

Evaluation of Subsystem Clock Oscillation Circuit

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

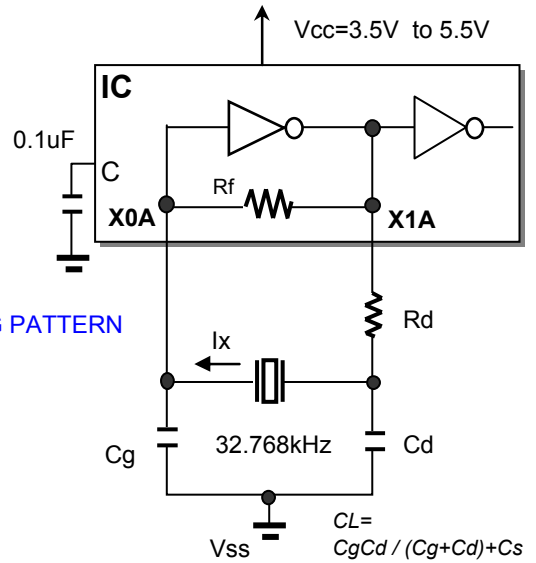
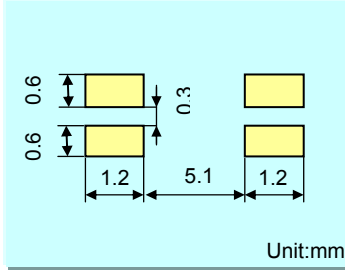


Model :SSP-T7
 Frequency :Fo=32.768kHz
 Frequency tolerance :dF/Fo= +/-20x10⁶
 Load capacitance :CL=12.5pF
 Equivalent series resistance :R1=65kohm max
 Max. drive level :DL=1x10⁶W max
 Level of drive :DL=0.1x10⁶W typ

FEATURES

- 1.Ultra thin type with 1.4mm Max.
- 2.SMD type suitable for automatic & high density surface mounting.
- 3.Plastic mold package containing highly reliable tubular type quartz crystal.
- 4.Excellent shock and heat resistance.
- 5.Cellular phones,PDA,Radio communication equipment, Portable applications etc.

RECOMMENDED SOLDERING PATTERN



Remark) i_x : current through crystal

MODEL:SSP-T7 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 : $df / f (\times 10^{-6})$	0.0	-0.6	Frequency offset volume at specified Vdd
Voltage Fluctuation : $+/-df / V (\times 10^{-6})$	1.2	1.2	Vdd +/-10% (Standard operating voltage range)
Drive Level : DL ($\times 10^{-6}W$)	0.40	0.72	$DL=i_x^2 Re < 1 \times 10^{-6}W, Re=R1(1 + Co / CL)^2$
Negative resistance : $ - RL (kohm)$	255	505	5 times larger than R_{1MAX}
Oscillation allowance : M (times)	3.9	7.8	Judgemental standard of oscillation stability
Voltage of oscillation start : Vstrat (V)	2.35	2.38	
Voltage of oscillation stop : Vstop (V)	2.11	2.11	
Oscillation start up time : Ts (sec)	2.54	1.14	Time to reach 90% of output level

Temperature characteristics of circuit		Vcc=(3.3V)	Vcc=5.0V	Remarks
at -40°C	Variation : $df / T (\times 10^{-6})$	-128	-128	Typ.Tp=25°C (K = $-3.5 \times 10^{-8} / ^\circ C^2$)
at +85°C	Variation : $df / T (\times 10^{-6})$	-132	-132	Typ.Tp=25°C (K = $-3.5 \times 10^{-8} / ^\circ C^2$)

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.

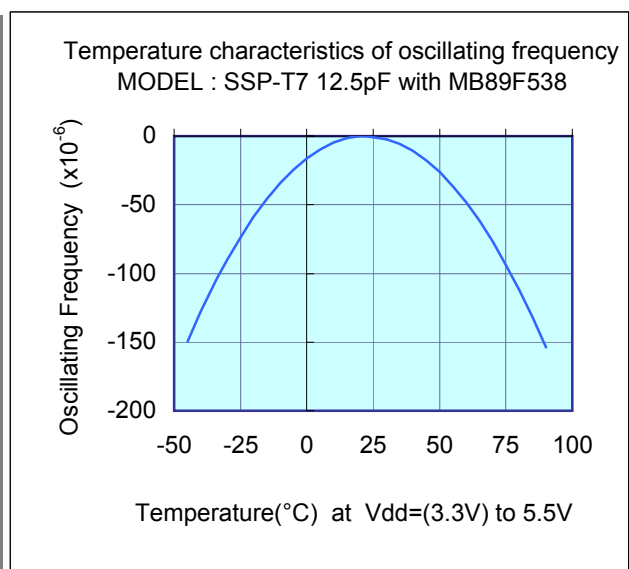
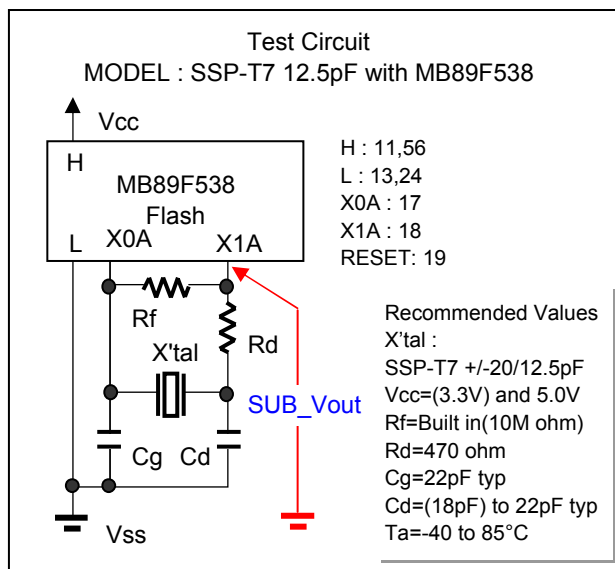
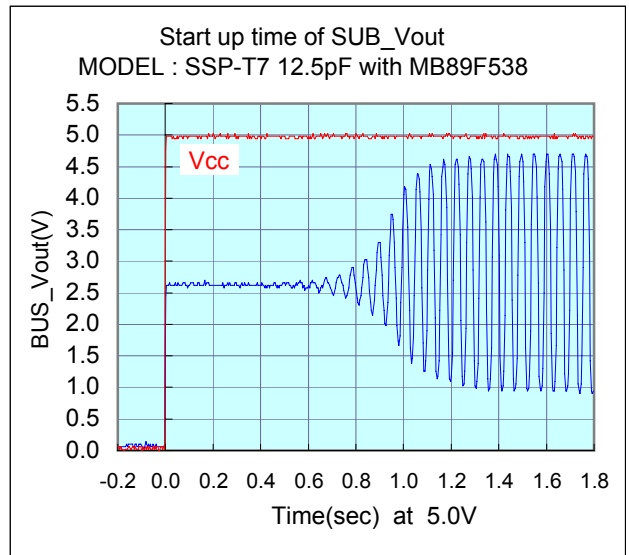
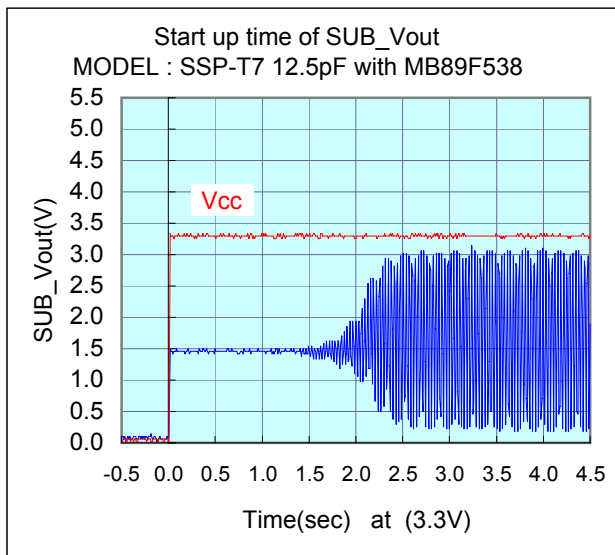
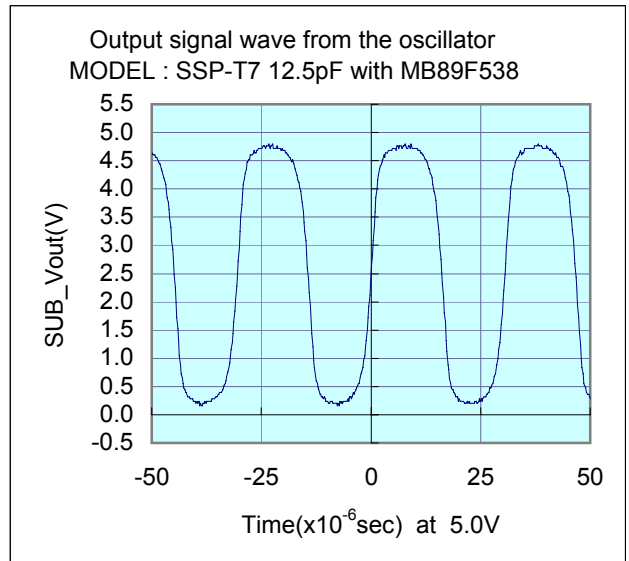
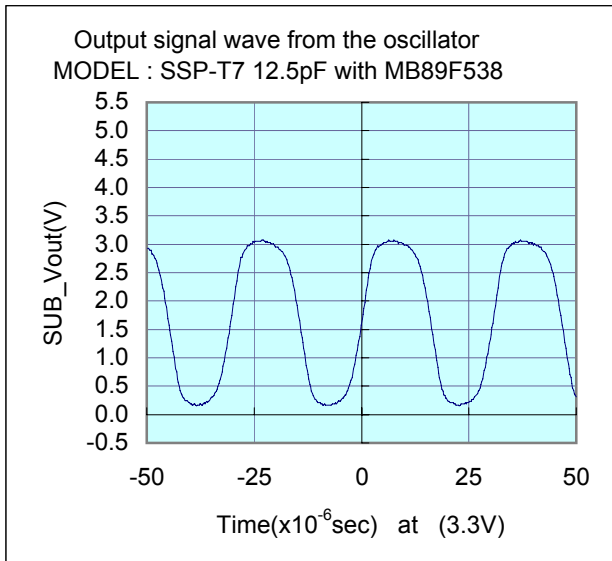
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Test Data at 25°C

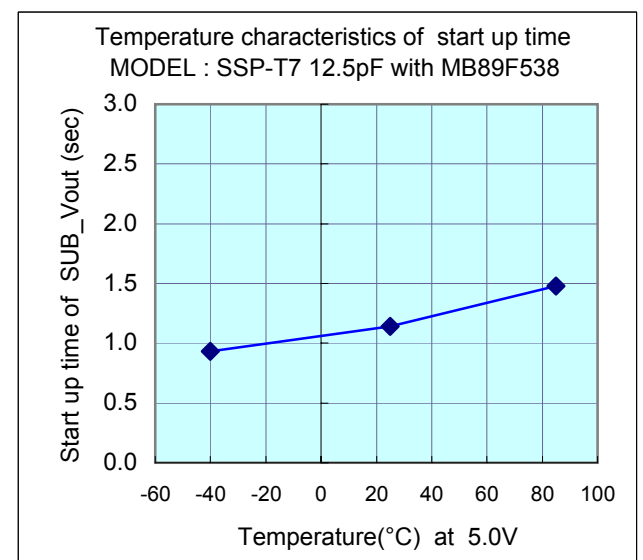
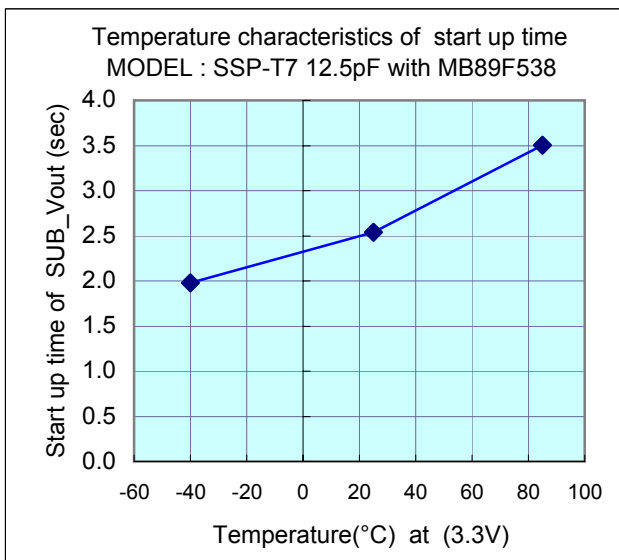
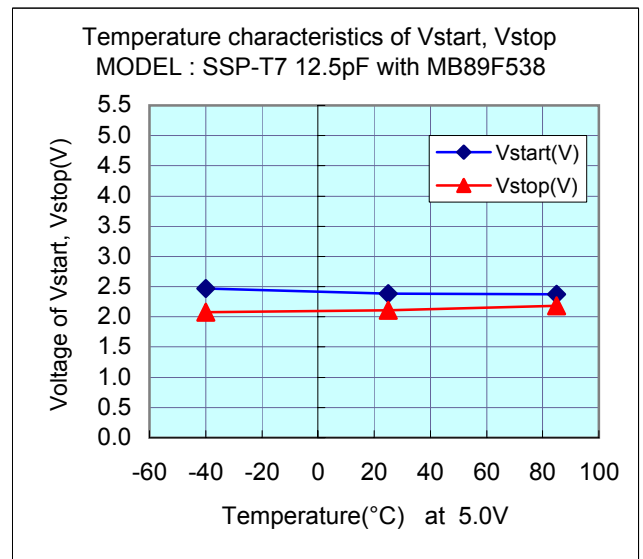
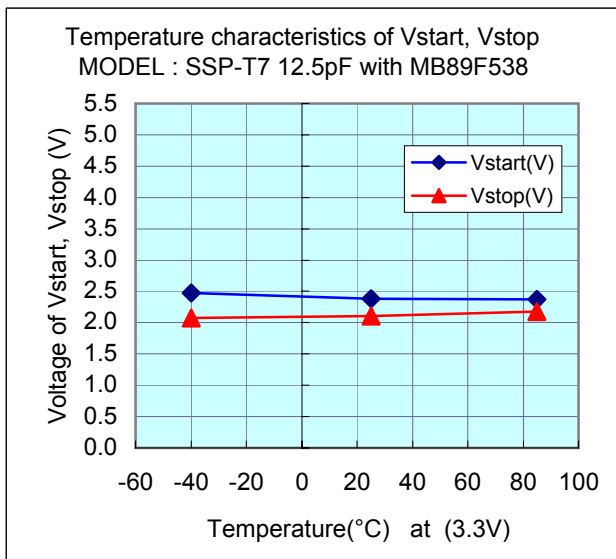
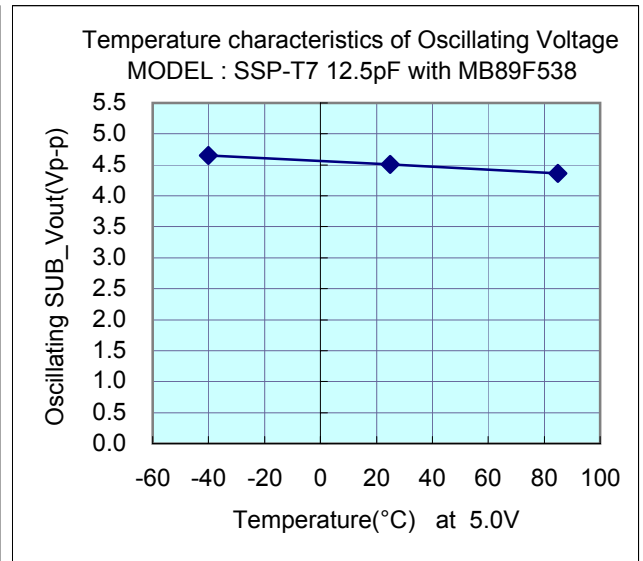
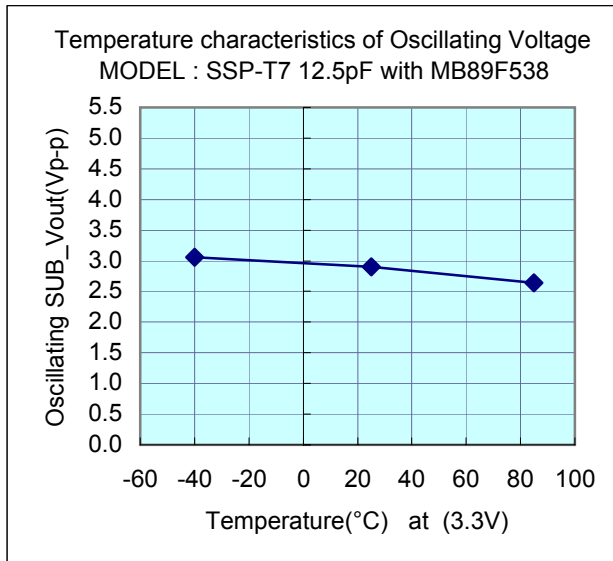


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Test Data : Temperature characteristics



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Referential components layout(see Figure 1)

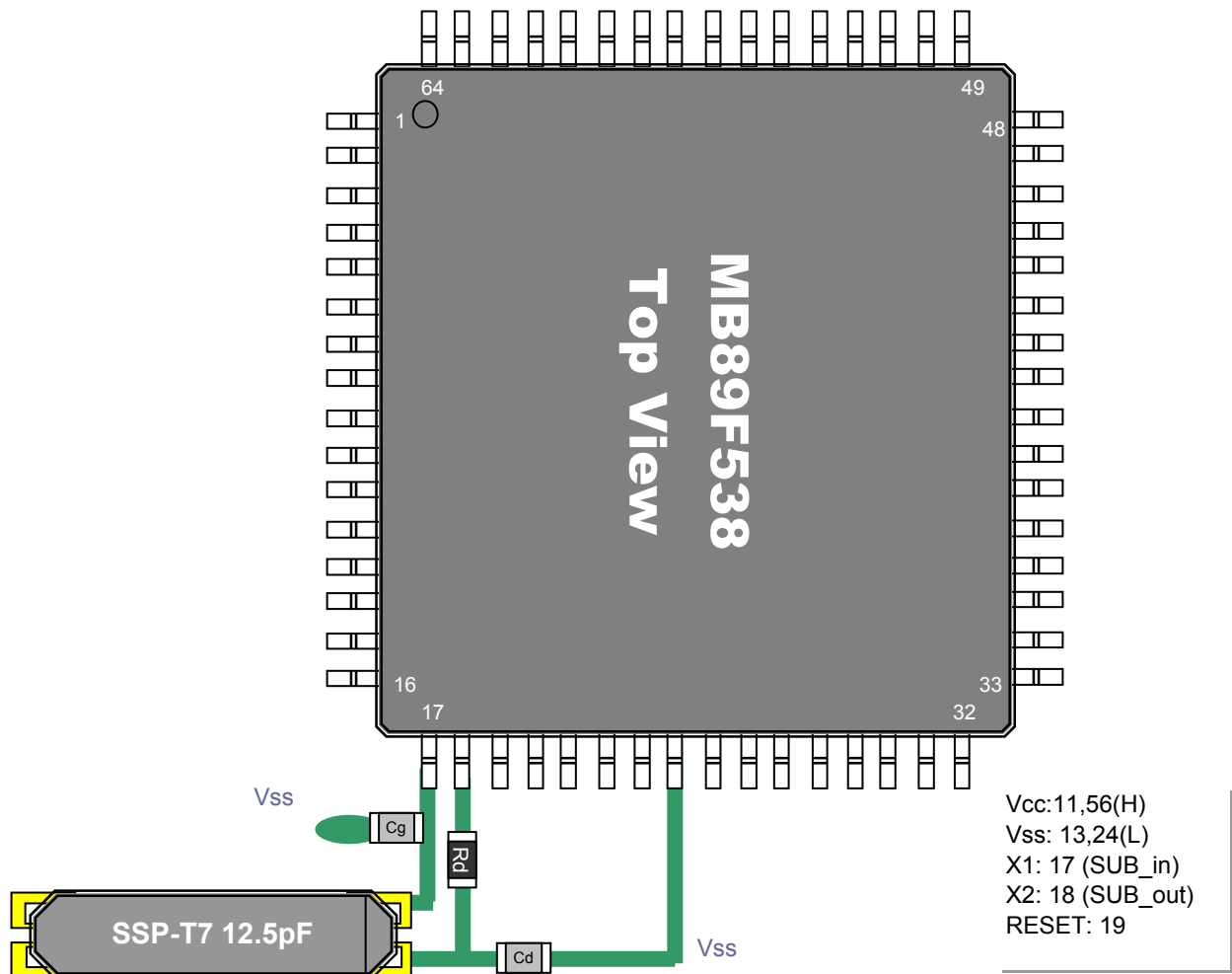


Figure 1 Referential components layout

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).

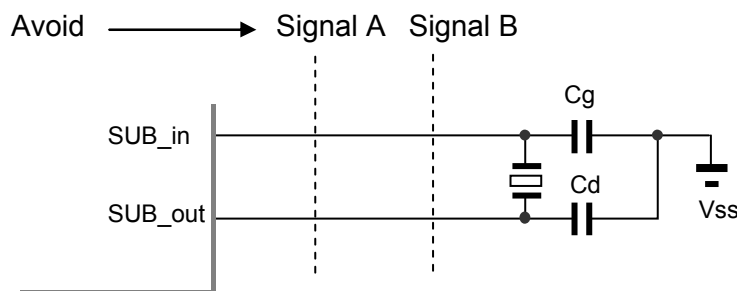


Figure 2 Example of Incorrect Board Design

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

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 Measurement conditions :5.0V , 3.3V(reference)

[Evaluation Sample : SSP-T7 12.5pF at 25°C]

SAMPLE	No.	CL(pF)	Fo(Hz)	fr(Hz)	R1(kohm)	Co(pF)	C1(fF)	Q(k)
SSP-T7 12.5pF	1	12.5	32768.00	32765.57	39.8	0.82	1.976	61.8
	2	12.5	32768.06	32765.60	45.1	0.84	2.003	53.8
	3	12.5	32768.16	32765.70	39.8	0.85	2.004	60.9

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

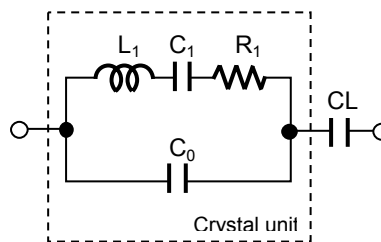
Vcc(V)	IC samples	Fosc(Hz)	df / f(x10 ⁻⁶)	DL(x10 ⁻⁶ W)	-RL (kohm	Vstart(V)	Ts(sec)
5.0	TYP_#1	32767.980	-0.61	0.72	505	2.38	1.14
	TYP_#2	32767.940	-1.83	0.72	465	2.38	1.22
	TYP_#3	---	---	---	---	---	---

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

Vcc(V)	IC samples	Fosc(Hz)	df / f(x10 ⁻⁶)	DL(x10 ⁻⁶ W)	-RL (kohm	Vstart(V)	Ts(sec)
(3.3)	TYP_#1	32768.000	0.00	0.40	255	2.35	2.54
	TYP_#2	32767.980	-0.61	0.39	235	2.38	2.60
	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

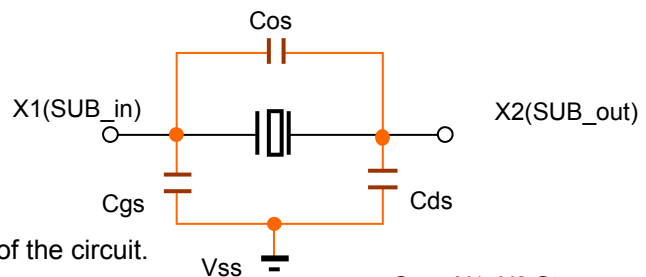
Figure 3 Equivalent circuit of crystal unit, and CL

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.