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 µA (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×V)
- Chip form (CF5007A××)

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_O	2	10	10	TTL	CMOS	LOW
CF5007AA2	30	30	$f_O/2$	2	10	10	TTL	CMOS	LOW
SM5007AL1V CF5007AL1	20	30	f_O	1	10	10	CMOS	CMOS	High impedance
SM5007AL2V CF5007AL2	20	30	$f_O/2$	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.

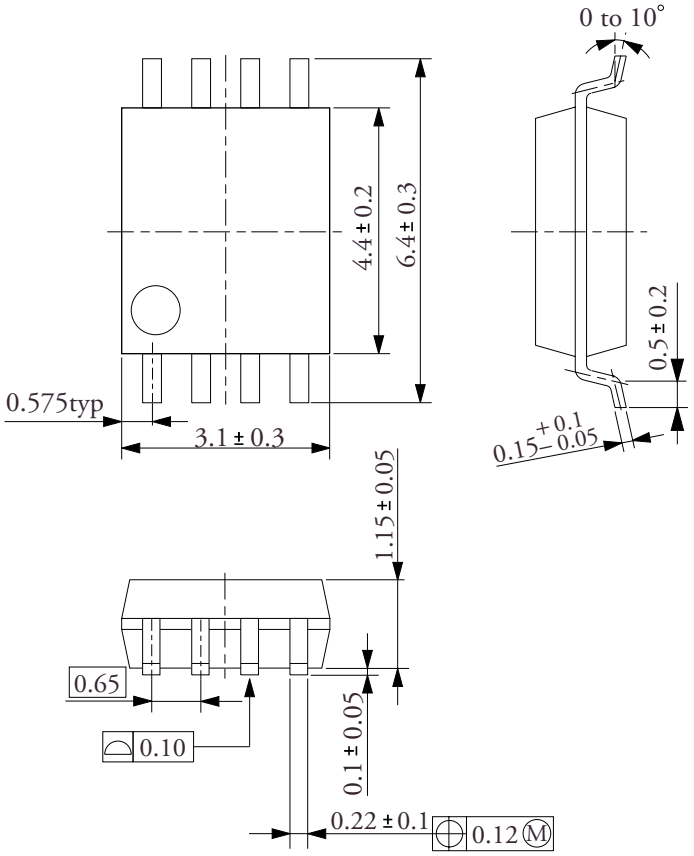
ORDERING INFORMATION

Device	Package
SM5007AL×V	8-pin VSOP
CF5007A××–1	Chip form

PACKAGE DIMENSIONS

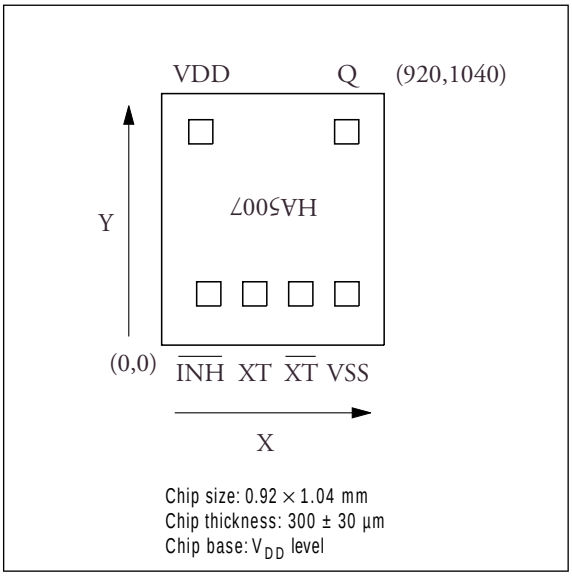
(Unit : mm)

- 8-pin VSOP



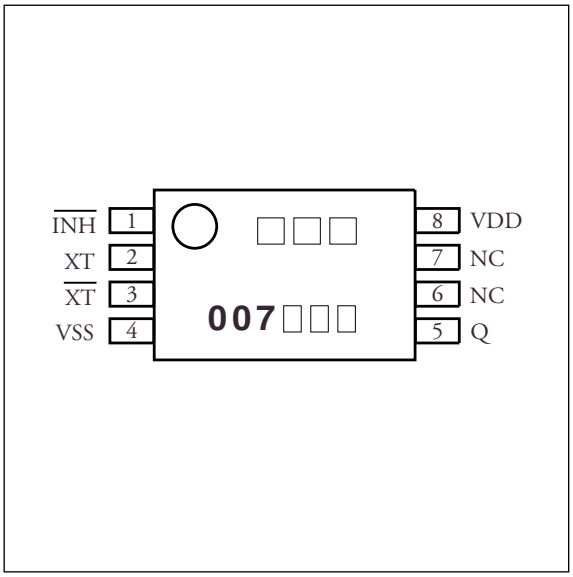
PAD LAYOUT

(Unit : µm)



PINOUT

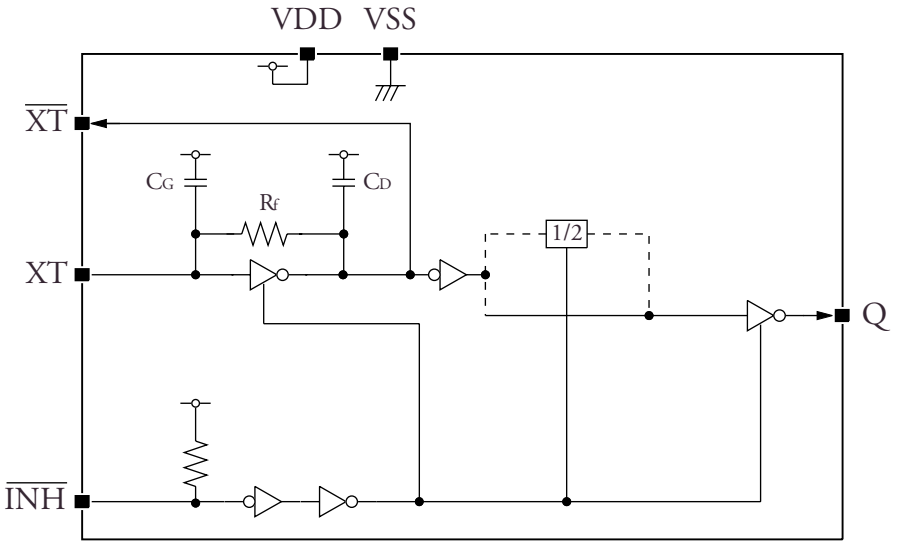
(Top view)



PIN DESCRIPTION and PAD DIMENSIONS

Number	Name	I/O	Description		Pad dimensions [µm]	
					X	Y
1	$\overline{INH}$	I	Output state control input. Oscillator stopped when LOW. Power-saving pull-up resistor built in		195	212
2	XT	I	Amplifier input.	Crystal oscillator connection pins. Crystal oscillator connected between XT and $\overline{XT}$	385	212
3	$\overline{XT}$	O	Amplifier output.		575	212
4	VSS	–	Ground		766	212
5	Q	O	Output. Output frequency (f_O or $f_O/2$) 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 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 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, Ta = –20 to 80 °C unless otherwise noted.

Parameter	Symbol	Condition		Rating min	Rating typ	Rating max	Unit
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	µA
		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	µA
$\overline{INH}$ pull-up resistance	R_{UP1}	Measurement cct 4, V_{DD} = 3 V, $\overline{INH}$ = V_{SS}		0.6	–	12	MΩ
	R_{UP2}	Measurement cct 4, V_{DD} = 3 V, $\overline{INH}$ = 2.1 V		40	–	200	kΩ
Negative resistance	$-R_L$	V_{DD} = 3 V, Ta = 25 °C, 30 MHz	CF5007AA×		–140		Ω
			SM5007AL×V CF5007AL×		–70		
Feedback resistance	R_f	Measurement cct 5		50	–	300	kΩ
Built-in capacitance	C_G	Design value		9.3	10	10.7	pF
	C_D			9.3	10	10.7	pF

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

Parameter	Symbol	Condition		Rating min	Rating typ	Rating max	Unit
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, $\overline{INH}$ = LOW, V_{OH} = V_{DD}		–	–	10	µA
		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×	–	–	0.8	
Current consumption	I_{DD1}	$\overline{INH}$ = 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}	$\overline{INH}$ = 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	µA
$\overline{INH}$ pull-up resistance	R_{UP1}	Measurement cct 4, V_{DD} = 5 V, $\overline{INH}$ = V_{SS}		0.3	–	6	MΩ
	R_{UP2}	Measurement cct 4, V_{DD} = 5 V, $\overline{INH}$ = 3.5 V		40	–	200	kΩ
Negative resistance	$-R_L$	V_{DD} = 5 V, Ta = 25 °C, 30 MHz	CF5007AA×		–360		Ω
			SM5007AL×V CF5007AL×		–190		
Feedback resistance	R_f	Measurement cct 5		50	–	300	kΩ
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, Ta = –20 to 80 °C unless otherwise noted.

Parameter	Symbol	Condition		Rating min	Rating typ	Rating max	Unit
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[1]	Duty	Measurement cct 2, load cct 1, Ta = 25 °C, V_{DD} = 3 V, C_L = 15 pF	f_O = 16MHz	45	–	55	%
			f_O = 30MHz	40	–	60	
Output disable delay time	t_{PLZ}	Measurement cct 6, load cct 1, Ta = 25 °C, V_{DD} = 3 V, $C_L \leq 15$ pF		–	–	100	ns
Output enable delay time[2]	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

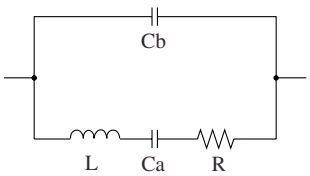
1. Determined by the lot monitor.
2. Oscillator stop function is built-in. When $\overline{INH}$ goes LOW, normal output stops. When $\overline{INH}$ goes HIGH, normal output is not resumed until after the oscillator start-up time has elapsed.

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

Parameter	Symbol	Condition	Rating min	Rating typ	Rating max	Unit
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[1]	Duty	Measurement cct 2, load cct 1, Ta = 25 °C, V_{DD} = 5 V, C_L = 15 pF	45	–	55	%
Output disable delay time	t_{PLZ}	Measurement cct 6, load cct 1, Ta = 25 °C, V_{DD} = 5 V, $C_L \leq 15$ pF	–	–	100	ns
Output enable delay time[2]	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

FUNCTIONAL DESCRIPTION

Standby Function

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

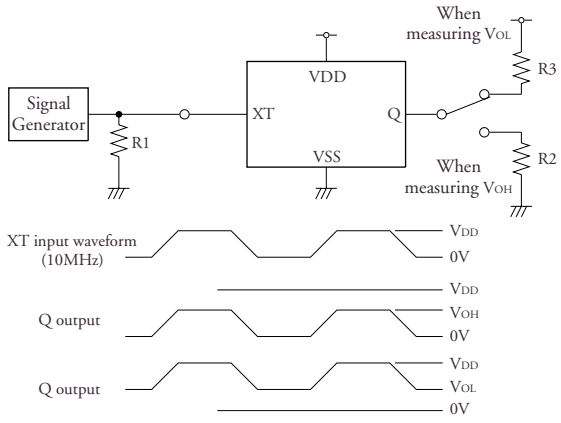
$\overline{INH}$	Q	Oscillator
HIGH (or open)	f_O or $f_O/2$ output frequency	Normal operation
LOW	AA series : LOW AL series : High impedance	Stopped

Power-save Pull-up Resistance

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

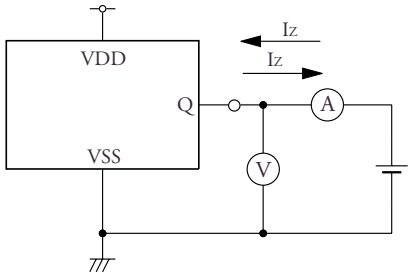
MEASUREMENT CIRCUITS

Measurement cct 1

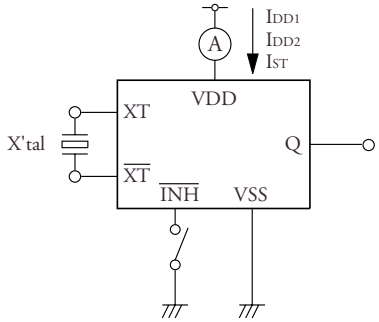


R1 : 50Ω
R2 : 1.25kΩ (V_{DD} = 4.5V), 1.375kΩ (V_{DD} = 2.7V)
R3 : 1.285kΩ (V_{DD} = 4.5V), 1.44kΩ (V_{DD} = 2.7V)

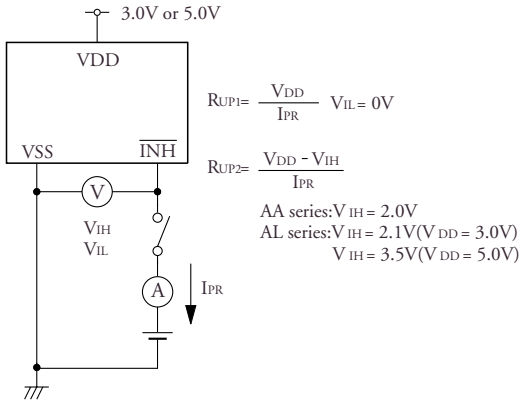
Measurement cct 2



Measurement cct 3



Measurement cct 4

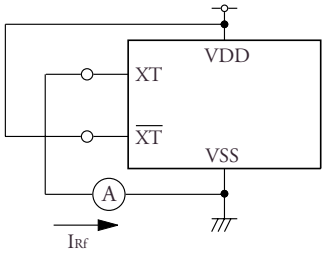


$R_{UP1} = \frac{V_{DD}}{I_{PR}}$ V_{IL} = 0V

$R_{UP2} = \frac{V_{DD} - V_{IH}}{I_{PR}}$

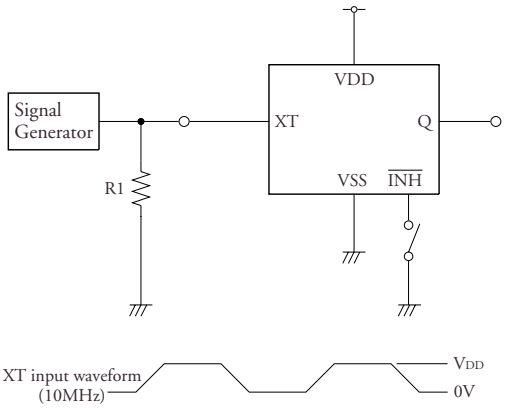
AA series: V_{IH} = 2.0V
AL series: V_{IH} = 2.1V (V_{DD} = 3.0V)
V_{IH} = 3.5V (V_{DD} = 5.0V)

Measurement cct 5



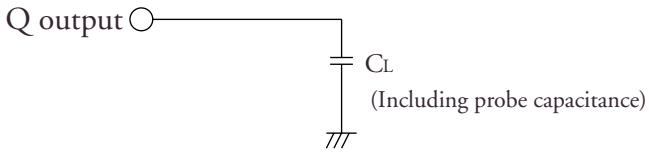
$R_f = \frac{V_{DD}}{I_{Rf}}$

Measurement cct 6



R1 : 50Ω

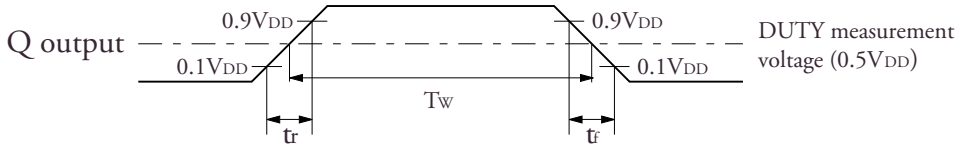
Load cct 1



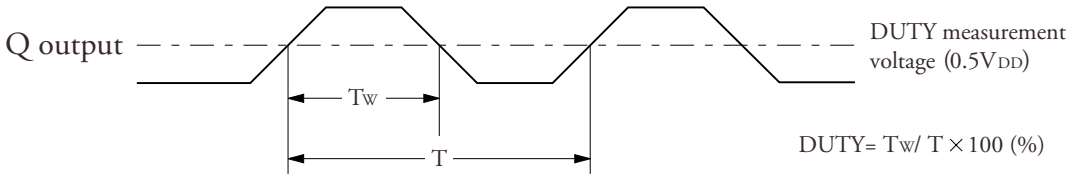
C_L = 15pF : I_{DD} , DUTY, t_r , t_f

Switching Time Measurement Waveform

Output duty level (CMOS)

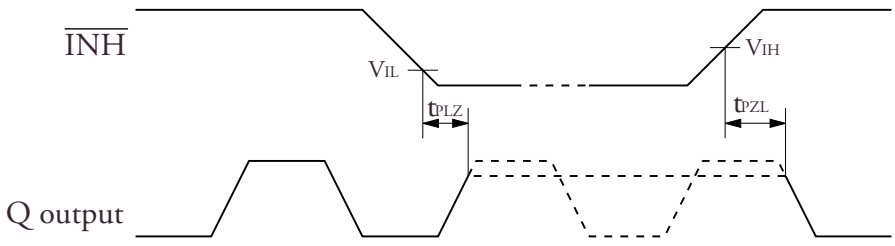


Output duty cycle (CMOS)



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.



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

NIPPON PRECISION CIRCUITS INC. reserves the right to make changes to the products described in this data sheet in order to improve the design or performance and to supply the best possible products. Nippon Precision Circuits Inc. assumes no responsibility for the use of any circuits shown in this data sheet, conveys no license under any patent or other rights, and makes no claim that the circuits are free from patent infringement. Applications for any devices shown in this data sheet are for illustration only and Nippon Precision Circuits Inc. makes no claim or warranty that such applications will be suitable for the use specified without further testing or modification. The products described in this data sheet are not intended to use for the apparatus which influence human lives due to the failure or malfunction of the products. Customers are requested to comply with applicable laws and regulations in effect now and hereinafter, including compliance with export controls on the distribution or dissemination of the products. Customers shall not export, directly or indirectly, any products without first obtaining required licenses and approvals from appropriate government agencies.

NPC
NIPPON PRECISION CIRCUITS INC.

NIPPON PRECISION CIRCUITS INC.

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

NC9703EE 2000.08