

OVERVIEW

The SM5007 series are crystal oscillator module ICs, that feature low current consumption. 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

- Capacitors C_G , C_D built-in
- Standby function (oscillator stops)
- 6 μ A (typ.) low standby current (5 V operation)
- Power-save pull-up resistor built-in
- Inverter amplifier feedback resistor built-in
- 3.2 mA ($V_{DD} = 4.5$ V), 1.6 mA ($V_{DD} = 2.7$ V) drive capability
- 2.7 to 5.5 V supply voltage
- Low current consumption
- Oscillator frequency output (f_O or $f_O/2$, determined by internal connection)
- 8-pin VSOP (SM5007AL \times V)
- Chip form (CF5007A \times \times)

SERIES CONFIGURATION

| Version | Recommended Operating frequency [MHz] | | Output frequency | gm ratio | Built-in capacitance [pF] | | Input level | Output duty level | Standby output state |
|-------------------------|---------------------------------------|----|------------------|----------|---------------------------|-------|-------------|-------------------|----------------------|
| | 3V | 5V | | | C_G | C_D | | | |
| CF5007AA1 | 30 | 30 | f_0 | 2 | 10 | 10 | TTL | CMOS | LOW |
| CF5007AA2 | 30 | 30 | $f_0/2$ | 2 | 10 | 10 | TTL | CMOS | LOW |
| SM5007AL1V CF5007AL1 | 20 | 30 | f_0 | 1 | 10 | 10 | CMOS | CMOS | High impedance |
| SM5007AL2V CF5007AL2 | 20 | 30 | $f_0/2$ | 1 | 10 | 10 | CMOS | CMOS | High impedance |

Note: Recommended operating frequency is not the guaranteed value but is measured using NPC's standard crystal.
Since the product feature is targeted at low current consumption, please evaluate oscillation margins seriously before actual use.

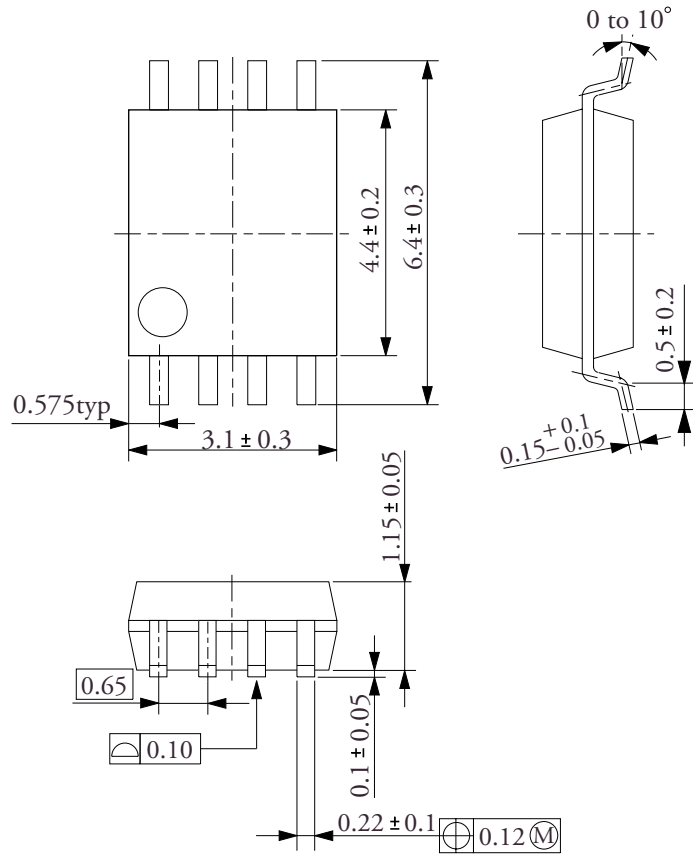
ORDERING INFORMATION

| Device | Package |
|------------------------------|------------|
| SM5007AL \times V | 8-pin VSOP |
| CF5007A \times \times -1 | Chip form |

PACKAGE DIMENSIONS

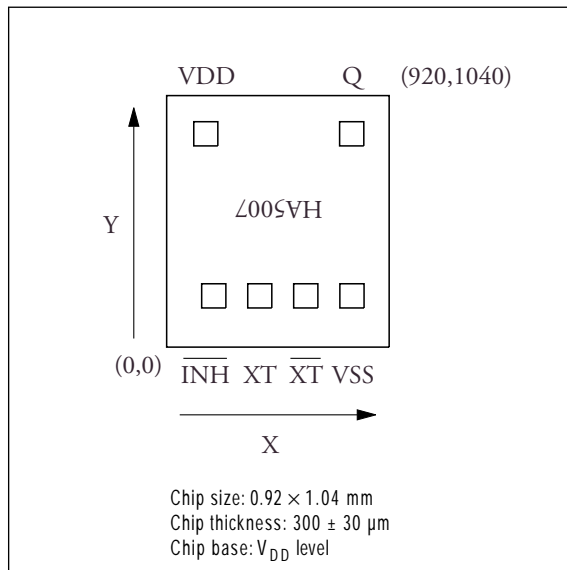
(Unit : mm)

- 8-pin VSOP



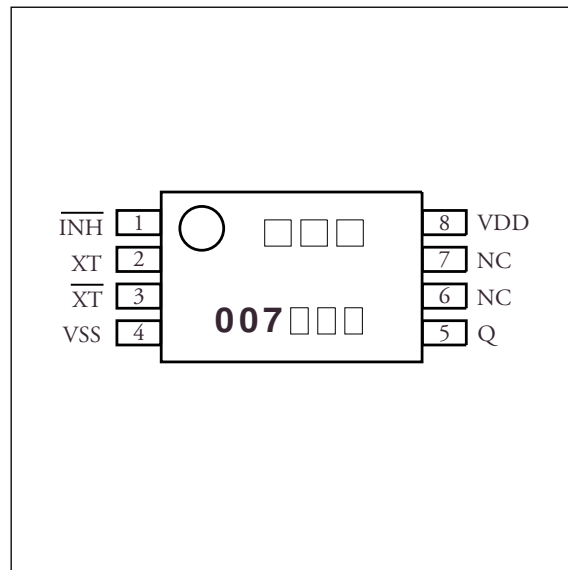
PAD LAYOUT

(Unit : μm)



PINOUT

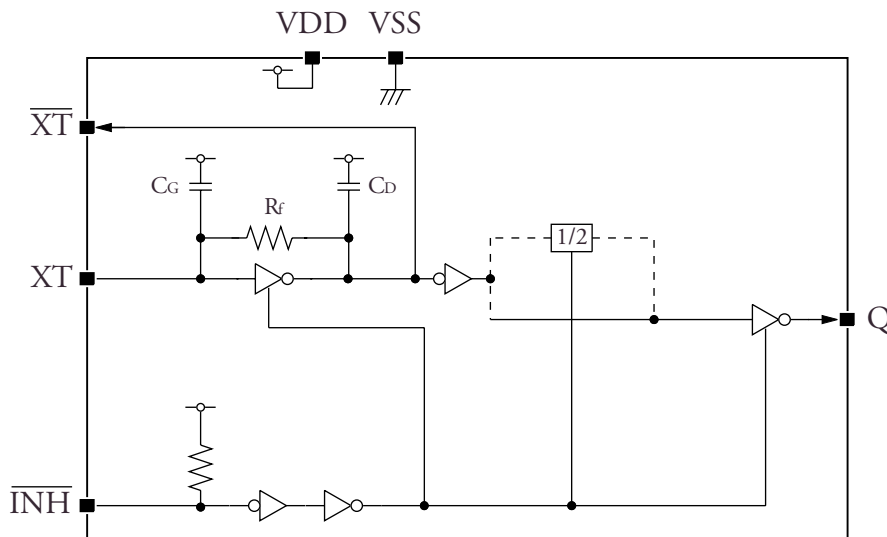
(Top view)



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 | 212 |
| 2 | XT | I | Amplifier input. | 385 | 212 |
| 3 | $\overline{\text{XT}}$ | O | Amplifier output. | 575 | 212 |
| 4 | VSS | - | Ground | 766 | 212 |
| 5 | Q | O | Output. Output frequency (f_0 or $f_0/2$) determined by internal connection | 765 | 882 |
| 6 | NC | - | No connection | - | - |
| 7 | NC | - | No connection | - | - |
| 8 | VDD | - | Supply voltage | 162 | 882 |

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 VSOP | -55 to 125 | |
| Output current | I_{OUT} | | 15 | mA |
| Power dissipation | P_D | 8-pin VSOP | 300 | mW |
| Soldering temperature | T_{sld} | 8-pin VSOP | 255 | °C |
| Soldering time | t_{sld} | 8-pin VSOP | 10 | s |

Recommended Operating Conditions

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

| 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: Since the recommended operating conditions will change in accordance with operating frequency, load capacitance, power dissipation, or crystal characteristics, please evaluate oscillation margins seriously before actual use.

Electrical Characteristics

3 V operation: $V_{DD} = 2.7$ to 3.3 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, $I_{OH} = 1.6$ mA | 2.2 | - | - | V | |
| LOW-level output voltage | V_{OL} | Q: Measurement cct 1, $I_{OL} = 1.6$ mA | - | - | 0.4 | V | |
| Output leakage current (AL series only) | I_Z | Q: Measurement cct 2, $\overline{INH} = LOW$, $V_{OH} = V_{DD}$ | - | - | 10 | μA | |
| | | Q: Measurement cct 2, $\overline{INH} = LOW$, $V_{OL} = V_{SS}$ | - | - | 10 | | |
| HIGH-level input voltage | V_{IH} | \overline{INH} | SM5007AL×V CF5007AL× | $0.7V_{DD}$ | - | - | V |
| | | CF5007AA× | 2.0 | - | - | | |
| LOW-level input voltage | V_{IL} | \overline{INH} | SM5007AL×V CF5007AL× | - | - | $0.3V_{DD}$ | V |
| | | CF5007AA× | - | - | 0.3 | | |
| Current consumption | I_{DD1} | $\overline{INH} = open$, Measurement cct 3, No load, $f = 30$ MHz crystal oscillator | CF5007AA1 | | 1.8 | 4.8 | mA |
| | | | SM5007AL1V CF5007AL1 | | 1.2 | 3.2 | |
| | | | CF5007AA2 | | 1.4 | 3.6 | |
| | | | SM5007AL2V CF5007AL2 | | 0.8 | 2.0 | |
| | I_{DD2} | $\overline{INH} = open$, Measurement cct 3, $C_L = 15$ pF, $f = 30$ MHz crystal oscillator | CF5007AA1 | | 3.4 | 6.8 | |
| | | | SM5007AL1V CF5007AL1 | | 2.8 | 5.2 | |
| | | | CF5007AA2 | | 2.2 | 4.6 | |
| | | | SM5007AL2V CF5007AL2 | | 1.6 | 3.0 | |
| Standby current | I_{ST} | $\overline{INH} = V_{SS}$, Measurement cct 3 | - | 2 | 5 | μA | |
| \overline{INH} pull-up resistance | R_{UP1} | Measurement cct 4, $V_{DD} = 3$ V, $\overline{INH} = V_{SS}$ | 0.6 | - | 12 | M Ω | |
| | R_{UP2} | Measurement cct 4, $V_{DD} = 3$ V, $\overline{INH} = 2.1$ V | 40 | - | 200 | k Ω | |
| Negative resistance | $-R_L$ | $V_{DD} = 3$ V, $T_a = 25$ °C, 30 MHz | CF5007AA× | | -140 | Ω | |
| | | | SM5007AL×V CF5007AL× | | -70 | | |
| Feedback resistance | R_f | Measurement cct 5 | 50 | - | 300 | k Ω | |
| Built-in capacitance | C_G | Design value | 9.3 | 10 | 10.7 | pF | |
| | C_D | | 9.3 | 10 | 10.7 | pF | |

SM5007 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 | | |
| HIGH-level output voltage | V_{OH} | Q: Measurement cct 1, $I_{OH} = 3.2$ mA | 4.0 | – | – | V | |
| LOW-level output voltage | V_{OL} | Q: Measurement cct 1, $I_{OL} = 3.2$ mA | – | – | 0.4 | V | |
| Output leakage current (AL series only) | I_z | Q: Measurement cct 2, $\overline{INH} = \text{LOW}$, $V_{OH} = V_{DD}$ | – | – | 10 | μA | |
| | | Q: Measurement cct 2, $\overline{INH} = \text{LOW}$, $V_{OL} = V_{SS}$ | – | – | 10 | | |
| HIGH-level input voltage | V_{IH} | \overline{INH} | SM5007AL×V CF5007AL× | $0.7V_{DD}$ | – | – | V |
| | | | CF5007AA× | 2.0 | – | – | |
| LOW-level input voltage | V_{IL} | \overline{INH} | SM5007AL×V CF5007AL× | – | – | $0.3V_{DD}$ | V |
| | | | CF5007AA× | – | – | 0.8 | |
| Current consumption | I_{DD1} | $\overline{INH} = \text{open}$, Measurement cct 3, No load, $f = 30$ MHz crystal oscillator | CF5007AA1 | | 3.0 | 6.8 | mA |
| | | | SM5007AL1V CF5007AL1 | | 2.2 | 4.8 | |
| | | | CF5007AA2 | | 2.2 | 5.0 | |
| | | | SM5007AL2V CF5007AL2 | | 1.4 | 3.0 | |
| | I_{DD2} | $\overline{INH} = \text{open}$, Measurement cct 3, $C_L = 15$ pF, $f = 30$ MHz crystal oscillator | CF5007AA1 | | 5.6 | 9.8 | |
| | | | SM5007AL1V CF5007AL1 | | 4.8 | 7.8 | |
| | | | CF5007AA2 | | 3.6 | 6.6 | |
| | | | SM5007AL2V CF5007AL2 | | 2.8 | 4.6 | |
| Standby current | I_{ST} | $\overline{INH} = V_{SS}$, Measurement cct 3 | – | 6 | 15 | μA | |
| \overline{INH} pull-up resistance | R_{UP1} | Measurement cct 4, $V_{DD} = 5$ V, $\overline{INH} = V_{SS}$ | 0.3 | – | 6 | $\text{M}\Omega$ | |
| | R_{UP2} | Measurement cct 4, $V_{DD} = 5$ V, $\overline{INH} = 3.5$ V | 40 | – | 200 | $\text{k}\Omega$ | |
| Negative resistance | $-R_L$ | $V_{DD} = 5$ V, $T_a = 25$ °C, 30 MHz | CF5007AA× | | –360 | Ω | |
| | | | SM5007AL×V CF5007AL× | | –190 | | |
| Feedback resistance | R_f | Measurement cct 5 | 50 | – | 300 | $\text{k}\Omega$ | |
| Built-in capacitance | C_G | Design value | 9.3 | 10 | 10.7 | pF | |
| | C_D | | 9.3 | 10 | 10.7 | pF | |

Switching Characteristics

3 V operation: $V_{DD} = 2.7$ to 3.3 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_r | Measurement cct 2, load cct 1, $0.1V_{DD}$ to $0.9V_{DD}$, $C_L = 15$ pF | - | 5 | 15 | ns | |
| Output fall time | t_f | Measurement cct 2, load cct 1, $0.9V_{DD}$ to $0.1V_{DD}$, $C_L = 15$ pF | - | 5 | 15 | ns | |
| Output duty cycle ¹ | Duty | Measurement cct 2, load cct 1, $T_a = 25$ °C, $V_{DD} = 3$ V, $C_L = 15$ pF | $f_0 = 16$ MHz | 45 | - | 55 | % |
| | | | $f_0 = 30$ MHz | 40 | - | 60 | |
| Output disable delay time | t_{pLZ} | Measurement cct 6, load cct 1, $T_a = 25$ °C, $V_{DD} = 3$ V, $C_L \leq 15$ pF | - | - | 100 | ns | |
| Output enable delay time ² | t_{pZL} | | - | - | 100 | ns | |
| Maximum operating frequency | f_{max} | Measurement cct 2, load cct 1, $C_L \leq 15$ pF | 30 | - | - | MHz | |
| Minimum operating frequency | f_{min} | Measurement cct 2, load cct 1, $C_L \leq 15$ pF | - | - | 4 | MHz | |

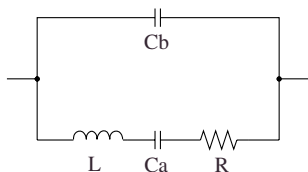
1. Determined by the lot monitor.
2. Oscillator stop function is built-in. When \overline{INH} goes LOW, normal output stops. When \overline{INH} goes HIGH, normal output is not resumed until after the oscillator start-up time has elapsed.

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_r | Measurement cct 2, load cct 1, $0.1V_{DD}$ to $0.9V_{DD}$, $C_L = 15$ pF | - | 3 | 9 | ns |
| Output fall time | t_f | Measurement cct 2, load cct 1, $0.9V_{DD}$ to $0.1V_{DD}$, $C_L = 15$ pF | - | 3 | 9 | ns |
| Output duty cycle ¹ | Duty | Measurement cct 2, load cct 1, $T_a = 25$ °C, $V_{DD} = 5$ V, $C_L = 15$ pF | 45 | - | 55 | % |
| Output disable delay time | t_{pLZ} | Measurement cct 6, load cct 1, $T_a = 25$ °C, $V_{DD} = 5$ V, $C_L \leq 15$ pF | - | - | 100 | ns |
| Output enable delay time ² | t_{pZL} | | - | - | 100 | ns |
| Maximum operating frequency | f_{max} | Measurement cct 2, load cct 1, $C_L \leq 15$ pF | 30 | - | - | MHz |
| Minimum operating frequency | f_{min} | Measurement cct 2, load cct 1, $C_L \leq 15$ pF | - | - | 4 | MHz |

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

The oscillator stops when $\overline{\text{INH}}$ goes LOW. When the oscillator stops, the oscillator output on Q changes as shown in the following table.

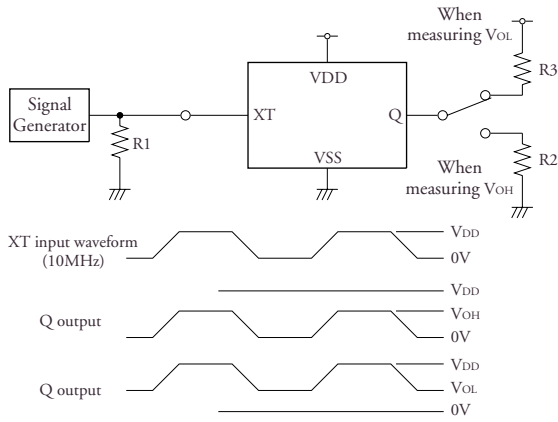
| $\overline{\text{INH}}$ | Q | Oscillator |
|-------------------------|---|------------------|
| HIGH (or open) | f_0 or $f_0/2$ output frequency | Normal operation |
| LOW | AA series : LOW AL series : High impedance | Stopped |

Power-save Pull-up Resistance

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.

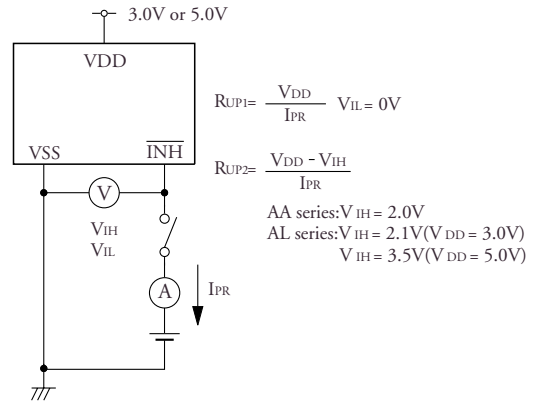
MEASUREMENT CIRCUITS

Measurement cct 1

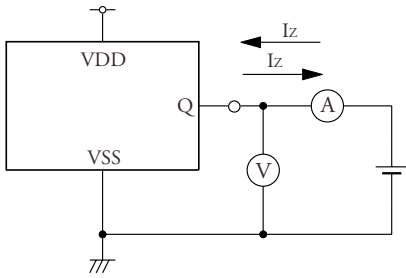


$R1 : 50\Omega$
 $R2 : 1.25k\Omega (V_{DD} = 4.5V), 1.375k\Omega (V_{DD} = 2.7V)$
 $R3 : 1.285k\Omega (V_{DD} = 4.5V), 1.44k\Omega (V_{DD} = 2.7V)$

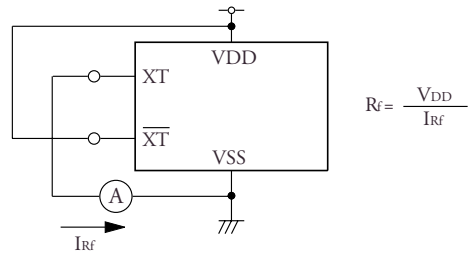
Measurement cct 4



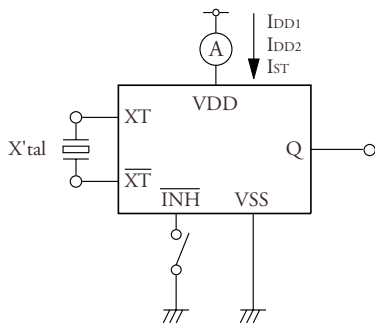
Measurement cct 2



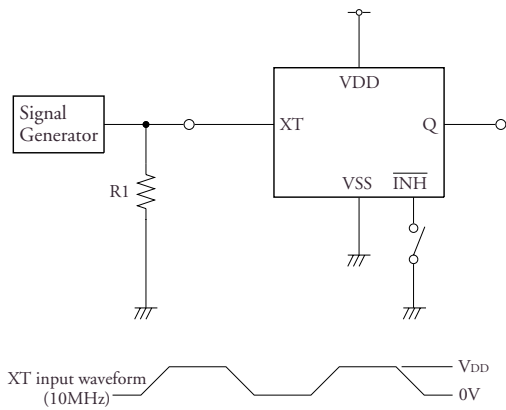
Measurement cct 5



Measurement cct 3

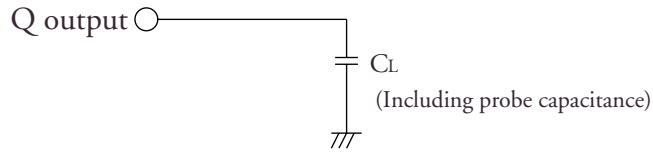


Measurement cct 6



$R1 : 50\Omega$

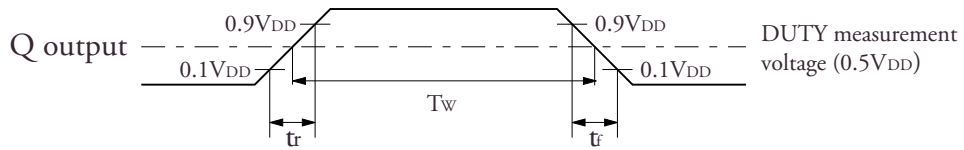
Load cct 1



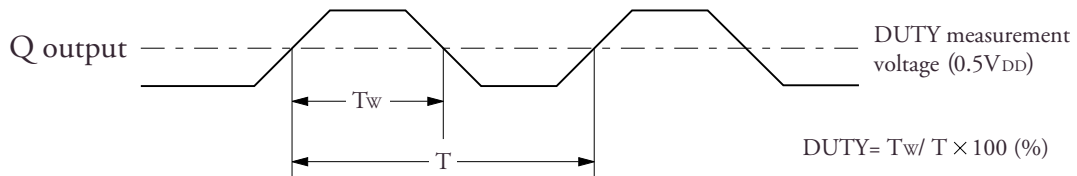
$C_L = 15\text{pF} : I_{DD}, \text{DUTY}, t_r, t_f$

Switching Time Measurement Waveform

Output duty level (CMOS)

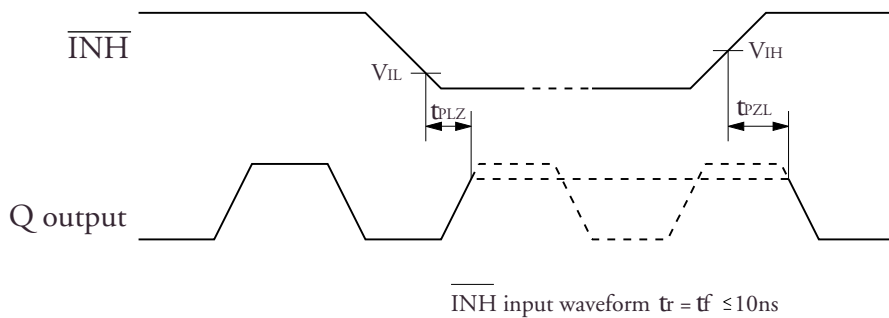


Output duty cycle (CMOS)



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.



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