CF5015 series

2.5V Operation Fundamental Frequency
Crystal Oscillator Module ICs

OVERVIEW

The CF5015 series are 2.5V operation crystal oscillator ICs. They are available for frequencies up to 60MHz. The product lineup consists of AL× series for 2.5V exclusive use and BL× series compliant with 2.5V to 5V. The built-in oscillator capacitor of AL× series is large, so that AL× series contribute to improve the frequency stability. For the BL× series, the current consumption and drive level reduced so that they can realize the characteristics easier to design small-sized crystal oscillators. The oscillator circuit of each version is simply constructed, so that it can realize the crystal oscillator with excellent phase noise characteristics. Even if the valued characteristics differ due to the application or the purpose, the selecting from these series for different purposes allows the optimization.

FEATURES

- Operating supply voltage range
  - CF5015AL×: 2.25 to 2.75V
  - CF5015BL×: 2.25 to 5.5V
- Up to 60MHz oscillation frequency range
- – 40 to 85°C operating temperature range
- Oscillation capacitors built-in
  - CF5015AL×: C_G = 18pF, C_D = 18pF
  - CF5015BL×: C_G = 4pF, C_D = 8pF
- Inverter amplifier feedback resistor built-in
- Standby function
  - High impedance in standby mode, oscillator stops
- Low standby current
  - Power-saving pull-up resistor built-in
- f_O, $f_O/2$, $f_O/4$, $f_O/8$, or $f_O/16$ output frequency, determined by internal connection
- CMOS output duty level (1/2VDD)
- Molybdenum-gate CMOS process
- Chip form (CF5015×L×)

SERIES CONFIGURATION

Version	Operating supply voltage range [V]	Recommended oscillation frequency range*1 [MHz]					Built-in capacitance [pF]		Output frequency	Standby mode	
		2.5V operation		3V operation		5V operation				Oscillator stop function	Output state
		C_L = 15pF	C_L = 30pF	C_L = 15pF	C_L = 30pF	C_L = 30pF	C_G	C_D			
CF5015AL1	2.25 to 2.75	4 to 60	4 to 50	–	–	–	18	18	f_O*2	Yes	Hi-Z
CF5015AL2									$f_O/2$		
CF5015AL3									$f_O/4$		
CF5015AL4									$f_O/8$		
CF5015AL5									$f_O/16$		
CF5015BL1	2.25 to 3.6 4.5 to 5.5	12 to 60	12 to 50	12 to 60	12 to 50	12 to 60	4	8	f_O*2	Yes	Hi-Z
CF5015BL2									$f_O/2$		
CF5015BL3									$f_O/4$		
CF5015BL4									$f_O/8$		
CF5015BL5									$f_O/16$		

*1. The recommended oscillation 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.

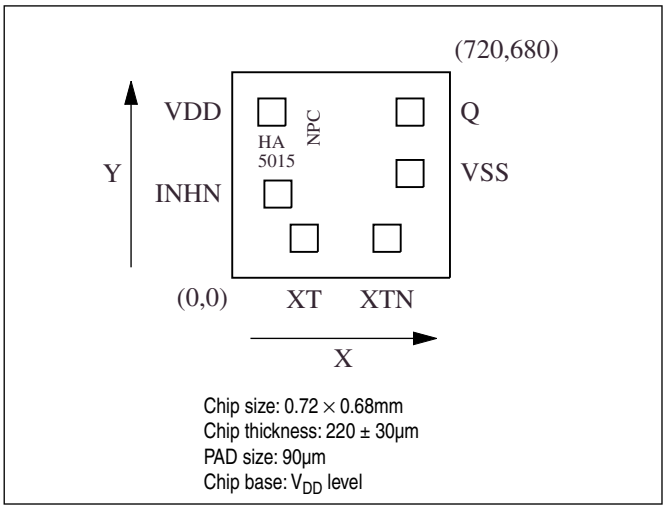
*2. Oscillation frequency

ORDERING INFORMATION

Device	Package
CF5015×L×–2	Chip form

PAD LAYOUT

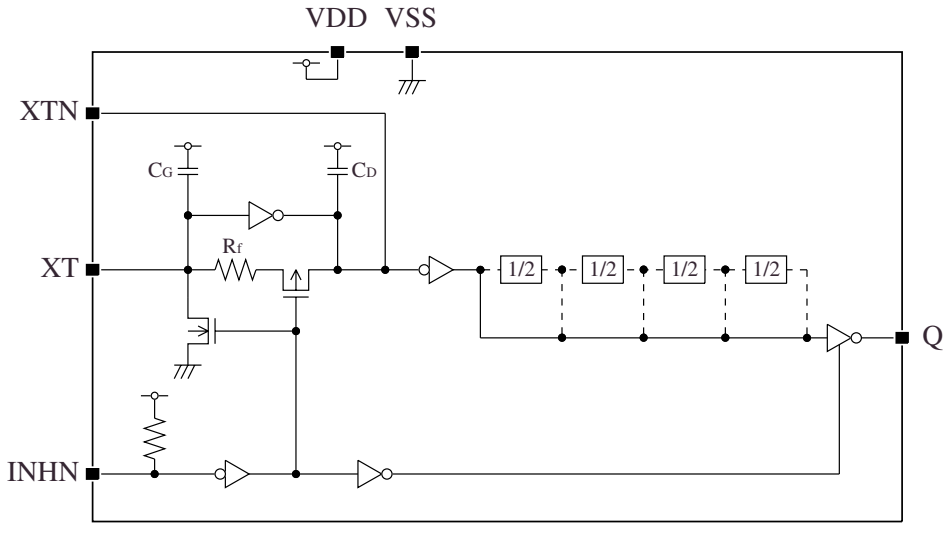
(Unit: µm)



PIN DESCRIPTION and PAD DIMENSIONS

Name	I/O	Description		Pad dimensions [µm]	
				X	Y
INHN	I	Output state control input. High impedance when LOW (oscillator stops). Power-saving pull-up resistor built-in.		151	277
XT	I	Amplifier input	Crystal connection pins. Crystal is connected between XT and XTN.	238	131
XTN	O	Amplifier output		512	131
VSS	–	Ground		588	345
Q	O	Output. Output frequency (f_O, $f_O/2$, $f_O/4$, $f_O/8$, $f_O/16$) determined by internal connection		588	548
VDD	–	Supply voltage		131	548

BLOCK DIAGRAM



INHN = 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}		–65 to +150	°C
Output current	I_{OUT}		12	mA

Recommended Operating Conditions

2.5V operation (CF5015AL×/CF5015BL×)

V_{SS} = 0V

Parameter	Symbol	Condition		Rating	Unit
Supply voltage range	V_{DD}			2.25 to 2.75	V
Input voltage range	V_{IN}			V_{SS} to V_{DD}	V
Operating temperature range	T_{OPR}			–40 to +85	°C
Oscillation frequency range	f_O	CF5015AL×		4 to 60	MHz
		CF5015BL×		12 to 60	MHz
Output frequency range	f_{OUT}	CF5015AL×	$C_L \leq$ 15pF	0.25 to 60	MHz
			$C_L \leq$ 30pF	0.25 to 50	MHz
		CF5015BL×	$C_L \leq$ 15pF	0.75 to 60	MHz
			$C_L \leq$ 30pF	0.75 to 50	MHz

3V operation (CF5015BL×)

V_{SS} = 0V

Parameter	Symbol	Condition	Rating	Unit
Supply voltage range	V_{DD}		2.7 to 3.6	V
Input voltage range	V_{IN}		V_{SS} to V_{DD}	V
Operating temperature range	T_{OPR}		–40 to +85	°C
Oscillation frequency range	f_O		12 to 60	MHz
Output frequency range	f_{OUT}	$C_L \leq$ 15pF	0.75 to 60	MHz
		$C_L \leq$ 30pF	0.75 to 50	MHz

5V operation (CF5015BL×)

V_{SS} = 0V

Parameter	Symbol	Condition	Rating	Unit
Supply voltage range	V_{DD}		4.5 to 5.5	V
Input voltage range	V_{IN}		V_{SS} to V_{DD}	V
Operating temperature range	T_{OPR}		–40 to +85	°C
Oscillation frequency range	f_O		12 to 60	MHz
Output frequency range	f_{OUT}	$C_L \leq$ 30pF	0.75 to 60	MHz

Electrical Characteristics

2.5V operation (CF5015AL×/CF5015BL×)

V_{DD} = 2.25 to 2.75V, V_{SS} = 0V, Ta = −40 to +85°C unless otherwise noted.

Parameter	Symbol	Condition		Rating			Unit
				min	typ	max	
HIGH-level output voltage	V_{OH}	Q: Measurement cct 1, V_{DD} = 2.25V, I_{OH} = 4mA		1.65	1.95	–	V
LOW-level output voltage	V_{OL}	Q: Measurement cct 1, V_{DD} = 2.25V, I_{OL} = 4mA		–	0.3	0.4	V
HIGH-level input voltage	V_{IH}	INHN		0.7V_{DD}	–	–	V
LOW-level input voltage	V_{IL}	INHN		–	–	0.3V_{DD}	V
Output leakage current	I_Z	Q: Measurement cct 2, INHN = LOW	V_{OH} = V_{DD}	–	–	10	µA
			V_{OL} = V_{SS}	–	–	10	µA
Current consumption	I_{DD}	Measurement cct 3, load cct 1, INHN = open, C_L = 15pF, f = 60MHz	CF5015AL1	–	5.5	11	mA
			CF5015AL2	–	4	8	mA
			CF5015AL3	–	3	6	mA
			CF5015AL4	–	2.5	5	mA
			CF5015AL5	–	2	4	mA
			CF5015BL1	–	4.5	9	mA
			CF5015BL2	–	3	6	mA
			CF5015BL3	–	2	4	mA
			CF5015BL4	–	1.5	3	mA
			CF5015BL5	–	1	2	mA
Standby current	I_{ST}	Measurement cct 3, INHN = LOW		–	–	3	µA
INHN pull-up resistance	R_{UP1}	Measurement cct 4		2	6	12	MΩ
	R_{UP2}			20	100	200	kΩ
Feedback resistance	R_f	Measurement cct 5		100	300	600	kΩ
Built-in capacitance	C_G	Design value. A monitor pattern on a wafer is tested.	CF5015AL×	15.3	18	20.7	pF
			CF5015BL×	3.4	4	4.6	pF
	C_D	Design value. A monitor pattern on a wafer is tested.	CF5015AL×	15.3	18	20.7	pF
			CF5015BL×	6.8	8	9.2	pF

3V operation (CF5015BL×)

V_{DD} = 2.7 to 3.6V, V_{SS} = 0V, Ta = –40 to +85°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} = 2.7V, I_{OH} = 4mA		2.1	2.4	–	V
LOW-level output voltage	V_{OL}	Q: Measurement cct 1, V_{DD} = 2.7V, I_{OL} = 4mA		–	0.3	0.4	V
HIGH-level input voltage	V_{IH}	INHN		0.7V_{DD}	–	–	V
LOW-level input voltage	V_{IL}	INHN		–	–	0.3V_{DD}	V
Output leakage current	I_Z	Q: Measurement cct 2, INHN = LOW	V_{OH} = V_{DD}	–	–	10	µA
			V_{OL} = V_{SS}	–	–	10	µA
Current consumption	I_{DD}	Measurement cct 3, load cct 1, INHN = open, C_L = 15pF, f = 60MHz	CF5015BL1	–	5.5	11	mA
			CF5015BL2	–	3	6	mA
			CF5015BL3	–	2	4	mA
			CF5015BL4	–	1.5	3	mA
			CF5015BL5	–	1	2	mA
Standby current	I_{ST}	Measurement cct 3, INHN = LOW		–	–	5	µA
INHN pull-up resistance	R_{UP1}	Measurement cct 4		1	4	10	MΩ
	R_{UP2}			20	100	200	kΩ
Feedback resistance	R_f	Measurement cct 5		100	300	600	kΩ
Built-in capacitance	C_G	Design value. A monitor pattern on a wafer is tested.		3.4	4	4.6	pF
	C_D			6.8	8	9.2	pF

5V operation (CF5015BL×)

V_{DD} = 4.5 to 5.5V, V_{SS} = 0V, Ta = –40 to +85°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} = 4.5V, I_{OH} = 8mA		3.9	4.2	–	V
LOW-level output voltage	V_{OL}	Q: Measurement cct 1, V_{DD} = 4.5V, I_{OL} = 8mA		–	0.3	0.4	V
HIGH-level input voltage	V_{IH}	INHN		0.7V_{DD}	–	–	V
LOW-level input voltage	V_{IL}	INHN		–	–	0.3V_{DD}	V
Output leakage current	I_Z	Q: Measurement cct 2, INHN = LOW	V_{OH} = V_{DD}	–	–	10	µA
			V_{OL} = V_{SS}	–	–	10	µA
Current consumption	I_{DD}	Measurement cct 3, load cct 1, INHN = open, C_L = 30pF, f = 60MHz	CF5015BL1	–	15	30	mA
			CF5015BL2	–	9.5	19	mA
			CF5015BL3	–	6.5	13	mA
			CF5015BL4	–	5	10	mA
			CF5015BL5	–	4	8	mA
Standby current	I_{ST}	Measurement cct 3, INHN = LOW		–	–	10	µA
INHN pull-up resistance	R_{UP1}	Measurement cct 4		0.5	2	8	MΩ
	R_{UP2}			10	50	150	kΩ
Feedback resistance	R_f	Measurement cct 5		100	300	600	kΩ
Built-in capacitance	C_G	Design value. A monitor pattern on a wafer is tested.		3.4	4	4.6	pF
	C_D			6.8	8	9.2	pF

Switching Characteristics

2.5V operation (CF5015AL×/CF5015BL×)

V_{DD} = 2.25 to 2.75V, V_{SS} = 0V, Ta = −40 to +85°C unless otherwise noted.

Parameter	Symbol	Condition		Rating			Unit
				min	typ	max	
Output rise time	t_{r1}	Measurement cct 3, load cct 1, 0.1V_{DD} to 0.9V_{DD}	C_L = 15pF	–	3	6	ns
	t_{r2}		C_L = 30pF	–	5	10	
Output fall time	t_{f1}	Measurement cct 3, load cct 1, 0.9V_{DD} to 0.1V_{DD}	C_L = 15pF	–	3	6	ns
	t_{f2}		C_L = 30pF	–	5	10	
Output duty cycle*1	Duty1	Measurement cct 3, load cct 1, V_{DD} = 2.5V, Ta = 25°C	C_L = 15pF f = 60MHz	45	–	55	%
	Duty2		C_L = 30pF f = 50MHz	45	–	55	%
Output disable delay time*2	t_{PLZ}	Measurement cct 6, load cct 1, V_{DD} = 2.5V, 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.

3V operation (CF5015BL×)

V_{DD} = 2.7 to 3.6V, V_{SS} = 0V, Ta = −40 to +85°C unless otherwise noted.

Parameter	Symbol	Condition		Rating			Unit
				min	typ	max	
Output rise time	t_{r1}	Measurement cct 3, load cct 1, 0.1V_{DD} to 0.9V_{DD}	C_L = 15pF	–	2.5	5	ns
	t_{r2}		C_L = 30pF	–	4	8	
Output fall time	t_{f1}	Measurement cct 3, load cct 1, 0.9V_{DD} to 0.1V_{DD}	C_L = 15pF	–	2.5	5	ns
	t_{f2}		C_L = 30pF	–	4	8	
Output duty cycle*1	Duty1	Measurement cct 3, load cct 1, V_{DD} = 3.0V, Ta = 25°C	C_L = 15pF f = 60MHz	45	–	55	%
	Duty2		C_L = 30pF f = 50MHz	45	–	55	%
Output disable delay time*2	t_{PLZ}	Measurement cct 6, load cct 1, V_{DD} = 3.0V, 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.

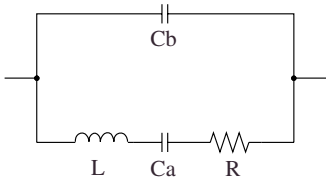
5V operation (CF5015BL×)

V_{DD} = 4.5 to 5.5V, V_{SS} = 0V, Ta = –40 to +85°C unless otherwise noted.

Parameter	Symbol	Condition		Rating min	Rating typ	Rating max	Unit
Output rise time	t_{r1}	Measurement cct 3, load cct 1, $0.1V_{DD}$ to $0.9V_{DD}$	C_L = 15pF	–	1.7	3.4	ns
	t_{r2}		C_L = 30pF	–	3	6	
Output fall time	t_{f1}	Measurement cct 3, load cct 1, $0.9V_{DD}$ to $0.1V_{DD}$	C_L = 15pF	–	1.7	3.4	ns
	t_{f2}		C_L = 30pF	–	3	6	
Output duty cycle*1	Duty1	Measurement cct 3, load cct 1, V_{DD} = 5.0V, Ta = 25°C	C_L = 30pF, f = 60MHz	45	–	55	%
Output disable delay time*2	t_{PLZ}	Measurement cct 6, load cct 1, V_{DD} = 5.0V, 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]
50	16.12	6.88	1.48	1.18
60*	–	–	–	–

* The 60MHz crystal parameter is confidential.

FUNCTIONAL DESCRIPTION

Standby Function

When INHN goes LOW, the oscillator stops and the oscillator output on Q becomes high impedance.

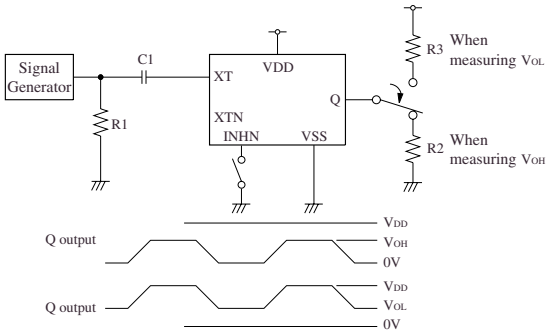
INHN	Q	Oscillator
HIGH (or open)	Any f_O, $f_O/2$, $f_O/4$, $f_O/8$ or $f_O/16$ output frequency	Normal operation
LOW	High impedance	Stopped

Power-saving Pull-up Resistor

The INHN pull-up resistance changes in response to the input level (HIGH or LOW). When INHN goes LOW (standby state), the pull-up resistance becomes large to reduce the current consumption during standby.

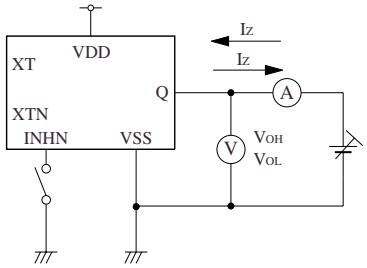
MEASUREMENT CIRCUITS

Measurement cct 1

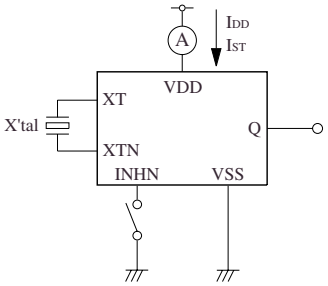


2Vp-p, 10MHz sine wave input signal
C1: 0.001µF
R1: 50Ω
R2: 413Ω (2.5V operation)
525Ω (3V operation)
488Ω (5V operation)
R3: 462Ω (2.5V operation)
575Ω (3V operation)
512Ω (5V operation)

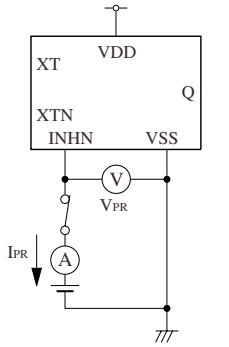
Measurement cct 2



Measurement cct 3



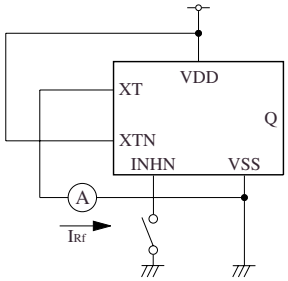
Measurement cct 4



$$R_{UP1} = \frac{V_{DD}}{I_{PR}} \quad (V_{PR} = V_{SS})$$

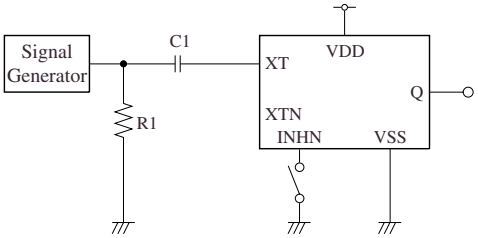
$$R_{UP2} = \frac{V_{DD} - V_{PR}}{I_{PR}} \quad (V_{PR} = 0.7V_{DD})$$

Measurement cct 5



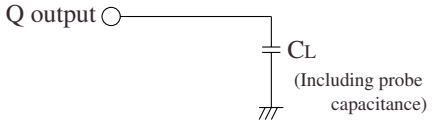
$$R_f = \frac{V_{DD}}{I_{Rf}}$$

Measurement cct 6



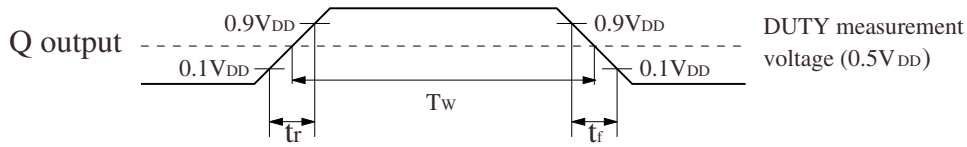
2Vp-p, 10MHz sine wave input signal
C1: 0.001µF
R1: 50Ω

Load cct 1

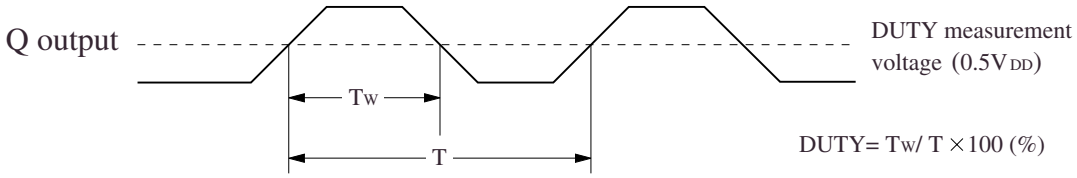


Switching Time Measurement Waveform

Output duty level

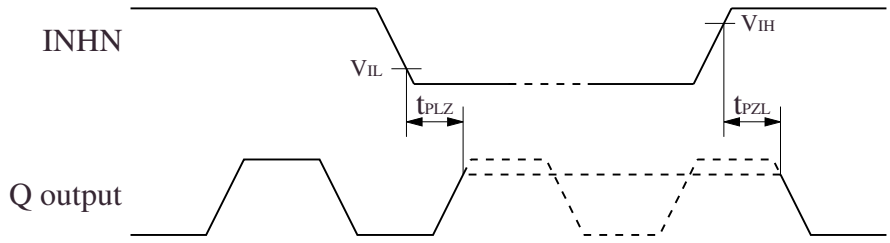


Output duty cycle



Output Enable/Disable Delay

when the device is in standby, the oscillator stops. When standby is released, the oscillator starts and stable oscillator output occurs after a short delay.



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

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