

### 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. Feedback resistors and high-frequency capacitors are built-in, eliminating the need for external components to make a stable fundamental oscillator.

### FEATURES

- Up to 30MHz operating frequency range (fundamental oscillation)
- Oscillator capacitors  $C_G$ ,  $C_D$  built-in (excluding A2A, A4A)
- Inverter amplifier feedback resistor built-in
- TTL input level
- Output drive capability
  - 4mA ( $V_{DD} = 2.7V$ )
  - 8mA ( $V_{DD} = 4.5V$ )
- Output three-state function
- Operating supply voltage range
  - 2.7 to 5.5V (AxA series)
  - 4.5 to 5.5V (BxA series)
- $f_O$ ,  $f_O/2$ ,  $f_O/4$ ,  $f_O/8$  output frequency, determined by internal connection
- 6-pin SOT (SM5022xAH)
- Chip form (CF5022xA)

### SERIES CONFIGURATION

Version <sup>*1</sup>	Operating supply voltage range [V]		Recommended operating frequency range <sup>*2</sup> [MHz]		Built-in capacitance [pF]		gm ratio	Rf [kΩ]	Output frequency	Output level	Standby mode	
	Chip	SOT	3V operation	5V operation	$C_G$	$C_D$					Oscillator stop function	Output state
SM5022A1AH	2.7 to 5.5	2.7 to 5.5	4 to 24	4 to 30	8	10	1	600	fo	CMOS	Yes	Hi-Z
SM5022A2AH					-	-			fo			
SM5022A3AH			8		10	fo/2						
SM5022A4AH			-		-	fo/2						
SM5022A5AH			8		10	fo/4						
SM5022A7AH			8		10	fo/8						
SM5022B1AH	4.5 to 5.5	4.5 to 5.5	×	4 to 30	8	10	1	600	fo	TTL	Yes	Hi-Z

\*1. Chip form devices have designation CF5022xA.

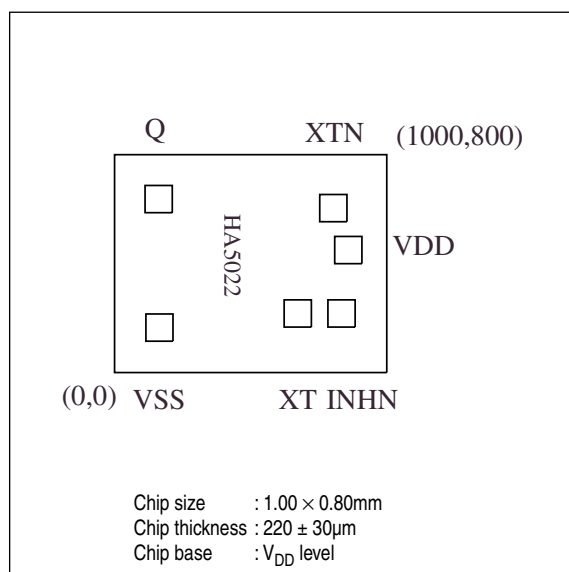
\*2. The recommended operating frequency is a yardstick value derived from the crystal used for NPC characteristics authentication. However, the oscillator frequency band is not guaranteed. Specifically, the characteristics can vary greatly due to crystal characteristics and mounting conditions, so the oscillation characteristics of components must be carefully evaluated.

### ORDERING INFORMATION

Device	Package
SM5022xAH	SOT23-6
CF5022xA-2	Chip form

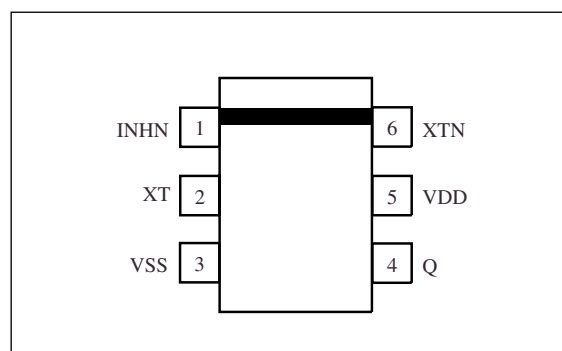
### PAD LAYOUT

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



### PINOUT

(Top view)



Version	Product ID
SM5022A1AH	A00
SM5022A2AH	A01
SM5022A3AH	A02
SM5022A4AH	A03
SM5022A5AH	A04
SM5022A7AH	A05
SM5022B1AH	A06

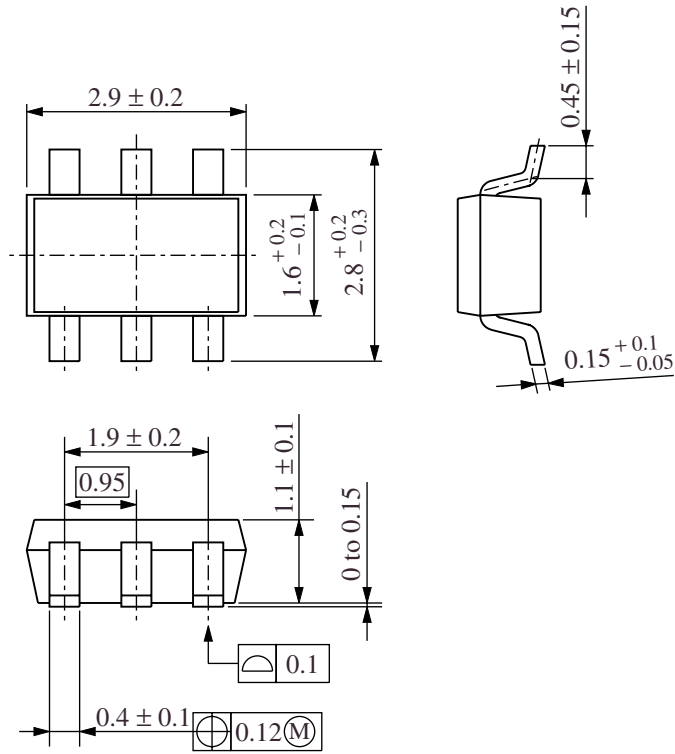
### PIN DESCRIPTION and PAD DIMENSIONS

Number	Name	I/O	Description	Pad dimensions [ $\mu\text{m}$ ]	
				X	Y
1	INH N	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 is connected between XT and XTN	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	XTN	O	Amplifier output. Crystal oscillator connection pins. Crystal oscillator is connected between XT and XTN	804	604

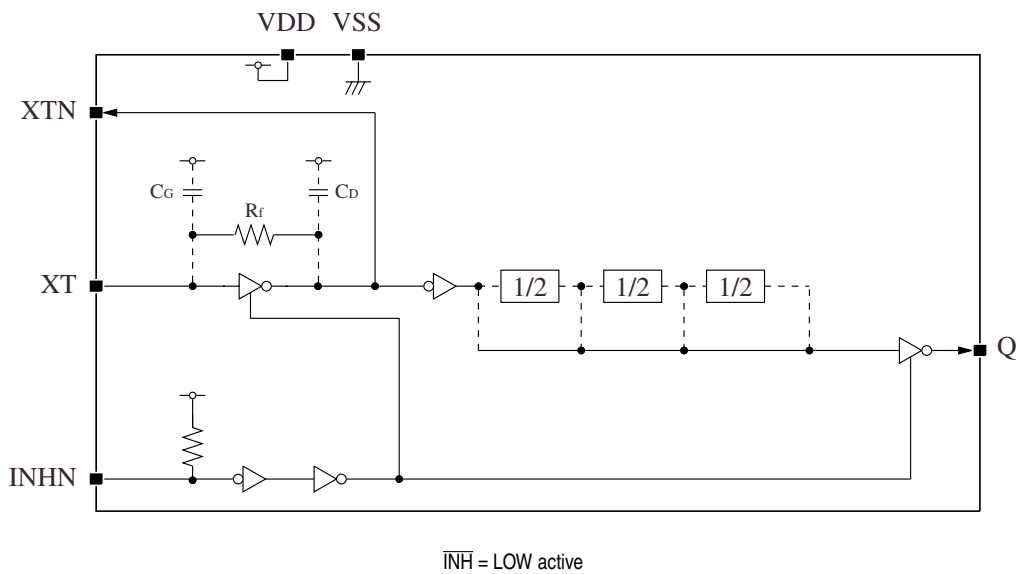
**PACKAGE DIMENSIONS**

(Unit: mm)

- 6-pin SOT



**BLOCK DIAGRAM**



## 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	$T_{stg}$	Chip form	- 65 to + 150	°C
		SOT23-6	- 55 to + 125	
Output current	$I_{OUT}$		13	mA
Power dissipation	$P_D$	SOT23-6	250	mW

### Recommended Operating Conditions

#### 3V operation: A×A series

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

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

#### 5V operation: A×A series/ B×A series

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

Parameter	Symbol	Condition	Rating			Unit
			min	typ	max	
Supply voltage	$V_{DD}$		4.5	-	5.5	V
Input voltage	$V_{IN}$		$V_{SS}$	-	$V_{DD}$	V
Operating temperature	$T_{OPR}$		- 20	-	+ 80	°C

**SM5022 series**

**Electrical Characteristics**

**3V operation: A×A series**

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

Parameter	Symbol	Condition	Rating			Unit	
			min	typ	max		
HIGH-level output voltage	$V_{OH}$	Q: Measurement cct 1, $V_{DD} = 2.7V$ , $I_{OH} = 4mA$	2.1	2.4	–	V	
LOW-level output voltage	$V_{OL}$	Q: Measurement cct 2, $V_{DD} = 2.7V$ , $I_{OL} = 4mA$	–	0.3	0.4	V	
HIGH-level input voltage	$V_{IH}$	INH N	2.0	–	–	V	
LOW-level input voltage	$V_{IL}$	INH N	–	–	0.5	V	
Output leakage current	$I_Z$	Q: Measurement cct 2, $V_{DD} = 3.6V$ , INHN = LOW, $V_{OH} = V_{DD}$	–	–	10	$\mu A$	
		Q: Measurement cct 2, $V_{DD} = 3.6V$ , INHN = LOW, $V_{OL} = V_{SS}$	–	–	10		
Current consumption	$I_{DD}$	30MHz crystal oscillator, measurement cct 3, load cct 1, INHN = open, $C_L = 15pF$	–	4	7	mA	
INH N pull-up resistance	$R_{UP}$	Measurement cct 4	25	100	250	$k\Omega$	
Feedback resistance	$R_f$	Measurement cct 5	200	600	1000	$k\Omega$	
Built-in capacitance	$C_G$	Design value. A monitor pattern on a wafer is tested.	SM5022A1AH, CF5022A1A SM5022A3AH, CF5022A3A SM5022A5AH, CF5022A5A SM5022A7AH, CF5022A7A	7.44	8	8.56	pF
	$C_D$			9.3	10	10.7	pF

**5V operation: A×A, B×A series**

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

Parameter	Symbol	Condition	Rating			Unit	
			min	typ	max		
HIGH-level output voltage	$V_{OH}$	Q: Measurement cct 1, $V_{DD} = 4.5V$ , $I_{OH} = 8mA$	3.9	4.2	–	V	
LOW-level output voltage	$V_{OL}$	Q: Measurement cct 2, $V_{DD} = 4.5V$ , $I_{OL} = 8mA$	–	0.3	0.4	V	
HIGH-level input voltage	$V_{IH}$	INH N	2.0	–	–	V	
LOW-level input voltage	$V_{IL}$	INH N	–	–	0.8	V	
Output leakage current	$I_Z$	Q: Measurement cct 2, $V_{DD} = 5.5V$ , INHN = LOW, $V_{OH} = V_{DD}$	–	–	10	$\mu A$	
		Q: Measurement cct 2, $V_{DD} = 5.5V$ , INHN = LOW, $V_{OL} = V_{SS}$	–	–	10		
Current consumption	$I_{DD}$	30MHz crystal oscillator, measurement cct 3, load cct 1, INHN = open, $C_L = 15pF$	SM5022A×AH, CF5022A×A	–	7	12	mA
		30MHz crystal oscillator, measurement cct 3, load cct 2, INHN = open, $C_L = 15pF$	SM5022B×AH, CF5022B×A	–	7	12	
INH N pull-up resistance	$R_{UP}$	Measurement cct 4	25	100	250	$k\Omega$	
Feedback resistance	$R_f$	Measurement cct 5	200	600	1000	$k\Omega$	
Built-in capacitance	$C_G$	Design value. A monitor pattern on a wafer is tested.	SM5022A1AH, CF5022A1A SM5022A3AH, CF5022A3A SM5022A5AH, CF5022A5A SM5022A7AH, CF5022A7A SM5022B1AH, CF5022B1A	7.44	8	8.56	pF
	$C_D$			9.3	10	10.7	pF

## Switching Characteristics

### CMOS Output Version: AxA series

#### 3V operation

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

Parameter	Symbol	Condition	Rating			Unit	
			min	typ	max		
Output rise time	$t_{r1}$	Measurement cct 6, load cct 1, $C_L = 15pF$	$0.2V_{DD}$ 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, $C_L = 15pF$	$0.8V_{DD}$ to $0.2V_{DD}$	–	5	10	ns
			$0.9V_{DD}$ to $0.1V_{DD}$	–	10	20	
Output duty cycle <sup>*1</sup>	Duty	Measurement cct 6, load cct 1, $V_{DD} = 3V$ , $T_a = 25^{\circ}C$ , $C_L = 15pF$ , $f = 30MHz$	45	–	55	%	
Output disable delay time <sup>*2</sup>	$t_{PLZ}$	Measurement cct 7, load cct 1, $V_{DD} = 3V$ , $T_a = 25^{\circ}C$ , $C_L = 15pF$	–	–	100	ns	
Output enable delay time <sup>*2</sup>	$t_{PZL}$		–	–	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.

#### 5V operation

$V_{DD} = 4.5$  to  $5.5V$ ,  $V_{SS} = 0V$ ,  $T_a = -20$  to  $+80^{\circ}C$  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 $0.9V_{DD}$ , $C_L = 15pF$	–	3.5	7	ns
Output fall time	$t_{f2}$	Measurement cct 6, load cct 1, $0.9V_{DD}$ to $0.1V_{DD}$ , $C_L = 15pF$	–	3.5	7	ns
Output duty cycle <sup>*1</sup>	Duty	Measurement cct 6, load cct 1, $V_{DD} = 5V$ , $T_a = 25^{\circ}C$ , $C_L = 15pF$ , $f = 30MHz$	45	–	55	%
Output disable delay time <sup>*2</sup>	$t_{PLZ}$	Measurement cct 7, load cct 1, $V_{DD} = 5V$ , $T_a = 25^{\circ}C$ , $C_L = 15pF$	–	–	100	ns
Output enable delay time <sup>*2</sup>	$t_{PZL}$		–	–	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.

**TTL Output Version: BxA series**

**5V operation**

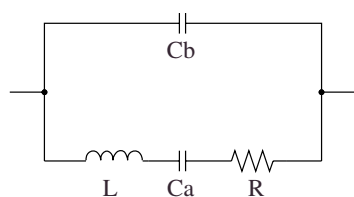
$V_{DD} = 4.5$  to  $5.5V$ ,  $V_{SS} = 0V$ ,  $T_a = -20$  to  $+80^{\circ}C$  unless otherwise noted.

Parameter	Symbol	Condition	Rating			Unit
			min	typ	max	
Output rise time	$t_{r3}$	Measurement cct 6, load cct 2, 0.4V to 2.4V, $C_L = 15pF$	–	2.5	7	ns
Output fall time	$t_{f3}$	Measurement cct 6, load cct 2, 2.4V to 0.4V, $C_L = 15pF$	–	2.5	7	ns
Output duty cycle <sup>*1</sup>	Duty	Measurement cct 6, load cct 2, $V_{DD} = 5V$ , $T_a = 25^{\circ}C$ , $C_L = 15pF$ , $f = 30MHz$	45	–	55	%
Output disable delay time <sup>*2</sup>	$t_{PLZ}$	Measurement cct 7, load cct 2, $V_{DD} = 5V$ , $T_a = 25^{\circ}C$ , $C_L = 15pF$	–	–	100	ns
Output enable delay time <sup>*2</sup>	$t_{PZL}$		–	–	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.

**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**

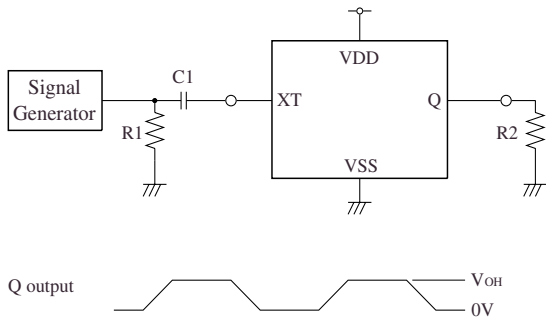
**Standby Function**

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

INHN	Q	Oscillator
HIGH (or open)	Any $f_O$ , $f_O/2$ , $f_O/4$ , or $f_O/8$ output frequency	Normal operation
LOW	High impedance	Stopped

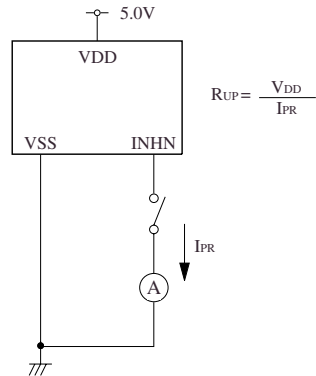
**MEASUREMENT CIRCUITS**

**Measurement cct 1**

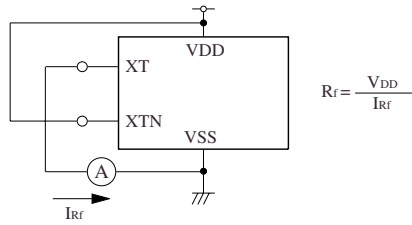


2.0Vp-p, 10MHz sine wave input signal (3V operation)  
 3.5Vp-p, 10MHz sine wave input signal (5V operation)  
 C1: 0.001μF  
 R1: 50Ω  
 R2: 525Ω (3V operation)  
 490Ω (5V operation)

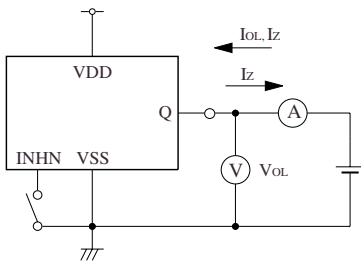
**Measurement cct 4**



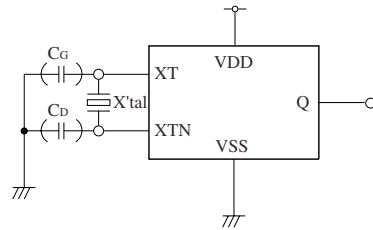
**Measurement cct 5**



**Measurement cct 2**

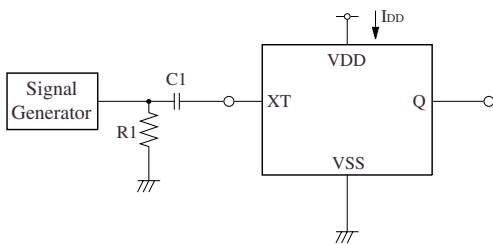


**Measurement cct 6**



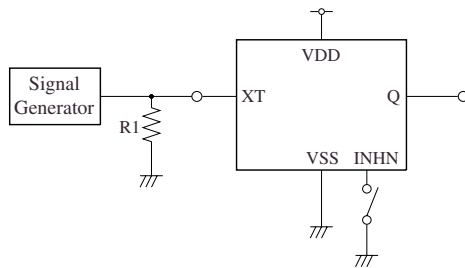
C<sub>G</sub>, C<sub>D</sub>: 10pF (5022A2, 5022A4)

**Measurement cct 3**



2.0Vp-p, 30MHz sine wave input signal (3V operation)  
 3.5Vp-p, 30MHz sine wave input signal (5V operation)  
 C1: 0.001μF  
 R1: 50Ω

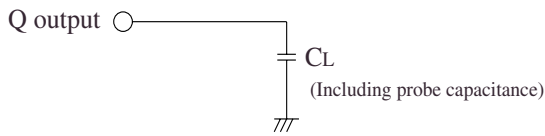
**Measurement cct 7**



R1: 50Ω

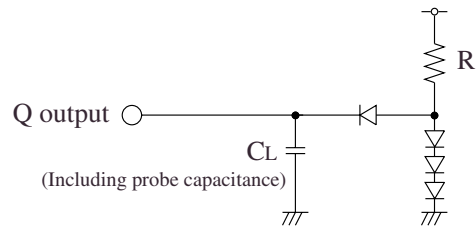


**Load cct 1**



$C_L = 15\text{pF}$

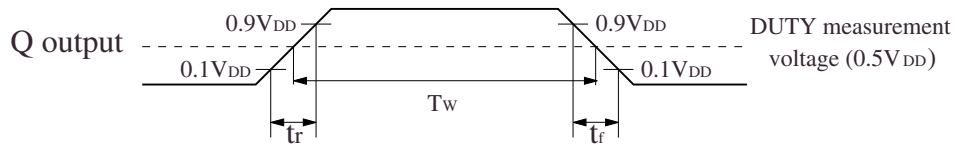
**Load cct 2**



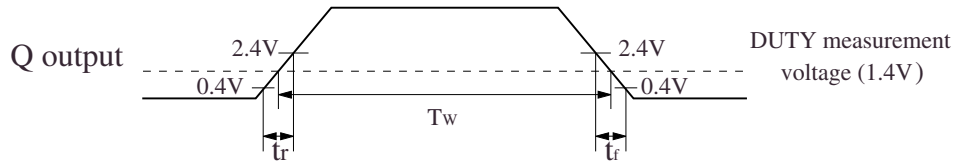
$C_L = 15\text{pF}$   
 $R = 800\Omega$

**Switching Time Measurement Waveform**

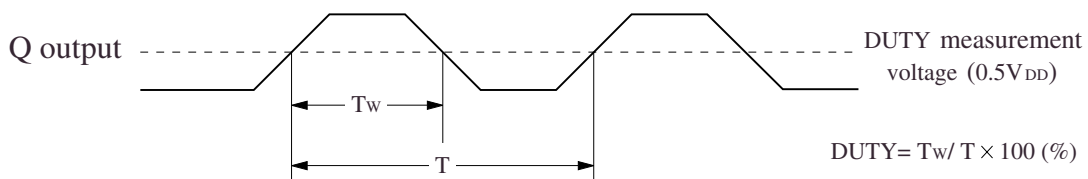
**Output duty level (CMOS)**



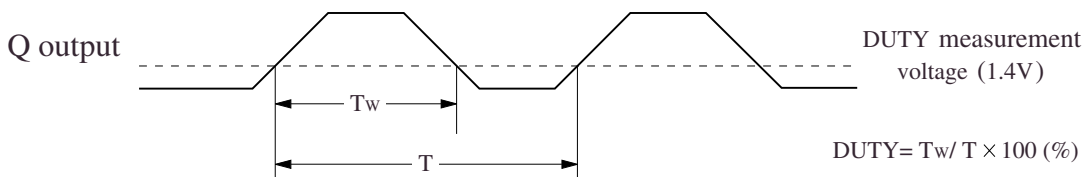
**Output duty level (TTL)**



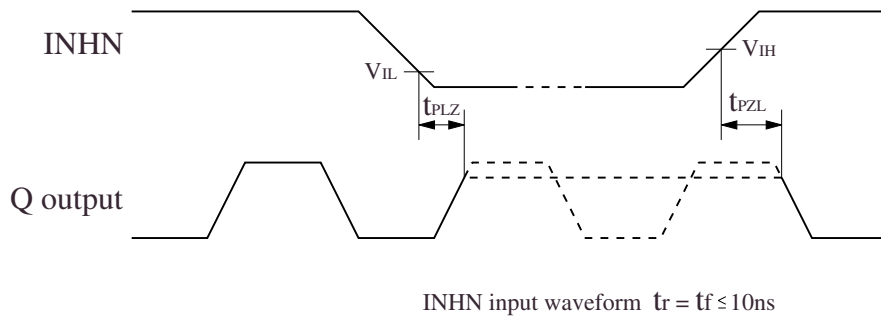
**Output duty cycle (CMOS)**



**Output duty cycle (TTL)**



Output Enable/Disable Delay



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The logo for NPC (Seiko NPC Corporation) consists of the letters 'NPC' in a bold, black, sans-serif font. The 'N' and 'P' are connected at the top, and the 'C' is positioned to the right of the 'P'.

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