LinLED Contactless Sensor Module
PROTOTYPE V5 User's Guide

Developped by
LinLED Team

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2024

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SATT SUD-EST
ACCÉLÉRONS LE TRANSFERT DE TECHNOLOGIES

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Prototype V5 :

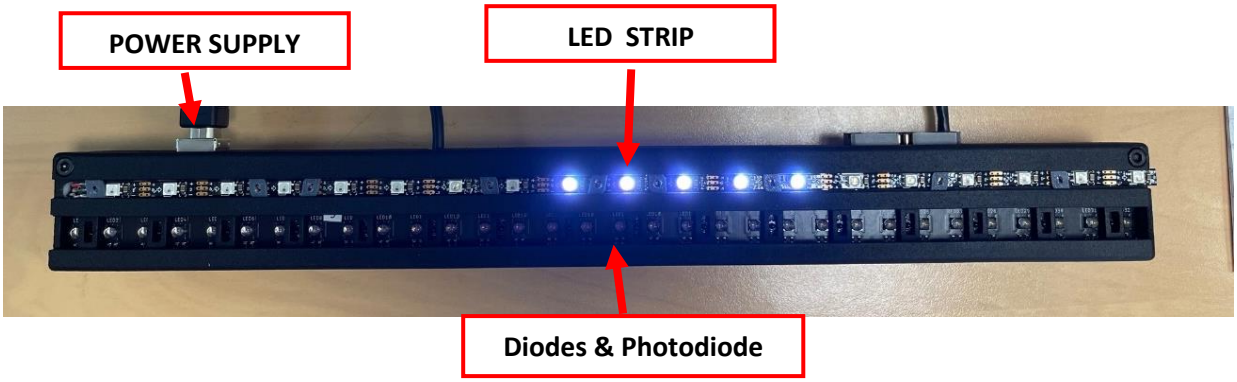
CAD Files attached :

Eagle Files :

- Bottom board Prototype 5 : PROTO_V5.2_Back.brd
- Bottom board Prototype 5 : PROTO_ V5.2_Back.sch
- Top board Prototype 5 : PROTO_ V5_Front.brd
- Top board Prototype 5 : PROTO_ V5_Front.sch
- Triple Power Supply board: ALIM_PROTOV5_3.sch
- Triple Power Supply board: ALIM_PROTOV5_3.brd
- Single Power Supply board: PROTO_V5_SIMPLE.sch
- Single Power Supply board: PROTO_V5_SIMPLE.brd

- 3D FILES.

Product Overview:



Characteristics:

Detect Length	320 mm (stackable 640,960mm)
Detect range	Up to 500 mm
Dimensions	320x35x20 mm
Max analog response time	400µs
Max resolution	320µm (Test bench limit)
Technologies	Infra-red
Type of Interaction	Finger, hand, IR Reflective object.

Assembly Diagram:

TRIPLE VERSION :

Proto 3	Proto 1	Proto 2

DOUBLE VERSION :

Proto 4	Proto 5

Prototype Listing:

Assembly	Prototype N°	Type	Configuration	Firmware Teensy 4.0
TRIPLE 930mm	1	Main 1	MAIN / SIMPLE	LinLED_V25_Coffee_PD_Serial_TRIPLE_1_V1
	2	Right 1	SIDE RIGHT	-
	3	Left 1	SIDE LEFT	-
DOUBLE 620mm	4	Main 2	MAIN / SIMPLE + LED	LinLED_V25_Coffee_PD_Serial_DOUBLE_4_V2
	5	Right 2	SIDE RIGHT + LED	-
SINGLE	6	Main 3	MAIN / SIMPLE	LinLED_V25_Coffee_PD_Serial_SIMPLE_6_V1_ino
SINGLE	7	Main 4	MAIN / SIMPLE	LinLED_V25_Coffee_PD_Serial_SIMPLE_7_V1
SINGLE	8	Main 5	MAIN / SIMPLE	LinLED_V25_Coffee_PD_Serial_SIMPLE_8_V1
SINGLE	9	Main 6	MAIN / SIMPLE + LED	LinLED_V25_Coffee_PD_Serial_SIMPLE_9_V1
SINGLE	10	Main 7	MAIN / SIMPLE + LED	LinLED_V25_Coffee_PD_Serial_SIMPLE_10_V2

Prototype V5 Electrical Diagram :

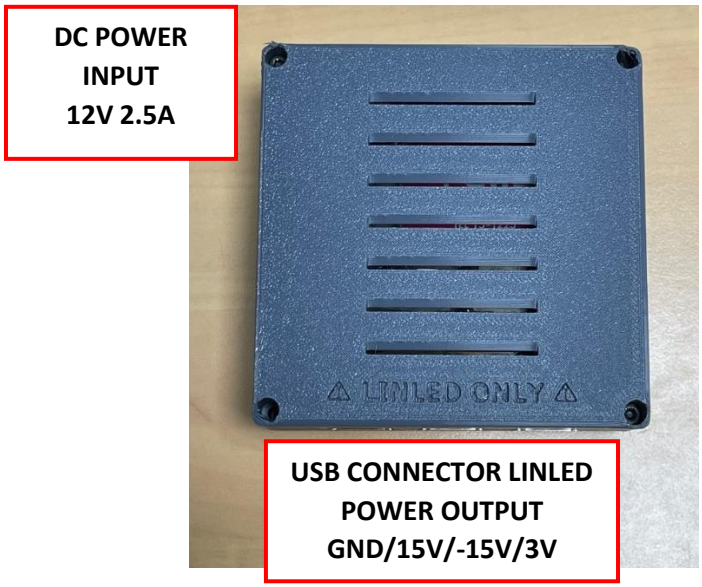
WARNING : LinLED prototype use common USB connector from LinLED Power Block. Make sure you don't plug USB – LinLED Integrated Teensy or other device on the USB POWER OUTPUT -15/+15/3V.

LinLED Prototype overview:

LinLED Prototype Wiring:

LinLED Power Supply Block :

POWER SUPPLY 3 Output :

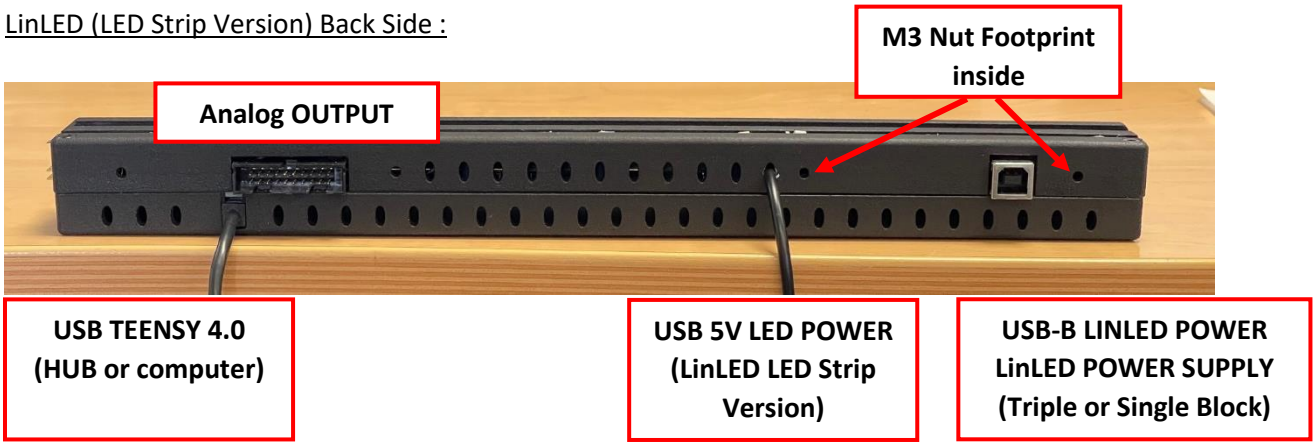


POWER SUPPLY Single Output :

WARNING : LinLED prototype use common USB connector from LinLED Power Block. Make sure you don't plug USB – LinLED Integrated Teensy or other device on the USB POWER OUTPUT -15/+15/3V.

Prototype V5 Pinout :

LinLED (LED Strip Version) Back Side :



Analog Ouput Pinout : 10x2 2.54mm Connector :

Analog Average	GND	S2	S4	S6	S8	S10	S12	S14	S16
Analog Sum	GND	S1	S3	S5	S7	S9	S11	S13	S15

Position Processing :

$$Weighted\ Sum\ \ S = \frac{1}{K}\sum_{1}^{16} i \times V_i$$

$$Unweighted\ Sum\ (Average)\ M = \frac{1}{K}\sum_{1}^{16} V_i$$

$$Normalized\ Sum\ \ S_n = \frac{S}{M}$$

$$Horizontal\ Position\ X\ (mm) = K \times\ S_n$$

$$Height\ Y\ (mm) = K \times\ M\ (\ Linear\ Approx.)$$

WARNING : Output analog Signal can be over 3.3V (0-5V signal) if you place mirror of reflective material on LinLED

LinLED Teensy 4.0 Firmare :

LinLED use a internal Teensy 4.0 microcontroller on a socket to acquire data, process to get x y position, speed, acceleration, detect gesture, send keyboard/mouse USB communication and control external Adafruit Led Strip.

there is limit to detect user presence and gesture. This defined threshold can change because it depend currently of environment, reflectivity, perpendicular screen, plexiglass, room and ceiling. This limit for each prototype can be adjust and is a bit more than minimum moy value(1,2,3) when there is no interaction and no user in LinLED Range.

LinLED Firmware Variable Adjustment :
Here a simple process to adjust LinLED variable if the last firmware don't match with a new configuration.

LinLED Firmware configuration :

Important variable to configure depending on your hardware and your need are :

1- Line 162 setup : configuration = 3; 1 for 1 main LinLED, 3 for 1meter version, 2 for 1 main and right side linLED (620mm)

LinLED Firmware X and Y Axis calibration :

1- In Setup line 182 : Sumnorm min and max for each prototype need do be measure to get the linear coefficient to convert normalized sum (Unitless) and X (mm) with conversion coef.

```
// Calibration Value & Calculation
  sumnorm_min=90.0;   //ok
  sumnorm_max=250.0;  //ok
  sumnorm2_min=90.0;  //ok
  sumnorm2_max=230.0; //ok
  sumnorm3_min=90.0;  //ok
  sumnorm3_max=280.0; //ok

  detect_length= 310;

  conversion_coef = detect_length/(sumnorm_max-sumnorm_min);
  conversion_coef2 = detect_length/(sumnorm2_max-sumnorm2_min);
  conversion_coef3 = detect_length/(sumnorm3_max-sumnorm3_min);
```

2- There is direct coefficient/value to computing y_main as below (in main loop):

```
y_main = (moy3Value*(-0.687)+617.4);
```

Please note that this is approximation of y value because it directly link to the Infrared Light you reflect and depend of your finger, hand, position in the sensor field. Moreover, Y position for a fixed type of interaction is not linear and closer to be:

$$Y_{position}(mm) = \frac{A}{d^2} \qquad A\ coefficient, d\ hand\ reel\ position\ (mm)$$

LinLED Firmware detection calibration :

1- Uncomment debug frame function :

```
send_trame();// envoie de trame serie debug
```

2- Start LinLED and check moy3Value moy1Value moy2Value in serial print

3- Compare moy3Value moy1Value moy2Value to

```
const float moyseuil = 160.0;       // Declaration Seuil de detection
proto1//  Config  LinLED 1m : (LinLED 3+ LinLED 1 main+ LinLED 2)
const float moyseuil2 = 130.0;      // Declaration Seuil de detection
proto2
const float moyseuil3 = 125.0;      // Declaration Seuil de detection
proto3
```

Moyseuil must be 5-10 unit higher than average moyvalue (with interaction).

4- Upload your new Firmware on LinLED's Teensy 4.0 with librairie and correct uploading parameters :

   Board : "Teensy 4.0"
   Port Serial Teensy Port
   Keyboard Layout :"French"
   Optimize : "Faster"
   CPU Speed : "600MHz"
   USB Type : "Serial+Keyboard+Mouse+Joystick"

5- You can control threshold and then commented again line 273 : send_trame();

LinLED Main loop Process :

LinLED Firmware use a main loop processing to update acquisition with about 240 Hz frequency.

The case studie is the general 1meter linLED (Left+ main+Right prototype combined)

The main loop process function below before start again and again:

- Dual : function to find if there is user detection and wich linLED detect it (1, 2, 3 or 12, 23, 31)
- If detection :Computing Position X main and Y main (read_adc function and switch case)
    - Led Strip handposition display
    - Send serial data frame

    - One time on n_geste loop turn(~50Hz) there is speed, acceleration and gesture processing.

- Else (no interaction detect) : reset gesture, detection variable led strip,flag,…

Read adc function :

Acquisition function of average value and weighted sum value for each LinLED Prototype (1 main, 2 right, 3 left) and numeric adc averaging (n=20 value to reduce noise)

Computing each linled x and y position.

Gesture function :

The LinLED Firware run the Gesture analyse function every 20ms to detect different kind of simple gesture and control Led Strip, mouse/Keyboard HID, serial print (Pure Data Frame or python, C,…)

There is condition to validate to get a gesture about position velocity, first flag,…

Ready state is a state detected where user is linled field and relatively “static” and reday to execute nest a gesture.

Click flag state is first step detected on a top/bottom clic type used as a condition to detec final Click

Click detection need a first step detection (Click Flag) to be detected. (check condition in gesture function).

There similar process to get swipe R/L detection, shortcut display and selection.

Version :

All firmware can change to ajust to demonstration and hadware :
Stellantis demonstration

- Stellantis :
  - LinLED_V21_IHM_PD_Serial_2024_commented.ino (last)
  - LinLED_V21_IHM_PD_Serial.ino
- Technologies Based Magic :
  - LinLED_V28_TBM__SWIPE_CLIC_dynamic.ino
  - LinLED_V27_TBM__SWIPE_CLIC_static.ino(staic click version)
- Coffee machin demonstrator
  - LinLED_V25_Coffee_PD_Serial.ino (last)

Led Strip display function :

Some function at the end of firmware can display graphic design with color and animation with the Adafruit 60Leds/m LED Strip.

- LED_off() : swith off Led Strip
- LED_tracking(Color) switch on some Led to track the hand position detect (NOT USED)
- LED_tracking2(n) tracking hand position with variable color side and position
- LED_Flash(strip.Color(255,255,255)) : 30ms flash on entire strip (used for clic)
- Top_Display() display colored segments top menu shortcut for Stellantis IHM demonstration
- Top_select() specific shortcut menu Stellantis IHM selection
- Click_LED() // Left And Right colorised from departure pixels color
- LED_Swipe_Left(strip.Color(255,255,255)) : Color wave from right to Left
- LED_Swipe_Right(strip.Color(255,255,255)) : Color wave from left to Right
- theaterChaseRainbow : Raimbow color function (NOT USED)

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