



## Features

- Spread Spectrum Crystal oscillator (Programmable)
- 0.25~160MHz Output Frequency range
- Operating voltages: 1.62 V to 3.63V
- Operating temperature: -40°C to +125°C
- Configurable spread spectrum settings:  
7 kinds of spread:  
 $\pm 0.25\%$ ,  $\pm 0.5\%$ ,  $-0.25\%$ ,  $-0.5\%$ ,  $-1\%$ ,  $-1.5\%$ ,  $-2.0\%$
- OE disable function
- 3 kinds of Rise time/Fall time:  
Default mode, Fast mode and Slow mode
- Modulation Frequency:  $F_{IN}/804$
- Spread Profile: Triangle
- Used for Fundamental Crystal Oscillator
- Used for 7050/5032/3225/2520 package

## Benefits

- Reduction in EMI
- System cost saving
- Reduced system complexity
- Faster time to market

## Description

The XO6501C are Programmable Crystal Oscillator series with CMOS output.

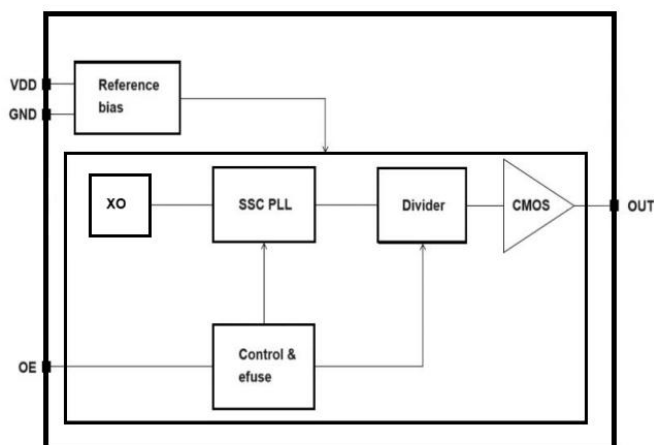
This series offer the easy programmability of frequencies and other parameters, they also have a wider operating temperature range, from -40°C to +125°C. In addition to a  $2.5 \times 2.0$  mm package that will enable electronics manufacturers to save board space, the oscillators will also be available in the following popular package sizes:  $3.2 \times 2.5$  mm,  $5.0 \times 3.2$  mm and  $7.0 \times 5.0$  mm. Users will be able to program the products to the required output frequency, as well as to the required spread spectrum settings.

This will also significantly contribute to performance, lower power requirements, fast development cycles, and low-volume production.

## Applications

- IP Camera
- Printers/MFPs
- Media players
- DTV/Set-top Box
- Embedded digital video devices
- LCD Panel Modules
- Automotive components
- Networking devices
- Surveillance

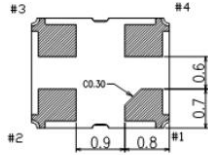
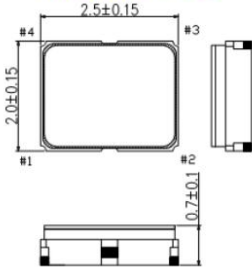
## Block Diagram



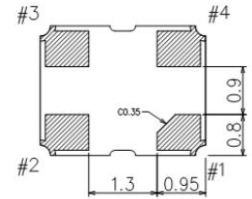
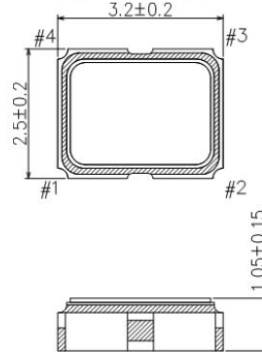


## Outline Drawing and Terminal Assignment

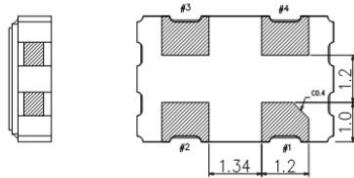
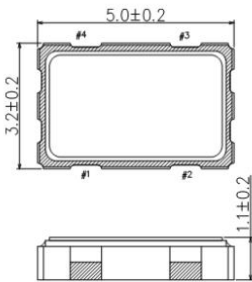
**XO6501CG**



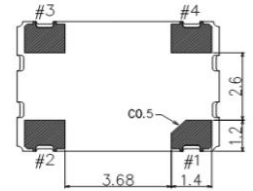
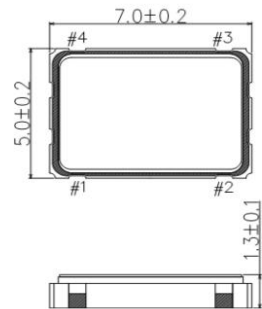
**XO6501CE**



**XO6501CB**



**XO6501CA**



| Pin # | Connection      | Function                 |                  |                               |
|-------|-----------------|--------------------------|------------------|-------------------------------|
| #1    | OE*             | OE terminal              |                  |                               |
|       |                 | OE function              | Osc. Circuit     | Output                        |
|       |                 | “H”                      | Oscillation      | Specified frequency: Enable   |
|       |                 | “L”                      | Oscillation      | Low (weak pull down): Disable |
|       | ST*             | ST terminal              |                  |                               |
|       |                 | ST function              | Osc. Circuit     | Output                        |
|       |                 | “H”                      | Oscillation      | Specified frequency: Enable   |
|       |                 | “L”                      | Oscillation Stop | Low (weak pull down): Disable |
| #2    | GND             | GND terminal             |                  |                               |
| #3    | OUT             | Output terminal          |                  |                               |
| #4    | V <sub>DD</sub> | V <sub>DD</sub> Terminal |                  |                               |

Note: \* Please do not use the OE/ST terminal in the open state.



## Order Information

**XO6501C - A - 25.000000 MHz - C - 20 - P - H - A**  
 ①                      ②                      ③                      ④    ⑤    ⑥ ⑦ ⑧

①: Model ②: Size ③: Output Frequency ④: Spread type ⑤: Spread width  
 ⑥: Function ⑦: Operating temperature ⑧: Rise time/Fall time

| ②: Size |               |
|---------|---------------|
| G       | 2.5mm × 2.0mm |
| E       | 3.2mm × 2.5mm |
| B       | 5.0mm × 3.2mm |
| A       | 7.0mm × 5.0mm |

| ④: Spread type |               |
|----------------|---------------|
| C              | Center Spread |
| D              | Down Spread   |

| ⑥: Function |                         |
|-------------|-------------------------|
| P           | Output enable(1#pin=OE) |
| S           | Standby(1#pin=ST)       |

| ⑤: Spread width |               |             |
|-----------------|---------------|-------------|
|                 | Center Spread | Down Spread |
| 02              | ±0.25%        | -0.25%      |
| 05              | ±0.5%         | -0.5%       |
| 10              | -             | -1.0%       |
| 15              | -             | -1.5%       |
| 20              | -             | -2.0%       |

| ⑦: Operating temperature |               |
|--------------------------|---------------|
| G                        | -40℃ to +85℃  |
| H                        | -40℃ to +105℃ |
| A                        | -40℃ to +125℃ |

| ⑧: Rise time/Fall time |         |
|------------------------|---------|
| A                      | Default |
| B                      | Fast    |
| C                      | Slow    |



## Maximum Rating

|                                         |                 |
|-----------------------------------------|-----------------|
| Supply Voltage to Ground Potential..... | 4V              |
| OE/ $\overline{ST}$ pin .....           | $V_{DD}+0.3V$   |
| Storage Temperature.....                | -40°C to +125°C |

### Note:

Stresses greater than those listed under MAXIMUM RATINGS may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect reliability.

## Recommended Operating Conditions

(GND=0V, unless otherwise noted.)

| Sym.       | Parameter             | Conditions                   | Min  | Typ | Max      | Unit |
|------------|-----------------------|------------------------------|------|-----|----------|------|
| $V_{DD}$   | Supply voltage        | -                            | 1.62 | -   | 3.63     | V    |
| $V_{IN}$   | Input voltage         | OE/ $\overline{ST}$ terminal | 0    | -   | $V_{DD}$ | V    |
| $T_A$      | Operating temperature | -                            | -40  | 25  | +85      | °C   |
|            |                       | -                            | -40  | 25  | +125     | °C   |
| $L_{CMOS}$ | CMOS load condition   | -                            | -    | -   | 15       | pf   |

### Note:

\* 0.1 $\mu$ F or over bypass capacitor should be connected between VCC and GND pins located close to the device

## Frequency Characteristics

| Sym.      | Parameter              | Conditions                   | Min                             | Typ | Max | Unit |
|-----------|------------------------|------------------------------|---------------------------------|-----|-----|------|
| $F_O$     | Output frequency       | OE/ $\overline{ST}$ terminal | 0.25                            | -   | 160 | MHz  |
| $F_{tol}$ | Frequency tolerance *1 | -                            | -50                             | -   | 50  | ppm  |
| $F_{age}$ | Frequency aging        | -                            | Included in frequency tolerance |     |     | ppm  |

### Note:

\*1: Frequency tolerance includes initial frequency tolerance, frequency / temperature characteristics, frequency / voltage coefficient, frequency / load coefficient and frequency aging (+25 °C, first year)



## DC Characteristics

V<sub>DD</sub>= 1.62V to 3.63V, Ambient Temperature -40 to +125°C

| Symbol           | Parameter                | Conditions                                       | Min.               | Typ. | Max.                | Unit |
|------------------|--------------------------|--------------------------------------------------|--------------------|------|---------------------|------|
| I <sub>DD</sub>  | Current consumption      | V <sub>DD</sub> =1.8V<br>No load                 | 2MHz               | 5.02 |                     | mA   |
|                  |                          |                                                  | 10MHz              | -    | 5.8                 | mA   |
|                  |                          |                                                  | 25MHz              | -    | 6.2                 | mA   |
|                  |                          |                                                  | 50MHz              | -    | 6.6                 | mA   |
|                  |                          |                                                  | 100MHz             | -    | 7.4                 | mA   |
|                  |                          |                                                  | 160MHz             | -    | 8.1                 | mA   |
|                  |                          | V <sub>DD</sub> =2.5V<br>No load                 | 2MHz               | 5.03 |                     | mA   |
|                  |                          |                                                  | 10MHz              | -    | 6.4                 | mA   |
|                  |                          |                                                  | 25MHz              | -    | 6.91                | mA   |
|                  |                          |                                                  | 50MHz              | -    | 7.4                 | mA   |
|                  |                          |                                                  | 100MHz             | -    | 8.3                 | mA   |
|                  |                          |                                                  | 160MHz             | -    | 9.3                 | mA   |
|                  |                          | V <sub>DD</sub> =3.3V<br>No load                 | 2MHz               | 5.04 |                     | mA   |
|                  |                          |                                                  | 10MHz              |      | 6.6                 | mA   |
|                  |                          |                                                  | 25MHz              |      | 7.2                 | mA   |
|                  |                          |                                                  | 50MHz              |      | 7.8                 | mA   |
|                  |                          |                                                  | 100MHz             |      | 9.1                 | mA   |
|                  |                          |                                                  | 160MHz             |      | 10.4                | mA   |
| I <sub>DIS</sub> | Disable current          | V <sub>DD</sub> =1.8V                            |                    | 5.9  |                     | mA   |
|                  |                          | V <sub>DD</sub> =2.5V                            |                    | 6.6  |                     | mA   |
|                  |                          | V <sub>DD</sub> =3.3V                            |                    | 6.7  |                     | mA   |
| I <sub>STD</sub> | Standby current          | V <sub>DD</sub> =1.8V                            | -                  | 1.0  | -                   | mA   |
|                  |                          | V <sub>DD</sub> =2.5V                            | -                  | 1.0  | -                   | mA   |
|                  |                          | V <sub>DD</sub> =3.3V                            | -                  | 1.0  | -                   | mA   |
| V <sub>OH</sub>  | Output high voltage      | V <sub>DD</sub> =1.8V, I <sub>OH</sub> = -2.5mA  | 0.9V <sub>DD</sub> | -    | -                   | V    |
|                  |                          | V <sub>DD</sub> =2.5V, I <sub>OH</sub> = -4.0mA  |                    |      |                     |      |
|                  |                          | V <sub>DD</sub> =3.3V, I <sub>OH</sub> = -5.0mA  |                    |      |                     |      |
| V <sub>OL</sub>  | Output low voltage       | V <sub>DD</sub> =1.8V, I <sub>OL</sub> = 2.5mA   | -                  | -    | 0.15V <sub>DD</sub> | V    |
|                  |                          | V <sub>DD</sub> =2.5V, I <sub>OL</sub> = 4.0mA   |                    |      |                     |      |
|                  |                          | V <sub>DD</sub> =3.3V, I <sub>OL</sub> = 5.0mA   |                    |      |                     |      |
| V <sub>IH</sub>  | HIGH level input voltage | OE/ $\overline{ST}$ terminal                     | 0.8V <sub>DD</sub> | -    |                     | V    |
| V <sub>IL</sub>  | LOW level input voltage  | OE/ $\overline{ST}$ terminal                     | -                  | -    | 0.2V <sub>DD</sub>  | V    |
| C <sub>IN</sub>  | Input pull-up resistance | OE/ $\overline{ST}$ terminal                     | -                  | 2.5  | 5                   | pf   |
| R <sub>UP1</sub> | Input pull-up resistance | OE/ $\overline{ST}$ = 80 % V <sub>DD</sub>       | 20                 | -    | 150                 | kΩ   |
| R <sub>UP2</sub> |                          | OE/ $\overline{ST}$ = 20 % V <sub>DD</sub>       | 5                  | -    | 60                  | MΩ   |
| R <sub>DN</sub>  | Output pull-down         | OE/ $\overline{ST}$ = GND, OUT = V <sub>DD</sub> | 0.5                |      | 5                   | MΩ   |



## AC Characteristics

VDD= 1.62V to 3.63V, Ambient Temperature -40 to +125°C

| Symbol                         | Parameter                                                        | Conditions                          | Min.   | Typ.    | Max.  | Unit |
|--------------------------------|------------------------------------------------------------------|-------------------------------------|--------|---------|-------|------|
| T <sub>STR</sub>               | Start-up time                                                    | VDD>1.62V                           | -      | -       | 5     | ms   |
| Duty cycle                     | Output duty cycle                                                | Load=15pf, 50%V <sub>DD</sub>       | 45     | 50      | 55    | %    |
| T <sub>r</sub> /T <sub>f</sub> | Rise time/Fall time<br>(20%V <sub>DD</sub> ~80%V <sub>DD</sub> ) | f <sub>o</sub> ≤ 20 MHz (Slow mode) |        |         | 10    | ns   |
|                                |                                                                  | f <sub>o</sub> ≤ 40 MHz (Default)   |        |         | 6     | ns   |
|                                |                                                                  | f <sub>o</sub> > 40 MHz (Default)   |        |         | 3     | ns   |
|                                |                                                                  | Fast mode                           |        |         | 3     | ns   |
| T <sub>stp_OE</sub>            | Output disable time (OE)                                         | OE terminal HIGH → LOW              |        |         | 1     | μs   |
| T <sub>stp_ST</sub>            | Output disable time (ST)                                         | ST terminal HIGH → LOW              |        |         | 1     | μs   |
| T <sub>sta_OE</sub>            | Output enable time (OE)                                          | OE terminal LOW → HIGH              |        |         | 1     | μs   |
| T <sub>sta_ST</sub>            | Output enable time (ST)                                          | ST terminal LOW → HIGH              |        |         | 3     | ms   |
| t <sub>c-c</sub>               | Cycle to Cycle jitter<br>(Clock cycle > 50 000)                  | V <sub>DD</sub> =1.8V<br>load=15pf  | 10MHz  |         | 312.1 | ps   |
|                                |                                                                  |                                     | 20MHz  |         | 225.3 | ps   |
|                                |                                                                  |                                     | 50MHz  |         | 91.7  | ps   |
|                                |                                                                  |                                     | 100MHz |         | 70.4  | ps   |
|                                |                                                                  |                                     | 160MHz |         | 65.6  | ps   |
|                                |                                                                  | V <sub>DD</sub> =2.5V<br>load=15pf  | 10MHz  |         | 292.9 | ps   |
|                                |                                                                  |                                     | 20MHz  |         | 136.6 | ps   |
|                                |                                                                  |                                     | 50MHz  |         | 48.7  | ps   |
|                                |                                                                  |                                     | 100MHz |         | 37.6  | ps   |
|                                |                                                                  |                                     | 160MHz |         | 40    | ps   |
|                                |                                                                  | V <sub>DD</sub> =3.3V<br>load=15pf  | 10MHz  |         | 290.1 | ps   |
|                                |                                                                  |                                     | 20MHz  |         | 128.8 | ps   |
|                                |                                                                  |                                     | 50MHz  |         | 44.6  | ps   |
|                                |                                                                  |                                     | 100MHz |         | 31.3  | ps   |
|                                |                                                                  |                                     | 160MHz |         | 29.5  | ps   |
| fmod                           | Modulation frequency                                             |                                     |        | Fin/804 |       | KHz  |

**Note:** Typical condition is on room temperature at 25°



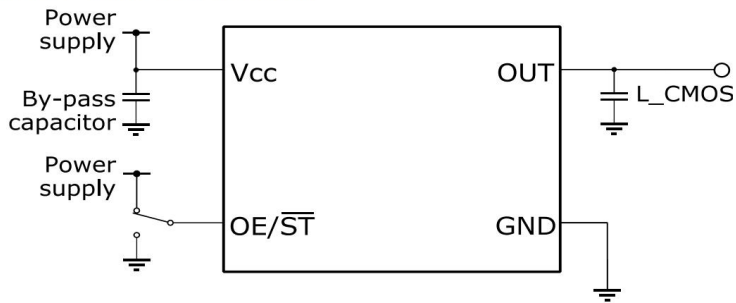
**Thermal resistance (For reference only)**

| Symbol        | Parameter            | Condition | Datasheet |       |      | Unit |
|---------------|----------------------|-----------|-----------|-------|------|------|
|               |                      |           | Min.      | Typ.  | Max. |      |
| Tj            | Junction temperature |           |           |       | +125 | °C   |
| $\theta_{jc}$ | Junction to case     | XO6501CG  | -         | 15.2  | -    | °C/W |
|               |                      | XO6501CE  | -         | 23.1  | -    |      |
|               |                      | XO6501CB  | -         | 16.1  | -    |      |
|               |                      | XO6501CA  | -         | 28.0  | -    |      |
| $\theta_{ja}$ | Junction to ambient  | XO6501CG  | -         | 91.9  | -    | °C/W |
|               |                      | XO6501CE  | -         | 103.8 | -    |      |
|               |                      | XO6501CB  | -         | 82.5  | -    |      |
|               |                      | XO6501CA  | -         | 78.8  | -    |      |

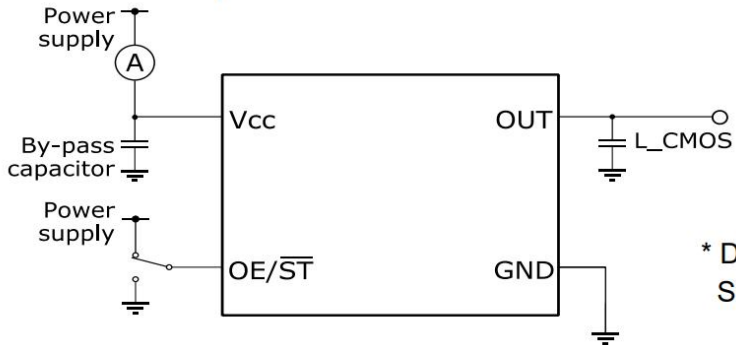


## Measurement Circuit

### Waveform Observation

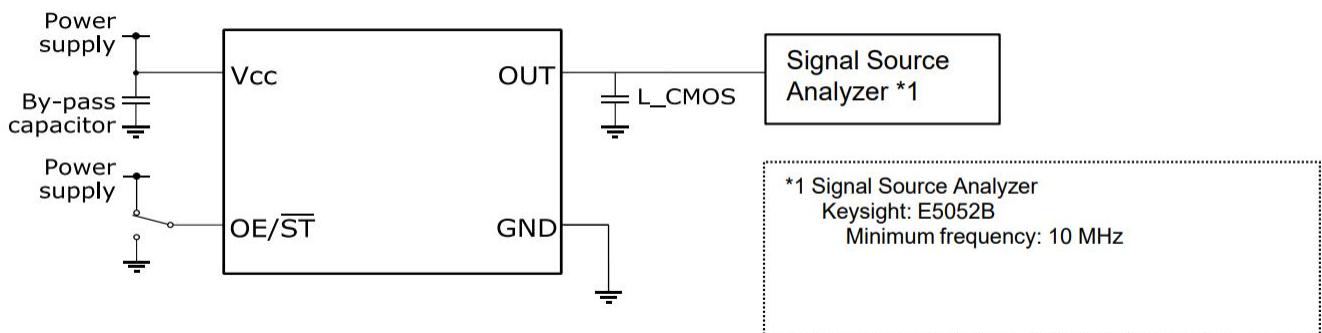


### Current Consumption Test



\* Disable current test should be OE = GND.  
Stand-by current test should be  $\overline{ST}$  = GND.

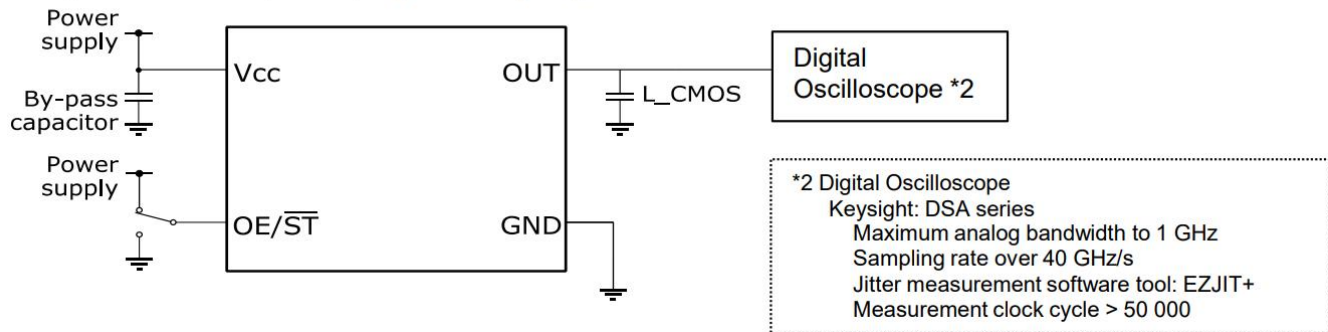
### Phase Jitter







### Jitter (Peak to Peak, RMS, Cycle to Cycle)

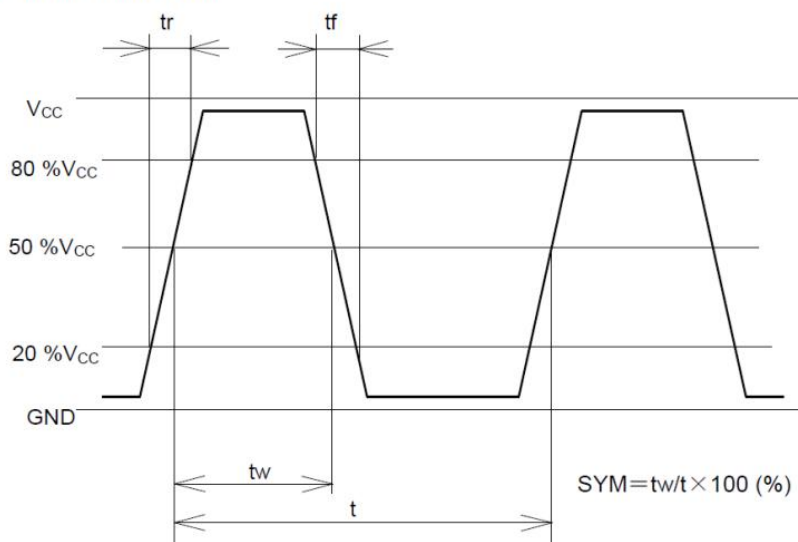


#### Note:

1. Oscilloscope The bandwidth should be minimum 5 times wider than measurement frequency The probe ground should be placed closely to the test point and the lead length should be as short as possible \* It is recommended to use miniature socket. Don't use earth lead.)
2. L\_CMOS includes probe capacitance.
3. 0.1μF bypass capacitor should be connected between VCC and GND pins located close to the device
4. Use a current meter with a low internal impedance
5. Power Supply Power supply startup time (0 %VCC → 90 %VCC) should be between 5 μs and 500 ms Power supply impedance should be as low as possible and GND line should be as short as possible

### Timing Chart

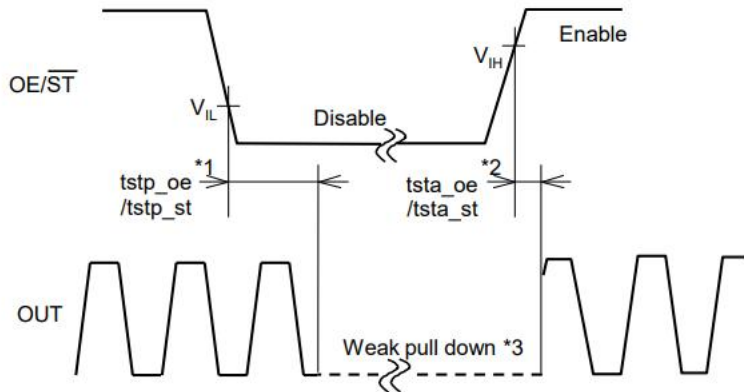
#### (1) Output Waveform and Level





## (2) OE/ $\overline{\text{ST}}$ Function and Timing

| OE/ $\overline{\text{ST}}$ terminal | Osc. circuit                              | Output status                                |
|-------------------------------------|-------------------------------------------|----------------------------------------------|
| "H"                                 | Oscillation                               | Specified frequency: Enable                  |
| "L"                                 | OE: Oscillation                           | Low (Weak pull down <sup>*3</sup> ): Disable |
|                                     | $\overline{\text{ST}}$ : Oscillation stop |                                              |



\*1 The period from OE/ $\overline{\text{ST}}$  =  $V_{IL}$  to OUT = Low (weak pull down) (Disable)

\*2 The period from OE/ $\overline{\text{ST}}$  =  $V_{IH}$  to OUT = Enable

\*3 Pulled down with Output pull down resistance ( $R_{DN}$ )

\* Judging the start of output when output waveform is observed.

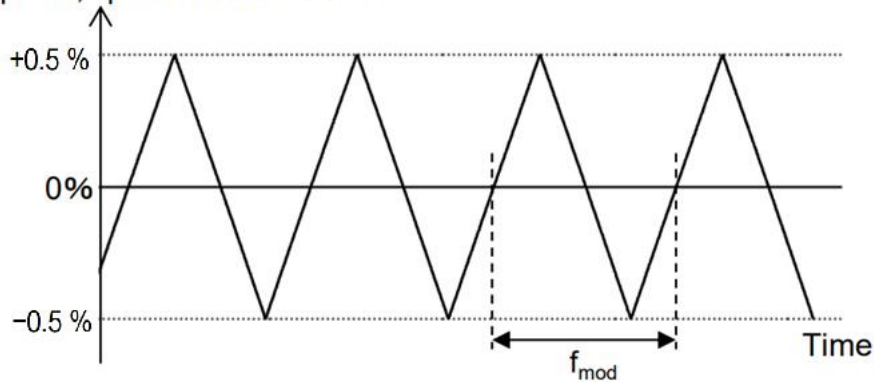
\* OE/ $\overline{\text{ST}}$  terminal voltage level should not exceed supply voltage when using OE/ $\overline{\text{ST}}$  function.  
Please note that OE/ $\overline{\text{ST}}$  rise time should not exceed supply voltage rise time at the start-up.

\* Please do not use the OE/ $\overline{\text{ST}}$  terminal in the open state.

Typically the output will be enable when OE/ST is open state, but the input pull resistance is large and OE/ $\overline{\text{ST}}$  terminal may drop to "L" level and be disable due to noise or leakage current.

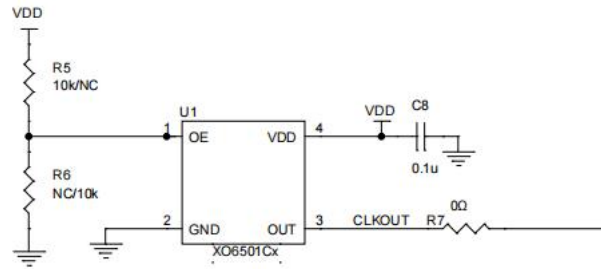
## 3) Triangle

Center spread, spread width:  $\pm 0.5\%$





## Application Circuit



## Revision History

| Revision | Description                                                                | Date      |
|----------|----------------------------------------------------------------------------|-----------|
| 1.0      | Initial release                                                            | 2024/7/22 |
| 1.1      | Update Cycle To Cycle Jitter                                               | 2024/9/5  |
| 1.2      | Update Block Diagram ; Update I <sub>STD</sub> ; Add application circuitry | 2025/4/15 |