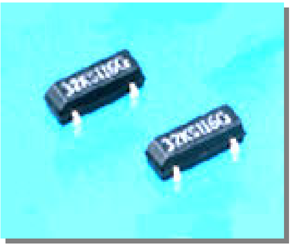
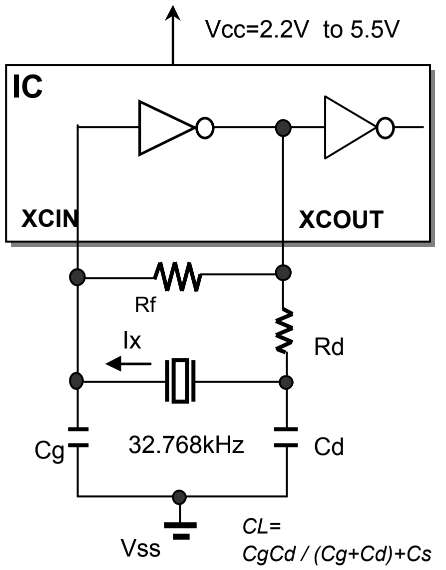
Evaluation of Subsystem Clock Oscillation Circuit

[R5F212D8SNFP-80P] LQFP(12x12) 0.5mm pitch

Measurement conditions :3.3V



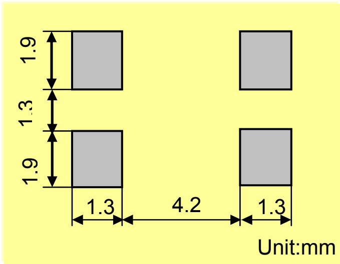
Model	:SP-T2A
Frequency	:Fo=32.768kHz
Frequency tolerance	:dF/Fo= +/-20x10^{6}
Load capacitance	:CL=6.0pF
Equivalent series resistance	:R1=50k ohm max
Max. Drive level	:DL=1x10^{-6}W max
Recommended drive level	:DL=0.1x10^{-6}W typ



FEATURES

1. Plastic mold package incorporated tubular type quartz crystal.
2. Suitable for automatic and high density surface mounting.
3. Excellent shock and heat resistance
4. Real time clocks, Timers, Portable applications,Clock source for Micro-Computers

RECOMMENDED SOLDERING PATTERN



Remark) Ix : current through crystal

MODEL:SP-T2A 6.0pF with R5F212D8SNFP at 25°C

Key specifications	Low	High	Remarks
Negative feedback resistance : Rf (M ohm)	Built_in	Built_in	
Current control resistance : Rd (k ohm)	0	0	Control drive level & secure phase margin
Capacitance at gate : Cg (pF)	1	6	Optimal capacity in response to CL
Capacitance at drain : Cd (pF)	0	6	(CL = Cd // Cg + stray capacitance)

Circuit characteristics (at 25°C)	Low	High	Remarks
Matching Accuracy : df / f (x10^{-6})	0.9	-0.9	Frequency offset volume at specified Vdd
Voltage Fluctuation : +/-df / V (x10^{-6})	0.6	2.4	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)	597	717	5 times larger than R_{1MAX}
Oscillation allowance : M (times)	11.9	14.3	Judgemental standard of oscillation stability
Voltage of oscillation start : Vstart (V)	1.77	1.77	
Voltage of oscillation stop : Vstop (V)	1.74	1.74	
Oscillation start up time : Ts (sec)	0.52	0.71	Time to reach 90% of output level

Temperature characteristics of circuit		Low	High	Remarks
at -40°C	Variation : df / T (x10^{-6})	-142	-143	Typ.Tp=25°C (K = -3.5×10^{-8} / °C^2)
at +85°C	Variation : df / T (x10^{-6})	-123	-123	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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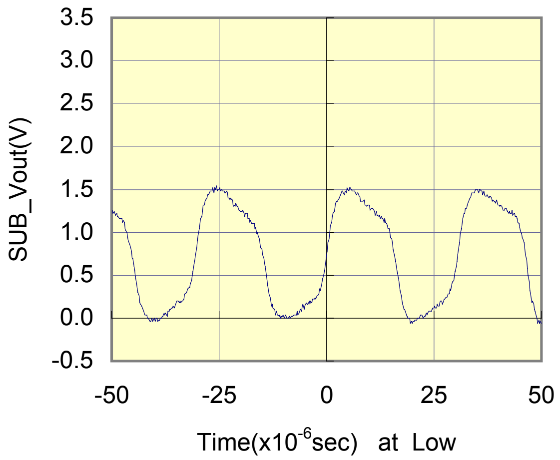
Evaluation of Subsystem Clock Oscillation Circuit

[R5F212D8SNFP-80P] LQFP(12x12) 0.5mm pitch

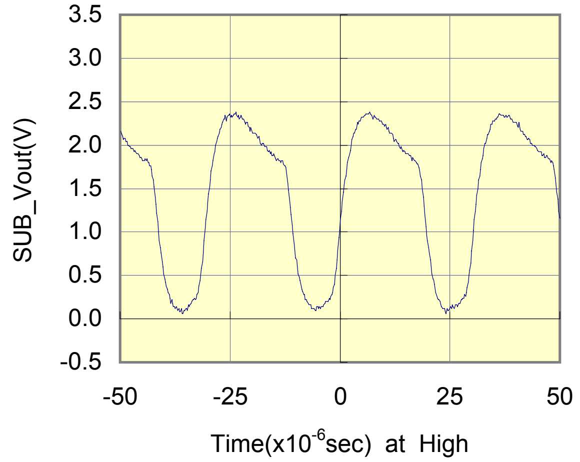
Measurement conditions :3.3V

Test Data at 25°C

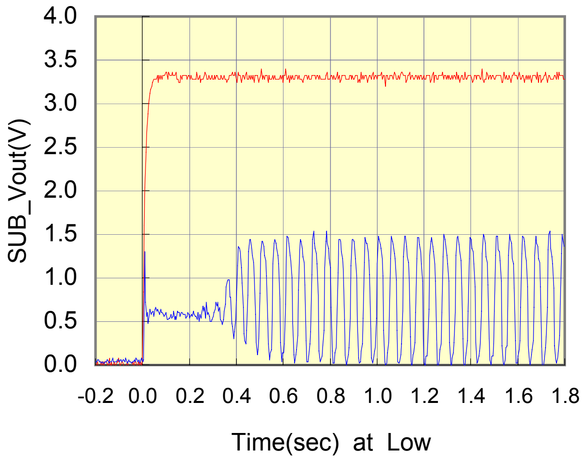
Output signal wave from the oscillator
MODEL : SP-T2A 6.0pF with R5F212D8SNFP



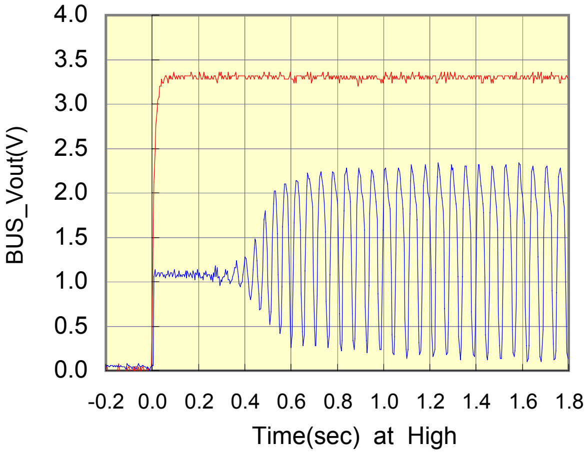
Output signal wave from the oscillator
MODEL : SP-T2A 6.0pF with R5F212D8SNFP



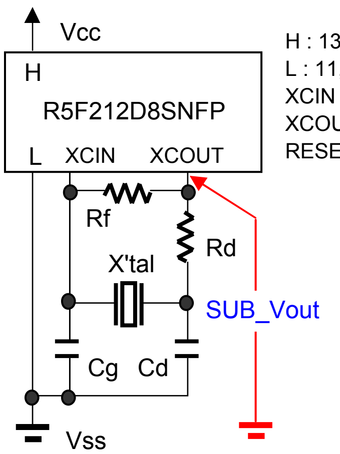
Start up time of SUB_Vout
MODEL : SP-T2A 6.0pF with R5F212D8SNFP



Start up time of SUB_Vout
MODEL : SP-T2A 6.0pF with R5F212D8SNFP

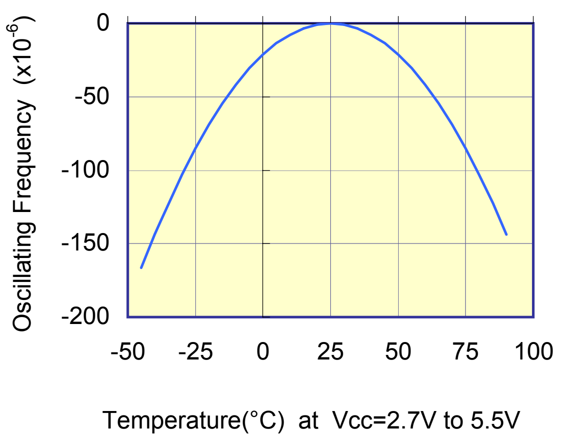


Test Circuit
MODEL : SP-T2A 6.0pF with R5F212D8SNFP



Recommended Values
X'tal :
SP-T2A +/-20/6.0pF
Vcc=2.7V to 5.5V
Rf=open
Rd=0 ohm
Cg= 1 to 6pF typ
Cd= 0 to 6pF typ
Ta=-40 to 85°C

Temperature characteristics of oscillating frequency
MODEL : SP-T2A 6.0pF with R5F212SNFP



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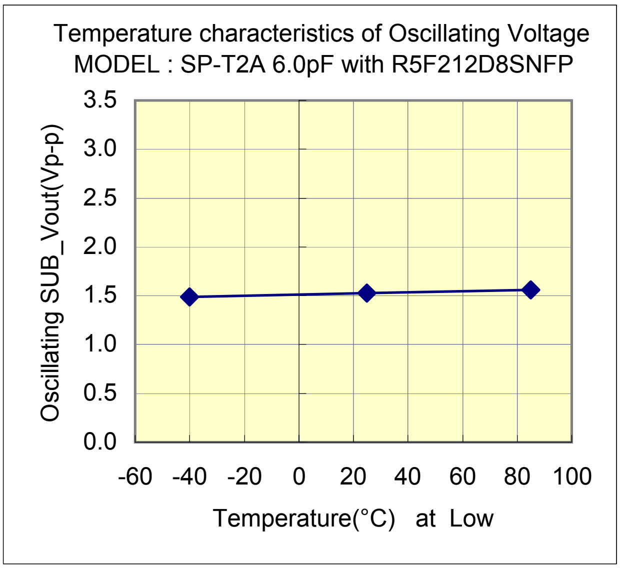
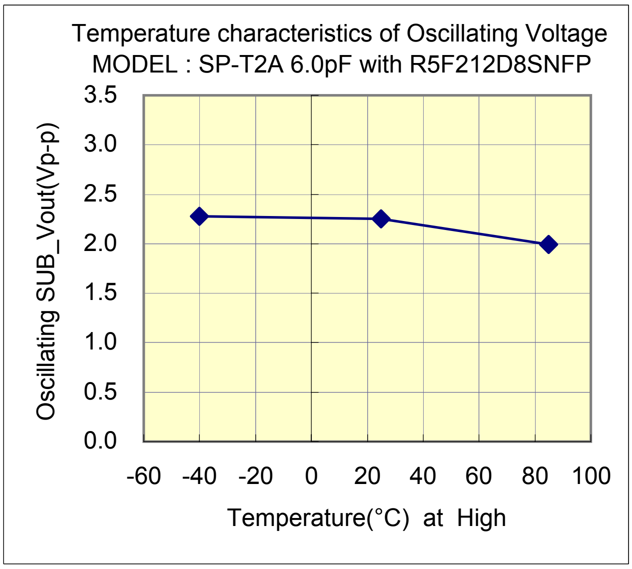
Evaluation of Subsystem Clock Oscillation Circuit

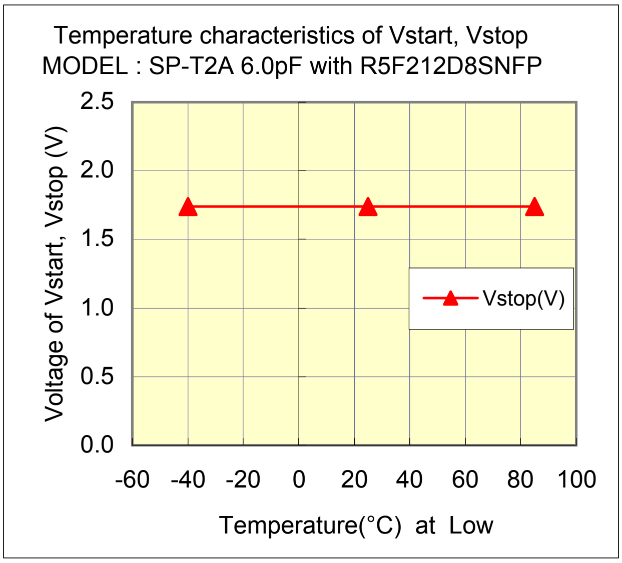
[R5F212D8SNFP-80P] LQFP(12x12) 0.5mm pitch

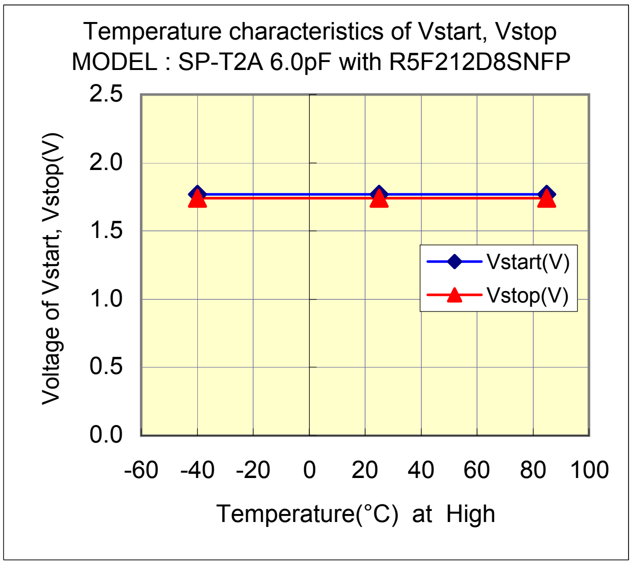
Measurement conditions :3.3V

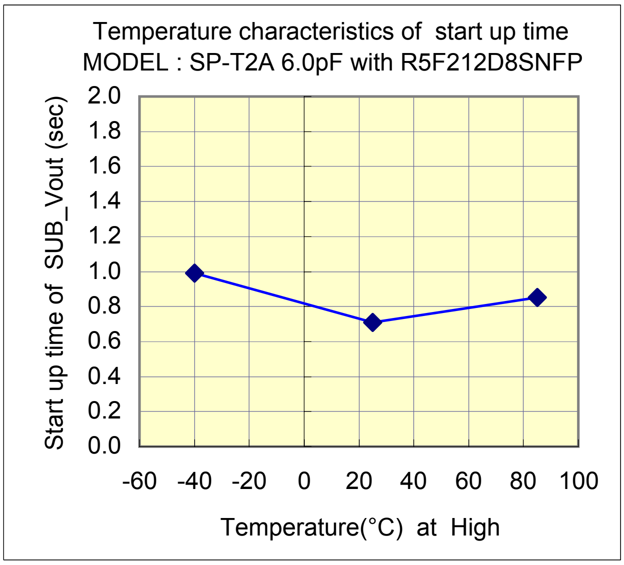
Test Data : Temperature characteristics











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Evaluation of Subsystem Clock Oscillation Circuit

[R5F212D8SNFP-80P] LQFP(12x12) 0.5mm pitch

Measurement conditions :3.3V

Referential components layout(see Figure 1)

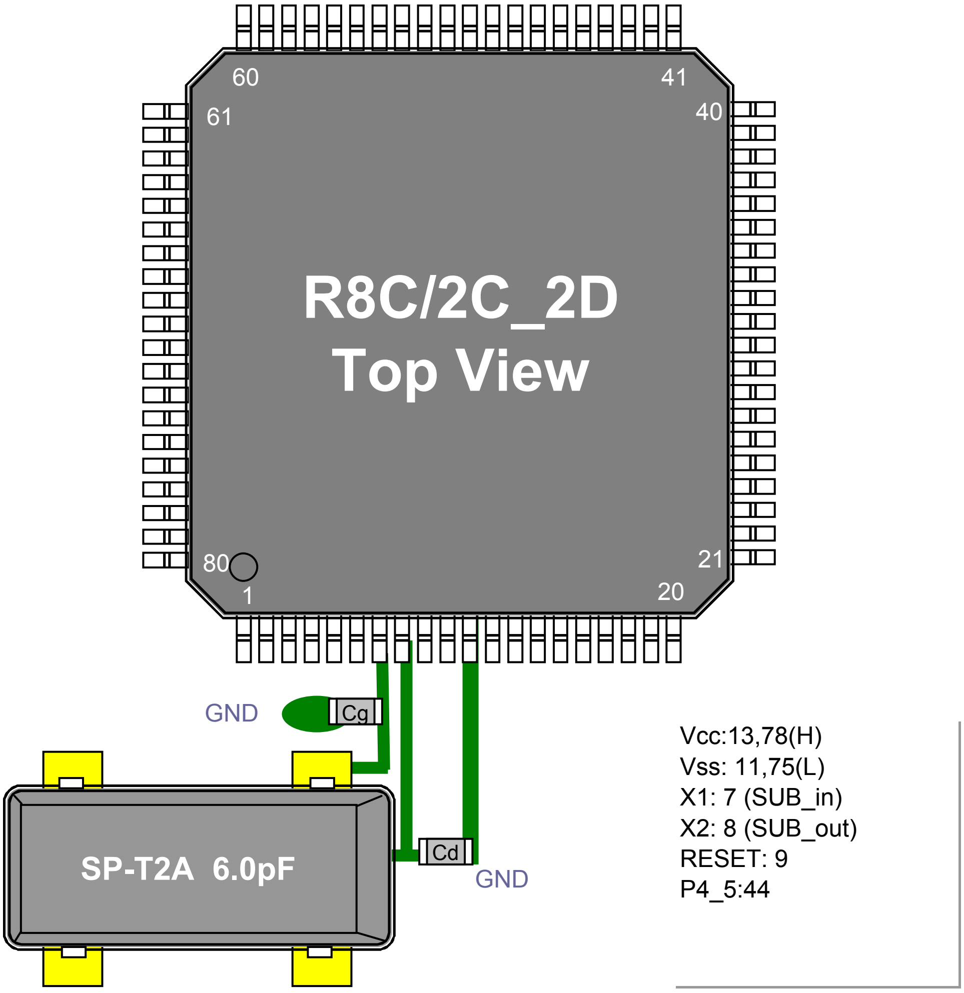


Figure 1 Referential components layout

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).

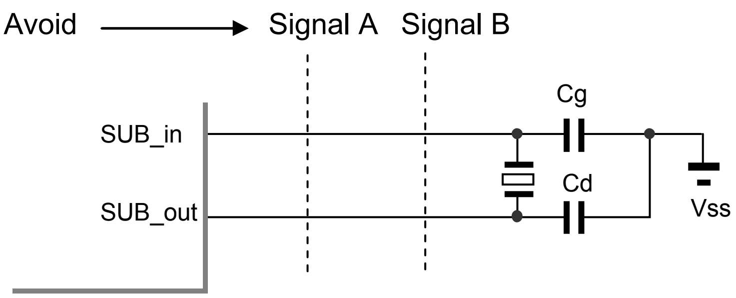


Figure 2 Example of Incorrect Board Design

Evaluation of Subsystem Clock Oscillation Circuit

[R5F212D8SNFP-80P] LQFP(12x12) 0.5mm pitch

Measurement conditions :3.3V

[Evaluation Sample : SP-T2A 6.0pF at 25°C]

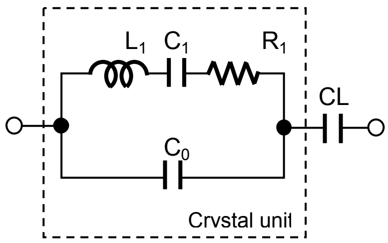
SAMPLE	No.	CL(pF)	Fo(Hz)	fr(Hz)	R1(kohm)	Co(pF)	C1(fF)	Q(k)
SP-T2A 6.0pF	1	6	32768.09	32762.69	27.3	1.02	2.314	76.9
	2	6	32767.76	32762.20	30.4	1.00	2.377	67.3
	3	6	32768.27	32762.68	31.5	1.02	2.394	64.4

[IC Test Data : IC samples Rd=0 ohm,Cg=1 to 6pF,Cd=0 to 6pF at 25°C]

MODE	IC samples	Fosc(Hz)	df / f($x10^{-6}$)	DL($x10^{-6}$W)	| -RL |(kohm)	Vstart(V)	Ts(sec)
High	TYP	32768.060	-0.92	0.01	717	1.77	0.71
	HH	32768.330	7.32	0.01	717	1.77	0.99
	HL	32768.300	6.41	0.01	597	1.70	0.99
	LH	32767.307	-23.90	0.01	857	1.70	0.79
	LL	32768.093	0.09	0.01	787	1.72	0.80
Low	TYP	32768.120	0.92	0.01	597	1.77	0.52
	HH	32768.178	2.69	0.01	597	1.77	0.57
	HL	32768.350	7.93	0.01	947	1.70	0.56
	LH	32768.115	0.76	0.01	507	1.70	0.57
	LL	32768.191	3.08	0.01	857	1.72	0.56

Remark (see figure 3)

$$Fo = fr \times \{ C1 / (2 \times (Co + CL)) + 1 \} \quad (Hz)$$



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

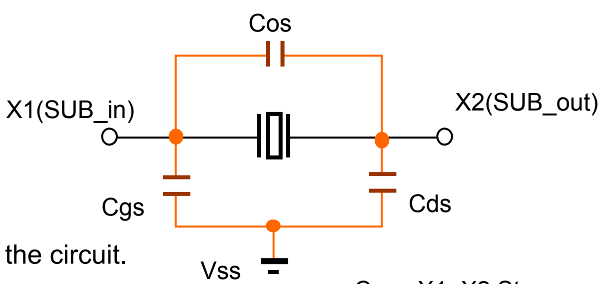
Figure 3 Equivalent circuit of crystal unit, and CL

Remark (see figure 4)

Approximate formula of the load capacitance of the circuit CL.

$$CL = Cg \times Cd / (Cg + Cd) + Cs \quad (pF)$$

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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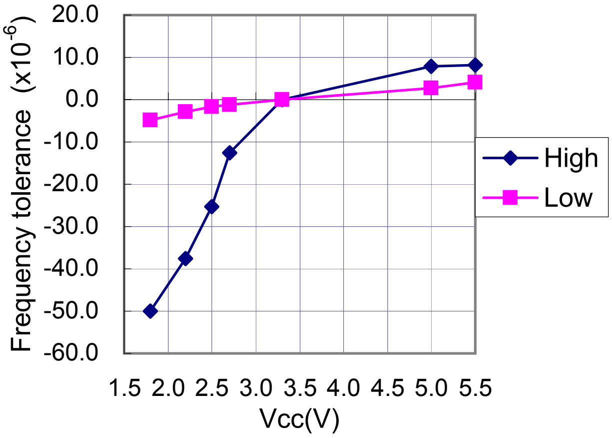
Evaluation of Subsystem Clock Oscillation Circuit

[R5F212D8SNFP-80P] LQFP(12x12) 0.5mm pitch

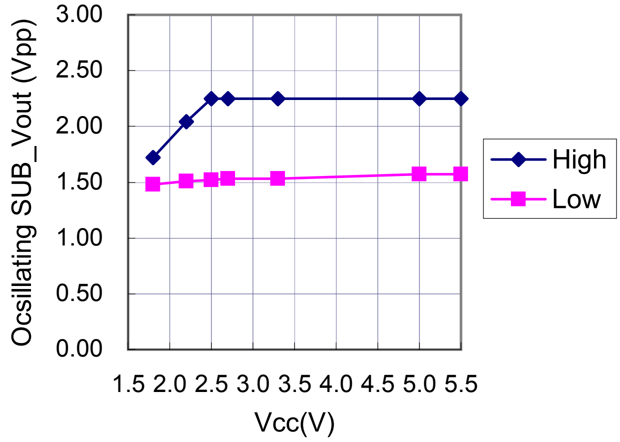
Measurement conditions : Vdd=1.8V to 5.5V at 25°C

Referential Data : Voltage characteristics

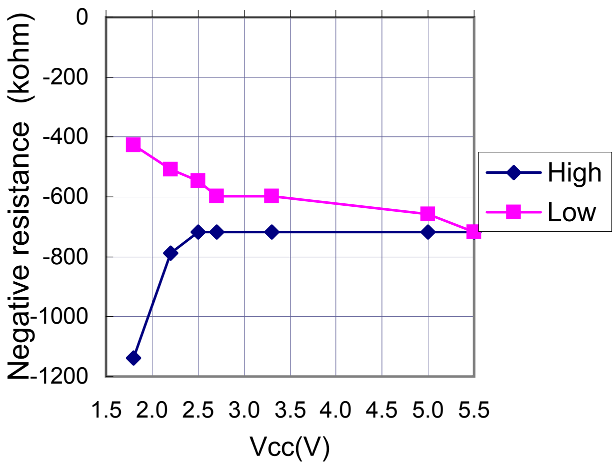
Frequency / voltage coefficient
MODEL : SP-T2A 6.0pF with R8F212D8SNFP



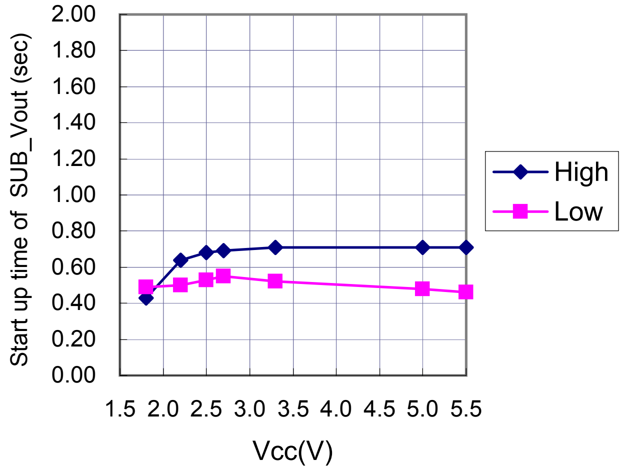
SUB_Vout / voltage coefficient
MODEL : SP-T2A 6.0pF with R5F212D8SNFP



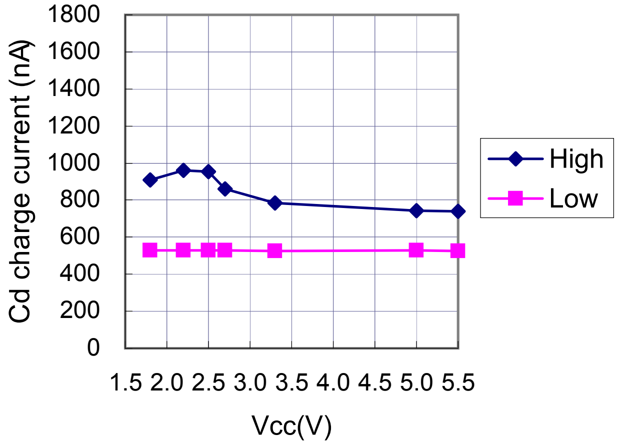
Negative resistance / voltage coefficient
MODEL : SP-T2A 6.0pF with R8F212D8SNFP



Start up time / voltage coefficient
MODEL : SP-T2A 6.0F with R5F212D8SNFP



Cd charge current / voltage coefficient
MODEL : SP-T2A 6.0pF with R5F212D8SNFP



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