Line Sensor Review

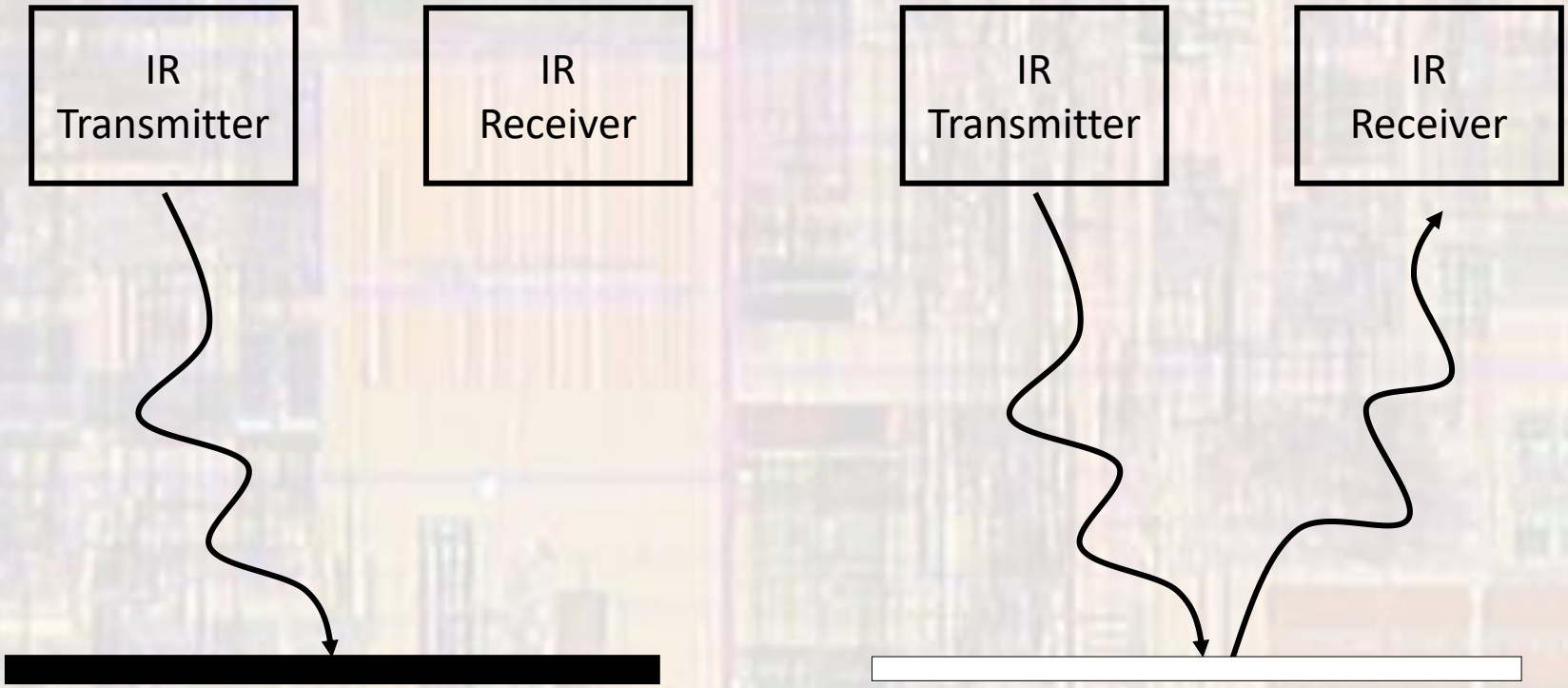
Last updated 12/15/21

Line Sensor Review

- Fundamentals
  - Two types of line sensors
    - Digital
    - Analog
  - Both operate by transmitting an IR beam and measuring how much is reflected back to the sensor

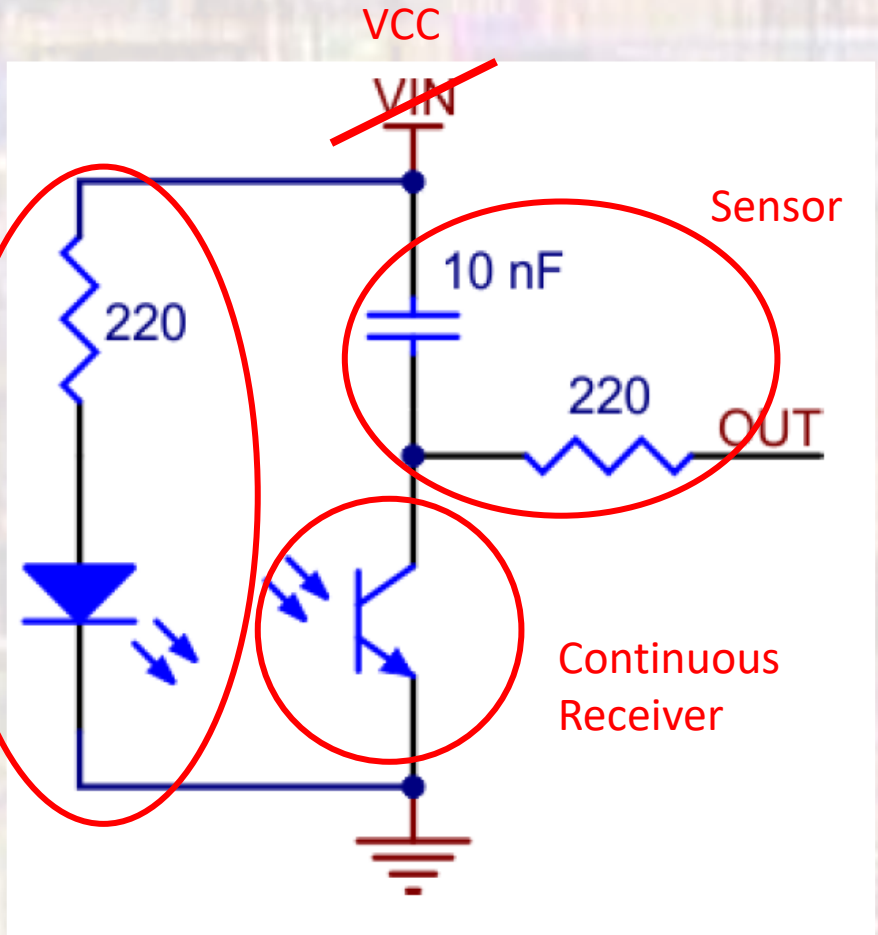
Line Sensor Review

- Fundamentals



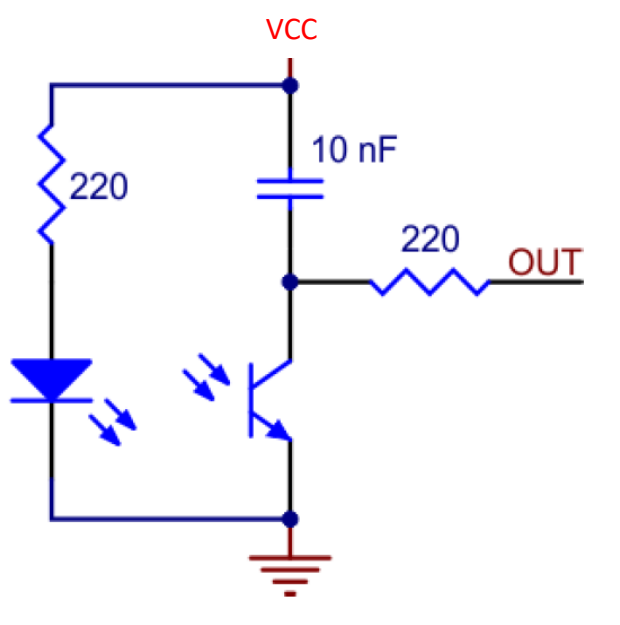
Line Sensor Review

- QTR-1RC



Line Sensor Review

- QTR-1RC



1) Discharge Capacitor

2) Received IR will cause the NPN to conduct

3) NPN conduction → charging the capacitor
→ Vout falling

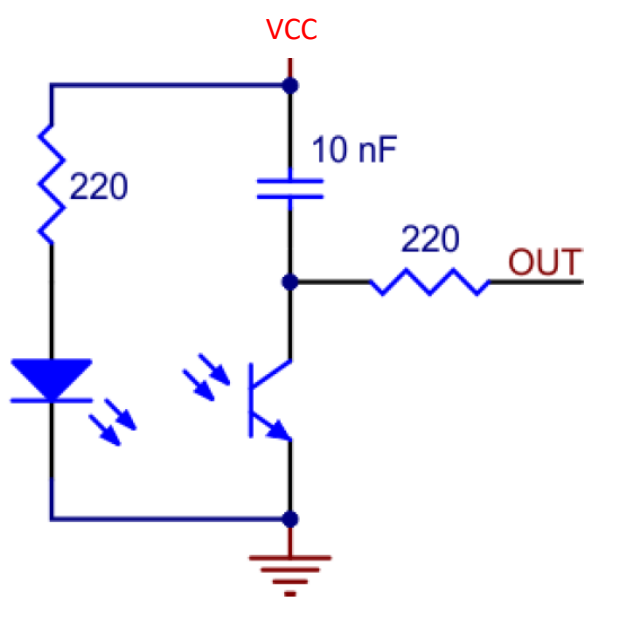
More received IR → more conduction
→ faster fall on Vout

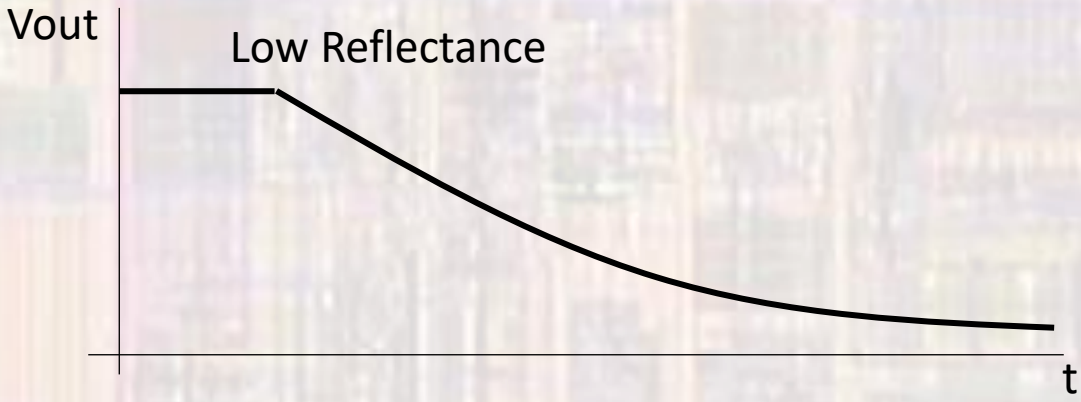
NOTE: Vout will eventually fall with just residual IR

Characterize the implementation to determine a threshold value for the fall time to indicate a high reflectance material is under the sensor

Line Sensor Review

- QTR-1RC

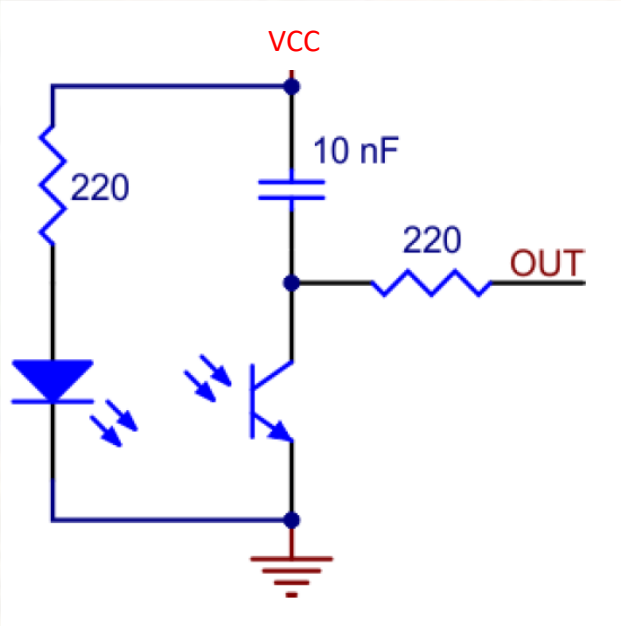


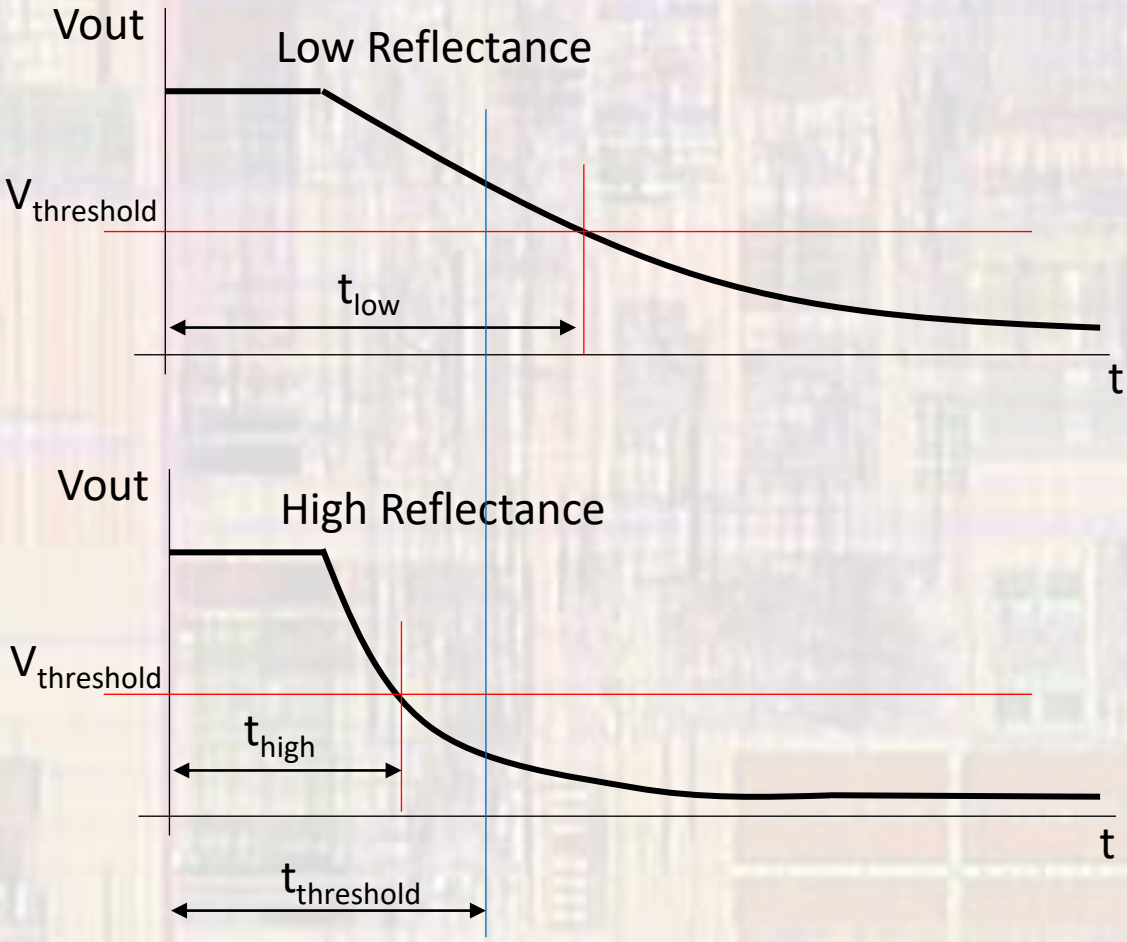


Line Sensor Review

- QTR-1RC

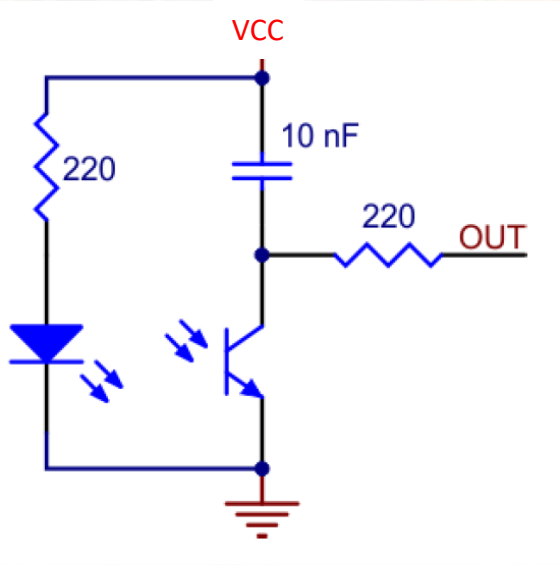
Characterize the implementation to determine a threshold value for the fall time to indicate a high reflectance material is under the sensor

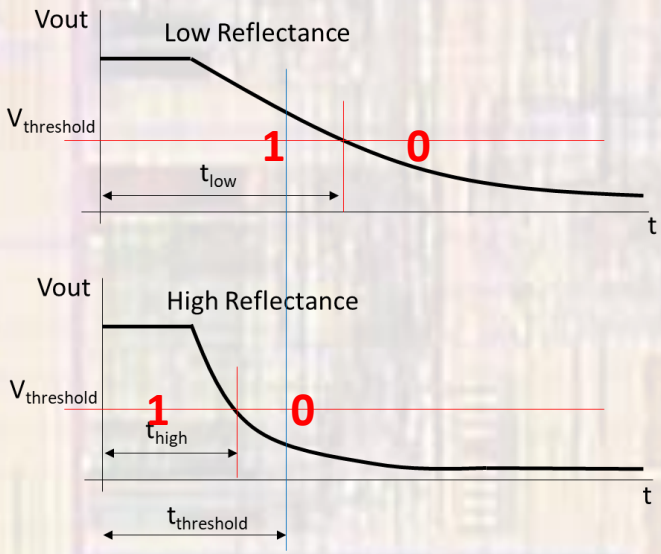




Line Sensor Review

- QTR-1RC
  - Tie the output to a digital input pin
  - Use the inherent digital input threshold as the measurement threshold
    - V_{in} detected will transition from 1 to 0 at the threshold voltage





Line Sensor Review

- QTR-1RC
  - MSP 432 I/O spec

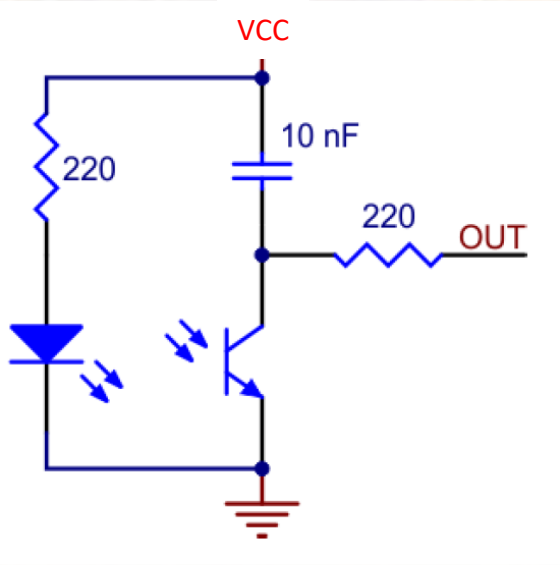
Table 5-22. Digital Inputs (Applies to Both Normal and High-Drive I/Os)

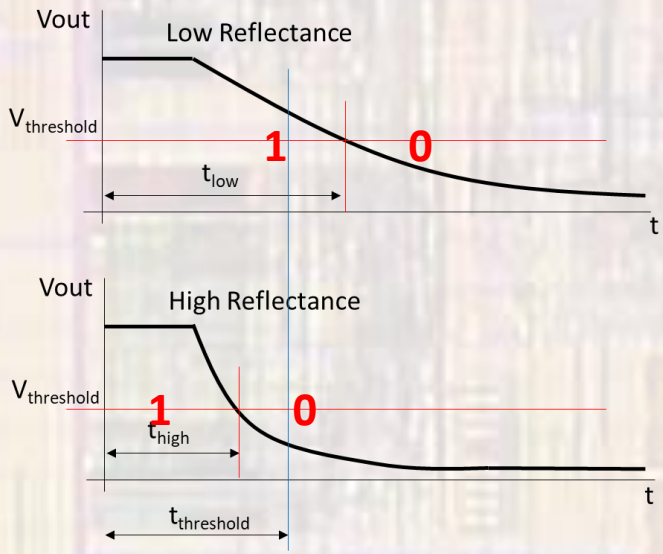
over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS	V_{CC}	MIN	TYP	MAX	UNIT
V_{IT+}	Positive-going input threshold voltage		2.2 V	0.99		1.65	V
			3 V	1.35		2.25	
V_{IT-}	Negative-going input threshold voltage		2.2 V	0.55		1.21	V
			3 V	0.75		1.65	
V_{hys}	Input voltage hysteresis ($V_{IT+} - V_{IT-}$)		2.2 V	0.32		0.84	V
			3 V	0.4		1.0	

Line Sensor Review

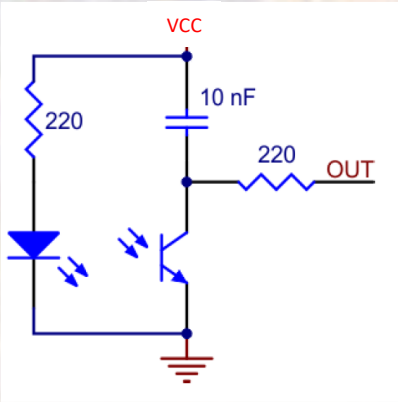
- QTR-1RC
  - Characterize the transition time (1 → 0) for
    - Different reflectivities (black, white, brown)
    - Different distances
  - Select a $t_{threshold}$ between light and dark

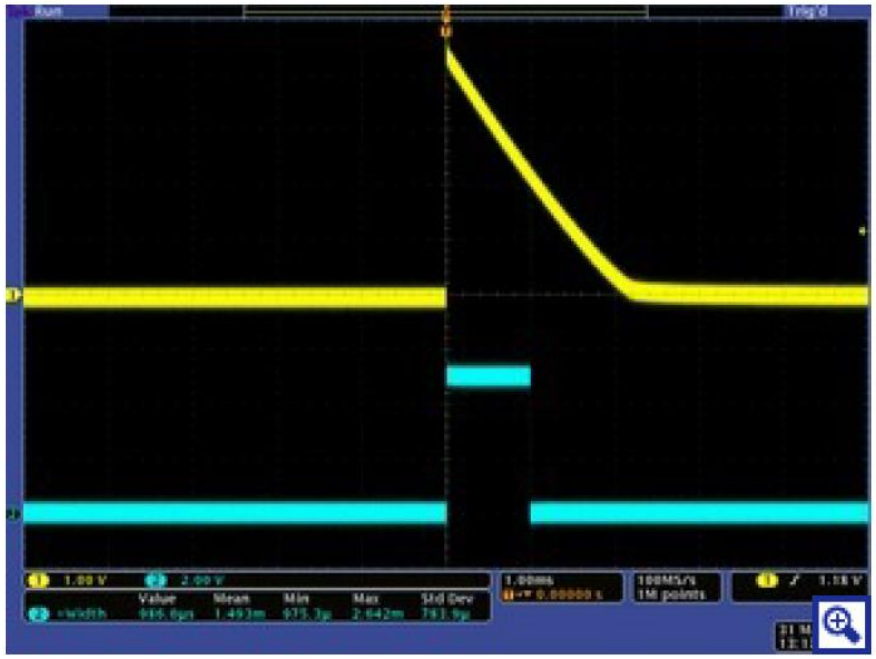




Line Sensor Review

- QTR-1RC
  - Operation
    - Pull the output high with a pin
    - Swap the pin to an input
    - Delay for $t_{threshold}$
    - Check the input pin value
      - If high – no line
      - If low - line

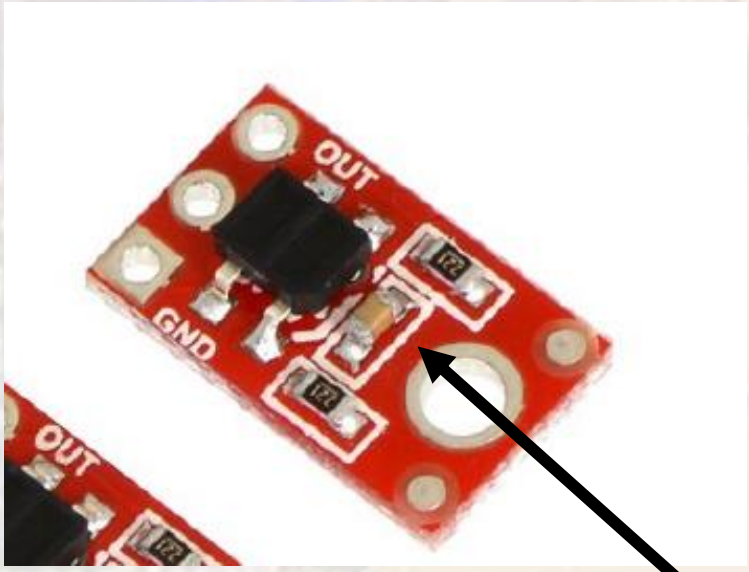


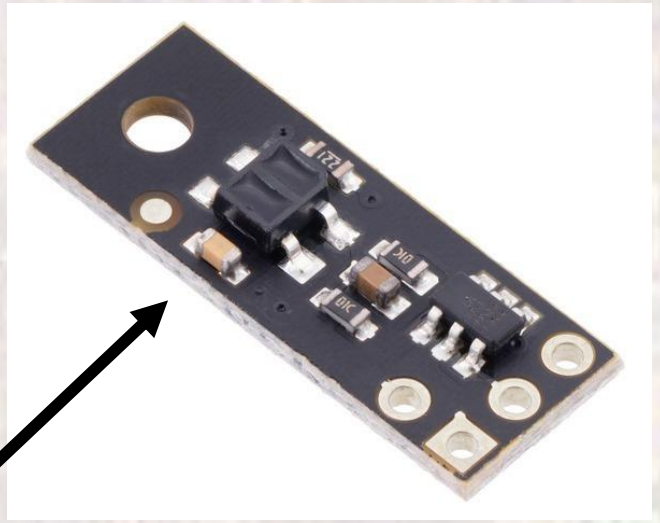


QTR-1RC output (yellow) when 1/8" above a white/black interface and microcontroller timing of that output (blue).

Line Sensor Review

- QTR-1RC





Light colored CAPACITOR

Line Sensor Review

- QTR-1RC

Optimal sensing distance: 5 mm

Maximum recommended sensing distance: 30 mm

Typical – light delays (high reflectance) – 10s of us
dark delays (low reflectance) – ~1ms

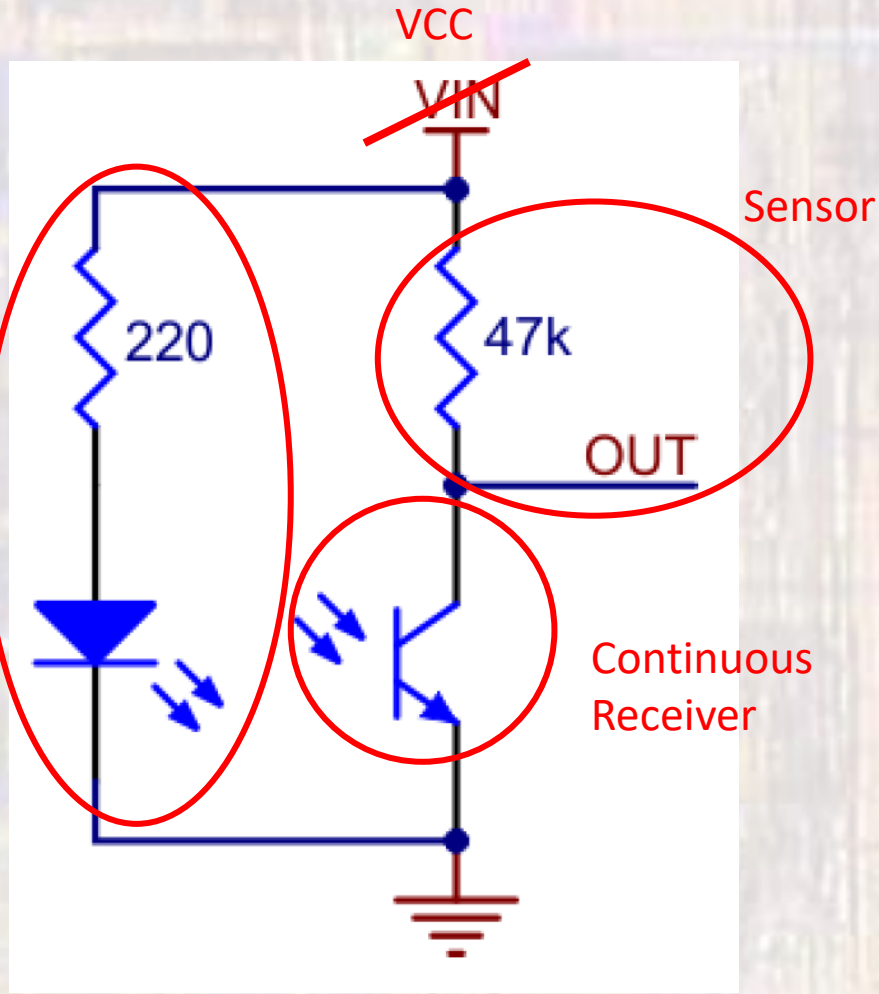
Discharge time – 10us why?

Line Sensor Review

- QTR-1RC
  - Operation
    - 3 options for operation
      - Polling
      - Interrupts (timer delay based)
      - Interrupts (pin transition based)

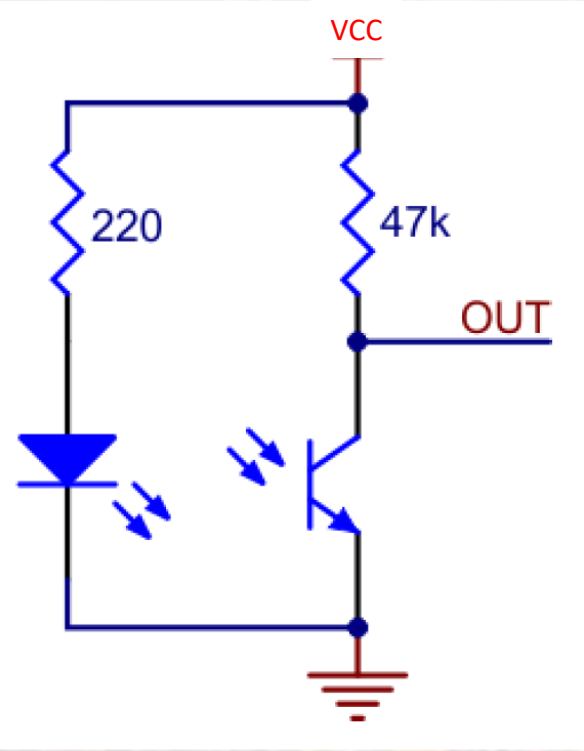
Line Sensor Review

- QTR-1A



Line Sensor Review

- QTR-1A



1) Received IR will cause the NPN to conduct

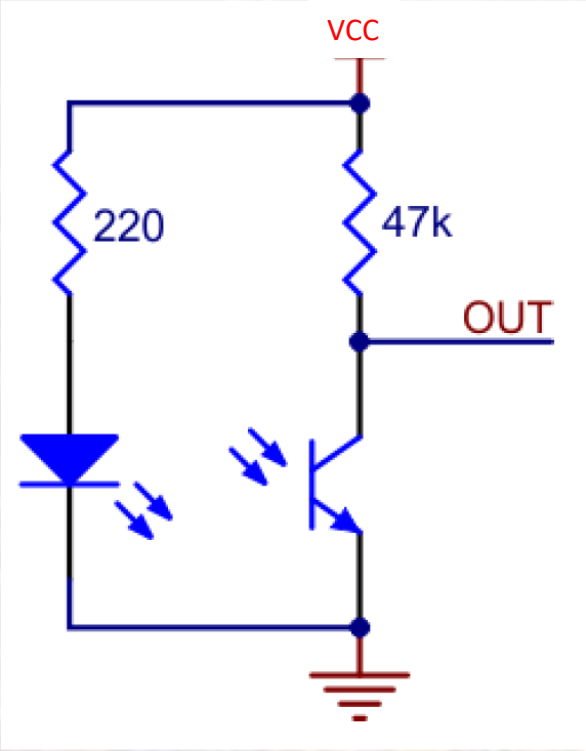
2) NPN conduction → current through resistor
→ Vout drops

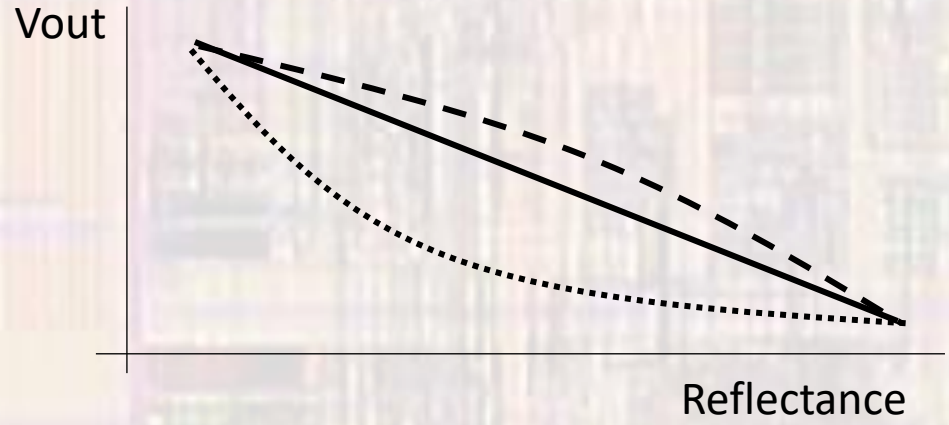
More received IR → more conduction
→ lower voltage on Vout

Characterize the implementation to determine a threshold value for the output voltage to indicate a high reflectance material is under the sensor

Line Sensor Review

- QTR-1A

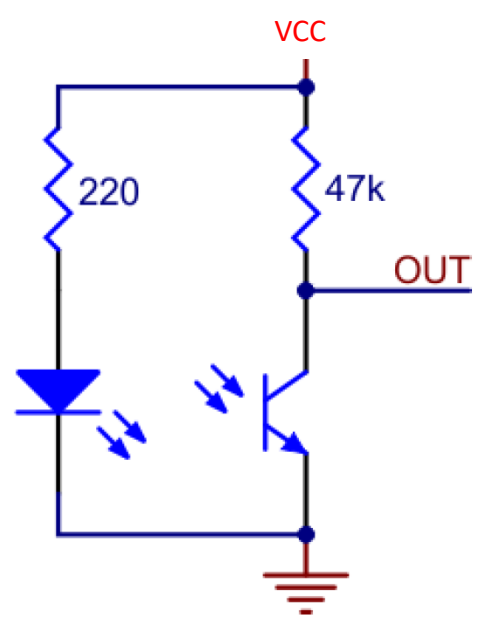


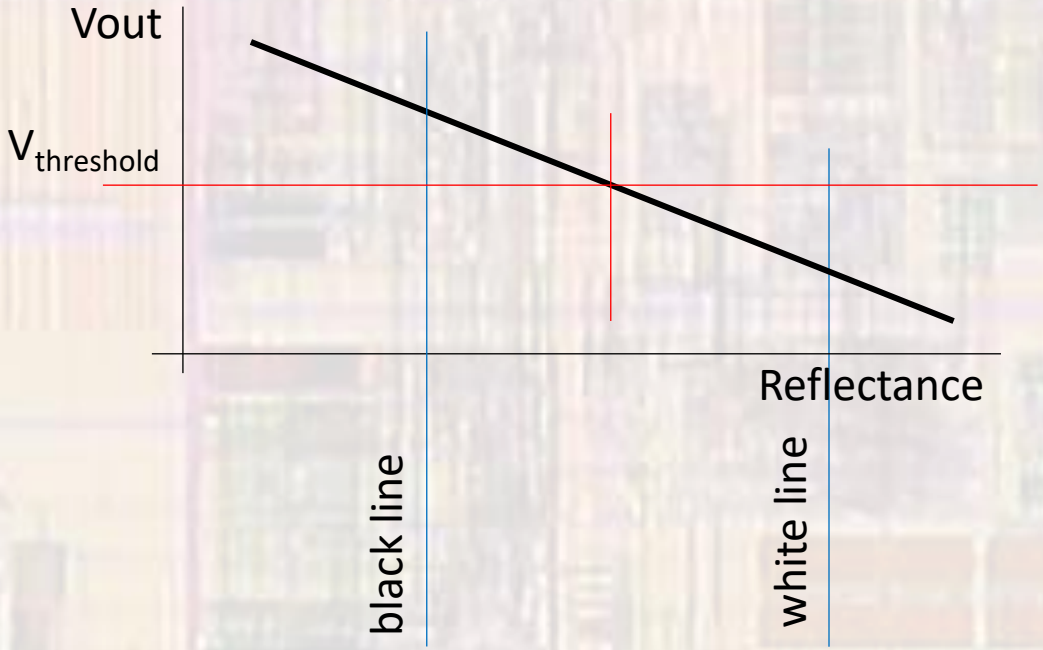


Line Sensor Review

- QTR-1A

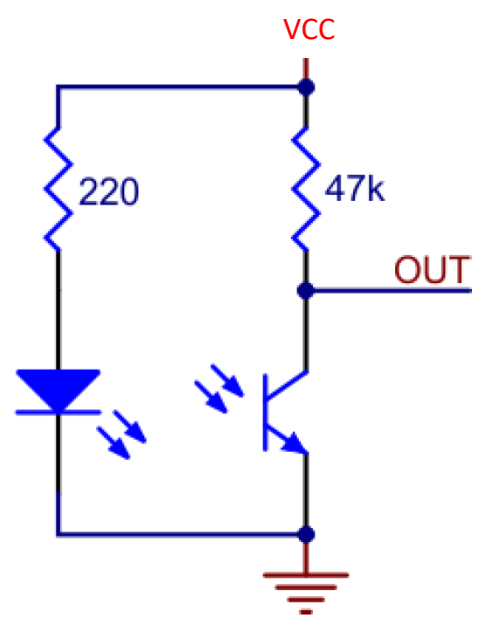
Characterize the implementation to determine a threshold value for the output voltage to indicate a high reflectance material is under the sensor

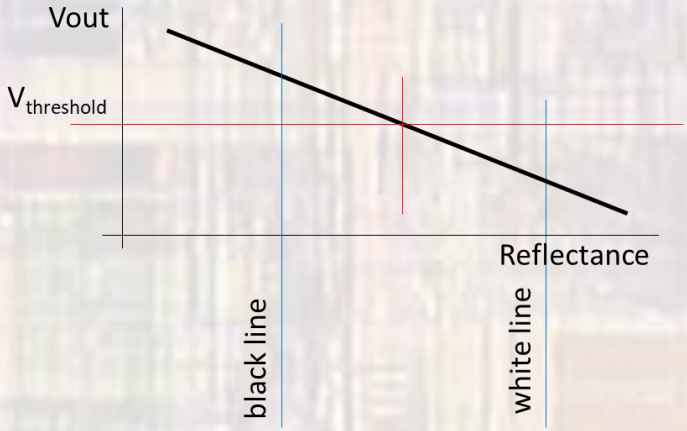




Line Sensor Review

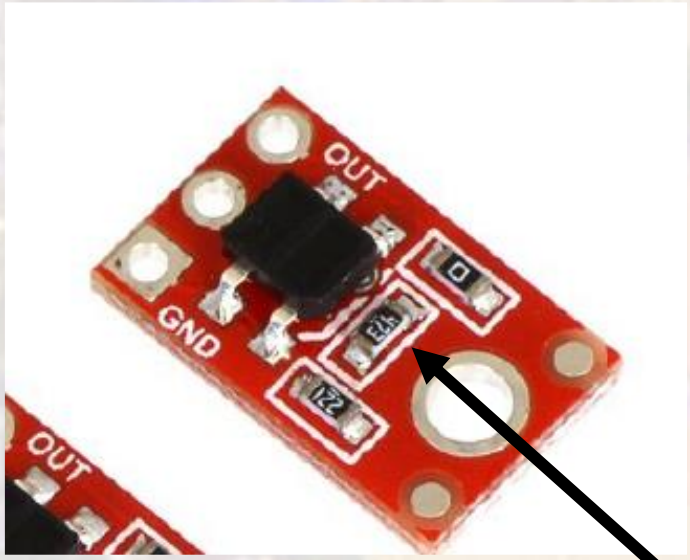
- QTR-1A
  - Tie the output to an A/D input pin
  - Measure the voltage and determine if high or low reflectance is measured (Based on $V_{threshold}$)

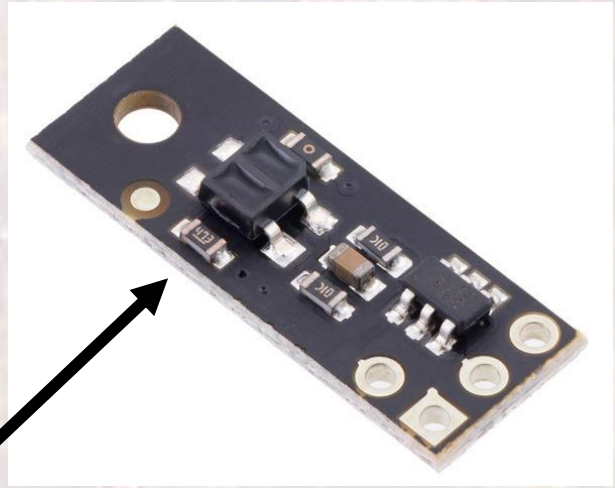




Line Sensor Review

- QTR-1A





Dark colored Resistor

Line Sensor Review

- QTR-1A

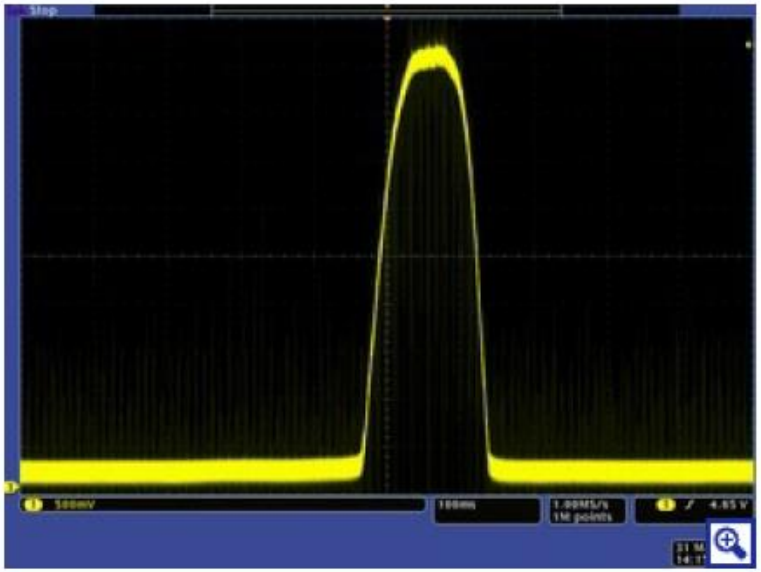
Optimal sensing distance: 5 mm

Maximum recommended sensing distance: 30 mm

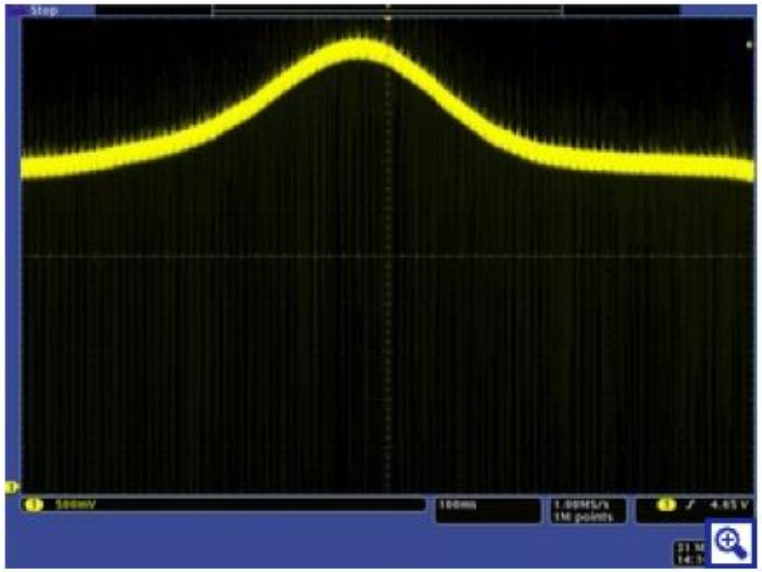
Line Sensor Review

- QTR-1A

Pololu - QTR-1A Reflectance Sensor (2-Pack)



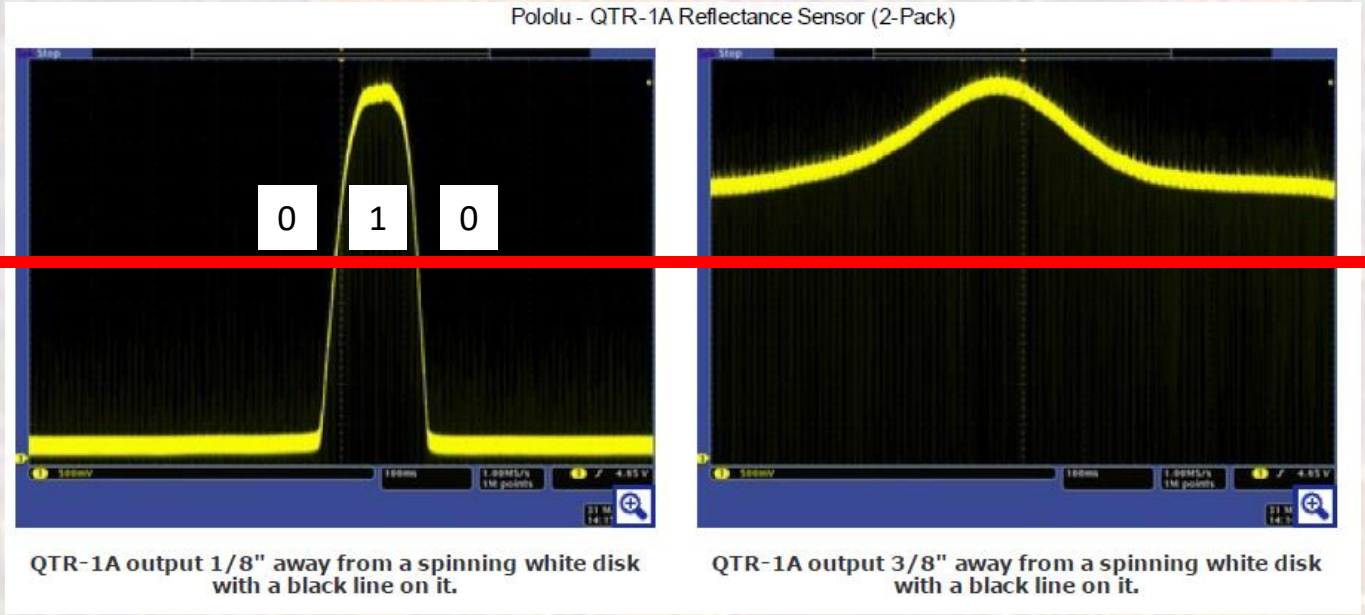
QTR-1A output 1/8" away from a spinning white disk with a black line on it.



QTR-1A output 3/8" away from a spinning white disk with a black line on it.

Line Sensor Review

- QTR-1A
  - Alternate solution
    - IFF you can get high enough signal
      - Simply tie the output to a digital input pin



Line Sensor Review

- QTR-1A
  - Operation
    - 3 options for operation
      - Polling (wait on A/D)
      - Interrupts (A/D conversion complete)
      - Direct digital Input