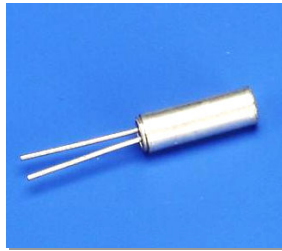


# Evaluation of Subsystem Clock Oscillation Circuit

[uPD78F0138M2GB-8EU] LQFP(10x10) 0.5mm pitch

Measurement conditions : 5.0V (In use of regulator), 5.0V (Non use of regulator)

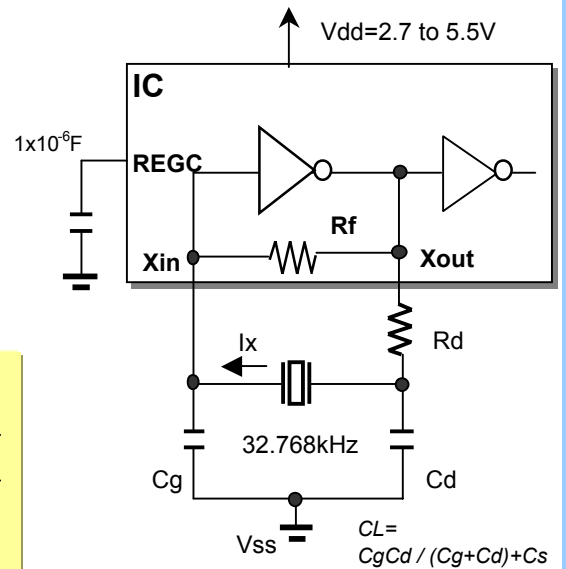
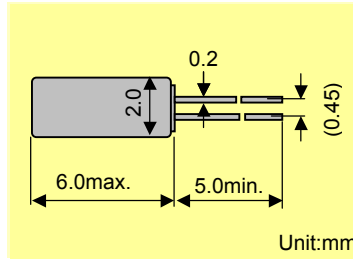


Model	:VT-200
Frequency	:Fo=32.768kHz
Frequency tolerance	:dF/Fo= +/-20x10 <sup>6</sup>
Load capacitance	:CL=6.0pF
Equivalent series resistance	:R1=50kohm max
Max. Drive level	:DL=x10 <sup>-6</sup> W max
Recommended drive level	:DL=0.1x10 <sup>-6</sup> W typ

## 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

When the internal power supply Step-Down circuit is not used, please connect the external power supply to the REGC pin and Vdd pin.

MODEL:VT-200 6.0pF with uPD78F0138M2GB at 5.0V,25°C

Key specifications	Non use	In use(REG)	Remarks
Current control resistance : Rd ( k ohm )	330	330	Control drive level & secure phase margin
Capacitance at gate : Cg ( pF )	6	5	Optimal capacity in response to CL
Capacitance at drain : Cd ( pF )	6	4	( CL = Cd // Cg + stray capacitance )

Circuit characteristics ( at 25°C )	Non use	In use(REG)	Remarks
Matching Accuracy : df / f ( x10 <sup>-6</sup> )	1.8	-0.5	Frequency offset volume at specified Vdd
Voltage Fluctuation : +/-df / V ( x10 <sup>-6</sup> )	6.0	0.0	Vdd +/-10% ( Standard operating voltage range )
Drive Level : DL ( x10 <sup>-6</sup> W )	0.08	0.05	DL=Ix <sup>2</sup> Re < 1x10 <sup>-6</sup> W, Re=R1( 1 + Co / CL ) <sup>2</sup>
Negative resistance :   - RL   ( kohm )	948	788	5 times larger than R1MAX
Oscillation allowance : M ( times )	19.0	15.8	Judgemental standard of oscillation stability
Oscillation start up time : Ts ( sec )	0.51	0.53	Time to reach 90% of output level

Temperature characteristics of circuit		Non use	In use(REG)	Remarks
at -40°C	Variation : df / T ( x10 <sup>-6</sup> )	-136	-136	Typ.Tp=25°C ( K = -3.5x10 <sup>-8</sup> / °C <sup>2</sup> )
at +85°C	Variation : df / T ( x10 <sup>-6</sup> )	-140	-139	Typ.Tp=25°C ( K = -3.5x10 <sup>-8</sup> / °C <sup>2</sup> )

The mention 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.

Seiko Instruments Inc.  
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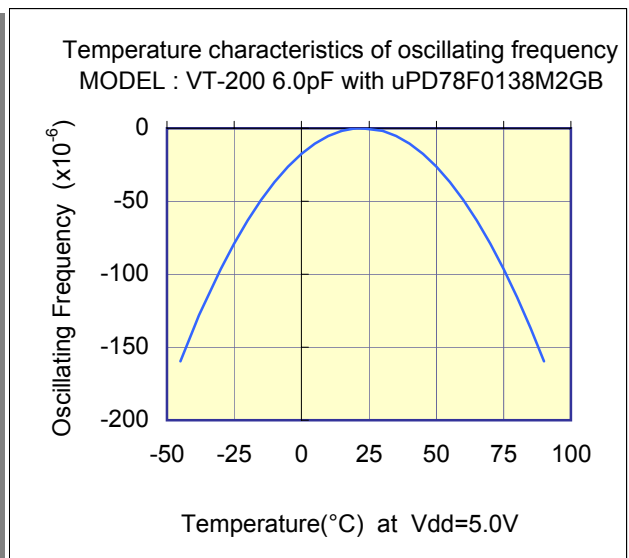
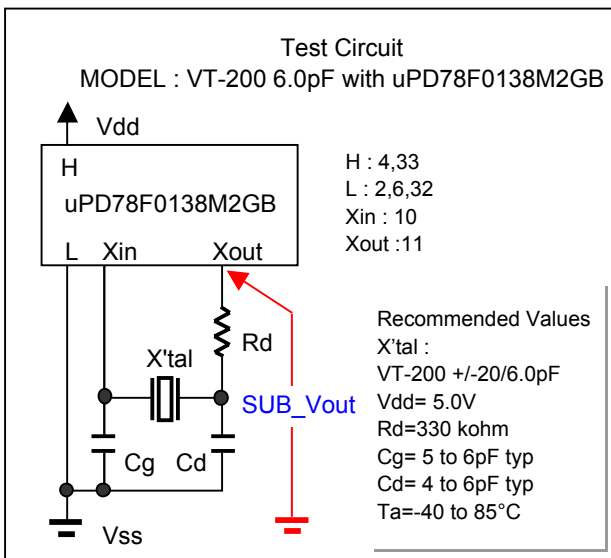
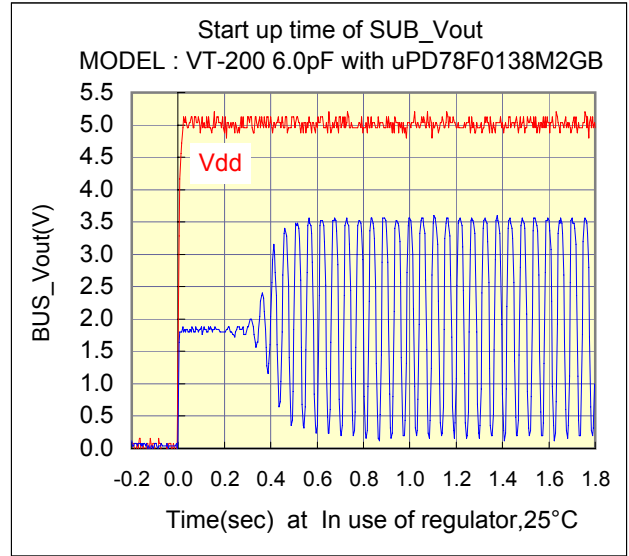
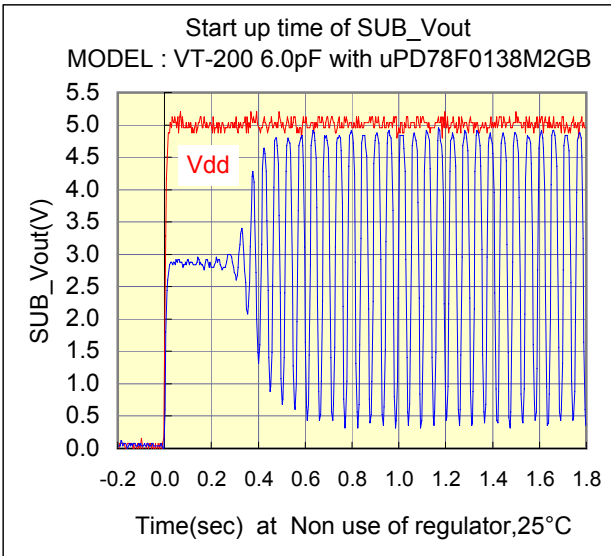
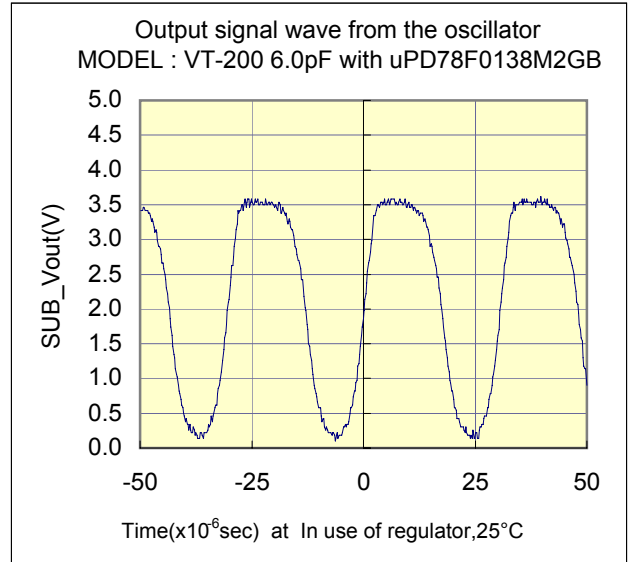
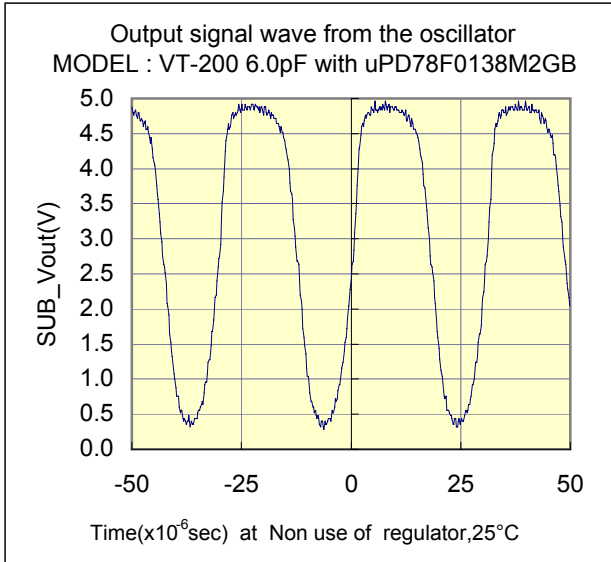
# Evaluation of Subsystem Clock Oscillation Circuit

[uPD78F0138M2GB-8EU] LQFP(10x10) 0.5mm pitch

Measurement conditions : 5.0V (In use of regulator), 5.0V (Non use of regulator)



## Test Data



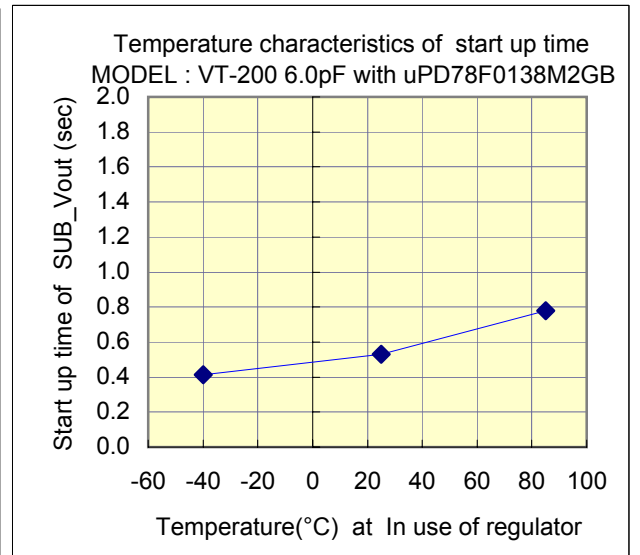
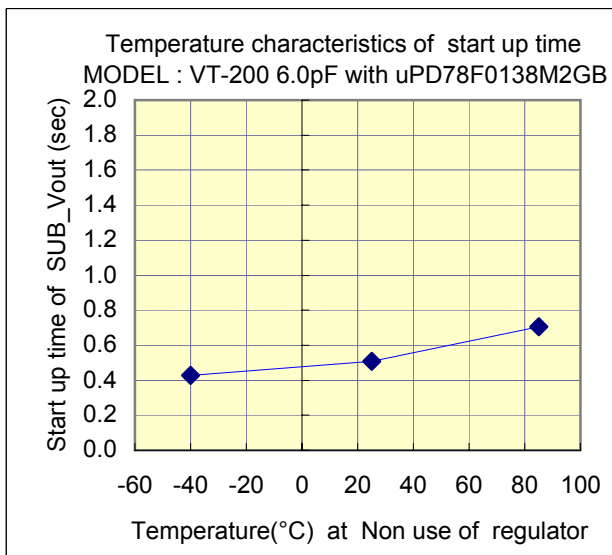
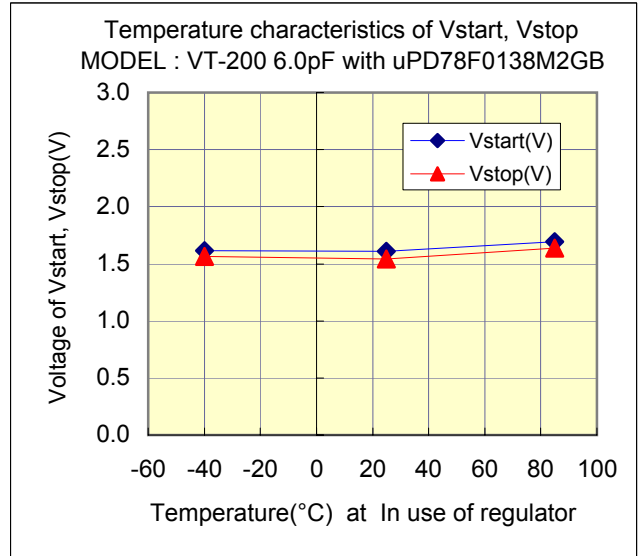
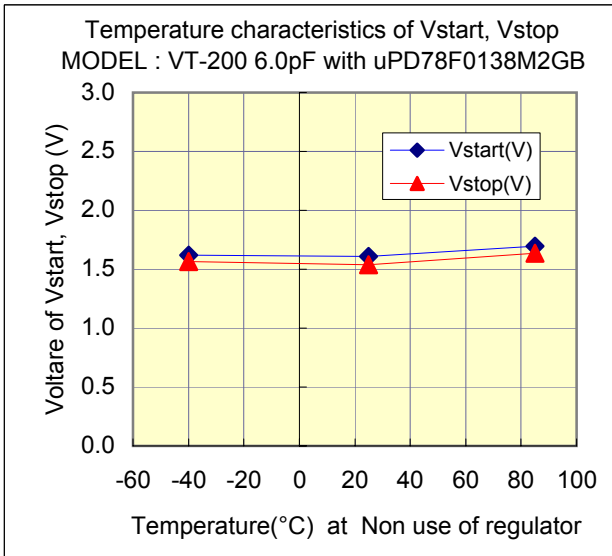
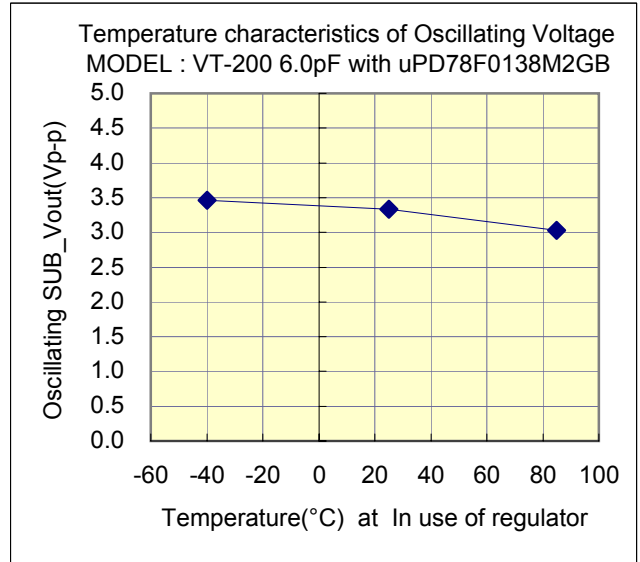
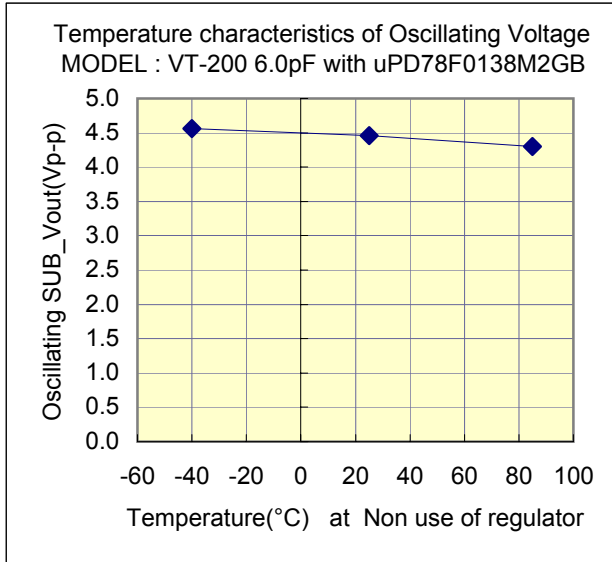
# Evaluation of Subsystem Clock Oscillation Circuit

[uPD78F0138M2GB-8EU] LQFP(10x10) 0.5mm pitch

Measurement conditions : 5.0V (In use of regulator), 5.0V (Non use of regulator)



## Test Data : Temperature characteristics



# Evaluation of Subsystem Clock Oscillation Circuit

[ $\mu$ PD78F0138M2GB-8EU] LQFP(10x10) 0.5mm pitch

Measurement conditions : 5.0V (In use of regulator), 5.0V (Non use of regulator)



## Referencial components layout(see Figure 1)

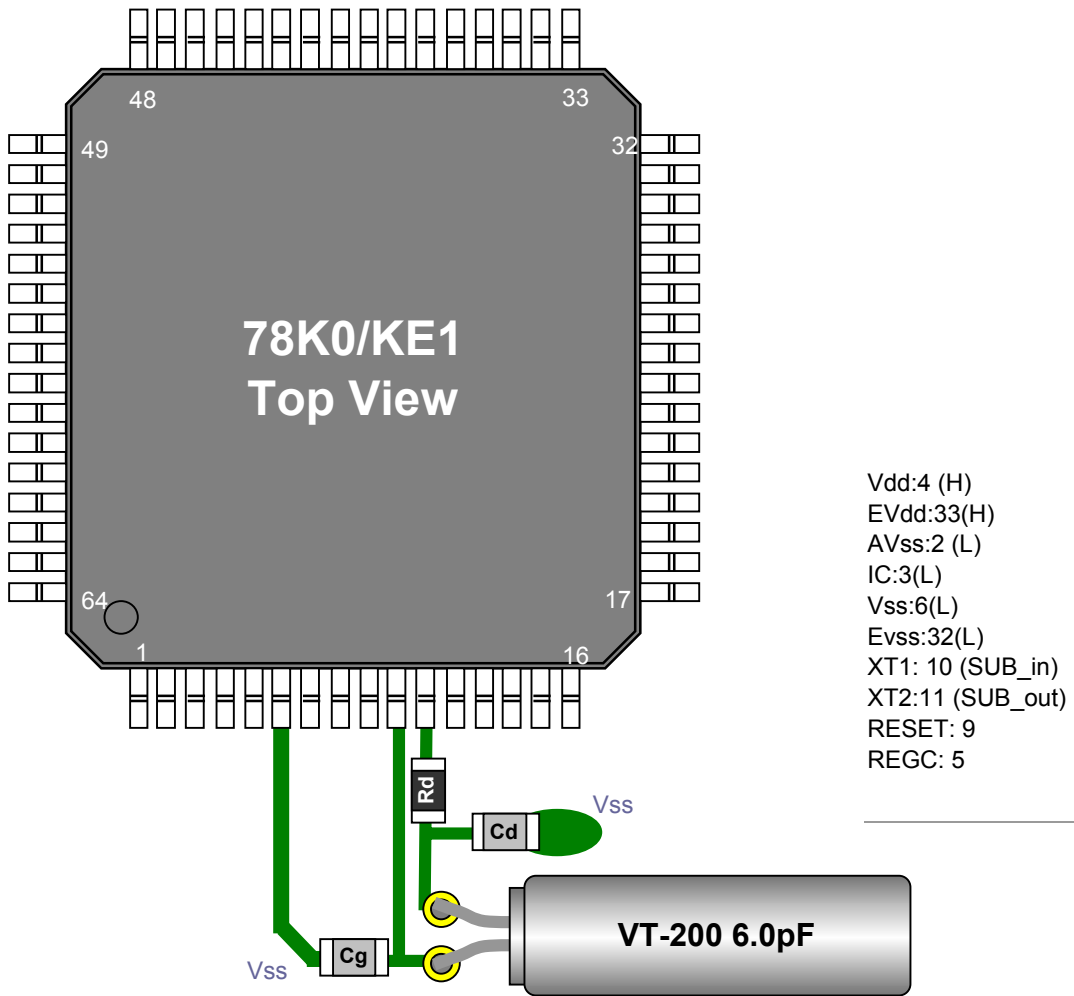


Figure 1 Referencial components layout

## Notes 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).

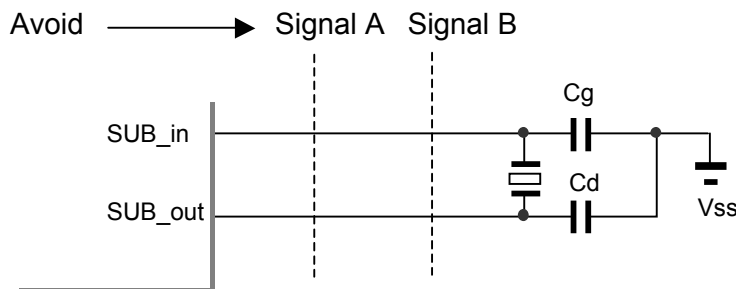


Figure 2 Example of Incorrect Board Design

**Remak** When using the subsystem clock, insert resistors Rd in series on the SUB\_out side.

# Evaluation of Subsystem Clock Oscillation Circuit

[ $\mu$ PD78F0138M2GB-8EU] LQFP(10x10) 0.5mm pitch

Measurement conditions : 5.0V (In use of regulator), 5.0V (Non use of regulator)



## [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	32768.18	32762.98	28.7	0.91	2.193	77.2
	2	6	32768.18	32763.04	27.8	0.89	2.161	80.9
	3	6	32768.19	32763.00	27.2	0.90	2.187	81.7

## [IC Test Data : IC Sampl Rd=330kohm,Cg=5pF,Cd=4pF at 25°C]

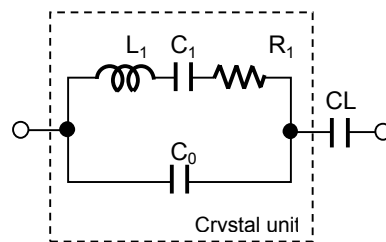
Regulator	IC Sampl	Fosc (Hz)	df / f (x10 <sup>-6</sup> )	DL(x10 <sup>-6</sup> W)	-RL  ( kohm)	Vstart ( V )	Ts(sec)
In use	typ-#01	32768.16	-0.49	0.05	788.1	1.61	0.53
	typ-#02	32768.16	-0.61	0.05	788.1	1.61	0.55
	typ-#03	32768.17	-0.31	0.05	788.1	1.61	0.52

## [IC Test Data : IC Sampl Rd=330kohm,Cg=6pF,Cd=6pF at 25°C]

Regulator	IC Sampl	Fosc (Hz)	df / f (x10 <sup>-6</sup> )	DL(x10 <sup>-6</sup> W)	-RL  ( kohm)	Vstart ( V )	Ts(sec)
Non use	typ-#01	32768.24	1.83	0.08	948.1	1.61	0.51
	typ-#02	32768.25	1.98	0.08	948.1	1.61	0.53
	typ-#03	32768.26	2.44	0.08	948.1	1.61	0.54

### Remak ( see figure 3 )

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



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

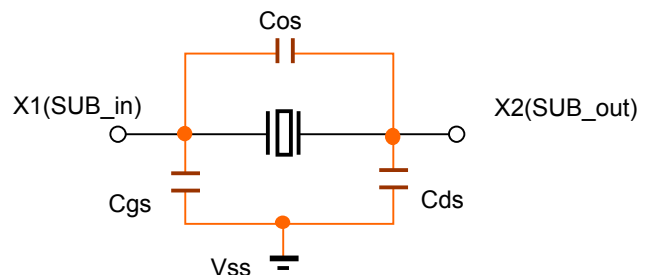
Figure 3 Equivalent circuit of crystal unit, and CL

### Remak ( see figure 4 )

Approximate formula of the load capacitance of the circuit CL.

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

Where Cs Stands for stray capacity 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.

