# 1.8V Operating Voltage 3rd Overtone Quartz Crystal Oscillator IC with Input Tolerant Function

## ■GENERAL DESCRIPTION

The NJU6227 series is a C-MOS quartz crystal oscillator IC realized excellent frequency stability for 3rd Overtone (up to 160MHz) oscillation, and consists of an oscillation amplifier, a 3-state output buffer, a built-in LDO and a input tolerant circuit.

The operating voltage is from 1.62V to 3.63V (x3, x4, x5, x6: from 2.25V to 3.63V), and the LDO holds down the characteristic change of the oscillation amplifier for operating voltage variation, and has been stabilized oscillation frequency (Frequency stability ±1ppm@$V_{DD}$±10%).

The input tolerant circuit ensures that 0 to 3.63 V can be applied to CONT terminal without regard to the supply voltage.

The oscillation stopping current is very low stand-by mode, therefore, it is suitable for the portable items of the communication equipment and the like. The 3-state output buffer is C-MOS compatible. The NJU6227A/D version are available for driving light loads (15pF load) and NJU6227C version are available for driving heavy loads (30pF load).

## ■PACKAGE OUTLINE

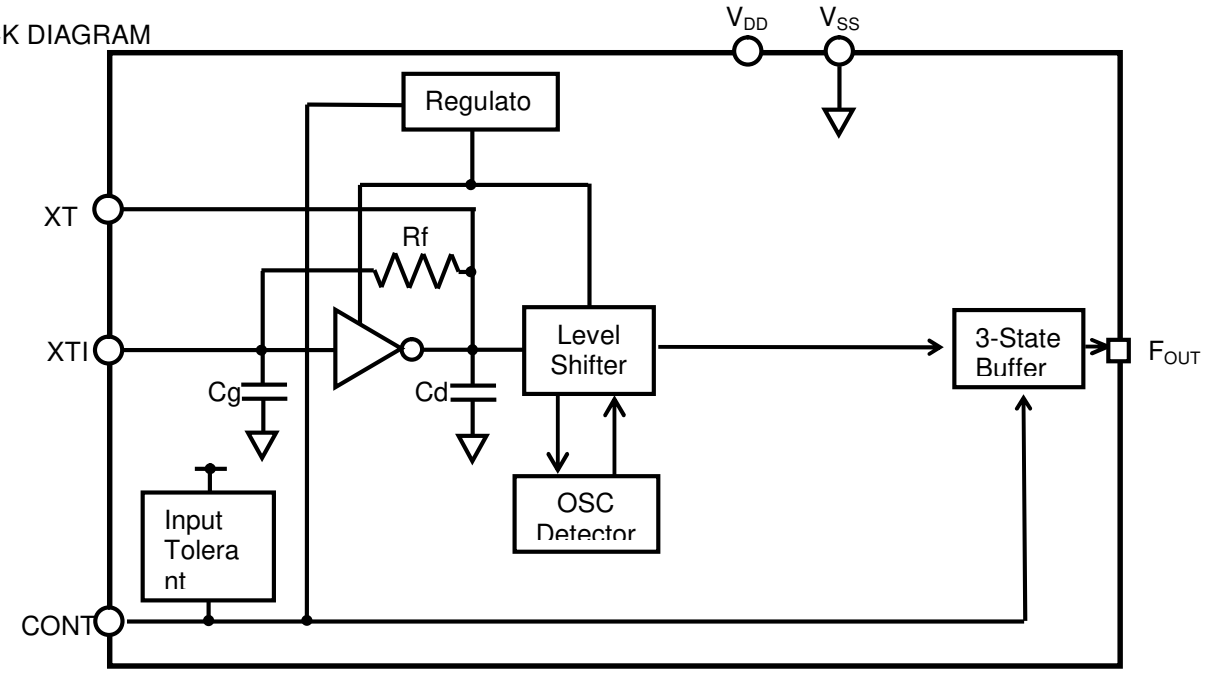


NJU6227xXC-V

## ■FEATURES

- ●Maximum Oscillation Frequency 160MHz(3rd Overtone)
- ●Frequency Stability ±1ppm@$V_{DD}$±10%
- ●Wide Operating Voltage 1.62 to 3.63V(x3, x4, x5, x6 2.25V to 3.63V)
- ●Built-in LDO
- ●Input Tolerant Circuit 0 to 3.63V@CONT Term.
- ●Stand-by Function ( Oscillation Stop and High-Z )
- ●3-State Output Buffer
- ●Variable Pull-up Resistance on-Die ( CONT Terminal: Pull-up resistance is large at Stand-by Function )
- ●Oscillation Capacitors Cg and Cg on-Die
- ●C-MOS Technology
- ●Package Outline Die/Wafer

## ■BLOCK DIAGRAM



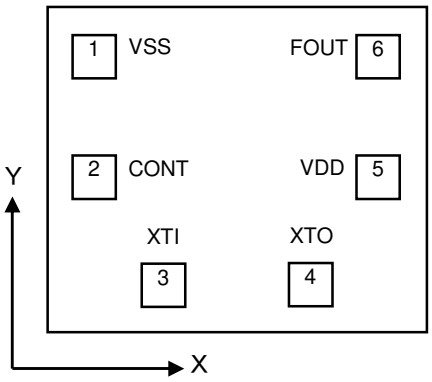
■LINE-UP TABLE

| Type No. | Recommended Oscillation Frequency | Version | | |
|---|---|---|---|---|
| | | Type A | Type C | Type D |
| NJU6227 | 40 to 50MHz | A1* | C1 | D1 |
| | 50 to 60MHz | A2* | C2 | D2 |
| | 60 to 85MHz | A3* | C3 | D3 |
| | 85 to 110MHz | A4* | C4 | D4 |
| | 110 to 130MHz | A5* | C5 | D5 |
| | 130 to 160MHz | A6* | C6 | D6 |

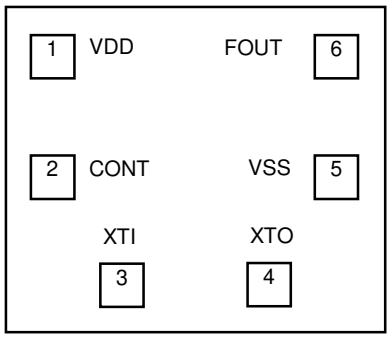
* Under development and tentative value.

■PAD LOCATION

Type A
( for Flip Chip Bonding )




Type C / D
( for Wire Bonding )




■COORDINATES

| | X | Y |
|---|---|---|
| 1 | -261.5 | 198.5 |
| 2 | -261.5 | -21.5 |
| 3 | -146.5 | -211.5 |
| 4 | 144.5 | -211.5 |
| 5 | 260.5 | -21.5 |
| 6 | 260.5 | 198.5 |

Starting Point: Die Center Unit[µm]
Die Size: 0.73x0.63mm
Die Thickness (C-V): 130±15µm
WaferThickness(WS4-V): 130±15µm
Wafer Thickness (W-B): 160±20µm
Wafer Thickness (W-H): 200±20µm
Pad size: 80x80µm
Die Substrate: $V_{SS}$ level

■PART NUMBER

NJU6227 □□ □-□

- □-□: W-H: Wafer (200µm); W-B: Wafer (160µm); WS4-V:1/4Wafer(130µm); C-V: Chip(130µm)
- □□: Version
- NJU6227: Device name

■VERSION DISCRIMINATION INTERNAL COMPONENTS

PAD layout version of the NJU6227 series is determined by the mask pattern and Notch Number. Frequency version of the NJU6227 series is determined by the internal fuse trimming.

Type Number and PAD layout version are identified externally by the combination of the version name marking (1), the locations of trimmed fuses (3) and The Notch number (2). (Table 1 shows the chip version identification)

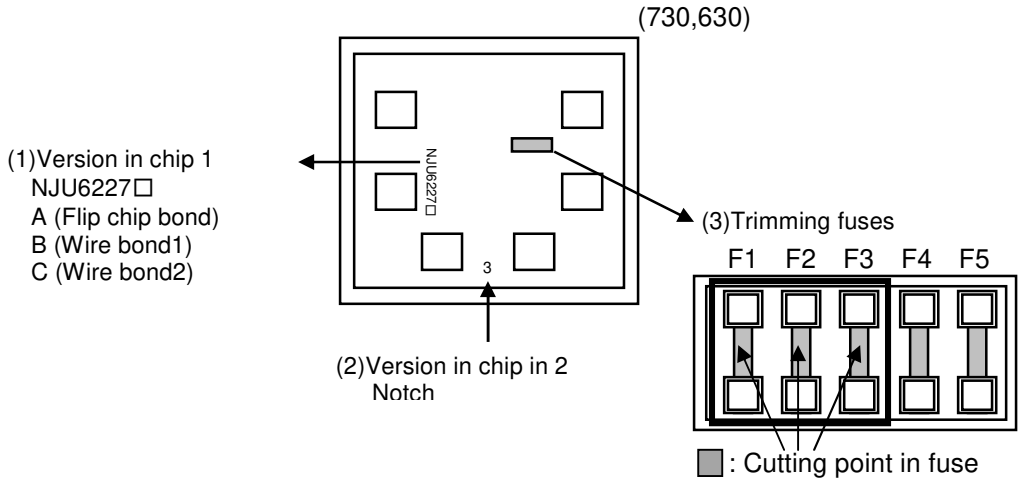



Table1: Frequency version and Cutting point in fuse.

| Discrimination 1 | Discrimination 2 | Type No. | Version name | Mask / Version set by trimming fuses | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | Mask | Trimming fuses | | | |
| | | | | Version | F1 | F2 | F3 | F4/F5 |
| NJU6227A | 4 | NJU6227A | NJU6227A1 | A | * | - | - | Untrimmed |
| | | | NJU6227A2 | A | * | - | * | |
| | | | NJU6227A3 | A | - | - | - | |
| | | | NJU6227A4 | A | - | - | * | |
| | | | NJU6227A5 | A | - | * | - | |
| | | | NJU6227A6 | A | - | * | * | |
| NJU6227C | | NJU6227D | NJU6227D1 | D | * | - | - | |
| | | | NJU6227D2 | D | * | - | * | |
| | | | NJU6227D3 | D | - | - | - | |
| | | | NJU6227D4 | D | - | - | * | |
| | | | NJU6227D5 | D | - | * | - | |
| | | | NJU6227D6 | D | - | * | * | |
| NJU6227C | 3 | NJU6227C | NJU6227C1 | C | * | - | - | |
| | | | NJU6227C2 | C | * | - | * | |
| | | | NJU6227C3 | C | - | - | - | |
| | | | NJU6227C4 | C | - | - | * | |
| | | | NJU6227C5 | C | - | * | - | |
| | | | NJU6227C6 | C | - | * | * | |

Note1) "- ": Uncut, "* ": Cutting

■TERMINAL DESCRIPTION

| SYMBOL | FUNCTION |
|---|---|
| CONT | Oscillation and 3-state Output Buffer Control<br>CONT: H or OPEN → Output frequency $f_0$; L → Oscillation Stop and High impedance Output |
| XTI | Quartz Crystal Connecting Terminals |
| XTO | |
| $V_{SS}$ | GND Terminal ($V_{SS}$=0V) |
| $F_{OUT}$ | Frequency Output |
| $V_{DD}$ | $V_{DD}$=1.62 to 3.63V (x3, x4, x5, x6 2.25 to 3.63V) |

■FUNCTIONAL DESCRIPTION

●Standby Function

When CONT Terminal goes "Low", the $F_{OUT}$ Terminal output becomes High impedance.

| CONT | $F_{OUT}$ | Oscillator |
|---|---|---|
| High(Open) | Frequency output | Normal operation |
| Low | High impedance | Stopped |

●Variable Pull-up Resistance

The CONT Terminal pull-up resistance changes in response to the input level. When CONT is tied "LOW" level, the pull-up resistance is large, reducing the current consumed by the resistance. When CONT is left open circuit, the pull-up resistance is small, which increases the input susceptibility to external noise. However, the pull-up resistance ties the CONT Terminal "High" level to prevent external noise from unexpectedly stopping the output.

■ABSOLUTE MAXIMUM RATINGS

($V_{SS}$=0V, Ta=25°C)

| PARAMETER | SYMBOL | RATING | UNIT |
|---|---|---|---|
| Supply Voltage | $V_{DD}$ | -0.5 to +4.0 | V |
| Input Voltage | $V_{IN}$ | -0.5 to +4.0 | V |
| Output Voltage | $V_O$ | -0.5 to $V_{DD}$+0.5 | V |
| Input Current | $I_{IN}$ | ±10 | mA |
| Output Current | $I_O$ | ±25 | mA |
| Operating Temperature Range | Topr | -40 to +85 | °C |
| Storage Temperature Range | Tstg | -55 to +125 | °C |

Note1) Input Voltage should be less than $V_{DD}$ or 4.0V.

Note2) Decupling capacitor should be connected between $V_{DD}$ and $V_{SS}$ due to the stabilized operation for the circuit.

■ELECTRICAL CHARACTERISTICS

(Ta=+25°C)

| PARAMETER | SYMBOL | CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| Operating Voltage | $V_{DD}$ | x1,x2, version | 1.62 | | 3.63 | V |
| Input Voltage | $V_{IN}$ | CONT | 0 | | 3.63 | V |
| Output Voltage | $V_{OUT}$ | $F_{OUT}$ | 0 | | $V_{DD}$ | V |
| Output Frequency Stability | df/f | $V_{DD}$±10% | | ±1 | | ppm |

(Ta=+25°C)

| PARAMETER | SYMBOL | CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| Operating Voltage | $V_{DD}$ | x3, x4, x5, x6 version | 2.25 | | 3.63 | V |
| Input Voltage | $V_{IN}$ | CONT | 0 | | 3.63 | V |
| Output Voltage | $V_{OUT}$ | $F_{OUT}$ | 0 | | $V_{DD}$ | V |
| Output Frequency Stability | df/f | $V_{DD}$±10% | | ±1 | | ppm |

Note3) C0 minimum requirement
Version: x1, x2, x3, x4, x5 1pF ≤ C0 ≤ 3pF
Version: x6 1.5pF ≤ C0 ≤ 3pF

($V_{DD}$=1.62 to 3.63V (x3, x4, x5, x6 2.25 to 3.63V), $V_{SS}$=0V, Ta=+25°C)

| PARAMETER | SYMBOL | CONDITIONS | | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|---|
| Operating Current | $I_{DD}$ | x1 version No load CONT=Open $f_{osc}$=50MHz | $V_{DD}$=1.8V | - | 2.0 | 2.6 | mA |
| | | | $V_{DD}$=2.5V | - | 2.4 | 3.1 | |
| | | | $V_{DD}$=3.3V | - | 3.1 | 4.0 | |
| | | x2 version No load CONT=Open $f_{osc}$=60MHz | $V_{DD}$=1.8V | - | 2.4 | 3.1 | |
| | | | $V_{DD}$=2.5V | - | 2.8 | 3.6 | |
| | | | $V_{DD}$=3.3V | - | 3.6 | 4.7 | |
| | | x3 version No load CONT=Open $f_{osc}$=85MHz | $V_{DD}$=2.5V | - | 6.0 | 7.8 | |
| | | | $V_{DD}$=3.3V | - | 7.0 | 9.1 | |
| | | x4 version No load CONT=Open $f_{osc}$=110MHz | $V_{DD}$=2.5V | - | 6.6 | 8.6 | |
| | | | $V_{DD}$=3.3V | - | 7.8 | 10.1 | |
| | | x5 version No load CONT=Open $f_{osc}$=130MHz | $V_{DD}$=2.5V | - | 6.8 | 8.8 | |
| | | | $V_{DD}$=3.3V | - | 8.2 | 10.7 | |
| | | x6 version No load CONT=Open $f_{osc}$=160MHz | $V_{DD}$=2.5V | - | 7.5 | 9.8 | |
| | | | $V_{DD}$=3.3V | - | 9.0 | 11.7 | |
| Oscillation Stopping Current | $I_{STB}$ | CONT=$V_{SS}$, No load | | - | - | 10 | µA |
| Output Voltage | $V_{OH}$ | $I_{OH}$=4mA | | $V_{DD}$-0.4 | - | - | V |
| | $V_{OL}$ | $I_{OL}$=4mA | | - | - | 0.4 | V |
| Input Voltage | $V_{IH}$ | CONT Input Tolerant Function | | 0.7$V_{DD}$ | - | - | V |
| | $V_{IL}$ | CONT | | - | - | 0.3$V_{DD}$ | V |
| Input Current Note4) | $I_{IN}$ | CONT=3.63V | | - | - | 1 | µA |
| | | CONT=0.8$V_{DD}$ | | - | - | 8 | |
| | | CONT=0.2$V_{DD}$ | | - | - | 5 | |
| 3-state Off Leakage Current | $I_{OZ}$ | CONT=$V_{SS}$, $F_{OUT}$= $V_{DD}$ or $V_{SS}$ | | - | - | ±0.1 | µA |

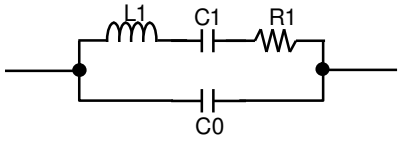
Note4) Absolute value.

($V_{DD}$=1.62 to 3.63V (x3, x4, x5, x6 2.25 to 3.63V), $V_{SS}$=0V, Ta=+25°C)

| PARAMETER | SYMBOL | CONDITIONS | | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|---|
| Feedback Resistance | Rf | x1 version | | - | 12.5 | - | kΩ |
| | | x2 version | | - | 6.8 | - | |
| | | x3 version | | - | 6.8 | - | |
| | | x4 version | | - | 12.3 | - | |
| | | x5 version | | -- | 12.4 | - | |
| | | x6 version | | - | 12.5 | - | |
| Internal Capacitor | Cg/Cd | x1 version | | - | 7.2/7.2 | - | pF |
| | | x2 version | | - | 7.2/7.2 | - | |
| | | x3 version | | - | 7.2/7.2 | - | |
| | | x4 version | | - | 5.1/5.4 | - | |
| | | x5 version | | - | 4.2/4.1 | - | |
| | | x6 version | | - | 3.1/3.1 | - | |
| Oscillation Frequency | fosc | Recommendation Note5) | | 40 | - | 50 | MHz |
| | | | | 50 | - | 60 | |
| | | | | 60 | - | 85 | |
| | | | | 85 | - | 110 | |
| | | | | 110 | - | 130 | |
| | | | | 130 | - | 160 | |
| Output Signal Symmetry | SYM | $C_L$=15pF, @$V_{DD}$/2 | | 45 | 50 | 55 | % |
| Output Signal Rise Time | tr | NJU6227C<br>$C_L$=15pF<br>0.1$V_{DD}$ to 0.9$V_{DD}$ | $V_{DD}$=1.8V | - | 2.0 | 4.0 | ns |
| | | | $V_{DD}$=2.5V | - | 1.1 | 2.1 | |
| | | | $V_{DD}$=3.3V | - | 0.8 | 1.7 | |
| | | NJU6227A/D<br>CL=15pF<br>0.1$V_{DD}$ to 0.9$V_{DD}$ | $V_{DD}$=1.8V | - | 2.75 | 5.5 | |
| | | | $V_{DD}$=2.5V | - | 1.4 | 2.8 | |
| | | | $V_{DD}$=3.3V | - | 1.1 | 2.2 | |
| Output Signal Fall Time | tf | NJU6227C<br>$C_L$=15pF<br>0.9$V_{DD}$ to 0.1$V_{DD}$ | $V_{DD}$=1.8V | - | 1.7 | 3.4 | |
| | | | $V_{DD}$=2.5V | - | 1.0 | 1.9 | |
| | | | $V_{DD}$=3.3V | - | 0.8 | 1.5 | |
| | | NJU6227A/D<br>CL=15pF<br>0.9$V_{DD}$ to 0.1$V_{DD}$ | $V_{DD}$=1.8V | - | 2.25 | 4.5 | |
| | | | $V_{DD}$=2.5V | - | 1.35 | 2.7 | |
| | | | $V_{DD}$=3.3V | - | 1.05 | 2.1 | |
| Output Disable time | $t_{POZ}$ | $C_L$=15pF, $R_L$=1kΩ | | - | - | 100 | ns |
| Output Enable Time | $t_{PZO}$ | $C_L$=15pF | | - | - | 1 | ms |

Note5) NJR's standard crystal is used for measurement of the oscillation frequency range and it does not guarantee oscillation. (Refer to EXAMPLE OF CRYSTAL PARAMETERS FOR MEASUREMENT CIRCUIT)
The oscillator circuit is optimized for small sized crystal oscillators.
When using for 7050 and 5032 sized crystal element that have large C0 and parasitic capacitance, additional evaluation is recommended before implementation due to the increased risk of insufficient oscillation margin.

■EXAMPLE OF CRYSTAL PARAMETERS FOR MEASUREMENT CIRCUITS

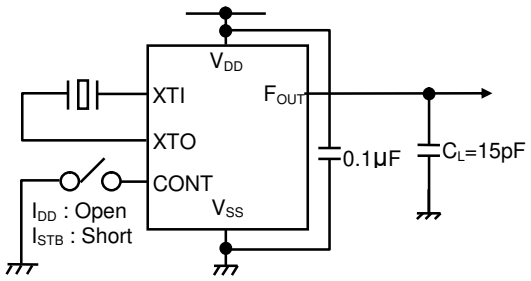


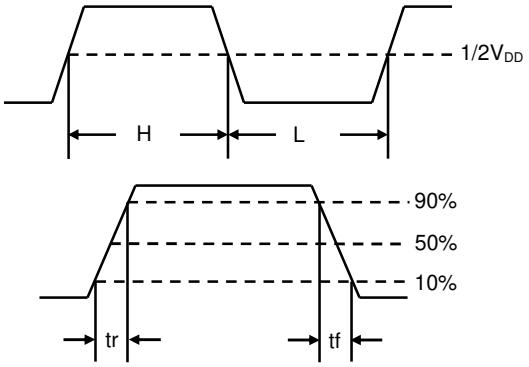

| f[MHz] | R1[Ω] | L1[mH] | C1[fF] | C0[pF] |
|---|---|---|---|---|
| 40 | 34.8 | 20.8 | 0.76 | 2.42 |
| 50 | 67.1 | 27.5 | 0.37 | 1.46 |
| 60 | 33.1 | 10.7 | 0.66 | 2.49 |
| 90 | 42.2 | 6.68 | 0.47 | 2.03 |
| 113 | 30.2 | 3.52 | 0.56 | 3.22 |
| 125 | 30.3 | 2.61 | 0.62 | 3.47 |
| 133 | 24.7 | 2.11 | 0.68 | 3.60 |
| 155 | 38.3 | 1.55 | 0.68 | 3.75 |

Note6) Please do use as small as possible parasitic capacitance of Crystal and $V_{SS}$, $V_{DD}$ terminal.
When using for large size package, the parasitic capacitance upward tendency.

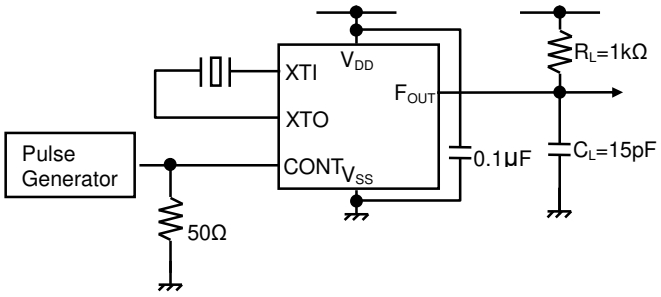
■MEASUREMENT CIRCUITS

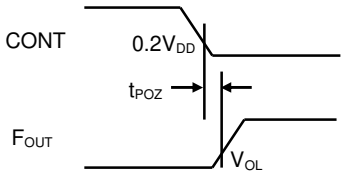
(1)Operating Current ($C_L$=0pF), Stand-by Current, Output Signal Symmetry($C_L$=15pF), Output Signal Rise/Fall Time ($C_L$=15pF)



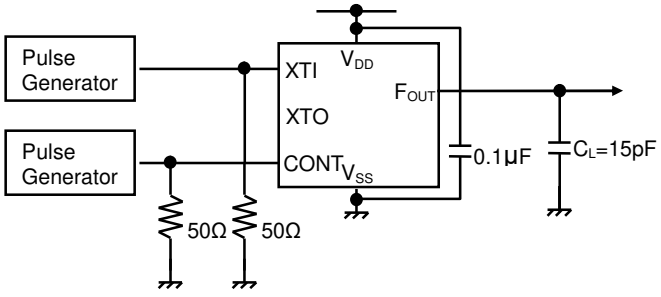



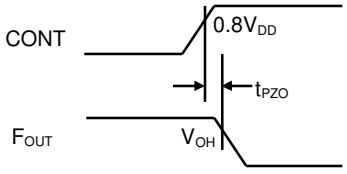

(2)Output Disable Time ($C_L$=15pF,$R_L$=1kΩ)



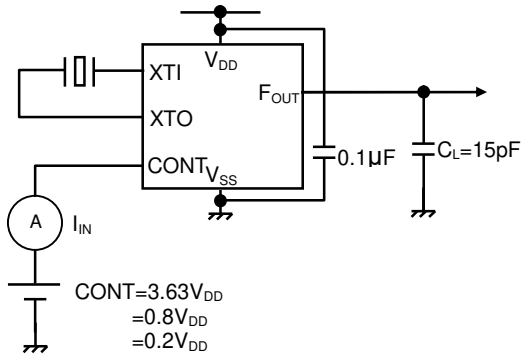




(3)Output Enable Time ($C_L$=15pF)



(4)Input Current ($C_L$=15pF)

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