NUC970 OSC CL

Design Note

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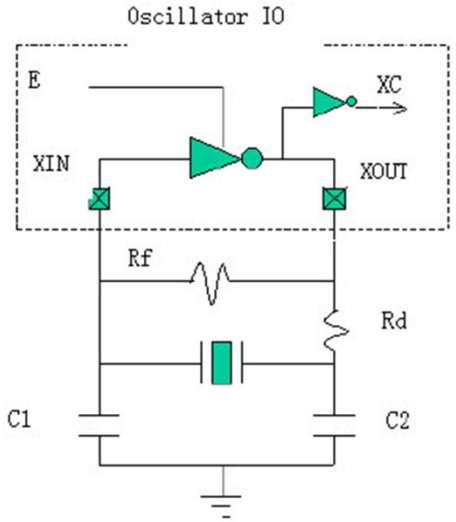
Nuvoton Technology Corp.

NUC970 Oscillator cell characteristic information (VSI comment)

frequency	ESR(ohm)	CLOAD(typical)
4M~8M	<100	20Pf
8M~18M	<50	14pF
18M~27M	<30	8pF

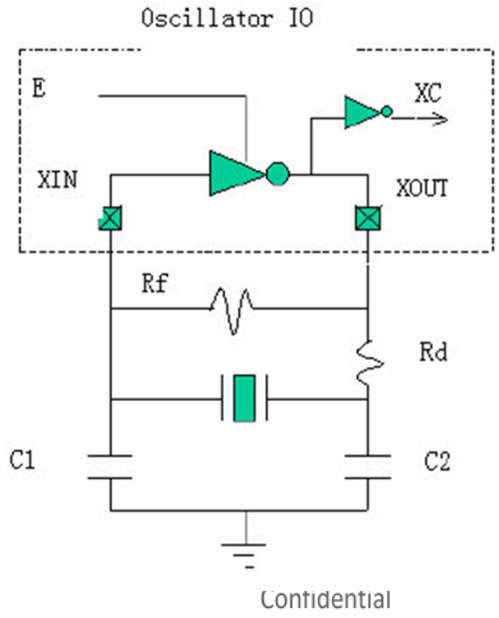
Description

- Figure shows the oscillating circuit is connected with the oscillator I/O cell.
- Components feedback resistor (Rf), damping resistor (Rd), C1 and C2 are used to adjust the turn on time, keep stability and accurate of the oscillator.
- Rf is used to bias the inverter in the high gain region. It cannot be too low or the loop may not oscillate. For mega Hertz range applications, Rf of **1Mohm** is applied.
- Rd is used to increase stability, low power consumption, suppress the gain in high frequency region and also reduce -Rd of the oscillator. Thus, proper Rd cannot be too large to stop the loop oscillating.
- C1 and C2 are deciding regard to the crystal or resonator CL specification. In the steady state of oscillating, CL is defined as (C1*C2)/(C1+C2).
- Actually, the I/O ports, bond pad, and package pin all contribute the parasitic capacitance to C1 and C2. Thus, CL can be rewrite to (C1'*C2')/(C1'+C2'), where C1'=(C1+Cin,stray) and C2'=(C2+Cout,stray).



How to get C1 & C2 capacitance

- **ESR meets process condition; <= 50Ω**
- Equation: NUC970 OSC PAD CL=14pf
  - When 12MHZ XTAL CL = 12pf
  - PKG parasitic C = 2pf
  - CL = 14pf = 0.5 * (12pf + 2pf + C1)
  - C1 = C2 = 14pf
- **If Crystal CL increment, then C1 and C2 must be reduce**



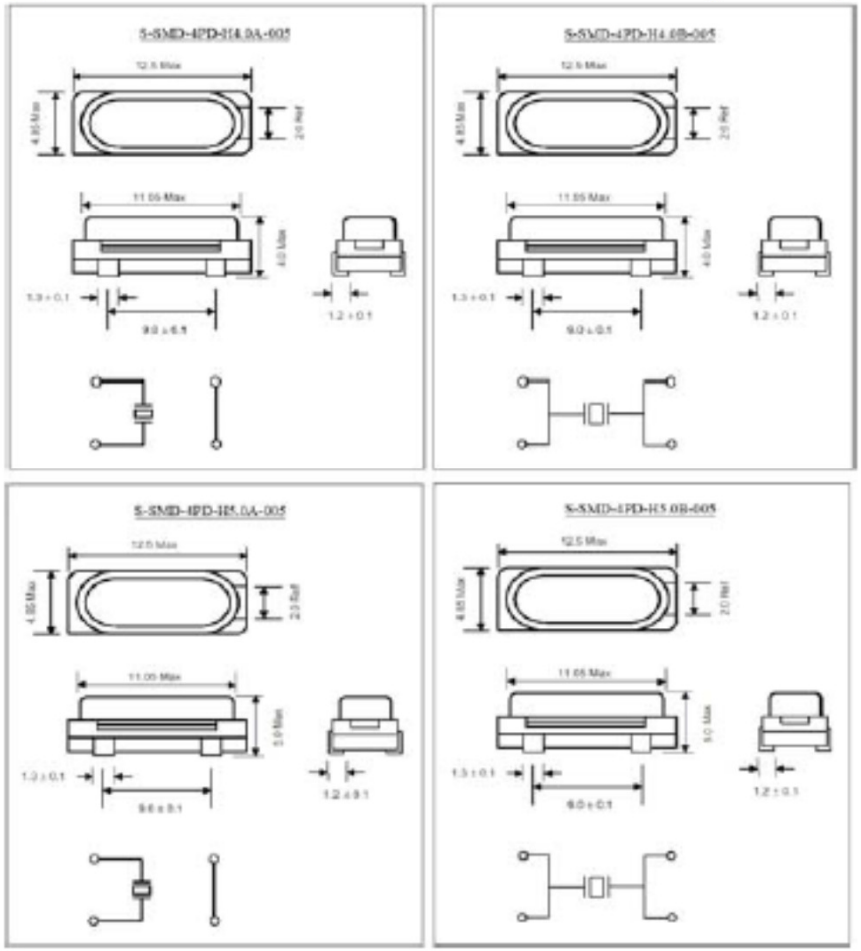
Appendix, Crystal unit information

Specification	HC-49/S 4PD
Frequency Range	3.5 to 66.0MHz
Mode of Oscillation	Fundamental / 3rd Overtone
Tolerance at 25°C	±10ppm to ±50ppm
Temperature Stability	±10ppm to ±50ppm
Operating Temperature Range	-10°C to +60°C / -40°C to +85°C
Storage Temperature Range	-55°C to +125°C
Load Capacitance	10 to 32pF / Series
ESR	* See Table Below
Drive Level	100μW Max.
Aging	±5ppm/year Max.

* HC-49/S 4PD ESR Table

Oscillation Mode	Frequency Range (MHz)	ESR (Ohm)
Fundamental	3.5 to 3.9	200 Max.
	4.0 to 7.9	150 Max.
	8.0 to 11.9	70 Max.
	12.0 to 23.9	50 Max.
	24.0 to 30.0	40 Max.
3rd Overtone	30.0 to 66.0	80 Max.

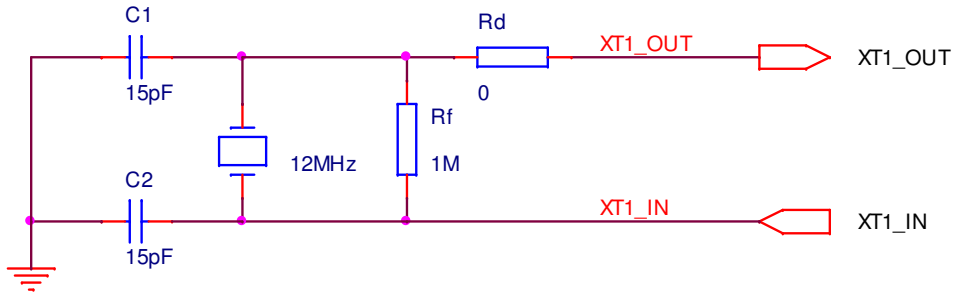
■ Dimension (Unit:mm)



Conclusion

- For 12MHZ XTAL, please use tolerance±20ppm, CL=12pf , ESR < 50 ohm, others are to be define (TBD).

(1). Crystal Frequency:12MHZ
(2). Mode of Vibration: fundamental
(3). Load Capacitance: suggestion 12pf
(4). Frequency tolerance: suggestion ±20ppm (25±5℃)
(5). Resonant Resistance (Max): 50Ω
(6). Shunt Capacitance (Max): TBD
(7). Drive Level (Min): TBD
(8). Operation Temperature Range: TBD, ex. (-40~85℃)
(9). Frequency Deviation over Temperature (Max range): suggestion ±20ppm
(10). Insulation resistance (Min): TBD



About Rf, Rd, C1 & C2

a.) Rf=1M is suggestion

b.) Rd=0ohm or TBD

c.) C1=C2=14pf (note)

Note, 15pf is popular than 14pf and easy for getting, you can use 15pf to instead of 14pf

Recommend for RTC 32K XTAL

- For 32.768 XTAL, please select tolerance±30ppm or under 30ppm for getting accurate time.
- For Rf, 10M ohm is suggestion
- For Rd, 0 ohm is suggestion
- C1=C2=20pf is suggestion
- Others are to be define (TBD).