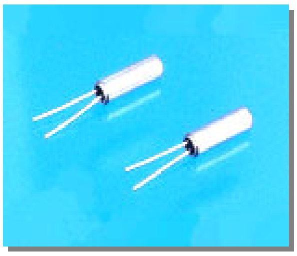
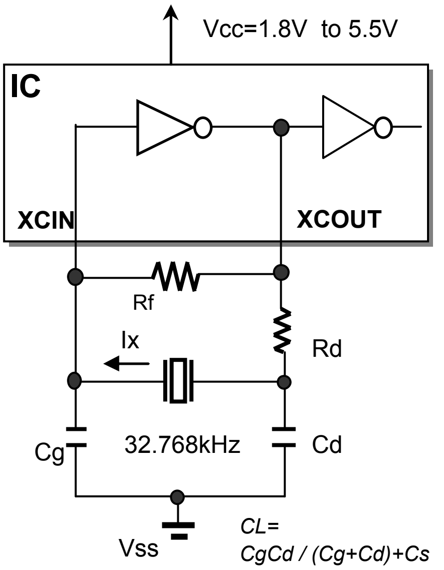
# Evaluation of Subsystem Clock Oscillation Circuit

[M38D59GFHP-80P] LQFP(12x12) 0.5mm pitch

Measurement conditions :3.3V, 5.0V



| | |
|---|---|
| Model | :VT-200 |
| Frequency | :Fo=32.768kHz |
| Frequency tolerance | :dF/Fo= +/-20x$10^{6}$ |
| Load capacitance | :CL=12.5pF |
| Equivalent series resistance | :R1=50kohm max |
| Max. drive level | :DL=1x$10^{-6}$W max |
| Level of drive | :DL=0.1x$10^{-6}$W typ |

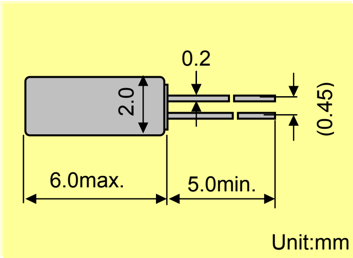



*Remark) Ix : current through crystal*

## FEATURES

1.Compact tubular package
2.Photolithographic process
3.Excellent shock resistance and environmental characteristics.
4.Real time clocks, Timers, Portable applications

## DIMENSIONS(VT-200)




MODEL:VT-200 12.5pF with M38D59GFHP at 25°C

| Key specifications | Vcc=3.3V | Vcc=5.0V | Remarks |
|---|---|---|---|
| Negative feedback resistance : Rf ( M ohm ) | 10 | 10 | |
| Current control resistance : Rd ( k ohm ) | 100 | 100 | Control drive level & secure phase margin |
| Capacitance at gate : Cg ( pF ) | 18 | 18 | Optimal capacity in response to CL |
| Capacitance at drain : Cd ( pF ) | 18 | 18 | ( CL = Cd // Cg + stray capacitance ) |

| Circuit characteristics ( at 25°C ) | Vcc=3.3V | Vcc=5.0V | Remarks |
|---|---|---|---|
| Matching Accuracy : df / f ( x$10^{-6}$ ) | 1.9 | 3.4 | Frequency offset volume at specified Vdd |
| Voltage Fluctuation : +/-df / V ( x$10^{-6}$ ) | 0.3 | 0.3 | Vdd +/-10% ( Standard operating voltage range ) |
| Drive Level : DL ( x$10^{-6}$W ) | 0.25 | 0.25 | DL=$Ix^2$ Re < 1x$10^{-6}$W,Re=R1( 1 + Co / CL $)^2$ |
| Negative resistance : \| - RL \| ( kohm ) | 654 | 714 | 5 times larger than $R_{1MAX}$ |
| Oscillation allowance : M ( times ) | 13.1 | 14.3 | Judgemental standard of oscillation stability |
| Voltage of oscillation start : Vstrat ( V ) | 1.62 | 1.62 | |
| Voltage of oscillation stop : Vstop ( V ) | 1.30 | 1.30 | |
| Oscillation start up time : Ts ( sec ) | 0.46 | 0.51 | Time to reach 90% of output level |

| Temperature characteristics of circuit | | Vcc=3.3V | Vcc=5.0V | Remarks |
|---|---|---|---|---|
| at -20°C | Variation : df / T ( x$10^{-6}$ ) | -65 | -65 | Typ.Tp=25°C ( K = -3.5×$10^{-8}$ / $°C^2$ ) |
| at +85°C | Variation : df / T ( x$10^{-6}$ ) | -134 | -134 | Typ.Tp=25°C ( K = -3.5×$10^{-8}$ / $°C^2$ ) |

The above mentioned value is only for your reference. The value is for the arbitrary samples and does not guarantee the product's characteristics. Please review and check above parameters at customer's end.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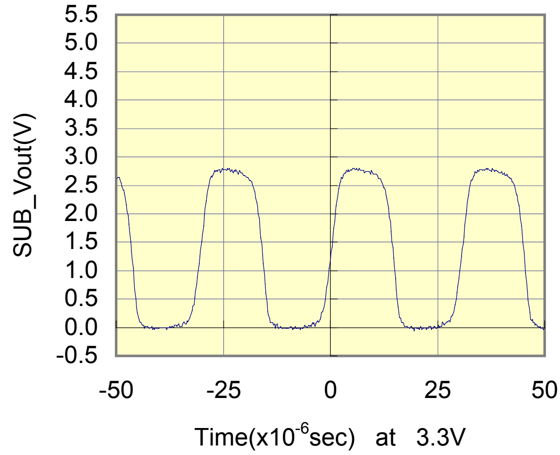
## Test Data at 25°C

Output signal wave from the oscillator
MODEL : VT-200 12.5pF with M38D59GFHP

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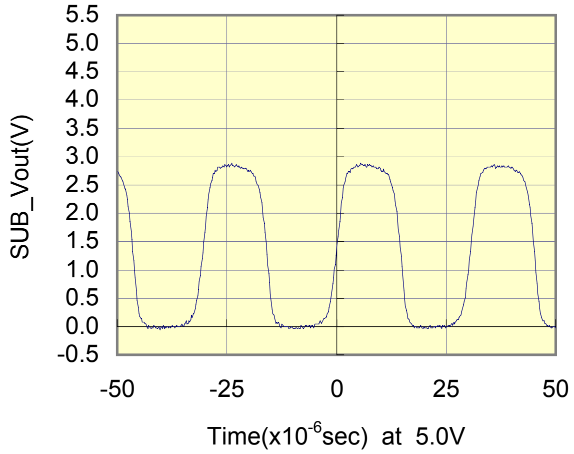
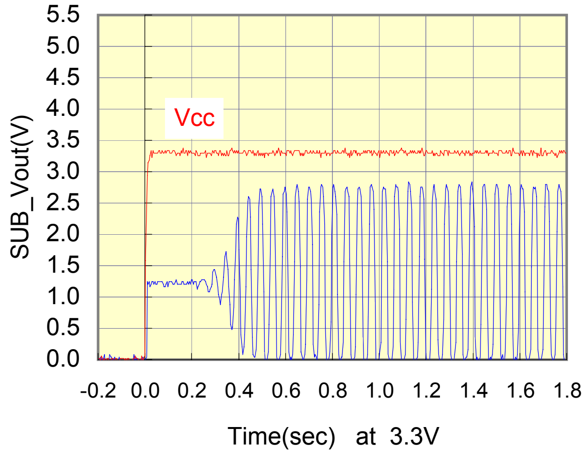



Start up time of SUB_Vout
MODEL : VT-200 12.5pF with M38D59GFHP

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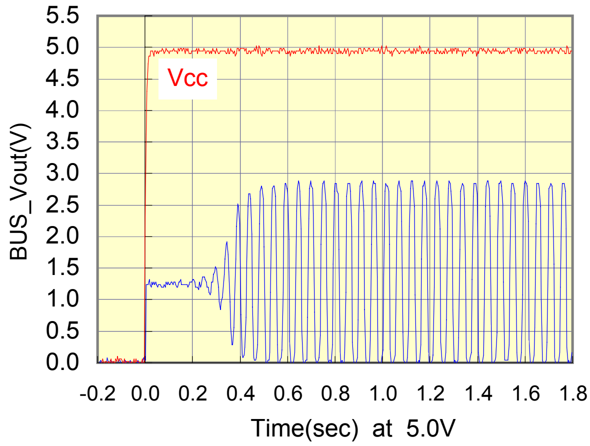
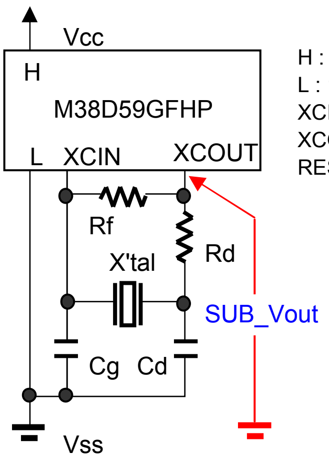


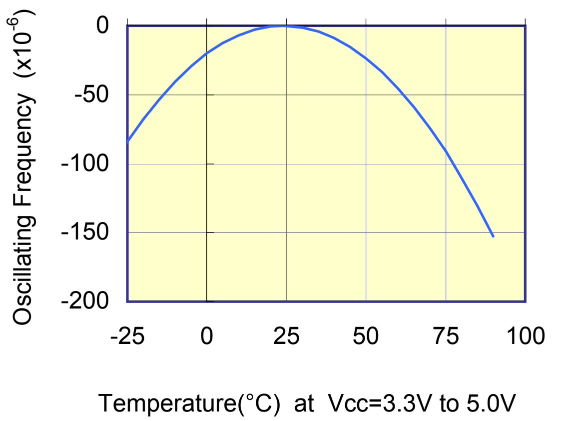

Test Circuit
MODEL : VT-200 12.5pF with M38D59GFHP




H : 14,72
L : 11,71
XCIN : 10
XCOUT : 9
RESET: 8

Recommended Values
X'tal :
VT-200 +/-20/12.5pF
Vcc=3.3V to 5.0V
Rf=10M ohm
Rd=100k ohm
Cg=18pF typ
Cd=18pF typ
Ta=-20 to 85°C

Temperature characteristics of oscillating frequency
MODEL : VT-200 12.5pF with M38D59GFHP



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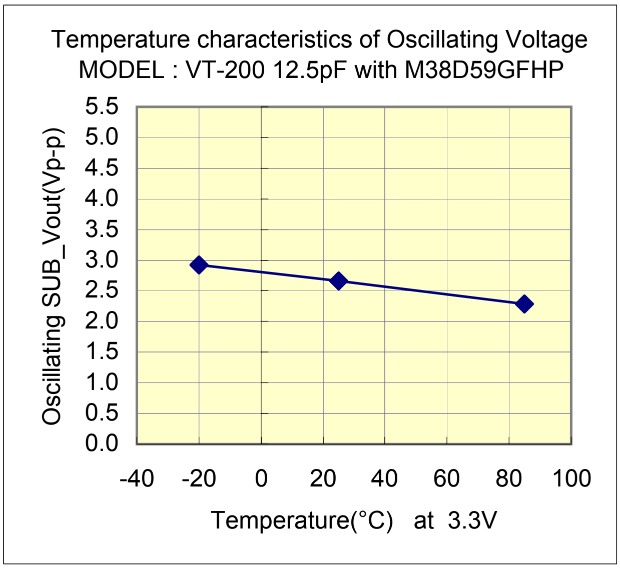
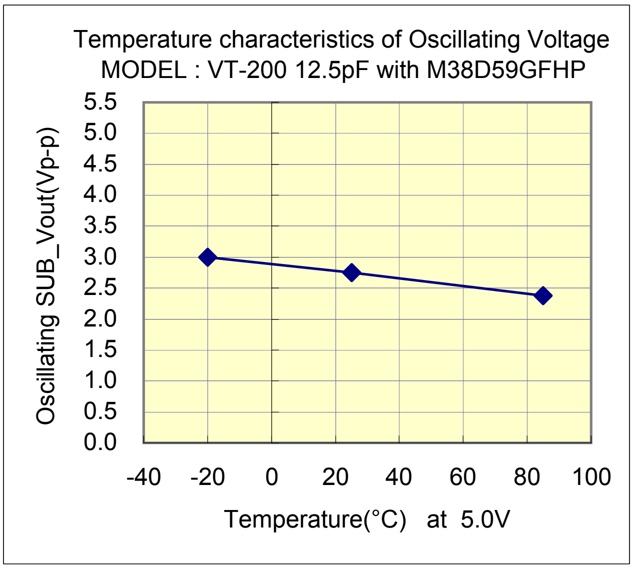
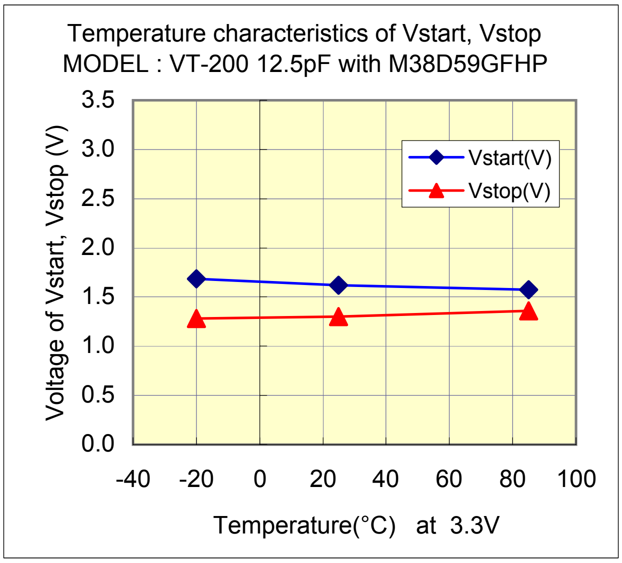
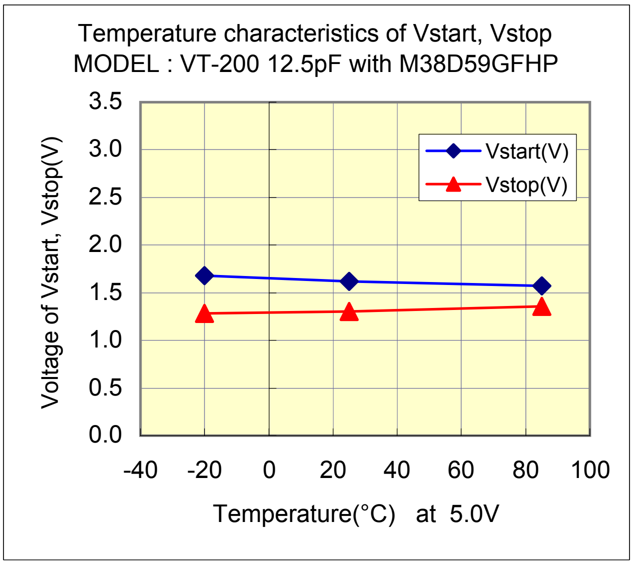
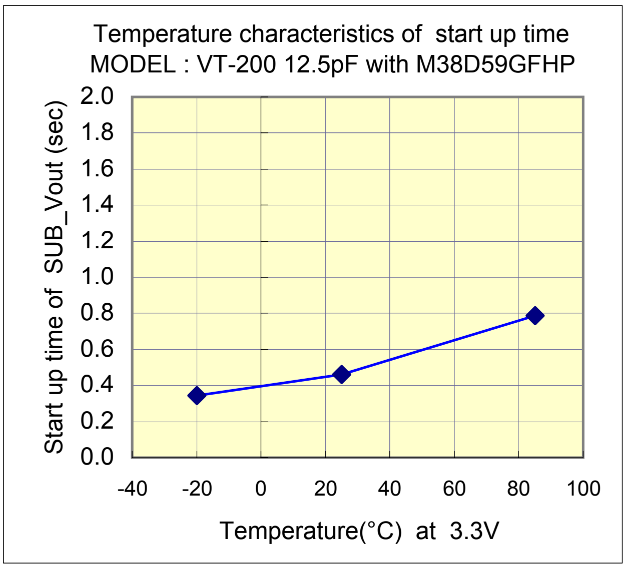
## Test Data : Temperature characteristics

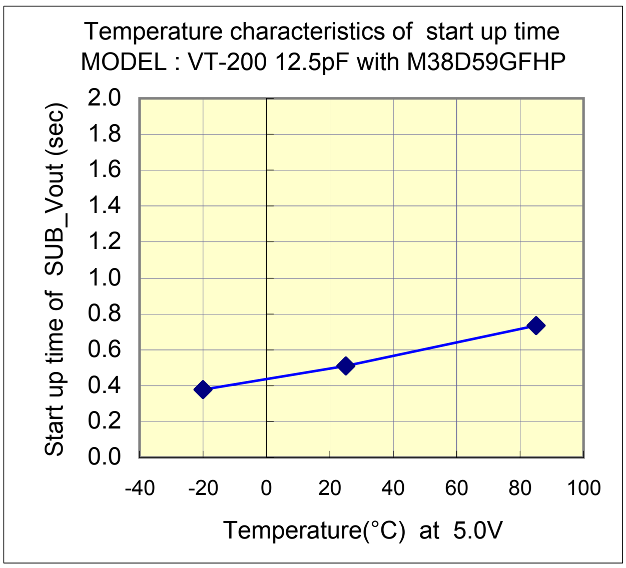


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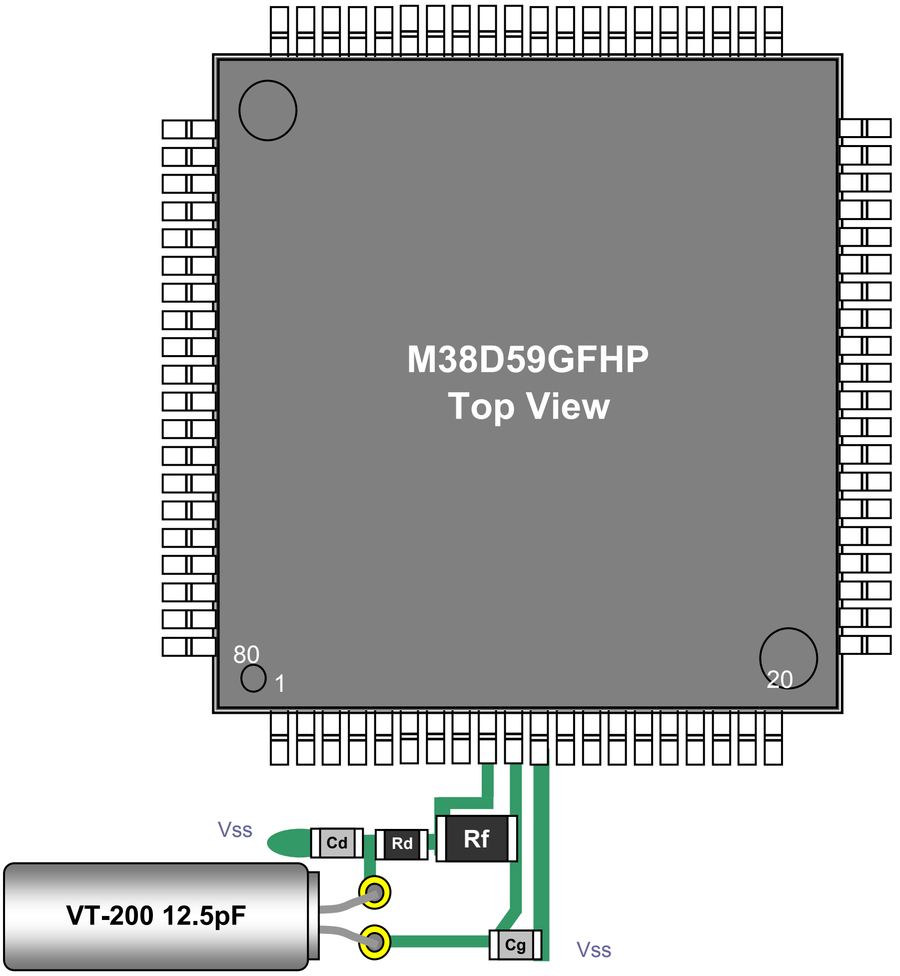
**Referential components layout(see Figure 1)**




Vcc:14 (H)
VREF:72(H)
CNVSS:7(H)
Vss: 11(L)
X1: 10 (SUB_in)
X2: 9 (SUB_out)
RESET: 8

**Figure 1 Referential components layout**

**Notes for Board Design**

When using a crystal resonator, place the resonator and its load capacitors as close as possible to SUB_in and SUB_out pins.
Other signal lines should be routed away from the resonator circuit to prevent induction from interfering with correct oscillation (see figure 2).

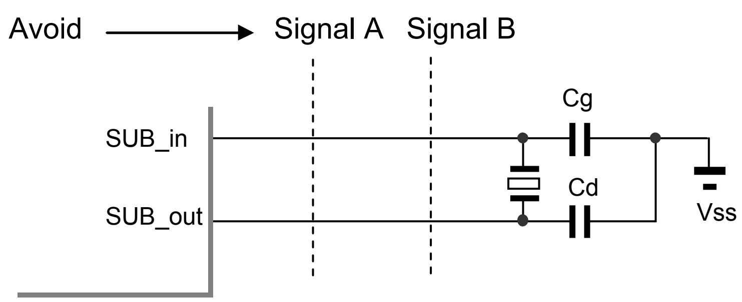



**Figure 2 Example of Incorrect Board Design**

**Remark** When using the subsystem clock, insert resistors Rd in series on the SUB_out side.

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Measurement conditions :3.3V, 5.0V

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### [Evaluation Sample : VT-200 12.5pF at 25°C]

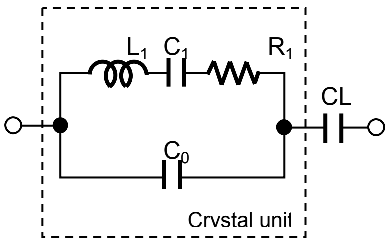
| SAMPLE | No. | CL( pF ) | Fo( Hz ) | fr( Hz ) | R1( kohm ) | Co( pF ) | C1( fF ) | Q( k ) |
|---|---|---|---|---|---|---|---|---|
| VT-200 12.5pF | 1 | 12.5 | 32768.11 | 32765.28 | 27.4 | 0.91 | 2.319 | 76.5 |
| | 2 | 12.5 | 32768.09 | 32765.24 | 26.9 | 0.89 | 2.333 | 77.4 |
| | 3 | 12.5 | 32768.34 | 32765.45 | 29.9 | 0.93 | 2.368 | 68.6 |

### [IC Test Data : IC samples Rf=10M,Rd=100k ohm,Cg=18pF,Cd=18pF at 25°C]

| Vcc(V) | IC samples | Fosc( Hz ) | df / f( $x10^{-6}$ ) | DL($x10^{-6}$W) | \| -RL \|( kohm | Vstart( V ) | Ts(sec) |
|---|---|---|---|---|---|---|---|
| 5.0 | TYP | 32768.450 | 3.38 | 0.25 | 714 | 1.62 | 0.51 |
| | HH | 32768.473 | 4.08 | 0.35 | 714 | 1.79 | 0.41 |
| | HL | 32768.410 | 2.16 | 0.28 | 714 | 1.67 | 0.43 |
| | LH | 32768.480 | 4.30 | 0.29 | 714 | 1.61 | 0.42 |
| | LL | 32768.393 | 1.64 | 0.23 | 654 | 1.47 | 0.49 |
| 3.3 | TYP | 32768.400 | 1.86 | 0.25 | 654 | 1.62 | 0.46 |
| | HH | 32768.427 | 2.68 | 0.34 | 714 | 1.79 | 0.43 |
| | HL | 32768.352 | 0.39 | 0.28 | 654 | 1.67 | 0.45 |
| | LH | 32768.452 | 3.44 | 0.28 | 654 | 1.61 | 0.42 |
| | LL | 32768.344 | 0.15 | 0.23 | 654 | 1.47 | 0.46 |

**Remark ( see figure 3 )**

Fo = fr ×{ C1/ ( 2×( Co + CL ) + 1 } ( Hz )




Fo : Load resonance frequency
fr : Resonance frequency
R1 : Motional resistance
C1 : Motional capacitance
Co : Shunt capacitance
CL : Load Capacitance

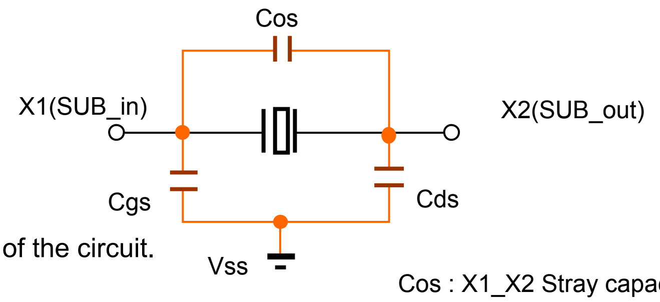
**Figure 3 Equivalent circuit of crystal unit, and CL**

**Remark ( see figure 4)**

Approximate formula of the load capacitance of the circuit CL.

CL = Cg×Cd / (Cg + Cd) + Cs (pF)

Where Cs(=2 to 4pF) Stands for stray capacitance of the circuit.




Cos : X1_X2 Stray capacitance
Cgs : X1_Vss Stray capacitance
Cds : X2_Vss Stray capacitance

**Figure 4 Stray capacitance Cos,Cgs,Cds of the circuit**

Resonator circuit constants will differ depending on the resonator element, stray capacitance in its interconnecting circuit, and other factors. Suitable constants should be determined in consultation with the resonator element manufacturer.