NPC

# WF5027 series

Crystal Oscillator Module ICs

## OVERVIEW

The WF5027 series are miniature crystal oscillator module ICs. The oscillator circuit stage has voltage regulator drive, significantly reducing current consumption and crystal current, compared with existing devices, and significantly reducing the oscillator characteristics supply voltage dependency. There are 3 pad layout package options available for optimized mounting, making these devices ideal for miniature crystal oscillators.

## FEATURES

- Wide range of operating supply voltage: 1.60 to 3.63V
- Regulated voltage drive oscillator circuit for reduced power consumption and crystal drive current
- Optimized low crystal drive current oscillation for miniature crystal units
- 3 pad layout options for mounting
  - 5027A×, M×, Q× series: for Flip Chip Bonding
  - 5027B×, N×, R× series: for Wire Bonding (type I)
  - 5027C×, P×, S× series: for Wire Bonding (type II)
- Recommended oscillation frequency range

  **For fundamental oscillator**
  - Low frequency version: 20MHz to 60MHz
  - High frequency version: 60MHz to 100MHz

  **For 3rd overtone oscillator**
  - Low frequency version: 40MHz to 110MHz
  - High frequency version*1: 110MHz to 180MHz

  *1: under development
- Multi-stage frequency divider for low-frequency output support: 0.9MHz (min)
- Frequency divider built-in (for fundamental oscillator)
  - Selectable by version: $f_O$, $f_O/2$, $f_O/4$, $f_O/8$, $f_O/16$, $f_O/32$, $f_O/64$
- –40 to 85°C operating temperature range
- Standby function
  - High impedance in standby mode, oscillator stops
- CMOS output duty level (1/2VDD)
- 50 ± 5% output duty
- 15pF output drive capability
- Wafer form (WF5027××)
  Chip form (CF5027××)

## APPLICATIONS

- 3.2 × 2.5, 2.5 × 2.0, 2.0 × 1.6 size miniature crystal oscillator modules

## ORDERING INFORMATION

| Device | Package |
|---|---|
| WF5027××–4 | Wafer form |
| CF5027××–4 | Chip form |

# SERIES CONFIGURATION

## For Fundamental Oscillator

| Operating supply voltage range [V] | Output drive capability [mA] | PAD layout | Recommended oscillation frequency range*1 [MHz] | Version*2 | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | $f_O$ output | $f_O/2$ output | $f_O/4$ output | $f_O/8$ output | $f_O/16$ output | $f_O/32$ output | $f_O/64$ output |
| 1.60 to 3.63 | ±4 | Flip Chip Bonding | 20 to 60 | 5027A1 | 5027A2 | 5027A3 | 5027A4 | 5027A5 | 5027A6 | 5027A7 |
| | | | 60 to 100 | 5027AP | 5027AQ | 5027AR | 5027AS | 5027AT | 5027AV | 5027AW |
| | | Wire Bonding Type I | 20 to 60 | 5027B1 | 5027B2 | 5027B3 | 5027B4 | 5027B5 | 5027B6 | 5027B7 |
| | | | 60 to 100 | 5027BP | 5027BQ | 5027BR | 5027BS | 5027BT | 5027BV | 5027BW |
| | | Wire Bonding Type II | 20 to 60 | 5027C1 | 5027C2 | 5027C3 | 5027C4 | 5027C5 | 5027C6 | 5027C7 |
| | | | 60 to 100 | 5027CP | 5027CQ | 5027CR | 5027CS | 5027CT | 5027CV | 5027CW |

*1. The recommended oscillation frequency is a yardstick value derived from the crystal used for NPC characteristics authentication. However, the oscillation frequency range 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. Wafer form devices have designation WF5027×× and chip form devices have designation CF5027××.

## For 3rd Overtone Oscillator

| Operating supply voltage range [V] | Output drive capability [mA] | PAD layout | Recommended oscillation frequency range*1 [MHz] and version*2 | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | 40 to 50 | 50 to 65 | 65 to 85 | 85 to 110 | 110 to 145 | 145 to 180 |
| 1.60 to 3.63 | ±8 | Flip Chip Bonding | 5027MA | 5027MB | 5027MC | 5027MD | (5027QE) | (5027QF) |
| | | Wire Bonding Type I | 5027NA | 5027NB | 5027NC | 5027ND | (5027RE) | (5027RF) |
| | | Wire Bonding Type II | 5027PA | 5027PB | 5027PC | 5027PD | (5027SE) | (5027SF) |

*1. The recommended oscillation frequency is a yardstick value derived from the crystal used for NPC characteristics authentication. However, the oscillation frequency range 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. Wafer form devices have designation WF5027×× and chip form devices have designation CF5027××.
Versions in parentheses ( ) are under development.

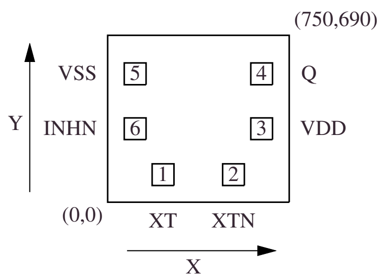
# VERSION NAME

<table>
<tr><th>Device</th><th>Package</th><th>Version name</th></tr>
<tr><td>WF5027××–4</td><td>Wafer form</td><td rowspan="2">WF5027□□–4<br>Form WF: Wafer form<br>CF: Chip (Die) form<br>Oscillation frequency range, frequency divider function<br>Pad layout type A, M, Q: for Flip Chip Bonding<br>B, N, R: for Wire Bonding (type I)<br>C, P, S: for Wire Bonding (type II)</td></tr>
<tr><td>CF5027××–4</td><td>Chip form</td></tr>
</table>

## PAD LAYOUT

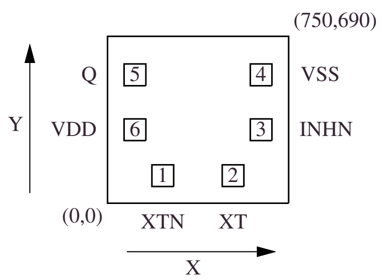
(Unit: µm)

- 5027A×, M×, Q×
  (for Flip Chip Bonding)



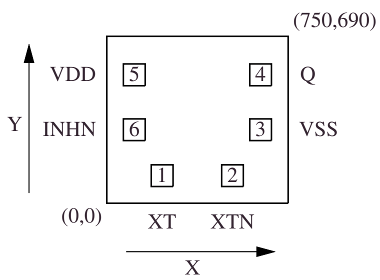

Chip size: 0.75 × 0.69mm
Chip thickness: 130 ± 15µm
PAD size: 90µm
Chip base: $V_{SS}$ level

- 5027B×, N×, R×
  (for Wire Bonding (type I))




Chip size: 0.75 × 0.69mm
Chip thickness: 130 ± 15µm
PAD size: 90µm
Chip base: $V_{SS}$ level

- 5027C×, P×, S×
  (for Wire Bonding (type II))




Chip size: 0.75 × 0.69mm
Chip thickness: 130 ± 15µm
PAD size: 90µm
Chip base: $V_{SS}$ level

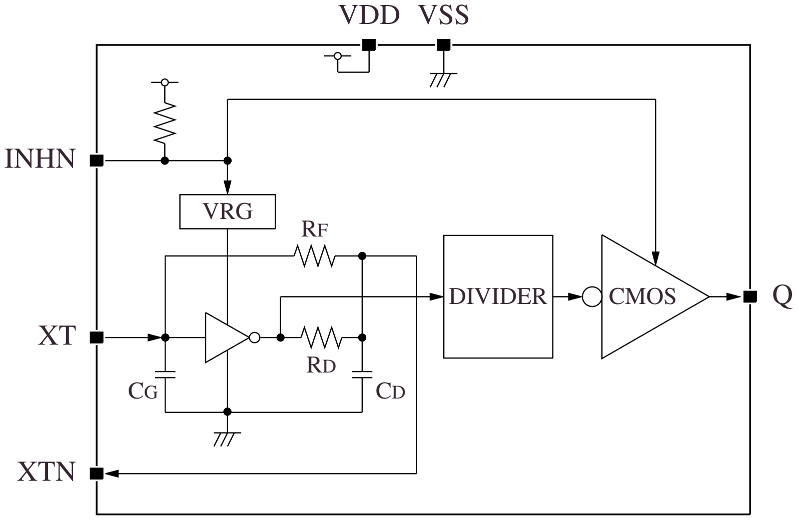
## PAD DIMENSIONS

| Pad No. | Pad dimensions [µm] X | Pad dimensions [µm] Y |
|---|---|---|
| 1 | 229 | 114 |
| 2 | 520 | 114 |
| 3 | 636 | 304 |
| 4 | 636 | 531 |
| 5 | 114 | 531 |
| 6 | 114 | 304 |

## PIN DESCRIPTION

| Pad No. 5027A× 5027M× 5027Q× | Pad No. 5027B× 5027N× 5027R× | Pad No. 5027C× 5027P× 5027S× | Pin | Name | Description |
|---|---|---|---|---|---|
| 1 | 2 | 1 | XT | Amplifier input | Crystal connection pins. Crystal is connected between XT and XTN. |
| 2 | 1 | 2 | XTN | Amplifier output | |
| 3 | 6 | 5 | VDD | (+) supply voltage | – |
| 4 | 5 | 4 | Q | Output | Output frequency determined by internal circuit to one of $f_O$, $f_O/2$, $f_O/4$, $f_O/8$, $f_O/16$, $f_O/32$, $f_O/64$ |
| 5 | 4 | 3 | VSS | (–) ground | – |
| 6 | 3 | 6 | INHN | Output state control input | High impedance when LOW (oscillator stops). Power-saving pull-up resistor built-in. |

## BLOCK DIAGRAM



## VERSION DISCRIMINATION INTERNAL COMPONENTS

The WF5027 series device version is not determined solely by the mask pattern, but can also be determined by the trimming of internal trimming fuses.

■ Version determined by laser trimming:

These chips are produced from a common device by the laser trimming of fuses corresponding to the ordered version, shown in table 1. These devices are shipped for electrical characteristics testing. Laser-trimmed versions are identified externally by the combination of the version name marking (1) and the locations of trimmed fuses (2).

■ Version determined by mask pattern:

These chips are fabricated using the mask corresponding to the ordered version, and do not require trimming. Mask-fabricated versions are identified externally by the version name marking (1) only.

Since the WF5027 series devices are manufactured using 2 methods, there are 2 types of IC chip available (identified externally) for the same version name. The identification markings for all WF5027 series device versions is shown in table 2.

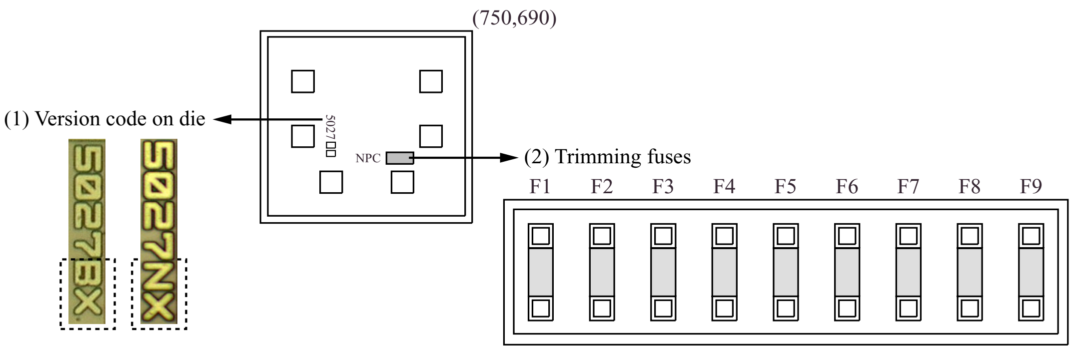
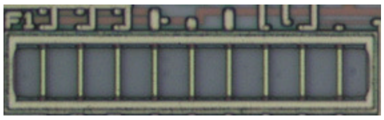


Table 1. Version and trimming fuses
(for fundamental oscillator)

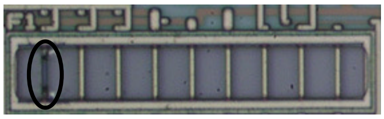
| Version | Trimming fuse number*1 | | | | |
|---|---|---|---|---|---|
| | F1 | F2 | F3 | F4 | F5 |
| 5027×1 | – | – | – | – | – |
| 5027×2 | × | – | – | – | – |
| 5027×3 | – | × | – | – | – |
| 5027×4 | × | × | – | – | – |
| 5027×5 | – | – | × | – | – |
| 5027×6 | × | – | × | – | – |
| 5027×7 | – | × | × | – | – |
| 5027×P | – | – | – | × | × |
| 5027×Q | × | – | – | × | × |
| 5027×R | – | × | – | × | × |
| 5027×S | × | × | – | × | × |
| 5027×T | – | – | × | × | × |
| 5027×V | × | – | × | × | × |
| 5027×W | – | × | × | × | × |

*1. –: untrimmed, ×: trimmed, F6 to F9 not used

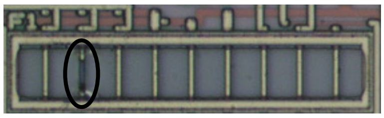
■ 5027×1 trimming fuses (untrimmed)



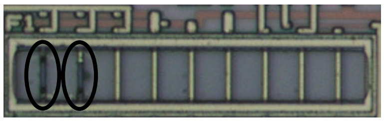
■ 5027×2 trimming fuses (F1 link trimmed)



■ 5027×3 trimming fuses (F2 link trimmed)



■ 5027×4 trimming fuses (F1 and F2 links trimmed)



: trimmed device

Table 2. Version and trimming fuses (for 3rd overtone oscillator)

| Version | Recommended oscillation frequency range*1 [MHz] | Trimming fuse number*2 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | F1 | F2 | F3 | F4 | F5 | F6 | F7 | F8 | F9 |
| 5027×A | 40 to 50 | – | – | – | – | – | – | × | × | × |
| 5027×B | 50 to 65 | – | × | – | – | – | – | – | × | × |
| 5027×C | 65 to 85 | × | × | – | – | × | – | × | – | × |
| 5027×D | 85 to 110 | – | × | × | × | × | – | × | – | × |
| 5027×E | (110 to 145) | | | | | TBD | | | | |
| 5027×F | (145 to 180) | | | | | | | | | |

*1. Values in parentheses ( ) are provisional only.
*2. –: untrimmed, ×: trimmed

Table 3. Version identification by version name and chip markings (for fundamental oscillator)

| Version name | Version set by trimming fuses | | | | | | | | | | Version set by mask pattern | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Version code on chip | Trimming fuses[*1] | | | | | | | | | Version code on chip | Trimming fuses |
| | | F1 | F2 | F3 | F4 | F5 | F6 | F7 | F8 | F9 | | F1 to F9 |
| 5027A1 | **AX** | – | – | – | – | – | Untrimmed | | | | **AX** | Untrimmed |
| 5027A2 | **AX** | × | – | – | – | – | | | | | **A2** | |
| 5027A3 | **AX** | – | × | – | – | – | | | | | **A3** | |
| 5027A4 | **AX** | × | × | – | – | – | | | | | **A4** | |
| 5027A5 | **AX** | – | – | × | – | – | | | | | **A5** | |
| 5027A6 | **AX** | × | – | × | – | – | | | | | **A6** | |
| 5027A7 | **AX** | – | × | × | – | – | | | | | **A7** | |
| 5027AP | **AX** | – | – | – | × | × | | | | | **AP** | |
| 5027AQ | **AX** | × | – | – | × | × | | | | | **AQ** | |
| 5027AR | **AX** | – | × | – | × | × | | | | | **AR** | |
| 5027AS | **AX** | × | × | – | × | × | | | | | **AS** | |
| 5027AT | **AX** | – | – | × | × | × | | | | | **AT** | |
| 5027AV | **AX** | × | – | × | × | × | | | | | **AV** | |
| 5027AW | **AX** | – | × | × | × | × | | | | | **AW** | |
| 5027B1 | **BX** | – | – | – | – | – | | | | | **BX** | |
| 5027B2 | **BX** | × | – | – | – | – | | | | | **B2** | |
| 5027B3 | **BX** | – | × | – | – | – | | | | | **B3** | |
| 5027B4 | **BX** | × | × | – | – | – | | | | | **B4** | |
| 5027B5 | **BX** | – | – | × | – | – | | | | | **B5** | |
| 5027B6 | **BX** | × | – | × | – | – | | | | | **B6** | |
| 5027B7 | **BX** | – | × | × | – | – | | | | | **B7** | |
| 5027BP | **BX** | – | – | – | × | × | | | | | **BP** | |
| 5027BQ | **BX** | × | – | – | × | × | | | | | **BQ** | |
| 5027BR | **BX** | – | × | – | × | × | | | | | **BR** | |
| 5027BS | **BX** | × | × | – | × | × | | | | | **BS** | |
| 5027BT | **BX** | – | – | × | × | × | | | | | **BT** | |
| 5027BV | **BX** | × | – | × | × | × | | | | | **BV** | |
| 5027BW | **BX** | – | × | × | × | × | | | | | **BW** | |
| 5027C1 | **CX** | – | – | – | – | – | | | | | **CX** | |
| 5027C2 | **CX** | × | – | – | – | – | | | | | **C2** | |
| 5027C3 | **CX** | – | × | – | – | – | | | | | **C3** | |
| 5027C4 | **CX** | × | × | – | – | – | | | | | **C4** | |
| 5027C5 | **CX** | – | – | × | – | – | | | | | **C5** | |
| 5027C6 | **CX** | × | – | × | – | – | | | | | **C6** | |
| 5027C7 | **CX** | – | × | × | – | – | | | | | **C7** | |
| 5027CP | **CX** | – | – | – | × | × | | | | | **CP** | |
| 5027CQ | **CX** | × | – | – | × | × | | | | | **CQ** | |
| 5027CR | **CX** | – | × | – | × | × | | | | | **CR** | |
| 5027CS | **CX** | × | × | – | × | × | | | | | **CS** | |
| 5027CT | **CX** | – | – | × | × | × | | | | | **CT** | |
| 5027CV | **CX** | × | – | × | × | × | | | | | **CV** | |
| 5027CW | **CX** | – | × | × | × | × | | | | | **CW** | |

*1. –: untrimmed, ×: trimmed

Table 4. Version identification by version name and chip markings (for 3rd overtone oscillator)

| Version name | Version set by trimming fuses | | | | | | | | | | Version set by mask pattern | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Version code on chip | Trimming fuses[*1] | | | | | | | | | Version code on chip | Trimming fuses |
| | | F1 | F2 | F3 | F4 | F5 | F6 | F7 | F8 | F9 | | F1 to F9 |
| 5027MA | **MX** | – | – | – | – | – | – | × | × | × | **MA** | Untrimmed |
| 5027MB | **MX** | – | × | – | – | – | – | – | × | × | **MB** | |
| 5027MC | **MX** | × | × | – | – | × | – | × | – | × | **MC** | |
| 5027MD | **MX** | – | × | × | × | × | – | × | – | × | **MD** | |
| 5027NA | **NX** | – | – | – | – | – | – | × | × | × | **NA** | |
| 5027NB | **NX** | – | × | – | – | – | – | – | × | × | **NB** | |
| 5027NC | **NX** | × | × | – | – | × | – | × | – | × | **NC** | |
| 5027ND | **NX** | – | × | × | × | × | – | × | – | × | **ND** | |
| 5027PA | **PX** | – | – | – | – | – | – | × | × | × | **PA** | |
| 5027PB | **PX** | – | × | – | – | – | – | – | × | × | **PB** | |
| 5027PC | **PX** | × | × | – | – | × | – | × | – | × | **PC** | |
| 5027PD | **PX** | – | × | × | × | × | – | × | – | × | **PD** | |
| (5027QE) | TBD | | | | | | | | | | | |
| (5027QF) | | | | | | | | | | | | |
| (5027RE) | | | | | | | | | | | | |
| (5027RF) | | | | | | | | | | | | |
| (5027SE) | | | | | | | | | | | | |
| (5027SF) | | | | | | | | | | | | |

*1. –: untrimmed, ×: trimmed

# SPECIFICATIONS

## Absolute Maximum Ratings

$V_{SS} = 0V$

| Parameter | Symbol | Condition | Rating | Unit |
|---|---|---|---|---|
| Supply voltage range | $V_{DD}$ | Between VDD and VSS | –0.5 to +4.0 | V |
| Input voltage range | $V_{IN}$ | Input pins | –0.5 to $V_{DD}$ + 0.5 | V |
| Output voltage range | $V_{OUT}$ | Output pins | –0.5 to $V_{DD}$ + 0.5 | V |
| Storage temperature range | $T_{STG}$ | Wafer form | –65 to +150 | °C |
| Output current | $I_{OUT}$ | Q pin | ± 20 | mA |

## Recommended Operating Conditions

### For Fundamental Oscillator

$V_{SS} = 0V$

| Parameter | Symbol | Condition | | Rating | | | Unit |
|---|---|---|---|---|---|---|---|
| | | | | min | typ | max | |
| Operating supply voltage | $V_{DD}$ | CL ≤ 15pF | | 1.60 | – | 3.63 | V |
| Input voltage | $V_{IN}$ | Input pins | | $V_{SS}$ | – | $V_{DD}$ | V |
| Operating temperature | $T_{OPR}$ | | | –40 | – | +85 | °C |
| Oscillation frequency*1 | $f_O$ | 5027×1 to 5027×7 | | 20 | – | 60 | MHz |
| | | 5027×P to 5027×W | | 60 | – | 100 | MHz |
| Output frequency | $f_{OUT}$ | CL ≤ 15pF | 5027×1 to 5027×7 | 0.9 | – | 60 | MHz |
| | | | 5027×P to 5027×W | 0.9 | – | 100 | MHz |

*1. The oscillation frequency is a yardstick value derived from the crystal used for NPC characteristics authentication. However, the oscillation frequency range 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.

### For 3rd Overtone Oscillator

$V_{SS} = 0V$

| Parameter | Symbol | Condition | Rating | | | Unit |
|---|---|---|---|---|---|---|
| | | | min | typ | max | |
| Operating supply voltage | $V_{DD}$ | CL ≤ 15pF | 1.60 | – | 3.63 | V |
| Input voltage | $V_{IN}$ | Input pins | $V_{SS}$ | – | $V_{DD}$ | V |
| Operating temperature | $T_{OPR}$ | | –40 | – | +85 | °C |
| Oscillation frequency*1 | $f_O$ | 5027×A | 40 | – | 50 | MHz |
| | | 5027×B | 50 | – | 65 | MHz |
| | | 5027×C | 65 | – | 85 | MHz |
| | | 5027×D | 85 | – | 110 | MHz |

*1. The oscillation frequency is a yardstick value derived from the crystal used for NPC characteristics authentication. However, the oscillation frequency range 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.

# Electrical Characteristics

## DC Characteristics

### For Fundamental Oscillator: Low frequency version (5027×1 to 5027×7)

$V_{DD}$ = 1.60 to 3.63V, $V_{SS}$ = 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 3, $I_{OH}$ = – 4mA | | $V_{DD}$ – 0.4 | – | – | V |
| LOW-level output voltage | $V_{OL}$ | Q: Measurement cct 3, $I_{OL}$ = 4mA | | – | – | 0.4 | V |
| HIGH-level input voltage | $V_{IH}$ | INHN, Measurement cct 4 | | 0.7$V_{DD}$ | – | – | V |
| LOW-level input voltage | $V_{IL}$ | INHN, Measurement cct 4 | | – | – | 0.3$V_{DD}$ | V |
| Output leakage current | $I_Z$ | Q: Measurement cct 5, INHN = LOW | $V_{OH}$ = $V_{DD}$ | – | – | 10 | μA |
| | | | $V_{OL}$ = $V_{SS}$ | – 10 | – | – | μA |
| Current consumption[*1] | $I_{DD}$ | 5027×1 ($f_O$), Measurement cct 1, no load, INHN = open, $f_O$ = 48MHz, $f_{OUT}$ = 48MHz | $V_{DD}$ = 3.3V | – | 1.6 | 2.4 | mA |
| | | | $V_{DD}$ = 2.5V | – | 1.3 | 2.0 | mA |
| | | | $V_{DD}$ = 1.8V | – | 1.0 | 1.5 | mA |
| | | 5027×2 ($f_O$/2), Measurement cct 1, no load, INHN = open, $f_O$ = 48MHz, $f_{OUT}$ = 24MHz | $V_{DD}$ = 3.3V | – | 1.5 | 2.3 | mA |
| | | | $V_{DD}$ = 2.5V | – | 1.2 | 1.8 | mA |
| | | | $V_{DD}$ = 1.8V | – | 0.9 | 1.4 | mA |
| | | 5027×3 ($f_O$/4), Measurement cct 1, no load, INHN = open, $f_O$ = 48MHz, $f_{OUT}$ = 12MHz | $V_{DD}$ = 3.3V | – | 1.3 | 2.0 | mA |
| | | | $V_{DD}$ = 2.5V | – | 1.0 | 1.5 | mA |
| | | | $V_{DD}$ = 1.8V | – | 0.8 | 1.2 | mA |
| | | 5027×4 ($f_O$/8), Measurement cct 1, no load, INHN = open, $f_O$ = 48MHz, $f_{OUT}$ = 6MHz | $V_{DD}$ = 3.3V | – | 1.1 | 1.7 | mA |
| | | | $V_{DD}$ = 2.5V | – | 0.9 | 1.4 | mA |
| | | | $V_{DD}$ = 1.8V | – | 0.75 | 1.15 | mA |
| | | 5027×5 ($f_O$/16), Measurement cct 1, no load, INHN = open, $f_O$ = 48MHz, $f_{OUT}$ = 3MHz | $V_{DD}$ = 3.3V | – | 1.05 | 1.6 | mA |
| | | | $V_{DD}$ = 2.5V | – | 0.85 | 1.3 | mA |
| | | | $V_{DD}$ = 1.8V | – | 0.7 | 1.1 | mA |
| | | 5027×6 ($f_O$/32), Measurement cct 1, no load, INHN = open, $f_O$ = 48MHz, $f_{OUT}$ = 1.5MHz | $V_{DD}$ = 3.3V | – | 1.0 | 1.5 | mA |
| | | | $V_{DD}$ = 2.5V | – | 0.85 | 1.3 | mA |
| | | | $V_{DD}$ = 1.8V | – | 0.7 | 1.1 | mA |
| | | 5027×7 ($f_O$/64), Measurement cct 1, no load, INHN = open, $f_O$ = 60MHz, $f_{OUT}$ = 0.94MHz | $V_{DD}$ = 3.3V | – | 1.0 | 1.5 | mA |
| | | | $V_{DD}$ = 2.5V | – | 0.85 | 1.3 | mA |
| | | | $V_{DD}$ = 1.8V | – | 0.7 | 1.1 | mA |
| Standby current | $I_{ST}$ | Measurement cct 1, INHN = LOW | | – | – | 10 | μA |
| INHN pull-up resistance | $R_{UP1}$ | Measurement cct 6 | | 0.4 | 1.5 | 8 | MΩ |
| | $R_{UP2}$ | | | 30 | 70 | 150 | kΩ |
| Oscillator feedback resistance | $R_f$ | | | 50 | 100 | 200 | kΩ |
| Oscillator capacitance | $C_G$ | Design value (a monitor pattern on a wafer is tested), Excluding parasitic capacitance. | | 4.8 | 6 | 7.2 | pF |
| | $C_D$ | | | 8 | 10 | 12 | pF |

*1. The consumption current $I_{DD}$ ($C_L$) with a load capacitance ($C_L$) connected to the Q pin is given by the following equation, where $I_{DD}$ is the no-load consumption current and $f_{OUT}$ is the output frequency.
$I_{DD}$ ($C_L$) [mA] = $I_{DD}$ [mA] + $C_L$ [pF] × $V_{DD}$ [V] × $f_{OUT}$ [MHz] × $10^{-3}$

## For Fundamental Oscillator: High frequency version (5027×P to 5027×W)

$V_{DD}$ = 1.60 to 3.63V, $V_{SS}$ = 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 3, $I_{OH}$ = – 4mA | | $V_{DD}$ – 0.4 | – | – | V |
| LOW-level output voltage | $V_{OL}$ | Q: Measurement cct 3, $I_{OL}$ = 4mA | | – | – | 0.4 | V |
| HIGH-level input voltage | $V_{IH}$ | INHN, Measurement cct 4 | | $0.7V_{DD}$ | – | – | V |
| LOW-level input voltage | $V_{IL}$ | INHN, Measurement cct 4 | | – | – | $0.3V_{DD}$ | V |
| Output leakage current | $I_Z$ | Q: Measurement cct 5, INHN = LOW | $V_{OH} = V_{DD}$ | – | – | 10 | μA |
| | | | $V_{OL} = V_{SS}$ | – 10 | – | – | μA |
| Current consumption[*1] | $I_{DD}$ | 5027×P ($f_O$), Measurement cct 1, no load, INHN = open, $f_O$ = 80MHz, $f_{OUT}$ = 80MHz | $V_{DD}$ = 3.3V | – | 2.5 | 3.8 | mA |
| | | | $V_{DD}$ = 2.5V | – | 2.0 | 3.0 | mA |
| | | | $V_{DD}$ = 1.8V | – | 1.6 | 2.4 | mA |
| | | 5027×Q ($f_O$/2), Measurement cct 1, no load, INHN = open, $f_O$ = 80MHz, $f_{OUT}$ = 40MHz | $V_{DD}$ = 3.3V | – | 2.4 | 3.6 | mA |
| | | | $V_{DD}$ = 2.5V | – | 1.9 | 2.9 | mA |
| | | | $V_{DD}$ = 1.8V | – | 1.5 | 2.3 | mA |
| | | 5027×R ($f_O$/4), Measurement cct 1, no load, INHN = open, $f_O$ = 80MHz, $f_{OUT}$ = 20MHz | $V_{DD}$ = 3.3V | – | 1.8 | 2.7 | mA |
| | | | $V_{DD}$ = 2.5V | – | 1.5 | 2.3 | mA |
| | | | $V_{DD}$ = 1.8V | – | 1.2 | 1.6 | mA |
| | | 5027×S ($f_O$/8), Measurement cct 1, no load, INHN = open, $f_O$ = 80MHz, $f_{OUT}$ = 10MHz | $V_{DD}$ = 3.3V | – | 1.7 | 2.6 | mA |
| | | | $V_{DD}$ = 2.5V | – | 1.4 | 2.1 | mA |
| | | | $V_{DD}$ = 1.8V | – | 1.1 | 1.7 | mA |
| | | 5027×T ($f_O$/16), Measurement cct 1, no load, INHN = open, $f_O$ = 80MHz, $f_{OUT}$ = 5MHz | $V_{DD}$ = 3.3V | – | 1.6 | 2.4 | mA |
| | | | $V_{DD}$ = 2.5V | – | 1.3 | 2.0 | mA |
| | | | $V_{DD}$ = 1.8V | – | 1.0 | 1.5 | mA |
| | | 5027×V ($f_O$/32), Measurement cct 1, no load, INHN = open, $f_O$ = 80MHz, $f_{OUT}$ = 2.5MHz | $V_{DD}$ = 3.3V | – | 1.5 | 2.3 | mA |
| | | | $V_{DD}$ = 2.5V | – | 1.2 | 1.8 | mA |
| | | | $V_{DD}$ = 1.8V | – | 1.0 | 1.5 | mA |
| | | 5027×W ($f_O$/64), Measurement cct 1, no load, INHN = open, $f_O$ = 80MHz, $f_{OUT}$ = 1.25MHz | $V_{DD}$ = 3.3V | – | 1.5 | 2.3 | mA |
| | | | $V_{DD}$ = 2.5V | – | 1.2 | 1.8 | mA |
| | | | $V_{DD}$ = 1.8V | – | 1.0 | 1.5 | mA |
| Standby current | $I_{ST}$ | Measurement cct 1, INHN = LOW | | – | – | 10 | μA |
| INHN pull-up resistance | $R_{UP1}$ | Measurement cct 6 | | 0.4 | 1.5 | 8 | MΩ |
| | $R_{UP2}$ | | | 30 | 70 | 150 | kΩ |
| Oscillator feedback resistance | $R_f$ | | | 50 | 100 | 200 | kΩ |
| Oscillator capacitance | $C_G$ | Design value (a monitor pattern on a wafer is tested), Excluding parasitic capacitance. | | 1.6 | 2 | 2.4 | pF |
| | $C_D$ | | | 3.2 | 4 | 4.8 | pF |

*1. The consumption current $I_{DD}$ ($C_L$) with a load capacitance ($C_L$) connected to the Q pin is given by the following equation, where $I_{DD}$ is the no-load consumption current and $f_{OUT}$ is the output frequency.
$I_{DD}(C_L)$ [mA] = $I_{DD}$ [mA] + $C_L$ [pF] × $V_{DD}$ [V] × $f_{OUT}$ [MHz] × $10^{-3}$

## For 3rd Overtone Oscillator (5027×A to 5027×D)

$V_{DD}$ = 1.60 to 3.63V, $V_{SS}$ = 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 3, $I_{OH}$ = – 8mA, $V_{DD}$ = 2.25 to 3.63V | | $V_{DD}$ – 0.4 | – | – | V |
| | | Q: Measurement cct 3, $I_{OH}$ = – 4mA, $V_{DD}$ = 1.60 to 2.25V | | $V_{DD}$ – 0.4 | – | – | V |
| LOW-level output voltage | $V_{OL}$ | Q: Measurement cct 3, $I_{OL}$ = 8mA, $V_{DD}$ = 2.25 to 3.63V | | – | – | 0.4 | V |
| | | Q: Measurement cct 3, $I_{OL}$ = 4mA, $V_{DD}$ = 1.60 to 2.25V | | – | – | 0.4 | V |
| HIGH-level input voltage | $V_{IH}$ | INHN, Measurement cct 4 | | $0.7V_{DD}$ | – | – | V |
| LOW-level input voltage | $V_{IL}$ | INHN, Measurement cct 4 | | – | – | $0.3V_{DD}$ | V |
| Output leakage current | $I_Z$ | Q: Measurement cct 5, INHN = LOW | $V_{OH} = V_{DD}$ | – | – | 10 | μA |
| | | | $V_{OL} = V_{SS}$ | – 10 | – | – | μA |
| Current consumption*1 | $I_{DD}$ | 5027×A, Measurement cct 1, no load, INHN = open, $f_O$ = 48MHz | $V_{DD}$ = 3.3V | – | 3.6 | 5.4 | mA |
| | | | $V_{DD}$ = 2.5V | – | 3.0 | 4.5 | mA |
| | | | $V_{DD}$ = 1.8V | – | 2.6 | 3.9 | mA |
| | | 5027×B, Measurement cct 1, no load, INHN = open, $f_O$ = 54MHz | $V_{DD}$ = 3.3V | – | 3.8 | 5.7 | mA |
| | | | $V_{DD}$ = 2.5V | – | 3.2 | 4.8 | mA |
| | | | $V_{DD}$ = 1.8V | – | 2.8 | 4.2 | mA |
| | | 5027×C, Measurement cct 1, no load, INHN = open, $f_O$ = 85MHz | $V_{DD}$ = 3.3V | – | 4.8 | 7.2 | mA |
| | | | $V_{DD}$ = 2.5V | – | 4.0 | 6.0 | mA |
| | | | $V_{DD}$ = 1.8V | – | 3.4 | 5.1 | mA |
| | | 5027×D, Measurement cct 1, no load, INHN = open, $f_O$ = 100MHz | $V_{DD}$ = 3.3V | – | 5.3 | 8.0 | mA |
| | | | $V_{DD}$ = 2.5V | – | 4.4 | 6.6 | mA |
| | | | $V_{DD}$ = 1.8V | – | 3.6 | 5.4 | mA |
| Standby current | $I_{ST}$ | Measurement cct 1, INHN = LOW | | – | – | 10 | μA |
| INHN pull-up resistance | $R_{UP1}$ | Measurement cct 6 | | 0.4 | 1.5 | 8 | MΩ |
| | $R_{UP2}$ | | | 30 | 70 | 150 | kΩ |
| Oscillator feedback resistance | $R_f$ | 5027×A | | 2.6 | 3.8 | 5.0 | kΩ |
| | | 5027×B | | 2.2 | 3.2 | 4.2 | kΩ |
| | | 5027×C | | 1.9 | 2.8 | 3.7 | kΩ |
| | | 5027×D | | 1.9 | 2.8 | 3.7 | kΩ |
| Oscillator capacitance | $C_G$ | Design value (a monitor pattern on a wafer is tested), Excluding parasitic capacitance. | 5027×A | 9.6 | 12 | 14.4 | pF |
| | | | 5027×B | 6.4 | 8 | 9.6 | pF |
| | | | 5027×C | 4.8 | 6 | 7.2 | pF |
| | | | 5027×D | 1.6 | 2 | 2.4 | pF |
| | $C_D$ | Design value (a monitor pattern on a wafer is tested), Excluding parasitic capacitance. | 5027×A | 9.6 | 12 | 14.4 | pF |
| | | | 5027×B | 9.6 | 12 | 14.4 | pF |
| | | | 5027×C | 6.4 | 8 | 9.6 | pF |
| | | | 5027×D | 4.8 | 6 | 7.2 | pF |

*1. The consumption current $I_{DD}$ ($C_L$) with a load capacitance ($C_L$) connected to the Q pin is given by the following equation, where $I_{DD}$ is the no-load consumption current and $f_{OUT}$ is the output frequency.
$I_{DD}(C_L)$ [mA] = $I_{DD}$ [mA] + $C_L$ [pF] × $V_{DD}$ [V] × $f_{OUT}$ [MHz] × $10^{-3}$

## AC Characteristics

### For Fundamental Oscillator (5027×1 to 5027×7, 5027×P to 5027×W)

$V_{DD}$ = 1.60 to 3.63V, $V_{SS}$ = 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 1, $C_L$ = 15pF, $0.1V_{DD}$ to $0.9V_{DD}$ | $V_{DD}$ = 2.25 to 3.36V | – | 2.0 | 4.5 | ns |
| | $t_{r2}$ | | $V_{DD}$ = 1.60 to 2.25V | – | 3.0 | 5.0 | ns |
| Output fall time | $t_{f1}$ | Measurement cct 1, $C_L$ = 15pF, $0.9V_{DD}$ to $0.1V_{DD}$ | $V_{DD}$ = 2.25 to 3.36V | – | 2.0 | 4.5 | ns |
| | $t_{f2}$ | | $V_{DD}$ = 1.60 to 2.25V | – | 3.0 | 5.0 | ns |
| Output duty cycle | Duty | Measurement cct 1, Ta = 25°C, $C_L$ = 15pF | | 45 | 50 | 55 | % |
| Output disable delay time | $t_{OD}$ | Measurement cct 2, Ta = 25°C, $C_L \leq$ 15pF | | – | – | 50 | µs |

### For 3rd Overtone Oscillator (5027×A to 5027×D)

$V_{DD}$ = 1.60 to 3.63V, $V_{SS}$ = 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 1, $C_L$ = 15pF, $0.1V_{DD}$ to $0.9V_{DD}$ | $V_{DD}$ = 2.25 to 3.36V | – | 1.2 | 3.0 | ns |
| | $t_{r2}$ | | $V_{DD}$ = 1.60 to 2.25V | – | 1.6 | 4.0 | ns |
| Output fall time | $t_{f1}$ | Measurement cct 1, $C_L$ = 15pF, $0.9V_{DD}$ to $0.1V_{DD}$ | $V_{DD}$ = 2.25 to 3.36V | – | 1.2 | 3.0 | ns |
| | $t_{f2}$ | | $V_{DD}$ = 1.60 to 2.25V | – | 1.6 | 4.0 | ns |
| Output duty cycle | Duty | Measurement cct 1, Ta = 25°C, $C_L$ = 15pF | | 45 | 50 | 55 | % |
| Output disable delay time | $t_{OD}$ | Measurement cct 2, Ta = 25°C, $C_L \leq$ 15pF | | – | – | 50 | µs |

## Timing chart

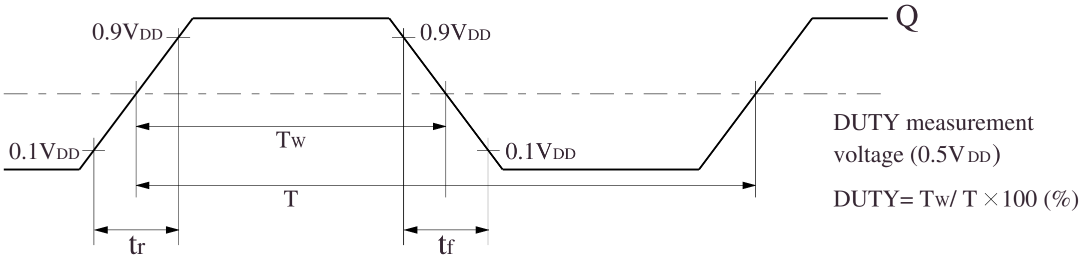
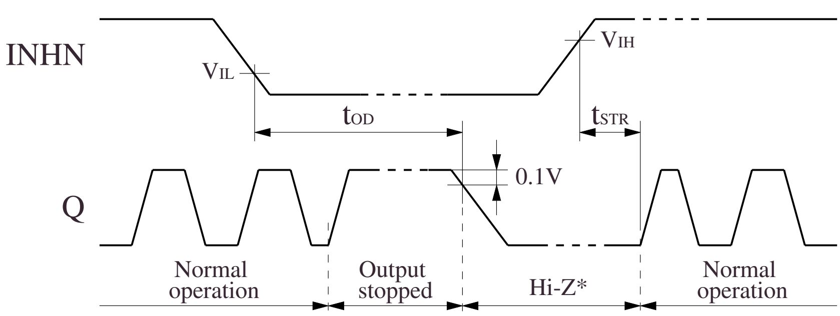



Figure 1. Output switching waveform




When INHN goes HIGH to LOW, the Q output goes HIGH once and then becomes high impedance.
When INHN goes LOW to HIGH, the Q output goes from high impedance to normal output operation when the oscillation starts (oscillation is detected).
*) The high-impedance interval in the figure is shown as a LOW level due to the 1kΩ pull-down resistor connected to the Q pin (see "Measurement circuit 2" in the "Measurement Circuits" section).

Figure 2. Output disable and oscillation start timing chart

# FUNCTIONAL DESCRIPTION

## Standby Function

When INHN goes LOW, the Q output becomes high impedance.

| INHN | Q | Oscillator |
|---|---|---|
| HIGH (or open) | Frequency output | Normal operation |
| LOW | High impedance | Stopped |

## Power-saving Pull-up Resistor

The INHN pin pull-up resistance $R_{UP1}$ or $R_{UP2}$ changes in response to the input level (HIGH or LOW). When INHN is tied LOW level, the pull-up resistance is large ($R_{UP1}$), reducing the current consumed by the resistance. When INHN is left open circuit, the pull-up resistance is small ($R_{UP2}$), which increases the input susceptibility to external noise. However, the pull-up resistance ties the INHN pin HIGH level to prevent external noise from unexpectedly stopping the output.

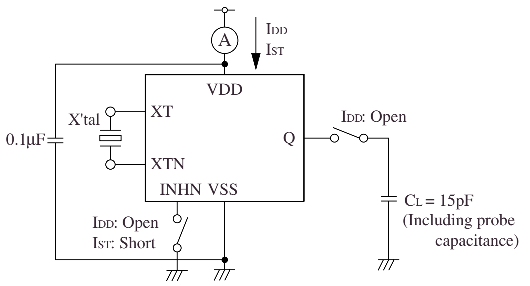
## Oscillation Detector Function

The WF5027 series also feature an oscillation detector circuit. This circuit functions to disable the outputs until the oscillator circuit starts and oscillation becomes stable. This alleviates the danger of abnormal oscillator output at oscillator start-up when power is applied or when INHN is switched.

# MEASUREMENT CIRCUITS

## Measurement cct 1

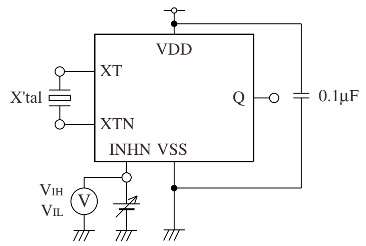
Measurement parameter: $I_{DD}$, $I_{ST}$, Duty, $t_r$ , $t_f$




Note: The AC characteristics are observed using an oscilloscope on pin Q.

## Measurement cct 4

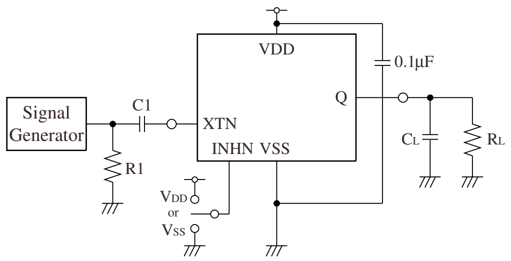
Measurement parameter: $V_{IH}$, $V_{IL}$




$V_{IH}$: Voltage in $V_{SS}$ to $V_{DD}$ transition that changes the output state.
$V_{IL}$: Voltage in $V_{DD}$ to $V_{SS}$ transition that changes the output state.
INHN has an oscillation stop function.

## Measurement cct 2

Measurement parameter: $t_{OD}$

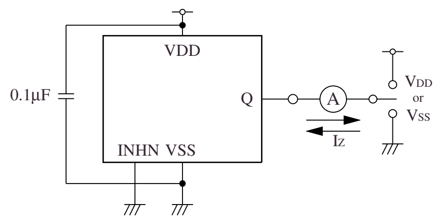



XTN input signal: 1Vp-p, sine wave

| | |
|---|---|
| C1: 0.001µF | $C_L$: 15pF |
| R1: 50Ω | $R_L$: 1kΩ |

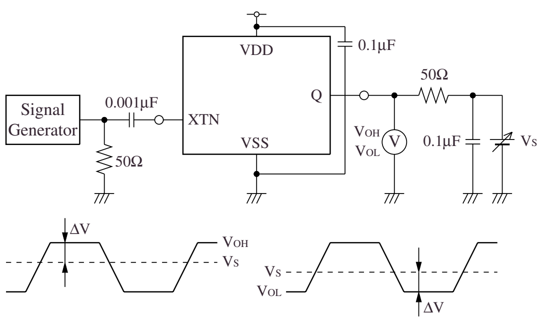
## Measurement cct 5

Measurement parameter: $I_Z$




## Measurement cct 3

Measurement parameter: $V_{OH}$, $V_{OL}$

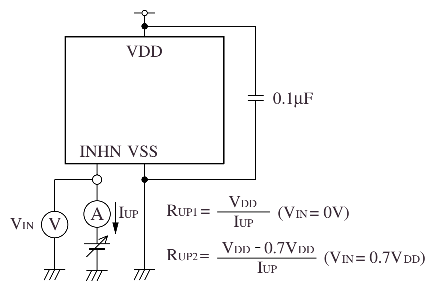



| | |
|---|---|
| $V_S$ adjusted such that $\Delta V = 50 \times I_{OH}$. | $V_S$ adjusted such that $\Delta V = 50 \times I_{OL}$. |

XTN input signal: 1Vp-p, sine wave

## Measurement cct 6

Measurement parameter: $R_{UP1}$, $R_{UP2}$



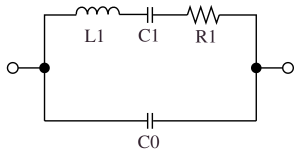
## TYPICAL PERFORMANCE (for fundamental oscillator)

The following characteristics measured using the crystal below. Note that the characteristics will vary with the crystal used.

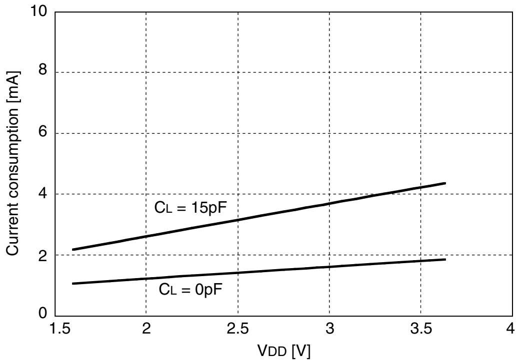
■ Crystal used for measurement

| Parameter | $f_O$ = 48MHz | $f_O$ = 80MHz |
|---|---|---|
| C0 [pF] | 1.6 | 2.1 |
| R1 [Ω] | 12 | 10 |

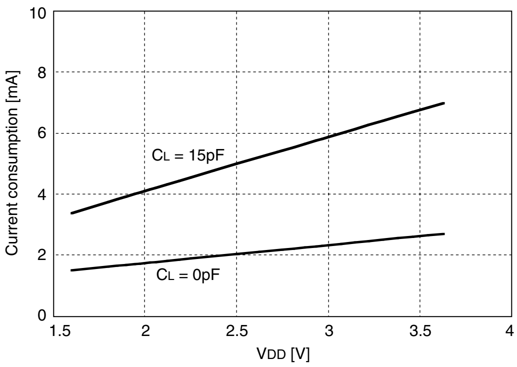
■ Crystal parameters




### Current Consumption

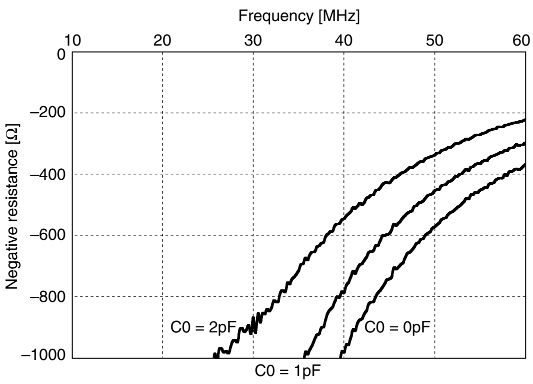



5027A1, $f_{OUT}$ = 48MHz, Ta = 25°C

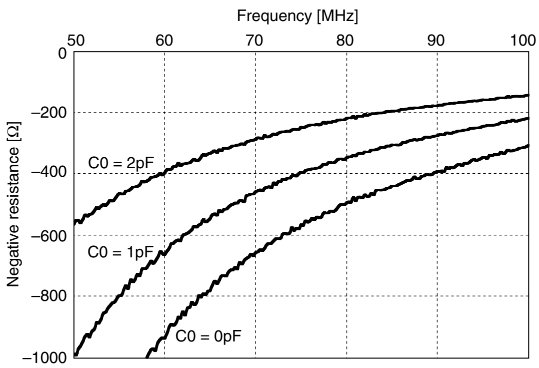



5027AP, $f_{OUT}$ = 80MHz, Ta = 25°C

### Negative Resistance



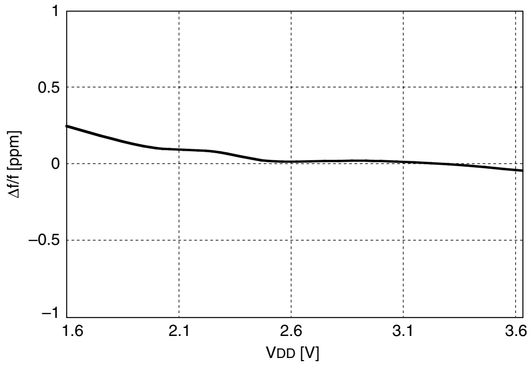

5027×1 to ×7, $V_{DD}$ = 3.3V, Ta = 25°C



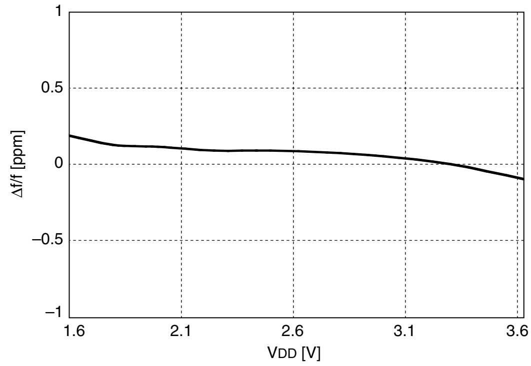

5027×P to ×W, $V_{DD}$ = 3.3V, Ta = 25°C

**Characteristics are measured with a capacitance C0, representing the crystal equivalent circuit C0 capacitance, connected between the XT and XTN pins. Measurements are performed with Agilent 4396B using the NPC test jig. Characteristics may vary with measurement jig and measurement conditions.**

## Frequency Deviation by Supply Voltage Change

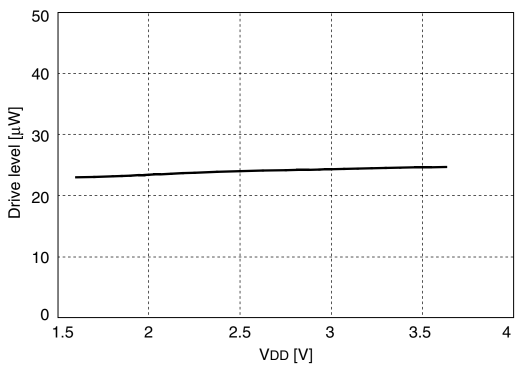



5027×1 to ×7, $f_{OUT}$ = 48MHz,
3.3V standard, Ta = 25°C

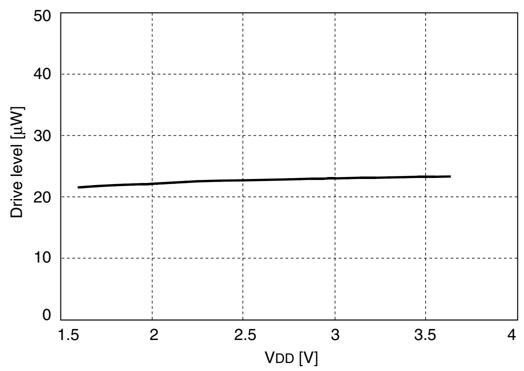



5027×P to ×W, $f_{OUT}$ = 80MHz,
3.3V standard, Ta = 25°C

## Drive Level



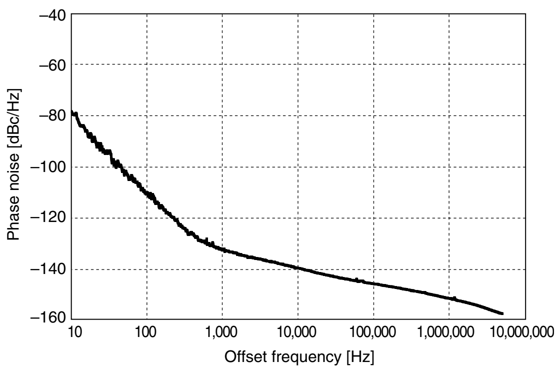

5027×1 to ×7, $f_{OUT}$ = 48MHz, Ta = 25°C



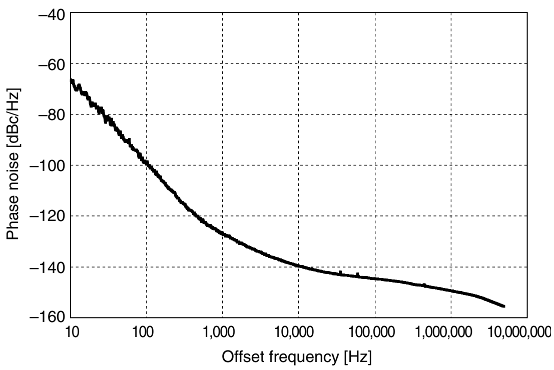

5027×P to ×W, $f_{OUT}$ = 80MHz, Ta = 25°C

## Phase Noise

Measurement equipment: Agilent E5052 Signal Source Analyzer



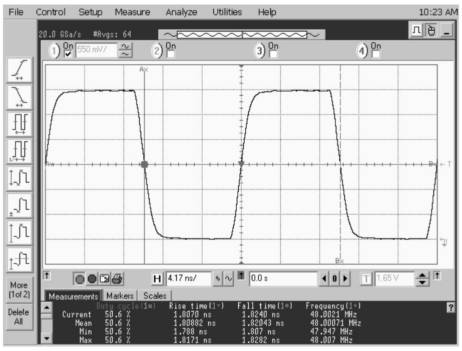

5027A1, $V_{DD}$ = 3.3V, $f_{OSC}$ = $f_{OUT}$ = 48MHz,
Ta = 25°C



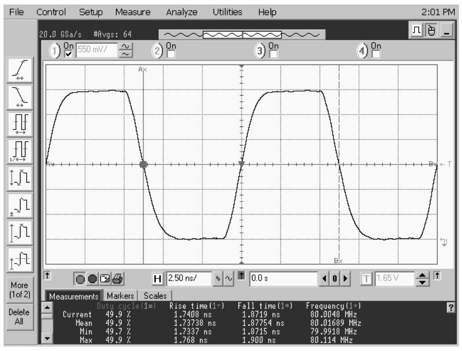

5027AP, $V_{DD}$ = 3.3V, $f_{OSC}$ = $f_{OUT}$ = 80MHz,
Ta = 25°C

## Output Waveform

Measurement equipment: Agilent 54855A Oscilloscope



5027A1, $V_{DD}$ = 3.3V, $f_{OUT}$ = 48MHz,
$C_L$ = 15pF, Ta = 25°C



5027AP, $V_{DD}$ = 3.3V, $f_{OUT}$ = 80MHz,
$C_L$ = 15pF, Ta = 25°C

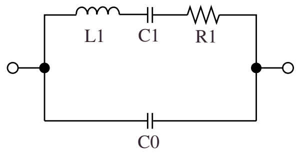
# TYPICAL PERFORMANCE (for 3rd overtone oscillator)

The following characteristics measured using the crystal below. Note that the characteristics will vary with the crystal used.

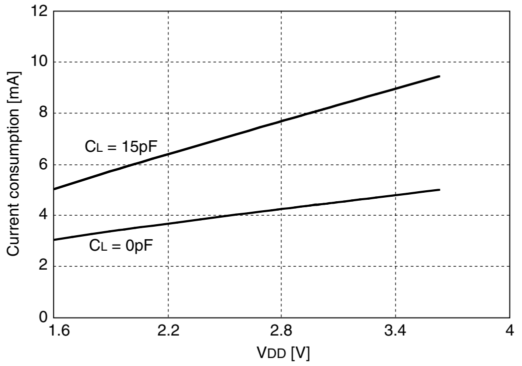
■ Crystal used for measurement

| Parameter | $f_O$ = 85MHz | $f_O$ = 100MHz |
|---|---|---|
| C0 [pF] | 0.9 | 1.2 |
| R1 [Ω] | 56 | 45 |

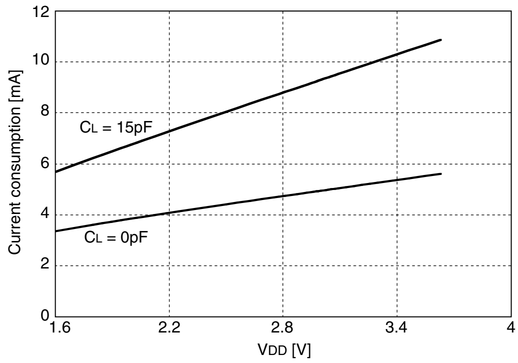
■ Crystal parameters




## Current Consumption

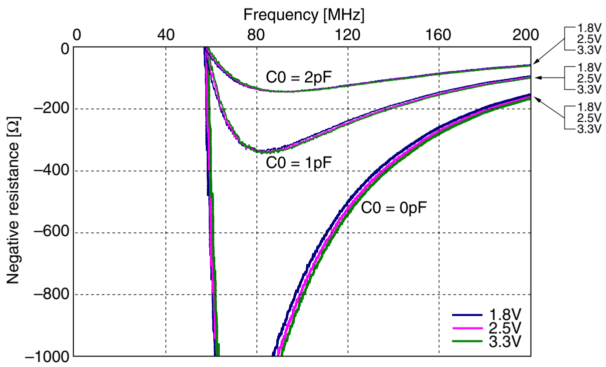



5027×D, $f_{OUT}$ = 85MHz, Ta = 25°C




5027AP, $f_{OUT}$ = 100MHz, Ta = 25°C

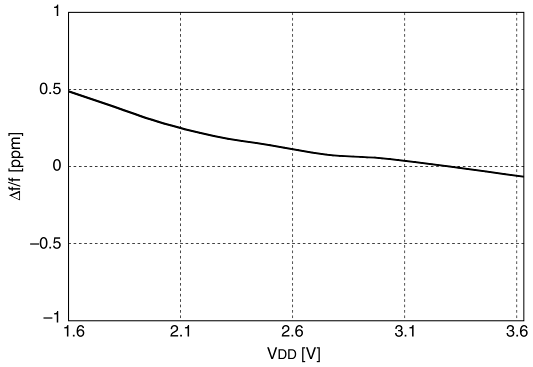
## Negative Resistance



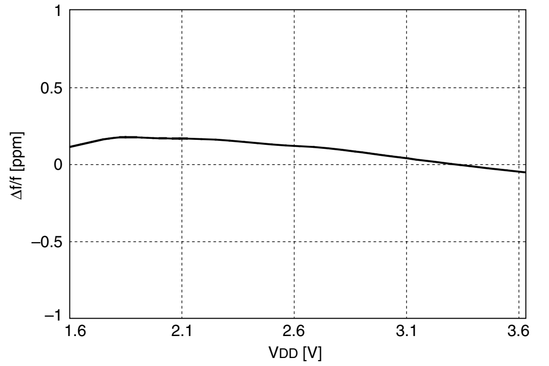

5027×D, Ta = 25°C, recommended operating frequency range: 85MHz to 110MHz

**Characteristics are measured with a capacitance C0, representing the crystal equivalent circuit C0 capacitance, connected between the XT and XTN pins. Measurements are performed with Agilent 4396B using the NPC test jig. Characteristics may vary with measurement jig and measurement conditions.**

## Frequency Deviation by Supply Voltage Change

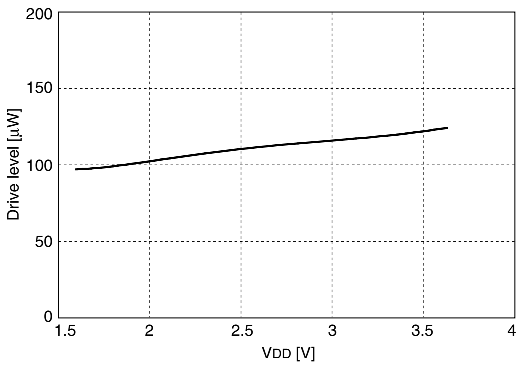



5027×D, $f_{OUT}$ = 85MHz, 3.3V standard, Ta = 25°C

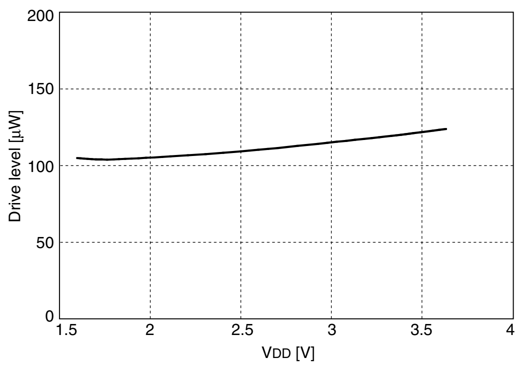



5027×D, $f_{OUT}$ = 100MHz, 3.3V standard, Ta = 25°C

## Drive Level



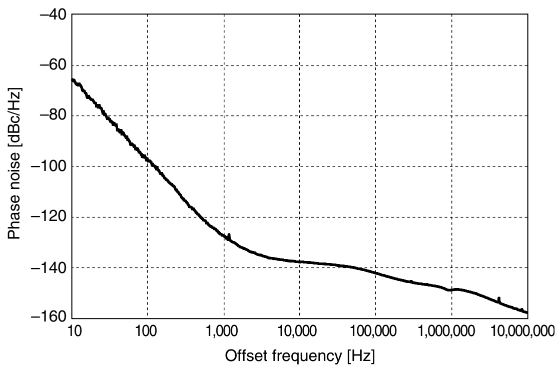

5027×D, $f_{OUT}$ = 85MHz, Ta = 25°C



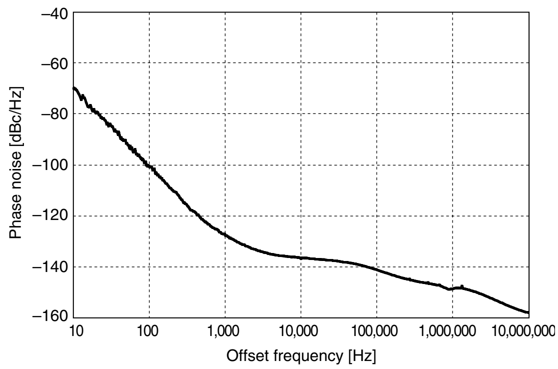

5027×D, $f_{OUT}$ = 100MHz, Ta = 25°C

## Phase Noise

Measurement equipment: Agilent E5052 Signal Source Analyzer



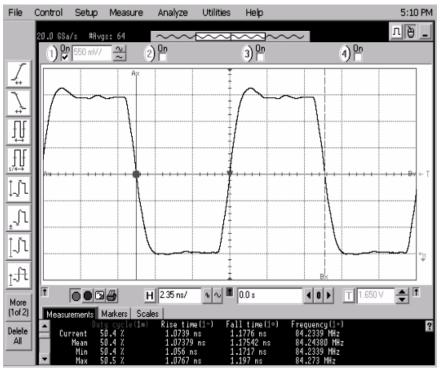

5027×D, $V_{DD}$ = 3.3V, $f_{OSC}$ = $f_{OUT}$ = 85MHz, Ta = 25°C



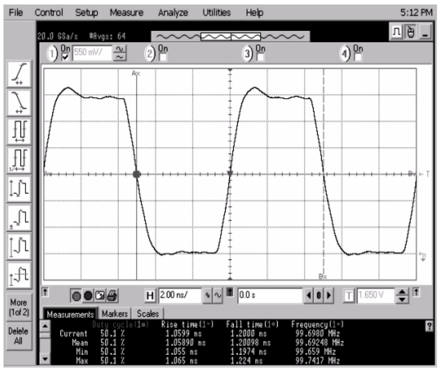

5027×D, $V_{DD}$ = 3.3V, $f_{OSC}$ = $f_{OUT}$ = 100MHz, Ta = 25°C

## Output Waveform

Measurement equipment: Agilent 54855A Oscilloscope




5027×D, $V_{DD}$ = 3.3V, $f_{OUT}$ = 85MHz,
$C_L$ = 15pF, Ta = 25°C




5027×D, $V_{DD}$ = 3.3V, $f_{OUT}$ = 100MHz,
$C_L$ = 15pF, Ta = 25°C

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NC0505CE 2007.03