Sheet: Connectors

12V_Raw▷ 12V_Raw
Shutdown_In▷
Brake1_Raw▷ Brake1_Signal_Raw
Brake2_Raw▷ Brake2_Signal_Raw
BMS_or_TPS1_Raw▷ BMS_or_TPS1_Signal_Raw
TPS2_Raw▷ TPS2_Signal_Raw

RELAY_VCU▷ VCU_Relay_Control
BOTS−▷ BOTS−
BOTS+◁
Brake1◁ Brake1_Signal
Brake2◁ Brake2_Signal

Brake1◁ Brake1_Signal
Shutdown_Out◁ Shutdown_Out
BSPD_TRIPPED◁ BSPD_TRIPPED

File: Connectors.sch

Sheet: HeProtec−R2

12V_Raw ▷12V_IN   12V_OUT▷ +12V

File: HeProtec−R2.sch

Sheet: Cheap Power Supply

+12V ▷12_IN   5V_OUT▷ +5V

File: cheap_power_supply.sch

Sheet: Brake1 Signal

Brake1_Signal_Raw ▷DataRaw_In   Signal_Active▷ Brake1_Signal
                                 Signal_Connected▷ Brake1_Connected

File: BrakeComparator.sch

Sheet: Brake2 Signal

Brake2_Signal_Raw ▷DataRaw_In   Signal_Active▷ Brake2_Signal
                                 Signal_Connected▷ Brake2_Connected

File: BrakeComparator.sch

Sheet: BMS or TPS1 Signal

BMS_or_TPS1_Signal_Raw ▷DataRaw_In   Signal_Active▷ BMS_or_TPS1_Signal
                                      Signal_Connected▷ BMS_or_TPS1_Connected

File: BMSorTPS1Comparator.sch

Sheet: [IC] TPS2 Signal

TPS2_Signal_Raw ▷DataRaw_In   Signal_Active▷ TPS2_Signal
                               Signal_Connected▷ TPS2_Connected

File: TPS2Comparator.sch

Sheet: BrakeSystemPlausibilityDevice

VCU_Relay_Control ▷RELAY_VCU   BSPD_TRIPPED▷ BSPD_TRIPPED
Brake1_Signal ▷BRAKE1_IN   RELAY▷ Shutdown_Control
Brake2_Signal ▷BRAKE2_IN   Brake1_Active▷ Brake1_Signal
BMS_or_TPS1_Signal ▷BMS_or_TPS1_IN
TPS2_Signal ▷TPS2_IN

Brake1_Signal ▷Brake1_Active
Brake1_Connected ▷BRAKE1_CONNECTED
Brake2_Connected ▷BRAKE2_CONNECTED
BMS_or_TPS1_Connected ▷BMS_or_TPS1_CONNECTED
TPS2_Connected ▷TPS2_CONNECTED

File: bspd.sch

Sheet: Shutdown Circuit

                    IN◁ BOTS−
                   OUT▷ Shutdown_Out
                    EN◁ Shutdown_Control

File: shutdown_circuit_switch_2.sch
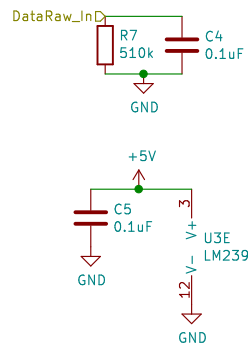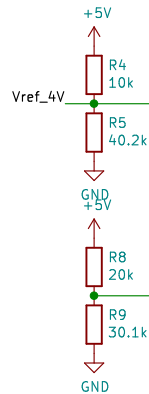
Longhorn Racing Electric
Sheet: /
File: 20−ELC−2−01−R2(Appetizer).sch
Title: Appetizer
Size: A4   Date: 2019−10−09   Rev: 1
KiCad E.D.A. kicad (5.1.6)−1   Id: 1/10

U1
L78M05ABDT-TR

12_IN
1 IN   OUT 3
GND
2
0.33uF
C1
C2
0.1uF
5V_OUT

GND

GND

C3
1uF

+12V

END

U2
MIC5014YM

1 V+   NC 8
2 INPUT   NC 7
3 SOURCE   NC 6
4 GROUND   GATE 5

1M
R1

GND

GND

R2
220

1M
R3

IN

Q1
CSD18512Q5B

OUT

REPLACE THIS WHOLE CIRCUIT FOR 2022!
This is very expensive to build ($3 total roughly)

Vref H: 4V

Output Behavior
DataRaw_In < 3V............. 0V
3V < DataRaw_In < 4V... 5V
DataRaw_In > 4V............. 0V

+5V

R4
10k

Vref_4V

R5
40.2k

GND
+5V

R8
20k

R9
30.1k

GND

Vref L: 3V

U3B
LM239
7 +
6 −
1

+5V

R6
10k

Signal_Active

DataRaw_In

U3A
LM239
5 +
4 −
2

DataRaw_In

R7
510k

C4
0.1uF

GND

+5V

C5
0.1uF

GND

U3E
LM239
3 V+
12 V−

GND

Active Signal

Vref H: 4V

Output Behavior
DataRaw_In < 1V............. 0V
1V < DataRaw_In < 4V... 5V
DataRaw_In > 4V............. 0V

Vref_4V

U3C
LM239
11 +
10 −
13

+5V

R10
10k

Signal_Connected

DataRaw_In

U3D
LM239
9 +
8 −
14

+5V

R11
40.2k

R12
10k

GND

Vref L: 1V
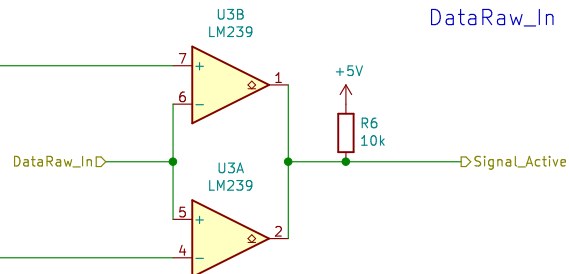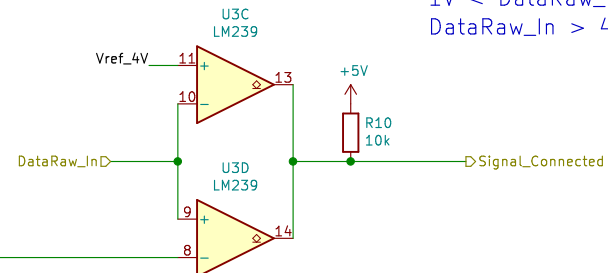
Connected Signal

[EV] NOPOP

[IC] TPS2 Config (5-0V)

Assuming 10% open = 4V

Vref H: 4V

Output Behavior

DataRaw_In < 0V............. 0V
0V < DataRaw_In < 4V... 5V
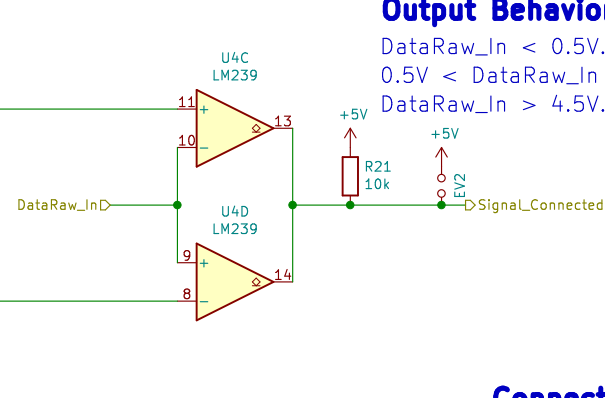DataRaw_In > 4V............. 0V

+5V

R13 10k

R14 40.2k

GND
+5V

DataRaw_In

R16 510k

C6 0.1uF

GND

+5V

C7 0.1uF

GND

U4E LM239

GND

R17 0 NOPOP

R18 0

Note: NOPOP and 0 ohm used here to maintain configurability

GND

Vref L: 0V

U4B LM239

7 +
6 −
1

U4A LM239

DataRaw_In

5 +
4 −
2

+5V

R15 10k

Signal_Active

EV1

GND
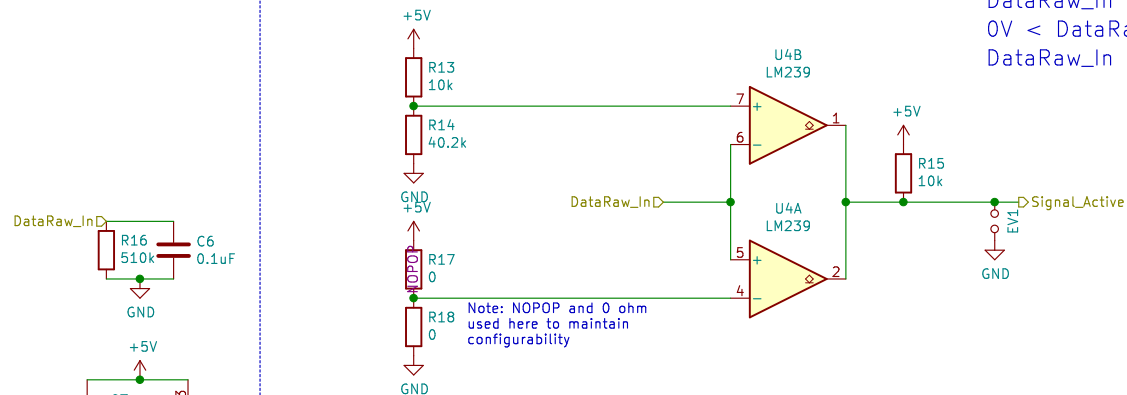
Active Signal

Vref H: 4.5V

Output Behavior

DataRaw_In < 0.5V.............. 0V
0.5V < DataRaw_In < 4.5V... 5V
DataRaw_In > 4.5V.............. 0V

+5V

R19 5k

R20 40.2k

GND
+5V

R22 40.2k

R23 5k

GND

Vref L: .5V

U4C LM239

11 +
10 −
13

U4D LM239

DataRaw_In

9 +
8 −
14

+5V

R21 10k

+5V

EV2

Signal_Connected

Connected Signal

Longhorn Racing Electric

Sheet: /[IC] TPS2 Signal/
File: TPS2Comparator.sch

Title: BSPD Dual Window Comparator Array
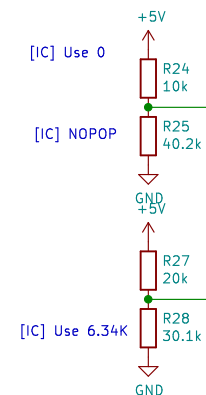
Size: A4   Date: 2021-01-18   **Rev: 2**

KiCad E.D.A. kicad (5.1.6)-1   Id: 5/10

BMS Config

[IC] TPS1 Config (0-5V)　　　Assuming 10% open = 1V

Vref H: 4V

+5V

[IC] Use 0

R24
10k

[IC] NOPOP

R25
40.2k

GND
+5V

R27
20k

[IC] Use 6.34K

R28
30.1k

GND

U5B
LM239

7
+
6
−
1

U5A
LM239

DataRaw_In

5
+
4
−
2

+5V

R26
10k

Signal_Active

Output Behavior
DataRaw_In < 3V............. 0V
3V < DataRaw_In < 4V... 5V
DataRaw_In > 4V............. 0V

Vref H: 5V

Output Behavior
DataRaw_In < 1.2V............ 0V
1.2V < DataRaw_In < 5V... 5V
DataRaw_In > 5V.............. 0V
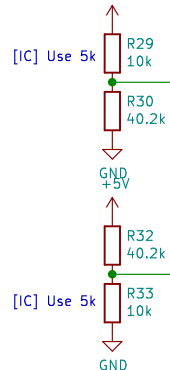
Vref L: 3V

Active Signal

Vref L: 1.2V

Active Signal

Vref H: 4V

+5V

[IC] Use 5k

R29
10k

R30
40.2k

GND
+5V

R32
40.2k

[IC] Use 5k

R33
10k

GND

U5C
LM239

11
+
10
−
13

U5D
LM239

DataRaw_In

9
+
8
−
14

+5V

R31
10k

Signal_Connected

Output Behavior
DataRaw_In < 1V............ 0V
1V < DataRaw_In < 4V... 5V
DataRaw_In > 4V............. 0V

Vref H: 4.5V

Output Behavior
DataRaw_In < 0.5V.............. 0V
0.5V < DataRaw_In < 4.5V... 5V
DataRaw_In > 4.5V.............. 0V

Vref L: 1V

Connected Signal

Vref L: .5V

Connected Signal

+5V

C8
0.1uF

GND

U5E
LM239

V+
3
V-
12

GND

DataRaw_In

R34
510k

C9
0.1uF

GND

Longhorn Racing Electric
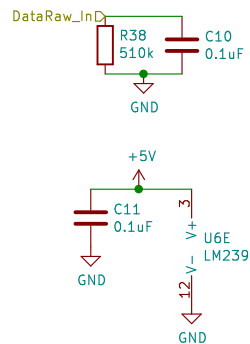Sheet: /BMS or TPS1 Signal/
File: BMSorTPS1Comparator.sch
Title: BSPD Dual Window Comparator Array
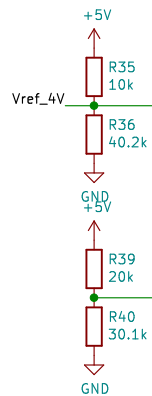Size: A4　　Date: 2021-01-18　　　　Rev: 2
KiCad E.D.A. kicad (5.1.6)-1　　　Id: 6/10

Vref H: 4V

Output Behavior
DataRaw_In < 3V............ 0V
3V < DataRaw_In < 4V... 5V
DataRaw_In > 4V............ 0V

+5V

R35
10k

Vref_4V

R36
40.2k

GND
+5V

R39
20k

R40
30.1k

GND

Vref L: 3V

U6B
LM239

7
+
6
−
1

+5V

R37
10k

Signal_Active

DataRaw_In

U6A
LM239

5
−
4
+
2

Active Signal

DataRaw_In

R38
510k

C10
0.1uF

GND

+5V

C11
0.1uF

GND

U6E
LM239

3 V+
12 V−

GND

Vref H: 4V

Output Behavior
DataRaw_In < 1V............ 0V
1V < DataRaw_In < 4V... 5V
DataRaw_In > 4V............ 0V

Vref_4V

U6C
LM239

11
+
10
−
13

+5V

R41
10k

Signal_Connected

DataRaw_In

U6D
LM239

9
+
8
−
14

+5V

R42
40.2k

R43
10k

GND

Vref L: 1V
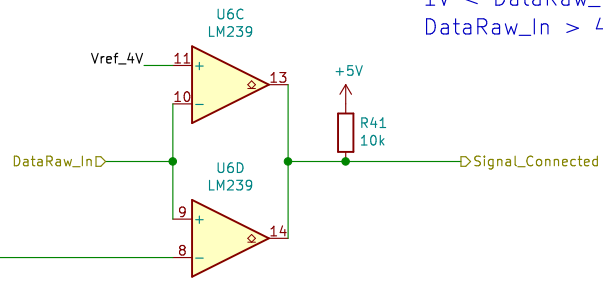
Connected Signal

Longhorn Racing Electric
Sheet: /Brake2 Signal/
File: BrakeComparator.sch
Title: BSPD Dual Window Comparator Array
Size: A4   Date: 2021−01−18   **Rev: 2**
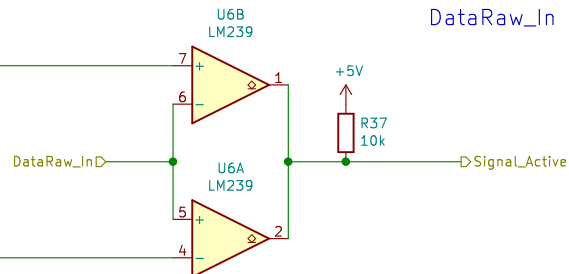KiCad E.D.A. kicad (5.1.6)−1   Id: 7/10

Brake Watchdogs and BOTS
Conn_02x04_Top_Bottom
J1

+5V
1A Brake1_Raw
F2

GND   1   5   GND
Brake1_Raw 2   6   Brake2_Raw
3   7
BOTS− 4   8   BOTS+

IC2
IC3

VCU/ECU
Conn_02x03_Top_Bottom
J2

RELAY_VCU
+5V
IC1

GND   1   4
Brake1 2   5   Brake1
Brake2 3   6   BSPD_TRIPPED

GLV Harness
J3
+5V
F1
1A IC Only

GND   1   6
12V_Raw 2   7   BMS_or_TPS1_Raw
Shutdown_In 3   8   TPS2_Raw
Shutdown_Out 4   9   GND IC Only
BSPD_TRIPPED 5   10 GND IC Only
EV3
Conn_02x05_Top_Bottom
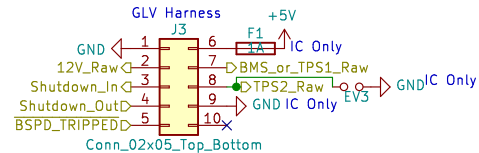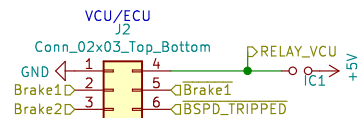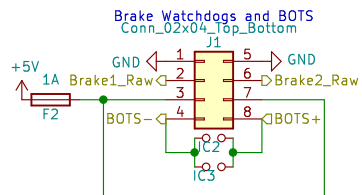
H1 MountingHole
H2 MountingHole
H3 MountingHole
H4 MountingHole

GND   1   J4
Conn_01x01

Brake2_Raw   TestPoint TP1
WSS_R_Raw   TestPoint TP2
BMS_or_TPS1_Raw   TestPoint TP3
Brake1_Raw   TestPoint TP4
WSS_F_Raw   TestPoint TP5
TPS2_Raw   TestPoint TP6

Brake2_Raw Brake1_Raw
1   2
D1
3
PSM712−LF−T7
GND

BMS_or_TPS1_Raw TPS2_Raw
1   2
D2
3
PSM712−LF−T7
GND

BRAKE1 OR BRAKE2
TPS1 or TPS2
IC Timer 1 or 2

5KW or Throttle AND Brakes
BSPD_NotTripped AND VCU_RELAY_CONTROL

Quad R/S Latch

+5V
C13
0.1uF
GND

+5V

TP8
TestPoint

BRAKE1_IND   1
BRAKE2_IND   2   3   BMS_or_Throttle
BMS_or_TPS1_IND   4
TPS2_IND   5   6   BMS_or_Throttle
Brakes_and_Power_TRIP   9
Signal_Lost_TRIP   10   8   TRIP
   12
   13   11
SN74HC32PWR
U8
GND

+5V
C12
0.1uF
GND

U9
74HC08D,653

10k
R45
GND
BMS_or_Throttle
1 1A
2 1B   3   1Y   TP7 TestPoint   Power_and_Brakes
Vcc   14

BSPD_TRIPPED   4 2A
RELAY_VCU   5 2B   6   2Y   RELAY
R48 10k   4.7k R47
GND
D4 LED
GND

9 3A
10 3B   8   3Y
12 4A
13 4B   11 4Y
7 GND
GND

+5V
LED D3
R44 4.7k
BSPD_TRIPPED

U7
HEF4043B
2 1Q   4Q 1   x
3 1R   VDD 16   +5V
SET 4 1S   4R 15   GND
5 OE   4S 14   GND
R46 10k 6 2S   n.c. 13   x
7 2R   3S 12   GND
8 Vss   3R 11   GND
        3Q 10   x
        2Q 9   x
GND

C14 0.1uF
GND

TRIP

TestPoint TP9

+5V
C15 0.1uF
GND

Brake1_Connected   1
Brake2_Connected   2   3   Brake_Connected
BMS_or_TPS1_Connected   4
TPS2_Connected   5   6   BMS_or_TPS_Connected
Brake_Connected   9
BMS_or_TPS_Connected   10   8   Signal_Lost
   12
   13   11
SN74HC32PWR
U10
GND

Connected Signal Inversion

U13A 74HC04
BRAKE1_CONNECTED   1   2   Brake1_Connected

U13B 74HC04
BRAKE2_CONNECTED   3   4   Brake2_Connected

U13C 74HC04
BMS_or_TPS1_CONNECTED   5   6   BMS_or_TPS1_Connected

U13D 74HC04
TPS2_CONNECTED   9   8   TPS2_Connected

U13E 74HC04
Brake1_Active   11   10   Brake1_Active

U13F 74HC04
   13   12

U13G 74HC04
7 GND
VCC 14   +5V
C19 0.1uF
GND

Delay <0.5s OR
Delay <1s [IC]

LTC6994-1
Power_and_Brakes   1 IN   OUT 6   Brakes_and_Power_TRIP
2 GND V+ 5   +5V   TP11 TestPoint
3 SET DIV 4
U12
GND
R51 180k R_SET
GND
R50 1M
R52 680k R_DIV
C17 0.1uF
GND
GND

[EV] REPOP

	EV (0.5s)	IC (1s)
R_SET	750K	180K
R_DIV	523K	680K
Delay	0.4915s	0.9437s

[EV] NOPOP   EV4
Delay <0.1s

LTC6994-1
Signal_Lost   1 IN   OUT 6   Signal_Lost_TRIP
2 GND V+ 5   +5V   TP12 TestPoint
3 SET DIV 4
U14
GND
R54 150k
GND
R53 1M
R55 523k
C18 0.1uF
GND
GND

Delay = 0.0983s

SW1
UK-B0228-G5-160-JZ Reset Button
+5V
R49 10k
GND
SET
TestPoint TP10

5V Voltage Supervisor
C16 0.1uF
GND
U11
VDD 3   RESET 2
GND 1
TLV810
GND

Longhorn Racing Electric
Sheet: /BrakeSystemPlausibilityDevice/
File: bspd.sch
Title:
Size: A4   Date: 2019-10-09   Rev:
KiCad E.D.A. kicad (5.1.6)-1   Id: 9/10

Reverse Polarity Protection

Overloads, short circuit, surge, excessive inrush, over voltage, and under voltage protection

12V_IND

D5
SS54

C20
0.1u

GND

R56
100k

R57
25k

TPS259261DRCR

3 VIN
2 EN/UVLO
11 GND   OUT 6
          ILIM 10
          dV/dT 1
U15

GND

R58
43k

GND

12V_OUT

C21
1uF

GND

Undervoltage:
Our favorite 12 to 5V regulator has a
dropout voltage of 2V. So, we need to
turn off supply when voltage falls
below 7V to maintain a safe 5V output.

100k and 25k give us an
undervoltage condition
under 7.76V

43k corresponds to limiting current at
about 2A. See datasheet...

Change to 10k to limit current to 1A.

Important note: The L78M05 has internal
current-limiting at .5A