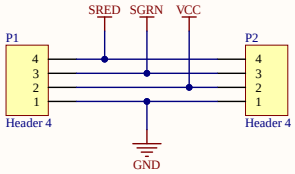
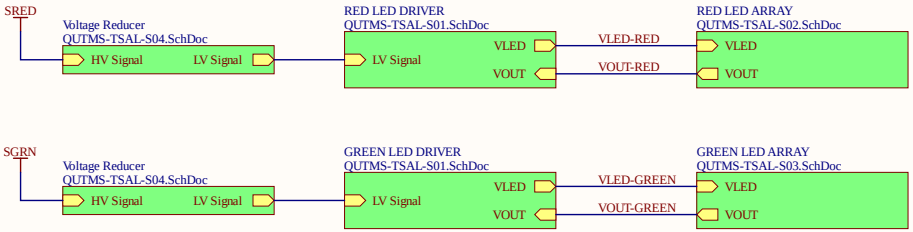


LYID1

1	2

2 Layer Identification PCB Marker



LOGO1

X

LBL Hot Surface S

LOGO3

X

LBL Hot Surface S

Revision History:

Rev	Date	Description

Sheet Title: **Tractive System Active Light - TSAL**

Project:

Size: A3 | Number: 1 | Version: | Revision: 2 | Sheet 1 of 5

Drawn By: Joseph Richards

Print Date: 28/08/2020 Print Time: 5:08:39 PM

File Name: QUTMS-TSAL-S00.SchDoc

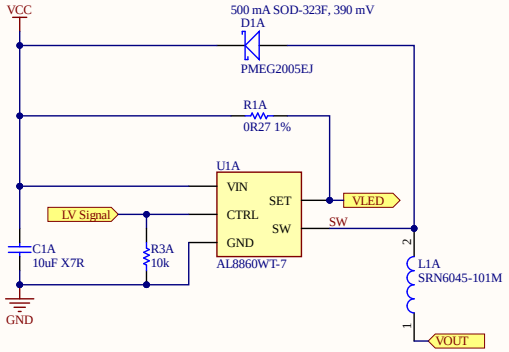
QUT Motorsport
Q-120, Gardens Point
2 George Street
Brisbane, QLD 4000
Australia

REV2 Change

C2 was used in Rev1 but this component has been replaced by R3.

This change fixed the issue on the Rev0 boards where the CTRL pin was left floating high and did not turn off. R2 allows voltage to drain to ground and the LED driver to switch off when input is low.

For the first generation boards remember:
C2 (Rev1) = R3 (Rev2)



R3 Power Dissipation

Vz: 3.3V
R3: 10kOhm

Resistor Current:
Ir = Vz / R

Resistor Power:
Pr = Ir x Vz

= Vz^2 / R

= 3.3^2 / 10k

= 1.09 x 10^-3

Pr = 1.09 mW

LED Driver Calculations

Voltage max: 40V
Current Max 1A
Duty Cyle Max: 98%
Ton_min: 500ns
Rsw: 0.2 ohms
Rs: 0.27 ohms
RL: 0.5 ohms
L: 100uH
Csoft: 4.7nF
Vin: 12.4V (worst case)

Soft Start: Csoft x 1.5ms/nF

= 4.7 x 1.5

= 7.05ms

LED Current:
Iled = 0.1 / Rs
= 0.1 / 0.27 = 370mA

Ripple Current:
Idelta = Iled / 4
= 0.37 / 4 = 92.5mA

Power Dissapation:
Pd = (1 - estimatedEfficiency) * Vin* Iled

= (1 - 0.95) x 12.4 x 0.37

= 229 mW

Total Power: 2 x Pd + Pred + Pgreen + 2 x Prz
= 2 x 0.37 + 3.27 + 3.55 + 2 x 0.00876
= 7.57752W

CTRL Pin Functionality

Voltage range: -0.3 to +6V

Normal operation: floating

Switched off: grounded (<0.2V)

Drive with DC voltage (0.3V < CTRL< 2.5V) to adjust output current from 0 to 100%,

Drive with PWM signal from open-collector or open-drain transistor, to adjust output current. Linear adjustment range from 1% to 100%for f < 500Hz

Connect a capacitor from this pin to ground to increase soft-start time

Red LED Driver Calculations

Red Vd = 2.2V
Red Vled: 4 x Vd = 8.8V

Red LED Switch on time:
Ton = L x Idelta / (Vin - Vled - Iled x (Rs + RL + Rsw))

= 100*10^-6 x 92.5*10^-3 / (12.4 - 8.8 - 0.37 x (0.27 + 0.5 + 0.2))

= 9.25*10^-6 / 3.24

= 2.54*10^-6

Ton = 2854ns

Red LED Switch off time:
Toff = L x Idelta / (Vled + Vd + Iled x (Rs + RL))

= 100*10^-6 x 92.5*10^-3 / (8.8 + 2.2 + 0.37 x (0.27 + 0.5))

= 9.25*10^-6 / 11.28

= 8.20*10^-7

Toff = 820ns

RED LED Duty Cycle: Dsw = Ton / (Ton + Toff)

= 2854 / (2854 + 820)

= 77.7%

Green LED Driver Calculations

Green Vd = 3.2V
Green Vled: 3 x Vd = 9.6V

Green LED Switch on time:
Ton = L x Idelta / (Vin - Vled - Iled x (Rs + RL + Rsw))

= 100*10^-6 x 92.5*10^-3 / (12.4 - 9.6 - 0.37 x (0.27 + 0.5 + 0.2))

= 9.25*10^-6 / 2.44

= 3.79*10^-6

Ton = 3791ns

Green LED Switch off time:
Toff = L x Idelta / (Vled + Vd + Iled x (Rs + RL))

= 100*10^-6 x 92.5*10^-3 / (9.6 + 3.2 + 0.37 x (0.27 + 0.5))

= 9.25*10^-6 / 13.08

= 7.072*10^-7

Toff = 707ns

Green LED Duty Cycle: Dsw = Ton / (Ton + Toff)

= 3791 / (3791 + 707)

= 84.3%

Revision History:

Rev	Date	Description

Sheet Title: LED Driver			
Project:			QUT Motorsport Q-120, Gardens Point 2 George Street Brisbane, QLD 4000 Australia
Size: A3	Number: 2	Version: Revision: 2	
Drawn By: Joseph Richards		Sheet 2 of 5	
Print Date: 28/08/2020	Print Time: 5:08:39 PM	File Name: QUTMS-TSAL-S01.SchDoc	

REV2 Change

C2 was used in Rev1 but this component has been replaced by R3.

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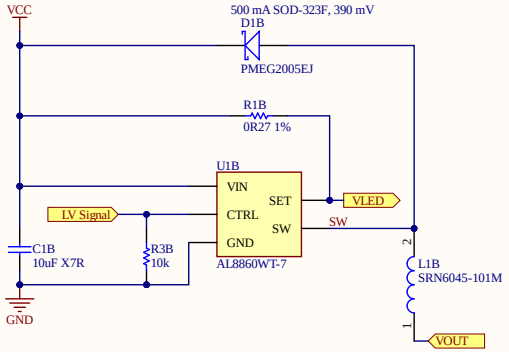

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R3: 10kOhm

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Resistor Power:
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= Vz^2 / R

= 3.3^2 / 10k

= 1.09 x 10^-3

Pr = 1.09 mW

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Current Max 1A
Duty Cyle Max: 98%
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Ripple Current:
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Pd = (1 - estimatedEfficiency) * Vin* Iled

= (1 - 0.95) x 12.4 x 0.37

= 229 mW

Total Power: 2 x Pd + Pred + Pgreen + 2 x Prz
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Red Vled: 4 x Vd = 8.8V

Red LED Switch on time:
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= 100*10^-6 x 92.5*10^-3 / (12.4 - 8.8 - 0.37 x (0.27 + 0.5 + 0.2))

= 9.25*10^-6 / 3.24

= 2.54*10^-6

Ton = 2854ns

Red LED Switch off time:
Toff = L x Idelta / (Vled + Vd + Iled x (Rs + RL))

= 100*10^-6 x 92.5*10^-3 / (8.8 + 2.2 + 0.37 x (0.27 + 0.5))

= 9.25*10^-6 / 11.28

= 8.20*10^-7

Toff = 820ns

RED LED Duty Cycle: Dsw = Ton / (Ton + Toff)

= 2854 / (2854 + 820)

= 77.7%

Green LED Driver Calculations

Green Vd = 3.2V
Green Vled: 3 x Vd = 9.6V

Green LED Switch on time:
Ton = L x Idelta / (Vin - Vled - Iled x (Rs + RL + Rsw))

= 100*10^-6 x 92.5*10^-3 / (12.4 - 9.6 - 0.37 x (0.27 + 0.5 + 0.2))

= 9.25*10^-6 / 2.44

= 3.79*10^-6

Ton = 3791ns

Green LED Switch off time:
Toff = L x Idelta / (Vled + Vd + Iled x (Rs + RL))

= 100*10^-6 x 92.5*10^-3 / (9.6 + 3.2 + 0.37 x (0.27 + 0.5))

= 9.25*10^-6 / 13.08

= 7.072*10^-7

Toff = 707ns

Green LED Duty Cycle: Dsw = Ton / (Ton + Toff)

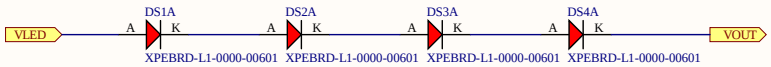
= 3791 / (3791 + 707)

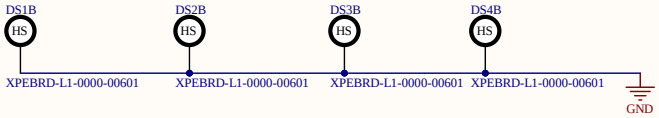
= 84.3%

Revision History:

Rev	Date	Description

Sheet Title: LED Driver			
Project:			QUT Motorsport Q-120, Gardens Point 2 George Street Brisbane, QLD 4000 Australia
Size: A3	Number: 2	Version:	
		Revision: 2	
Drawn By: Joseph Richards		Sheet 2 of 5	
Print Date: 28/08/2020	Print Time: 5:08:39 PM	File Name: QUTMS-TSAL-S01.SchDoc	





Red LED Array Calculations
Max Current: 1A
Forward Voltage: 2.2V
Forward Current: 370mA

Total Voltage Drop: 4 x 2.2 = 8.8V

Total Power: 8.8 x 0.37 = 3.27 W

Luminous Flux: 68.2 lm @ 370mA

Luminous Intensity: 68.2 lm/130 deg = 18.8cd

Total Brightness: 4 x 18.8 = 75.2cd*
*Meets International UN standards (60-180cd)

Revision History:

Rev	Date	Description

Sheet Title: **Red LED Array**

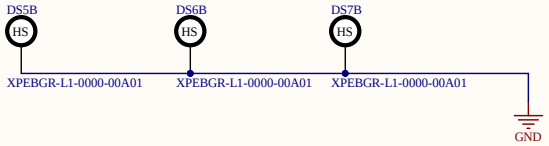
Project:

Size: A3 | Number: **3** | Version: | Revision: **2**

Drawn By: Joseph Richards | Sheet **3** of **5**

Print Date: 28/08/2020 Print Time: 5:08:39 PM | File Name: QUTMS-TSAL-S02.SchDoc

QUT Motorsport
Q-120, Gardens Point
2 George Street
Brisbane, QLD 4000
Australia



Green LED Array Calculations
Max Current: 1A
Forward Voltage: 3.2V
Forward Current: 370mA

Total Voltage Drop: 3 x 3.2 = 9.6V

Total Power: 9.6 x 0.37 = 3.55 W

Luminous Flux: 90 lm @ 370mA

Luminous Intensity: 90 lm/135 deg = 23.2cd

Total Brightness: 3 x 23.2 = 69.6cd*
*Meets International UN standards (60-180cd)

Revision History:

Rev	Date	Description

Sheet Title: **Green LED Array**

Project:

Size: A3 | Number: **4** | Version: | Revision: **2**

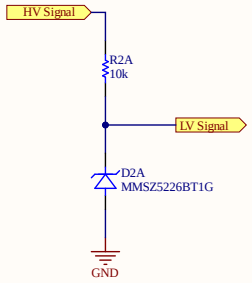
Drawn By: Joseph Richards

Sheet **4** of **5**

Print Date: 28/08/2020 Print Time: 5:08:39 PM

File Name: QUTMS-TSAL-S03.SchDoc

QUT Motorsport
Q-120, Gardens Point
2 George Street
Brisbane, QLD 4000
Australia



Voltage Reducer Circuit Calculations

Vin: 12V
Vz: 3.3V
R: 10kOhm

Current Flow: (Vin - Vz) / R
= (12 - 3.3) / 10000
I = 0.87 mA

Resistor Power: I^2 x R
= 0.00087^2 x 10000
Pr = 7.57 mW

Zener Power: I x V
= 0.00087 x 3.3
Pz = 2.87 mW

Total Power: Prz = Pr + Pz
= 0.00757 + 0.00287
Prz = 10.44 mW

Revision History:

Rev	Date	Description

Sheet Title: **Zener Voltage Regulator**

Project:

Size: A3 | Number: 5 | Version: | Revision: 2

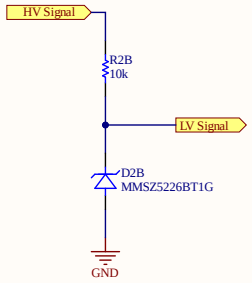
Drawn By: Joseph Richards

Sheet 5 of 5

Print Date: 28/08/2020 Print Time: 5:08:39 PM

File Name: QUTMS-TSAL-S04.SchDoc

QUT Motorsport
Q-120, Gardens Point
2 George Street
Brisbane, QLD 4000
Australia



Voltage Reducer Circuit Calculations

Vin: 12V
Vz: 3.3V
R: 10kOhm

Current Flow: (Vin - Vz) / R
= (12 - 3.3) / 10000
I = 0.87 mA

Resistor Power: I^2 x R
= 0.00087^2 x 10000
Pr = 7.57 mW

Zener Power: I x V
= 0.00087 x 3.3
Pz = 2.87 mW

Total Power: Prz = Pr + Pz
= 0.00757 + 0.00287
Prz = 10.44 mW

Revision History:

Rev	Date	Description

Sheet Title: **Zener Voltage Regulator**

Project:

Size: A3 | Number: 5 | Version: | Revision: 2

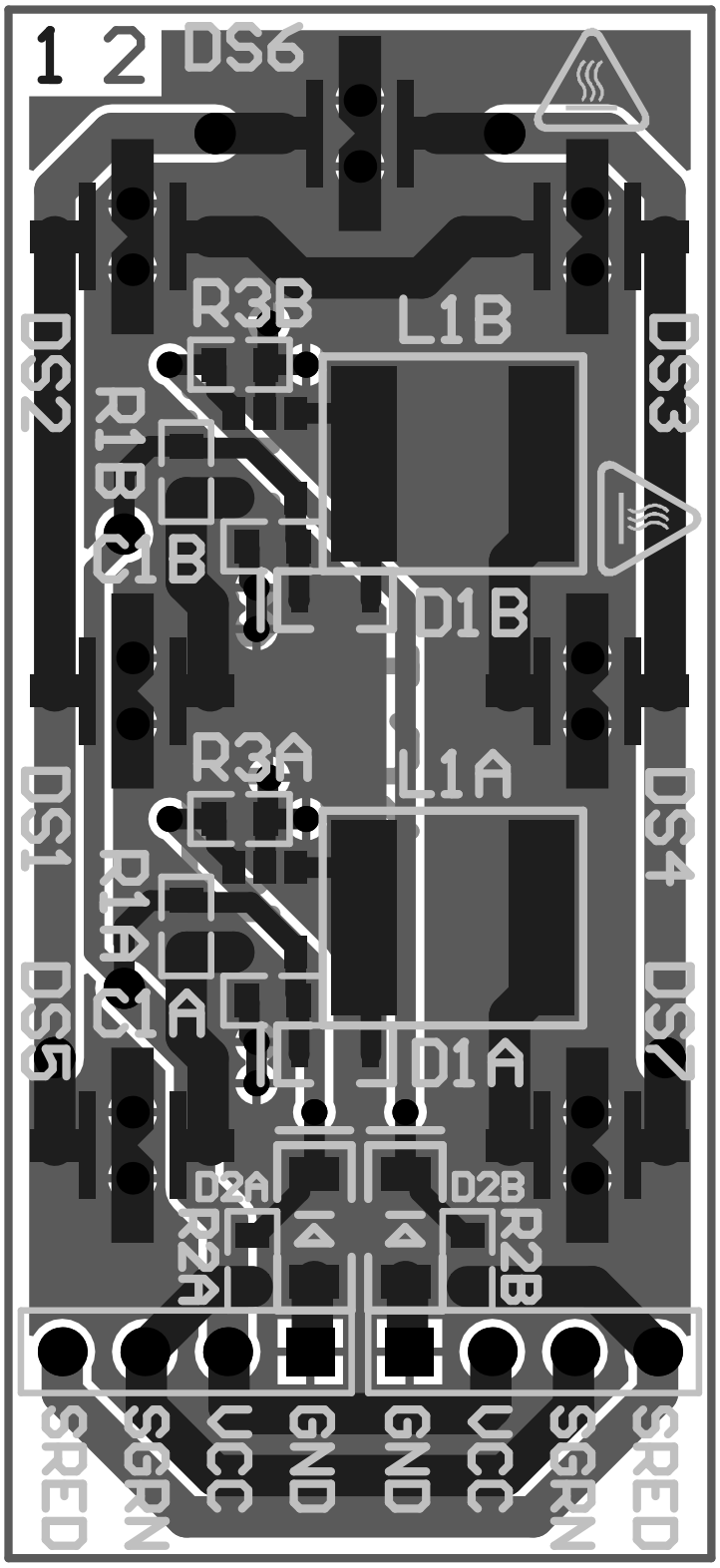
Drawn By: Joseph Richards

Sheet 5 of 5

Print Date: 28/08/2020 Print Time: 5:08:39 PM

File Name: QUTMS-TSAL-S04.SchDoc

QUT Motorsport
Q-120, Gardens Point
2 George Street
Brisbane, QLD 4000
Australia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DS6
R3B
L1B
DS2
DS3
R1B
C1B
D1B
R3A
L1A
DS1
DS4
R1A
C1A
DS5
DS7
D1A
D2A
D2B
R2A
R2B
SRED
SGRN
VCC
GND
GND
VCC
SGRN
SRED

Board Stack Report