	–	300	$\text{k}\Omega$	
Built-in capacitance	$C_G$	Design value	9.3	10	10.7	pF	
	$C_D$		9.3	10	10.7	pF	

### Switching Characteristics

3 V operation:  $V_{DD} = 2.7$  to  $3.3$  V,  $V_{SS} = 0$  V,  $T_a = -20$  to  $80$  °C unless otherwise noted.

Parameter	Symbol	Condition	Rating			Unit	
			min	typ	max		
Output rise time	$t_r$	Measurement cct 2, load cct 1, $0.1V_{DD}$ to $0.9V_{DD}$ , $C_L = 15$ pF	-	5	15	ns	
Output fall time	$t_f$	Measurement cct 2, load cct 1, $0.9V_{DD}$ to $0.1V_{DD}$ , $C_L = 15$ pF	-	5	15	ns	
Output duty cycle <sup>1</sup>	Duty	Measurement cct 2, load cct 1, $T_a = 25$ °C, $V_{DD} = 3$ V, $C_L = 15$ pF	$f_0 = 16$ MHz	45	-	55	%
			$f_0 = 30$ MHz	40	-	60	
Output disable delay time	$t_{pLZ}$	Measurement cct 6, load cct 1, $T_a = 25$ °C, $V_{DD} = 3$ V, $C_L \leq 15$ pF	-	-	100	ns	
Output enable delay time <sup>2</sup>	$t_{pZL}$		-	-	100	ns	
Maximum operating frequency	$f_{max}$	Measurement cct 2, load cct 1, $C_L \leq 15$ pF	30	-	-	MHz	
Minimum operating frequency	$f_{min}$	Measurement cct 2, load cct 1, $C_L \leq 15$ pF	-	-	4	MHz	

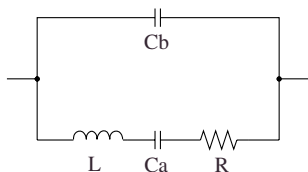
1. Determined by the lot monitor.
2. Oscillator stop function is built-in. When  $\overline{INH}$  goes LOW, normal output stops. When  $\overline{INH}$  goes HIGH, normal output is not resumed until after the oscillator start-up time has elapsed.

5 V operation:  $V_{DD} = 4.5$  to  $5.5$  V,  $V_{SS} = 0$  V,  $T_a = -20$  to  $80$  °C unless otherwise noted.

Parameter	Symbol	Condition	Rating			Unit
			min	typ	max	
Output rise time	$t_r$	Measurement cct 2, load cct 1, $0.1V_{DD}$ to $0.9V_{DD}$ , $C_L = 15$ pF	-	3	9	ns
Output fall time	$t_f$	Measurement cct 2, load cct 1, $0.9V_{DD}$ to $0.1V_{DD}$ , $C_L = 15$ pF	-	3	9	ns
Output duty cycle <sup>1</sup>	Duty	Measurement cct 2, load cct 1, $T_a = 25$ °C, $V_{DD} = 5$ V, $C_L = 15$ pF	45	-	55	%
Output disable delay time	$t_{pLZ}$	Measurement cct 6, load cct 1, $T_a = 25$ °C, $V_{DD} = 5$ V, $C_L \leq 15$ pF	-	-	100	ns
Output enable delay time <sup>2</sup>	$t_{pZL}$		-	-	100	ns
Maximum operating frequency	$f_{max}$	Measurement cct 2, load cct 1, $C_L \leq 15$ pF	30	-	-	MHz
Minimum operating frequency	$f_{min}$	Measurement cct 2, load cct 1, $C_L \leq 15$ pF	-	-	4	MHz

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

### Current consumption and Output waveform with NPC's standard crystal



f (MHz)	R (Ω)	L (mH)	Ca (fF)	Cb (pF)
30	17.2	4.36	6.46	2.26

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## FUNCTIONAL DESCRIPTION

### Standby Function

The oscillator stops when  $\overline{\text{INH}}$  goes LOW. When the oscillator stops, the oscillator output on Q changes as shown in the following table.

$\overline{\text{INH}}$	Q	Oscillator
HIGH (or open)	$f_0$ or $f_0/2$ output frequency	Normal operation
LOW	AA series : LOW AL series : High impedance	Stopped

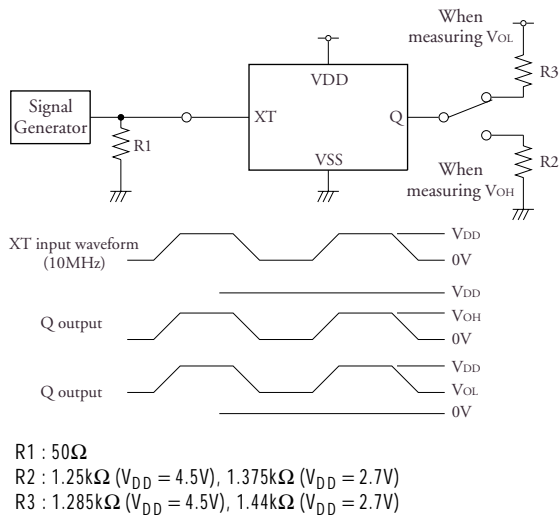
### Power-save Pull-up Resistance

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.

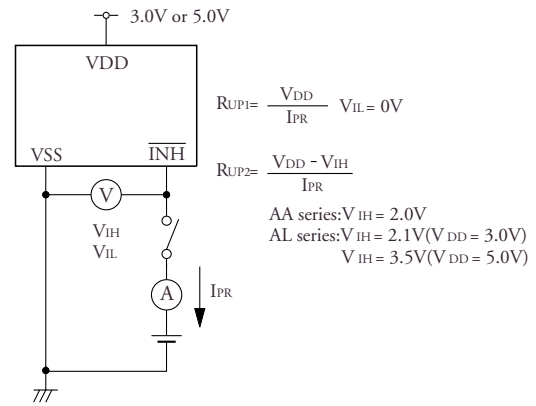


## MEASUREMENT CIRCUITS

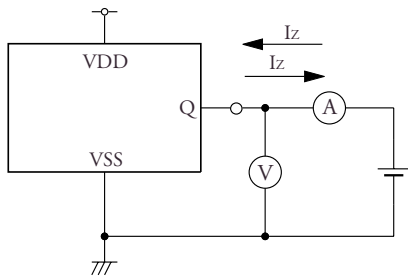
### Measurement cct 1



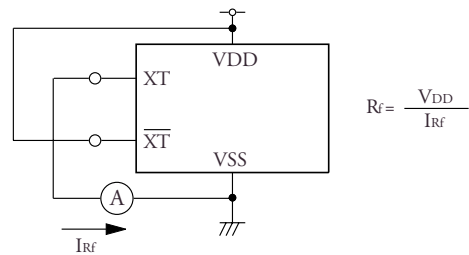
### Measurement cct 4



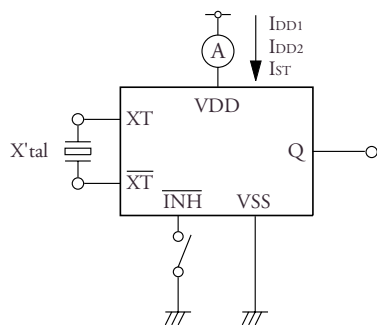
### Measurement cct 2



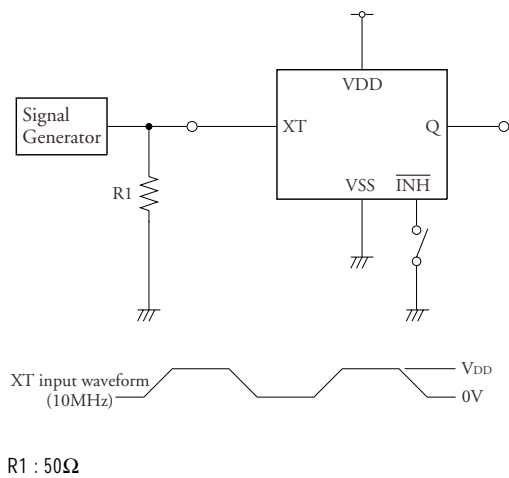
### Measurement cct 5



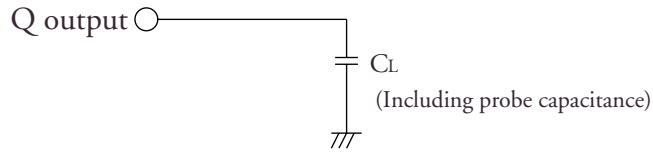
### Measurement cct 3



### Measurement cct 6



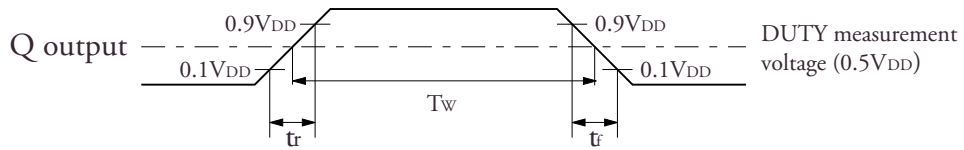
**Load cct 1**



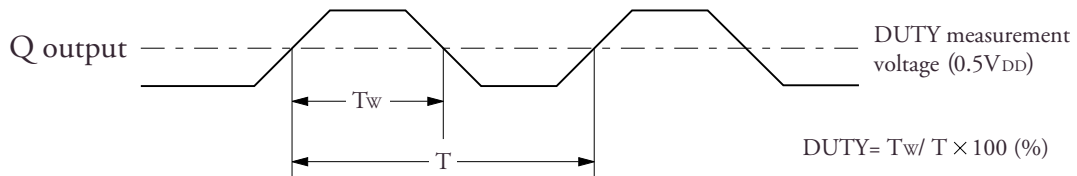
$C_L = 15\text{pF} : I_{DD}, \text{DUTY}, t_r, t_f$

**Switching Time Measurement Waveform**

**Output duty level (CMOS)**

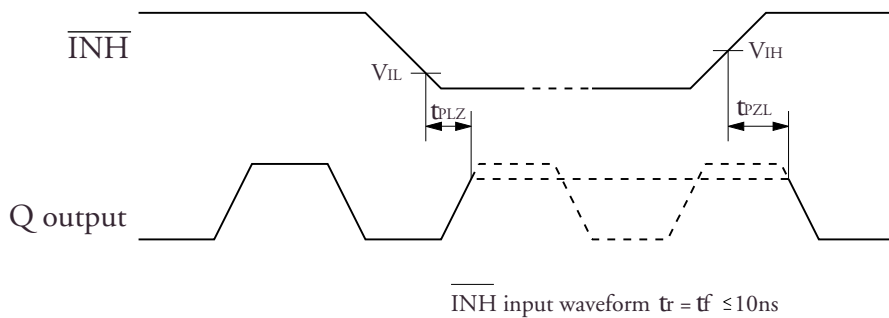


**Output duty cycle (CMOS)**



**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.



INH input waveform  $t_r = t_f \leq 10\text{ns}$

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