Evaluation of a Low Frequency Clock Oscillation Circuit

VT-200-FL 6.0pF with R5F2L3ACCNFP-100P [LQFP(14x14) 0.50mm pitch]

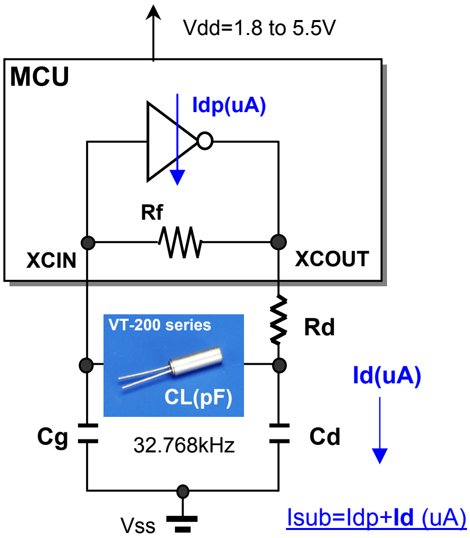
Measurement conditions : Vdd=3.3V,5.0V

Low power consumption MCU

Selection of XCIN oscillation mode and recommended load capacitance

For R8C/Lx series

XCIN oscillation circuit consists of an excellent power saving circuit which realizes stable oscillation at low amplitude.



RENESAS MPU R8C/Lx series

- **R8C/L35C group (52pin)**
- **R8C/L36C group (64pin)**
- **R8C/L38C group (80pin)**
- **R8C/L3AC group (100pin)**

For your design reliability, please refer to Table 1 which shows the performance of the XCIN oscillation circuit and the recommended load capacitance for each resonator.

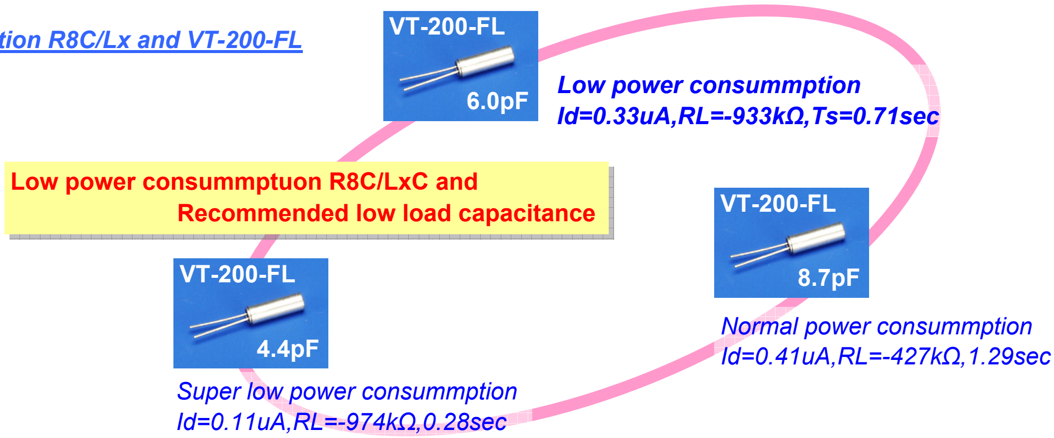
VT-200 series

VT-200-FL CL=4.4pF,6.0pF and VT-200-F CL=9.0pF

Table 1 XCIN oscillation circuit and load capacitance for a resonator

Resonator	Vcc	Recommended circuit constant and load capacitance for a resonator			
		Rd=680kΩ Cg=3pF,Cd=2pF	**Rd=0Ω Cg=6pF,Cd=5pF**	Rd=0Ω Cg=7pF,Cd=7pF	Rd=0Ω Cg=10pF,Cd=10pF
VT-200-FL Low CL resonator	5.0V	VT-200-FL 4.4pF Id=0.116uA typ RL=-974kΩ typ Ts=0.25sec typ	**VT-200-FL 6.0pF Id=0.340uA typ RL=-933kΩ typ Ts=0.66sec typ**	-	-
	3.3V	VT-200-FL 4.4pF Id=0.109uA typ RL=-974kΩ typ Ts=0.28sec typ	**VT-200-FL 6.0pF Id=0.326A typ RL=-933kΩ typ Ts=0.71sec typ**	-	-
VT-200-F Existing product	5.0V	-	-	-	VT-200-F 9.0pF Id=0.430uA typ RL=-427kΩ typ Ts=1.19sec typ
	3.3V	-	-	-	VT-200-F 9.0pF Id=0.412A typ RL=-427kΩ typ Ts=1.29sec typ

Low power consumption R8C/Lx and VT-200-FL



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R8C/LxC

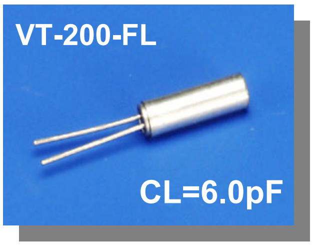
Evaluation of a Low Frequency Clock Oscillation Circuit

VT-200-FL 6.0pF with R5F2L3ACCNFP-100P [LQFP(14x14) 0.50mm pitch]

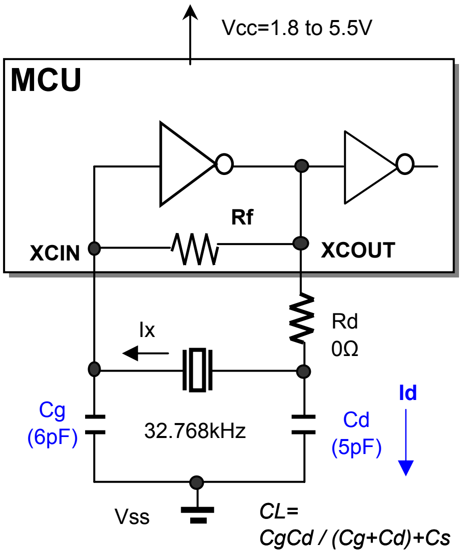
Measurement conditions : Vdd=3.3V,5.0V

An external resistor,Rf Built-in,Rd 0Ω

New



Model	:VT-200-FL
Frequency	:Fo=32.768kHz
Frequency tolerance	:dF/Fo= +/-20x10^{-6}
Load capacitance	:CL=6.0pF
Equivalent series resistance	:R1=50kΩ max
Max. drive level	:DL=1μW max
Level of drive	:DL=0.01μW typ

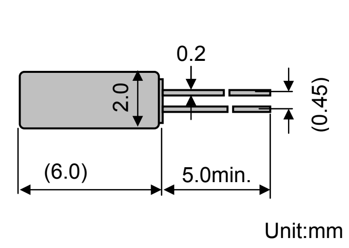


Remark) Ix : current through crystal

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)



Low power consumption R8C/LxC and VT-200-FL 6.0pF

XCIN oscillation circuit consists of an excellent power saving circuit which realizes stable oscillation at low amplitude.

MODEL:VT-200-FL 6.0pF with R5F2L3ACCNFP at 25°C

Key specifications	Vcc=3.3V	Vcc=5.0V	Remarks
Current control resistance : Rd (k ohm)	0	0	Control drive level & secure phase margin
Capacitance at gate : Cg (pF)	6	6	Optimal capacitance in response to CL
Capacitance at drain : Cd (pF)	5	5	(CL = Cd // Cg + stray capacitance)

Circuit characteristics (at 25°C)	Vcc=3.3V	Vcc=5.0V	Remarks
Matching Accuracy : df / f (x10^{-6})	-0.3	0.7	Frequency offset volume at specified Vcc
Voltage Fluctuation : +/-df / V (x10^{-6})	0.2	0.3	Vcc +/-10% (Standard operating voltage range)
Drive Level : DL (μW)	0.06	0.07	DL=Ix^2 Re < 1x10^{-6}W,Re=R1(1 + Co / CL $)^2$
Negative resistance : | - RL | (kΩ)	961	961	5 times larger than R_{1MAX}
Oscillation allowance : M (times)	19	19	Judgmental standard of oscillation stability
Low current consumption : Id (uA)	0.300	0.312	Cd charge current, Id = f*Cd*Vd
Voltage of oscillation start : Vstart (V)	1.44	1.44	
Voltage of oscillation stop : Vstop (V)	1.41	1.41	
Oscillation start up time : Ts (sec)	0.74	0.69	Time to reach 90% of output level, Ts < 1.0sec

Temperature characteristics of circuit		Vcc=3.3V	Vcc=5.0V	Remarks
at -40°C	Variation : df / T (x10^{-6})	-128	-128	Typ.Tp=25°C (K = -3.5×10^{-8} / °C^2)
at +85°C	Variation : df / T (x10^{-6})	-138	-138	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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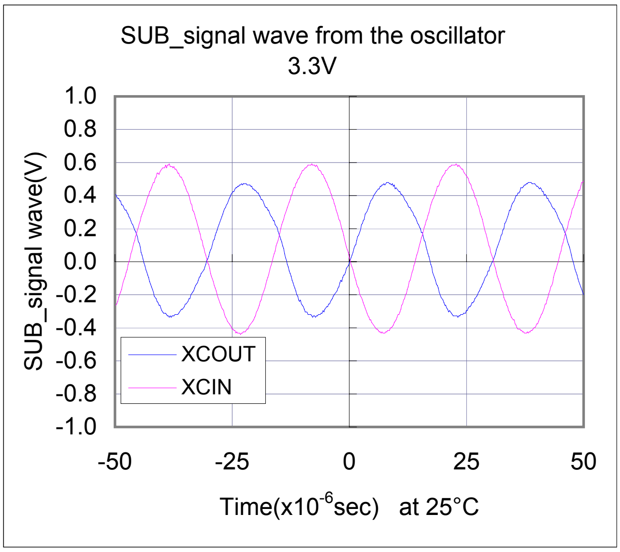
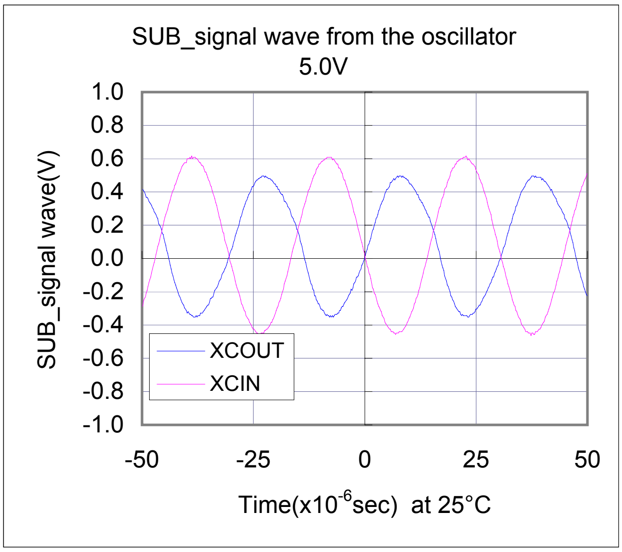
Evaluation of a Low Frequency Clock Oscillation Circuit

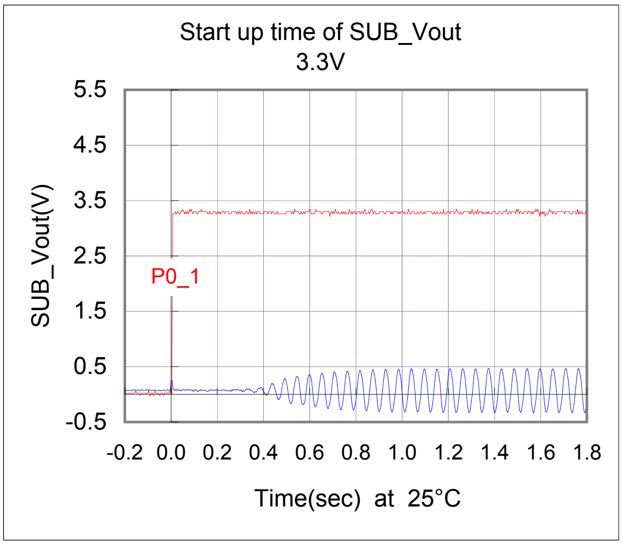
VT-200-FL 6.0pF with R5F2L3ACCNFP-100P [LQFP(14x14) 0.50mm pitch]

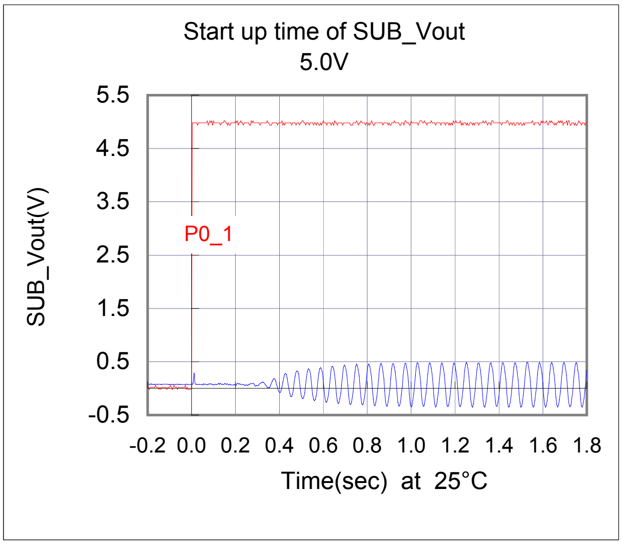
Measurement conditions : Vdd=3.3V,5.0V **An external resistor,Rf Built-in,Rd 0Ω**

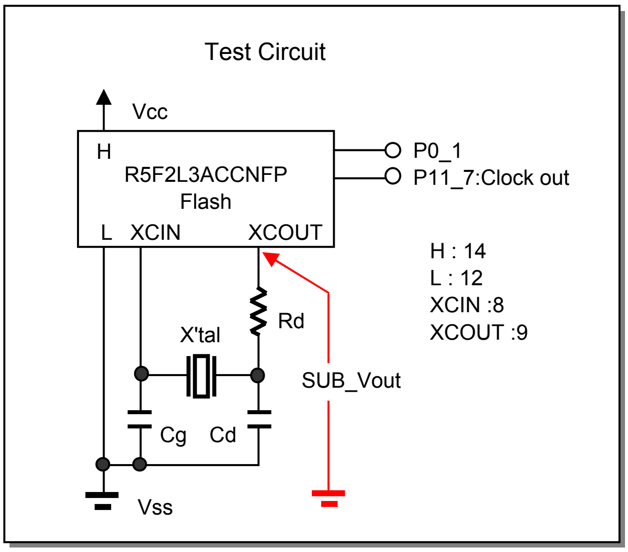
Test Data

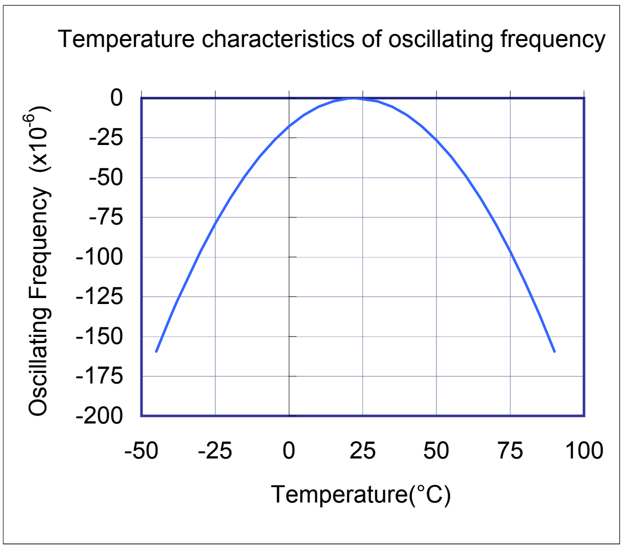












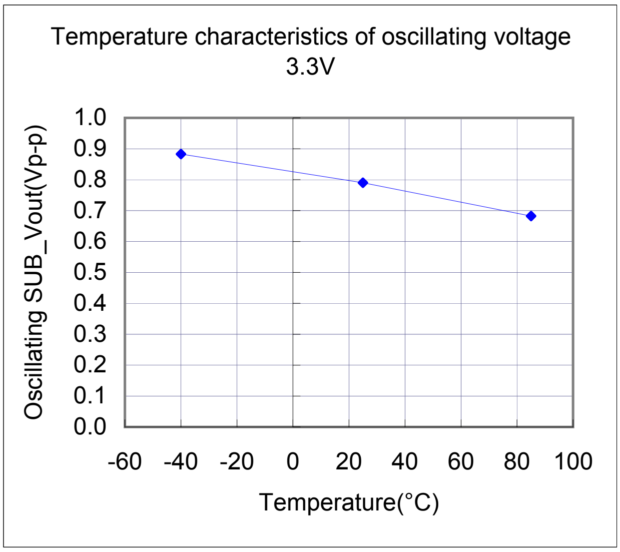
Evaluation of a Low Frequency Clock Oscillation Circuit

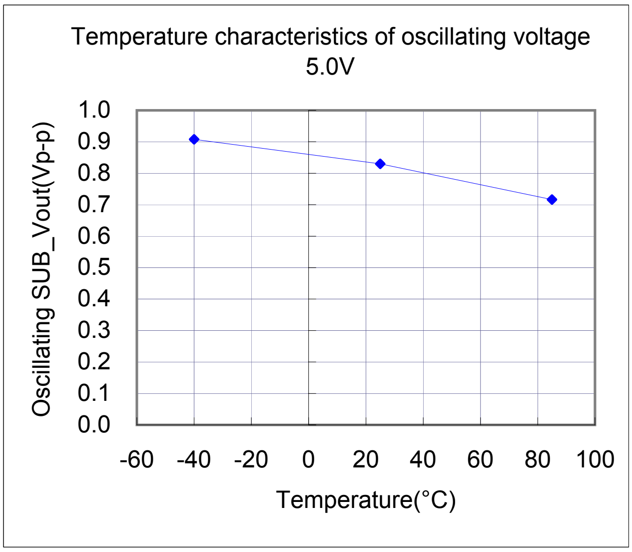
VT-200-FL 6.0pF with R5F2L3ACCNFP-100P [LQFP(14x14) 0.50mm pitch]

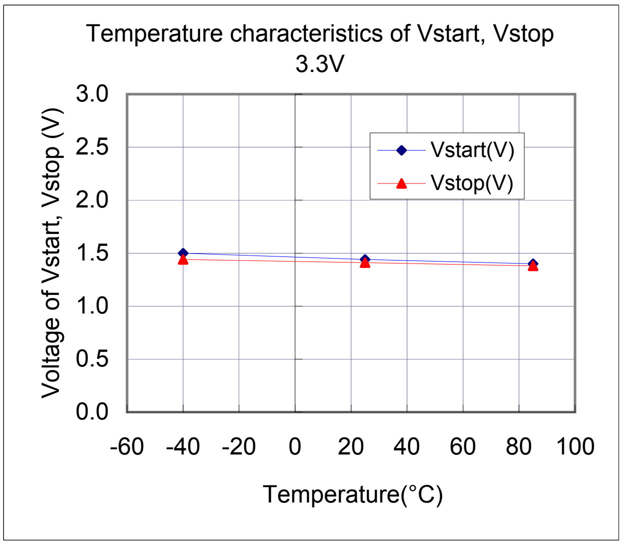
Measurement conditions : Vdd=3.3V,5.0V

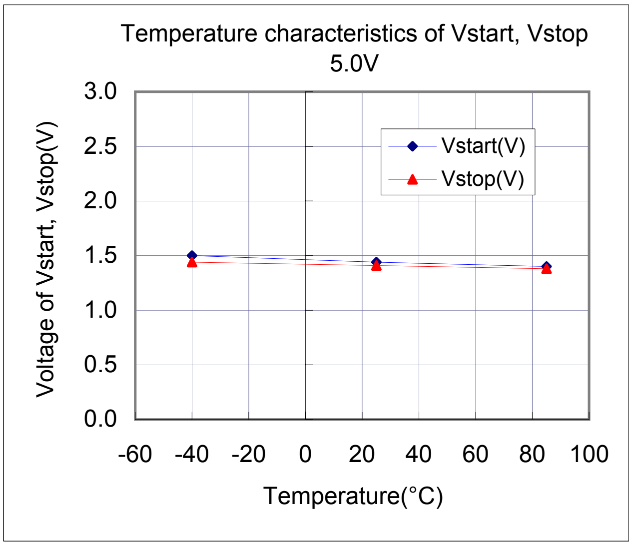
An external resistor,Rf Built-in,Rd 0Ω

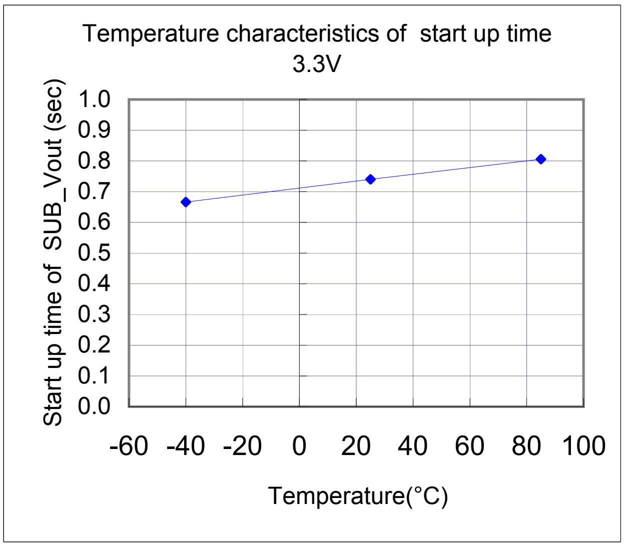
Test Data : Temperature characteristics(CC,HH,LL)

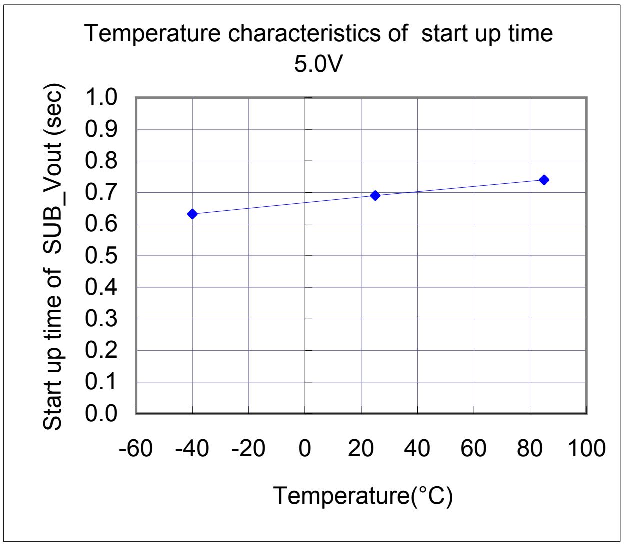










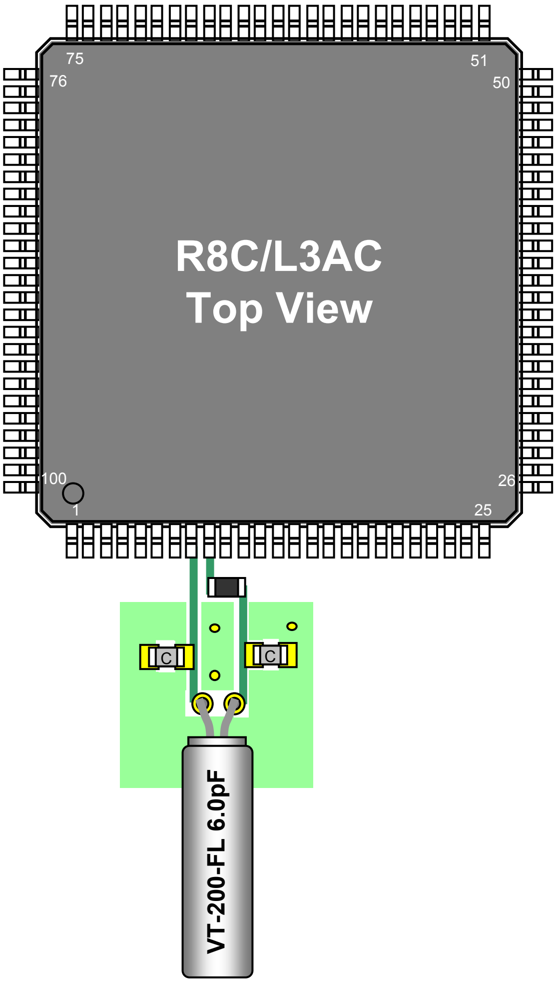


Evaluation of a Low Frequency Clock Oscillation Circuit

VT-200-FL 6.0pF with R5F2L3ACCNFP-100P [LQFP(14x14) 0.50mm pitch]

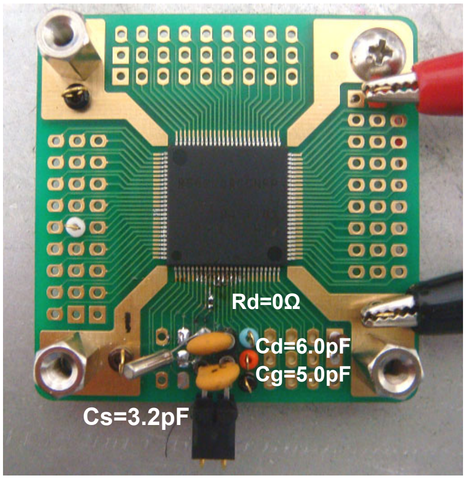
Measurement conditions : Vdd=3.3V,5.0V **An external resistor,Rf Built-in,Rd 0Ω**

Referential components layout(see Figure 1)



R8C/Lx series

R8C/L35C group
R8C/L36C group
R8C/L38C group
R8C/L3AC group



MODEL:VT-200-FL 6.0pF with R5F2L3ACCNFP at Vcc=1.8V,25°C

CL(pF)	Rd(kΩ)	Cg(pF)	Cd(pF)	Id(uA) typ
6.0	0	6	5	0.317

Figure 1 Referential 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).

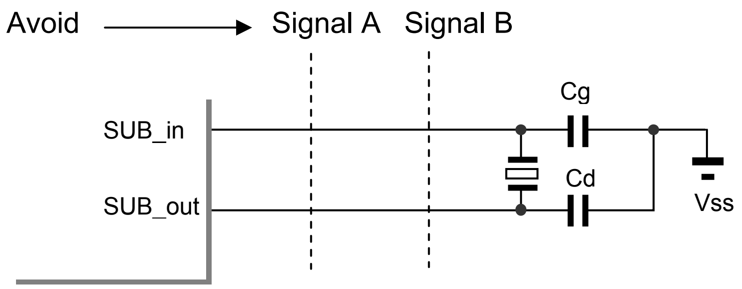


Figure 2 Example of Incorrect Board Design

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

Evaluation of a Low Frequency Clock Oscillation Circuit

VT-200-FL 6.0pF with R5F2L3ACCNFP-100P [LQFP(14x14) 0.50mm pitch]

Measurement conditions : Vdd=3.3V,5.0V

An external resistor,Rf Built-in,Rd 0Ω

[Evaluation Sample at 25°C]

SAMPLE	No.	CL(pF)	Fo(Hz)	fr(Hz)	R1(kΩ)	Co(pF)	C1(fF)	Q(k)
VT-200-FL	1	6	32768.04	32763.11	39.3	0.85	2.060	60.0
	2	6	32767.98	32763.01	40.6	0.86	2.082	57.5
	3	6	32768.27	32763.23	38.8	0.88	2.117	59.2

[IC Test Data : IC Sample Rd=0Ω,Cg=6pF,Cd=5pF at 25°C]

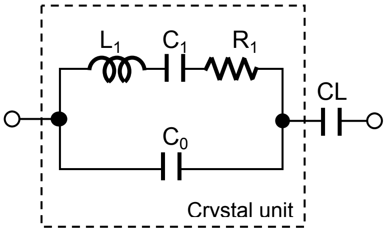
Vcc(V)	IC Sample	Fosc(Hz)	df / f($x10^{-6}$)	DL(μW)	| -RL |(kΩ)	Id (uA)	DC_Bias(V)	Vstart(V)	Ts(sec)
5.0	CC	32768.06	0.7	0.068	961	0.31	1.14	1.44	0.69
	HH	32768.03	-0.3	0.084	911	0.36	1.04	1.37	0.63
	HL	32768.03	-0.2	0.067	871	0.31	1.09	1.53	0.66
	LH	32768.02	-0.5	0.092	961	0.38	1.06	1.30	0.66
	LL	32768.02	-0.5	0.073	961	0.34	1.09	1.32	0.64
AVG.		32768.03	-0.16	0.077	933	0.340	1.083	1.39	0.66

[IC Test Data : IC Sample Rd=0Ω,Cg=6pF,Cd=5pF at 25°C]

Vcc(V)	IC Sample	Fosc(Hz)	df / f($x10^{-6}$)	DL(μW)	| -RL |(kΩ)	Id (uA)	DC_Bias(V)	Vstart(V)	Ts(sec)
3.3	CC	32768.03	-0.3	0.065	961	0.30	1.13	1.44	0.74
	HH	32768.00	-1.4	0.079	911	0.34	1.04	1.37	0.69
	HL	32768.00	-1.2	0.062	871	0.30	1.10	1.53	0.73
	LH	32767.99	-1.6	0.087	961	0.36	1.07	1.30	0.72
	LL	32767.98	-1.7	0.068	961	0.32	1.09	1.32	0.68
AVG.		32768.00	-1.25	0.072	933	0.326	1.086	1.39	0.71

Remark (see figure 3)

Fo = fr ×{ C1/ (2×(Co + CL)) + 1 } (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

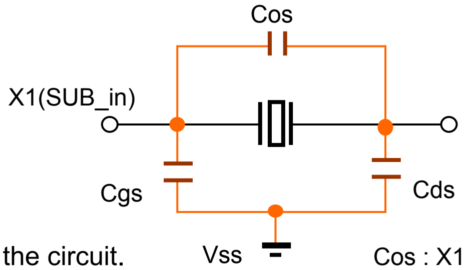
Remark (see figure 4)

Approximate formula of the load capacitance of the circuit CL,

CL = Cg×Cd / (Cg + Cd) + Cs (pF)

Cs = Cgs×Cds / (Cgs + Cds) + Cos (pF)

where Cs(=3 to 5pF) 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 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.

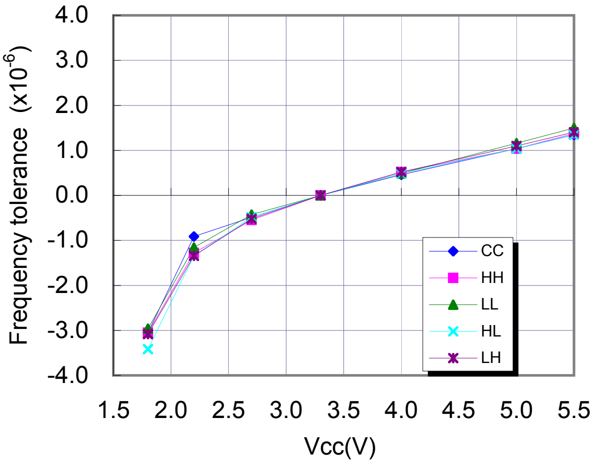
Evaluation of a Low Frequency Clock Oscillation Circuit

VT-200-FL 6.0pF with R5F2L3ACCNFP-100P [LQFP(14x14) 0.50mm pitch]

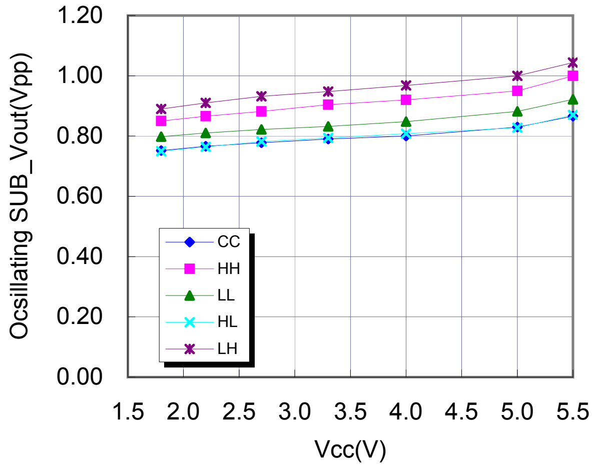
Measurement conditions : Vcc=1.8V to 5.5V at 25°C **An external resistor,Rf Built-in,Rd 0Ω**

Referential Data(1): Voltage characteristics (CC,HH,LL,HL,LH)

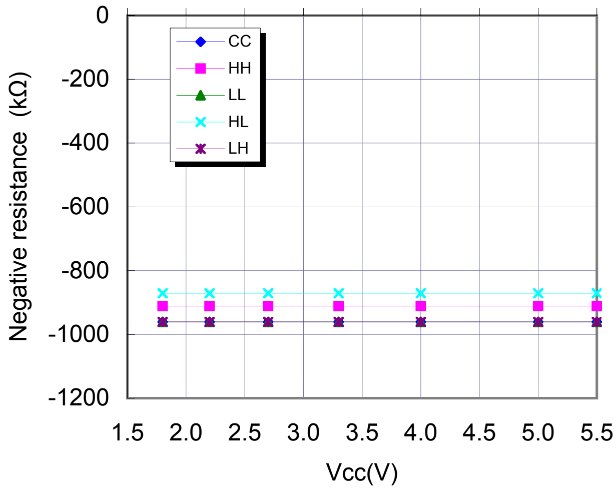
Frequency / voltage coefficient



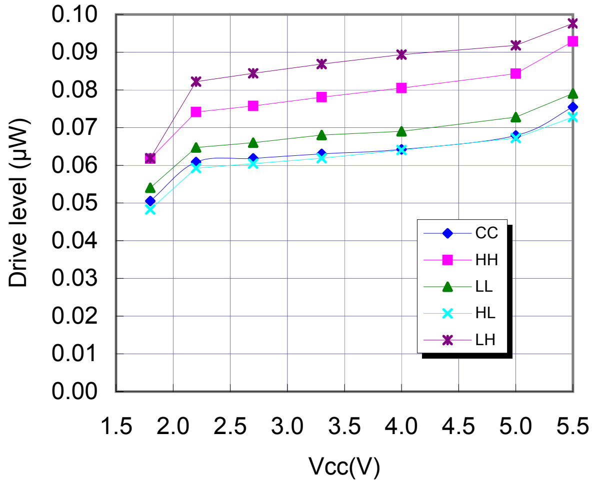
SUB_Vout / voltage coefficient



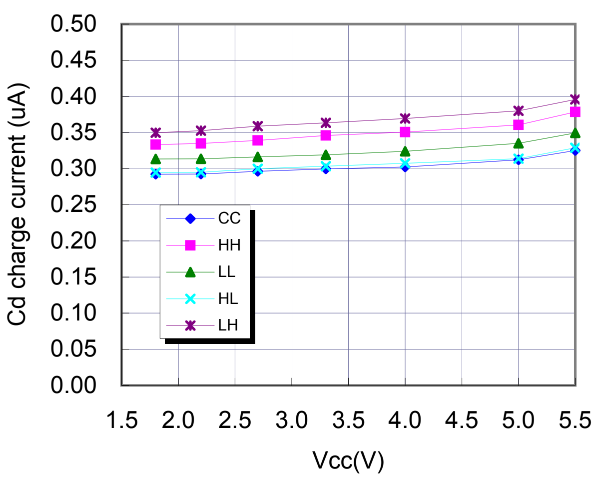
Negative resistance / voltage coefficient



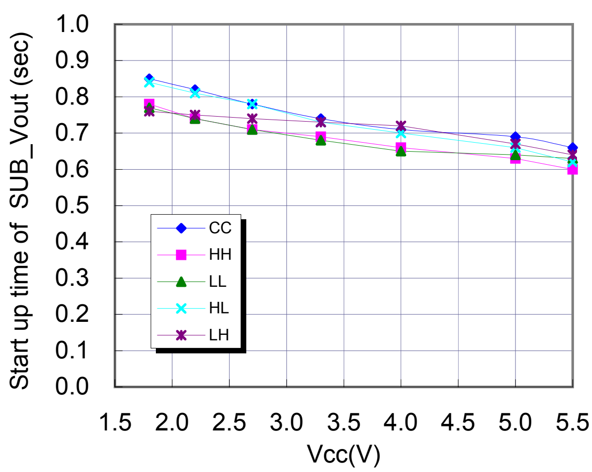
Drive level / voltage coefficient



Cd charge current / voltage coefficient



Start up time / voltage coefficient



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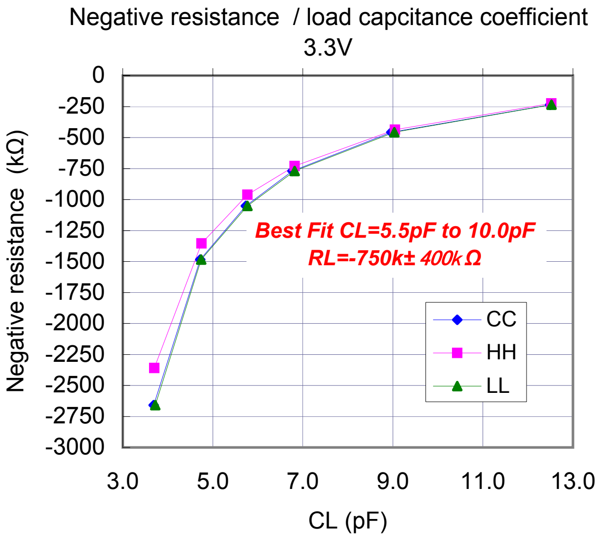
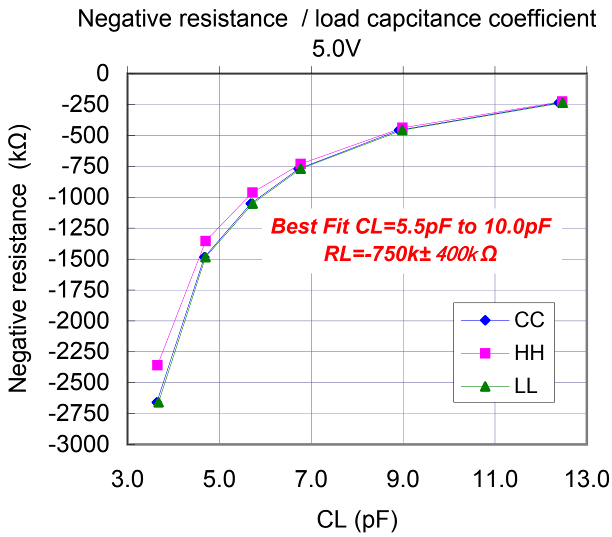
Evaluation of a Low Frequency Clock Oscillation Circuit

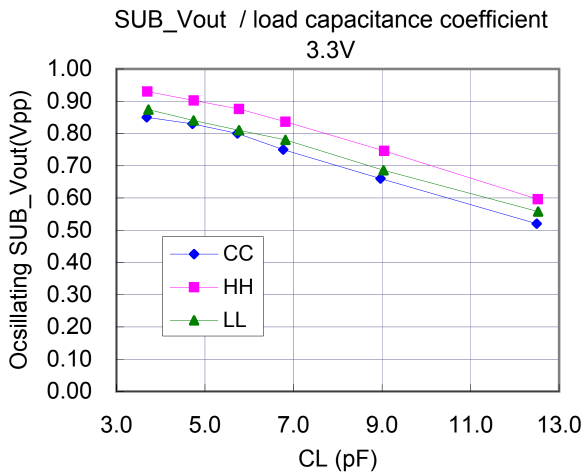
VT-200-FL 6.0pF with R5F2L3ACCNFP-100P [LQFP(14x14) 0.50mm pitch]

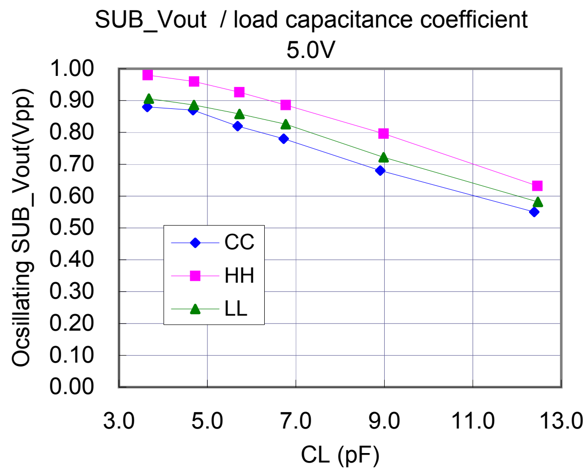
Measurement conditions : Vdd=3.3V,5.0V at 25°C **An external resistor,Rf Built-in,Rd 0Ω**

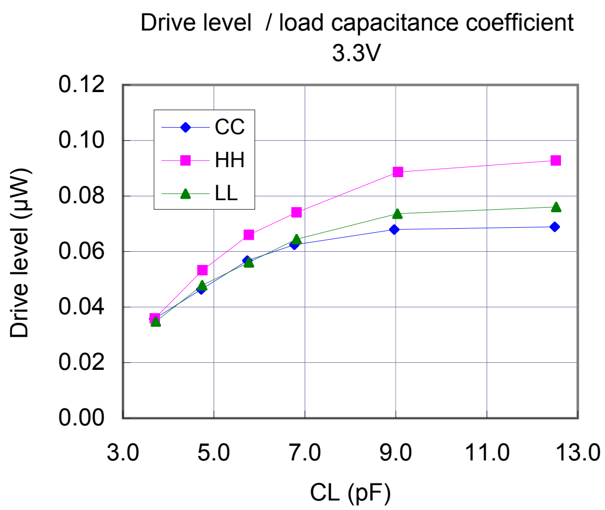
Referential Data(2) : Load capacitance characteristics(CC,HH,LL)

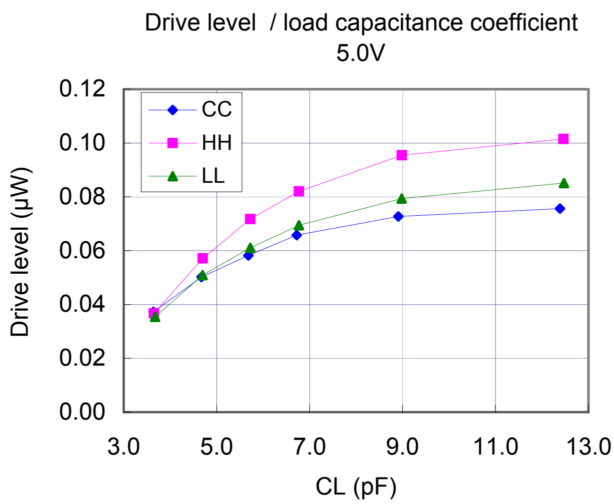










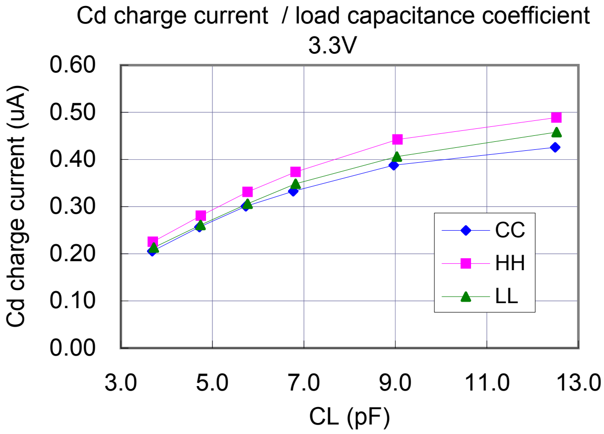


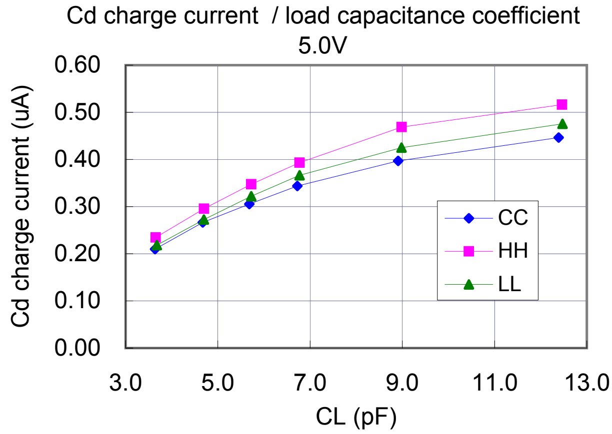
Evaluation of a Low Frequency Clock Oscillation Circuit

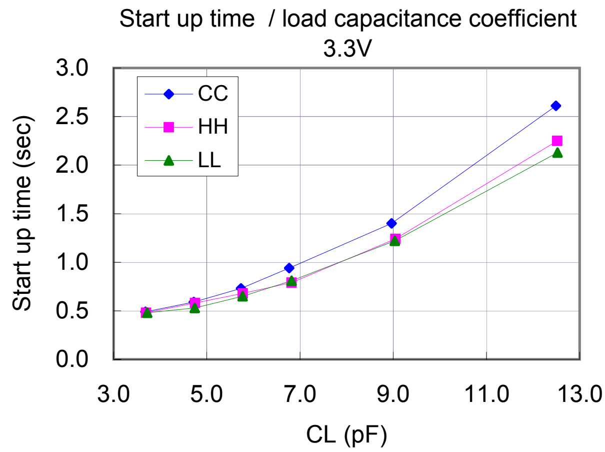
VT-200-FL 6.0pF with R5F2L3ACCNFP-100P [LQFP(14x14) 0.50mm pitch]

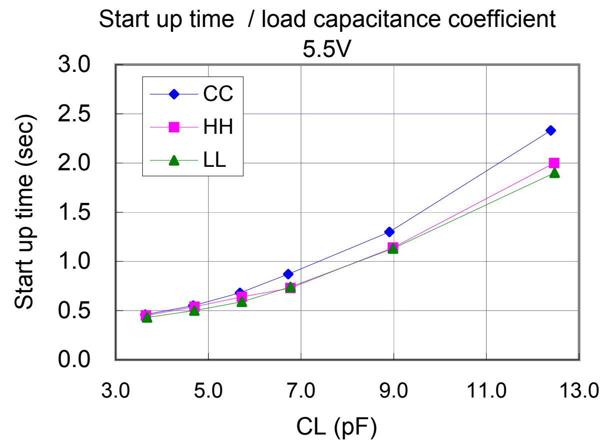
Measurement conditions : Vdd=3.3V,5.0V at 25°C — **An external resistor,Rf Built-in,Rd 0Ω**

Referential Data(3) : Load capacitance characteristics(CC,HH,LL)









Low power consumption R8C/Lx and Low CL VT-200-FL 6.0pF

In addition, the VT-200-FL_4.4pF will be offered, realizing a 1/3 power consumption reduction in oscillation and a 2 .7x super high speed oscillation start-up time.

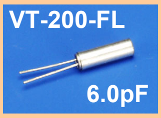


Table 1 XCIN oscillation circuit and load capacitance for a resonator

CL(pF)	Rd(kΩ)	Cg(pF)	Cg(pF)	Vcc (Cd charge current: Id)
6.0	**0**	**6**	**5**	**3.3V(0.33A typ),5.0V(0.34A typ)**
4.4	680	3	2	3.3V(0.11uA typ),5.0V(0.12uA typ)

**RENESAS MPU R8C/Lx group; R8C/L35x,R8C/L36x,R8C/L38x and R8C/L3Ax & VT-200 series*

IC sample Rd=0Ω,Cg=6pF,Cd=5pF,CL=6.0pF

Vcc(V)	IC sample	M(times)*	Id(uA)	Ts(sec)
5.0	CC	19	0.31	0.69
	HH	18	0.36	0.63
	HL	17	0.31	0.66
	LH	19	0.38	0.66
	LL	19	0.34	0.64
3.3	CC	19	0.30	0.74
	HH	18	0.34	0.69
	HL	17	0.30	0.73
	LH	19	0.36	0.72
	LL	19	0.32	0.68

*R1max=50kΩ

IC sample Rd=680kΩ,Cg=3pF,Cd=2F,CL=4.4pF

Vcc(V)	IC sample	M(times)*	Id(nA)	Ts(sec)
5.0	CC	19	0.11	0.24
	HH	19	0.12	0.25
	HL	18	0.11	0.25
	LH	19	0.13	0.24
	LL	19	0.11	0.23
3.3	CC	19	0.11	0.27
	HH	19	0.12	0.27
	HL	18	0.10	0.29
	LH	19	0.12	0.27
	LL	19	0.10	0.27

*R1max=50kΩ

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