

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-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×A series)
4.5 to 5.5 V supply voltage (B×A series)
- Oscillator frequency output (f_O , $f_O/2$, $f_O/4$, $f_O/8$ determined by internal connection)
- 6-pin SOT (SM5022××AH)
- Chip form (CF5022××A)

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					
SM5022A1AH	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
SM5022A2AH	2.7 to 5.5	2.7 to 5.5	4 to 24	4 to 30	—	—	1	600	f_O	CMOS	High impedance
SM5022A3AH	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
SM5022A4AH	2.7 to 5.5	2.7 to 5.5	4 to 30	4 to 30	—	—	1	600	$f_O/2$	CMOS	High impedance
SM5022A5AH	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
SM5022A7AH	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
SM5022B1AH	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××.

Note: Recommended operating frequency is not the guaranteed value but is measured using NPC's standard crystal.

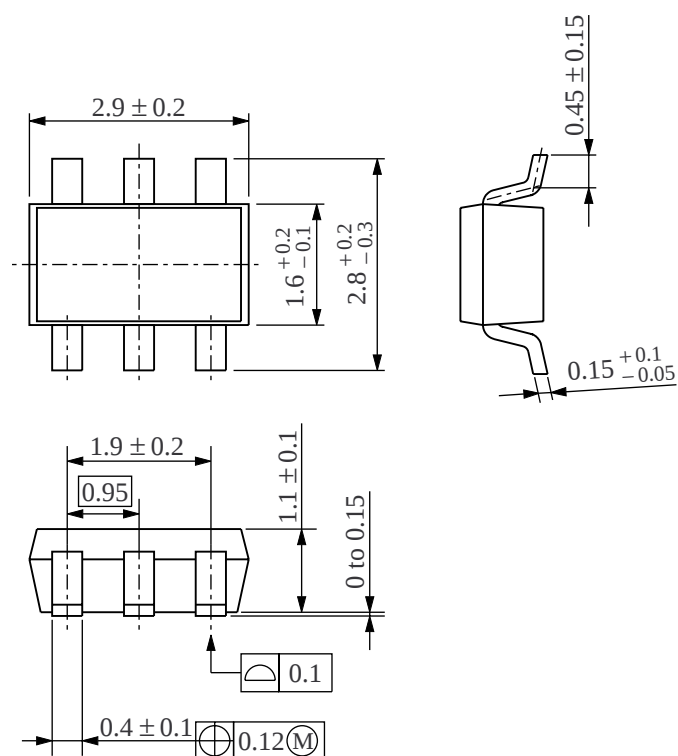
ORDERING INFORMATION

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

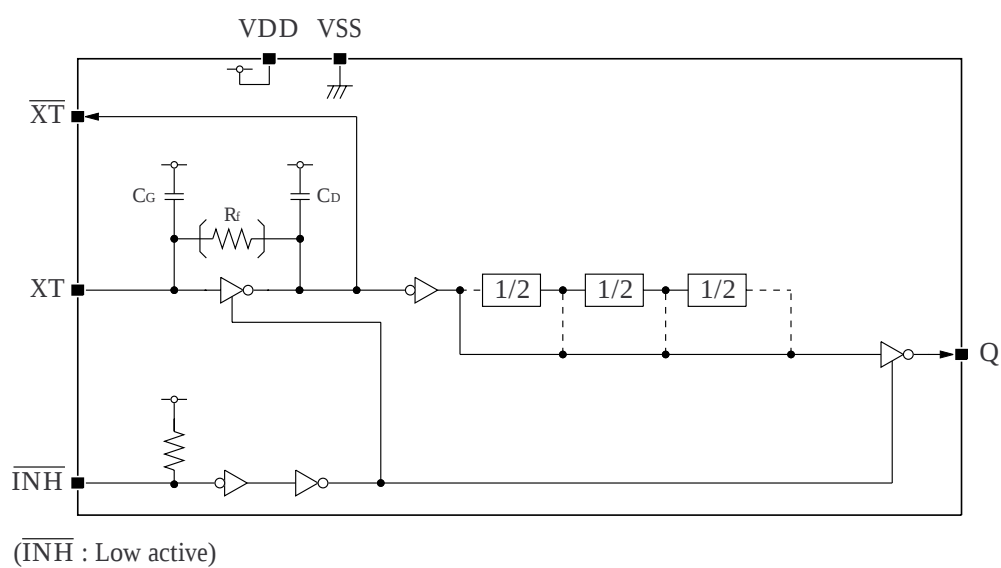
PACKAGE DIMENSIONS

(UNIT : mm)

- 6-pin SOT

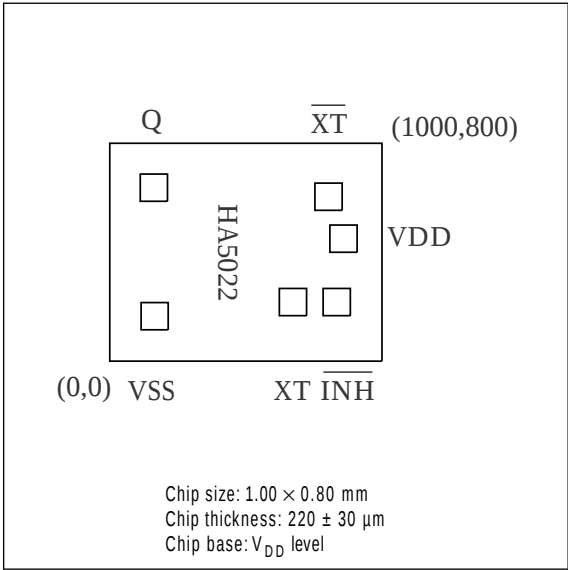


BLOCK DIAGRAM



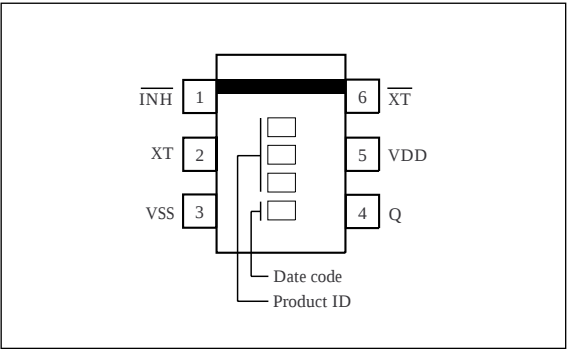
PAD LAYOUT

(Unit : μm)



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 [μm]	
					X	Y
1	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 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	XT	O	Amplifier output.	Crystal oscillator connection pins. Crystal oscillator connected between XT and XT	804	604

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

3 V operation: A×A series

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

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

5 V operation: A×A series/ B×A series

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

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

Electrical Characteristics

3 V operation: A×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, $\overline{INH} = LOW$, $V_{OH} = V_{DD}$	–	–	10	μA
		Q: Measurement cct 2, $V_{DD} = 3.6$ V, $\overline{INH} = LOW$, $V_{OL} = V_{SS}$	–	–	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}	$\overline{INH} = open$, 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	7.44	8	8.56	μF
	C_D					pF

5 V operation: A×A series/ B×A 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, $\overline{INH} = LOW$, $V_{OH} = V_{DD}$	–	–	10	μA
		Q: Measurement cct 2, $V_{DD} = 5.5$ V, $\overline{INH} = LOW$, $V_{OL} = V_{SS}$	–	–	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}	$\overline{INH} = open$, Measurement cct 3, load cct 1, $C_L = 15$ pF, 30 MHz crystal oscillator	–	7	12	mA
		$\overline{INH} = open$, Measurement cct 3, load cct 2, $C_L = 15$ pF, 30 MHz crystal oscillator				
$\overline{INH}$ 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	7.44	8	8.56	μF
	C_D					pF

Switching Characteristics

CMOS (A×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, $C_L = 15\text{ pF}$	$0.2V_{DD}$ 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, $C_L = 15\text{ pF}$	$0.8V_{DD}$ 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, $T_a = 25\text{ }^{\circ}\text{C}$, $V_{DD} = 3\text{ V}$, $C_L = 15\text{ pF}$, $f = 30\text{ MHz}$		45	–	55	%
Output disable delay time ²	t_{PLZ}	Measurement cct 7, load cct 1, $T_a = 25\text{ }^{\circ}\text{C}$, $V_{DD} = 3\text{ V}$, $C_L = 15\text{ pF}$		–	–	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, 0.1 V_{DD} to 0.9 V_{DD} , $C_L = 15$ pF	–	3.5	7	ns
Output fall time	t_{f2}	Measurement cct 6, load cct 1, 0.9 V_{DD} to 0.1 V_{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.

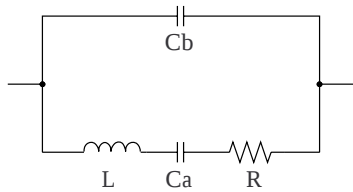
TTL (B×A series)**5 V operation**

$V_{DD} = 4.5$ 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 (mH)	Ca (fF)	Cb (pF)
30	17.2	4.36	6.46	2.26

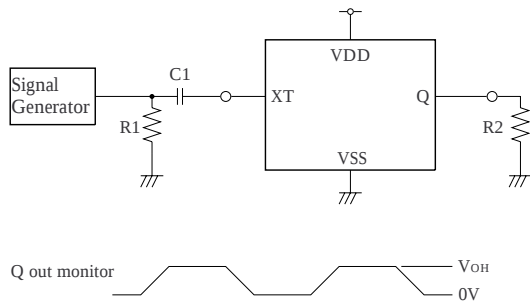
FUNCTIONAL DESCRIPTION**Standby Function**

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

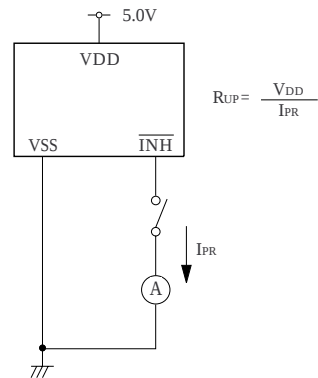
MEASUREMENT CIRCUITS

Measurement cct 1



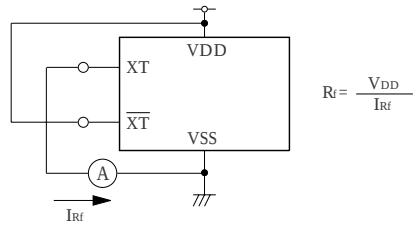
2.0V_{p-p}, 10MHz sine wave input signal (3V operation)
 3.5V_{p-p}, 10MHz sine wave input signal (5V operation)
 C1 : 0.001μF
 R1 : 50Ω
 R2 : 525Ω (3V operation)
 490Ω (5V operation)

Measurement cct 4



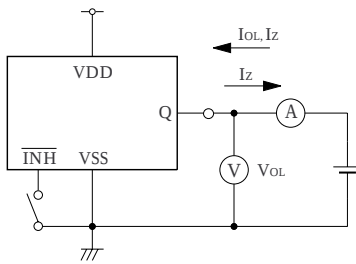
$$R_{UP} = \frac{V_{DD}}{I_{PR}}$$

Measurement cct 5

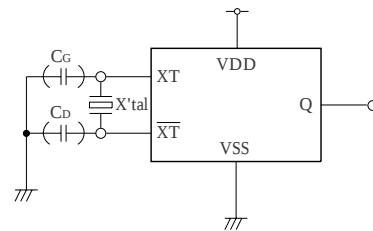


$$R_f = -\frac{V_{DD}}{I_{Rf}}$$

Measurement cct 2

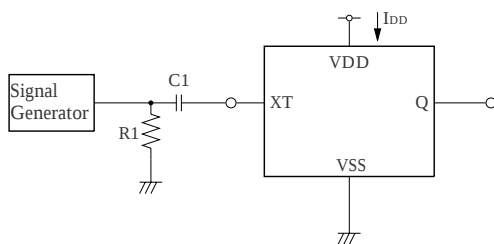


Measurement cct 6



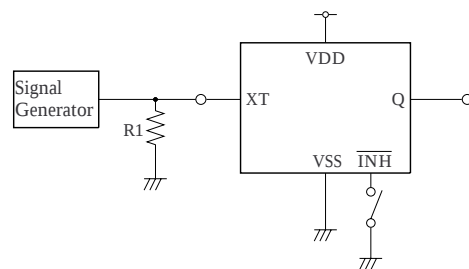
C_G, C_D : 10pF (5022A2, 5022A4)

Measurement cct 3



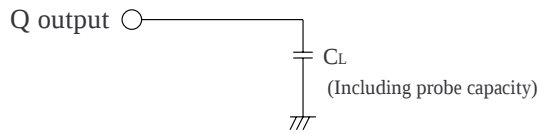
2.0V_{p-p}, 30MHz sine wave input signal (3V operation)
 3.5V_{p-p}, 30MHz sine wave input signal (5V operation)
 C1 : 0.001μF
 R1 : 50Ω

Measurement cct 7



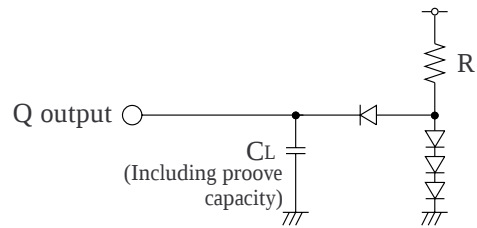
R1 : 50Ω

Load cct 1



$$C_L = 15\text{pF}$$

Load cct 2

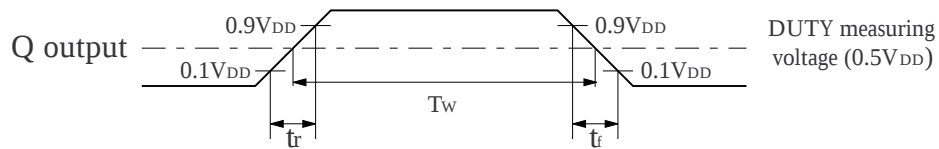


$$C_L = 15\text{pF}$$

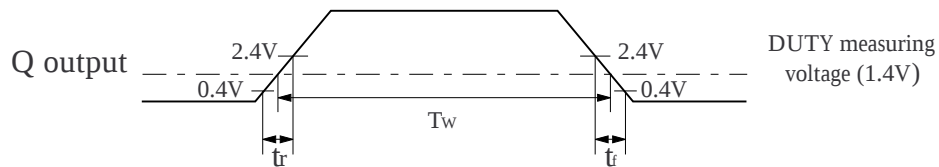
$$R = 800\Omega$$

Switching Time Measurement Waveform

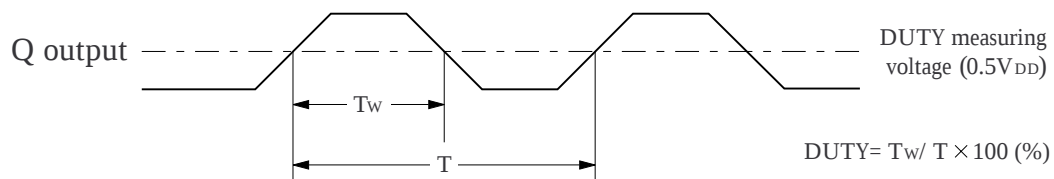
Output duty level (CMOS)



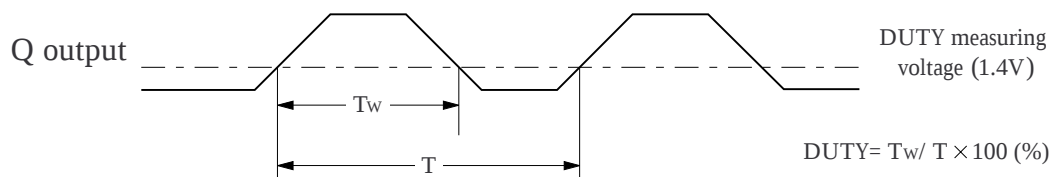
Output duty level (TTL)



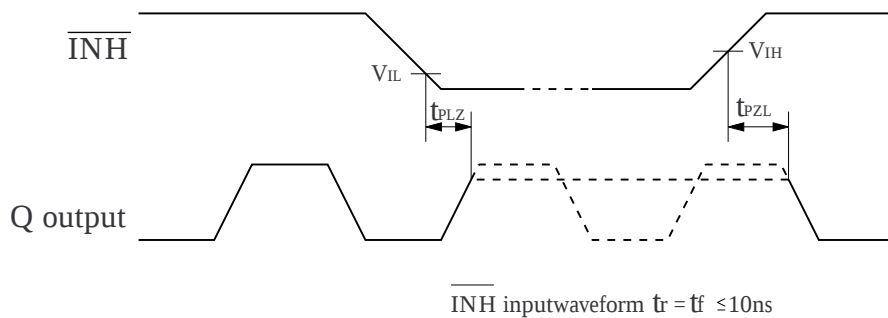
Output duty cycle (CMOS)



Output duty cycle (TTL)



Output Enable/Disable Delay



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