

Evaluation of Subsystem Clock Oscillation Circuit

[M38D29GFHP-64P] LQFP(10x10) 0.5mm pitch

Measurement conditions :3.3V,5.0V

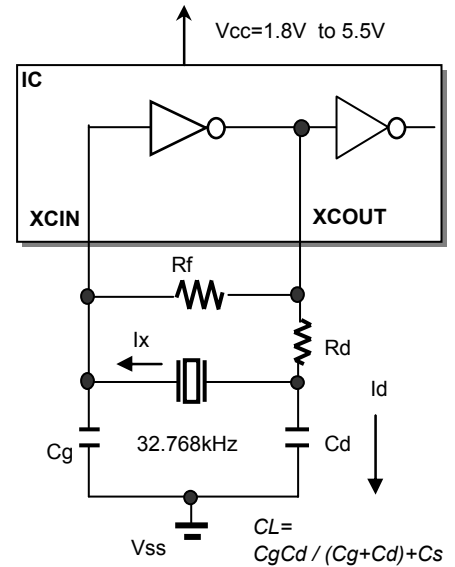
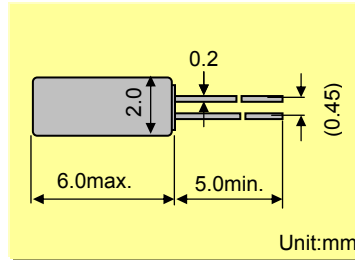


Model :VT-200
 Frequency :Fo=32.768kHz
 Frequency tolerance :dF/Fo= +/-20x10⁶
 Load capacitance :CL=6.0pF
 Equivalent series resistance :R1=50kohm max
 Max. drive level :DL=1x10⁻⁶W max
 Level of drive :DL=0.1x10⁻⁶W typ

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)



Remark) Ix : current through crystal

MODEL:VT-200 6.0pF with M38D29GFHP 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) | 330 | 330 | Control drive level & secure phase margin |
| Capacitance at gate : Cg (pF) | 5 | 5 | Optimal capacitance in response to CL |
| Capacitance at drain : Cd (pF) | 4 | 4 | (CL = Cd // Cg + stray capacitance) |

| Circuit characteristics (at 25°C) | Vcc=3.3V | Vcc=5.0V | Remarks |
|---|----------|----------|---|
| Matching Accuracy : df / f (x10 ⁻⁶) | 1.5 | 6.7 | Frequency offset volume at specified Vdd |
| Voltage Fluctuation : +/-df / V (x10 ⁻⁶) | 1.2 | 1.2 | Vdd +/-10% (Standard operating voltage range) |
| Drive Level : DL (x10 ⁻⁶ W) | 0.01 | 0.01 | $DL = Ix^2 Re < 1x10^{-6}W, Re = R1(1 + Co / CL)^2$ |
| Negative resistance : - RL (kohm) | 717 | 717 | 5 times larger than R _{1MAX} |
| Oscillation allowance : M (times) | 14 | 14 | Judgemental standard of oscillation stability |
| Consumption current : Id (nA) | 893 | 880 | Cd charge current, Id = ωCd*Vd |
| Voltage of oscillation start : Vstart (V) | 1.67 | 1.67 | |
| Voltage of oscillation stop : Vstop (V) | 1.47 | 1.47 | |
| Oscillation start up time : Ts (sec) | 0.45 | 0.43 | Time to reach 90% of output level |

| Temperature characteristics of circuit | | Vcc=3.3V | Vcc=5.0V | Remarks |
|--|--|----------|----------|---|
| at -20°C | Variation : df / T (x10 ⁻⁶) | -58 | -59 | Typ.Tp=25°C (K = -3.5x10 ⁻⁸ / °C ²) |
| at +85°C | Variation : df / T (x10 ⁻⁶) | -146 | -145 | Typ.Tp=25°C (K = -3.5x10 ⁻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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We value the "takumi" spirit.

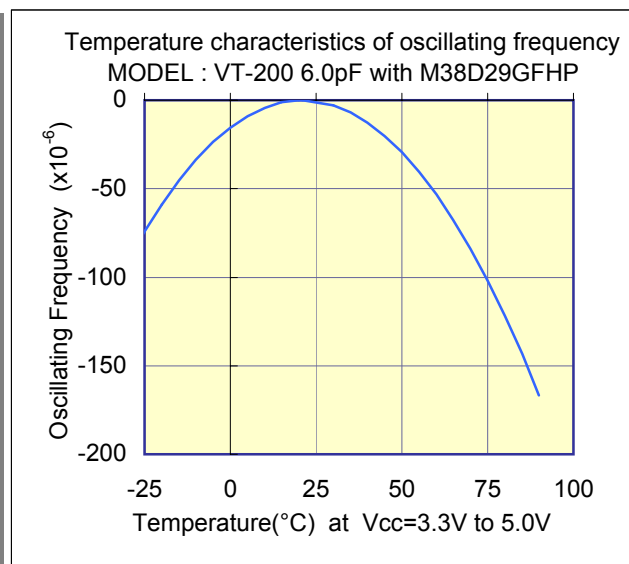
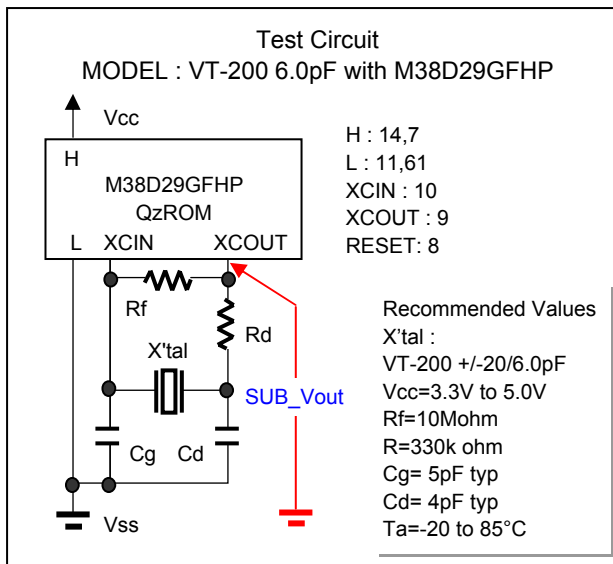
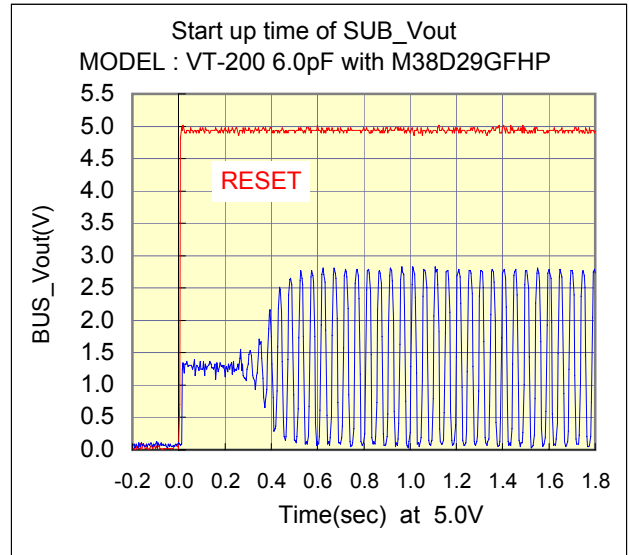
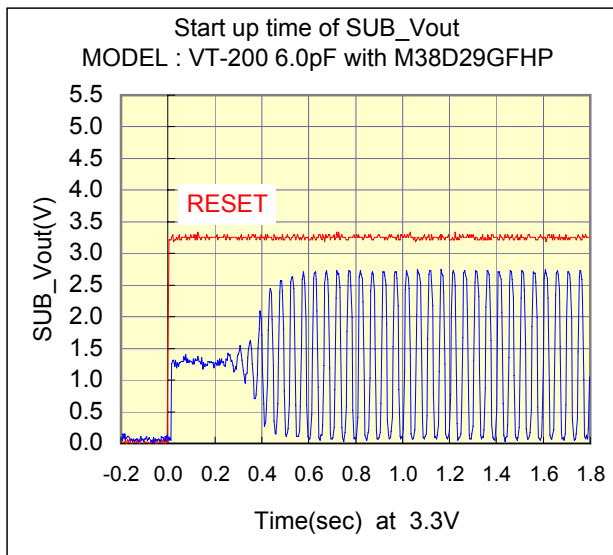
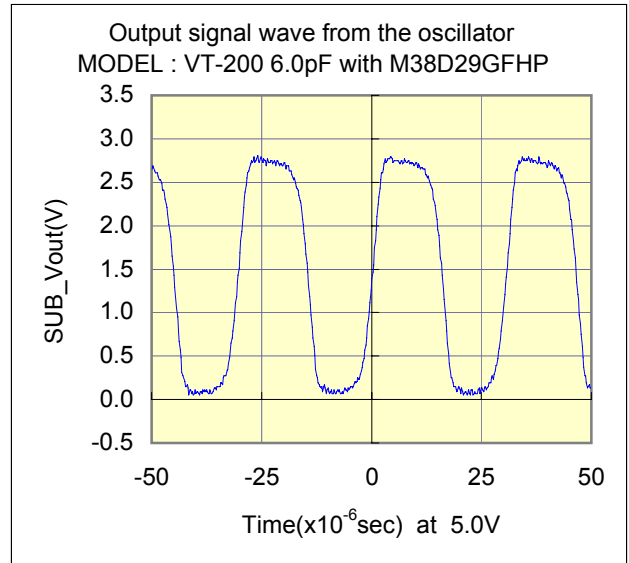
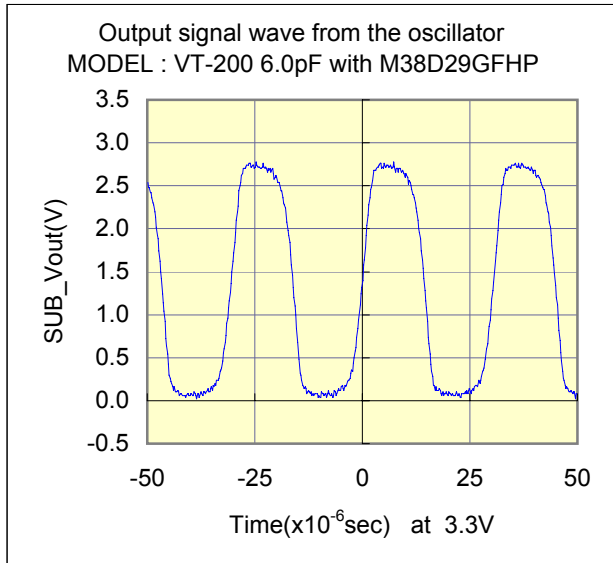
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Test Data at 25°C

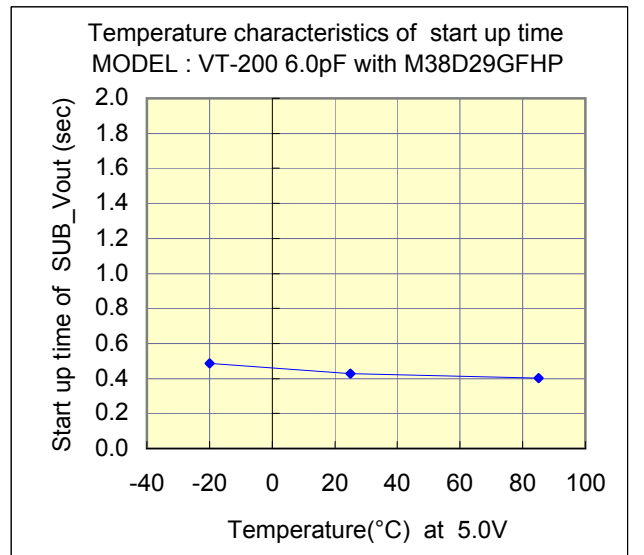
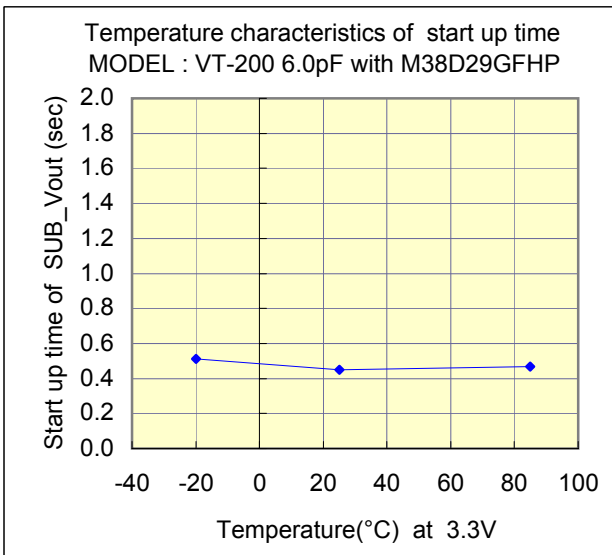
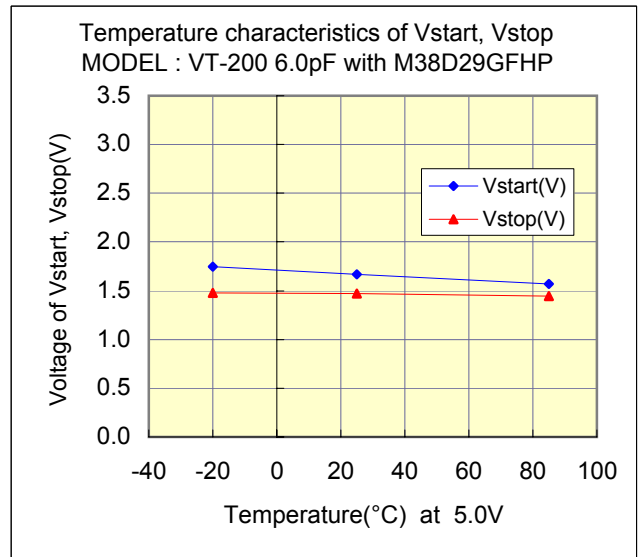
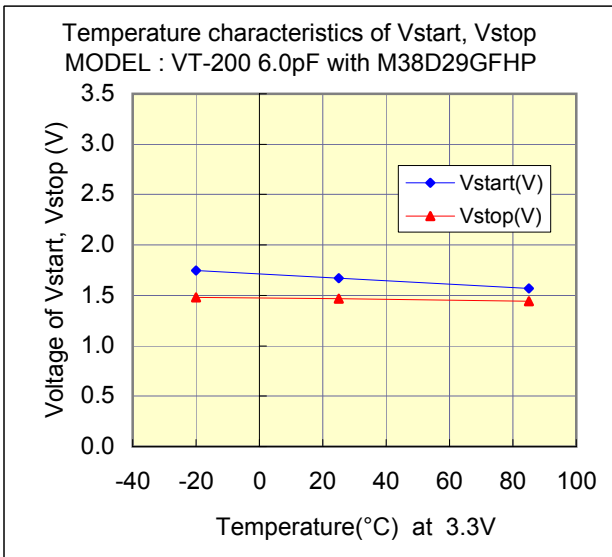
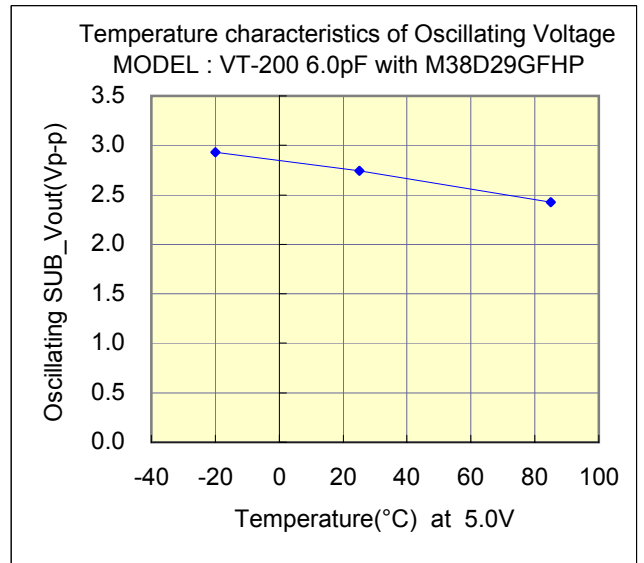
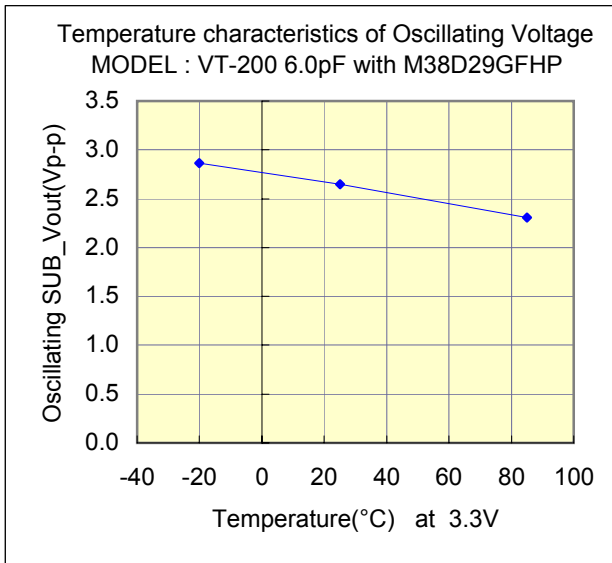


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Test Data : Temperature characteristics



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Referential components layout(see Figure 1)

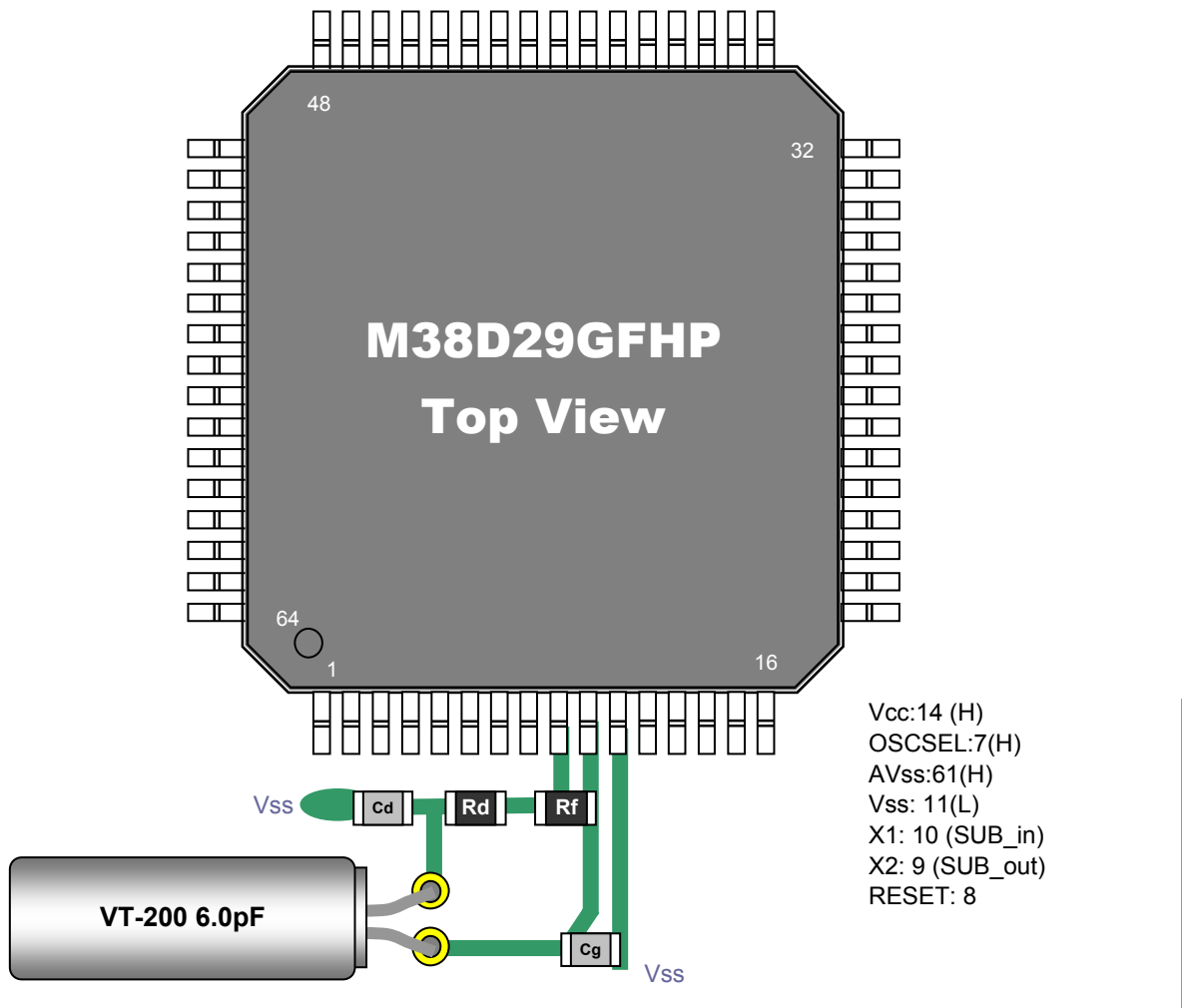


Figure 1 Referential components layout

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).

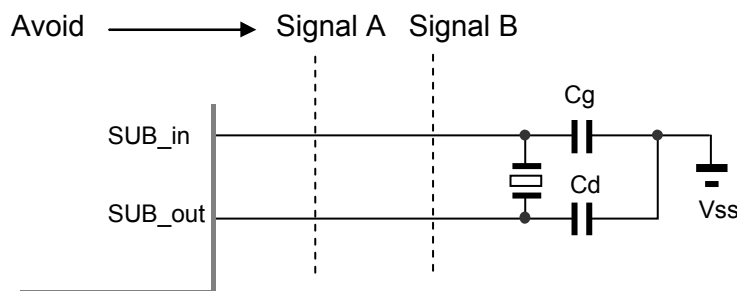


Figure 2 Example of Incorrect Board Design

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

Evaluation of Subsystem Clock Oscillation Circuit

[M38D29GFHP-64P] LQFP(10x10) 0.5mm pitch

Measurement conditions :3.3V,5.0V



[Evaluation Sample : VT-200 6.0pF at 25°C]

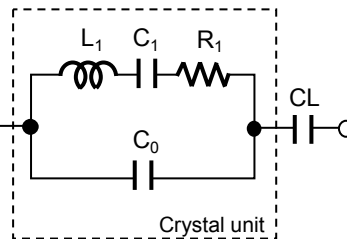
| SAMPLE | No. | CL (pF) | Fo (Hz) | fr (Hz) | R1 (kohm) | Co (pF) | C1 (fF) | Q (k) |
|-----------------|-----|---------|----------|----------|-----------|---------|---------|-------|
| VT-200 6.0pF | 1 | 6 | 32767.90 | 32762.79 | 28.8 | 0.88 | 2.148 | 78.6 |
| | 2 | 6 | 32768.18 | 32763.04 | 27.8 | 0.89 | 2.161 | 80.9 |
| | 3 | 6 | 32768.01 | 32762.79 | 28 | 0.90 | 2.199 | 78.9 |

[IC Test Data : IC sample Rd=330k ohm,Cg=5pF,Cd=4pF at 25°C]

| Vcc(V) | IC sample | Fosc (Hz) | df / f (x10 ⁻⁶) | DL(x10 ⁻⁶ W) | -RL (kohm) | Vstart(V) | Ts(sec) |
|--------|-----------|-----------|-----------------------------|-------------------------|--------------|------------|---------|
| 5.0 | TYP | 32768.230 | 6.71 | 0.01 | 717 | 1.67 | 0.43 |
| | HH | 32768.315 | 9.31 | 0.01 | 717 | 1.84 | 0.45 |
| | HL | 32768.175 | 5.04 | 0.01 | 717 | 1.70 | 0.44 |
| | LH | 32768.295 | 8.70 | 0.01 | 717 | 1.55 | 0.42 |
| | LL | 32768.210 | 6.10 | 0.01 | 717 | 1.44 | 0.40 |
| 3.3 | TYP | 32768.060 | 1.53 | 0.01 | 717 | 1.67 | 0.45 |
| | HH | 32768.098 | 2.69 | 0.01 | 717 | 1.84 | 0.50 |
| | HL | 32767.946 | -1.95 | 0.01 | 787 | 1.71 | 0.46 |
| | LH | 32768.097 | 2.66 | 0.01 | 717 | 1.57 | 0.46 |
| | LL | 32767.997 | -0.40 | 0.01 | 717 | 1.44 | 0.41 |

Remark (see figure 3)

$$F_o = f_r \times \{ C_1 / (2 \times (C_o + C_L)) + 1 \} \text{ (Hz)}$$



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

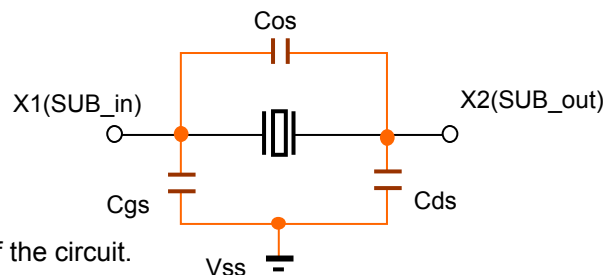
Figure 3 Equivalent circuit of crystal unit, and CL

Remark (see figure 4)

Approximate formula of the load capacitance of the circuit CL.

$$C_L = C_g \times C_d / (C_g + C_d) + C_s \text{ (pF)}$$

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.

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Referential Data : Voltage characteristics

