

# Evaluation of Subsystem Clock Oscillation Circuit

[MB89F538-64P] LQFP(12x12) 0.65mm pitch  
 Measurement conditions :5.0V , 3.3V(reference)

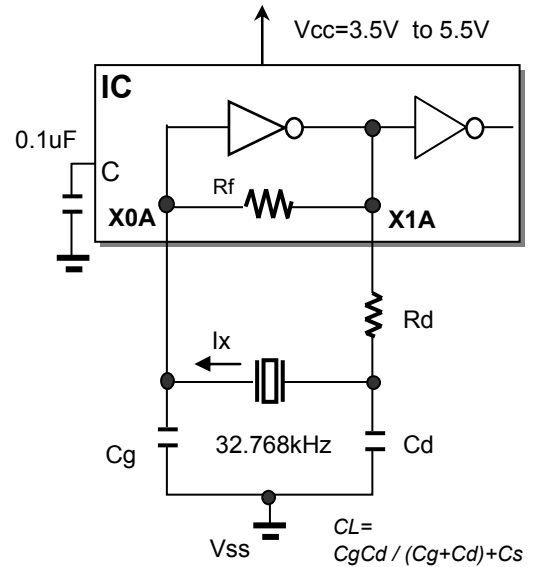
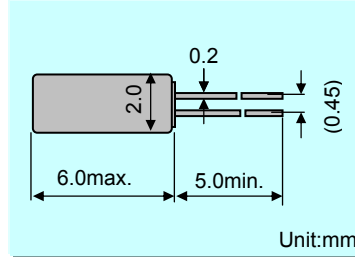


Model :VT-200  
 Frequency :Fo=32.768kHz  
 Frequency tolerance :dF/Fo= +/-20x10<sup>6</sup>  
 Load capacitance :CL=12.5pF  
 Equivalent series resistance :R1=50kohm max  
 Max. drive level :DL=1x10<sup>6</sup>W max  
 Level of drive :DL=0.1x10<sup>6</sup>W typ

## 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

MODEL:VT-200 12.5pF with MB89F538 at 25°C

Key specifications	Vcc=(3.3V)	Vcc=5.0V	Remarks
Negative feedback resistance : Rf ( M ohm )	Built-in	Built-in	
Current control resistance : Rd ( k ohm )	470	470	Control drive level & secure phase margin
Capacitance at gate : Cg ( pF )	22	22	Optimal capacitance in response to CL
Capacitance at drain : Cd ( pF )	18	22	( CL = Cd // Cg + stray capacitance )

Circuit characteristics ( at 25°C )	Vcc=(3.3V)	Vcc=5.0V	Remarks
Matching Accuracy : df / f ( x10 <sup>-6</sup> )	1.8	0.3	Frequency offset volume at specified Vdd
Voltage Fluctuation : +/-df / V ( x10 <sup>-6</sup> )	1.5	0.9	Vdd +/-10% ( Standard operating voltage range )
Drive Level : DL ( x10 <sup>-6</sup> W )	0.33	0.59	DL=Ix <sup>2</sup> Re < 1x10 <sup>-6</sup> W, Re=R1( 1 + Co / CL ) <sup>2</sup>
Negative resistance :   - RL   ( kohm )	255	505	5 times larger than R <sub>1MAX</sub>
Oscillation allowance : M ( times )	5.1	10.1	Judgemental standard of oscillation stability
Voltage of oscillation start : Vstrat ( V )	2.28	2.35	
Voltage of oscillation stop : Vstop ( V )	2.02	2.02	
Oscillation start up time : Ts ( sec )	1.90	0.87	Time to reach 90% of output level

Temperature characteristics of circuit		Vcc=(3.3V)	Vcc=5.0V	Remarks
at -40°C	Variation : df / T ( x10 <sup>-6</sup> )	-128	-128	Typ.Tp=25°C ( K = -3.5x10 <sup>-8</sup> / °C <sup>2</sup> )
at +85°C	Variation : df / T ( x10 <sup>-6</sup> )	-131	-131	Typ.Tp=25°C ( K = -3.5x10 <sup>-8</sup> / °C <sup>2</sup> )

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.

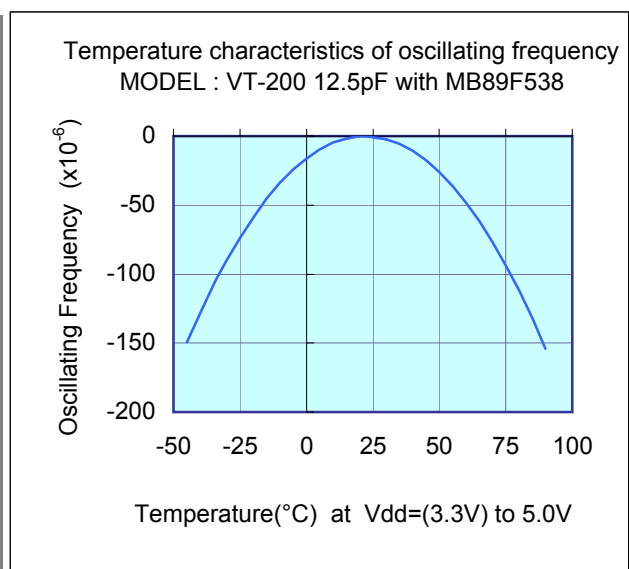
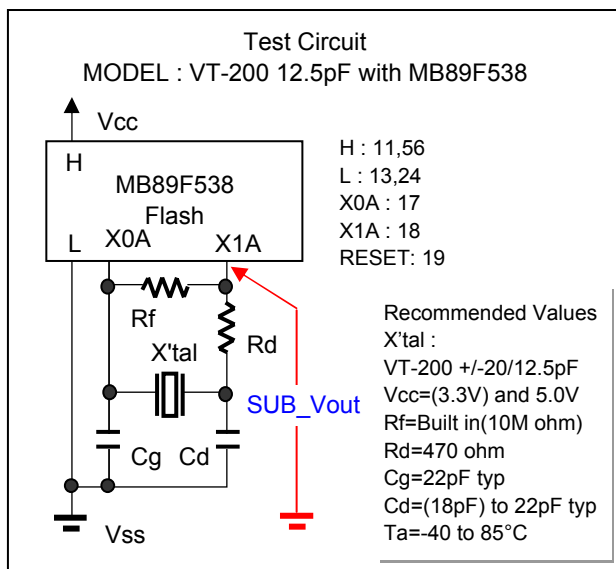
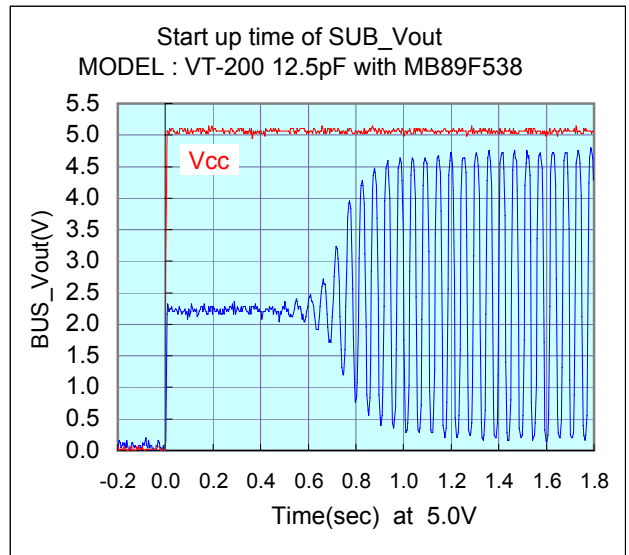
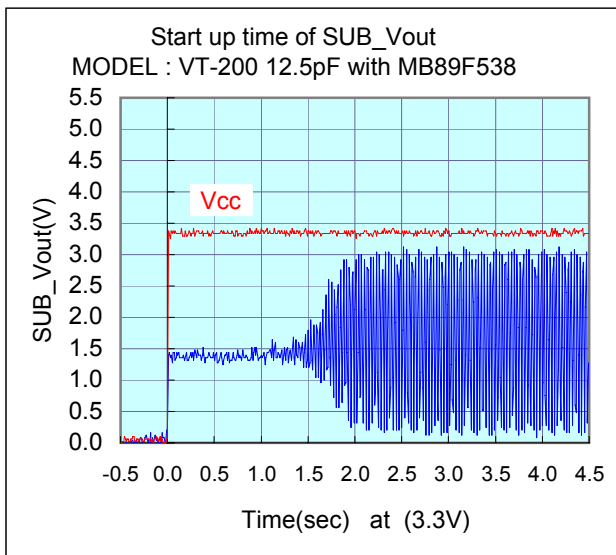
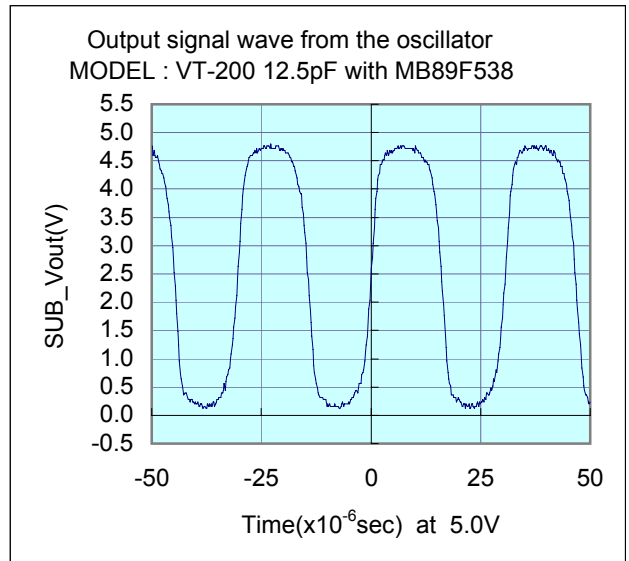
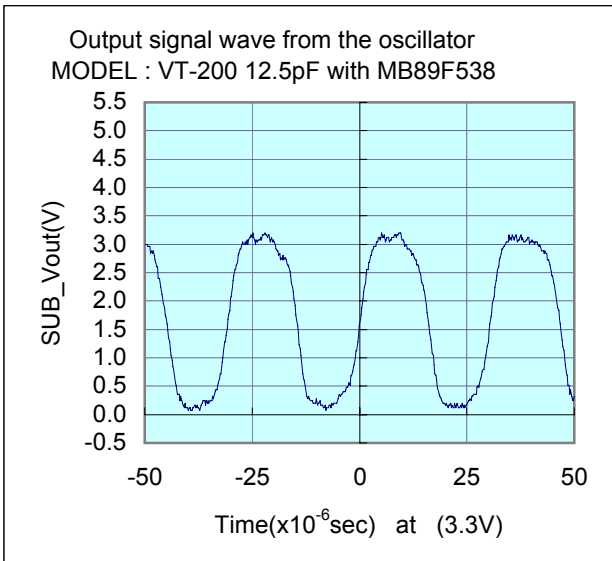
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## Test Data at 25°C

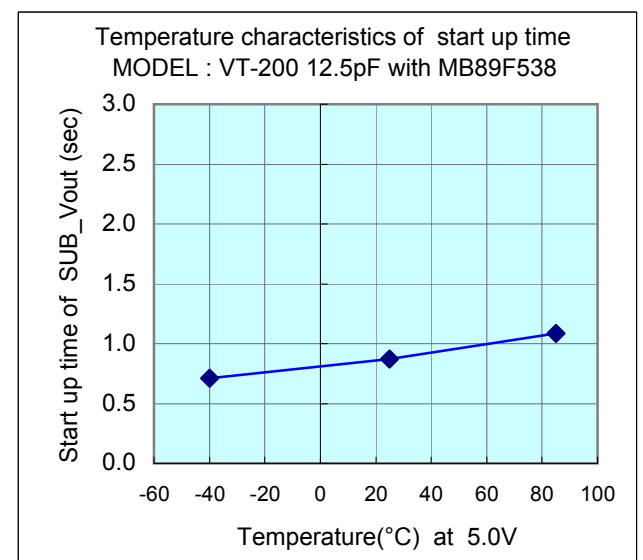
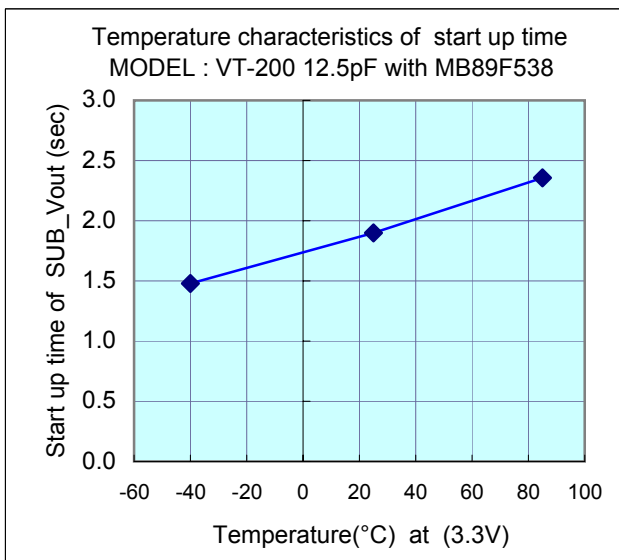
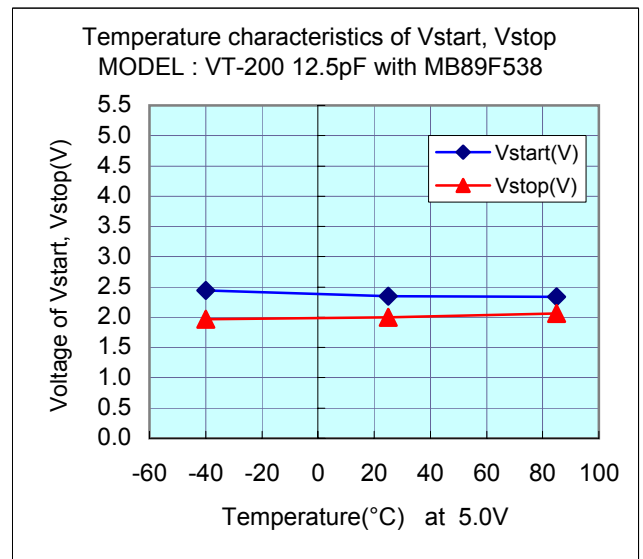
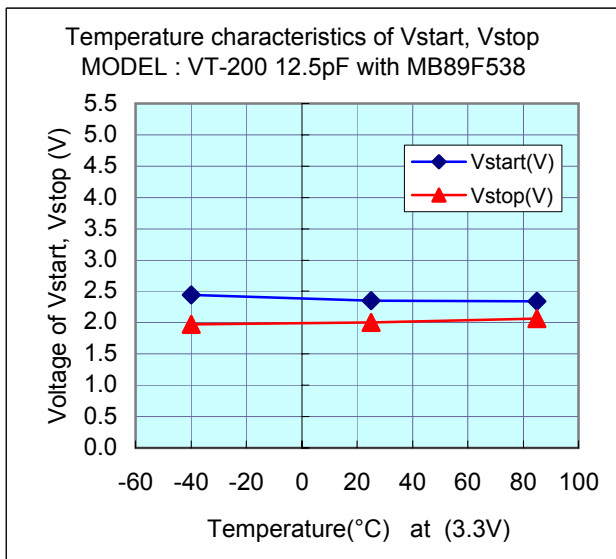
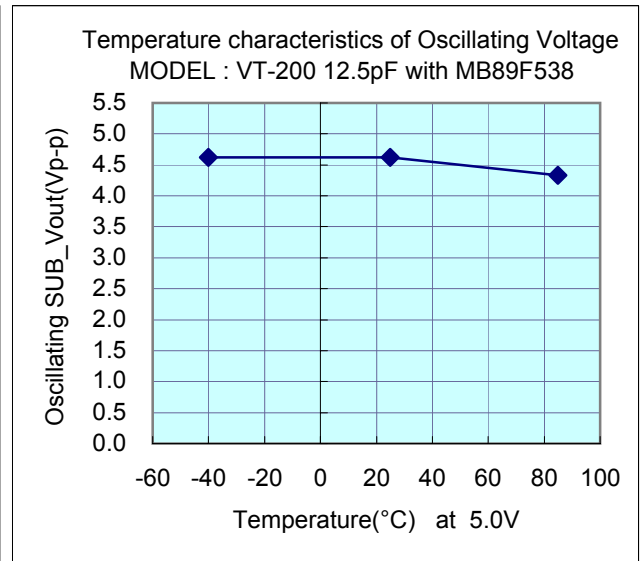
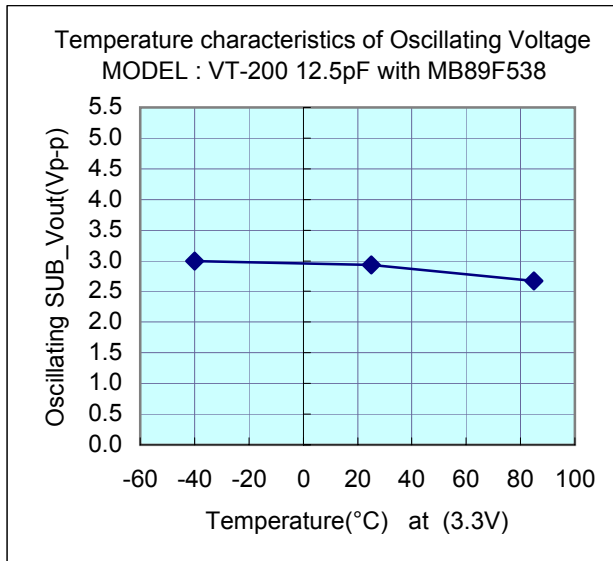


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 Measurement conditions :5.0V , 3.3V(reference)



## Test Data : Temperature characteristics



# Evaluation of Subsystem Clock Oscillation Circuit

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## Referential components layout(see Figure 1)

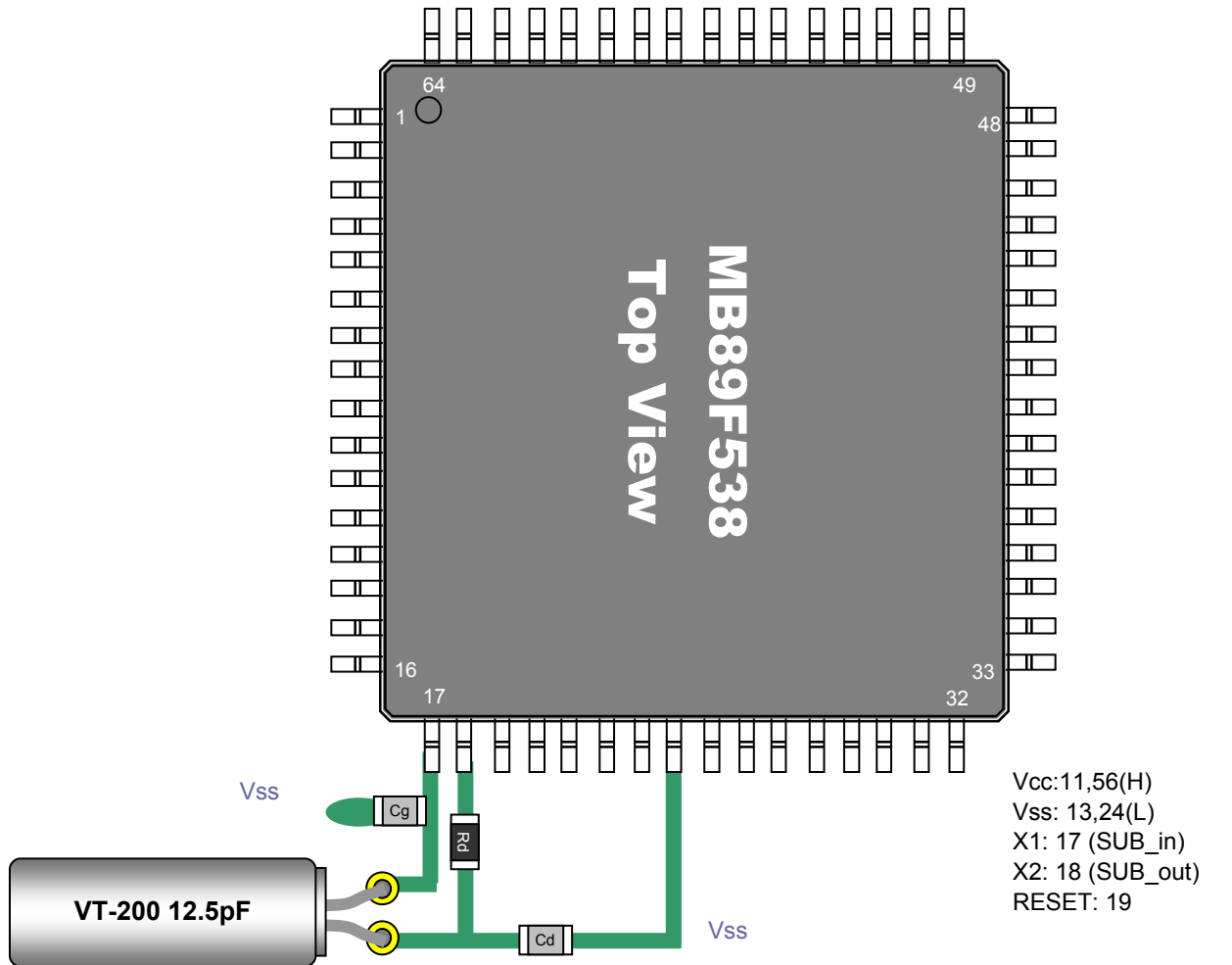


Figure 1 Referential components layout

## 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).

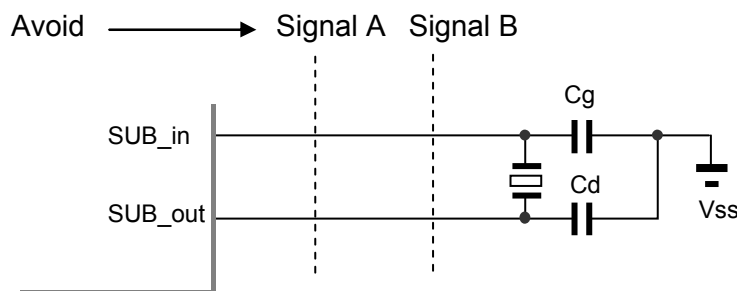


Figure 2 Example of Incorrect Board Design

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

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 Measurement conditions :5.0V , 3.3V(reference)

## [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	32768.30	32765.60	27.8	0.89	2.207	79.2
	2	12.5	32767.83	32765.10	29.0	0.90	2.233	75.0
	3	12.5	32768.38	32765.60	30.0	0.92	2.277	71.1

## [IC Test Data : IC sample Rd=470k ohm,Cg=22pF,Cd=22pF at 25°C]

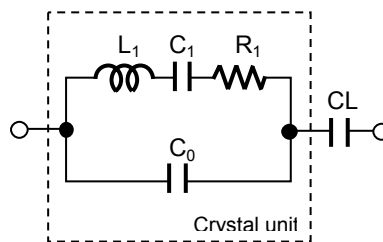
Vcc(V)	IC samples	Fosc( Hz )	df / f( x10 <sup>-6</sup> )	DL(x10 <sup>-6</sup> W)	-RL  ( kohm	Vstart( V )	Ts(sec)
5.0	TYP_#1	32768.390	0.31	0.59	505	2.35	0.87
	TYP_#2	32768.360	-0.61	0.59	465	2.35	0.96
	TYP_#3	---	---	---	---	---	---

## [IC Test Data : IC sample Rd=470k ohm,Cg=(22pF),Cd=(18pF) at 25°C]

Vcc(V)	IC samples	Fosc( Hz )	df / f( x10 <sup>-6</sup> )	DL(x10 <sup>-6</sup> W)	-RL  ( kohm	Vstart( V )	Ts(sec)
(3.3)	TYP_#1	32768.440	1.83	0.33	255	2.28	1.90
	TYP_#2	32768.410	0.92	0.33	235	2.35	2.20
	TYP_#3	---	---	---	---	---	---

### 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

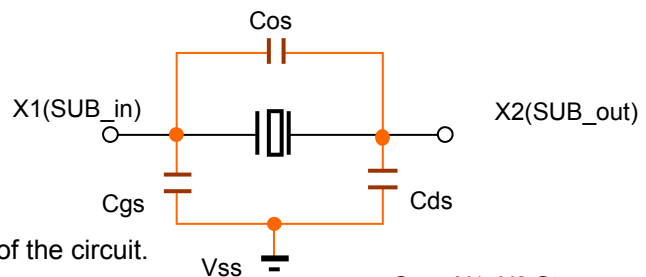
Figure 3 Equivalent circuit of crystal unit, and CL

### 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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Measurement conditions : Vdd=(2.7V) to 5.5V at 25°C

## Referential Data : Voltage characteristics

