**Crystal Oscillator analysis:**

**Model of Crystal Oscillator** (<https://www.electronics-tutorials.ws/oscillator/crystal.html>):

Diagram of a diagram of a circuit model

Description automatically generated

Using this model, depending on the influence of Cp, the range of frequencies provided by this oscillator would be within this range:

Since that the load capacitance (CL) is parallel to cp:

NOTE: This means as CL increases f decreases towards and tol decreases.

**Circuit Analysis** (<https://onlinedocs.microchip.com/pr/GUID-F626284A-58F0-4C25-A6F3-0EA5054F3E2B-en-US-6/index.html?GUID-A1E15E02-F60E-49F0-8E9E-6493FDB4DCA1>):

A diagram of a circuit

Description automatically generated

A diagram of a circuit

Description automatically generated

A diagram of electrical wiring

Description automatically generated

A diagram of a computer

Description automatically generated

Assuming that there is no significant ground charge build-up or ground loop, the ground does not play into the resonance. Thus, the effective C\_L is the following:

Assuming symmetry (including C13 = C14 = C\_e), this simplifies down:

**Quantifying the effect of using a load other than the specified :**

From Series 9B datasheet:

C\_s < 7 pF for the 9B Series that is currently installed.

R\_s = 30 Ohms

F\_s = 16 MHz @ C\_L = 12 pF

Tolerance (*t*) = +/-30 ppm = +/-3e-5

1. Finding C\_p:

Assume that Tolerance is measured symmetrically and that the effect of C\_p is distributed uniformly over the tested components.

Since we are solving for C\_p in this, lets simplify this down:

Define:

Such that:

Substitute back in h(C\_p) and solve for C\_p:

Substitute in A and insert values (assume maximal C\_s):

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1. Finding L\_s:

Assume that the F\_s reported is the average value seen based on how tolerance was reported, and therefore, the lower range for frequency tolerance would yield the following:

Solve for L\_s:

Plug in values:

Finally, plugging everything in to find the frequency range with C\_e = 0.1 uF (what we currently have):

Assume minimal parasitic and board capacitance:

Tol = +/- 1.74 \* 10^-6 ppm (tiny)

F\_s ~ F\_min ~ 12.7 MHz