

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. Highly

accurate thin-film 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× series)
- 4.5 to 5.5 V supply voltage (B× series)
- Oscillator frequency output (f_0 , $f_0/2$, $f_0/4$, $f_0/8$ determined by internal connection)
- 6-pin SOT (SM5022××H)
- Chip form (CF5022××)

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	CG	CD					
SM5022A1H	2.7 to 5.5	2.7 to 5.5	4 to 24	4 to 30	8	10	1	600	f_0	CMOS	High impedance
SM5022A2H	2.7 to 5.5	2.7 to 5.5	4 to 24	4 to 30	-	-	1	600	f_0	CMOS	High impedance
SM5022A3H	2.7 to 5.5	2.7 to 5.5	4 to 30	4 to 30	8	10	1	600	$f_0/2$	CMOS	High impedance
SM5022A4H	2.7 to 5.5	2.7 to 5.5	4 to 30	4 to 30	-	-	1	600	$f_0/2$	CMOS	High impedance
SM5022A5H	2.7 to 5.5	2.7 to 5.5	4 to 30	4 to 30	8	10	1	600	$f_0/4$	CMOS	High impedance
SM5022A7H	2.7 to 5.5	2.7 to 5.5	4 to 30	4 to 30	8	10	1	600	$f_0/8$	CMOS	High impedance
SM5022B1H	4.5 to 5.5	4.5 to 5.5	4 to 30	4 to 30	8	10	1	600	f_0	TTL	High impedance

1. Chip form devices have designation CF5022××.

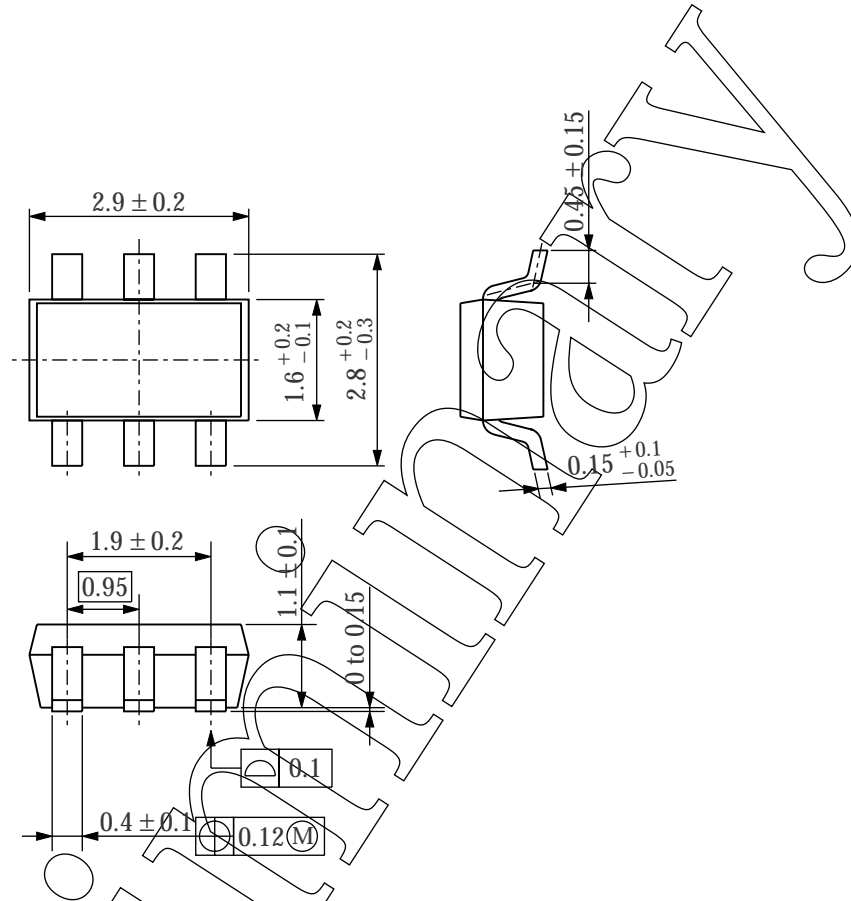
ORDERING INFORMATION

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

PACKAGE DIMENSIONS

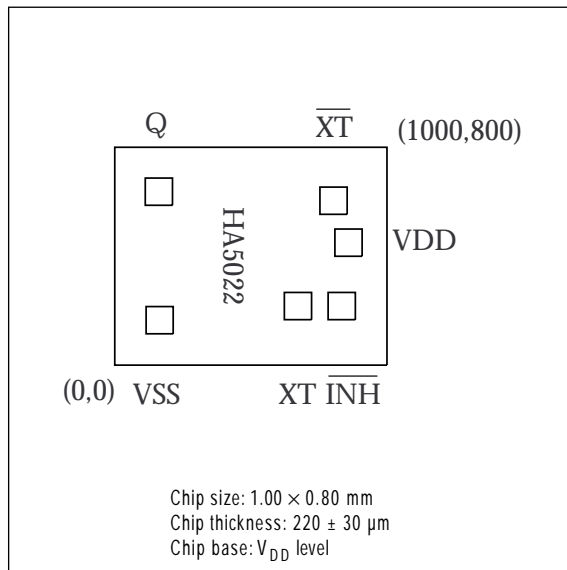
(UNIT : mm)

- 6-pin SOT



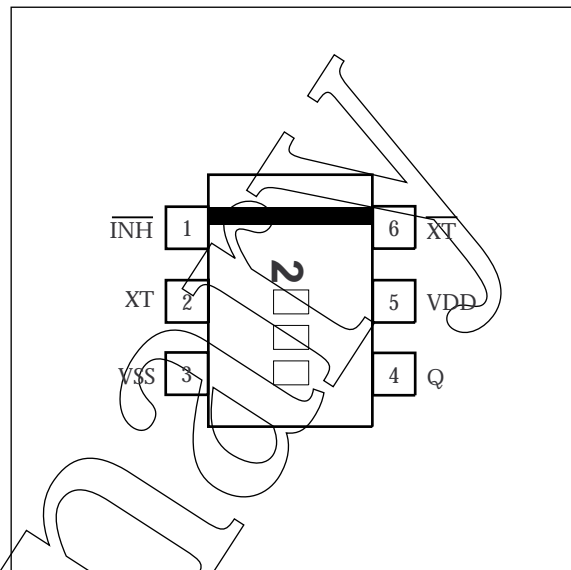
PAD LAYOUT

(Unit : μm)



PINOUT

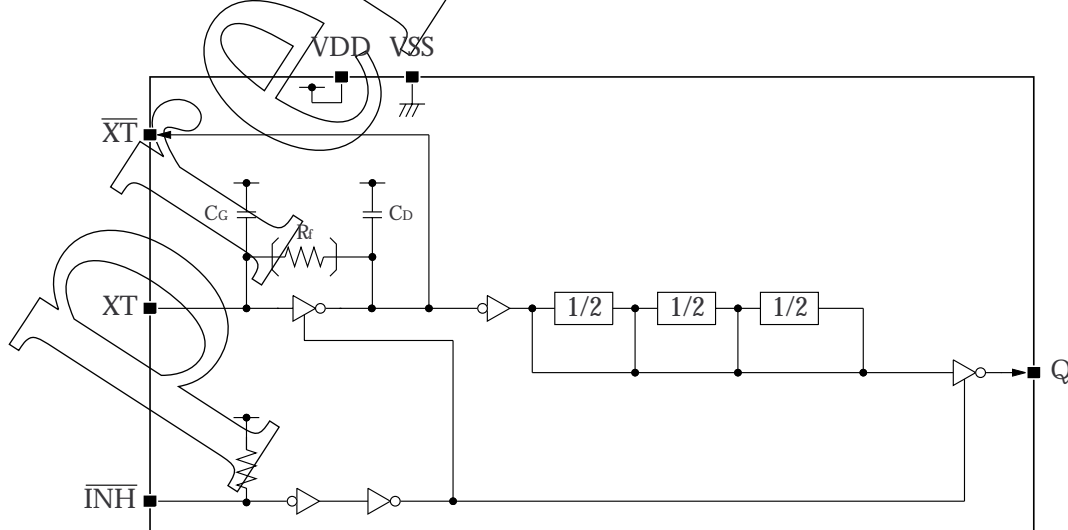
(Top View)



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	834	217
2	XT	I	Amplifier input Crystal oscillator connection pins. Crystal oscillator connected between XT and $\overline{\text{XT}}$	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	$\overline{\text{XT}}$	O	Amplifier output Crystal oscillator connection pins. Crystal oscillator connected between XT and $\overline{\text{XT}}$	804	604

BLOCK DIAGRAM



($\overline{\text{INH}}$: Low active)

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

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

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.

SM5022 series

Electrical Characteristics

3 V operation: 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, $\overline{INH} = \text{LOW}$, $V_{OH} = V_{DD}$	-	-	10	μA	
		Q: Measurement cct 2, $V_{DD} = 3.6$ 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, 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	SM5022A1H, CF5022A1	7.44	8	8.56	pF
	C_D		SM5022A3H, CF5022A3 SM5022A5H, CF5022A5 SM5022A7H, CF5022A7	9.3	10	10.7	pF

5 V operation: A× series/ B× 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, $\overline{INH} = \text{LOW}$, $V_{OH} = V_{DD}$	-	-	10	μA	
		Q: Measurement cct 2, $V_{DD} = 5.5$ 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}	-	-	0.8	V	
Current consumption	I_{DD}	$\overline{INH} = \text{open}$, Measurement cct 3, load cct 1, $C_L = 15$ pF, 30 MHz crystal oscillator	SM5022A×H, CF5022A×	-	7	12	mA
		$\overline{INH} = \text{open}$, Measurement cct 3, load cct 2, $C_L = 15$ pF, 30 MHz crystal oscillator	SM5022B×H, CF5022B×	-	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	SM5022A1H, CF5022A1 SM5022A3H, CF5022A3 SM5022A5H, CF5022A5	7.44	8	8.56	pF
	C_D		SM5022A7H, CF5022A7 SM5022B1H, CF5022B1	9.3	10	10.7	pF

Switching Characteristics

CMOS (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, $C_L = 15$ 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, $T_a = 25$ °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, $T_a = 25$ °C, $V_{DD} = 3$ V, $C_L = 15$ pF	-	-	100	ns	
Output enable delay time ²	t_{PZL}	Measurement cct 7, load cct 1, $T_a = 25$ °C, $V_{DD} = 3$ V, $C_L = 15$ pF	-	-	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, $0.1V_{DD}$ 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, $T_a = 25$ °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}	Measurement cct 7, load cct 1, $T_a = 25$ °C, $V_{DD} = 5$ V, $C_L = 15$ pF	-	-	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× series)

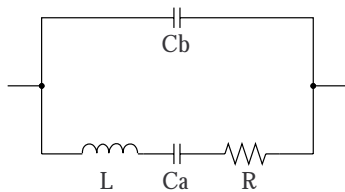
5 V operation

$V_{DD} = 4.5$ 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	18.62	16.24	1.733	5.337

FUNCTIONAL DESCRIPTION

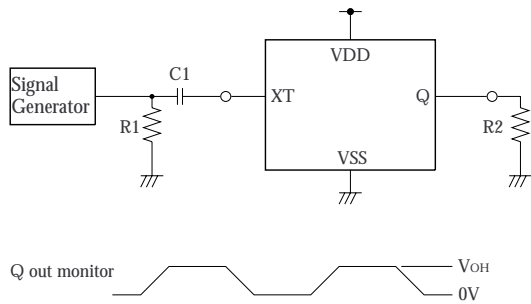
Standby Function

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

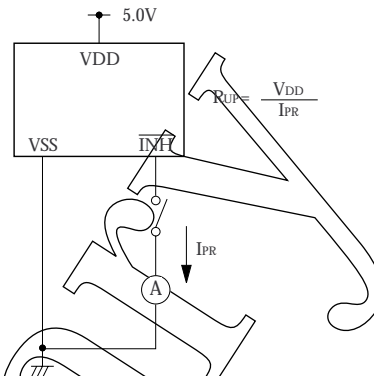
MEASUREMENT CIRCUITS

Measurement cct 1

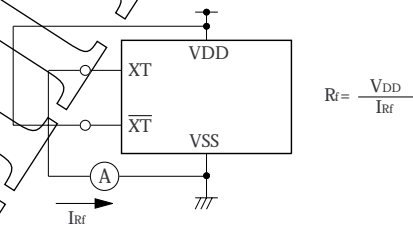


2.0V_{p-p}, 10MHz sine wave input signal (3V operation)
 3.5V_{p-p}, 10MHz sine wave input signal (5V operation)
 C1 : 0.001μF
 R1 : 50Ω
 R2 : 525Ω (3V operation)
 490Ω (5V operation)

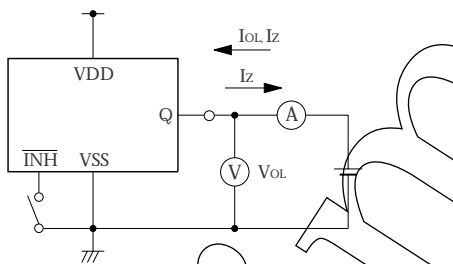
Measurement cct 4



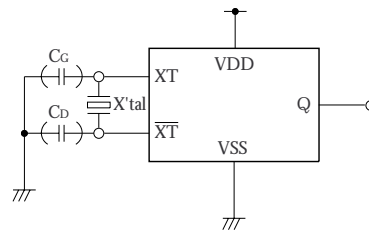
Measurement cct 5



Measurement cct 2

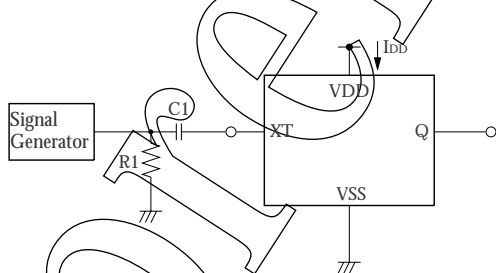


Measurement cct 6



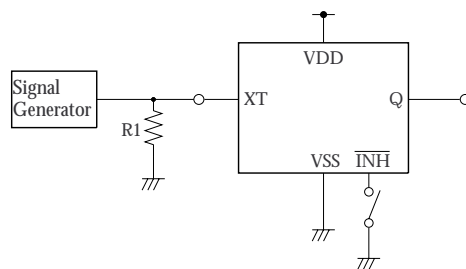
C_G, C_D : 10pF (5022A2, 5022A4)

Measurement cct 3



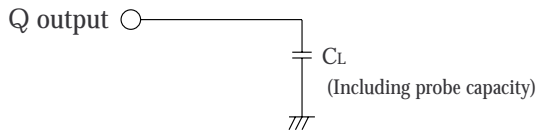
2.0V_{p-p}, 30MHz sine wave input signal (3V operation)
 3.5V_{p-p}, 30MHz sine wave input signal (5V operation)
 C1 : 0.001μF
 R1 : 50Ω

Measurement cct 7



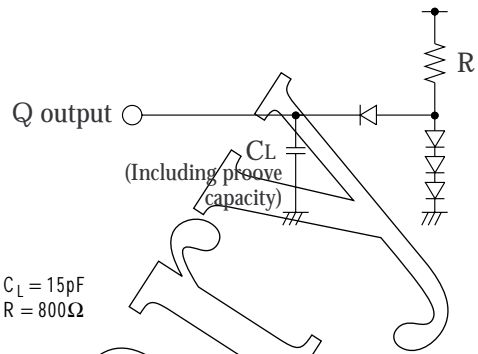
R1 : 50Ω

Load cct 1



$C_L = 15\text{pF}$

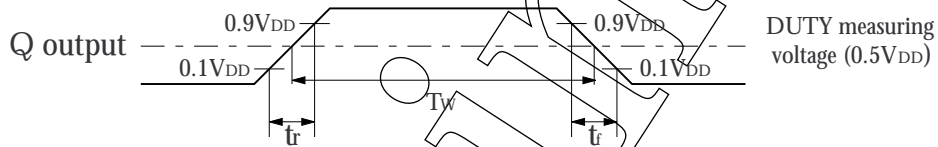
Load cct 2



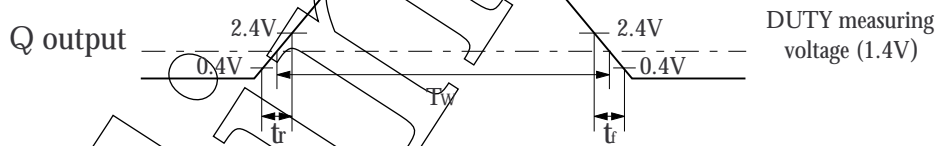
$C_L = 15\text{pF}$
 $R = 800\Omega$

Switching Time Measurement Waveform

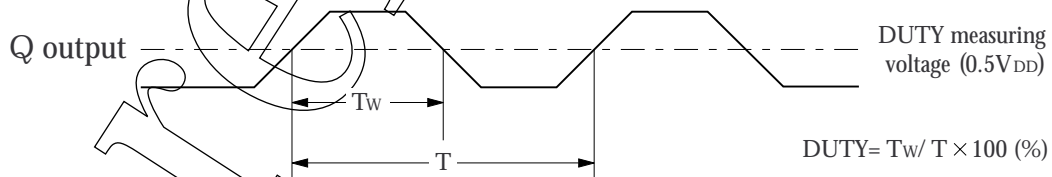
Output duty level (CMOS)



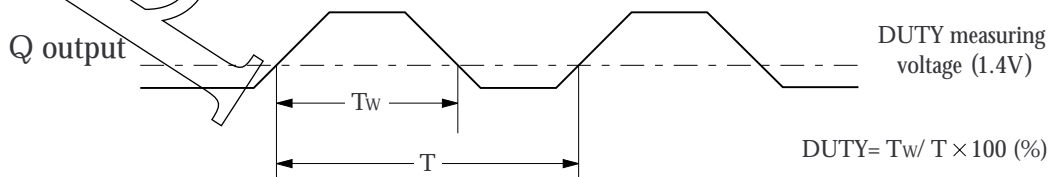
Output duty level (TTL)



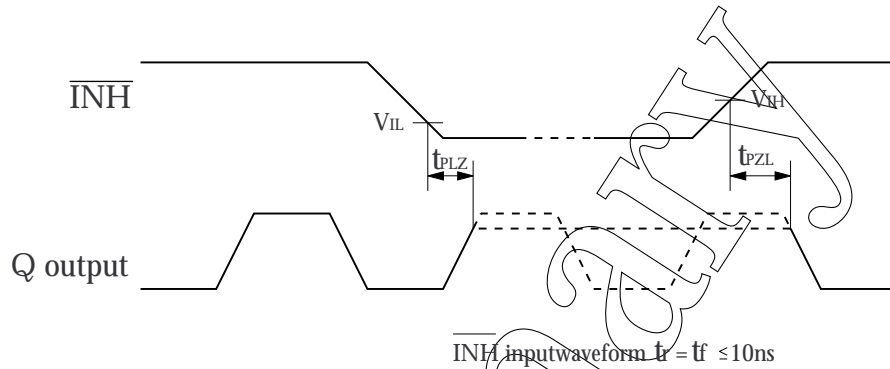
Output duty cycle (CMOS)



Output duty cycle (TTL)



Output Enable/Disable Delay



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