Based on Deliveriables.pdf from canvas

Phase 1:

Only relevant parameter is capacitance range

Same operating conditions – including temperature, mechanical stress, chemical environment etc.

PVC gives higher capacitance range with presence or absence of water

Phase 2:

Opamps aren’t ideal – Mohm range across input terminals

* Therefore resistors in Kohm range, ideally less than 100k
* Also high resistances have inductance because of their physical construction – noise so having small er resistors decreases noise
* Cannot be too low otherwise too much current draw and loading previous cct so above 1k
* Tried to reduce different resistor values across RX and TX – decreased different parts required to order if mass produced

5V supply block – used recommended peripherals (capacitors) from datasheet

Midpoint supply block - used recommended peripherals for unity gain cct from datasheet. Midpoint is less than 5/2=2.5V, since opamp max supply is 4.4V, not 5V

Integrator/Comparator overview – constraints of the probe (very small capacitance) means very high frequency (fast charge/discharge). Main challenge was to decrease frequency. To help this, modified the cct to add a capacitor in parallel to the probe – increase the capacitance across every value

Integrator block – chose resistor to decrease ramping speed of intergrator while still under the 100k resistor range – to decrease frequency.

Comparator block – chose hysteresis band that was large while using low Kohm resistors. Large hysteresis band means the integrator needs to increase/decrease its output voltage sufficiently to trigger comparator -> decreases frequency

Frequency variation – non-linear/linear with modded capacitor. For PoC, the non-linearity isn’t exactly tested tho

Above stuff addresses frequency range, stability and accuracy. Doesn’t address TX/RX range, power and lifespan.

Phase 3:

Same opamps used as phase 2 – non ideal opamps to tried to use 1k-100k resistors

5V and midpoint supply blocks are same as phase 2

CCT overview – amplification of tiny light signal (since signal decreases to distance^2) with accuracy, and producing useful corresponding output (voltage levels)

Detector block – sufficient amplification (by configuring resistor value) to amplify the tiny signal from the photodiode, while minimizing resistor value – (to decrease noise and maximise bandwidth increasing accuracy)

Capacitor makes the opamp double as low pass filter to filter out DC (ambient light level)

Only 1 decoupling capacitor necessary (for stability and less noise, any additional adds unnecessary complexity.

Amplifier block – further amplification to trigger the following capacitor block.

EDIT using larger resistors to increase voltage drop across this block to not load previous detector block

Comparator block – generate square wave based on received frequency from previous blocks. Used same values as comparator in TX

Rising edge detector – stores fixed energy on every rising edge – changing duty cycle to convert frequency to average voltage. Appropriate stored energy amount (capacitor size) and charge/discharge rate (resistors)

Comparator block – normalizes the charged time of the rising edge detector.  
Omitted hysteresis – minimal noise because of capacitors in previous (rising detector) block and following filter. A hysteresis using 1Mohm resistor range would be required introducing noise

Unity gain – used values from datasheet to not load the output when connected to following voltage conditioner

Inverting amplifier – appropriate amplification (2V range) and offset introduced for ideal output. Added modified capacitor to function as a low pass filter – now 2nd order – further smooths output voltage

Above stuff addresses stability and accuracy