

## OVERVIEW

The SM5010 series are crystal oscillator module ICs, that incorporate oscillator and output buffer circuits. High-frequency capacitors and feedback resistors are built-in, eliminating the need for external components to make a stable fundamental-harmonic oscillator.

## FEATURES

- Inverter amplifier feedback resistor built-in
- Capacitors  $C_G$ ,  $C_D$  built-in
- Standby function
- Power-save pull-up resistor built-in (5010CL×)
- 16 mA ( $V_{DD} = 4.5$  V) drive capability (5010AN×, AK×, BN×, BK×, CL×, DN×)
- 4 mA ( $V_{DD} = 4.5$  V) drive capability (5010AH×, BH×)
- Output three-state function
- 2.7 to 5.5 V supply voltage
- Oscillator frequency output ( $f_0$ ,  $f_0/2$ ,  $f_0/4$ ,  $f_0/8$  determined by internal connection)
- 8-pin SOP (SM5010×××S)
- Chip form (CF5010×××)

## SERIES CONFIGURATION

| Version <sup>1</sup> | Output frequency | 3V operating           |   | 5V operating           |   |                     | $R_D$ [ $\Omega$ ] | Built-in capacitance |            | Input level (5V) | Output duty level | Standby function |
|----------------------|------------------|------------------------|---|------------------------|---|---------------------|--------------------|----------------------|------------|------------------|-------------------|------------------|
|                      |                  | Output load (max) [pF] | Recommended operating frequency range [MHz] | Output load (max) [pF] | Recommended operating frequency range [MHz] | Output current [mA] |                    | $C_G$ [pF]           | $C_D$ [pF] |                  |                   |                  |
| SM5010AN1S           | $f_0$            | 15                     | 30  | 50                     | 30  | 16                  | -                  | TBD                  |            | TTL              | CMOS              | No               |
| SM5010AN2S           | $f_0/2$          | 15                     | 30  | 50                     | 30  | 16                  | -                  |                      |            | TTL              | CMOS/TTL          | No               |
| SM5010AN3S           | $f_0/4$          | 15                     | 30  | 50                     | 30  | 16                  | -                  |                      |            | TTL              | CMOS/TTL          | No               |
| SM5010AN4S           | $f_0/8$          | 15                     | 30  | 50                     | 30  | 16                  | -                  |                      |            | TTL              | CMOS/TTL          | No               |
| SM5010AK1S           | $f_0$            | -                      | -   | 15                     | 30  | 16                  | -                  |                      |            | TTL              | TTL               | No               |
| SM5010AH1S           | $f_0$            | 15                     | 16  | 15                     | 30  | 4                   | -                  |                      |            | TTL              | CMOS              | No               |
| SM5010AH2S           | $f_0/2$          | 15                     | 16  | 15                     | 30  | 4                   | -                  |                      |            | TTL              | CMOS              | No               |
| SM5010AH3S           | $f_0/4$          | 15                     | 16  | 15                     | 30  | 4                   | -                  |                      |            | TTL              | CMOS              | No               |
| SM5010AH4S           | $f_0/8$          | 15                     | 16  | 15                     | 30  | 4                   | -                  |                      |            | TTL              | CMOS              | No               |
| SM5010BN1S           | $f_0$            | 15                     | 30  | 50                     | 30  | 16                  | 820                |                      |            | TTL              | CMOS              | No               |
| SM5010BN2S           | $f_0/2$          | 15                     | 30  | 50                     | 30  | 16                  | 820                |                      |            | TTL              | CMOS/TTL          | No               |
| SM5010BN3S           | $f_0/4$          | 15                     | 30  | 50                     | 30  | 16                  | 820                |                      |            | TTL              | CMOS/TTL          | No               |
| SM5010BN4S           | $f_0/8$          | 15                     | 30  | 50                     | 30  | 16                  | 820                |                      |            | TTL              | CMOS/TTL          | No               |
| SM5010BK1S           | $f_0$            | -                      | -   | 15                     | 30  | 16                  | 820                |                      |            | TTL              | TTL               | No               |
| SM5010BH1S           | $f_0$            | 15                     | 16  | 15                     | 30  | 4                   | 820                |                      |            | TTL              | CMOS              | No               |
| SM5010BH2S           | $f_0/2$          | 15                     | 16  | 15                     | 30  | 4                   | 820                |                      |            | TTL              | CMOS              | No               |
| SM5010BH3S           | $f_0/4$          | 15                     | 16  | 15                     | 30  | 4                   | 820                |                      |            | TTL              | CMOS              | No               |
| SM5010BH4S           | $f_0/8$          | 15                     | 16  | 15                     | 30  | 4                   | 820                |                      |            | TTL              | CMOS              | No               |
| SM5010CL1S           | $f_0$            | 15                     | 30  | 50                     | 30  | 16                  | -                  |                      |            | CMOS             | CMOS              | Yes              |
| SM5010CL2S           | $f_0/2$          | 15                     | 30  | 50                     | 30  | 16                  | -                  |                      |            | CMOS             | CMOS              | Yes              |
| SM5010CL3S           | $f_0/4$          | 15                     | 30  | 50                     | 30  | 16                  | -                  |                      |            | CMOS             | CMOS              | Yes              |
| SM5010CL4S           | $f_0/8$          | 15                     | 30  | 50                     | 30  | 16                  | -                  |                      |            | CMOS             | CMOS              | Yes              |
| SM5010DN1S           | $f_0$            | 15                     | 30  | 50                     | 30  | 16                  | 820                |                      |            | TTL              | CMOS              | No               |

1. Chip form devices have designation CF5010×××.

Note: Recommended operating frequency is not the guaranteed value but is measured using NPC's standard crystal.

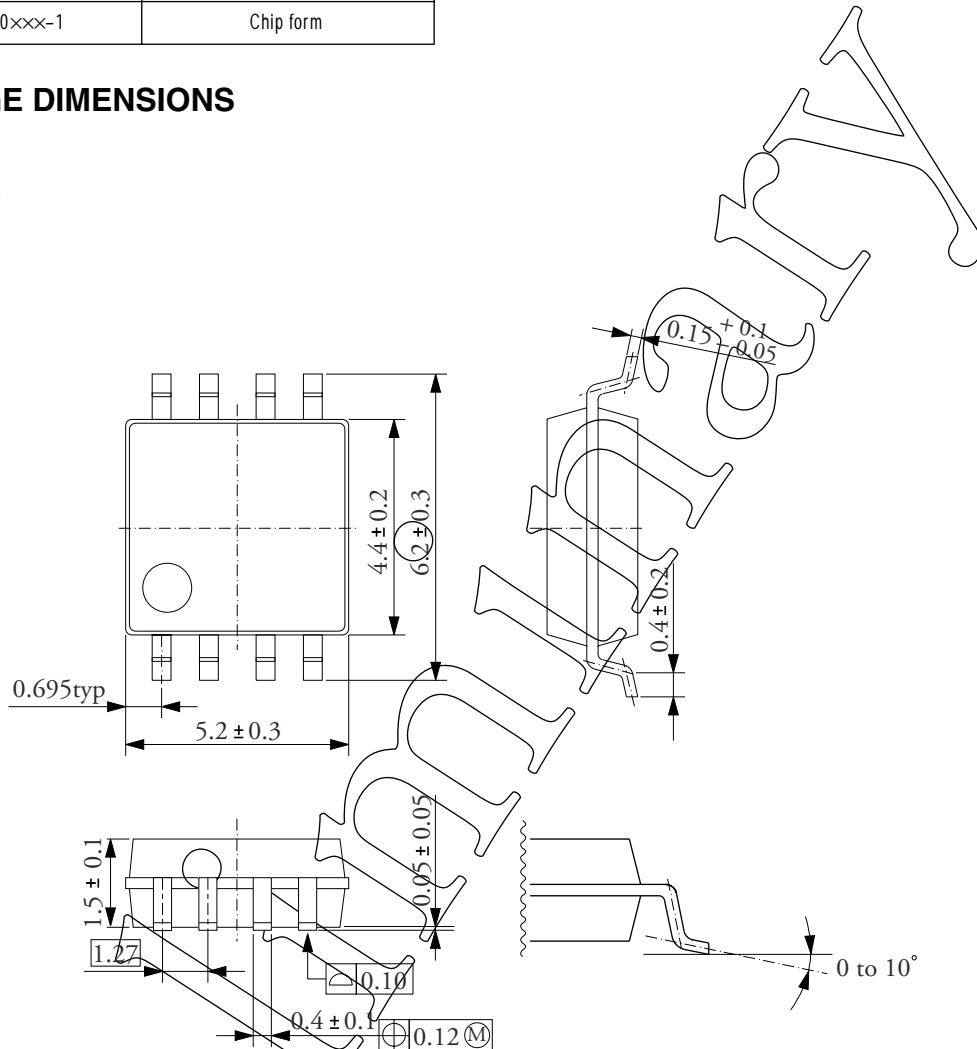
**ORDERING INFORMATION**

| Device      | Package   |
|-------------|-----------|
| SM5010xxxS  | 8-pin SOP |
| CF5010xxx-1 | Chip form |

**PACKAGE DIMENSIONS**

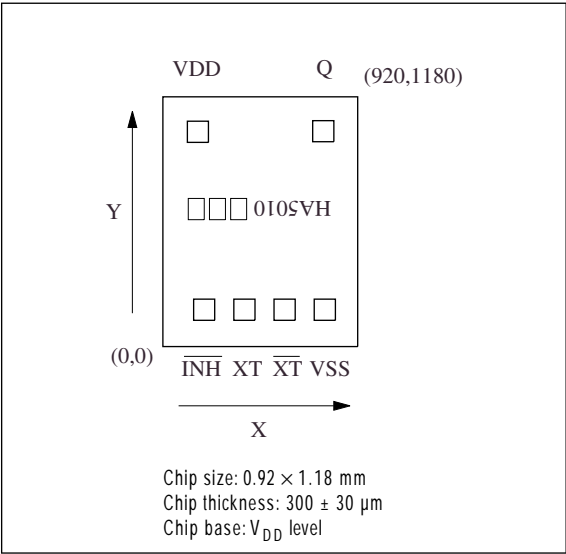
(Unit:mm)

- 8-pin SOP



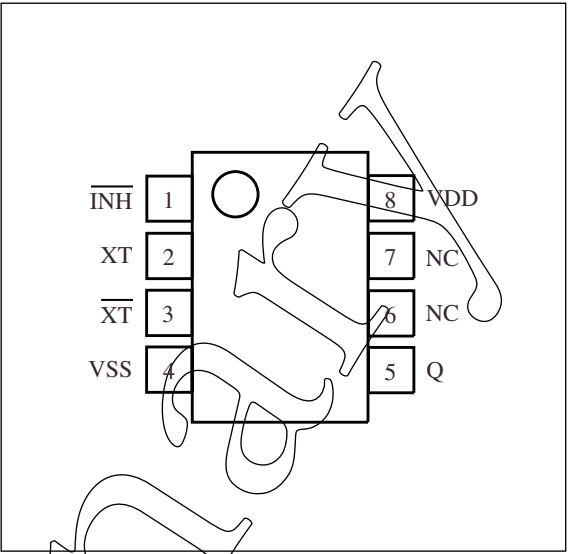
PAD LAYOUT

(Unit:μm)



PINOUT

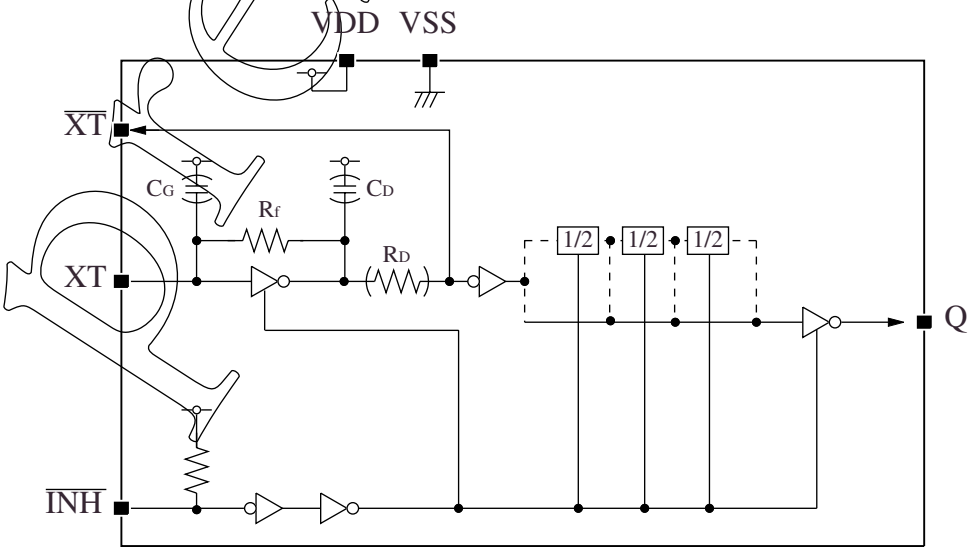
(Top view)



PIN DESCRIPTION and PAD DIMENSIONS

| Number | Name | I/O | Description   | Pad dimensions [μm] |        |
|--------|------|-----|---|---------------------|--------|
|        |      |     |   | X                   | Y      |
| 1      | INH  | I   | Output state control input. High impedance when LOW. In the case of the 5010CLx, the oscillator stops and Power-saving pull-up resistor built in. | 195                 | 174.4  |
| 2      | XT   | I   | Amplifier input.  | 385                 | 174.4  |
| 3      | XT   | O   | Amplifier output.   | 575                 | 174.4  |
| 4      | VSS  | -   | Ground  | 765                 | 174.4  |
| 5      | Q    | O   | Output. Output frequency ( $f_0$ , $f_0/2$ , $f_0/4$ , $f_0/8$ ) determined by internal connection  | 757.6               | 1017.6 |
| 6      | NC   | -   | No connection   | -                   | -      |
| 7      | NC   | -   | No connection   | -                   | -      |
| 8      | VDD  | -   | Supply voltage  | 165.4               | 1014.6 |

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   |
|                             |            | 8-pin SOP         | -55 to 125             |      |
| Output current              | $I_{OUT}$  | 5010×H×           | 10                     | mA   |
|                             |            | 5010×N×, ×K×, CL× | 25                     |      |
| Power dissipation           | $P_D$      | 8-pin SOP         | 500                    | mW   |
| Soldering temperature       | $T_{slid}$ | 8-pin SOP         | 255                    | °C   |
| Soldering time              | $t_{slid}$ | 8-pin SOP         | 10                     | s    |

### Recommended Operating Conditions

#### 3V operation

 $V_{SS} = 0\text{ V}$ 

| Parameter             | Symbol    | Series | Condition   | Rating   |     |          | Unit |
|-----------------------|-----------|--------|---|----------|-----|----------|------|
|                       |           |        |   | min      | typ | max      |      |
| Supply voltage        | $V_{DD}$  | ×N×    | $2 \leq f \leq 30\text{ MHz}$ , $C_L \leq 15\text{ pF}$ | 2.7      | -   | 3.6      | V    |
|                       |           | ×H×    | $2 \leq f \leq 16\text{ MHz}$ , $C_L \leq 15\text{ pF}$ | 2.7      | -   | 3.6      |      |
|                       |           | CL×    | $2 \leq f \leq 30\text{ MHz}$ , $C_L \leq 15\text{ pF}$ | 2.7      | -   | 3.6      |      |
| Input voltage         | $V_{IN}$  | ×N×    | $2 \leq f \leq 30\text{ MHz}$ , $C_L \leq 15\text{ pF}$ | $V_{SS}$ | -   | $V_{DD}$ | V    |
|                       |           | ×H×    | $2 \leq f \leq 16\text{ MHz}$ , $C_L \leq 15\text{ pF}$ | $V_{SS}$ | -   | $V_{DD}$ |      |
|                       |           | CL×    | $2 \leq f \leq 30\text{ MHz}$ , $C_L \leq 15\text{ pF}$ | $V_{SS}$ | -   | $V_{DD}$ |      |
| Operating temperature | $T_{OPR}$ | ×N×    | $2 \leq f \leq 30\text{ MHz}$ , $C_L \leq 15\text{ pF}$ | -10      | -   | +70      | °C   |
|                       |           | ×H×    | $2 \leq f \leq 16\text{ MHz}$ , $C_L \leq 15\text{ pF}$ | -10      | -   | +70      |      |
|                       |           | CL×    | $2 \leq f \leq 30\text{ MHz}$ , $C_L \leq 15\text{ pF}$ | -20      | -   | +80      |      |

#### 5V operation

 $V_{SS} = 0\text{ V}$ 

| Parameter             | Symbol    | Series | Condition   | Rating   |     |          | Unit |
|-----------------------|-----------|--------|---|----------|-----|----------|------|
|                       |           |        |   | min      | typ | max      |      |
| Supply voltage        | $V_{DD}$  | ×N×    | $2 \leq f \leq 30\text{ MHz}$ , $C_L \leq 50\text{ pF}$ | 4.5      | -   | 5.5      | V    |
|                       |           | ×K×    | $2 \leq f \leq 30\text{ MHz}$ , $C_L \leq 15\text{ pF}$ | 4.5      | -   | 5.5      |      |
|                       |           | ×H×    | $2 \leq f \leq 30\text{ MHz}$ , $C_L \leq 15\text{ pF}$ | 4.5      | -   | 5.5      |      |
|                       |           | CL×    | $2 \leq f \leq 30\text{ MHz}$ , $C_L \leq 50\text{ pF}$ | 4.5      | -   | 5.5      |      |
| Input voltage         | $V_{IN}$  | ×N×    | $2 \leq f \leq 30\text{ MHz}$ , $C_L \leq 50\text{ pF}$ | $V_{SS}$ | -   | $V_{DD}$ | V    |
|                       |           | ×K×    | $2 \leq f \leq 30\text{ MHz}$ , $C_L \leq 15\text{ pF}$ | $V_{SS}$ | -   | $V_{DD}$ |      |
|                       |           | ×H×    | $2 \leq f \leq 30\text{ MHz}$ , $C_L \leq 15\text{ pF}$ | $V_{SS}$ | -   | $V_{DD}$ |      |
|                       |           | CL×    | $2 \leq f \leq 30\text{ MHz}$ , $C_L \leq 50\text{ pF}$ | $V_{SS}$ | -   | $V_{DD}$ |      |
| Operating temperature | $T_{OPR}$ | ×N×    | $2 \leq f \leq 30\text{ MHz}$ , $C_L \leq 50\text{ pF}$ | -40      | -   | +85      | °C   |
|                       |           | ×K×    | $2 \leq f \leq 30\text{ MHz}$ , $C_L \leq 15\text{ pF}$ | -40      | -   | +85      |      |
|                       |           | ×H×    | $2 \leq f \leq 30\text{ MHz}$ , $C_L \leq 15\text{ pF}$ | -40      | -   | +85      |      |
|                       |           | CL×    | $2 \leq f \leq 30\text{ MHz}$ , $C_L \leq 50\text{ pF}$ | -40      | -   | +85      |      |

## Electrical Characteristics

## 5010×N× series

3 V operation:  $V_{DD} = 2.7$  to  $3.6$  V,  $V_{SS} = 0$  V,  $T_a = -10$  to  $70$  °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, $I_{OH} = 8$ mA  | 2.1              | 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, $\overline{INH} = \text{LOW}$ , $V_{DD} = 3.6$ V, $V_{OH} = V_{DD}$      | —                | —   | 10  | $\mu\text{A}$ |
|  |           | Q: Measurement cct 2, $\overline{INH} = \text{LOW}$ , $V_{DD} = 3.6$ V, $V_{OL} = V_{SS}$      | —                | —   | 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                    | $I_{DD}$  | Measurement cct 3, load cct 1,<br>$\overline{INH} = \text{open}$ , $C_L = 15$ pF, $f = 30$ MHz | 5010×N1          | TBD |     | mA            |
|  |           |  | 5010×N2          |     |     |               |
|  |           |  | 5010×N3          |     |     |               |
|  |           |  | 5010×N4          |     |     |               |
| $\overline{INH}$ pull-up resistance    | $R_{UP1}$ | Measurement cct 4  | —                | 100 | —   | k $\Omega$    |
| Feedback resistance                    | $R_f$     | Measurement cct 5  | —                | 200 | —   | k $\Omega$    |
| Oscillator amplifier output resistance | $R_D$     | Design value   | 5010B××          | —   | 820 | $\Omega$      |
| Built-in capacitance                   | $C_G$     | Design value, determined by the internal wafer pattern   | 5010A××, 5010B×× | TBD |     | pF            |
|  | $C_D$     |  |                  |     |     | pF            |

## 5010×N×, ×K× series

5 V operation:  $V_{DD} = 4.5$  to  $5.5$  V,  $V_{SS} = 0$  V,  $T_a = -40$  to  $85$  °C unless otherwise noted.

| Parameter                              | Symbol    | Condition  | Rating           |     |     | Unit          |
|--|-----------|--|------------------|-----|-----|---------------|
|  |           |  | min              | typ | max |               |
| HIGH-level output voltage              | $V_{OH}$  | Q: Measurement cct 1, $V_{DD} = 4.5$ V, $I_{OH} = 16$ mA                                       | 3.9              | 4.2 | —   | V             |
| LOW-level output voltage               | $V_{OL}$  | Q: Measurement cct 2, $V_{DD} = 4.5$ V, $I_{OL} = 16$ mA                                       | —                | 0.3 | 0.4 | V             |
| Output leakage current                 | $I_Z$     | Q: Measurement cct 2, $\overline{INH} = \text{LOW}$ , $V_{DD} = 5.5$ V, $V_{OH} = V_{DD}$      | —                | —   | 10  | $\mu\text{A}$ |
|  |           | Q: Measurement cct 2, $\overline{INH} = \text{LOW}$ , $V_{DD} = 5.5$ V, $V_{OL} = V_{SS}$      | —                | —   | 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                    | $I_{DD}$  | Measurement cct 3, load cct 2,<br>$\overline{INH} = \text{open}$ , $C_L = 50$ pF, $f = 30$ MHz | 5010×N1          | TBD |     | mA            |
|  |           |  | 5010×N2          |     |     |               |
|  |           |  | 5010×N3          |     |     |               |
|  |           |  | 5010×N4          |     |     |               |
|  |           | Measurement cct 3, load cct 1,<br>$\overline{INH} = \text{open}$ , $C_L = 15$ pF, $f = 30$ MHz | 5010×K×          |     |     |               |
| $\overline{INH}$ pull-up resistance    | $R_{UP1}$ | Measurement cct 4  | —                | 100 | —   | k $\Omega$    |
| Feedback resistance                    | $R_f$     | Measurement cct 5  | —                | 200 | —   | k $\Omega$    |
| Oscillator amplifier output resistance | $R_D$     | Design value   | 5010B××          | —   | 820 | $\Omega$      |
| Built-in capacitance                   | $C_G$     | Design value, determined by the internal wafer pattern   | 5010A××, 5010B×× | TBD |     | pF            |
|  | $C_D$     |  |                  |     |     | pF            |

**5010×H× series**

3 V operation:  $V_{DD} = 2.7$  to  $3.6$  V,  $V_{SS} = 0$  V,  $T_a = -10$  to  $70$  °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, $I_{OH} = 2$ mA  | 2.1              | 2.4 | –   | V             |
| LOW-level output voltage               | $V_{OL}$  | Q: Measurement cct 2, $V_{DD} = 2.7$ V, $I_{OL} = 2$ mA  | –                | 0.3 | 0.5 | V             |
| Output leakage current                 | $I_Z$     | Q: Measurement cct 2, $\overline{INH} = \text{LOW}$ , $V_{DD} = 3.6$ V, $V_{OH} = V_{DD}$      | –                | –   | 10  | $\mu\text{A}$ |
|  |           | Q: Measurement cct 2, $\overline{INH} = \text{LOW}$ , $V_{DD} = 3.6$ V, $V_{OL} = V_{SS}$      | –                | –   | 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                    | $I_{DD}$  | Measurement cct 3, load cct 2,<br>$\overline{INH} = \text{open}$ , $C_L = 15$ pF, $f = 16$ MHz | 5010×H1          | TBD |     | mA            |
|  |           |  | 5010×H2          |     |     |               |
|  |           |  | 5010×H3          |     |     |               |
|  |           |  | 5010×H4          |     |     |               |
| $\overline{INH}$ pull-up resistance    | $R_{UP1}$ | Measurement cct 4  | –                | 100 | –   | k $\Omega$    |
| Feedback resistance                    | $R_f$     | Measurement cct 5  | –                | 200 | –   | k $\Omega$    |
| Oscillator amplifier output resistance | $R_D$     | Design value   | –                | 820 | –   | $\Omega$      |
| Built-in capacitance                   | $C_G$     | Design value, determined by the internal wafer pattern   | 5010A××, 5010B×× | TBD |     | pF            |
|  | $C_D$     |  |                  |     |     | pF            |

5 V operation:  $V_{DD} = 4.5$  to  $5.5$  V,  $V_{SS} = 0$  V,  $T_a = -40$  to  $85$  °C unless otherwise noted.

| Parameter                              | Symbol    | Condition  | Rating           |     |     | Unit          |
|--|-----------|--|------------------|-----|-----|---------------|
|  |           |  | min              | typ | max |               |
| HIGH-level output voltage              | $V_{OH}$  | Q: Measurement cct 1, $V_{DD} = 4.5$ V, $I_{OH} = 4$ mA  | 3.9              | 4.2 | –   | V             |
| LOW-level output voltage               | $V_{OL}$  | Q: Measurement cct 2, $V_{DD} = 4.5$ V, $I_{OL} = 4$ mA  | –                | 0.3 | 0.5 | V             |
| Output leakage current                 | $I_Z$     | Q: Measurement cct 2, $\overline{INH} = \text{LOW}$ , $V_{DD} = 5.5$ V, $V_{OH} = V_{DD}$      | –                | –   | 10  | $\mu\text{A}$ |
|  |           | Q: Measurement cct 2, $\overline{INH} = \text{LOW}$ , $V_{DD} = 5.5$ V, $V_{OL} = V_{SS}$      | –                | –   | 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                    | $I_{DD}$  | Measurement cct 3, load cct 2,<br>$\overline{INH} = \text{open}$ , $C_L = 15$ pF, $f = 30$ MHz | 5010×H1          | TBD |     | mA            |
|  |           |  | 5010×H2          |     |     |               |
|  |           |  | 5010×H3          |     |     |               |
|  |           |  | 5010×H4          |     |     |               |
| $\overline{INH}$ pull-up resistance    | $R_{UP1}$ | Measurement cct 4  | –                | 100 | –   | k $\Omega$    |
| Feedback resistance                    | $R_f$     | Measurement cct 5  | –                | 200 | –   | k $\Omega$    |
| Oscillator amplifier output resistance | $R_D$     | Design value   | –                | 820 | –   | $\Omega$      |
| Built-in capacitance                   | $C_G$     | Design value, determined by the internal wafer pattern   | 5010A××, 5010B×× | TBD |     | pF            |
|  | $C_D$     |  |                  |     |     | pF            |

**5010CL× 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         |               |
| 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, $\overline{INH} = \text{LOW}$ , $V_{DD} = 3.6$ V, $V_{OH} = V_{DD}$      | —           | —   | 10          | $\mu\text{A}$ |
|                                     |           | Q: Measurement cct 2, $\overline{INH} = \text{LOW}$ , $V_{DD} = 3.6$ V, $V_{OL} = V_{SS}$      | —           | —   | 10          |               |
| HIGH-level input voltage            | $V_{IH}$  | $\overline{INH}$   | $0.7V_{DD}$ |     |             | V             |
| LOW-level input voltage             | $V_{IL}$  | $\overline{INH}$   |             |     | $0.3V_{DD}$ | V             |
| Current consumption                 | $I_{DD}$  | Measurement cct 3, load cct 2,<br>$\overline{INH} = \text{open}$ , $C_L = 15$ pF, $f = 30$ MHz | 5010CL1     | TBD |             | mA            |
|                                     |           |  | 5010CL2     |     |             |               |
|                                     |           |  | 5010CL3     |     |             |               |
|                                     |           |  | 5010CL4     |     |             |               |
| $\overline{INH}$ pull-up resistance | $R_{UP1}$ | Measurement cct 4  | —           | 100 | —           | k $\Omega$    |
|                                     | $R_{UP2}$ |  | TBD         |     |             | M $\Omega$    |
| Feedback resistance                 | $R_f$     | Measurement cct 5  | —           | 200 | —           | k $\Omega$    |
| Built-in capacitance                | $C_G$     | Design value, determined by the internal wafer pattern   | TBD         |     |             | pF            |
|                                     | $C_D$     |  |             |     |             | pF            |

5 V operation:  $V_{DD} = 4.5$  to  $5.5$  V,  $V_{SS} = 0$  V,  $T_a = -40$  to  $85$  °C unless otherwise noted.

| Parameter                           | Symbol    | Condition  | Rating      |     |             | Unit          |
|-------------------------------------|-----------|--|-------------|-----|-------------|---------------|
|                                     |           |  | min         | typ | max         |               |
| HIGH-level output voltage           | $V_{OH}$  | Q: Measurement cct 1, $V_{DD} = 4.5$ V, $I_{OH} = 16$ mA                                       | 4.0         | 4.2 | —           | V             |
| LOW-level output voltage            | $V_{OL}$  | Q: Measurement cct 2, $V_{DD} = 4.5$ V, $I_{OL} = 16$ mA                                       | —           | 0.3 | 0.4         | V             |
| Output leakage current              | $I_Z$     | Q: Measurement cct 2, $\overline{INH} = \text{LOW}$ , $V_{DD} = 5.5$ V, $V_{OH} = V_{DD}$      | —           | —   | 10          | $\mu\text{A}$ |
|                                     |           | Q: Measurement cct 2, $\overline{INH} = \text{LOW}$ , $V_{DD} = 5.5$ V, $V_{OL} = V_{SS}$      | —           | —   | 10          |               |
| HIGH-level input voltage            | $V_{IH}$  | $\overline{INH}$   | $0.7V_{DD}$ |     |             | V             |
| LOW-level input voltage             | $V_{IL}$  | $\overline{INH}$   |             |     | $0.3V_{DD}$ | V             |
| Current consumption                 | $I_{DD}$  | Measurement cct 3, load cct 2,<br>$\overline{INH} = \text{open}$ , $C_L = 50$ pF, $f = 30$ MHz | 5010CL1     | TBD |             | mA            |
|                                     |           |  | 5010CL2     |     |             |               |
|                                     |           |  | 5010CL3     |     |             |               |
|                                     |           |  | 5010CL4     |     |             |               |
| $\overline{INH}$ pull-up resistance | $R_{UP1}$ | Measurement cct 4  | —           | 100 | —           | k $\Omega$    |
|                                     | $R_{UP2}$ |  | TBD         |     |             | M $\Omega$    |
| Feedback resistance                 | $R_f$     | Measurement cct 5  | —           | 200 | —           | k $\Omega$    |
| Built-in capacitance                | $C_G$     | Design value, determined by the internal wafer pattern   | TBD         |     |             | pF            |
|                                     | $C_D$     |  |             |     |             | pF            |

## Switching Characteristics

## 5010×N× series

3 V operation:  $V_{DD} = 2.7$  to  $3.6$  V,  $V_{SS} = 0$  V,  $T_a = -10$  to  $70$  °C unless otherwise noted.

| Parameter                      | Symbol    | Condition   | Rating |     |     | Unit |
|--------------------------------|-----------|---|--------|-----|-----|------|
|                                |           |   | min    | typ | max |      |
| Output rise time               | $t_{r1}$  | Measurement cct 6, load cct 2, $C_L = 15$ pF, $0.1V_{DD}$ to $0.9V_{DD}$                    | –      | 3.0 | 6.0 | ns   |
| Output fall time               | $t_{f1}$  | Measurement cct 6, load cct 2, $C_L = 15$ pF, $0.9V_{DD}$ to $0.1V_{DD}$                    | –      | 3.0 | 6.0 | ns   |
| Output duty cycle <sup>1</sup> | Duty      | Measurement cct 6, load cct 2, $V_{DD} = 3.0$ V, $T_a = 25$ °C, $C_L = 15$ pF, $f = 30$ MHz | 40     | –   | 60  | %    |
| Output disable delay time      | $t_{PLZ}$ | Measurement cct 7, load cct 2, $V_{DD} = 3.0$ V, $T_a = 25$ °C, $C_L = 15$ pF               | –      | –   | 100 | ns   |
| Output enable delay time       | $t_{PZL}$ |   | –      | –   | 100 | ns   |

1. Determined by the lot monitor.

## 5010×N×, ×K× series

5 V operation (5010×N×):  $V_{DD} = 4.5$  to  $5.5$  V,  $V_{SS} = 0$  V,  $T_a = -40$  to  $85$  °C unless otherwise noted.

| Parameter                      | Symbol    | Condition   | Rating |     |     | Unit |
|--------------------------------|-----------|---|--------|-----|-----|------|
|                                |           |   | min    | typ | max |      |
| Output rise time               | $t_{r2}$  | Measurement cct 6, load cct 2, $C_L = 15$ pF, $0.1V_{DD}$ to $0.9V_{DD}$                    | –      | 2.0 | 4.0 | ns   |
|                                | $t_{r3}$  | $C_L = 50$ pF   | –      | 4.0 | 8.0 |      |
| Output fall time               | $t_{f2}$  | Measurement cct 6, load cct 2, $C_L = 15$ pF, $0.9V_{DD}$ to $0.1V_{DD}$                    | –      | 2.0 | 4.0 | ns   |
|                                | $t_{f3}$  | $C_L = 50$ pF   | –      | 4.0 | 8.0 |      |
| Output duty cycle <sup>1</sup> | Duty      | Measurement cct 6, load cct 2, $V_{DD} = 5.0$ V, $T_a = 25$ °C, $C_L = 50$ pF, $f = 30$ MHz | 45     | –   | 55  | %    |
| Output disable delay time      | $t_{PLZ}$ | Measurement cct 7, load cct 2, $V_{DD} = 5.0$ V, $T_a = 25$ °C, $C_L = 15$ pF               | –      | –   | 100 | ns   |
| Output enable delay time       | $t_{PZL}$ |   | –      | –   | 100 | ns   |

1. Determined by the lot monitor.

5 V operation (5010AN2, AN3, AN4, BN2, BN3, BN4, ×K×):  $V_{DD} = 4.5$  to  $5.5$  V,  $V_{SS} = 0$  V,  $T_a = -40$  to  $85$  °C unless otherwise noted.

| Parameter                      | Symbol    | Condition   | Rating |     |     | Unit |
|--------------------------------|-----------|---|--------|-----|-----|------|
|                                |           |   | min    | typ | max |      |
| Output rise time               | $t_{r4}$  | Measurement cct 6, load cct 1, $C_L = 15$ pF, $0.4V$ to $2.4V$                              | –      | 1.5 | 3.0 | ns   |
| Output fall time               | $t_{f4}$  | Measurement cct 6, load cct 1, $C_L = 15$ pF, $2.4V$ to $0.4V$                              | –      | 1.5 | 3.0 | ns   |
| Output duty cycle <sup>1</sup> | Duty      | Measurement cct 6, load cct 1, $V_{DD} = 5.0$ V, $T_a = 25$ °C, $C_L = 15$ pF, $f = 30$ MHz | 45     | –   | 55  | %    |
| Output disable delay time      | $t_{PLZ}$ | Measurement cct 7, load cct 1, $V_{DD} = 5.0$ V, $T_a = 25$ °C, $C_L = 15$ pF               | –      | –   | 100 | ns   |
| Output enable delay time       | $t_{PZL}$ |   | –      | –   | 100 | ns   |

1. Determined by the lot monitor.



**5010×H× series**

3 V operation:  $V_{DD} = 2.7$  to  $3.6$  V,  $V_{SS} = 0$  V,  $T_a = -10$  to  $70$  °C unless otherwise noted.

| Parameter                      | Symbol    | Condition   | Rating |     |     | Unit |
|--------------------------------|-----------|---|--------|-----|-----|------|
|                                |           |   | min    | typ | max |      |
| Output rise time               | $t_{r1}$  | Measurement cct 6, load cct 2, $C_L = 15$ pF, $0.1V_{DD}$ to $0.9V_{DD}$                    | –      | 15  | 30  | ns   |
| Output fall time               | $t_{f1}$  | Measurement cct 6, load cct 2, $C_L = 15$ pF, $0.9V_{DD}$ to $0.1V_{DD}$                    | –      | 15  | 30  | ns   |
| Output duty cycle <sup>1</sup> | Duty      | Measurement cct 6, load cct 2, $V_{DD} = 3.0$ V, $T_a = 25$ °C, $C_L = 15$ pF, $f = 16$ MHz | 40     | –   | 60  | %    |
| Output disable delay time      | $t_{PLZ}$ | Measurement cct 7, load cct 2, $V_{DD} = 3.0$ V, $T_a = 25$ °C, $C_L = 15$ pF               | –      | –   | 100 | ns   |
| Output enable delay time       | $t_{PZL}$ |   | –      | –   | 100 | ns   |

1. Determined by the lot monitor.

5 V operation:  $V_{DD} = 4.5$  to  $5.5$  V,  $V_{SS} = 0$  V,  $T_a = -40$  to  $85$  °C unless otherwise noted.

| Parameter                      | Symbol    | Condition   | Rating |     |     | Unit |
|--------------------------------|-----------|---|--------|-----|-----|------|
|                                |           |   | min    | typ | max |      |
| Output rise time               | $t_{r2}$  | Measurement cct 6, load cct 2, $0.1V_{DD}$ to $0.9V_{DD}$                                   | –      | 5   | 10  | ns   |
|                                | $t_{r3}$  |   | –      | 13  | 26  |      |
| Output fall time               | $t_{f2}$  | Measurement cct 6, load cct 2, $0.9V_{DD}$ to $0.1V_{DD}$                                   | –      | 5   | 10  | ns   |
|                                | $t_{f3}$  |   | –      | 13  | 26  |      |
| Output duty cycle <sup>1</sup> | Duty      | Measurement cct 6, load cct 2, $V_{DD} = 5.0$ V, $T_a = 25$ °C, $C_L = 15$ pF, $f = 30$ MHz | 45     | –   | 55  | %    |
| Output disable delay time      | $t_{PLZ}$ | Measurement cct 7, load cct 2, $V_{DD} = 5.0$ V, $T_a = 25$ °C, $C_L = 15$ pF               | –      | –   | 100 | ns   |
| Output enable delay time       | $t_{PZL}$ |   | –      | –   | 100 | ns   |

1. Determined by the lot monitor.

**5010CL× 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                       | $t_{r2}$  | Measurement cct 6, load cct 2,<br>$0.1V_{DD}$ to $0.9V_{DD}$                                   | $C_L = 15$ pF |     | -   | ns   |
|  | $t_{r4}$  |  | $C_L = 30$ pF |     | -   |      |
| Output fall time                       | $t_{f2}$  | Measurement cct 6, load cct 2,<br>$0.9V_{DD}$ to $0.1V_{DD}$                                   | $C_L = 15$ pF |     | -   | ns   |
|  | $t_{f4}$  |  | $C_L = 30$ pF |     | -   |      |
| Output duty cycle <sup>1</sup>         | Duty      | Measurement cct 6, load cct 2, $V_{DD} = 3.0$ V, $T_a = 25$ °C,<br>$C_L = 15$ pF, $f = 30$ MHz | 45            | -   | 55  | %    |
| Output disable delay time <sup>2</sup> | $t_{PLZ}$ | Measurement cct 7, load cct 2, $V_{DD} = 3.0$ V, $T_a = 25$ °C,<br>$C_L = 15$ pF               | -             | -   | 100 | ns   |
| Output enable delay time <sup>2</sup>  | $t_{PZL}$ |  | -             | -   | 100 | ns   |

1. Determined by the lot monitor.

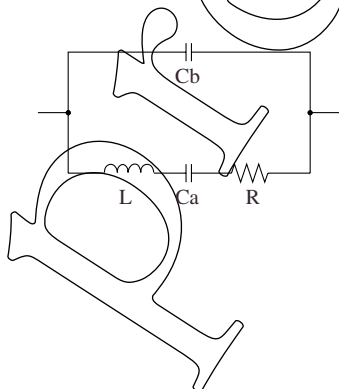
2. Oscillator stop function is built-in. When  $\overline{INH}$  goes LOW, normal output stops. When  $\overline{INH}$  goes HIGH, normal output is not resumed until after the oscillator start-up time has elapsed.

5 V operation:  $V_{DD} = 4.5$  to  $5.5$  V,  $V_{SS} = 0$  V,  $T_a = -40$  to  $85$  °C unless otherwise noted.

| Parameter                              | Symbol    | Condition  | Rating        |     |     | Unit |
|--|-----------|--|---------------|-----|-----|------|
|  |           |  | min           | typ | max |      |
| Output rise time                       | $t_{r2}$  | Measurement cct 6, load cct 2,<br>$0.1V_{DD}$ to $0.9V_{DD}$                                   | $C_L = 15$ pF |     | -   | ns   |
|  | $t_{r3}$  |  | $C_L = 50$ pF |     | -   |      |
| Output fall time                       | $t_{f2}$  | Measurement cct 6, load cct 2,<br>$0.9V_{DD}$ to $0.1V_{DD}$                                   | $C_L = 15$ pF |     | -   | ns   |
|  | $t_{f3}$  |  | $C_L = 50$ pF |     | -   |      |
| Output duty cycle <sup>1</sup>         | Duty      | Measurement cct 6, load cct 2, $V_{DD} = 5.0$ V, $T_a = 25$ °C,<br>$C_L = 50$ pF, $f = 30$ MHz | 40            | -   | 60  | %    |
| Output disable delay time <sup>2</sup> | $t_{PLZ}$ | Measurement cct 7, load cct 2, $V_{DD} = 5.0$ V, $T_a = 25$ °C,<br>$C_L = 15$ pF               | -             | -   | 100 | ns   |
| Output enable delay time <sup>2</sup>  | $t_{PZL}$ |  | -             | -   | 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      | 17.2  | 4.36   | 6.46    | 2.26    |

## FUNCTIONAL DESCRIPTION

### Standby Function

#### AH, AK, AN, BH, BK, BN, DN series

When  $\overline{\text{INH}}$  goes LOW, the output on Q becomes high impedance, but internally the oscillator does not stop.

#### CL series

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

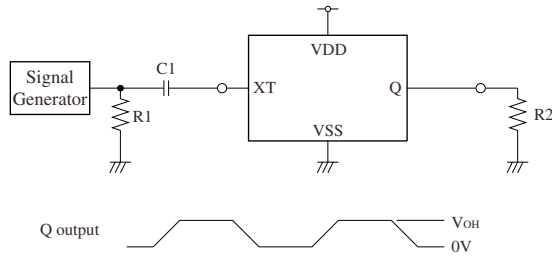
| Version                           | $\overline{\text{INH}}$ | Q   | Oscillator       |
|-----------------------------------|-------------------------|---|------------------|
| AH, AK, AN, BH, BK, BN, DN series | HIGH (or open)          | Any $f_0$ , $f_0/2$ , $f_0/4$ or $f_0/8$ output frequency | Normal operation |
|                                   | LOW                     | High impedance  | Normal operation |
| CL series                         | HIGH (or open)          | Any $f_0$ , $f_0/2$ , $f_0/4$ or $f_0/8$ output frequency | Normal operation |
|                                   | LOW                     | High impedance  | Stopped          |

### Power-save Pull-up Resistance (CL series only)

The  $\overline{\text{INH}}$  pull-up resistance changes in response to the input level (HIGH or LOW). When  $\overline{\text{INH}}$  goes LOW (standby state), the pull-up resistance becomes large to reduce the current consumption during standby.

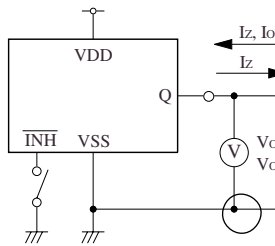
## MEASUREMENT CIRCUITS

Measurement cct 1

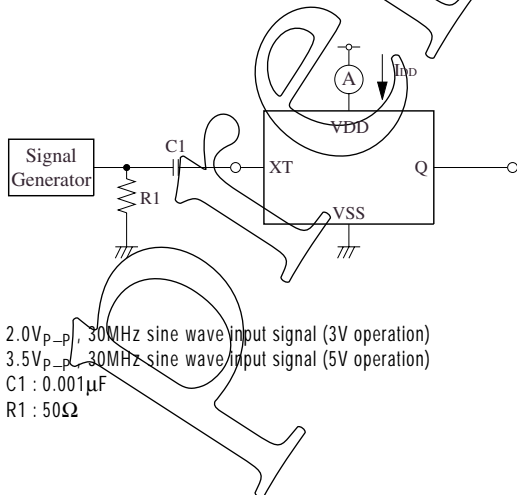


2.0V<sub>P-P</sub>, 10MHz sine wave input signal (3V operation)  
 3.5V<sub>P-P</sub>, 10MHz sine wave input signal (5V operation)  
 C1 : 0.001μF  
 R1 : 50Ω  
 R2 : 263Ω (5010×N×, ×K×/ 3V operation)  
 245Ω (5010×N×, ×K×/ 5V operation)  
 1050Ω (5010×H×/ 3V operation)  
 975Ω (5010×H×/ 5V operation)  
 275Ω (5010CL×/ 3V operation)  
 250Ω (5010CL×/ 5V operation)

Measurement cct 2

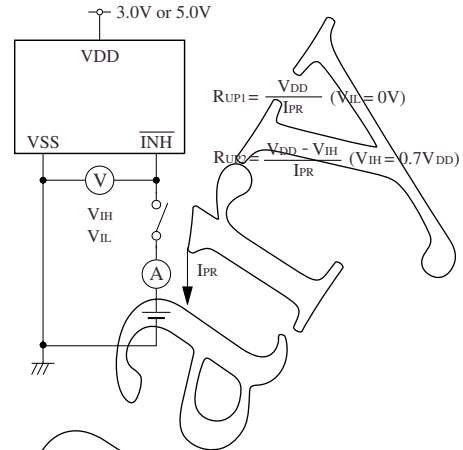


Measurement cct 3



2.0V<sub>P-P</sub>, 30MHz sine wave input signal (3V operation)  
 3.5V<sub>P-P</sub>, 30MHz sine wave input signal (5V operation)  
 C1 : 0.001μF  
 R1 : 50Ω

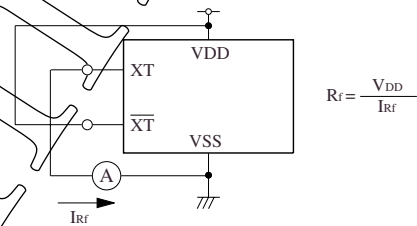
Measurement cct 4



$$R_{UP1} = \frac{V_{DD}}{I_{PR}} \quad (V_{IL} = 0V)$$

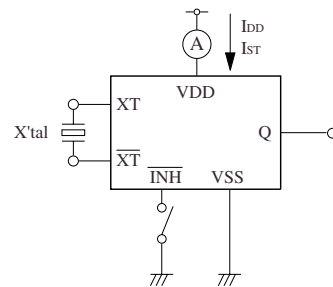
$$R_{UP2} = \frac{V_{DD} - V_{IH}}{I_{PR}} \quad (V_{IH} = 0.7V_{DD})$$

Measurement cct 5

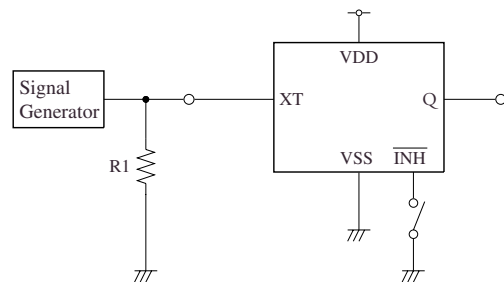


$$R_f = \frac{V_{DD}}{I_{Rf}}$$

Measurement cct 6

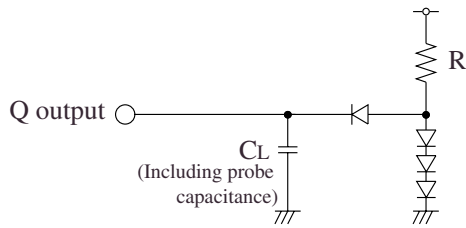


Measurement cct 7



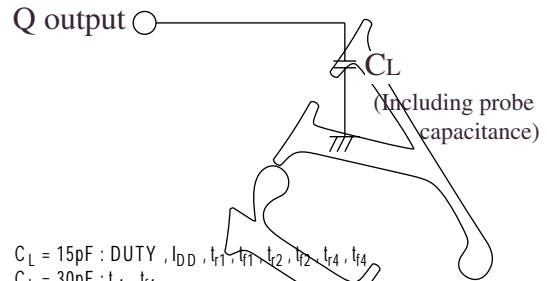
R1 : 50Ω

## Load cct 1



$C_L = 15\text{pF}$  : DUTY,  $I_{DD}$ ,  $t_r$ ,  $t_f$   
 $R = 400\Omega$

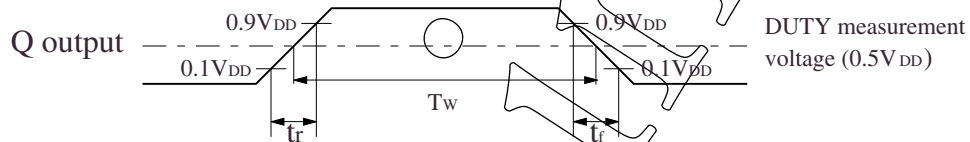
## Load cct 2



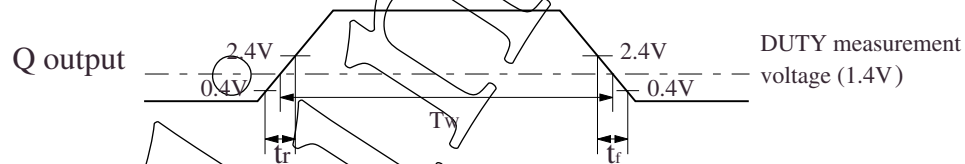
$C_L = 15\text{pF}$  : DUTY,  $I_{DD}$ ,  $t_{r1}$ ,  $t_{f1}$ ,  $t_{r2}$ ,  $t_{f2}$ ,  $t_{r4}$ ,  $t_{f4}$   
 $C_L = 30\text{pF}$  :  $t_{r4}$ ,  $t_{f4}$   
 $C_L = 50\text{pF}$  :  $t_{r3}$ ,  $t_{f3}$

## Switching Time Measurement Waveform

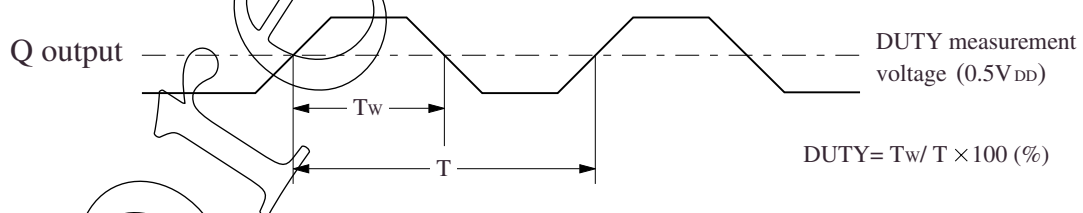
### Output duty level (CMOS)



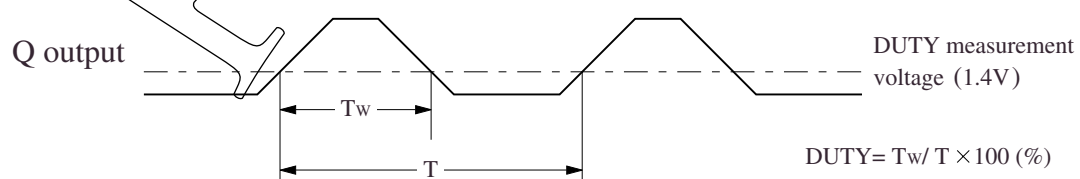
### Output duty level (TTL)



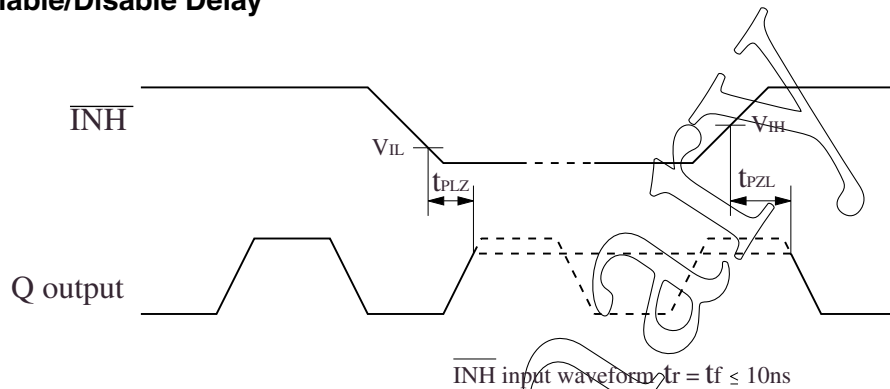
### Output duty cycle (CMOS)



### Output duty cycle (TTL)



## Output Enable/Disable Delay



Note (CL series only) : 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.

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