

OVERVIEW

The SM5021 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 3rd-harmonic oscillator.

FEATURES

- 3rd overtone oscillation
- Capacitors CG, CD built-in
- Inverter amplifier feedback resistor built-in (A×, B× series)
- 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×, K× series)
4.5 to 5.5 V supply voltage (B×, L× series)
- Oscillator frequency output
- 6-pin SOT (SM5021××H)
- Chip form (CF5021××)

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					
SM5021AAH	4.5 to 5.5	4.5 to 5.5	×	22 to 30	8	15	1	6.0	f _o	CMOS	High impedance
SM5021ABH	2.7 to 5.5	2.7 to 5.5	22 to 30	30 to 43	8	15	1	3.3	f _o	CMOS	High impedance
SM5021ACH	2.7 to 5.5	2.7 to 5.5	30 to 40	43 to 55	8	15	2	3.9	f _o	CMOS	High impedance
SM5021ADH	2.7 to 5.5	2.7 to 5.5	40 to 50	55 to 70	8	15	3	2.7	f _o	CMOS	High impedance
SM5021AEH	2.7 to 3.6	×	50 to 70	×	8	12	4	2.7	f _o	CMOS	High impedance
SM5021BAH	4.5 to 5.5	4.5 to 5.5	×	22 to 30	8	15	1	6.0	f _o	TTL	High impedance
SM5021BBH	4.5 to 5.5	4.5 to 5.5	×	30 to 43	8	15	1	3.3	f _o	TTL	High impedance
SM5021BCH	4.5 to 5.5	4.5 to 5.5	×	43 to 55	8	15	2	3.9	f _o	TTL	High impedance
SM5021BDH	4.5 to 5.5	4.5 to 5.5	×	55 to 70	8	15	3	2.7	f _o	TTL	High impedance
SM5021KDH	2.7 to 5.5	2.7 to 5.5	22 to 50	22 to 70	8	15	3	—	f _o	CMOS	High impedance
SM5021KEH	2.7 to 3.6	2.7 to 3.6	50 to 70	×	8	12	4	—	f _o	CMOS	High impedance
SM5021LDH	4.5 to 5.5	4.5 to 5.5	×	22 to 70	8	15	3	—	f _o	TTL	High impedance

1. Chip form devices have designation CF5021××.

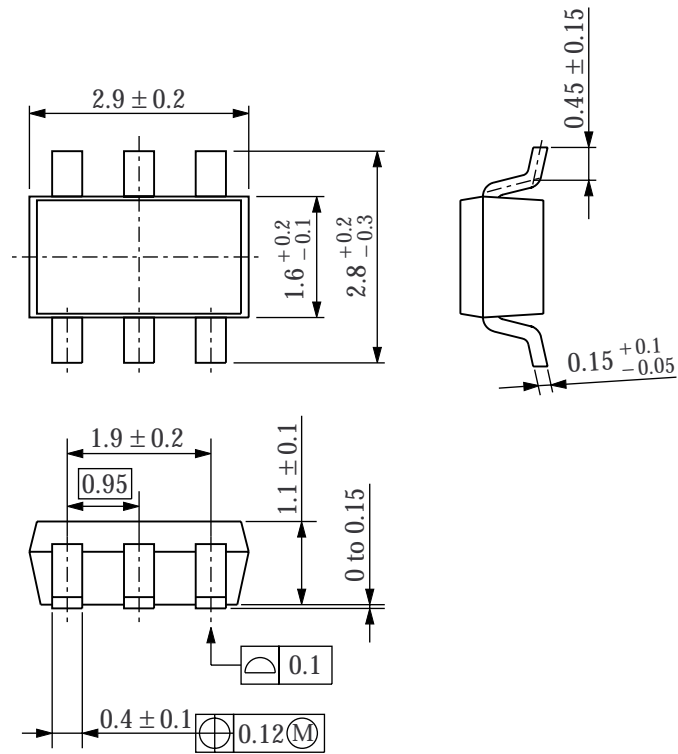
ORDERING INFORMATION

Devicez	Package
SM5021××H	6-pin SOT
CF5021××-2	Chip form

PACKAGE DIMENSIONS

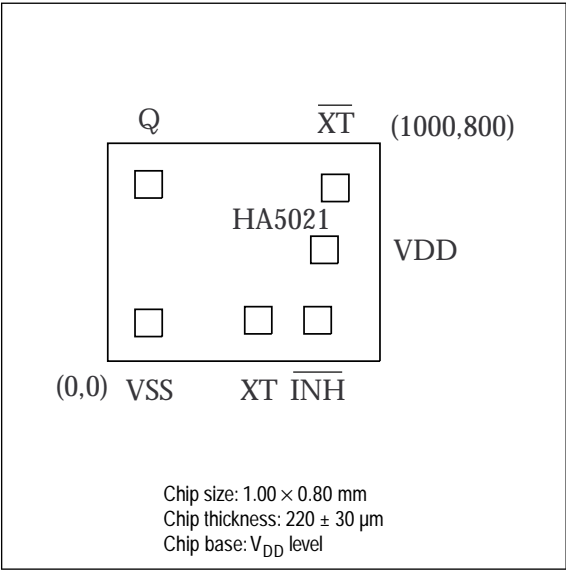
(UNIT : mm)

- 6-pin SOT



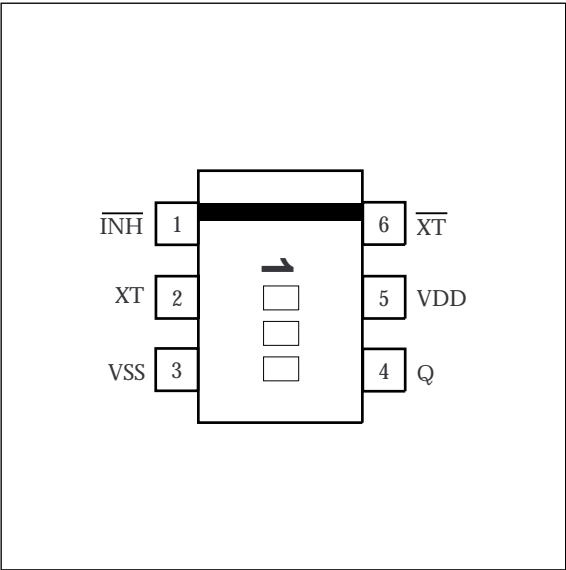
PAD LAYOUT

(Unit : μm)



PINOUT

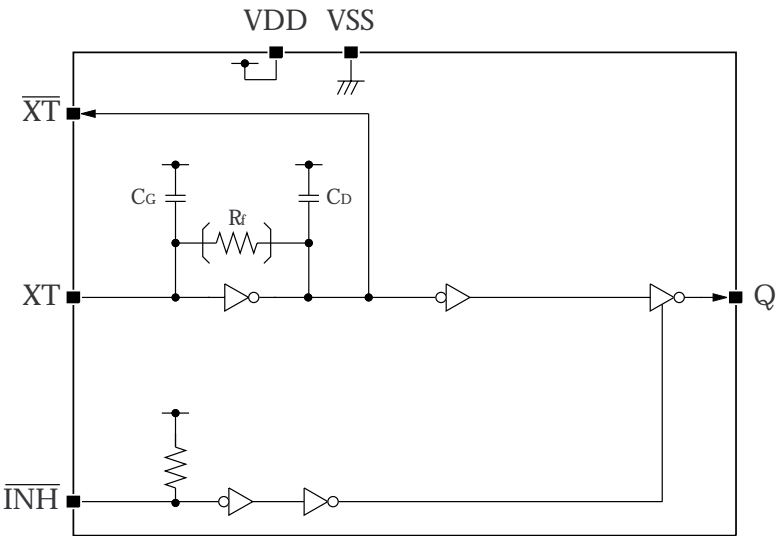
(Top View)



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	771	150
2	XT	I	Amplifier input. Crystal oscillator connection pins. Crystal oscillator connected between XT and $\overline{\text{XT}}$	553	150
3	VSS	-	Ground	150	140
4	Q	O	Output. Output frequency (f_o)	150	649
5	VDD	-	Supply voltage	796	409
6	$\overline{\text{XT}}$	O	Amplifier output. Crystal oscillator connection pins. Crystal oscillator connected between XT and $\overline{\text{XT}}$	836	636

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

$$V_{SS} = 0 \text{ V}, f \leq 70\text{MHz}, C_L \leq 15\text{pF}$$

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.

Electrical Characteristics

3 V operation: AA, AB, AC, AD, AE series/ KD, KE 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	SM5021×AH, CF5021×A SM5021×BH, CF5021×B SM5021×CH, CF5021×C SM5021×DH, CF5021×D	2.1	2.4	–	V
		Q: Measurement cct 1, $V_{DD} = 2.7$ V, $I_{OH} = 8$ mA	SM5021×EH, CF5021×E				
LOW-level output voltage	V_{OL}	Q: Measurement cct 2, $V_{DD} = 2.7$ V, $I_{OL} = 4$ mA	SM5021×AH, CF5021×A SM5021×BH, CF5021×B SM5021×CH, CF5021×C SM5021×DH, CF5021×D	–	0.3	0.4	V
		Q: Measurement cct 2, $V_{DD} = 2.7$ V, $I_{OL} = 8$ mA	SM5021×EH, CF5021×E				
Output leakage current	I_Z	Q: Measurement cct 2, $V_{DD} = 3.3$ V, $\overline{INH} = \text{LOW}$, $V_{OH} = V_{DD}$		–	–	10	μA
		Q: Measurement cct 2, $V_{DD} = 3.3$ 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, 70 MHz crystal oscillator	SM5021A×H, CF5021A× SM5021K×H, CF5021K×	–	13	25	mA
\overline{INH} pull-up resistance	R_{UP}	Measurement cct 4		25	100	250	k Ω
Feedback resistance (A× series only)	R_f	Measurement cct 5	SM5021×AH, CF5021×A	5.1	6.0	6.9	k Ω
			SM5021×BH, CF5021×B	2.8	3.3	3.8	
			SM5021×CH, CF5021×C	3.3	3.9	4.5	
			SM5021×DH, CF5021×D SM5021×EH, CF5021×E	2.3	2.7	3.1	
Built-in capacitance	C_G	Design value, determined by the internal wafer pattern		7.44	8	8.56	pF
	C_D	Design value, determined by the internal wafer pattern	SM5021×AH, CF5021×A SM5021×BH, CF5021×B SM5021×CH, CF5021×C SM5021×DH, CF5021×D	13.95	15	16.05	pF
			SM5021×EH, CF5021×E	11.16	12	12.84	

SM5021 series

5 V operation: AA, AB, AC, AD series/ BA, BB, BC, BD series/ KD series/ LD 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, $\overline{\text{INH}}$ = LOW, V _{OH} = V _{DD}		–	–	10	μA
		Q: Measurement cct 2, V _{DD} = 5.5 V, $\overline{\text{INH}}$ = LOW, V _{OL} = V _{SS}		–	–	10	
HIGH-level input voltage	V _{IH}	$\overline{\text{INH}}$		2.0	–	–	V
LOW-level input voltage	V _{IL}	$\overline{\text{INH}}$		–	–	0.8	V
Current consumption	I _{DD}	$\overline{\text{INH}}$ = open, Measurement cct 3, load cct 1, C _L = 15 pF, 70 MHz crystal oscillator	SM5021AAH, CF5021AA SM5021ABH, CF5021AB SM5021ACH, CF5021AC SM5021ADH, CF5021AD SM5021KDH, CF5021KD	–	18	35	mA
		$\overline{\text{INH}}$ = open, Measurement cct 3, load cct 2, C _L = 15 pF, 70 MHz crystal oscillator	SM5021B×H, CF5021B× SM5021L×H, CF5021L×	–	18	35	
$\overline{\text{INH}}$ pull-up resistance	R _{UP}	Measurement cct 4		25	100	250	kΩ
Feedback resistance (A×, B× series only)	R _f	Measurement cct 5	SM5021×AH, CF5021×A	5.1	6.0	6.9	kΩ
			SM5021×BH, CF5021×B	2.8	3.3	3.8	
			SM5021×CH, CF5021×C	3.3	3.9	4.5	
			SM5021×DH, CF5021×D	2.3	2.7	3.1	
Built-in capacitance	C _G	Design value, determined by the internal wafer pattern	SM5021×AH, CF5021×A SM5021×BH, CF5021×B	7.44	8	8.56	pF
	C _D		SM5021×CH, CF5021×C SM5021×DH, CF5021×D	13.95	15	16.05	pF

Switching Characteristics

CMOS

3 V operation: AA, AB, AC, AD, AE series/ KD, KE 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	
Output rise time	t_{r1}	Measurement cct 6, load cct 1, $0.1V_{DD}$ to $0.9V_{DD}$, $C_L = 15$ pF	–	5	10	ns
		SM5021AAH, CF5021AA SM5021ABH, CF5021AB SM5021ACH, CF5021AC SM5021ADH, CF5021AD SM5021KDH, CF5021KD	–	3.5	7	
		Measurement cct 6, load cct 1, $0.2V_{DD}$ to $0.8V_{DD}$, $C_L = 15$ pF	–	3.5	7	
Output fall time	t_{f1}	Measurement cct 6, load cct 1, $0.9V_{DD}$ to $0.1V_{DD}$, $C_L = 15$ pF	–	5	10	ns
		SM5021AAH, CF5021AA SM5021ABH, CF5021AB SM5021ACH, CF5021AC SM5021ADH, CF5021AD SM5021KDH, CF5021KD	–	3.5	7	
		Measurement cct 6, load cct 1, $0.8V_{DD}$ to $0.2V_{DD}$, $C_L = 15$ pF	–	3.5	7	
Output duty cycle ¹	Duty	Measurement cct 6, load cct 1, $T_a = 25$ °C, $V_{DD} = 3$ V, $C_L = 15$ pF, $f \leq 70$ MHz	45	–	55	%
Output disable delay time	t_{PLZ}	Measurement cct 6, load cct 1, $T_a = 25$ °C, $V_{DD} = 3$ V, $C_L = 15$ pF	–	–	100	ns
Output enable delay time	t_{PZL}		–	–	100	ns

1. Determined by the lot monitor.

5 V operation: AA, AB, AC, AD series/ KD 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	
Output rise time	t_{r1}	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_{f1}	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, $f \leq 70$ MHz	45	–	55	%
Output disable delay time	t_{PLZ}	Measurement cct 6, load cct 1, $T_a = 25$ °C, $V_{DD} = 5$ V, $C_L = 15$ pF	–	–	100	ns
Output enable delay time	t_{PZL}		–	–	100	ns

1. Determined by the lot monitor.

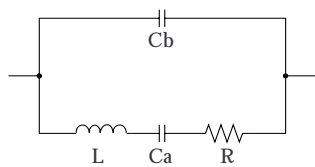
TTL

5 V operation: BA, BB, BC, BD series/ LD 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	
Output rise time	t_{r2}	Measurement cct 6, load cct 2, 0.4V to 2.4V, $C_L = 15$ pF	–	2.5	7	ns
Output fall time	t_{f2}	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, $f \leq 70$ MHz	45	–	55	%
Output disable delay time	t_{PLZ}	Measurement cct 6, load cct 2, $T_a = 25$ °C, $V_{DD} = 5$ V, $C_L = 15$ pF	–	–	100	ns
Output enable delay time	t_{PZL}		–	–	100	ns

1. Determined by the lot monitor.

Current consumption and Output waveform with NPC's standard crystal

f (MHz)	R (Ω)	L (mH)	Ca (fF)	Cb (pF)
30	18.62	16.24	1.733	5.337
40	20.53	11.34	1.396	3.989
50	22.17	7.40	1.370	4.105
60	22.20	5.05	1.388	4.226
70	25.42	4.18	1.254	5.170

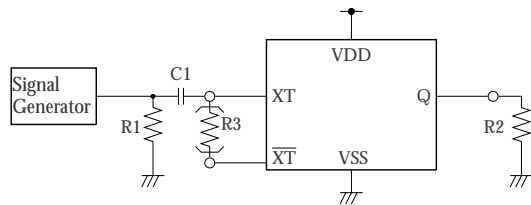
FUNCTIONAL DESCRIPTION**Standby Function**

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

\overline{INH}	Q	Oscillator
HIGH (or open)	f_O output frequency	Normal operation
LOW	High impedance	Normal operation

MEASUREMENT CIRCUITS

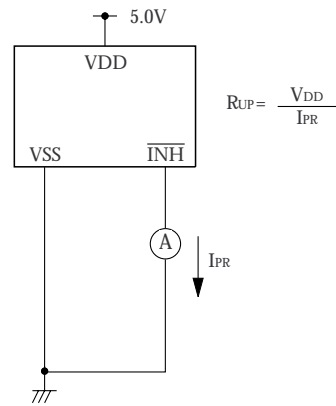
Measurement cct 1



Q out monitor V_{OH}
0V

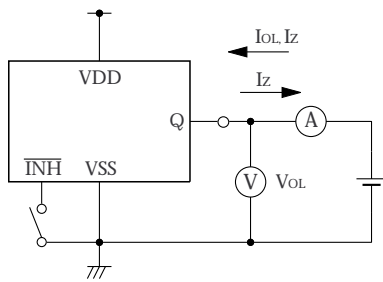
2.0V_{P-P}, 10MHz sine wave input signal (3V operation)
3.5V_{P-P}, 10MHz sine wave input signal (5V operation)
C1 : 0.001μF
R1 : 50Ω
R2 : 525Ω (3V operation/×A, ×B, ×C, ×D series)
263Ω (3V operation/×E series)
490Ω (5V operation)
R3 : 100kΩ (K×, L× series)

Measurement cct 4

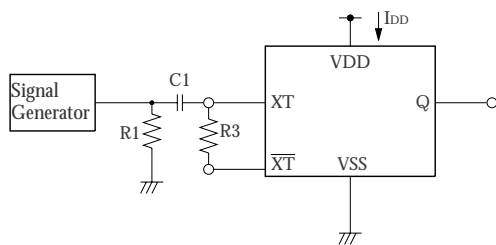


$$R_{UP} = \frac{V_{DD}}{I_{PR}}$$

Measurement cct 2

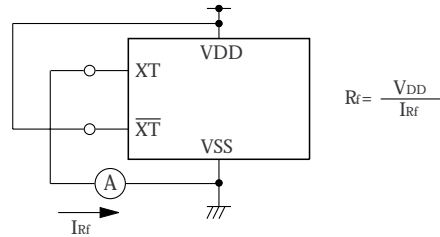


Measurement cct 3



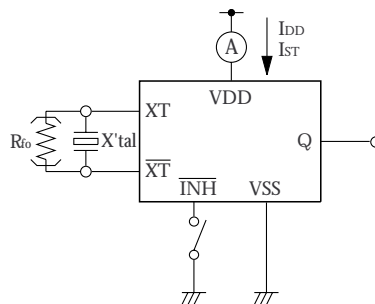
2.0V_{P-P}, 70MHz sine wave input signal (3V operation)
3.5V_{P-P}, 70MHz sine wave input signal (5V operation)
C1 : 0.001μF
R1 : 50Ω
R3 : 100kΩ (K×, L× series)

Measurement cct 5



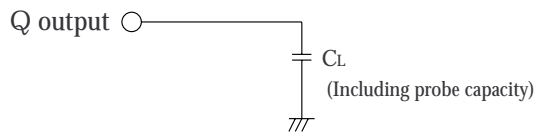
$$R_f = \frac{V_{DD}}{I_{rf}}$$

Measurement cct 6



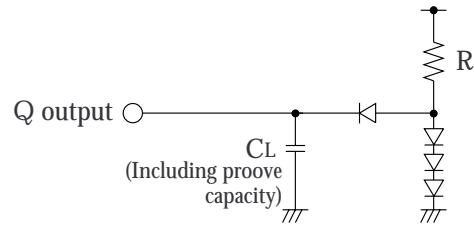
R_{f0} : 2.7kΩ (K×, L× series)

Load cct 1



$$C_L = 15\text{pF}; t_{r1}, t_{f1}$$

Load cct 2

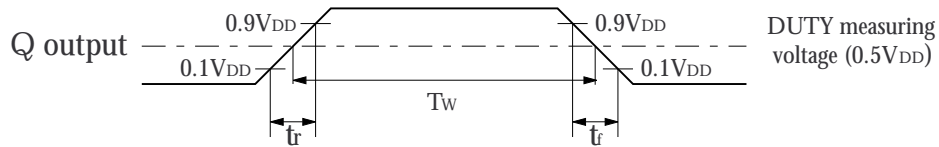


$$C_L = 15\text{pF}; t_{r2}, t_{f2}$$

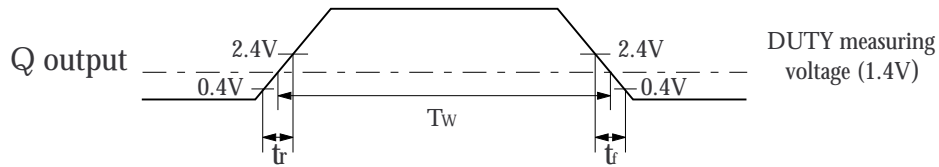
$$R = 800\Omega$$

Switching Time Measurement Waveform

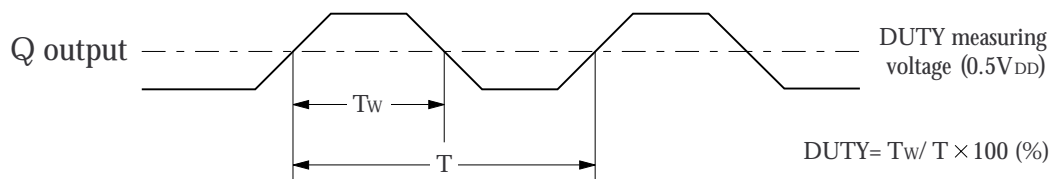
Output duty level (CMOS)



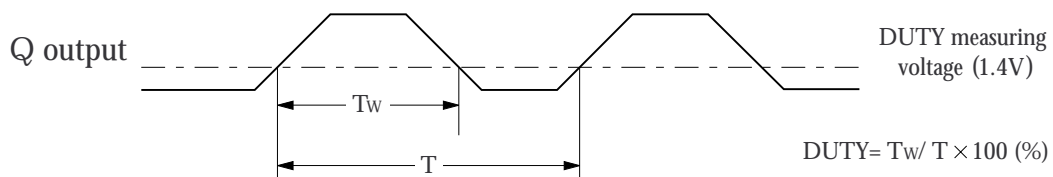
Output duty level (TTL)



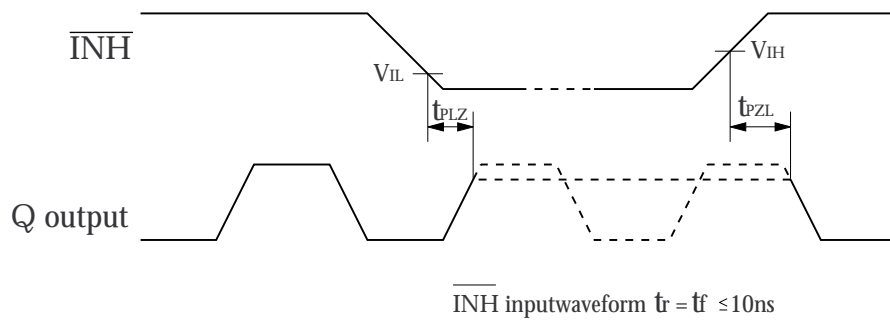
Output duty cycle (CMOS)



Output duty cycle (TTL)



Output Enable/Disable Delay



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NC9903AE 1999.11