



SM5022 series Crystal Oscillator Module ICs

OVERVIEW

The SM5022 series are crystal oscillator module ICs fabricated in NPC's Molybdenum-gate CMOS, 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 fundamental-harmonic oscillator.

FEATURES

- Up to 30MHz operation
- Fundamental oscillation
- Capacitors CG, CD built-in
- Inverter amplifier feedback resistor built-in
- TTL input level
- 4 mA ($V_{DD} = 2.7\text{ V}$) drive capability
8 mA ($V_{DD} = 4.5\text{ V}$) drive capability
- Output three-state function
- 2.7 to 5.5 V supply voltage (A× series)
4.5 to 5.5 V supply voltage (B× series)
- Oscillator frequency output (f_O , $f_O/2$, $f_O/4$, $f_O/8$ determined by internal connection)
- 6-pin SOT (SM5022××H)
- Chip form (CF5022××)

SERIES CONFIGURATION

Version ¹	Supply voltage		Recommended operating frequency range (MHz)		Built-in capacitance (pF)		gm ratio	Rf (kΩ)	Output frequency	Output level	Standby output state
	Chip	SOT	3V	5V	C _G	C _D					
SM5022A1H	2.7 to 5.5	2.7 to 5.5	4 to 24	4 to 30	8	10	1	600	f_O	CMOS	High impedance
SM5022A2H	2.7 to 5.5	2.7 to 5.5	4 to 24	4 to 30	-	-	1	600	f_O	CMOS	High impedance
SM5022A3H	2.7 to 5.5	2.7 to 5.5	4 to 30	4 to 30	8	10	1	600	$f_O/2$	CMOS	High impedance
SM5022A4H	2.7 to 5.5	2.7 to 5.5	4 to 30	4 to 30	-	-	1	600	$f_O/2$	CMOS	High impedance
SM5022A5H	2.7 to 5.5	2.7 to 5.5	4 to 30	4 to 30	8	10	1	600	$f_O/4$	CMOS	High impedance
SM5022A7H	2.7 to 5.5	2.7 to 5.5	4 to 30	4 to 30	8	10	1	600	$f_O/8$	CMOS	High impedance
SM5022B1H	4.5 to 5.5	4.5 to 5.5	×	4 to 30	8	10	1	600	f_O	TTL	High impedance

1. Chip form devices have designation CF5022××.

ORDERING INFORMATION

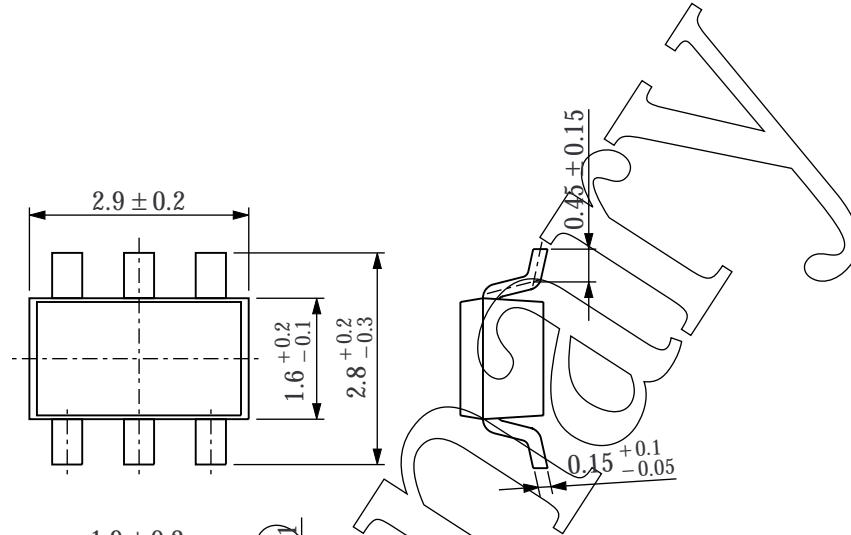
Device	Package
SM5022××H	6-pin SOT
CF5022××-2	Chip form



PACKAGE DIMENSIONS

(UNIT : mm)

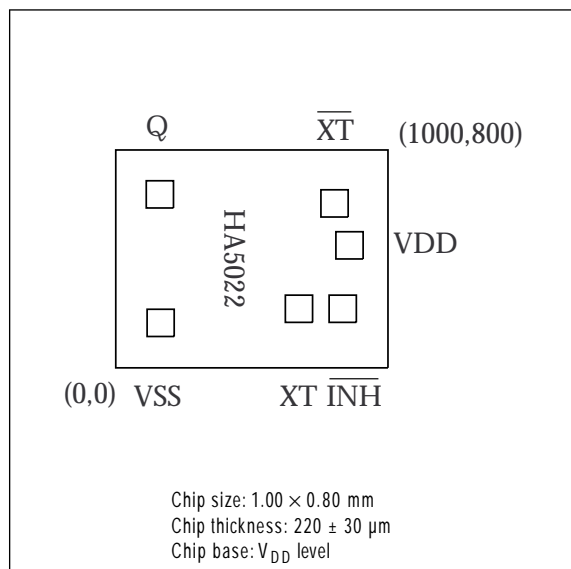
- 6-pin SOT



PRELIMINARY

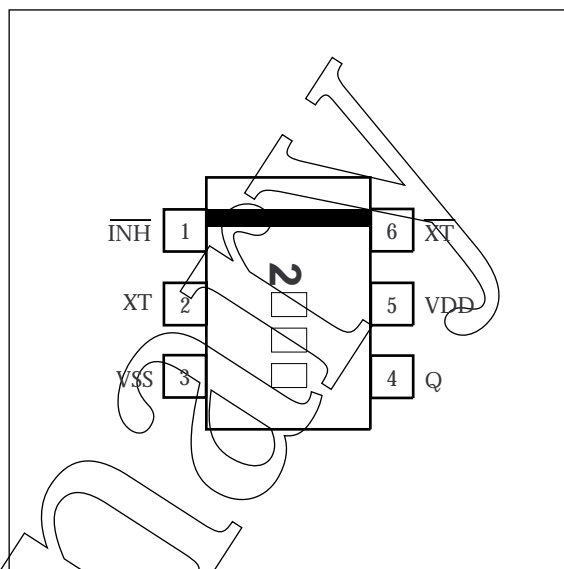
PAD LAYOUT

(Unit : μm)



PINOUT

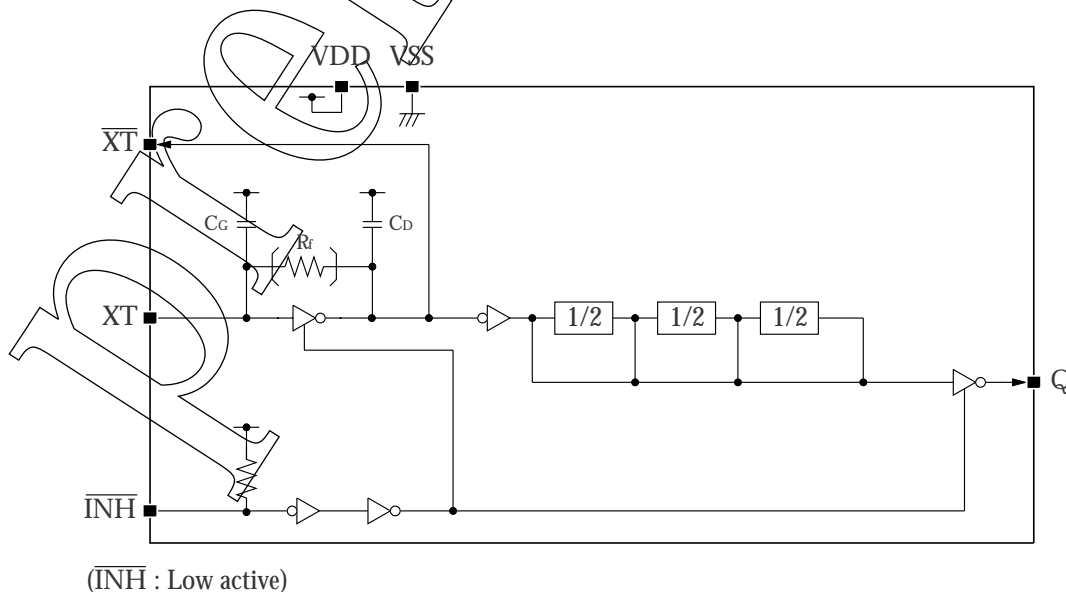
(Top View)



PIN DESCRIPTION and PAD DIMENSIONS

Number	Name	I/O	Description	Pad dimensions [μm]	
				X	Y
1	$\overline{\text{INH}}$	I	Output state control input. High impedance when LOW. Pull-up resistor built in	834	217
2	XT	I	Amplifier input. Crystal oscillator connection pins. Crystal oscillator connected between XT and $\overline{\text{XT}}$	637	217
3	VSS	-	Ground	165	165
4	Q	O	Output. Output frequency ($f_0, f_0/2, f_0/4, f_0/8$) determined by internal connection	162	637
5	VDD	-	Supply voltage	859	450
6	$\overline{\text{XT}}$	O	Amplifier output. Crystal oscillator connection pins. Crystal oscillator connected between XT and $\overline{\text{XT}}$	804	604

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
		6-pin SOT	-55 to 125	
Output current	I_{OUT}		13	mA
Power dissipation	P_D	6-pin SOT	250	mW

Recommended Operating Conditions

 $V_{SS} = 0 \text{ V}$, $f \leq 30 \text{ MHz}$, $C_L \leq 15 \text{ pF}$

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: Recommended operating conditions will change in accordance with operating frequency, load capacitance, or power dissipation.

SM5022 series

Electrical Characteristics

3 V operation: A× series

$V_{DD} = 2.7$ 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, $I_{OH} = 4$ mA	2.1	2.4	-	V	
LOW-level output voltage	V_{OL}	Q: Measurement cct 2, $V_{DD} = 2.7$ V, $I_{OL} = 4$ mA	-	0.3	0.4	V	
Output leakage current	I_Z	Q: Measurement cct 2, $V_{DD} = 3.6$ V, $\overline{INH} = \text{LOW}$, $V_{OH} = V_{DD}$	-	-	10	μA	
		Q: Measurement cct 2, $V_{DD} = 3.6$ V, $\overline{INH} = \text{LOW}$, $V_{OL} = V_{SS}$	-	-	10		
HIGH-level input voltage	V_{IH}	\overline{INH}	2.0	-	-	V	
LOW-level input voltage	V_{IL}	\overline{INH}	-	-	0.5	V	
Current consumption	I_{DD}	$\overline{INH} = \text{open}$, Measurement cct 3, load cct 1, $C_L = 15$ pF, 30 MHz crystal oscillator	-	4	7	mA	
\overline{INH} pull-up resistance	R_{UP}	Measurement cct 4	25	100	250	k Ω	
Feedback resistance	R_f	Measurement cct 5	200	600	1000	k Ω	
Built-in capacitance	C_G	Design value, determined by the internal wafer pattern	SM5022A1H, CF5022A1 SM5022A3H, CF5022A3 SM5022A5H, CF5022A5 SM5022A7H, CF5022A7	7.44	8	8.56	μF
	C_D		9.3	10	10.7		

5 V operation: A× series/ B× series

$V_{DD} = 4.5$ 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, $V_{DD} = 4.5$ V, $I_{OH} = 8$ mA	3.9	4.2	-	V	
LOW-level output voltage	V_{OL}	Q: Measurement cct 2, $V_{DD} = 4.5$ V, $I_{OL} = 8$ mA	-	0.3	0.4	V	
Output leakage current	I_Z	Q: Measurement cct 2, $V_{DD} = 5.5$ V, $\overline{INH} = \text{LOW}$, $V_{OH} = V_{DD}$	-	-	10	μA	
		Q: Measurement cct 2, $V_{DD} = 5.5$ V, $\overline{INH} = \text{LOW}$, $V_{OL} = V_{SS}$	-	-	10		
HIGH-level input voltage	V_{IH}	\overline{INH}	2.0	-	-	V	
LOW-level input voltage	V_{IL}	\overline{INH}	-	-	0.8	V	
Current consumption	I_{DD}	$\overline{INH} = \text{open}$, Measurement cct 3, load cct 1, $C_L = 15$ pF, 30 MHz crystal oscillator	SM5022A×H, CF5022A×	-	7	12	mA
		$\overline{INH} = \text{open}$, Measurement cct 3, load cct 2, $C_L = 15$ pF, 30 MHz crystal oscillator	SM5022B×H, CF5022B×	-	7	12	
\overline{INH} pull-up resistance	R_{UP}	Measurement cct 4	25	100	250	k Ω	
Feedback resistance	R_f	Measurement cct 5	200	600	1000	k Ω	
Built-in capacitance	C_G	Design value, determined by the internal wafer pattern	SM5022A1H, CF5022A1 SM5022A3H, CF5022A3 SM5022A5H, CF5022A5 SM5022A7H, CF5022A7	7.44	8	8.56	μF
	C_D		SM5022B1H, CF5022B1	9.3	10	10.7	

Switching Characteristics

CMOS (A× series)

3 V operation

$V_{DD} = 2.7$ 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		
Output rise time	t_{r1}	Measurement cct 6, load cct 1, $C_L = 15$ pF	$0.2V_{DD}$ to $0.8V_{DD}$	-	5	10	ns
			$0.1V_{DD}$ to $0.9V_{DD}$	-	10	20	
Output fall time	t_{f1}	Measurement cct 6, load cct 1, $C_L = 15$ pF	$0.8V_{DD}$ to $0.2V_{DD}$	-	5	10	ns
			$0.9V_{DD}$ to $0.1V_{DD}$	-	10	20	
Output duty cycle ¹	Duty	Measurement cct 6, load cct 1, $T_a = 25$ °C, $V_{DD} = 3$ V, $C_L = 15$ pF, $f = 30$ MHz	45	-	55	%	
Output disable delay time ²	t_{PLZ}	Measurement cct 7, load cct 1, $T_a = 25$ °C, $V_{DD} = 3$ V, $C_L = 15$ pF	-	-	100	ns	
Output enable delay time ²	t_{PZL}		-	-	100	ns	

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_{r2}	Measurement cct 6, load cct 1, $0.1V_{DD}$ to $0.9V_{DD}$, $C_L = 15$ pF	-	3.5	7	ns
Output fall time	t_{f2}	Measurement cct 6, load cct 1, $0.9V_{DD}$ to $0.1V_{DD}$, $C_L = 15$ pF	-	3.5	7	ns
Output duty cycle ¹	Duty	Measurement cct 6, load cct 1, $T_a = 25$ °C, $V_{DD} = 5$ V, $C_L = 15$ pF, $f = 30$ MHz	45	-	55	%
Output disable delay time ²	t_{PLZ}	Measurement cct 7, load cct 1, $T_a = 25$ °C, $V_{DD} = 5$ V, $C_L = 15$ pF	-	-	100	ns
Output enable delay time ²	t_{PZL}		-	-	100	ns

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.

SM5022 series

TTL (B× series)

5 V operation

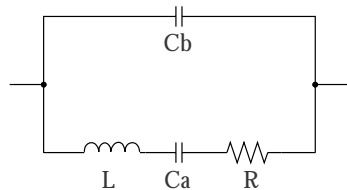
$V_{DD} = 4.5$ to 5.5 V, $V_{SS} = 0$ V, $T_a = -20$ to 80 °C unless otherwise noted.

Parameter	Symbol	Condition	Rating			Unit
			min	typ	max	
Output rise time	t_{r3}	Measurement cct 6, load cct 2, 0.4V to 2.4V, $C_L = 15$ pF	-	2.5	7	ns
Output fall time	t_{f3}	Measurement cct 6, load cct 2, 2.4V to 0.4V, $C_L = 15$ pF	-	2.5	7	ns
Output duty cycle ¹	Duty	Measurement cct 6, load cct 2, $T_a = 25$ °C, $V_{DD} = 5$ V, $C_L = 15$ pF, $f = 30$ MHz	45	-	55	%
Output disable delay time ²	t_{pLZ}	Measurement cct 7, load cct 2, $T_a = 25$ °C, $V_{DD} = 5$ V, $C_L = 15$ pF	-	-	100	ns
Output enable delay time ²	t_{pZL}		-	-	100	ns

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_z (mH)	C_a (fF)	C_b (pF)
30	18.62	16.24	1.733	5.337

FUNCTIONAL DESCRIPTION

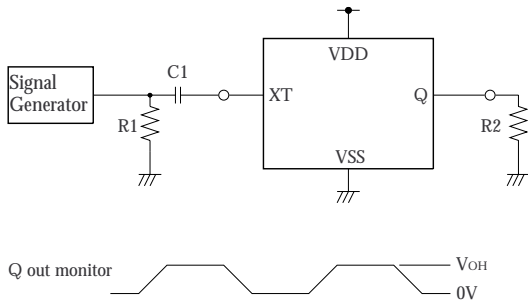
Standby Function

When \overline{INH} goes LOW, the oscillator output on Q goes high impedance.

\overline{INH}	Q	Oscillator
HIGH (or open)	Any f_0 , $f_0/2$, $f_0/4$, or $f_0/8$ output frequency	Normal operation
LOW	High impedance	Stopped

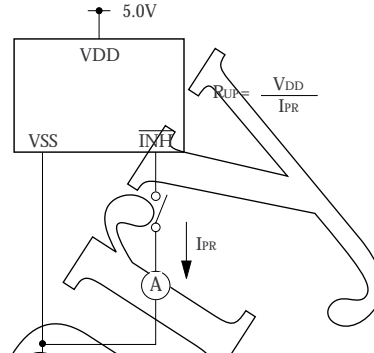
MEASUREMENT CIRCUITS

Measurement cct 1

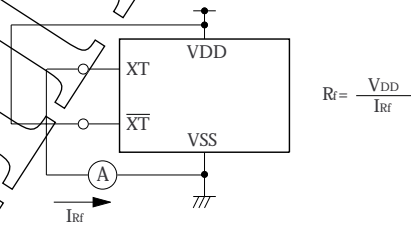


2.0V_{P-P}, 10MHz sine wave input signal (3V operation)
 3.5V_{P-P}, 10MHz sine wave input signal (5V operation)
 C1 : 0.001μF
 R1 : 50Ω
 R2 : 525Ω (3V operation)
 490Ω (5V operation)

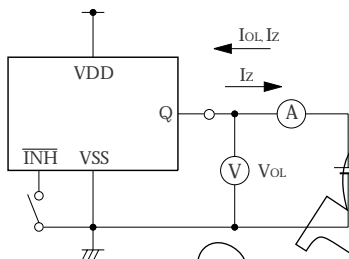
Measurement cct 4



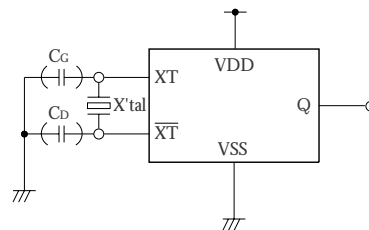
Measurement cct 5



Measurement cct 2

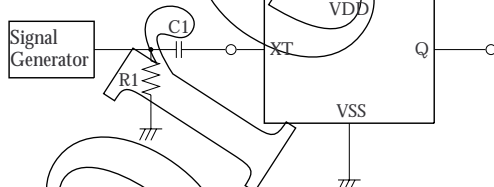


Measurement cct 6



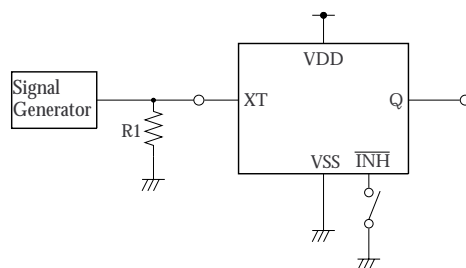
C_G, C_D : 10pF (5022A2, 5022A4)

Measurement cct 3



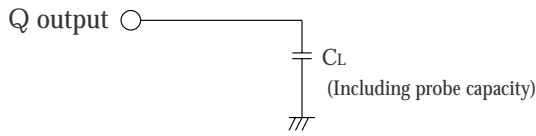
2.0V_{P-P}, 30MHz sine wave input signal (3V operation)
 3.5V_{P-P}, 30MHz sine wave input signal (5V operation)
 C1 : 0.001μF
 R1 : 50Ω

Measurement cct 7



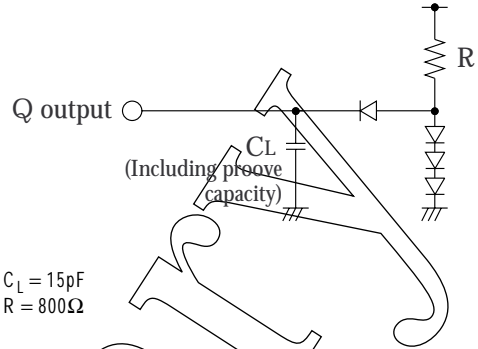
R1 : 50Ω

Load cct 1



$C_L = 15\text{pF}$

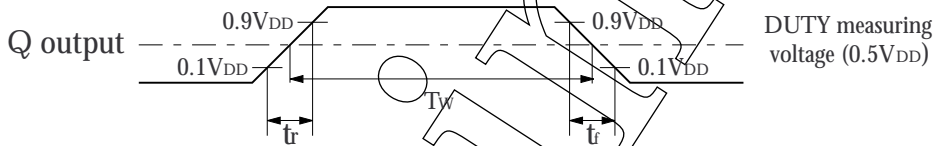
Load cct 2



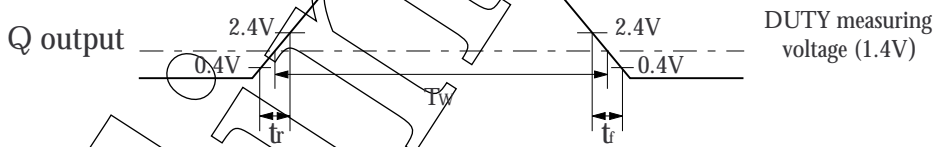
$C_L = 15\text{pF}$
 $R = 800\Omega$

Switching Time Measurement Waveform

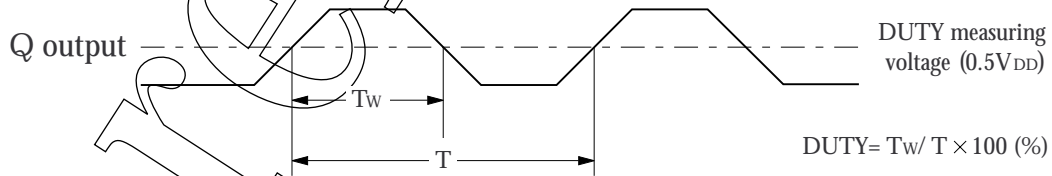
Output duty level (CMOS)



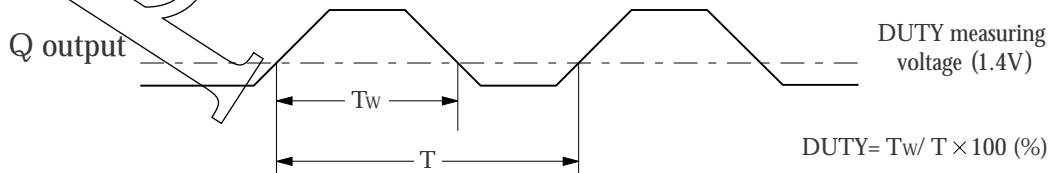
Output duty level (TTL)



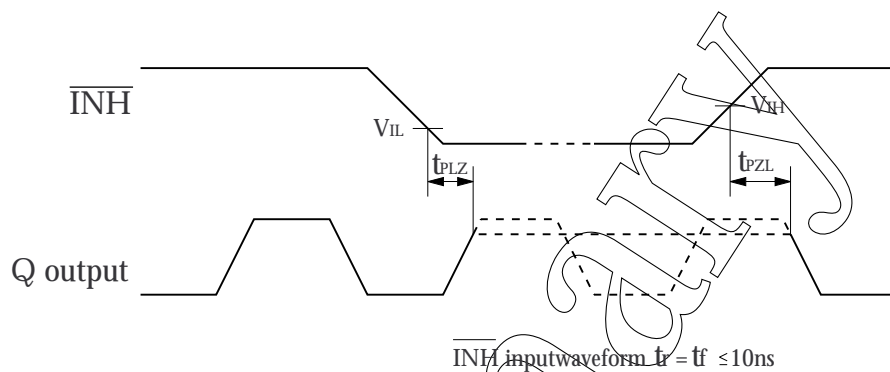
Output duty cycle (CMOS)



Output duty cycle (TTL)



Output Enable/Disable Delay



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