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

SERIES CONFIGURATION

Version*1	Operating supply voltage range [V]		Recommended operating frequency range*2 [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			4 to 30		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 CF5022××.

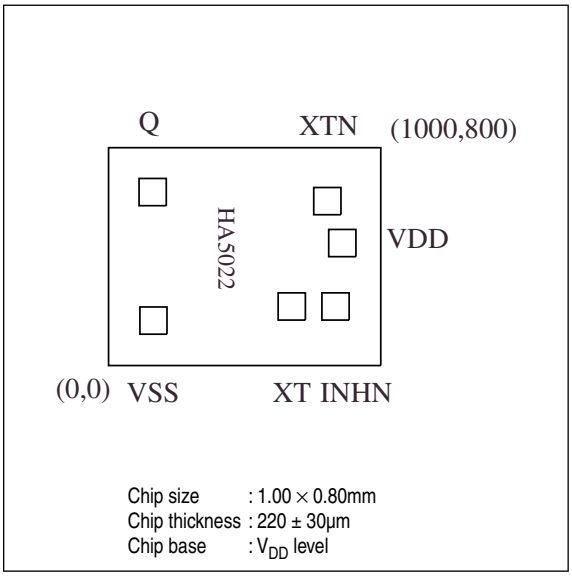
*2. The recommended operating frequency is a yardstick value derived from the crystal used for NPC characteristics authentication. However, the oscillator frequency band is not guaranteed. Specifically, the characteristics can vary greatly due to crystal characteristics and mounting conditions, so the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

ORDERING INFORMATION

Device	Package
SM5022××AH	SOT23-6
CF5022××A–2	Chip form

PAD LAYOUT

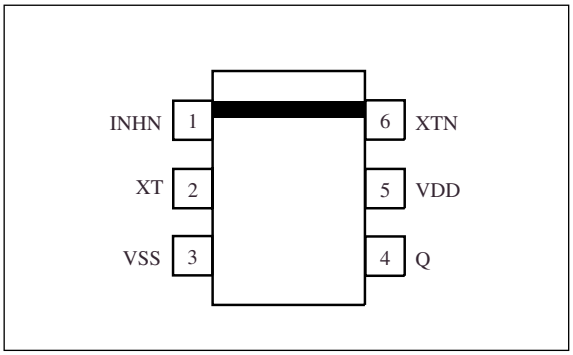
(Unit: µm)



Chip size : 1.00 × 0.80mm
Chip thickness : 220 ± 30µm
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

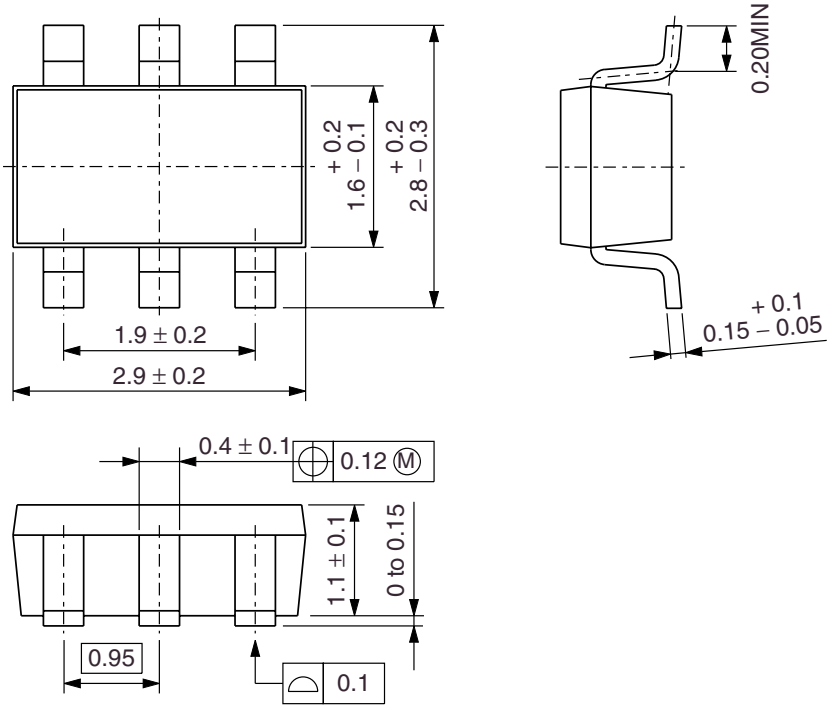
PIN DESCRIPTION and PAD DIMENSIONS

Number	Name	I/O	Description		Pad dimensions [µm]	
					X	Y
1	INHN	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_O, $f_O/2$, $f_O/4$, $f_O/8$) 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

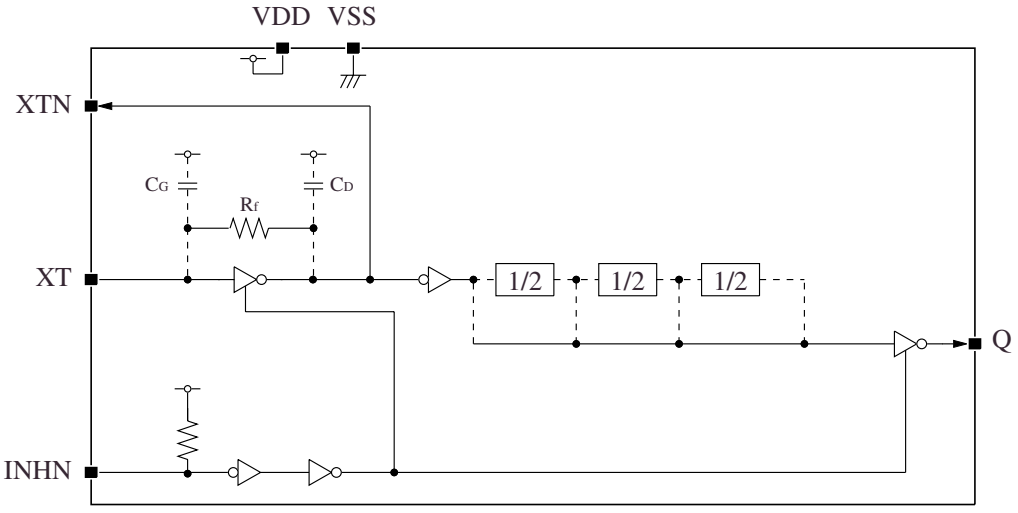
PACKAGE DIMENSIONS

(Unit: mm)

• 6-pin SOT



BLOCK DIAGRAM



$\overline{INH}$ = LOW active

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 ≤ 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

5V operation: A×A series/ B×A series

V_{SS} = 0V, 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

3V operation: A×A series

V_{DD} = 2.7 to 3.6V, V_{SS} = 0V, Ta = − 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} = 2.7V, 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}	INHN		2.0	–	–	V
LOW-level input voltage	V_{IL}	INHN		–	–	0.5	V
Output leakage current	I_Z	Q: Measurement cct 2, V_{DD} = 3.6V, INHN = LOW, V_{OH} = V_{DD}		–	–	10	µA
		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
INHN 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. 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, Ta = − 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} = 4.5V, 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}	INHN		2.0	–	–	V
LOW-level input voltage	V_{IL}	INHN		–	–	0.8	V
Output leakage current	I_Z	Q: Measurement cct 2, V_{DD} = 5.5V, INHN = LOW, V_{OH} = V_{DD}		–	–	10	µA
		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	
INHN 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. 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: A×A series

3V operation

V_{DD} = 2.7 to 3.6V, V_{SS} = 0V, Ta = − 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 = 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*1	Duty	Measurement cct 6, load cct 1, V_{DD} = 3V, Ta = 25°C, C_L = 15pF, f = 30MHz		45	–	55	%
Output disable delay time*2	t_{PLZ}	Measurement cct 7, load cct 1, V_{DD} = 3V, Ta = 25°C, C_L = 15pF		–	–	100	ns
Output enable delay time*2	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, Ta = − 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 = 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*1	Duty	Measurement cct 6, load cct 1, V_{DD} = 5V, Ta = 25°C, C_L = 15pF, f = 30MHz	45	–	55	%
Output disable delay time*2	t_{PLZ}	Measurement cct 7, load cct 1, V_{DD} = 5V, Ta = 25°C, C_L = 15pF	–	–	100	ns
Output enable delay time*2	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: B×A series

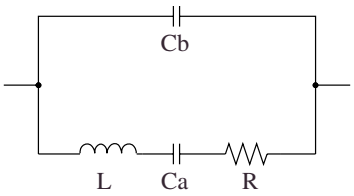
5V operation

V_{DD} = 4.5 to 5.5V, V_{SS} = 0V, 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 = 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*1	Duty	Measurement cct 6, load cct 2, V_{DD} = 5V, Ta = 25°C, C_L = 15pF, f = 30MHz	45	–	55	%
Output disable delay time*2	t_{PLZ}	Measurement cct 7, load cct 2, V_{DD} = 5V, Ta = 25°C, C_L = 15pF	–	–	100	ns
Output enable delay time*2	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

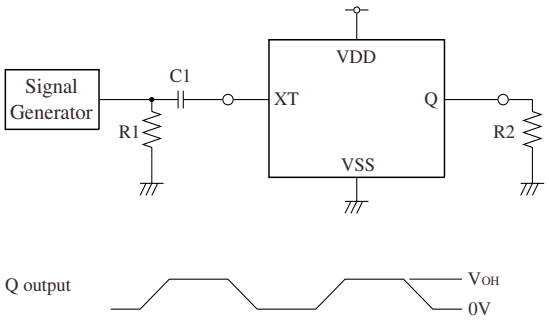
Standby Function

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

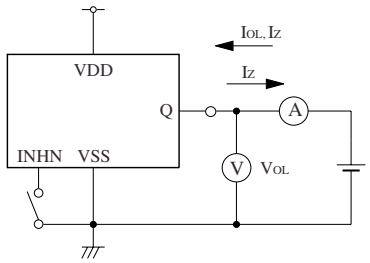
MEASUREMENT CIRCUITS

Measurement cct 1

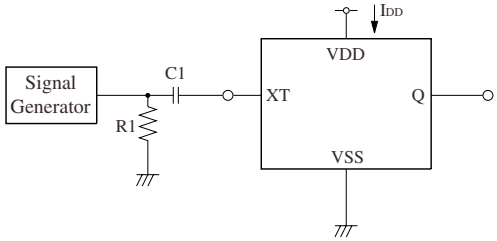


2.0Vp-p, 10MHz sine wave input signal (3V operation)
3.5Vp-p, 10MHz sine wave input signal (5V operation)
C1: 0.001µF
R1: 50Ω
R2: 525Ω (3V operation)
490Ω (5V operation)

Measurement cct 2

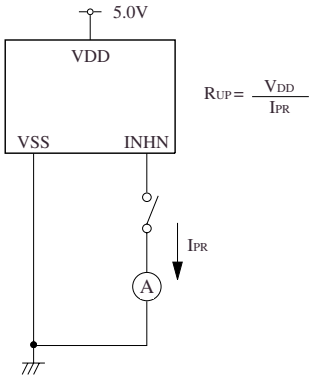


Measurement cct 3

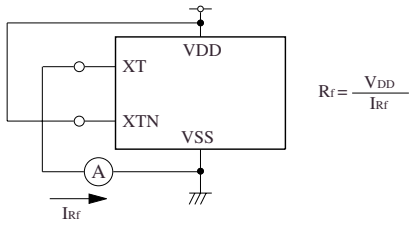


2.0Vp-p, 30MHz sine wave input signal (3V operation)
3.5Vp-p, 30MHz sine wave input signal (5V operation)
C1: 0.001µF
R1: 50Ω

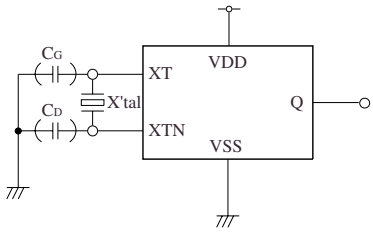
Measurement cct 4



Measurement cct 5

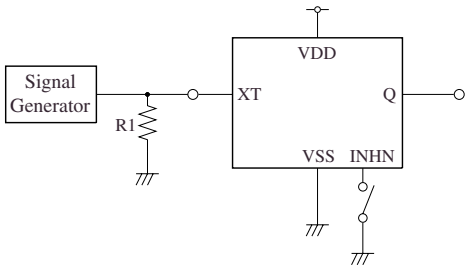


Measurement cct 6



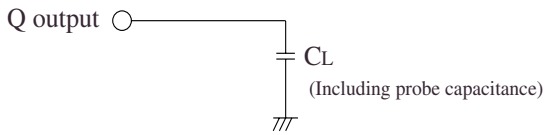
C_G , C_D: 10pF (5022A2, 5022A4)

Measurement cct 7



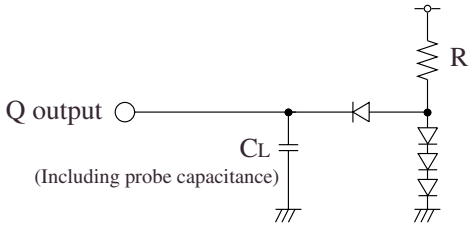
R1: 50Ω

Load cct 1



C_L = 15pF

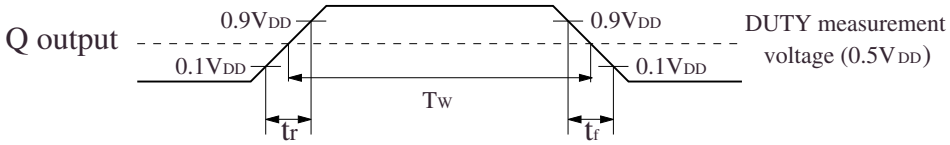
Load cct 2



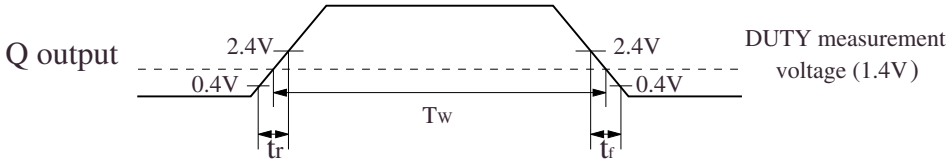
C_L = 15pF
R = 800Ω

Switching Time Measurement Waveform

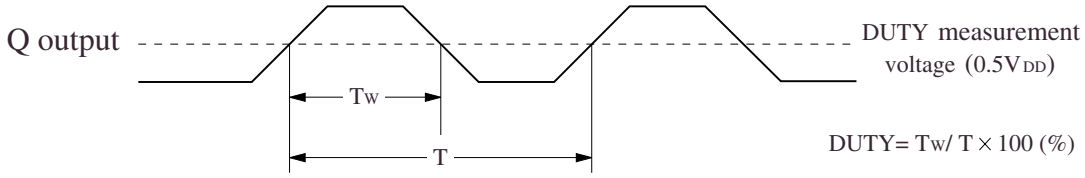
Output duty level (CMOS)



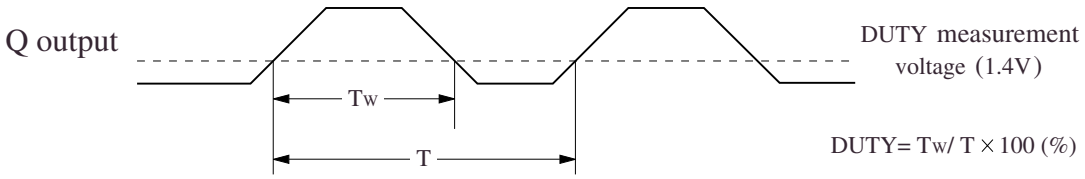
Output duty level (TTL)



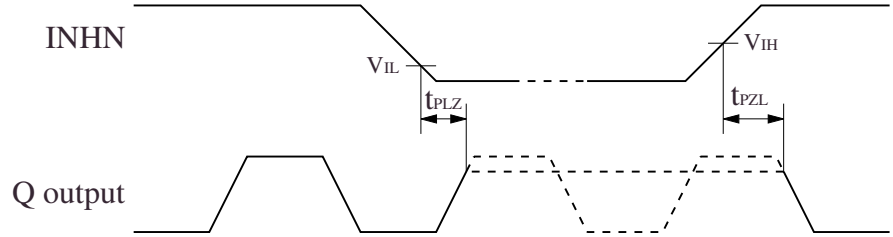
Output duty cycle (CMOS)



Output duty cycle (TTL)



Output Enable/Disable Delay



INHN input waveform $t_r = t_f \leq 10$ns

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