2-Lane Flat Track Drag Race Timer

For 1/10 Scale RC Cars - Version 4E (English)

This timer design is intended for those who wish to replicate the features of a professional drag race system into their 1/10 scale Radio Controlled (RC) car race events. It incorporates functions that mimic electronic timing systems associated with professional drag strips including:

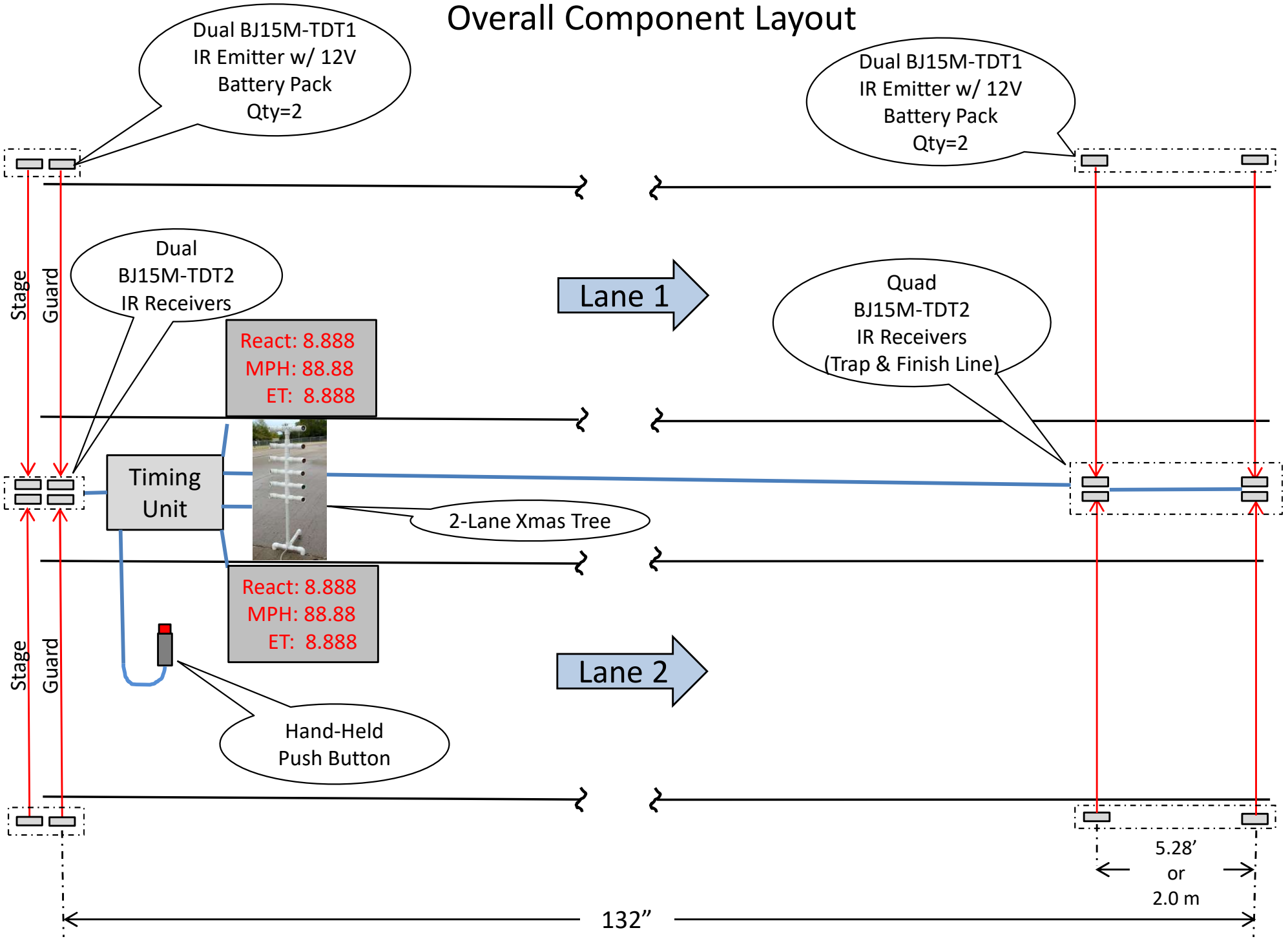
- A functional Light Tree using bright LEDs
- Vehicle staging with Christmas Tree indication (Sorry…No pre-staging)*
- Measurement/Display of Reaction Time, Speed (Selectable in MPH or km/h) and Elapsed Time (ET)
- Selectable Standard / Professional Tree Operation
  - Timing is 0.4 Sec. Pro and 0.4 Sec. STD (Sportsman/Full) setting IAW Radio Controlled Drag Racing League (RCDRL) 2022 Rulebook
- Selectable Manual / Auto start timing
- Winner indication on Light Tree
  - Automatic winner determination IAW Radio Controlled Drag Racing League (RCDRL) 2022 Rulebook

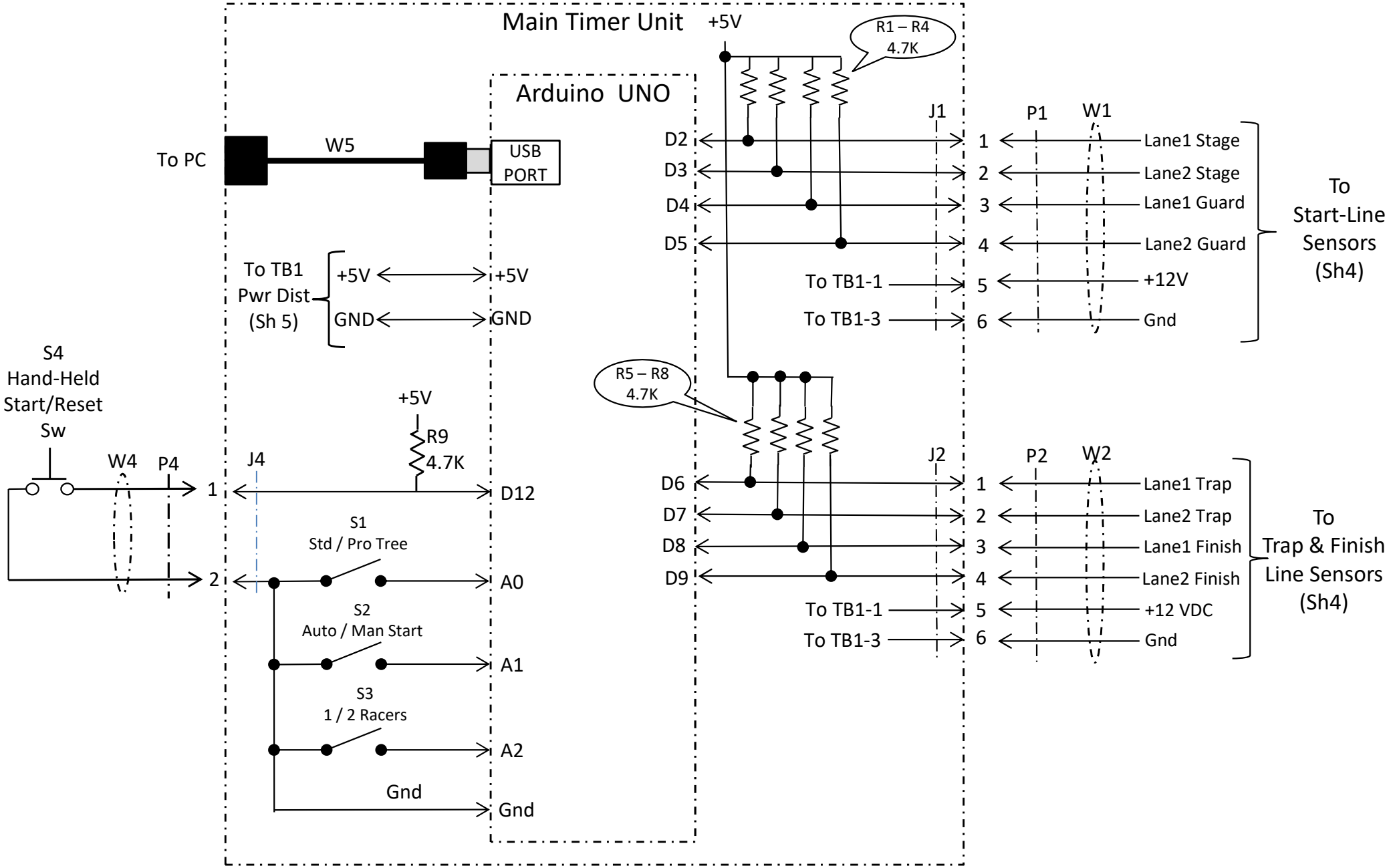
*Note: Many RC cars do not have adequate chassis/ground clearance to permit start line staging based on front wheel position. Hence, this version uses the car's body to detect its position for pre-stage and stage indications. A "guard" beam positioned about 1" forward of the stage beam is used to detect when the car leaves the start line.

This version is a stand-alone 12 volt battery operated system designed for portability and easy setup. It is controlled by a single hand-held pushbutton. Numeric displays are used to display the racer's reaction time, speed and elapsed time (ET) at the end of each race. As an option, a USB interface is provided for connecting to a PC running the author's race management software that can also control the timer, display and save the race results.

This design uses the Autonics™ BJ15M-TDT 'through beam' IR emitter and receiver pairs positioned at the start line, trap and finish line positions of both lanes.

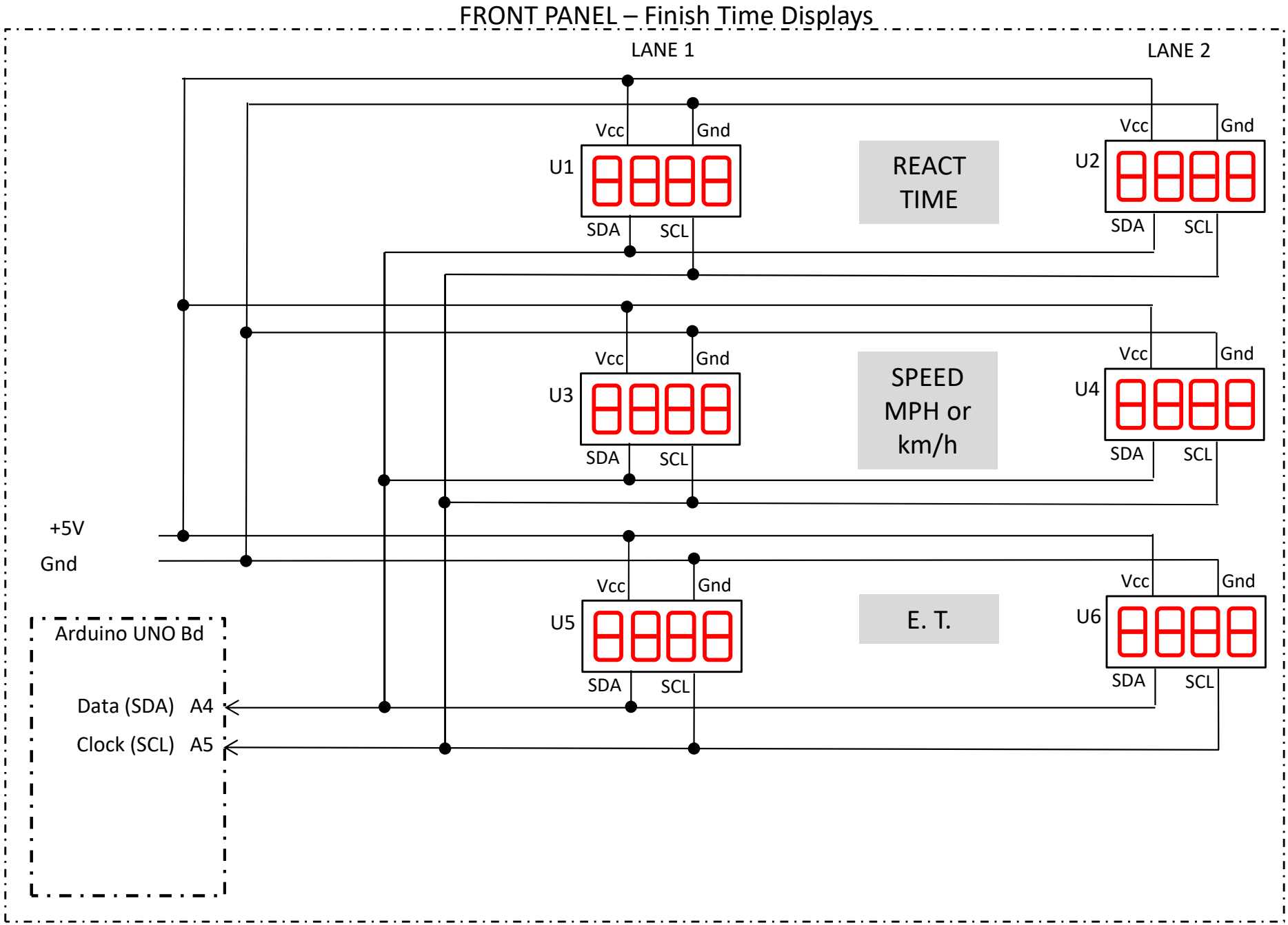
Overall Component Layout





SCHEM DIAG: RC DRT Ver4 Sh1 of 7

Designed by: W. van Leeuwen
Email: billv923@outlook.com



Note:
See Design Notes for configuring the Adafruit display address jumpers.

SCHEM DIAG: RC DRT Ver4 Sh2 of 7

Designed by: W. van Leeuwen
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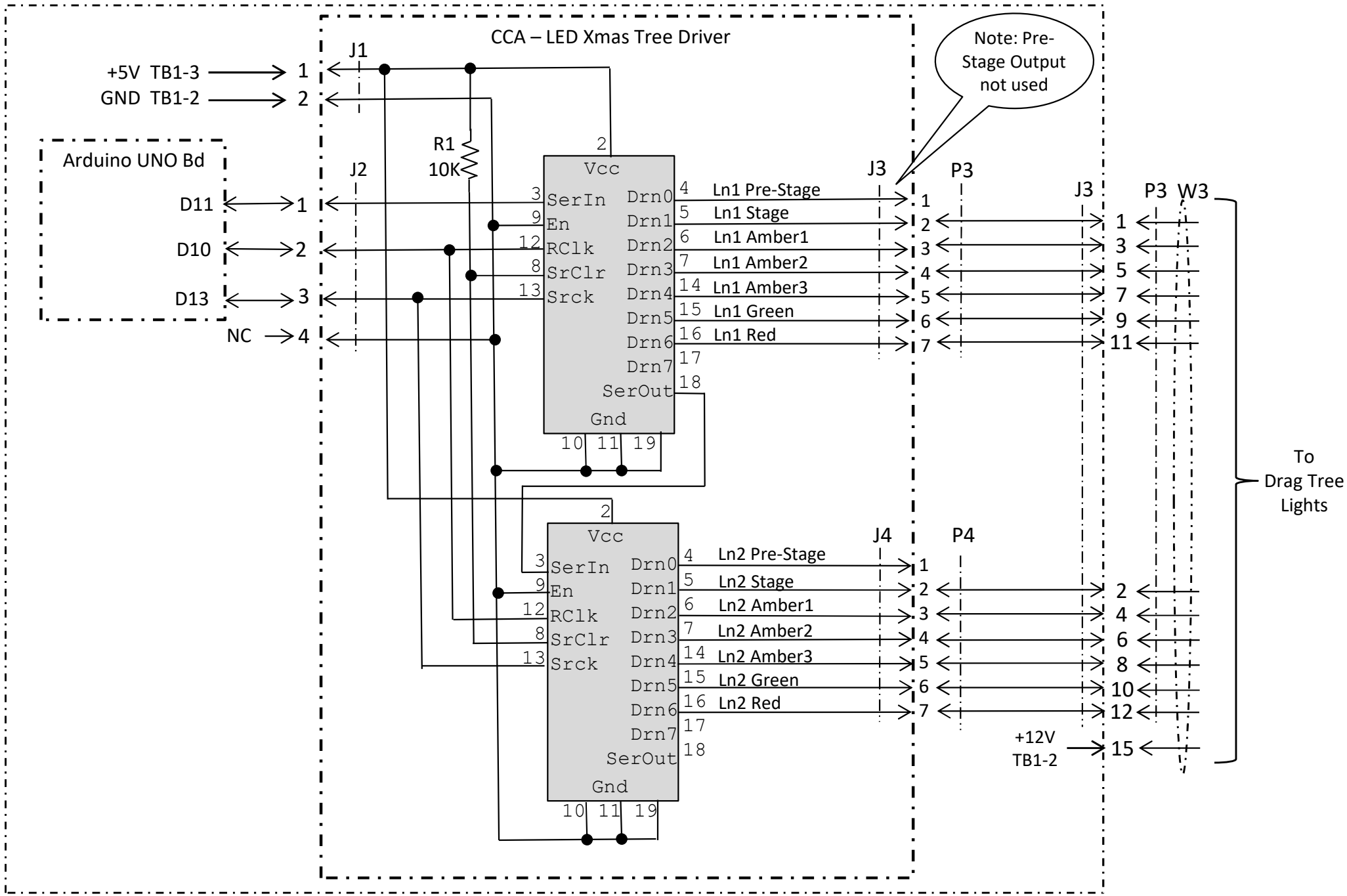
Light Tree Lamp Driver



SCHEM DIAG: RC DRT Ver4 Sh3 of 7

Designed by: W. van Leeuwen
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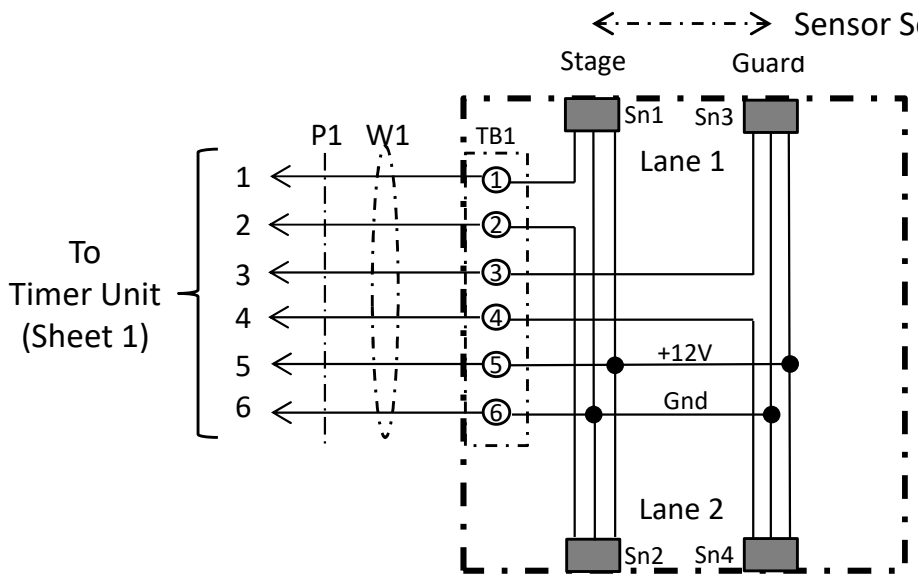
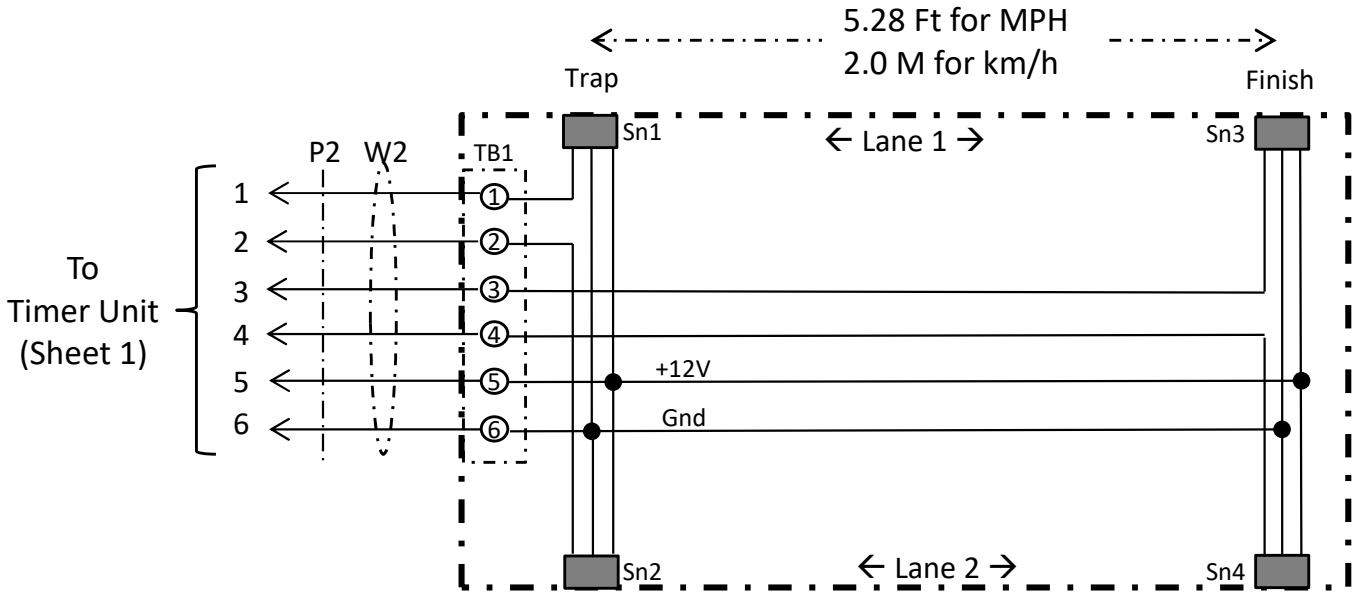
AUTONICS™ BJ15M-TDT IR RECEIVERS



Lane 1 & 2
Start Line Sensors



Lane 1 & 2
Trap & Finish Line Sensors

SCHEM DIAG: RC DRT Ver4 Sh4 of 7

Designed by: W. van Leeuwen
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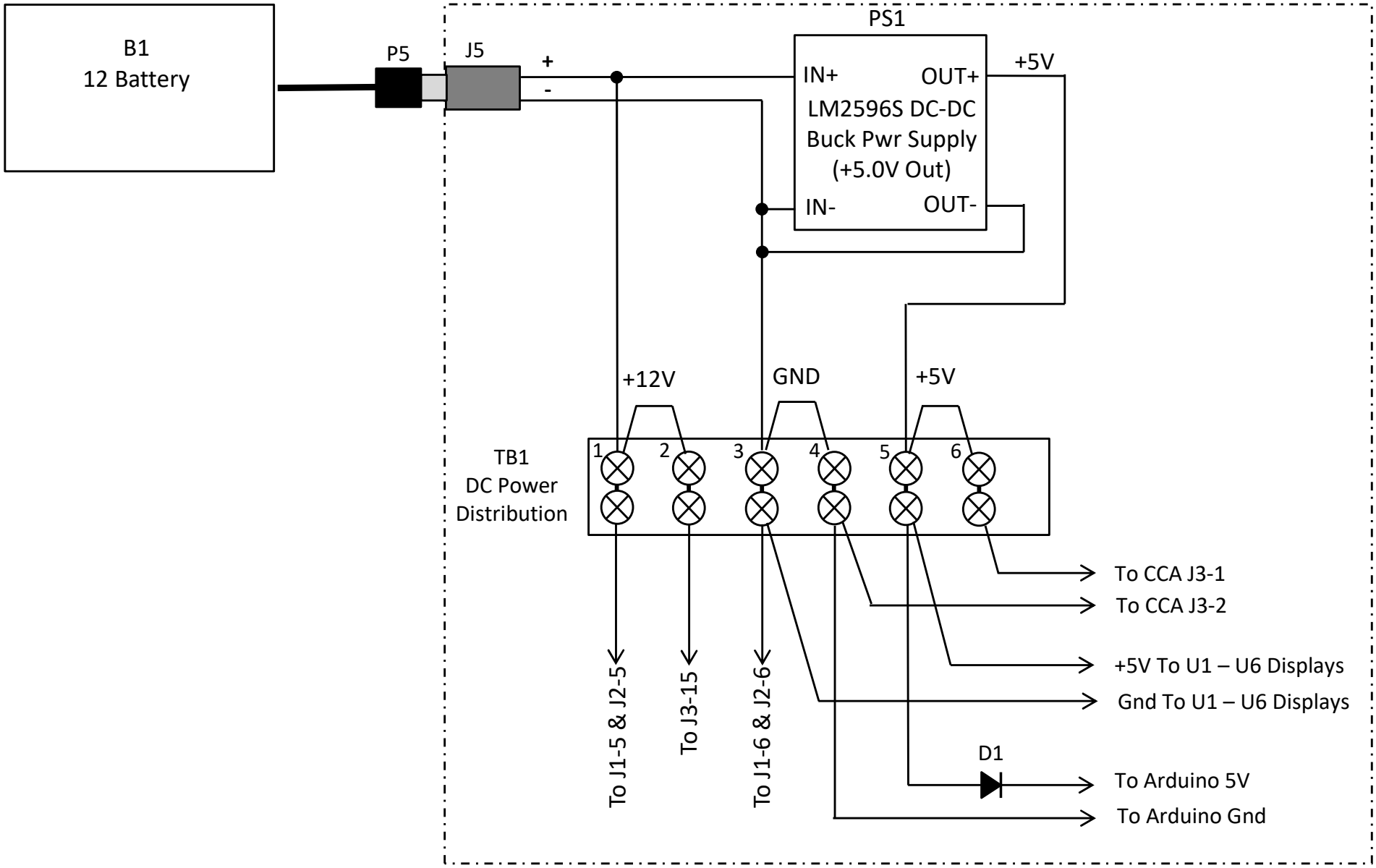
Power Distribution



SCHEM DIAG: RC DRT Ver4 Sh5 of 7

Designed by: W. van Leeuwen
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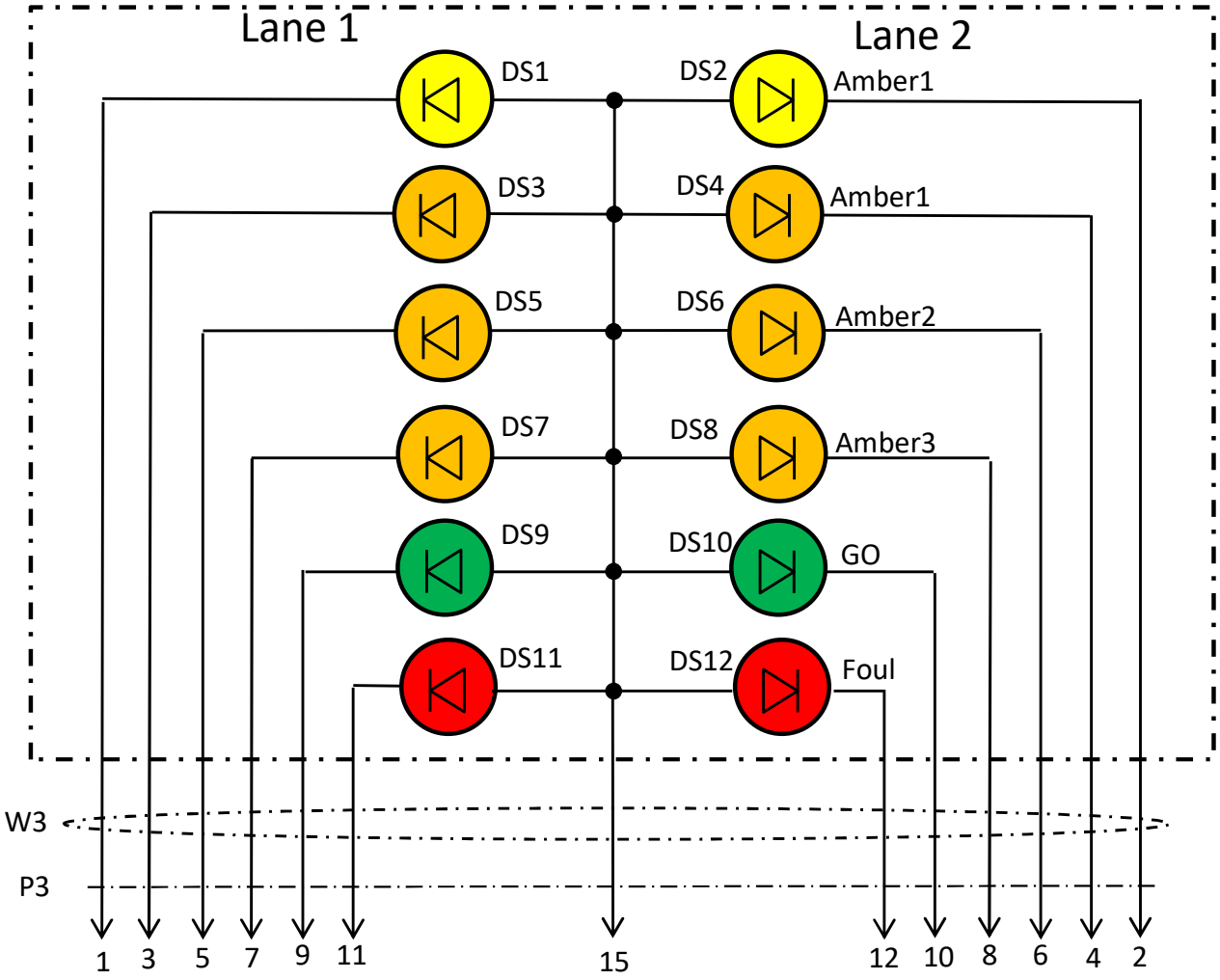
LIGHT TREE UNIT



See separate parts list and design notes for building this light tree.

SCHEM DIAG: RC DRT Ver4 Sh6 of 7
Designed by: W. van Leeuwen
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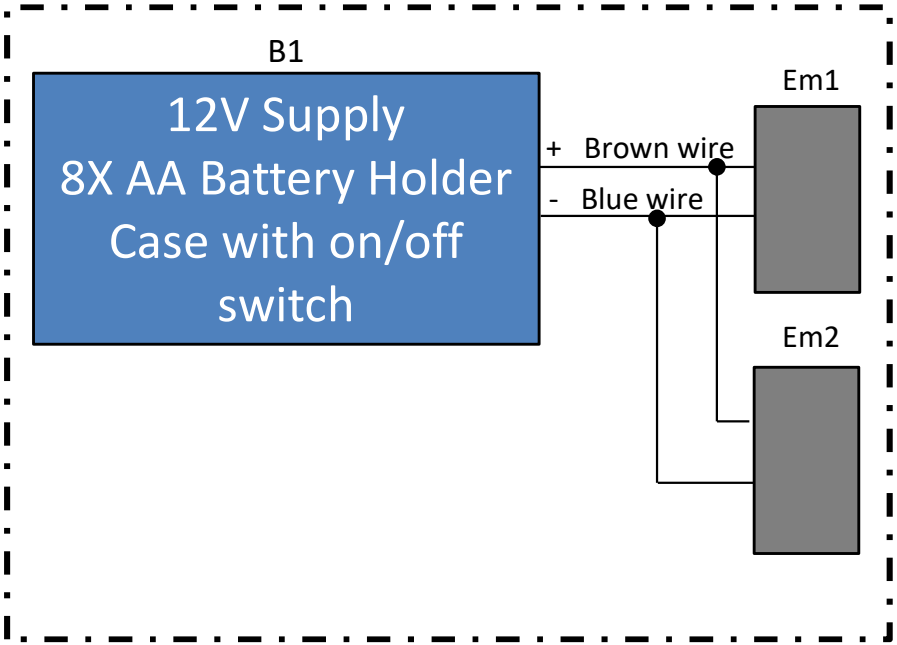
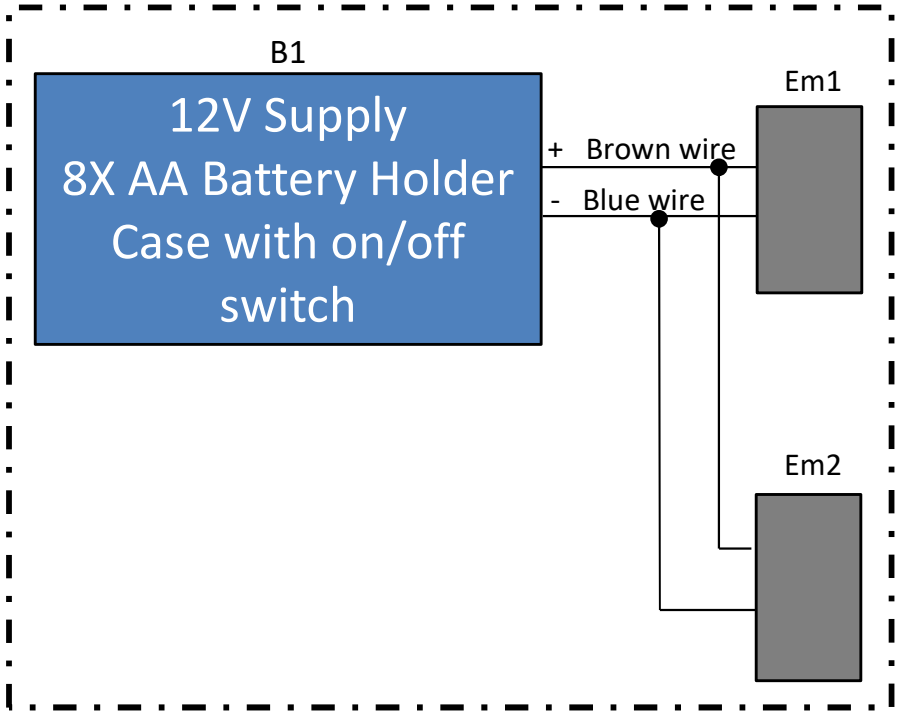
AUTONICS™ BJ15M-TDT IR EMITTERS

Lane 1 & 2
Start Line Emitter Assy (Qty=2)



Lane 1 & 2
Trap/Finish Line Emitter Assy (Qty=2)



SCHEM DIAG: RC DRT Ver4 Sh7 of 7
Designed by: W. van Leeuwen
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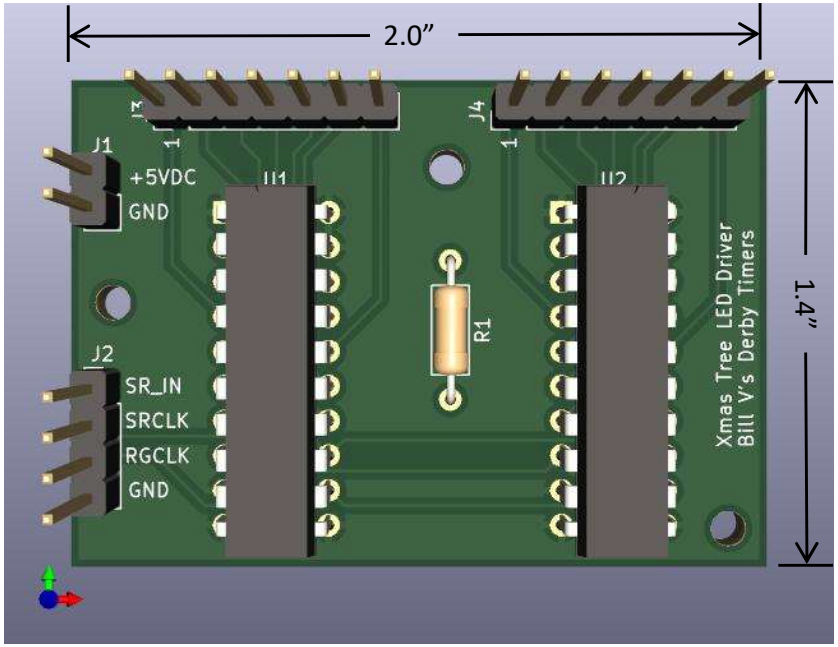
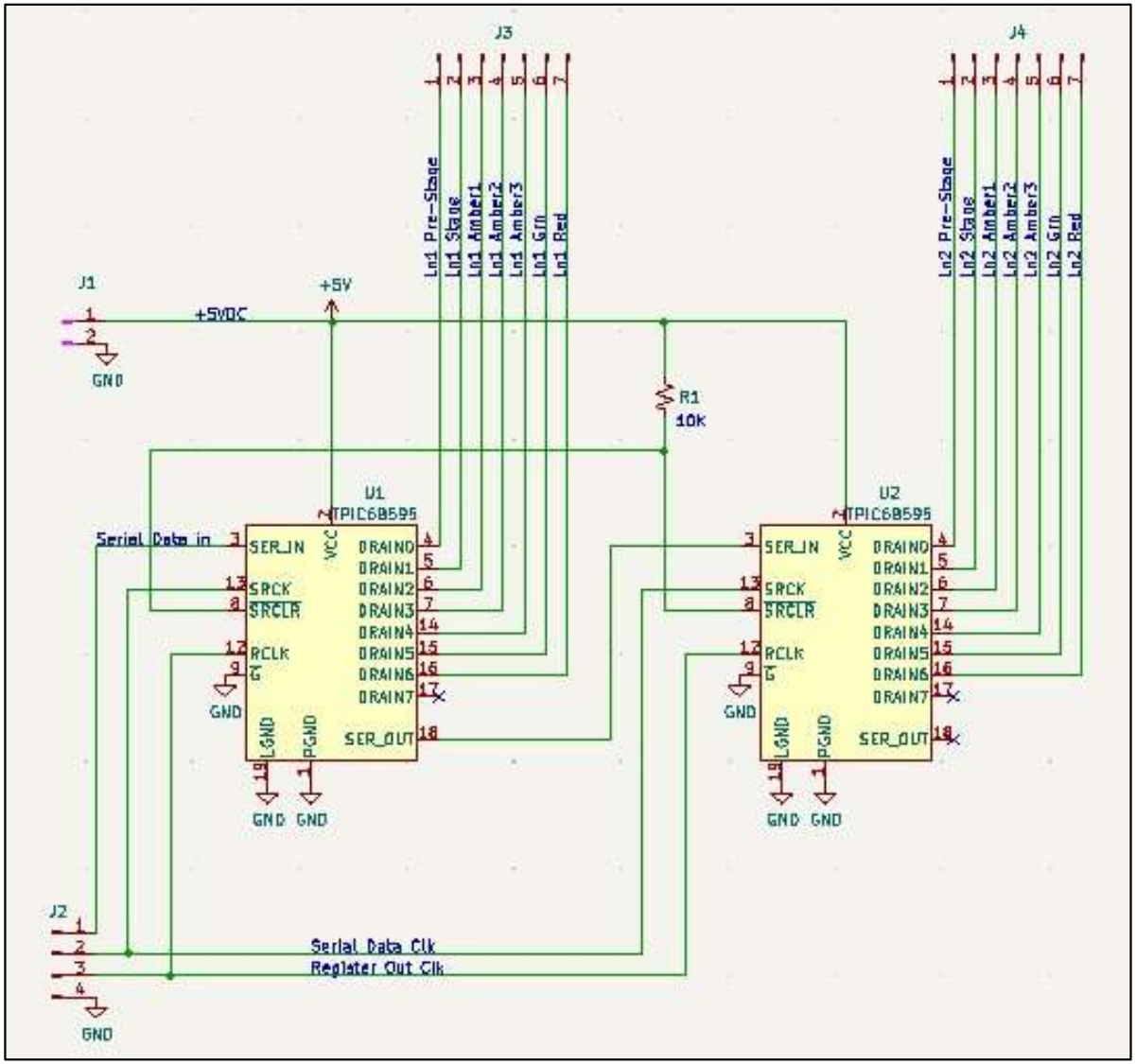
CCA - LED Xmas Tree Driver Circuit Board Assy





Circuit board was designed using KiCad software downloadable for free from the WEB at: **kicad.org/download**

Circuit board was manufactured by OSHPARK (ref. **https://oshpark.com**)

The following file provided in this design package can be uploaded to Oshpark to have the board manufactured by them:

- LED_XmasTree_Driver_Ver3.kicad_pcb

Fully assembled boards can also be purchased from the author for a fee.

Drag Race Timer Schematic Diagram

Suggested Parts List*

Ref.	Qty	Description	Part No.	Manufacturer
TIMER UNIT				
--	1	Circuit Board: Arduino UNO	See www.Arduino.cc	Arduino
--	1	Circuit Board Assy – LED Xmas Tree Driver (See separate parts list)	n/a	
D1	1	Schottky Diode, 1 amp, 30v	1N5818 or Equiv.	Various
S1 – S3	3	Switch, miniature toggle, SPST	Various	Various
S4	1	Pushbutton switch (hand held)	See EBay	
R1 – R9	9	Resistor, 4.7K-Ohm, ¼ Watt	NTE QW247	NTE Electronics
TB1	1	Cinch Terminal Block, 6 Position, #6-32 screw size	Various	Cinch or Waldon
PS1	1	DC-DC Buck Power Supply, 5VDC Output (1Amp Minimum)	LM2596S	
J1, J2	2	Panel Mount 16mm Dia. Screw 6 Pin Metal Aviation Receptacle (See separate sheet for more info)	See EBay	TBD
J3	1	Connector, Female DB-15 D-Sub, 2 Row, 15-Pin Jack, Panel Mount		
J4	1	Jack, ¼" Phone, Monaural, Panel Mount	See EBay	TBD
P4	1	Plug, ¼" Phone, Monaural	See EBay	TBD
J5	1	Jack, DC Power Socket Female Panel Mount Connector, 5.5mm	See EBay	TBD
P5	1	Plug, DC Power, 5.5mm	See EBay	TBD

*Notes:

- The Autonics BJ15M-TDT sensors are purchased as a pair with 1 emitter unit and 1 sensor unit
- Parts can be substituted to meet the builder's desires/needs (i.e. choice of switches or connectors).
- Parts list does not include enclosure (box) or mounting hardware (screws, circuit board standoffs, etc.).

Drag Race Timer Schematic Diagram

Suggested Parts List (Cont.)*

Ref.	Qty	Description	Part No.	Manufacturer
TIMER UNIT (Cont.)				
U1 – U6	6	Adafruit 4-digit, 7-segment numeric display w/ I2C Backpack	Adafruit 878 (red) (Other colors Avail.)	Adafruit
W4	1	Cable, 2 conductor, 20 Ft (Make from light duty 16AWG extension cord)	TBD	Various
W5	1	USB Male to USB 'B' Female Socket Printer Panel Mount Extension Cable	(See EBay)	Various

Ref.	Qty	Description	Part No.	Manufacturer
LED DRIVER CCA ASSY				
---	1	Circuit Board – LED Xmas Tree Driver (Design by: Bill V's Derby Timers)	n/a	OSHPARK
U1, U2	2	Power Logic 8 Bit Shift Register, 20 Pin DIP	TPIC6B595	Texas Instruments
R1	1	Resistor, 10K-Ohm, ¼ Watt	NTE QW310	NTE Electronics
J1	1	Connector, Male Header, 1 x 2, 2.54mm Pitch	Various	Various
J2	1	Connector, Male Header, 1 x 4, 2.54mm Pitch	Various	Various
J3, J4	2	Connector, Male Header, 1 x 7, 2.54mm Pitch	Various	Various

Drag Race Timer Schematic Diagram

Suggested Parts List (Cont.)*

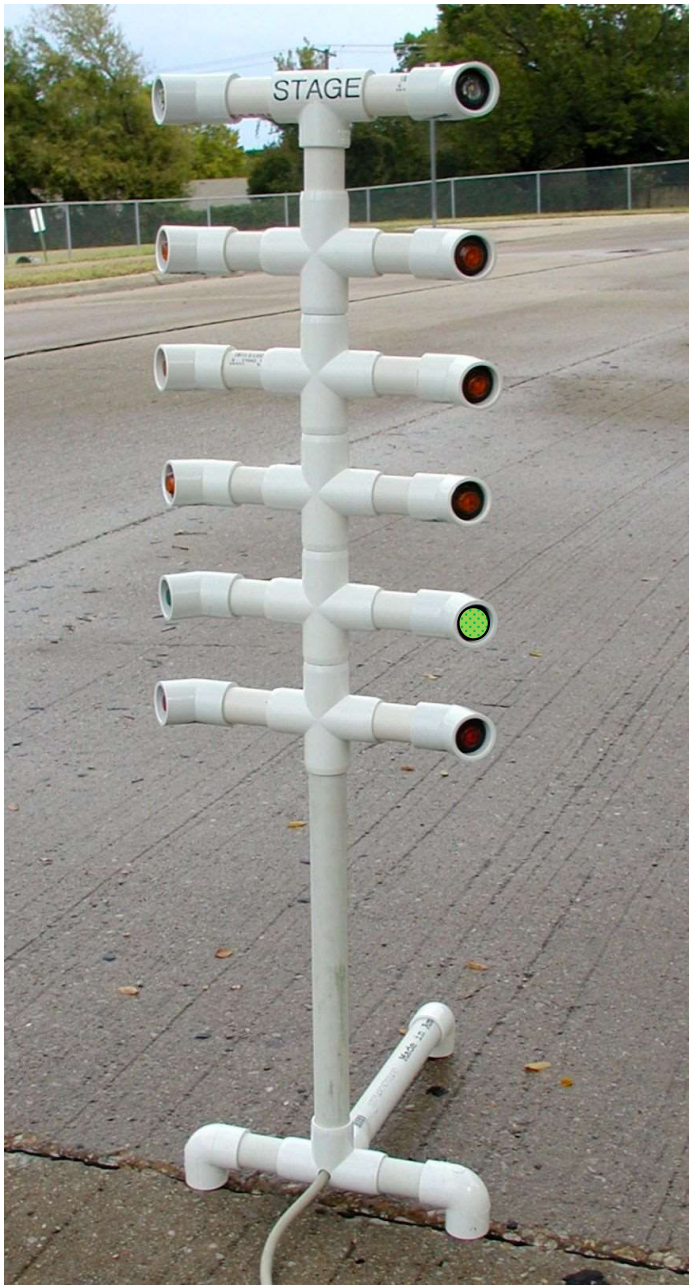
Ref.	Qty	Description	Part No.	Manufacturer
START LINE STAGE & GUARD SENSOR UNIT				
Sn1 – Sn4	4	Infrared trough-beam Sensor	BJ15M-TDT2	Autonics
TB1	1	Terminal Block, 6 position, #6-32 screw	TBD	Cinch/Walden
W1	15 ft	Cable, 6 conductor, 18 AWG sprinkler system cable	54706	Southwire
P1	1	16mm Dia. Screw 6 Pin Metal Aviation Plug (See separate sheet for more info)	See EBay	TBD
START LINE EMITTER UNIT (Qty of 2 required – 1 for each lane)				
Em1, Em2	2	Infrared trough-beam Emitter	BJ15M-TDT1	Autonics
B1	1	12V Battery Pack, 8X AA Battery Holder Case with on/off switch	See EBay	TBD
TRAP & FINISH LINE SENSOR UNIT				
Sn1 – Sn4	4	Infrared trough-beam Sensor	BJ15M-TDT2	Autonics
TB1	1	Terminal Block, 6 position, #6-32 screw	TBD	Cinch/Walden
W2	130’	Cable, 6 conductor, 18 AWG sprinkler system cable	54706	Southwire
P2	1	16mm Dia. Screw 6 Pin Metal Aviation Plug (See separate sheet for more info)	See EBay	TBD
TRAP & FINISH LINE EMITTER UNIT (Qty of 2 required – 1 for each lane)				
Em1, Em2	2	Infrared trough-beam Emitter	BJ15M-TDT1	Autonics
B1	1	12V Battery Pack, 8X AA Battery Holder Case with on/off switch	See EBay	TBD

LIGHT Tree Construction

The light tree can be constructed using ¾” Schedule 40 PVC pipe & fittings available at most hardware stores. Alternately, “furniture grade” PVC pipe and fittings can be used, are available in various colors and can be purchased online (Ref. www.pvcfittingsonline.com).

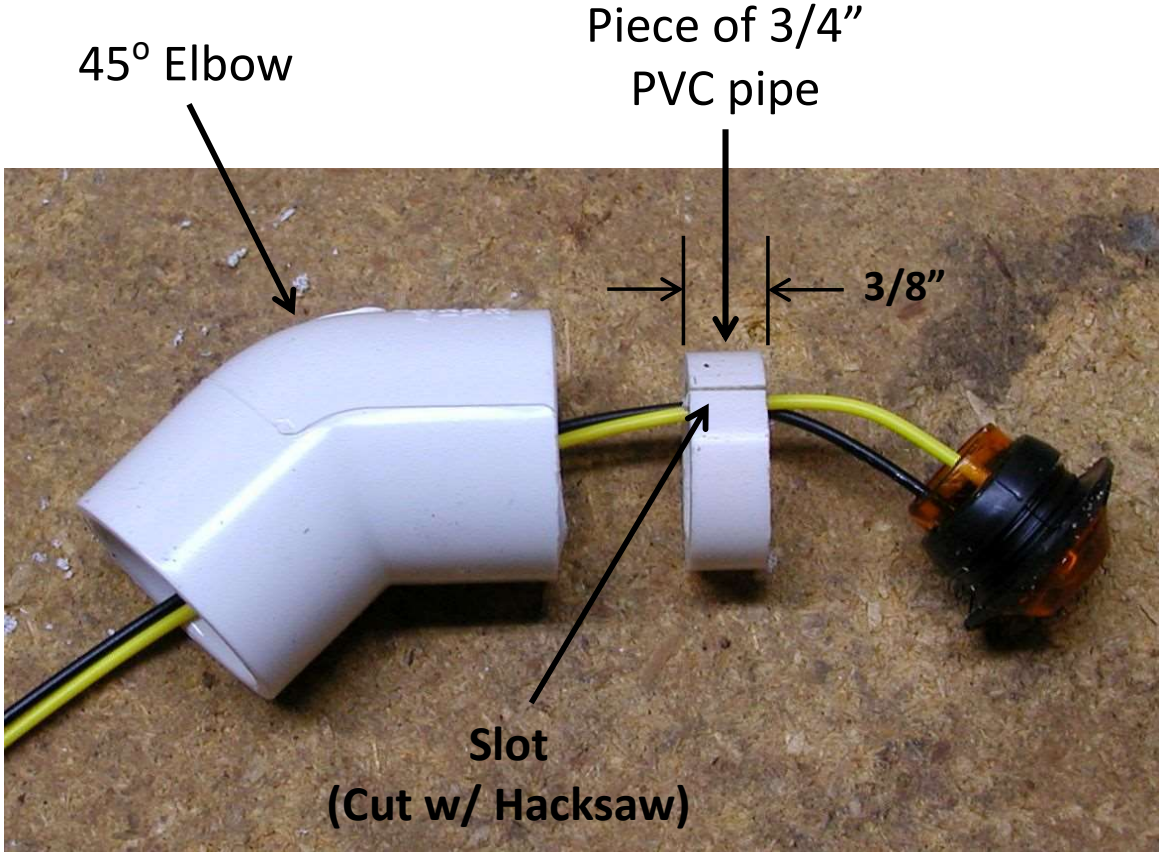
The truck trailer marker lights used in this design fit snugly into the ¾” pipe ends. All fittings are press fit only. No glue was used.

A piece of metal rebar or other heavy slender object can be inserted into the rear facing leg to give it weight and prevent it from tipping over



Light Tree Construction (Cont.)

The pictures below show how the lamp assembly is constructed. A 3/8” wide piece of ¾” PVC pipe is inserted into the elbow end to snuggly hold the LED lamp. To ease insertion, a slot is cut into the 3/8” wide piece of pipe using a hacksaw.



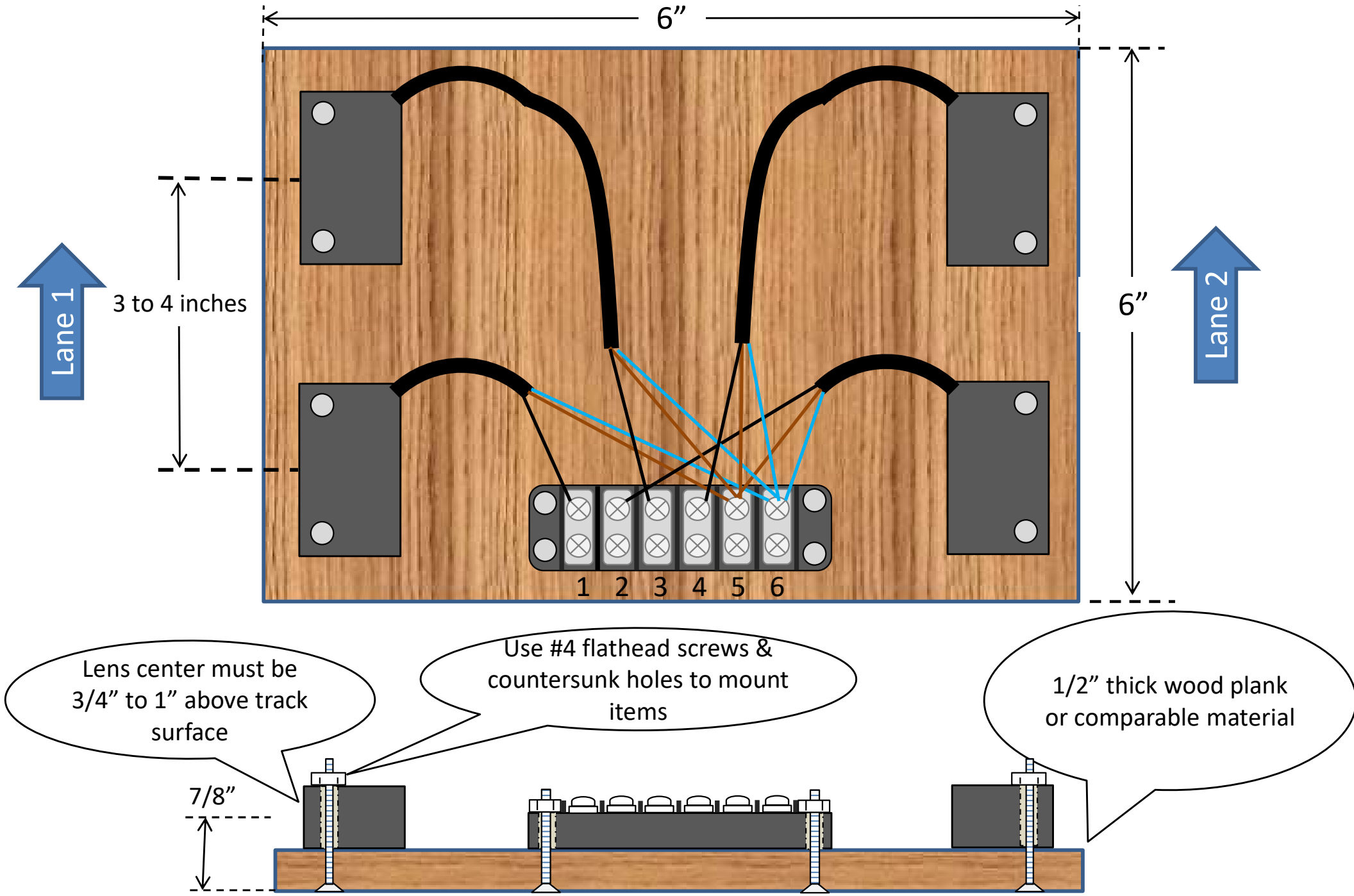
LIGHT TREE

Suggested Parts List*

Ref.	Qty	Description	Part No.	Manufacturer
LIGHT TREE				
P3	1	Male DB-15 D-Sub, 2 Row, 15-Pin Plug	Various	Various
W3	1	Cable, 13 Conductor (minimum), 6 – 8 Ft,	Various	Various
DS1 – DS2	2	¾” Marker Lights, LED, White	See EBay	TBD
DS3 – DS8	6	¾” Marker Lights, LED, Amber	See EBay	TBD
DS9, DS10	2	¾” Marker Lights, LED, Green	See EBay	TBD
DS11, DS12	2	¾” Marker Lights, LED, Red	See EBay	TBD
---	6 Ft	¾” Sch-40 PVC Pipe, 6 Ft	Various	Various
---	12	¾” Sch-40 PVC 45 Deg. Elbow, Slip Joint	Various	Various
---	1	¾” Sch-40 PVC Tee fitting, Slip Joint	Various	Various
---	1	¾” Sch-40 PVC 4-Way Elbow, Slip Joint	Various	Various
---	5	¾” Sch-40 PVC 4-Way Cross, Slip Joint	Various	Various
---	3	¾” Sch-40 PVC 90 Deg. Elbow, Slip Joint	Various	Various

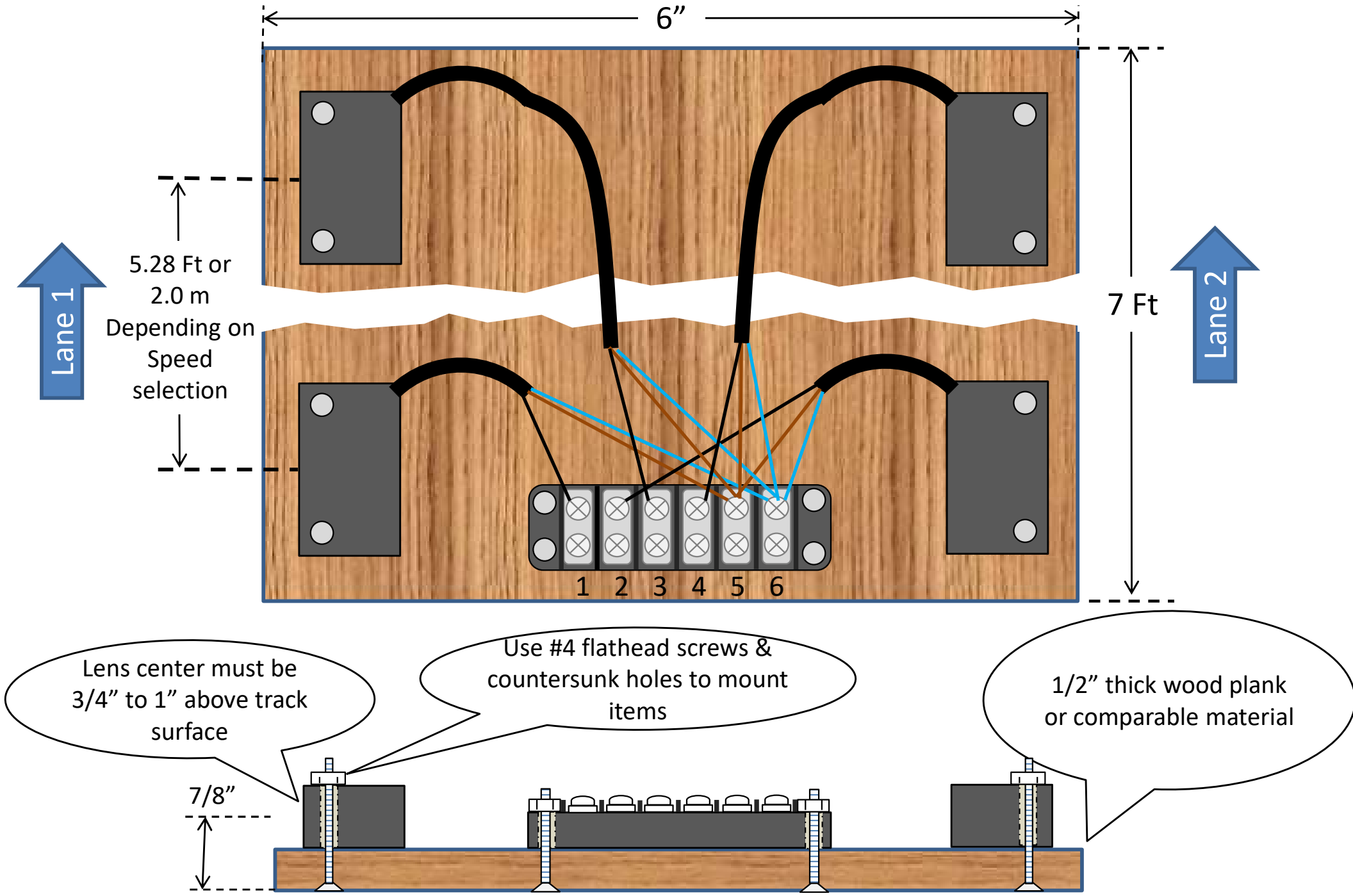
- - Conceptual Design - -

Stage & Guard IR Sensor Assy with 4ea BJ15M-TDT2 Sensors



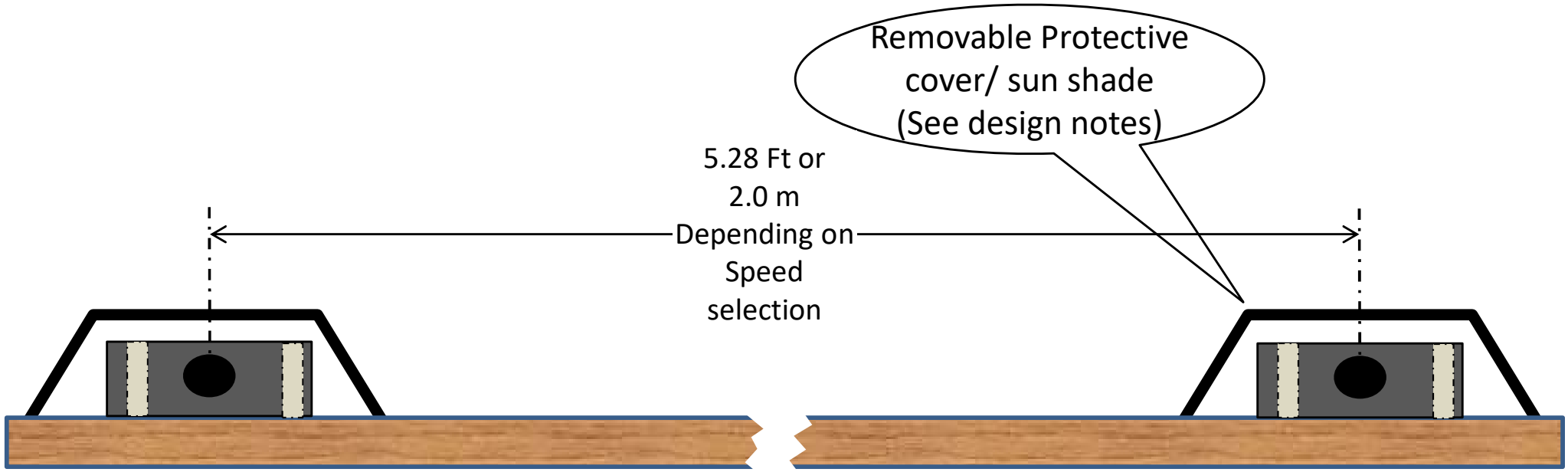
- - Conceptual Design - -

Trap & Finish Line IR Sensor Assy with 4ea BJ15M-TDT2 Sensors

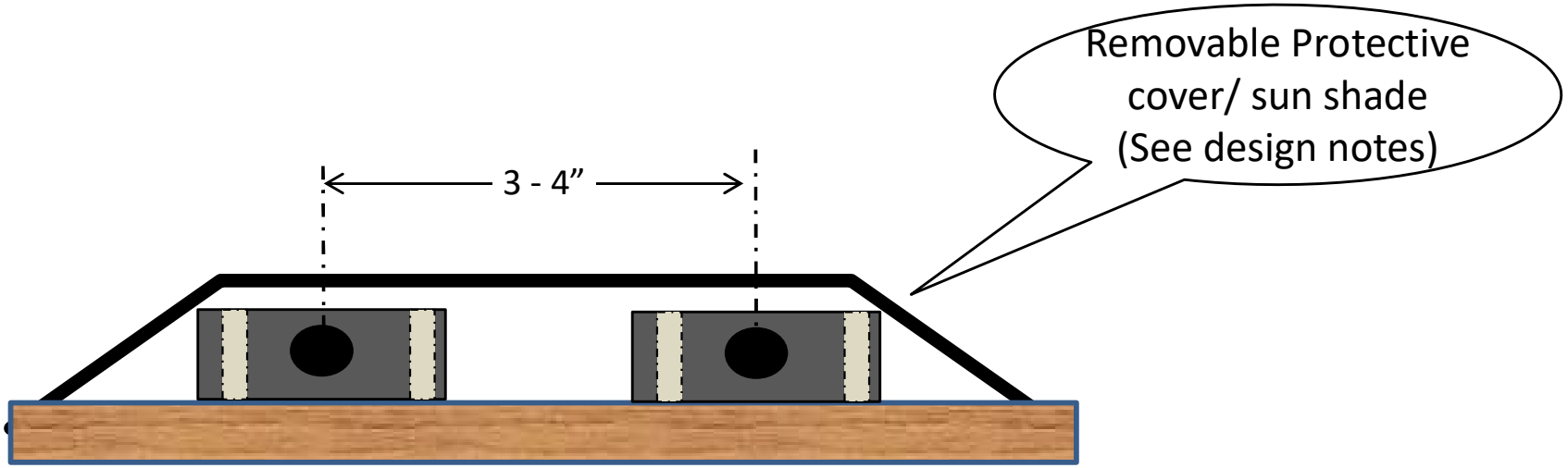


- - Conceptual Design - -

IR Sensor Protective covers



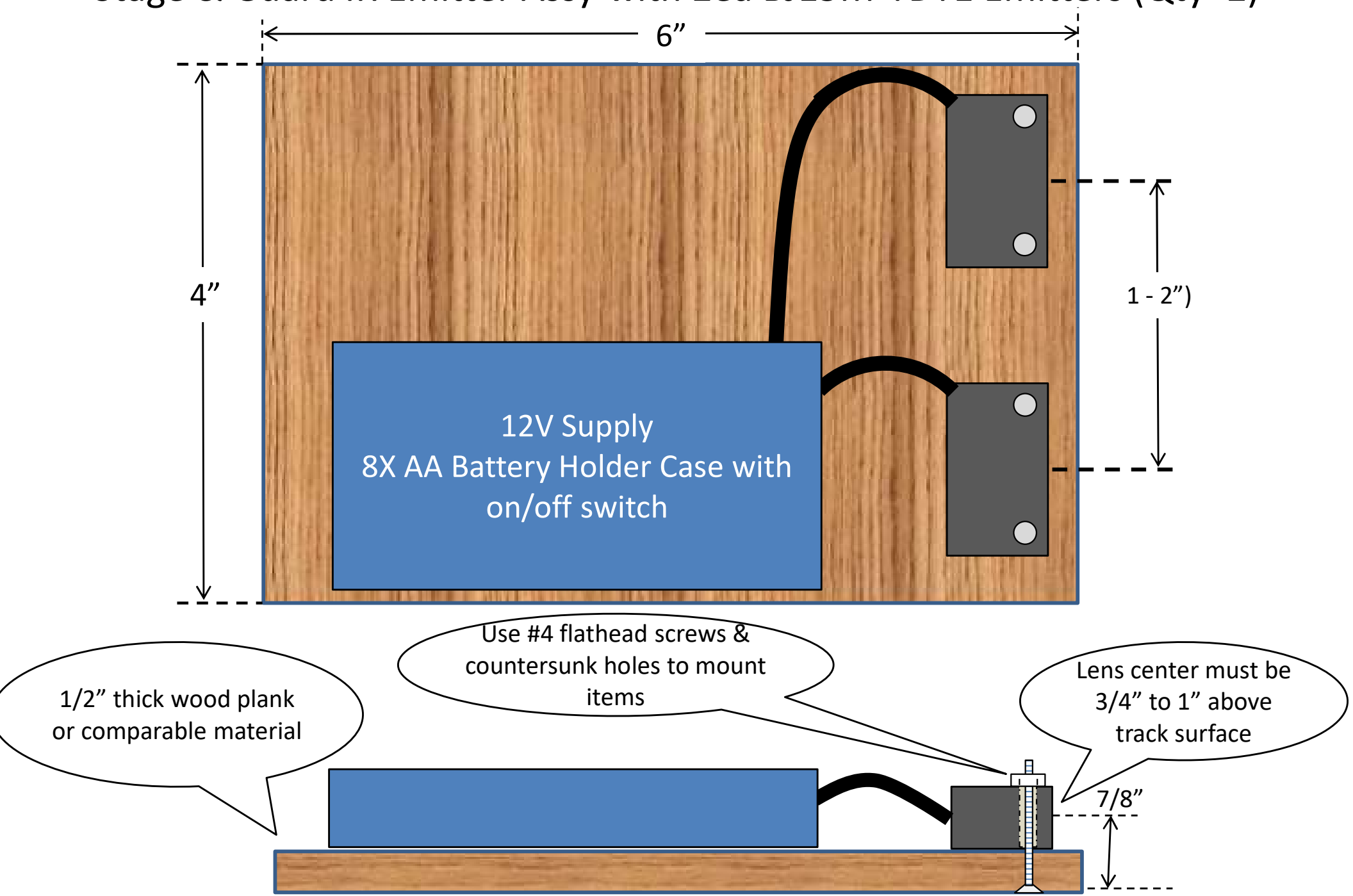
Trap & Finish Line Sensor Assy



Stage & Guard Line Sensor Assy

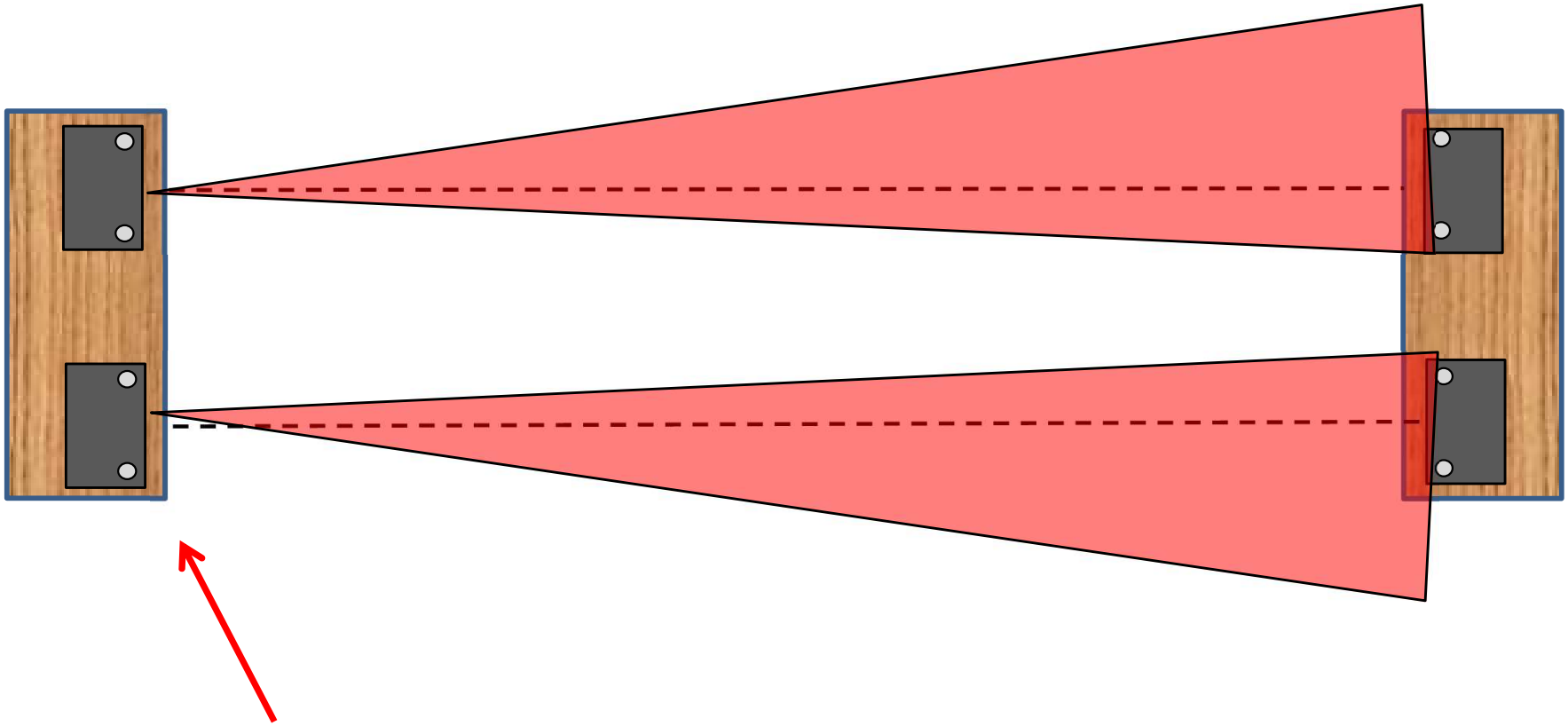
- - Conceptual Design - -

Stage & Guard IR Emitter Assy with 2ea BJ15M-TDT1 Emitters (Qty=2)



- - Conceptual Design - -

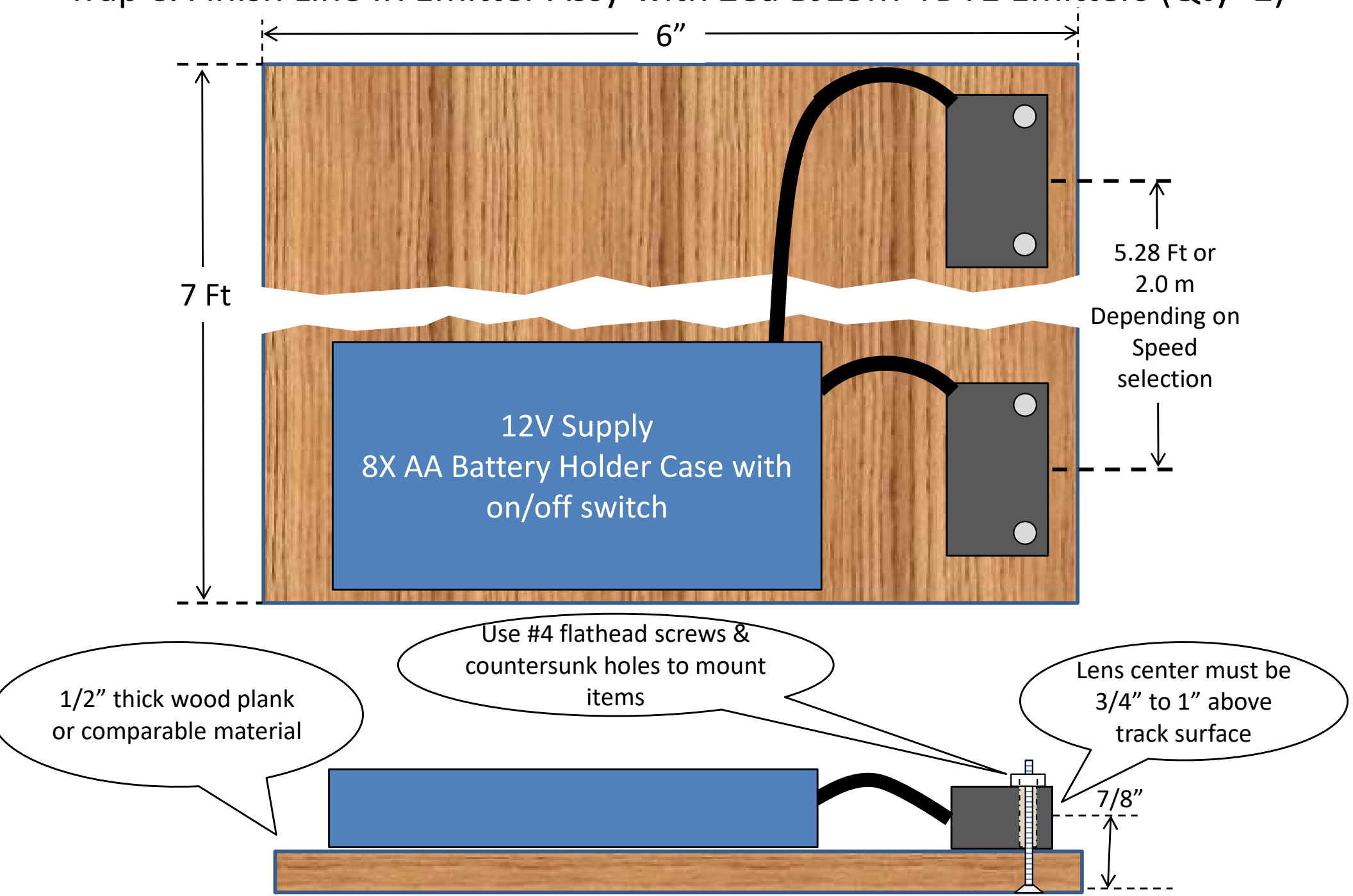
Stage & Guard IR Emitter Assy with 2ea BJ15M-TDT1 Emitters (Qty=2)



The aiming direction of the stage & guard beam emitters may have to be skewed outwards a small amount so the beams will not interfere with each others receiver.

- - Conceptual Design - -

Trap & Finish Line IR Emitter Assy with 2ea BJ15M-TDT1 Emitters (Qty=2)



Autonics™ BJ15M-TDT Through-Beam Sensor

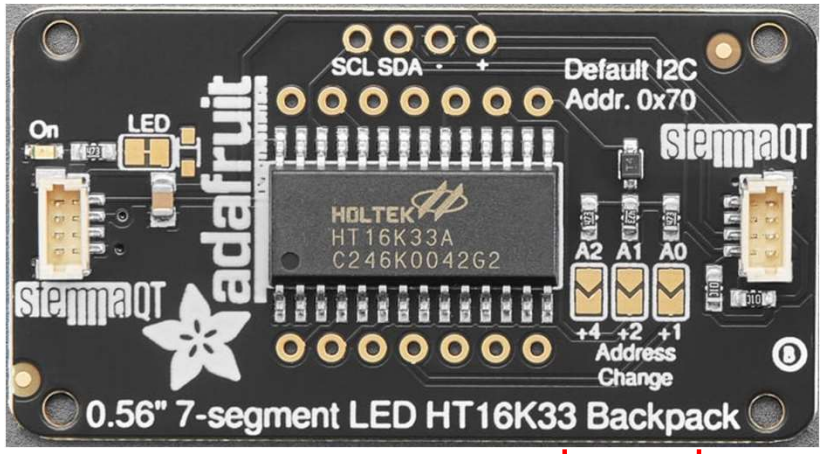
Each sensor pair consists of an emitter unit (BJ15M-TDT1) and a receiver unit (BJ15M-TDT2).

- Emitter Unit
  - Power indicator (Green)
- Receiver unit
  - Stability/Power indicator (Green)
  - Beam detect indicator (Red)
  - Light ON/Dark ON mode select switch
  - Sensitivity adjuster
- Refer to manufacturer's data sheets for more information

Schematic Diagram
Design Notes

- Address jumpers for the Adafruit 0.56” displays (U1 – U6) are as follows:
  - U1: Address (HEX) = 0x70 – No jumpers installed
  - U2: Address (HEX) = 0x71 – A0 jumpered
  - U3: Address (HEX) = 0x72 – A1 jumpered
  - U4: Address (HEX) = 0x73 – A0 & A1 jumpered
  - U5: Address (HEX) = 0x74 – A2 jumpered
  - U6: Address (HEX) = 0x75 – A2 & A0 jumpered

To add a jumper apply small dab of solder across the two portions of the jumper tabs to short them together.



Address Jumpers

- The Adafruit 0.56” 4-digit 7-segment displays w/ I2C Backpack are available in the following colors (See Adafruit web site):
  - Red: Part No. Adafruit 878
  - Yellow: Part No. Adafruit 879
  - Green: Part No. Adafruit 880
  - Blue Part No. Adafruit 881
  - White: Part No. Adafruit 1002

Schematic Diagram
Design Notes (Cont.)

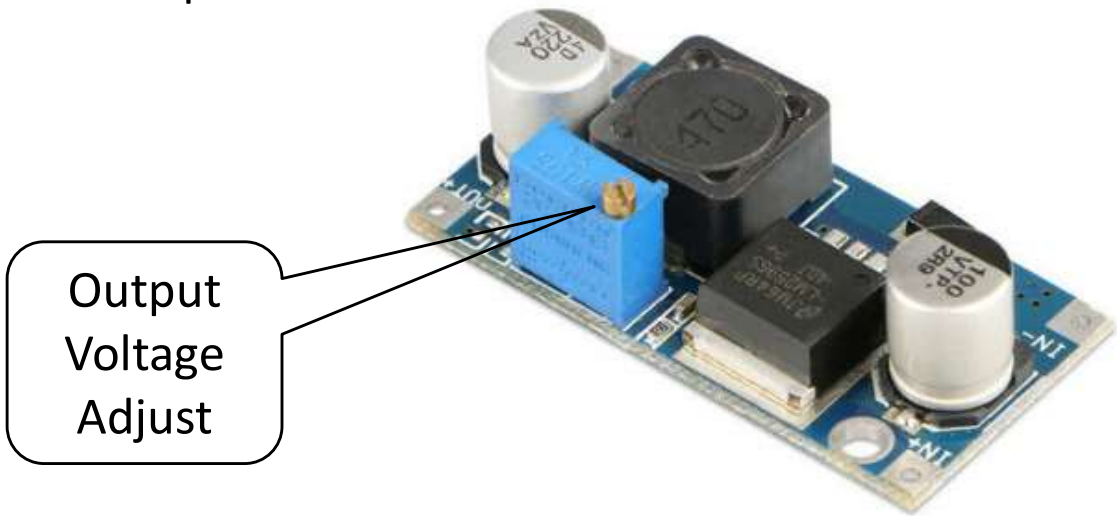
- Xmas Tree LED Driver Circuit Board
  - The Xmas Tree LED Driver circuit board was designed using KiCad, a free circuit board design application (ref. https://kicad.org/).
  - The file LED_XmasTree_Driver_Ver3.kicad_pcb can be sent to circuit board manufacturer Oshpark (https://oshpark.com) who will make 3 prototype copies of the circuit board for about $15.
  - A completely assembled circuit board can also be purchased from the author for a fee.

- BJ15M-TDT Emitter & Sensor Protective Covers
  - Must be removable to allow adjustment of sensitivity control
  - Must provide shade from direct sunlight
  - Be durable enough to protect unit from RC car running over it
- The Hand-Held Start switch (S4) use the normally open (N.O.) set of contacts.
- The Std/Pro select switch (S1): Std = Contacts Open, Pro = Contacts Closed
- The Man/Auto Start switch (S2): Man = Contacts Open, Auto = Contacts Closed
- The 1/2 Racer select switch: 2 Racers = Contacts Open, 1 Racer = Contacts Closed

Schematic Diagram
Design Notes (Cont.)

- To simplify the floating point math done in the software to calculate speed, the trap and finish line sensor separation distance is either set to 5.28 feet for the MPH setting or to 2.0 meters for the km/h setting. The resulting equation for speed thus becomes:
  - S = 3600 / dT (for MPH) or S = 7200 / dT (for km/h)
    Where:
    S = Speed in MPH or km/h
    dT = Time difference in milliseconds between tripping of the trap and finish line sensors

- **WARNING:** The LM2596S DC to DC Buck Power Module must be adjusted for an output voltage of +5 Volts before connecting into the circuit. Failure to do so may result in damage to other electrical components.

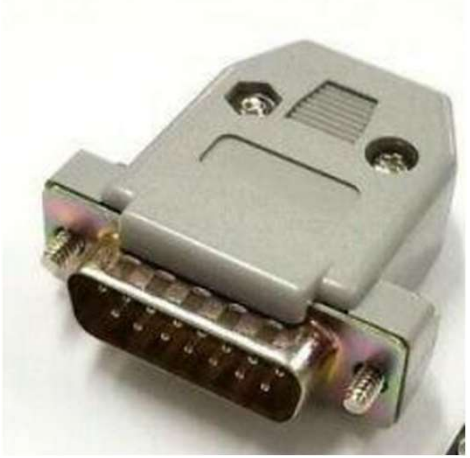


Schematic Diagram

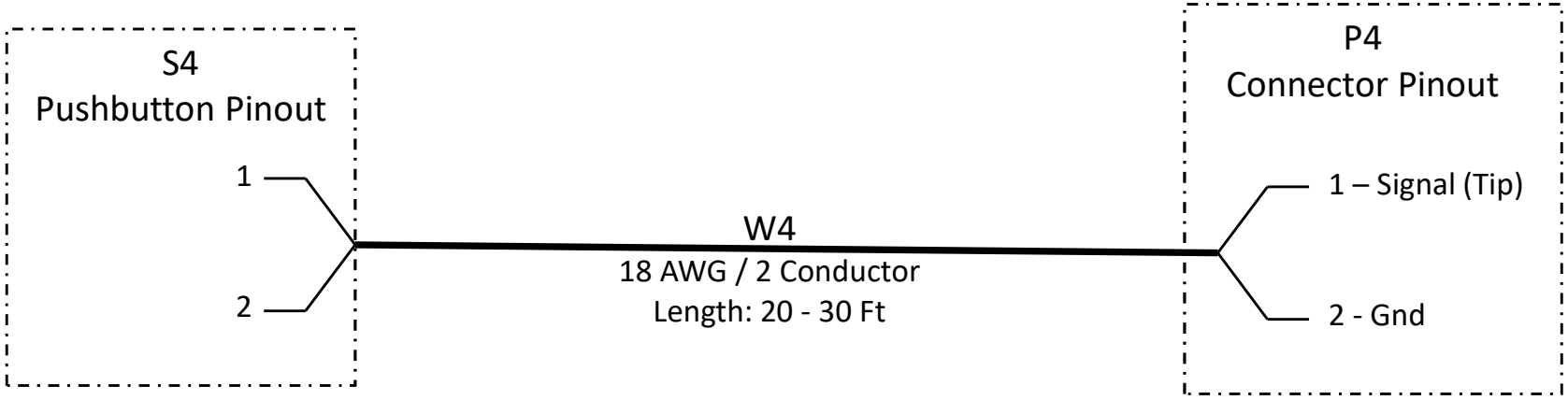
Design Notes (Cont.)

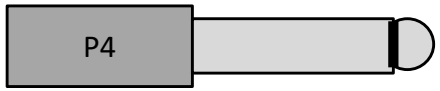
- Recommended connector P1 & P2/J1 & J2: GX16 6-Pin Panel Mount 16mm Dia Screw, Metal Aviation Wire Connector Plug & Receptacle (See EBay).

- Recommended connector P3/J3: DB-15 D-Sub, 2 Row, 15-Pin



Pushbutton Cable Fabrication Information
(W4)





Suggestion: Use an inexpensive 20 – 30 foot outdoor rated extension chord for the cable.

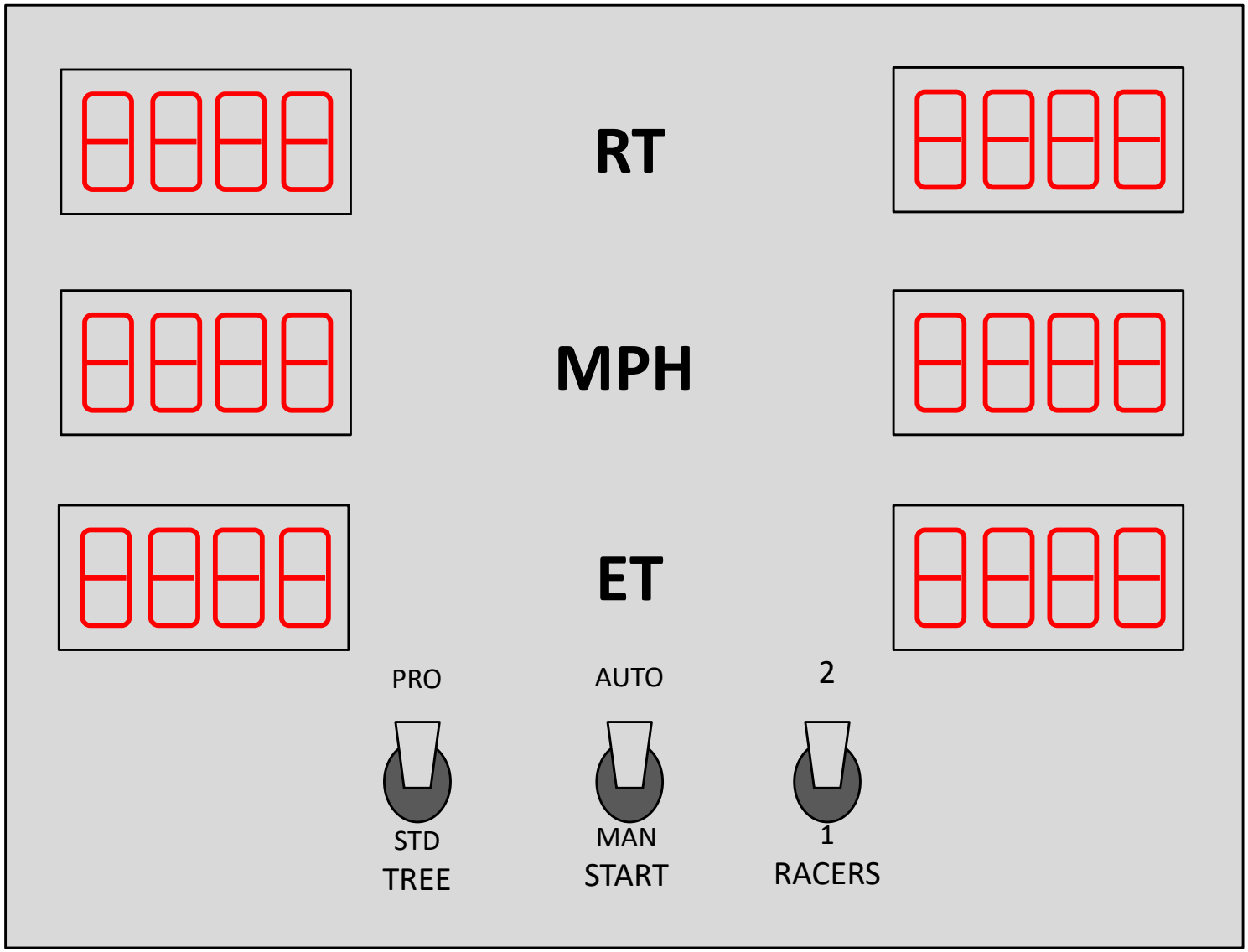
- - - CANDIDATE ENCLOSURES FOR TIMER UNIT - -

BUD Industries PC-11495 Plastic Style F Box
9" W x 5" H x 8.5" D

BUD Industries PC-11491 Plastic Style F Box
8" W x 6" H x 3" D

- - Conceptual Design - -

Control Panel Layout
(w/ MPH Legend)



- - Conceptual Design - -

Control Panel Layout
(w/ km/h Legend)