NIPPON PRECISION CIRCUITS INC.

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. 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 V) drive capability
  8 mA (V_{DD} = 4.5 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	fo	CMOS	High impedance
SM5022A2AH	2.7 to 5.5	2.7 to 5.5	4 to 24	4 to 30	–	–	1	600	fo	CMOS	High impedance
SM5022A3AH	2.7 to 5.5	2.7 to 5.5	4 to 30	4 to 30	8	10	1	600	fo/2	CMOS	High impedance
SM5022A4AH	2.7 to 5.5	2.7 to 5.5	4 to 30	4 to 30	–	–	1	600	fo/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	fo/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	fo/8	CMOS	High impedance
SM5022B1AH	4.5 to 5.5	4.5 to 5.5	×	4 to 30	8	10	1	600	fo	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.

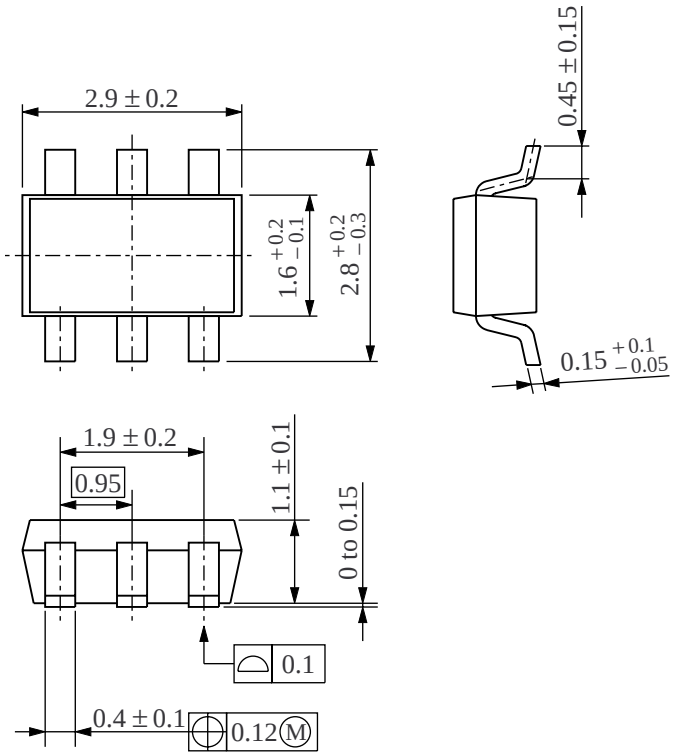
ORDERING INFORMATION

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

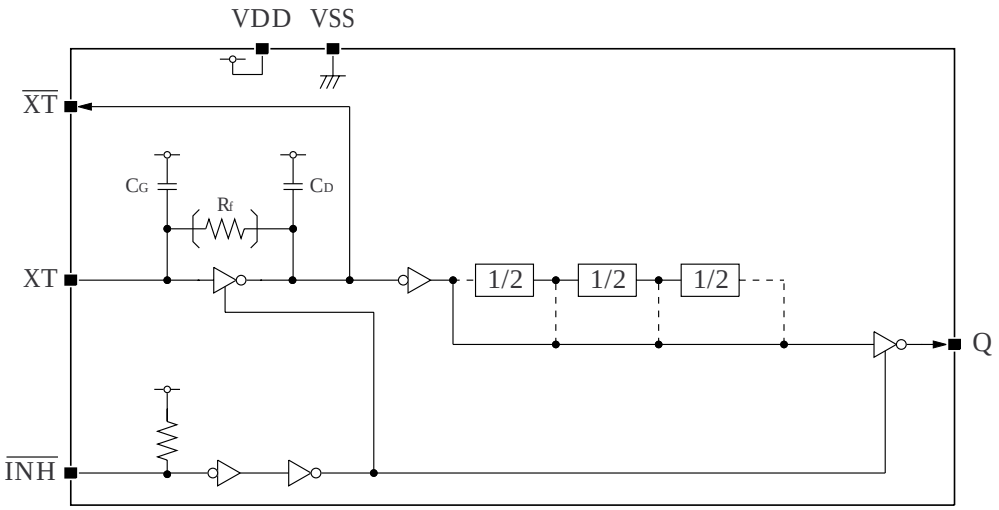
PACKAGE DIMENSIONS

(UNIT : mm)

• 6-pin SOT



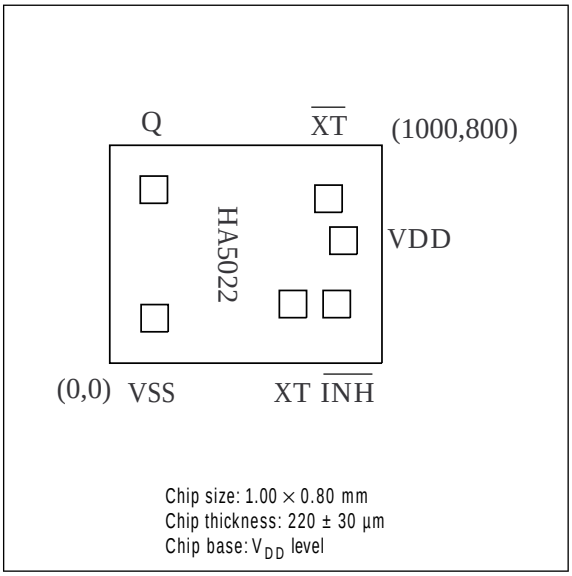
BLOCK DIAGRAM



(INH : Low active)

PAD LAYOUT

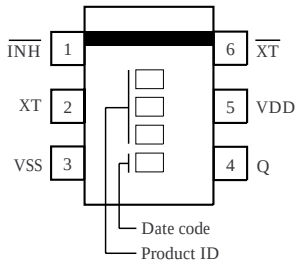
(Unit : µm)



Chip size: 1.00 × 0.80 mm
Chip thickness: 220 ± 30 µm
Chip base: V_{DD} level

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	$\overline{INH}$	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 $\overline{XT}$	637	217
3	VSS	–	Ground		165	165
4	Q	O	Output. Output frequency (f_O, $f_O/2$, $f_O/4$, $f_O/8$) determined by internal connection		162	637
5	VDD	–	Supply voltage		859	450
6	$\overline{XT}$	O	Amplifier output.	Crystal oscillator connection pins. Crystal oscillator connected between XT and $\overline{XT}$	804	604

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
		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 V, f ≤ 30MHz, C_L ≤ 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

5 V operation: A×A series/ B×A series

V_{SS} = 0 V, f ≤ 30MHz, C_L ≤ 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

Electrical Characteristics

3 V operation: A×A series

V_{DD} = 2.7 to 3.6 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, 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	kΩ
Feedback resistance	R_f	Measurement cct 5		200	600	1000	kΩ
Built-in capacitance	C_G	Design value, determined by the internal wafer pattern	SM5022A1AH, CF5022A1A SM5022A3AH, CF5022A3A SM5022A5AH, CF5022A5A SM5022A7AH, CF5022A7A	7.44	8	8.56	pF
	C_D			9.3	10	10.7	pF

5 V operation: A×A series/ B×A series

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, 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	SM5022A×AH, CF5022A×A	–	7	12	mA
		$\overline{INH}$ = open, Measurement cct 3, load cct 2, C_L = 15 pF, 30 MHz crystal oscillator	SM5022B×AH, CF5022B×A	–	7	12	
$\overline{INH}$ pull-up resistance	R_{UP}	Measurement cct 4		25	100	250	kΩ
Feedback resistance	R_f	Measurement cct 5		200	600	1000	kΩ
Built-in capacitance	C_G	Design value, determined by the internal wafer pattern	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 (A×A series)

3 V operation

V_{DD} = 2.7 to 3.6 V, V_{SS} = 0 V, Ta = –20 to 80 °C unless otherwise noted.

Parameter	Symbol	Condition		Rating			Unit
				min	typ	max	
Output rise time	t_{f1}	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, Ta = 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, Ta = 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, Ta = –20 to 80 °C unless otherwise noted.

Parameter	Symbol	Condition	Rating			Unit
			min	typ	max	
Output rise time	t_{f2}	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, Ta = 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, Ta = 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)

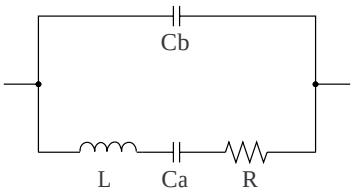
5 V operation

V_{DD} = 4.5 to 5.5 V, V_{SS} = 0 V, Ta = –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, Ta = 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, Ta = 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

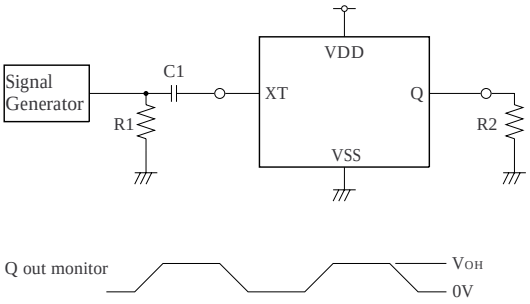
Standby Function

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

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

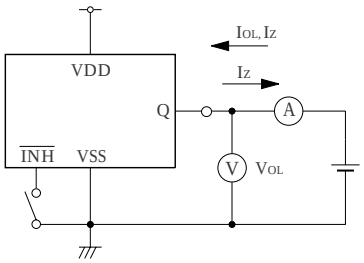
MEASUREMENT CIRCUITS

Measurement cct 1

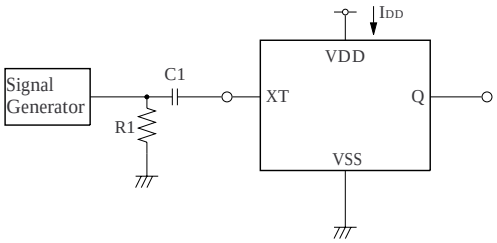


$2.0V_{P-P}$, 10MHz sine wave input signal (3V operation)
$3.5V_{P-P}$, 10MHz sine wave input signal (5V operation)
C1 : 0.001µF
R1 : 50Ω
R2 : 525Ω (3V operation)
490Ω (5V operation)

Measurement cct 2

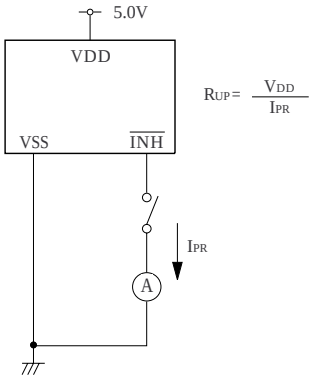


Measurement cct 3

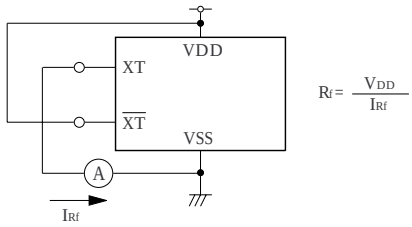


$2.0V_{P-P}$, 30MHz sine wave input signal (3V operation)
$3.5V_{P-P}$, 30MHz sine wave input signal (5V operation)
C1 : 0.001µF
R1 : 50Ω

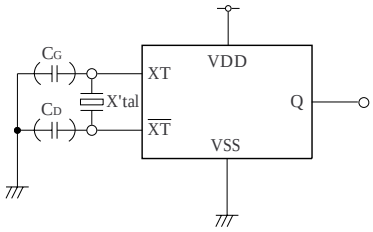
Measurement cct 4



Measurement cct 5

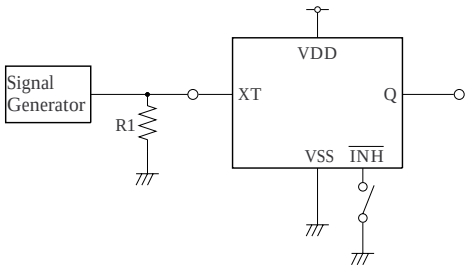


Measurement cct 6



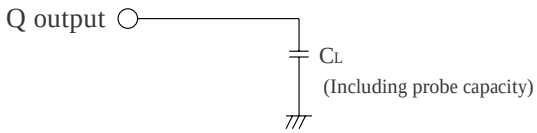
C_G , C_D : 10pF (5022A2, 5022A4)

Measurement cct 7



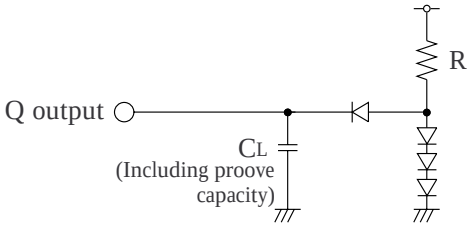
R1 : 50Ω

Load cct 1



$C_L = 15pF$

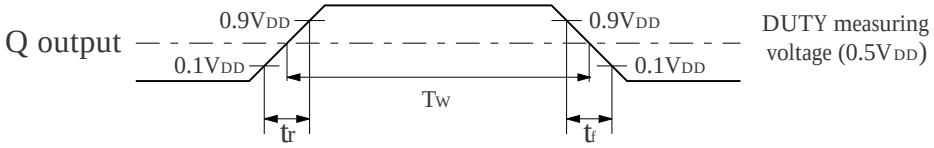
Load cct 2



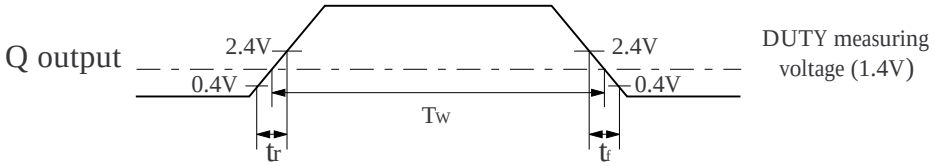
$C_L = 15pF$
$R = 800\Omega$

Switching Time Measurement Waveform

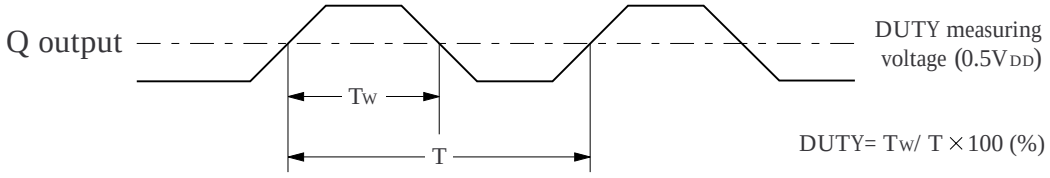
Output duty level (CMOS)



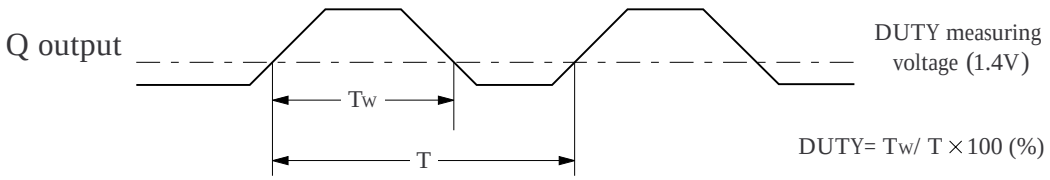
Output duty level (TTL)



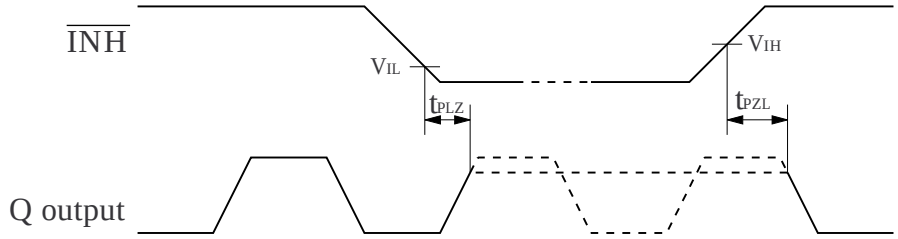
Output duty cycle (CMOS)



Output duty cycle (TTL)



Output Enable/Disable Delay



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

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