This file documents the Test Coach ä Corp. FINN ä color sensor product

Materials and information provided with the starter kit

1. Theory of operation
2. HP parts description library file (separate file).
3. HP sensor tests (separate files).
4. Instructions for development, integration and adjustment.
5. Instructions for fixture construction.
6. One sample sensor (choice of color; red, green, blue or clear) with Integrated bias resistor, and 2 QA slotted probes.

Theory of operation

The sensor is a low cost solution for detecting color of light emitting diodes (LED's). It is a combination of a photosensitive semiconductor and an optical filter. The filter is design to pass light from the target wavelength (color) and block light of wavelengths outside the target color wavelength. The sensor produces current when excited by the target wavelength of light. The current creates a voltage across the bias resistor, which is measured by the target test system.

The test is easy to adjust and maintain because it uses the tester resources that the test engineer is already familiar with. There are no potentiometers to adjust. Adjusting upper and lower limits in an analog test statement is all that is needed to support most applications.

The sensor is also very small allowing it to be easily mounted in the fixture near the LED's. There is usually no need for optical cables in the fixture. The sensor does not require power so only two wires are needed per sensor. A common return could be used in high LED count applications to reduce the wire resources to one per sensor plus one for the common return.

Wavelengths

LED Color	Nom.Wavelength	FINN type	Sensor Peak Sensitivity Wavelength / 50% bandwidth
Red	655-700nm	Red/TC3001	660nm / 615-705nm
Orange	605nm	Red/TC3001	660nm / 615-705nm
Yellow	585nm	Green/TC2901	540nm / 505-575nm
Green	560nm	Green/TC2901	540nm / 505-575nm
Blue	450-500nm	Blue/TC2801	460nm / 415-505nm
Any/Clear	N/A	Clear/TC8704	560nm/ 400-680nm

To understand the above chart only a few terms need to be defined. These definitions are suitable for this discussion but oversimplified for optical physic. The Nom. Wavelength column gives typical wavelengths emitted by standard LED's. The Sensor Peak Sensitivity Wavelength is the wavelength at which the sensor generates the most current per light striking the sensors active region. The 50% bandwidth entry is similar to a 3db point of an electronic filter. So light of a wavelength on the edge of the 50% bandwidth would produce half the current of the same amount of light at the Peak Sensitivity wavelength.

For example: A red LED may produce enough light on the active region of the red sensor for a voltage of 450mv to be developed across the sensor. A yellow led with the same light intensity might produce about 120mv and a green or blue LED even less. So setting the test limit at 300mv would guarantee a red led with a minimum working intensity is installed in the circuit card assembly (CCA).

From the above chart, you can see that it is difficult to detect the difference between green and yellow LED's. We now recommend using a green sensor. All the variables must be optimized and fault insertion must be used to set the limits. Variations from lot to lot may require additional tweaking of the test.

The clear sensor can be used to detect both elements of a bi-color LED turning on. Another way to check a red-green bi-color LED is to use 2 sensor at a 90degree angle to each other, one sensor green and one sensor red, then position these in front of the LED like a book. We have new FINN with a green and red sensor mounted to just 2 probes. The photosensitive areas of the sensors face each other but open like a V. The reading is positive for red and negative for green. These FINN's are currently available for SMT LED's emitting light perpendicular to the surface of the PCB. If you choose this method for side emitting LED's it will require a little more fixture setup.

LED Color	Nom.Reading On Red Finn	Nom.Reading On Green Finn	Nom.Reading On Blue Finn
Red	450mV	Less than 50mV	Less than 50mV
Orange	300mV	Less than 50mV	Less than 50mV
Yellow	200mV	200mV	Less than 50mV
Green	Less than 50mV	300mV	Less than 50mV
Blue/White	N/A	N/A	450mV
Readings are for new FINN resistor values	330k bias	510k bias	1.2Meg bias

Typical readings are taken at distance of 0.1-0.15 inches from the lens of the LED.

If readings for the target LED color are higher; then the sensor maybe close to saturation and effectiveness of the sensor is diminished. If you can adjust the intensity of the LED adjust it until the FINN reads the target voltage in the chart.

LED Color	FINN Saturation Voltage	Test voltage target	FINN suggested limits
Red	550mV	400mV	450/350mV
Orange	Using red FINN	300mV	350/250mV
Yellow	Using green FINN	200mV	250/150mV
Green	390mV	300mV	350/270mV
Blue/White	550mV	400mV	450/350mV

If the LED is too bright you can:

Reduce the intensity of the LED by reducing the drive current.
Cover part of the active area of the sensor to reduce light entering.
Move the FINN further from the LED.
Add resistance across the FINN.
Adjust the upper and lower limits in the test program.

With the LED off, the ambient light should not produce more than a 50mV reading.
If the ambient reading is higher try reducing the ambient light by shading the test area or by moving the FINN closer to the LED. Ambient light is not usually a problem in in-circuit test fixtures with over-clamps.
Note: if you are trying to detect the difference between *green* and *yellow* there must be no ambient light.

If readings for the target LED color are lower; then the LED may not be illuminated properly or the voltmeter may not have a high even input impedance (greater than 5megohm).

Please note these typical readings are for the new release of the FINNs with sensitivity enhancements. These readings will be slightly different from FINNs purchased before Jan-2002.

Fixture Considerations

The sensor is mounted using two 100mil sockets.
The placement of the pair of sockets is as follows:

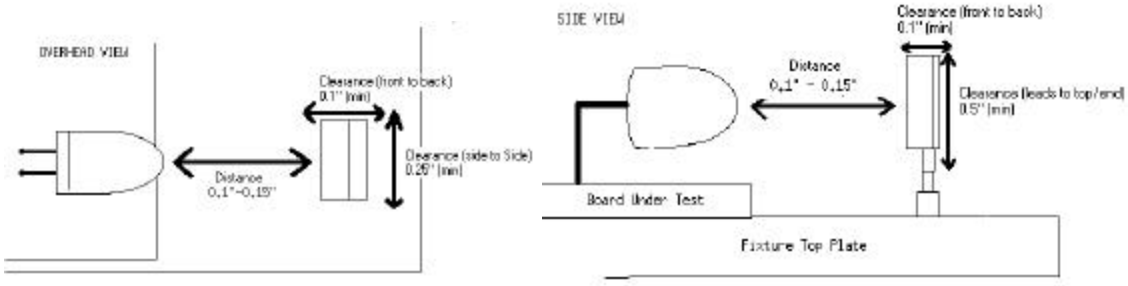
- Distance center to center (apart): 0.125” nominal +/- 0.01”
- Recommended Clearance/ milling: 0.25” minimum (side to side)
  0.15” minimum (front to back)
  0.50” minimum (leads to top/end)

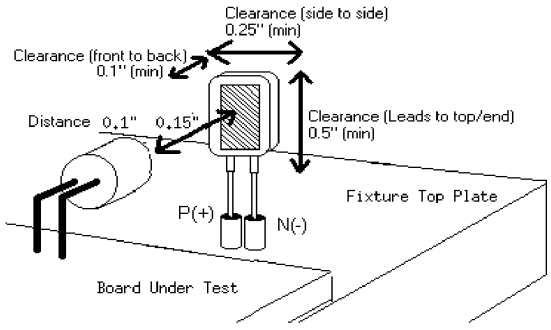
The face of the sensor must always be placed to maximize the light from the LED hitting the center of the active region of the sensor.

It is desirable to reduce the ambient light coming in from above the fixture. This can be done easily if there is a hold down gate. Material can be mounted on the hold down gate or if there is a solid lexan plate then black electrical tape can be used to block the light. The test method is tolerant of small changes of ambient light but if the ambient light is close to the intensity of the light from the LED’s then the test will not be reliable.

The 2 most common applications are LED’s on the edge of the board and SMT LED’s, which lay flat on the PCB. Each case is described below.

1. ***LED’s emitting light to the side of the PCB “Use Part # TCxxxxVP”***
   Recommended distances
   - Sensor lens to lens of LED:
     Minimum: 0.10” *Maximum*: 0.15” or more*
     *Depending on strength of light source and ambient light.
   - Sensor setup:
     - Align center of sensor active region with center of the LED lens.
     - There will be no compression of the probe.

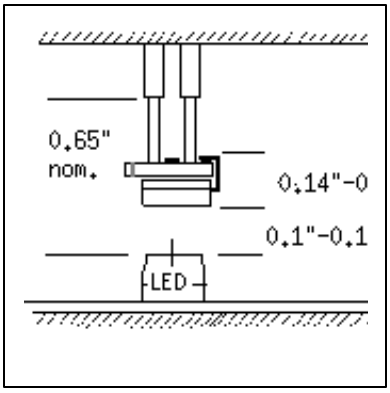


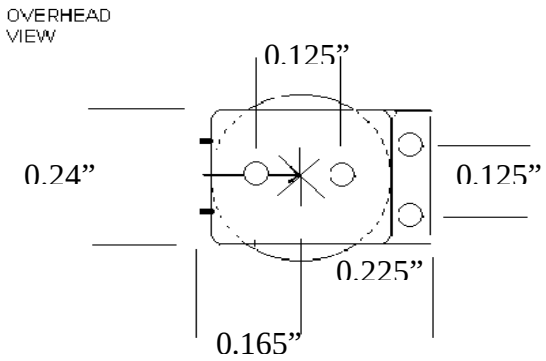


For HP programmer only, this is how to setup the part directly in HP board file and board_xy file.

- Make the LED a pin library. Then add 2 pins to the device. Name the 2 new pins func_p and func_n. The node names for the 2 pins should be easily identifable (such as fix_FINN_func_n, fix_led1_func_p). Use separate node name for each sensor positive pin.
- Give the part the appropriate part number (i.e the pde file name: led_grn, led_red …)
- Note: The pde file includes a diode test for the LED, self-test for the FINN, and the actual color sensing test.
- Calculate the pin x,y locations as below.
- Find edge of emitting lens or edge of the board. Add 0.1" in the direction away from the PCB for clearance.
- Find the center of the beam. Add +/-0.0625" perpendicular to the light beam. If the sockets are to be installed in the probe plate then the p-side will be clockwise. If the sockets are to be installed in the over-clamp, the p-side will be counterclockwise.
- Note: You may need to extend the outline of the board to encompass the probes.

2. ***SMT LED's emitting light perpendicular to the surface of the PCB " Use Part # TCxxxxRP "***
   Recommended distances
   - Sensor lens to top of LED:
     Minimum: 0.10" *Maximum*: 0.15" or more*
     *Depending on strength of light source and ambient light.
   - Sensor setup:
     - Seat topside probes so that a 0.250 stroke probe sits above the board 0.15 when engaged
     - Probe offsets from center of led light source
       1. +0.0625" one direction (p or n side probes)
       2. -0.0625" one direction (p or n side probes)





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- Give the part the appropriate part number (i.e the pde file name: led_grn, led_red …)
- Note: The pde file includes a diode test for the LED, self-test for the FINN, and the actual color sensing test.
- Calculate the pin x,y locations from drawings above or use the FINN_Calculation basic program provided with the starter kit.