

OVERVIEW

The SM5002L series crystal oscillator module ICs fabricated in NPC's Molybdenum-gate CMOS. They comprise low-voltage low-current consumption oscillator circuits and output buffers. They incorporate built-in oscillation capacitance with superior frequency response to realize stable 3rd overtone oscillation without any external components.

FEATURES

- Oscillation frequency up to 100 MHz
- Third harmonic
- Capacitors C_G and C_D built-in
- Standby function (oscillator stops)
- 3 μ A (typ) low standby current
- Inverter amplifier feedback resistance built-in
- $\overline{\text{INH}}$ pin pull-up resistance built-in
 - $\overline{\text{INH}}= \text{L} : 2\text{M}\Omega$ typ
 - $\overline{\text{INH}}= \text{H} : 90\text{k}\Omega$ typ
- CMOS input level
- 8 mA ($V_{\text{DD}} = 3.0 \text{ V}$) output drive capability
- CMOS output duty level
- Output three-state function
- 2.7 to 3.6 V supply voltage
- Oscillator frequency output
- 8-pin SOP (SM5002L \times S)
- Chip form (CF5002L \times)

SERIES CONFIGURATION

| Version | Recommended operating frequency range (MHz) | g_m (relative value) | Built-in capacitance | | R_{f1} (k Ω) | C_f (pF) | Output duty level | Output current (mA) | Standby function |
|-----------------------|---|------------------------|----------------------|------------|------------------------|------------|-------------------|---------------------|------------------|
| | | | C_G (pF) | C_D (pF) | | | | | |
| CF5002LA SM5002LAS | 30 to 40 | 1.0 | 8 | 15 | 5.6 | 22 | CMOS | 8 | Yes |
| CF5002LB SM5002LBS | 40 to 50 | 1.5 | 8 | 15 | 4.7 | 22 | CMOS | 8 | Yes |
| CF5002LC SM5002LCS | 50 to 70 | 1.5 | 8 | 10 | 3.9 | 22 | CMOS | 8 | Yes |
| CF5002LD SM5002LDS | 70 to 90 | 2.0 | 8 | 10 | 3.9 | 22 | CMOS | 8 | Yes |
| CF5002LE SM5002LES | 85 to 100 | 2.0 | 8 | 10 | 2.7 | 22 | CMOS | 8 | Yes |
| CF5002LF SM5002LFS | 25 to 30 | 1.0 | 10 | 15 | 8.5 | 22 | CMOS | 8 | Yes |

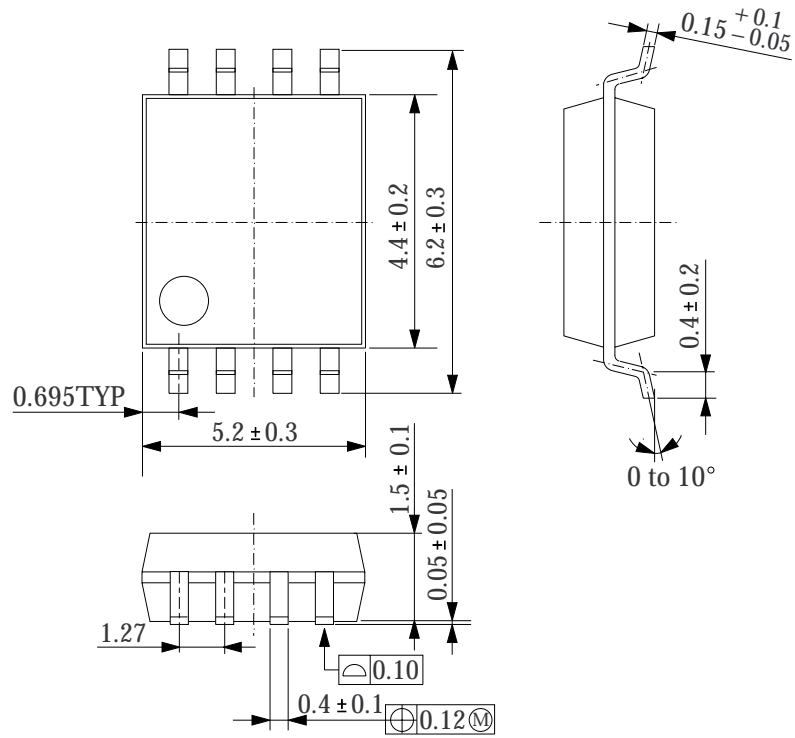
ORDERING INFORMATION

| Device | Package |
|--------------------|-----------|
| SM5002L \times S | 8-pin SOP |
| CF5002L \times | Chip form |

PACKAGE DIMENSIONS

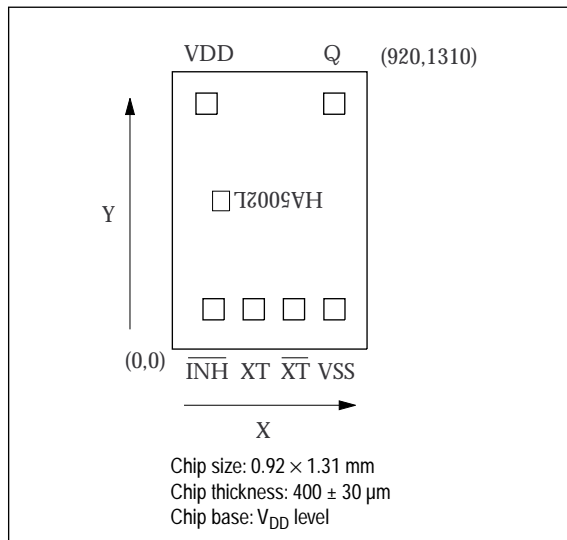
(UNIT : mm)

- 8-pin SOP



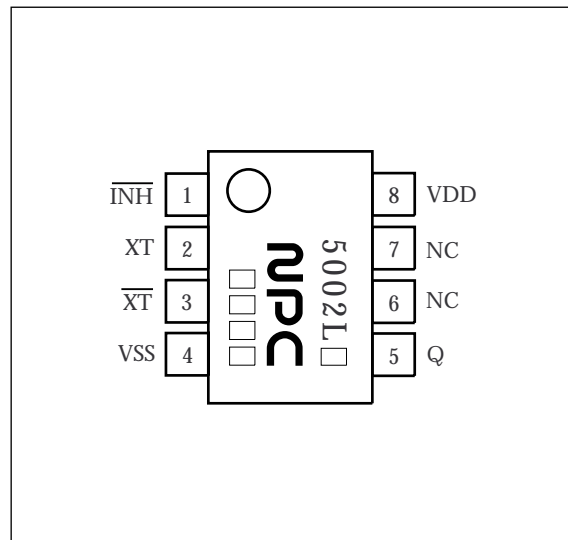
PAD LAYOUT

(Unit : μm)



PINOUT

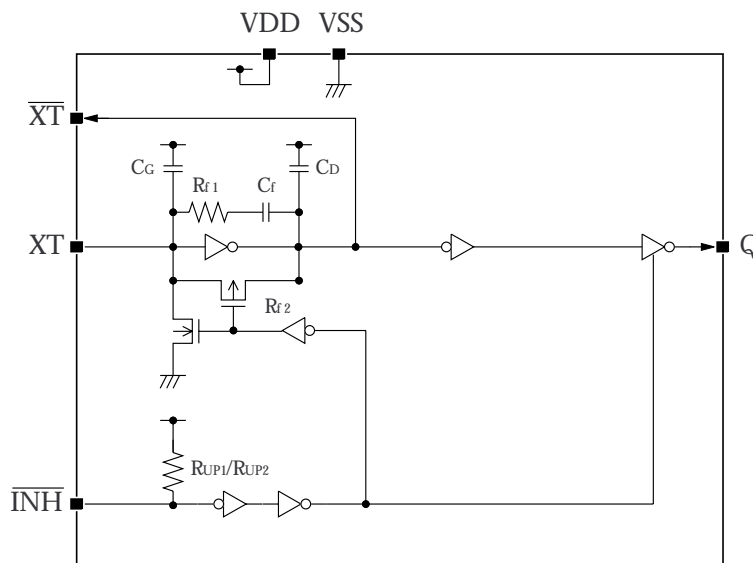
(Top View)



PIN DESCRIPTION and PAD DIMENSIONS

| Number | Name | I/O | Description | Pad dimensions [μm] | |
|--|-------------------------|-----|---|----------------------------------|------|
| | | | | X | Y |
| 1 | $\overline{\text{INH}}$ | I | Output state control input. Oscillator stopped when LOW. Power-saving pull-up resistor built in | 195 | 188 |
| 2 | XT | I | Amplifier input. | 385 | 188 |
| 3 | $\overline{\text{XT}}$ | O | Amplifier output. | 575 | 188 |
| Crystal oscillator connection pins. Crystal oscillator connected between XT and $\overline{\text{XT}}$ | | | | | |
| 4 | VSS | - | Ground | 766 | 188 |
| 5 | Q | O | Output. Output frequency. High impedance at standby operation | 765 | 1159 |
| 6 | NC | - | No connection | - | - |
| 7 | NC | - | No connection | - | - |
| 8 | VDD | - | Supply voltage | 162 | 1159 |

BLOCK DIAGRAM



SPECIFICATIONS

Absolute Maximum Ratings

$V_{SS} = 0$ V unless otherwise noted.

| 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_{stg1} | Chip form | -65 to 150 | °C |
| | T_{stg2} | 8-pin SOP | -40 to 125 | |
| Output current | I_{OUT} | | 25 | mA |
| Power dissipation | P_D | $T_a \leq 85^\circ\text{C}$, 8-pin SOP | 200 | mW |
| Soldering temperature | T_{sld} | 8-pin SOP | 255 | °C |
| Soldering time | t_{sld} | 8-pin SOP | 10 | s |

Recommended Operating Conditions

CF5002L× series (Chip form)

$V_{SS} = 0$ V unless otherwise noted.

| Parameter | Symbol | Conditions | Limits | | | Units |
|-----------------------|-----------|--|----------|-----|----------|-------|
| | | | min | typ | max | |
| Supply voltage | V_{DD} | $C_L \leq 15\text{pF}$, $f \leq 70$ MHz | 2.7 | - | 3.6 | V |
| | | $C_L \leq 15\text{pF}$, $70 < f \leq 100$ MHz | 3.0 | - | 3.6 | V |
| | | $C_L \leq 30\text{pF}$, $f \leq 70$ MHz | 3.0 | - | 3.6 | V |
| Input voltage | V_{IN} | | V_{SS} | - | V_{DD} | V |
| Operating temperature | T_{OPR} | | -20 | - | 80 | °C |

SM5002L×S series (8-pin SOP)

$V_{SS} = 0$ V unless otherwise noted.

| Parameter | Symbol | Conditions | Limits | | | Units |
|-----------------------|-----------|---|----------|-----|----------|-------|
| | | | min | typ | max | |
| Supply voltage | V_{DD} | $C_L \leq 15\text{pF}$, $f \leq 50$ MHz | 2.7 | - | 3.6 | V |
| | | $C_L \leq 15\text{pF}$, $50 < f \leq 70$ MHz | 3.0 | - | 3.6 | V |
| | | $C_L \leq 30\text{pF}$, $f \leq 50$ MHz | 3.0 | - | 3.6 | V |
| Input voltage | V_{IN} | | V_{SS} | - | V_{DD} | V |
| Operating temperature | T_{OPR} | | -20 | - | 80 | °C |

SM5002L series

Electrical Characteristics

$V_{DD} = 2.7$ to 3.6 V, $V_{SS} = 0$ V, $T_a = -20$ to 80 °C, unless otherwise noted.

| Parameter | Symbol | Conditions | Limits | | | Units | |
|-------------------------------------|-----------|--|---|------|-------------|------------|------------|
| | | | min | typ | max | | |
| HIGH-level output voltage | V_{OH} | Q: Measurement cct 1, $V_{DD} = 2.7$ V, $I_{OH} = 8$ mA | 2.2 | 2.4 | – | V | |
| LOW-level output voltage | V_{OL} | Q: Measurement cct 2, $V_{DD} = 2.7$ V, $I_{OL} = 8$ mA | – | 0.3 | 0.4 | V | |
| Output leakage current | I_z | Q: Measurement cct 2, $V_{OH} = V_{DD}$ $\overline{INH} = \text{LOW}$, $V_{DD} = 3.6$ V | – | – | 10 | μ A | |
| | | $V_{OL} = V_{SS}$ | – | – | 10 | μ A | |
| HIGH-level input voltage | V_{IH} | \overline{INH} pin | $0.7V_{DD}$ | – | – | V | |
| LOW-level input voltage | V_{IL} | \overline{INH} pin | – | – | $0.3V_{DD}$ | V | |
| Current consumption | I_{DD} | $\overline{INH} = \text{open}$, Measurement cct 3, load cct 1, $V_{DD} = 3.0$ to 3.6 V | SM5002LAS, SM5002LFS CF5002LA, CF5002LF $C_L = 30$ pF, $f = 30$ MHz | – | 10 | 18 | mA |
| | | | SM5002LBS, CF5002LB $C_L = 30$ pF, $f = 50$ MHz | – | 15 | 25 | mA |
| | | | SM5002LCS, CF5002LC $C_L = 30$ pF, $f = 70$ MHz | – | 20 | 35 | mA |
| | | | SM5002LDS, SM5002LES CF5002LD, CF5002LE $C_L = 15$ pF, $f = 100$ MHz | – | 25 | 45 | mA |
| Standby current | I_{ST} | $\overline{INH} = \text{LOW}$, Measurement cct 3 | – | 3 | 10 | μ A | |
| \overline{INH} pull-up resistance | R_{UP1} | Measurement cct 4, $\overline{INH} = \text{LOW}$ | 0.4 | – | 4 | M Ω | |
| | R_{UP2} | Measurement cct 4, $\overline{INH} = 0.7V_{DD}$ | 50 | – | 150 | k Ω | |
| AC feedback resistance | R_{f1} | Design value, determined by the internal wafer pattern | SM5002LAS, CF5002LA | 4.7 | 5.6 | 6.5 | k Ω |
| | | | SM5002LBS, CF5002LB | 4.0 | 4.7 | 5.4 | k Ω |
| | | | SM5002LCS, SM5002LDS CF5002LC, CF5002LD | 3.3 | 3.9 | 4.5 | k Ω |
| | | | SM5002LES, CF5002LE | 2.2 | 2.7 | 3.2 | k Ω |
| | | | SM5002LFS, CF5002LF | 7.2 | 8.5 | 9.8 | k Ω |
| DC feedback resistance | R_{f2} | Measurement cct 5 | 50 | – | 150 | k Ω | |
| AC feedback capacitance | C_f | Design value, determined by the internal wafer pattern | 19.8 | 22 | 24.2 | pF | |
| Built-in capacitance | C_G | Design value, determined by the internal wafer pattern | SM5002LAS, CF5002LA SM5002LBS, CF5002LB SM5002LCS, CF5002LC SM5002LDS, CF5002LD SM5002LES, CF5002LE | 7.2 | 8 | 8.8 | pF |
| | | | SM5002LFS, CF5002LF | 9 | 10 | 11 | pF |
| | C_D | | SM5002LAS, CF5002LA SM5002LBS, CF5002LB SM5002LFS, CF5002LF | 13.5 | 15 | 16.5 | pF |
| | | | SM5002LCS, CF5002LC SM5002LDS, CF5002LD SM5002LES, CF5002LE | 9 | 10 | 11 | pF |

Switching Characteristics

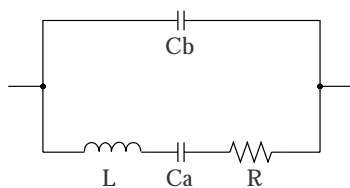
$V_{SS} = 0\text{ V}$, $T_a = -20\text{ to }80\text{ }^\circ\text{C}$ unless otherwise noted.

| Parameter | Symbol | Conditions | Limits | | | Units | |
|--|-----------|--|--|-----|-----|-------|----|
| | | | min | typ | max | | |
| Output rise time | t_{r1} | Measurement cct 3, load cct 1, $0.1V_{DD} \rightarrow 0.9V_{DD}$ | $V_{DD} = 2.7\text{ to }3.6\text{ V}$, $C_L = 15\text{ pF}$ | - | 2 | 4 | ns |
| | t_{r2} | | $V_{DD} = 3.0\text{ to }3.6\text{ V}$, $C_L = 30\text{ pF}$ | - | 2.5 | 5 | ns |
| Output fall time | t_{f1} | Measurement cct 3, load cct 1, $0.9V_{DD} \rightarrow 0.1V_{DD}$ | $V_{DD} = 2.7\text{ to }3.6\text{ V}$, $C_L = 15\text{ pF}$ | - | 2 | 4 | ns |
| | t_{f2} | | $V_{DD} = 3.0\text{ to }3.6\text{ V}$, $C_L = 30\text{ pF}$ | - | 2.5 | 5 | ns |
| Output duty cycle ¹ | DUTY | Measurement cct 3, load cct 1, $T_a = 25\text{ }^\circ\text{C}$, $V_{DD} = 3.0\text{ V}$ | SM5002LAS, SM5002LFS CF5002LA, CF5002LF $C_L = 30\text{ pF}$, $f = 30\text{ MHz}$ | 45 | - | 55 | % |
| | | | SM5002LBS, CF5002LB $C_L = 30\text{ pF}$, $f = 50\text{ MHz}$ | 45 | - | 55 | % |
| | | | SM5002LCS, CF5002LC $C_L = 30\text{ pF}$, $f = 70\text{ MHz}$ | 45 | - | 55 | % |
| | | | SM5002LDS, SM5002LES $C_L = 15\text{ pF}$, $f = 100\text{ MHz}$ | 40 | - | 60 | % |
| | | | CF5002LD, CF5002LE $C_L = 15\text{ pF}$, $f = 100\text{ MHz}$ | 45 | - | 55 | % |
| Output disable delay time ² | t_{PLZ} | Measurement cct 6, $T_a = 25\text{ }^\circ\text{C}$, $V_{DD} = 2.7\text{ V}$, load $C_L \leq 15\text{ pF}$ | - | - | 100 | ns | |
| Output enable delay time ² | t_{PZL} | | - | - | 100 | ns | |

1. Monitored in sample lots.

2. Oscillator stop function is built-in. When $\overline{\text{INH}}$ goes LOW, normal output stops. When $\overline{\text{INH}}$ 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 |
| 50 | 22.17 | 7.40 | 1.370 | 4.105 |
| 70 | 25.42 | 4.18 | 1.254 | 5.170 |
| 100 | 16.60 | 3.56 | 0.726 | 5.394 |

FUNCTIONAL DESCRIPTION

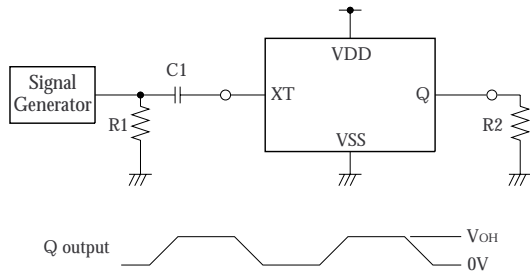
Standby Function

The oscillator stops when $\overline{\text{INH}}$ goes LOW. When the oscillator stops, the oscillator output on Q goes high impedance.

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

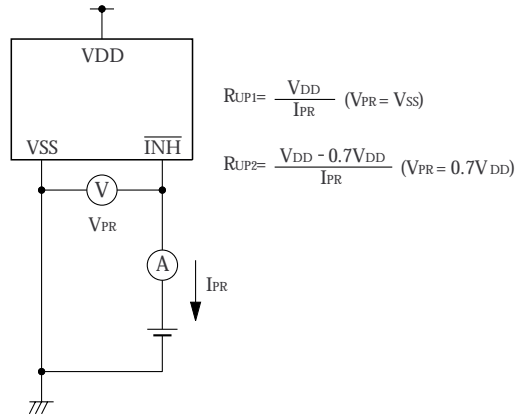
MEASUREMENT CIRCUITS

Measurement cct 1

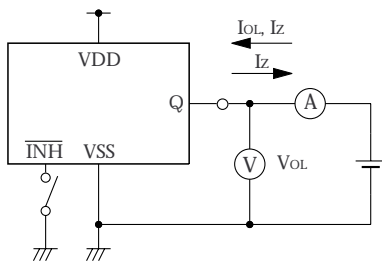


2.5V_{p-p}, 10MHz sine wave input signal
 C1 : 0.001μF
 R1 : 50Ω
 R2 : 275Ω

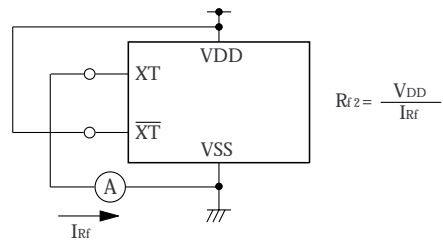
Measurement cct 4



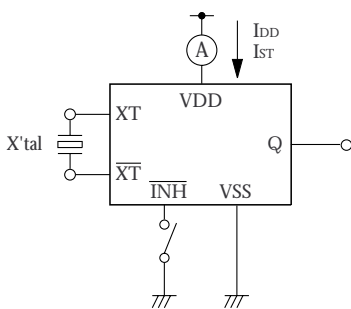
Measurement cct 2



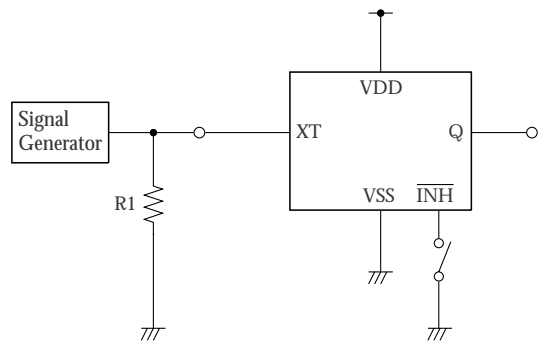
Measurement cct 5



Measurement cct 3

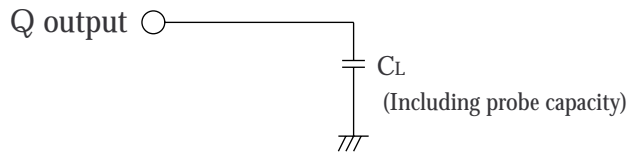


Measurement cct 6



R1 : 50Ω

Load cct 1

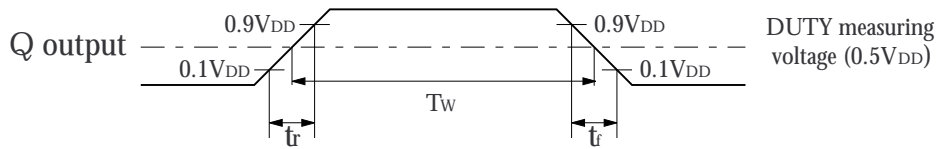


$$C_L = 15\text{pF} : t_{r1}, t_{f1} / \text{DUTY}, I_{DD} \quad (70\text{MHz} < f \leq 100\text{MHz})$$

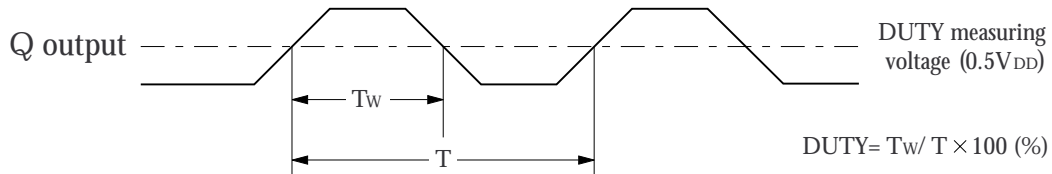
$$C_L = 30\text{pF} : t_{r2}, t_{f2} / \text{DUTY}, I_{DD} \quad (f \leq 70\text{MHz})$$

Switching Time Measurement Waveform

Output duty level (CMOS)

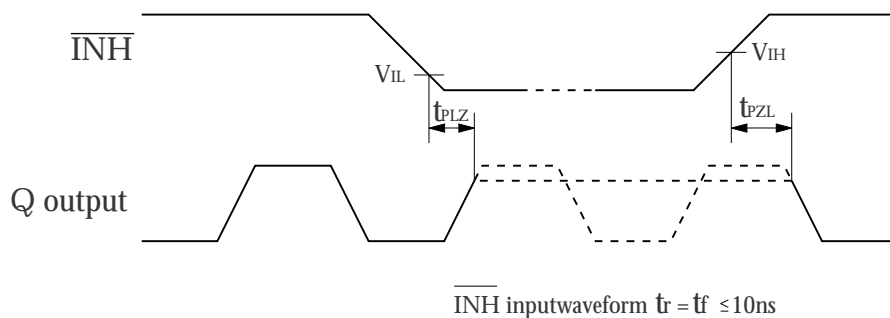


Output duty cycle (CMOS)



Output Enable/Disable Delay

The following figure shows the oscillator timing during normal operation. Note that 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.



NIPPON PRECISION CIRCUITS INC. reserves the right to make changes to the products described in this data sheet in order to improve the design or performance and to supply the best possible products. Nippon Precision Circuits Inc. assumes no responsibility for the use of any circuits shown in this data sheet, conveys no license under any patent or other rights, and makes no claim that the circuits are free from patent infringement. Applications for any devices shown in this data sheet are for illustration only and Nippon Precision Circuits Inc. makes no claim or warranty that such applications will be suitable for the use specified without further testing or modification. The products described in this data sheet are not intended to use for the apparatus which influence human lives due to the failure or malfunction of the products. Customers are requested to comply with applicable laws and regulations in effect now and hereinafter, including compliance with export controls on the distribution or dissemination of the products. Customers shall not export, directly or indirectly, any products without first obtaining required licenses and approvals from appropriate government agencies.



NIPPON PRECISION CIRCUITS INC.

4-3, Fukuzumi 2-chome
Koto-ku, Tokyo 135-8430, Japan
Telephone: 03-3642-6661
Facsimile: 03-3642-6698

NC9505DE 1999.10