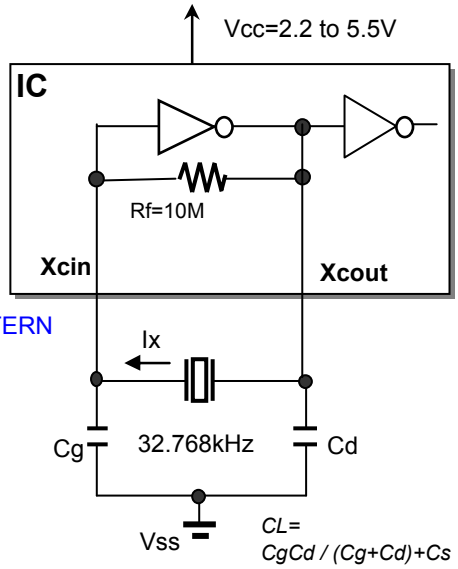
Evaluation of Subsystem Clock Oscillation Circuit

[R5F21276SN-32P] QFP(7x7) 0.80mm pitch

Measurement conditions : 3.3V

Model	:SSP-T7
Frequency	:Fo=32.768kHz
Frequency tolerance	:dF/Fo= +/-20x10^{6}
Load capacitance	:CL=7.0pF
Equivalent series resistance	:R1=65kohm max
Max. drive level	:DL=1x10^{-6}W max
Level of drive	:DL=0.1x10^{-6}W typ

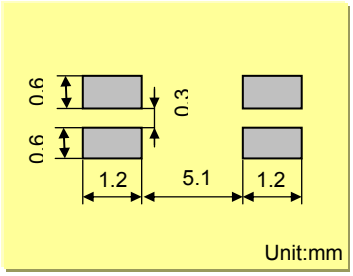


Remark) Ix : current through crystal

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



Drivability of oscillation can be changed to "High" or "Low" by user program.

MODEL:SSP-T7 7.0pF with R5F21276SN at 3.3V,25°C

Key specifications	Low	High	Remarks
Negative feedback resistance : Rf (M ohm)	Built-in	Built-in	The build-in 10M ohm Rf can be opened by user program.
Capacitance at gate : Cg (pF)	5	10	Optimal capacity in response to CL
Capacitance at drain : Cd (pF)	6	9	(CL = Cd // Cg + stray capacitance)

Circuit characteristics (at 25°C)	Low	High	Remarks
Matching Accuracy : df / f (x10^{-6})	0.6	1.2	Frequency offset volume at specified Vdd
Voltage Fluctuation : +/-df / V (x10^{-6})	0.4	1.5	Vdd +/-10% (Standard operating voltage range)
Drive Level : DL (x10^{-6}W)	0.05	0.04	DL=Ix^{2} Re < 1x10^{-6}W,Re=R1(1 + Co / CL)^{2}
Negative resistance : | - RL | (kohm)	737	3357	5 times larger than R_{1MAX}
Oscillation allowance : M (times)	11.3	51.6	Judgemental standard of oscillation stability
Voltage of oscillation start : Vstart (V)	1.69	1.59	
Voltage of oscillation stop : Vstop (V)	1.37	1.03	
Oscillation start up time : Ts (sec)	0.30	0.22	Time to reach 90% of output level

Temperature characteristics of circuit		Low	High	Remarks
at -40°C	Variation : df / T (x10^{-6})	-140	-140	Typ.Tp=25°C (K = -3.5×10^{-8} / °C^{2})
at +85°C	Variation : df / T (x10^{-6})	-128	-128	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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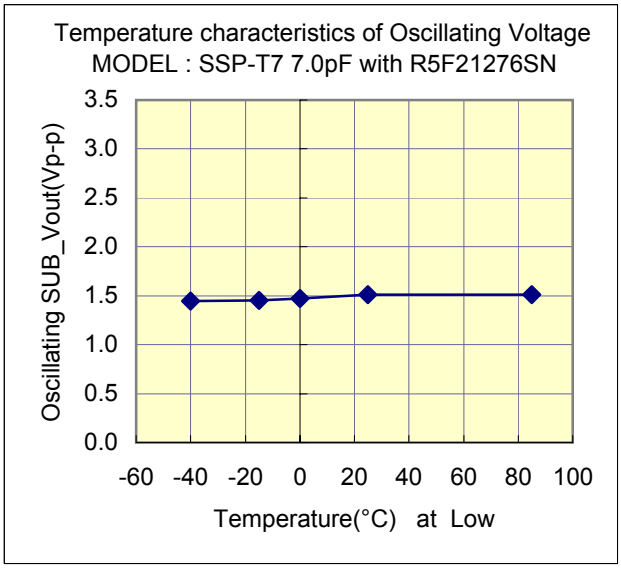
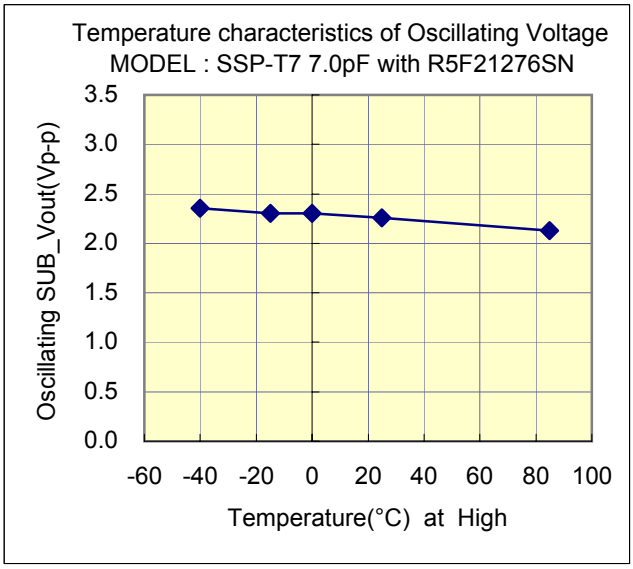
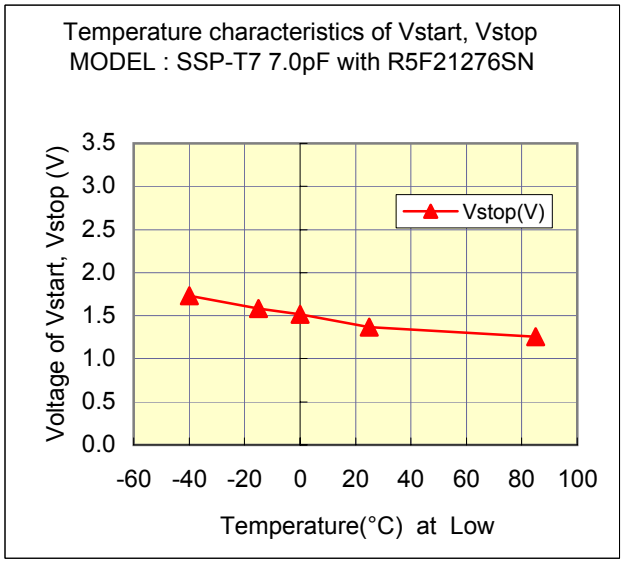
[R5F21276SN-32P] QFP(7x7) 0.80mm pitch

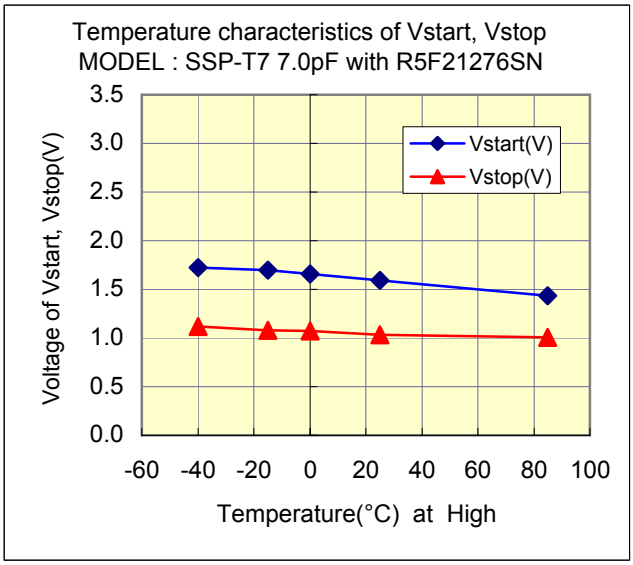
Measurement conditions : 3.3V

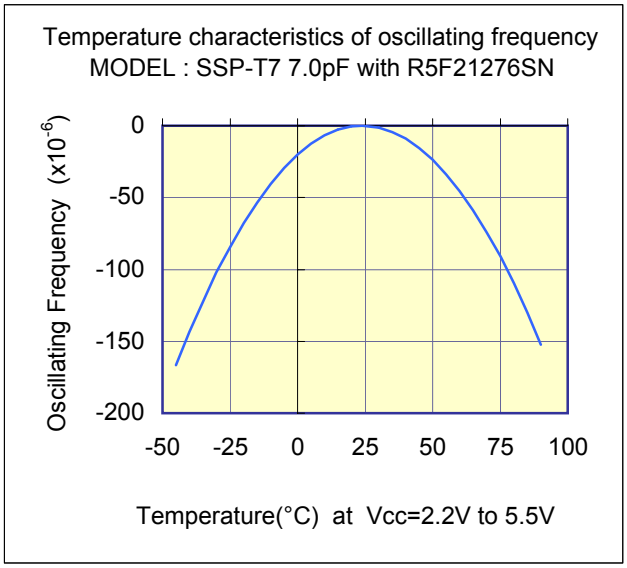
Test Data : Temperature characteristics at Vcc=3.3V

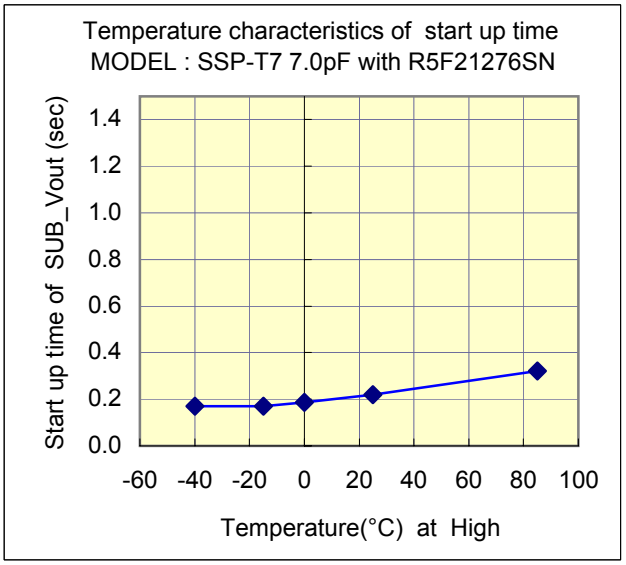












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Evaluation of Subsystem Clock Oscillation Circuit

[R5F21276SN-32P] QFP(7x7) 0.80mm pitch
Measurement conditions : 3.3V

Referential components layout(see Figure 1)

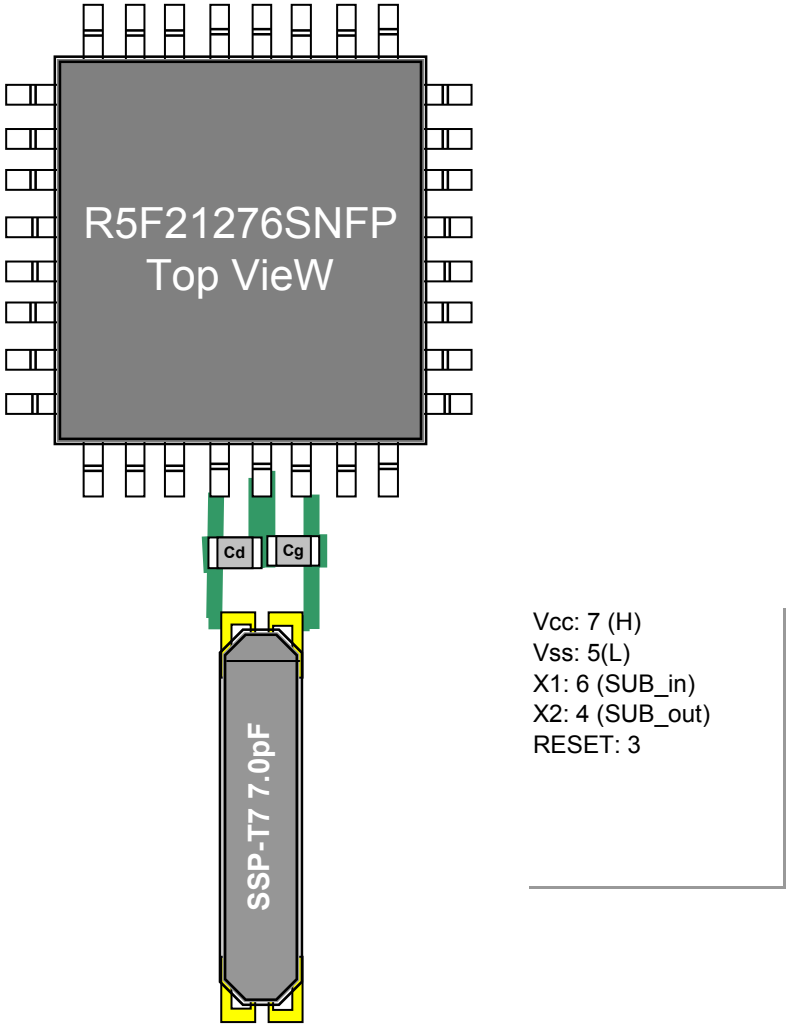


Figure 1 Referential components layout

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).

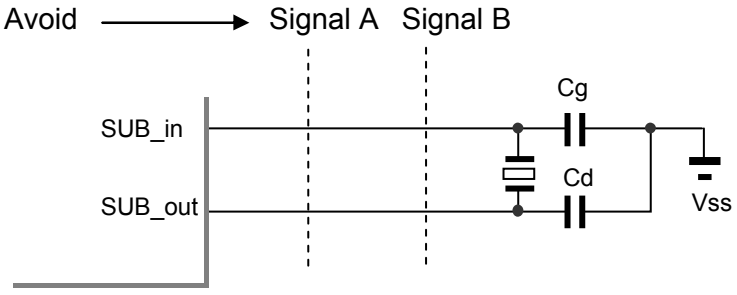


Figure 2 Example of Incorrect Board Design

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

Evaluation of Subsystem Clock Oscillation Circuit

[R5F21276SN-32P] QFP(7x7) 0.80mm pitch

Measurement conditions : 3.3V

[Evaluation Sample : SSP-T7 7.0pF at 25°C]

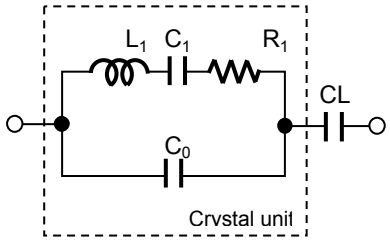
SAMPLE	No.	CL(pF)	Fo(Hz)	fr(Hz)	R1(kohm)	Co(pF)	C1(fF)	Q(k)
SSP-T7 7.0pF	1	7	32767.98	32763.81	45.1	0.86	2.001	53.9
	2	7	32767.99	32763.82	40.8	0.86	2.001	59.5
	3	7	32768.05	32763.90	41.9	0.85	1.989	58.3

[IC Test Data : IC samples Rd=Built_in,Cg=5 to 10pF,Cd=6 to 9pF at Vcc=3.3V,25°C]

Mode	IC samples	Fosc(Hz)	df / f(x10^{-6})	DL(x10^{-6}W)	| -RL |(kohm)	Vstart(V)	Ts(sec)
High	TYP	32768.020	1.22	0.04	3357	1.59	0.22
	HL	32768.180	6.10	0.04	3357	1.47	0.18
	LH	32767.840	-4.27	0.04	3357	1.69	0.18
	LL	32767.910	-2.14	0.04	3357	1.49	0.18
	HH	32768.090	3.36	0.04	3357	1.55	0.20
Low	TYP	32768.000	0.61	0.05	737	1.69	0.30
	HL	32768.050	2.14	0.04	737	1.65	0.33
	LH	32768.030	1.53	0.05	387	1.49	0.36
	LL	32768.100	3.66	0.04	967	1.77	0.28
	HH	32768.000	0.61	0.04	387	1.70	0.33

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

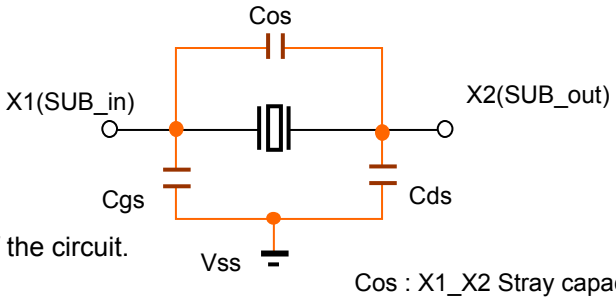
Figure 3 Equivalent circuit of crystal unit, and CL

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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