# Main section for developing the Objectives

**Objectives**

There is a significant body of work on how radiation causes faults in electronics and embedded systems. [1] However, there is no quantitative data on how common RF (radio frequency) emissions in the range of X Hz to 5 GHz affects clock drift in an internal RC (resistor-capacitor) oscillator found in many microcontrollers. Usually, a clock source for a microcontroller is selected based on known factors, such as required accuracy, cost, availability of board space, and expected temperature level and variation. Without any data on the effects of RF radiation, selection of an appropriate clock source is limited to a conservative approach to this unknown. Therefore, in order to remove any guesswork associated with this unknown, the main objective of this experiment is to collect data on the effect on microcontroller’s internal RC oscillator clock drift due to common frequencies and corresponding power densities of RF emissions.

The implications of new data will affect the viability of the internal RC oscillator in embedded systems. Quantitative data on the effects of RF emissions will make internal RC oscillators a viable options in applications where heavy RF emissions are expected to be present. Since RF emissions are extremely common due to the communications industry, designers will be able to understand how their systems will be affected by RF emissions for the first time. In addition to new data being collected, we hope to answer whether frequency or power density has more of an effect on clock drift. Also, we hope to establish trends for the effects of frequency, power density, and both variables combined together.

* Primary Objective
  + To gather data, in terms of clock oscillations per [unit time] and rate of change of the oscillations, by testing the internal RC oscillator from 5 microcontroller part numbers, from 4 vendors, due to common frequencies and corresponding power densities of RF emissions.
    - The microcontroller vendors and part numbers are:
    - The control group will consist of 3 units of each part number
    - The frequencies to be tested are: X, Y, Z
    - The power densities to be tested are: ??
      * Combine the previous 2 points?
* Secondary Objectives
  + To determine the trend using regression techniques relating differing frequencies at the same power densities to the clock drift recorded.
  + To determine the trend using regression techniques relating differing power densities to the same frequencies.
  + Establish a stable system, consisting of microcontroller hardware, microcontroller firmware, test equipment, and data acquisition system, to test both the control microcontrollers and the microcontrollers under test.
  + Elaboration on setting up a valid experiment?

# Outline and Prototyping

1. Main Objective
   1. To determine what, if any, effect radio-frequency emissions from external sources have on clock drift.
      1. What kind of clock?
      2. Is specifying external sources needed?
      3. We need to be more specific on “radio-frequency emissions”
   2. To determine the effects of common radio-frequency emissions on external sources on clock drift.
   3. To determine the effect on clock drift due to common frequencies and corresponding power densities of radio-frequency emissions.
      1. I think we should look into a set of power densities for each frequency. This way we could better determine what affects clock drift more: the frequency, the power of that frequency, and the trend that incorporates both. This would account for real world scenarios where devices will experience various frequencies, but will receive radiation at various distances from the source. This is the equivalent of varying power density.
   4. To establish the relationship between internal RC oscillator frequency drift and radio frequency emissions.
      1. Is this too indirect?
   5. To establish the relationship between internal RC oscillator frequency drift and the energy…blah blah
2. Secondary Objectives
   1. Preparation
      1. Choose 4 popular vendors
         1. Microchip Technologies (PIC), Texas Instruments, STMicroelectronics, NXP Semiconductor.
      2. Choose 5 part numbers
         1. What are they?
            1. What is the justification of our selection method

Popularity and flexibility of devices

* + 1. To establish stable clock sources for each device being tested.
       1. Custom boards. Consistent firmware/software.
       2. Find a method to determine the stability of clock sources under test.
    2. To establish a stable system for each device
       1. External circuitry will not affect
  1. Controlling factors during the experiment to ensure valid data.
     1. To eliminate temperature factors while testing devices.
     2. To eliminate ambient radiation from the testing environment.
        1. Environment RF radiation, environment light radiation, EMI from power sources.
     3. To eliminate mechanical (sound) energy from affecting
     4. To prevent the RF radiation source from affecting test equipment to preserve the integrity of data.
  2. The experiment
     1. To determine a control for the experiment of internal RC oscillator drift by testing 3 units of 5 part numbers from 4 popular vendors

1. The problem and significance of proposed work
   1. The problem
      1. Without data on the effects of RF emissions on internal RC oscillators, clock source selection is based on a conservative approach to unknown.
   2. Significance of proposed work
      1. Collecting data on these effects will allow a method for effectively choosing a clock source based known risk and performance.
      2. Removing unknown aspects of MCU internal RC oscillators will increase their viability as a device clock source. This will ultimately lead to the potential of reducing cost and board space by removing the need for an external oscillator.
      3. To find new data on internal RC oscillators
         1. To determine the viability of the use of internal RC oscillators on devices potentially going into space.
         2. Satellites!
         3. To determine the viability of the use of internal RC oscillators on devices operating near sources of RF emissions.

* References
  + [1] Radiation Effects on Embedded Systems
  + Space radiation on astronauts
    - <http://ac.els-cdn.com/S2251729412000213/1-s2.0-S2251729412000213-main.pdf?_tid=a6001e42-5fda-11e5-a3a7-00000aab0f01&acdnat=1442783019_ee866973a42a8922bbb67e264f9c4a8b>
  + Radiation bands into space
    - <http://www.spaceacademy.net.au/spacelink/radiospace.htm>
* Notes
  + For objectives
    - What the objective is
    - Then how to do it in the research plan
  + For objectives
    - We are testing MCU
      * “To measure clock drift by X”
      * “To establish an accurate method of measuring clock drift”