



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 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

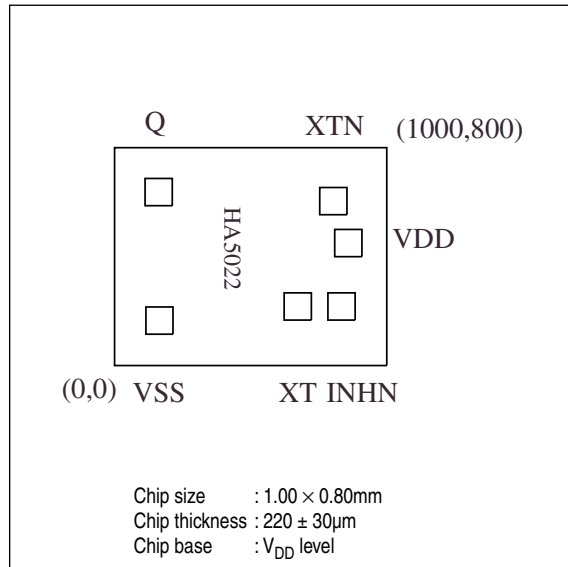
Version ^{*1}	Operating supply voltage range [V]		Recommended operating frequency range ^{*2} [MHz]		Built-in capacitance [pF]		gm ratio	Rf [kΩ]	Output frequency	Output level	Standby mode	
	Chip	SOT	3V operation	5V operation	C _G	C _D					Oscillator stop function	Output state
SM5022A1AH	2.7 to 5.5	2.7 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××.

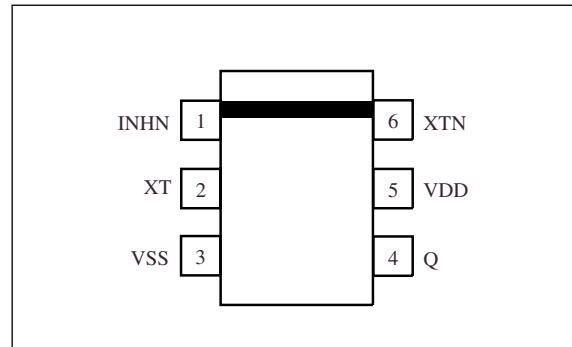
*2. The recommended operating frequency is a yardstick value derived from the crystal used for NPC characteristics authentication. However, the oscillator frequency band is not guaranteed. Specifically, the characteristics can vary greatly due to crystal characteristics and mounting conditions, so the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

(Top view)



Version	Product ID
SM5022A1AH	A00
SM5022A2AH	A01
SM5022A3AH	A02
SM5022A4AH	A03
SM5022A5AH	A04
SM5022A7AH	A05
SM5022B1AH	A06

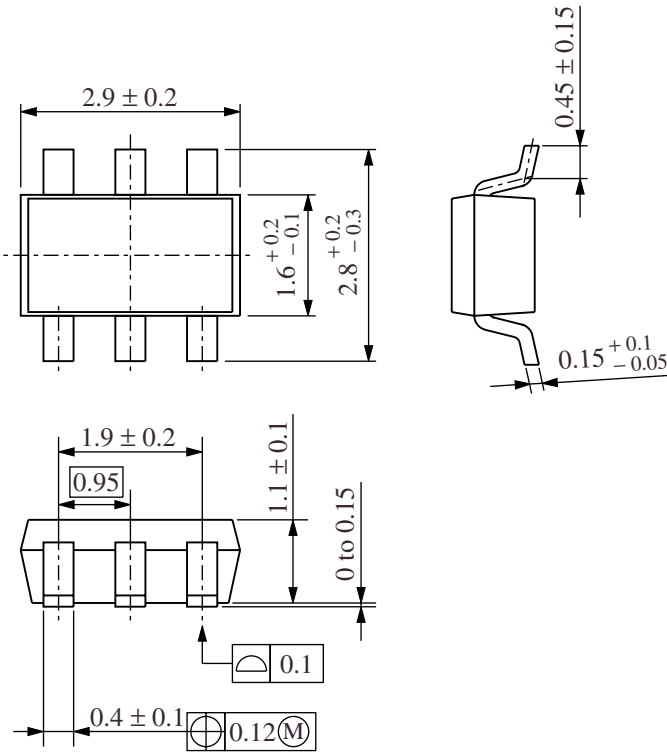
PIN DESCRIPTION and PAD DIMENSIONS

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

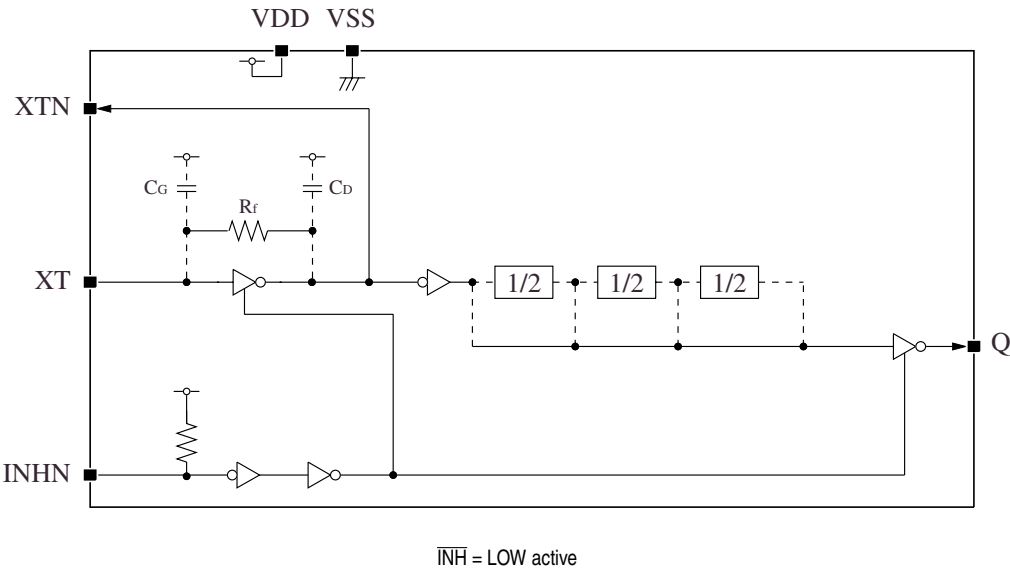
PACKAGE DIMENSIONS

(Unit: mm)

- 6-pin SOT



BLOCK DIAGRAM



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

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

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

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

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 3.6 V, $V_{SS} = 0$ V, $T_a = -20$ to $+80^{\circ}\text{C}$ 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
HIGH-level input voltage	V_{IH}	INH N	2.0	–	–	V
LOW-level input voltage	V_{IL}	INH N	–	–	0.5	V
Output leakage current	I_Z	Q: Measurement cct 2, $V_{DD} = 3.6$ V, INHN = LOW, $V_{OH} = V_{DD}$	–	–	10	μA
		Q: Measurement cct 2, $V_{DD} = 3.6$ V, INHN = LOW, $V_{OL} = V_{SS}$	–	–	10	
Current consumption	I_{DD}	30MHz crystal oscillator, measurement cct 3, load cct 1, INHN = open, $C_L = 15$ pF	–	4	7	mA
INH N 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. A monitor pattern on a wafer is tested.	7.44	8	8.56	pF
	C_D					pF

5V operation: A×A, B×A series

$V_{DD} = 4.5$ to 5.5 V, $V_{SS} = 0$ V, $T_a = -20$ to $+80^{\circ}\text{C}$ 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
HIGH-level input voltage	V_{IH}	INH N	2.0	–	–	V
LOW-level input voltage	V_{IL}	INH N	–	–	0.8	V
Output leakage current	I_Z	Q: Measurement cct 2, $V_{DD} = 5.5$ V, INHN = LOW, $V_{OH} = V_{DD}$	–	–	10	μA
		Q: Measurement cct 2, $V_{DD} = 5.5$ V, INHN = LOW, $V_{OL} = V_{SS}$	–	–	10	
Current consumption	I_{DD}	30MHz crystal oscillator, measurement cct 3, load cct 1, INHN = open, $C_L = 15$ pF SM5022A×AH, CF5022A×A	–	7	12	mA
		30MHz crystal oscillator, measurement cct 3, load cct 2, INHN = open, $C_L = 15$ pF SM5022B×AH, CF5022B×A	–	7	12	
INH N 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. A monitor pattern on a wafer is tested.	7.44	8	8.56	pF
	C_D					pF

Switching Characteristics

CMOS Output Version: A×A series

3V operation

$V_{DD} = 2.7$ to $3.6V$, $V_{SS} = 0V$, $T_a = -20$ to $+80^{\circ}C$ 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 $5.5V$, $V_{SS} = 0V$, $T_a = -20$ to $+80^{\circ}C$ 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} , $C_L = 15pF$	–	3.5	7	ns
Output fall time	t_{f2}	Measurement cct 6, load cct 1, 0.9 V_{DD} to 0.1 V_{DD} , $C_L = 15pF$	–	3.5	7	ns
Output duty cycle ^{*1}	Duty	Measurement cct 6, load cct 1, $V_{DD} = 5V$, $T_a = 25^{\circ}C$, $C_L = 15pF$, $f = 30MHz$	45	–	55	%
Output disable delay time ^{*2}	t_{PLZ}	Measurement cct 7, load cct 1, $V_{DD} = 5V$, $T_a = 25^{\circ}C$, $C_L = 15pF$	–	–	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

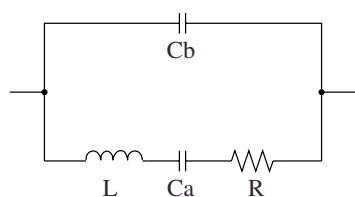
$V_{DD} = 4.5$ to $5.5V$, $V_{SS} = 0V$, $T_a = -20$ to $+80^{\circ}C$ unless otherwise noted.

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, $V_{DD} = 5V$, $T_a = 25^{\circ}C$, $C_L = 15pF$, $f = 30MHz$	45	–	55	%
Output disable delay time ^{*2}	t_{PLZ}	Measurement cct 7, load cct 2, $V_{DD} = 5V$, $T_a = 25^{\circ}C$, $C_L = 15pF$	–	–	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

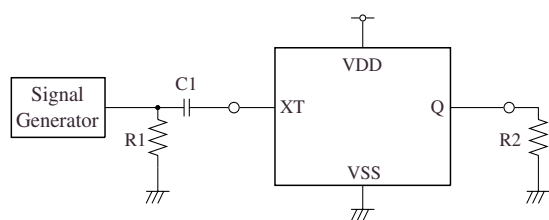
Standby Function

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



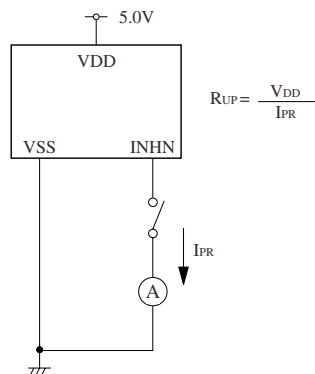
Q output

V_{OH}

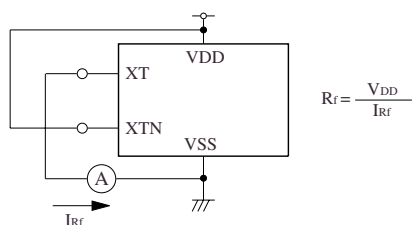
0V

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)

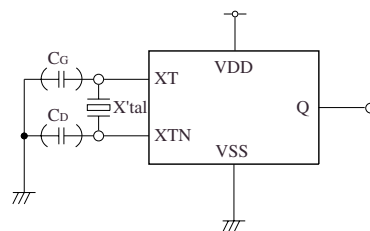
Measurement cct 4



Measurement cct 5

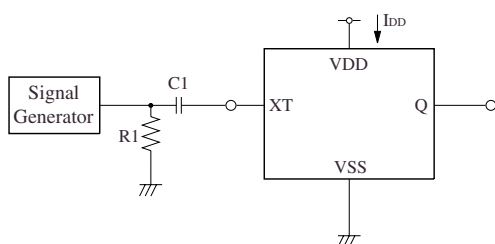


Measurement cct 6



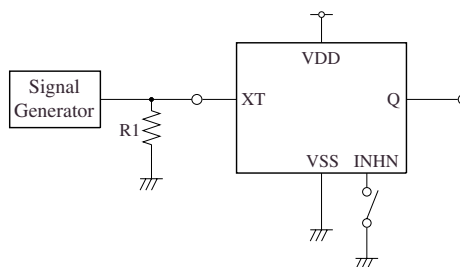
C_G, C_D: 10pF (5022A2, 5022A4)

Measurement cct 3

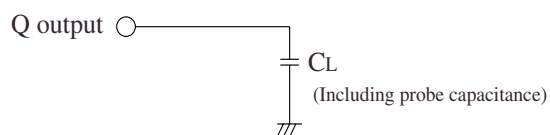


2.0Vp-p, 30MHz sine wave input signal (3V operation)
 3.5Vp-p, 30MHz sine wave input signal (5V operation)
 C1: 0.001μF
 R1: 50Ω

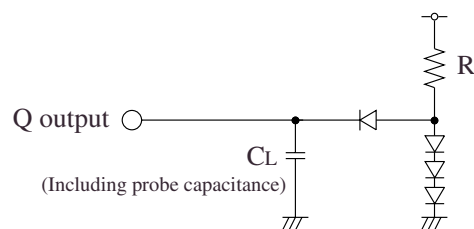
Measurement cct 7



R1: 50Ω

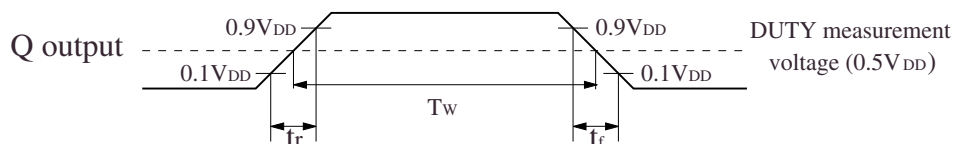
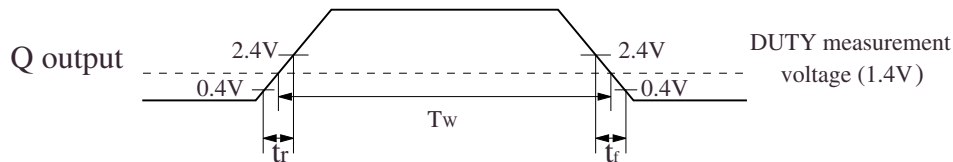
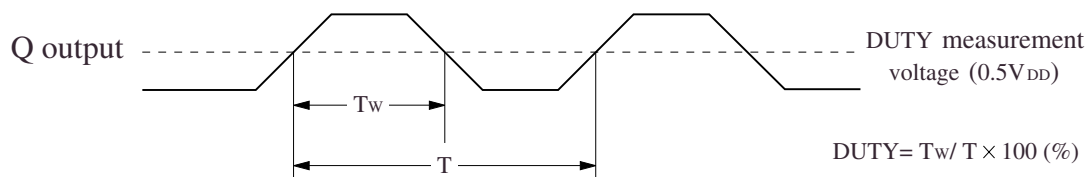
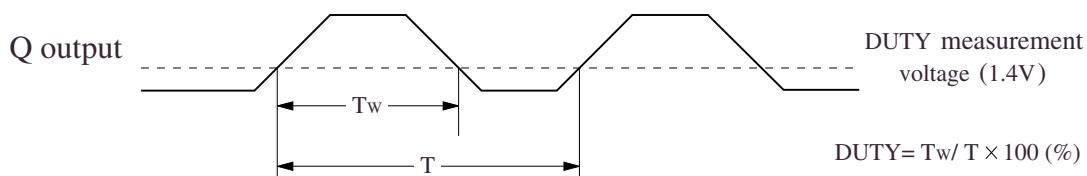
Load cct 1


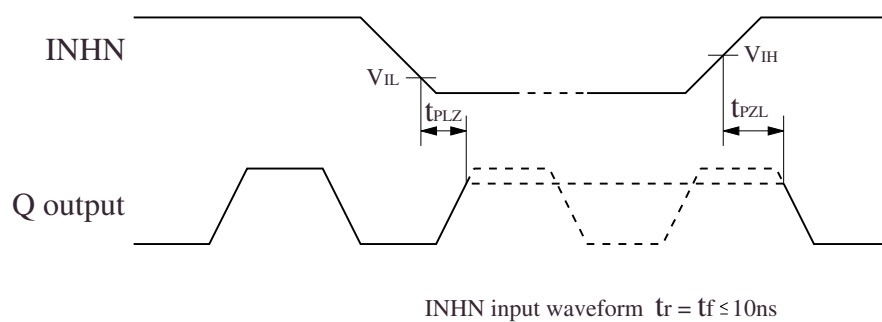
$$C_L = 15\text{pF}$$

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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