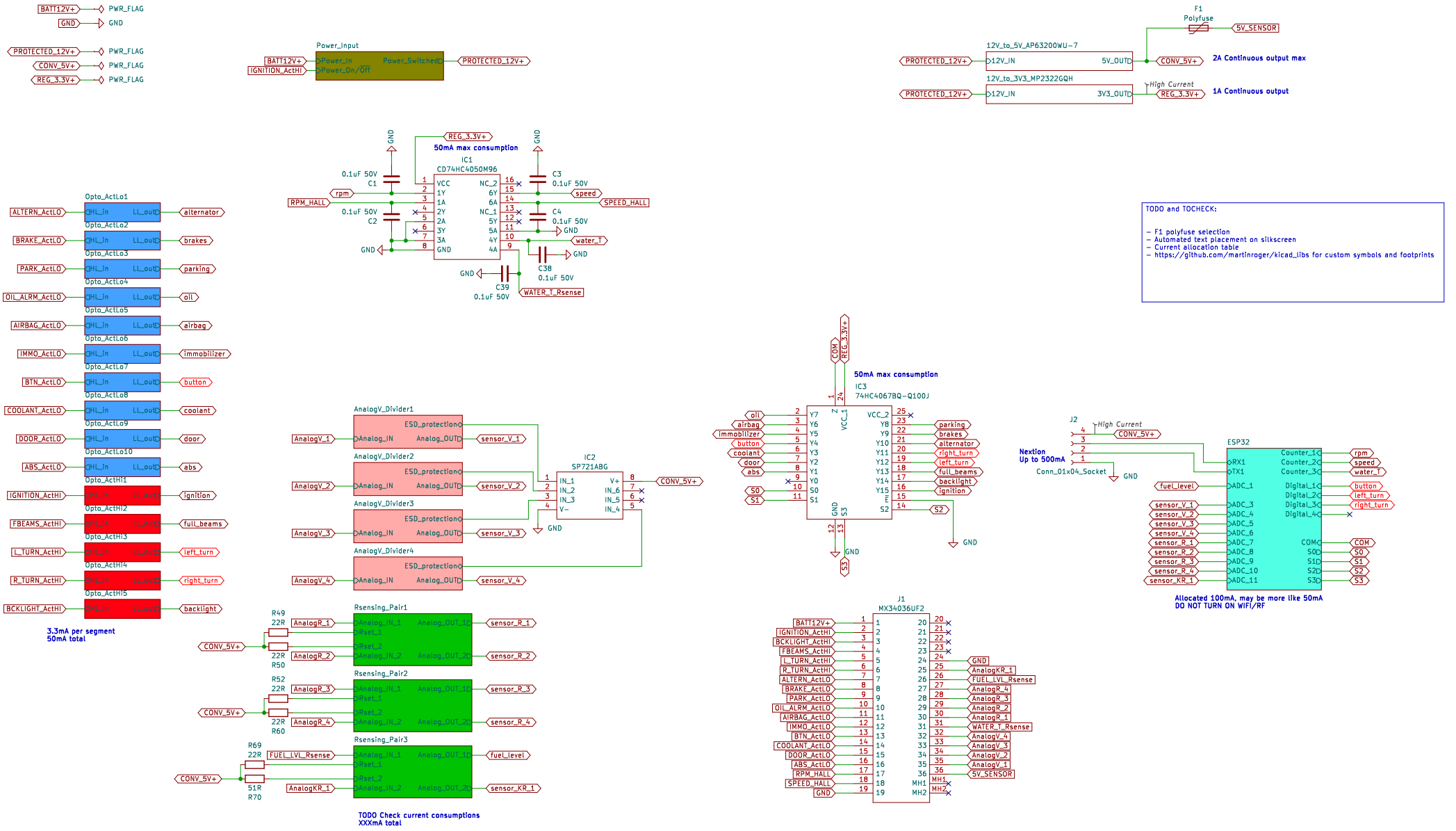
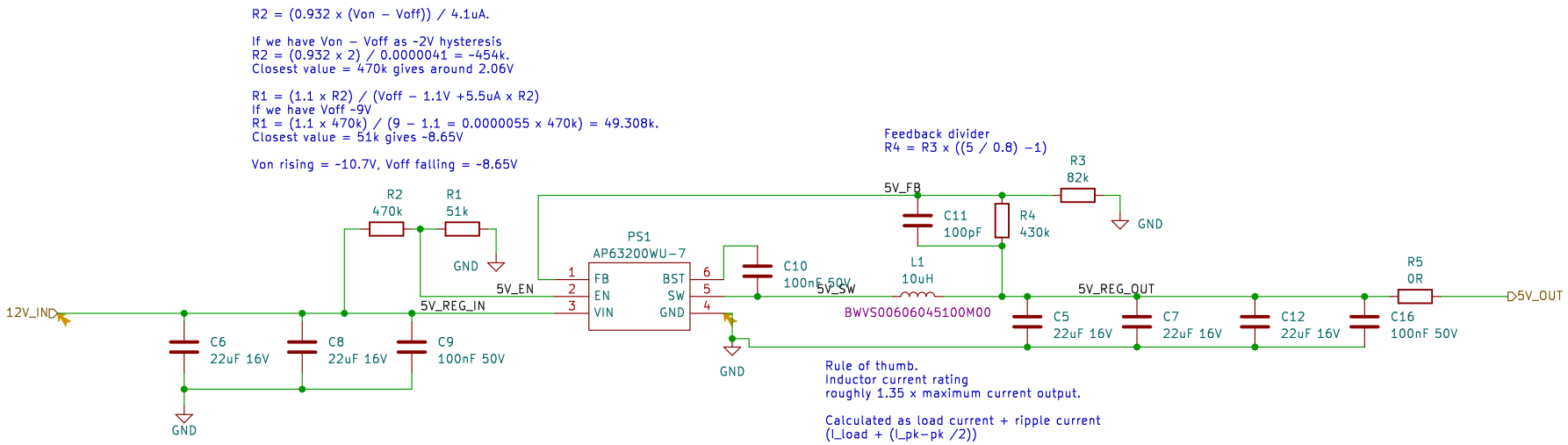

BATT12V+
PWR_FLAG
GND
GND
PROTECTED_12V+
PWR_FLAG
CONV_5V+
PWR_FLAG
REG_3.3V+
PWR_FLAG
Power_Input
BATT12V+
IGNITION_ActHI
Power_In
Power_On/Off
Power_Switched
PROTECTED_12V+
F1
Polyfuse
5V_SENSOR
12V_to_5V_AP63200WU-7
PROTECTED_12V+
12V_IN
5V_OUT
CONV_5V+
2A Continuous output max
12V_to_3V3_MP2322GQH
PROTECTED_12V+
12V_IN
3V3_OUT
High Current
REG_3.3V+
1A Continuous output
GND
REG_3.3V+
50mA max consumption
IC1
CD74HC4050M96
0.1uF 50V
C1
rpm
0.1uF 50V
C2
RPM_HALL
GND
C3
0.1uF 50V
speed
SPEED_HALL
C4
0.1uF 50V
GND
water_T
GND
C38
0.1uF 50V
GND
C39
0.1uF 50V
WATER_T_Rsense
Opto_ActLo1
ALTERN_ActLO
alternator
Opto_ActLo2
BRAKE_ActLO
brakes
Opto_ActLo3
PARK_ActLO
parking
Opto_ActLo4
OIL_ALRM_ActLO
oil
Opto_ActLo5
AIRBAG_ActLO
airbag
Opto_ActLo6
IMMO_ActLO
immobilizer
Opto_ActLo7
BTN_ActLO
button
Opto_ActLo8
COOLANT_ActLO
coolant
Opto_ActLo9
DOOR_ActLO
door
Opto_ActLo10
ABS_ActLO
abs
Opto_ActHI1
IGNITION_ActHI
ignition
Opto_ActHI2
FBEAMS_ActHI
full_beams
Opto_ActHI3
L_TURN_ActHI
left_turn
Opto_ActHI4
R_TURN_ActHI
right_turn
Opto_ActHI5
BCKLIGHT_ActHI
backlight
3.3mA per segment
50mA total
AnalogV_Divider1
AnalogV_1
ESD_protection
Analog_IN
Analog_OUT
sensor_V_1
AnalogV_Divider2
AnalogV_2
sensor_V_2
AnalogV_Divider3
AnalogV_3
sensor_V_3
AnalogV_Divider4
AnalogV_4
sensor_V_4
IC2
SP721ABG
IN_1
IN_2
IN_3
V-
V+
IN_6
IN_5
IN_4
CONV_5V+
GND
Rsensing_Pair1
R49
22R
AnalogR_1
CONV_5V+
22R
R50
AnalogR_2
Rset_1
Rset_2
Analog_IN_1
Analog_IN_2
Analog_OUT_1
Analog_OUT_2
sensor_R_1
sensor_R_2
Rsensing_Pair2
R52
22R
AnalogR_3
CONV_5V+
22R
R60
AnalogR_4
sensor_R_3
sensor_R_4
Rsensing_Pair3
R69
22R
FUEL_LVL_Rsense
CONV_5V+
51R
R70
AnalogKR_1
fuel_level
sensor_KR_1
TODO Check current consumptions
XXXmA total
COM
REG_3.3V+
50mA max consumption
IC3
74HC4067BQ-Q100J
oil
airbag
immobilizer
button
coolant
door
abs
S0
S1
Z
VCC_1
GND
S3
VCC_2
Y8
Y9
Y10
Y11
Y12
Y13
Y14
Y15
E
S2
parking
brakes
alternator
right_turn
left_turn
full_beams
backlight
ignition
S2
GND
S3
GND
J2
High Current
CONV_5V+
Nextion
Up to 500mA
Conn_01x04_Socket
GND
ESP32
RX1
TX1
ADC_1
ADC_3
ADC_4
ADC_5
ADC_6
ADC_7
ADC_8
ADC_9
ADC_10
ADC_11
Counter_1
Counter_2
Counter_3
Digital_1
Digital_2
Digital_3
Digital_4
COM
S0
S1
S2
S3
rpm
speed
water_T
button
left_turn
right_turn
COM
S0
S1
S2
S3
fuel_level
sensor_V_1
sensor_V_2
sensor_V_3
sensor_V_4
sensor_R_1
sensor_R_2
sensor_R_3
sensor_R_4
sensor_KR_1
Allocated 100mA, may be more like 50mA
DO NOT TURN ON WIFI/RF
J1
MX34036UF2
BATT12V+
IGNITION_ActHI
BCKLIGHT_ActHI
FBEAMS_ActHI
L_TURN_ActHI
R_TURN_ActHI
ALTERN_ActLO
BRAKE_ActLO
PARK_ActLO
OIL_ALRM_ActLO
AIRBAG_ActLO
IMMO_ActLO
BTN_ActLO
COOLANT_ActLO
DOOR_ActLO
ABS_ActLO
RPM_HALL
SPEED_HALL
GND
GND
AnalogKR_1
FUEL_LVL_Rsense
AnalogR_4
AnalogR_3
AnalogR_2
AnalogR_1
WATER_T_Rsense
AnalogV_4
AnalogV_3
AnalogV_2
AnalogV_1
5V_SENSOR
MH1
MH2
TODO and TOCHECK:
- F1 polyfuse selection
- Automated text placement on silkscreen
- Current allocation table
- https://github.com/martinroger/kicad_libs for custom symbols and footprints
https://cadlab.io/projects/vxdash
https://github.com/martinroger/VXDash
Sheet:
File: VXDash.kicad_sch
Title: Main architecture
Size: A3
Date: 2023-05-27
KiCad E.D.A. kicad (7.0.0)
Rev: 1.2.2
Id: 1/27



MAX 2A CONTINUOUS OUTPUT

All resistors low tolerance
All capacitors low ESR

https://cadlab.io/projects/vxdash
https://github.com/martinroger/VXDash

Sheet:
File: 12V_to_5V_AP63200WU−7.kicad_sch

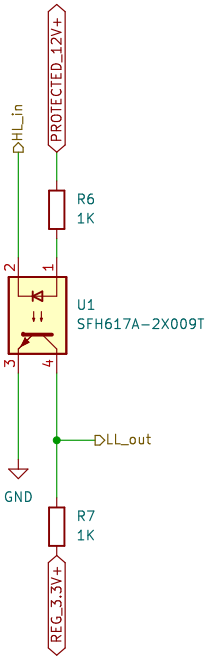
Title: 12V to 5V conversion

Size: A4	Date: 2023−05−14	**Rev: 1.2.2**
KiCad E.D.A. kicad (7.0.0)		Id: 2/27

SFH617A-2X009T
CTR 63-125%
Vf = 1.35V

Circuit CTR:
If = (12V-1.35V)/1K = 10.65mA
Ic = 3.3/1K = 3.3mA
CTRc = 3.3/10.65 = 30.9%

Opto is always in saturation



https://cadlab.io/projects/vxdash
https://github.com/martinroger/VXDash

Sheet:
File: Opto_ActLo.kicad_sch

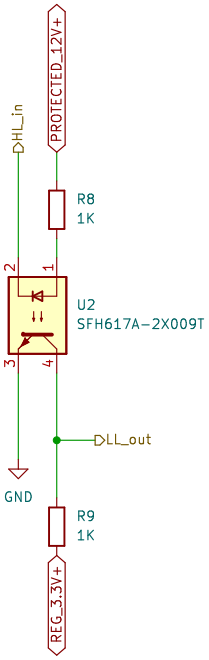
Title: Active Low Optocoupler circuit

Size: A4	Date: 2023-05-14	**Rev: 1.2.2**
KiCad E.D.A. kicad (7.0.0)		Id: 3/27

SFH617A-2X009T
CTR 63-125%
Vf = 1.35V

Circuit CTR:
If = (12V-1.35V)/1K = 10.65mA
Ic = 3.3/1K = 3.3mA
CTRc = 3.3/10.65 = 30.9%

Opto is always in saturation



https://cadlab.io/projects/vxdash
https://github.com/martinroger/VXDash

Sheet:
File: Opto_ActLo.kicad_sch

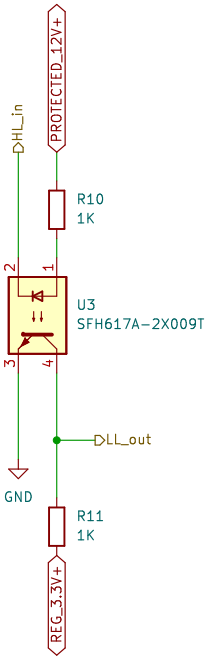
Title: Active Low Optocoupler circuit

Size: A4	Date: 2023-05-14	**Rev: 1.2.2**
KiCad E.D.A. kicad (7.0.0)		Id: 4/27

SFH617A-2X009T
CTR 63-125%
Vf = 1.35V

Circuit CTR:
If = (12V-1.35V)/1K = 10.65mA
Ic = 3.3/1K = 3.3mA
CTRc = 3.3/10.65 = 30.9%

Opto is always in saturation



https://cadlab.io/projects/vxdash
https://github.com/martinroger/VXDash

Sheet:
File: Opto_ActLo.kicad_sch

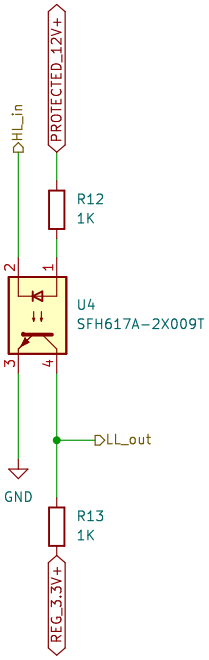
Title: Active Low Optocoupler circuit

Size: A4	Date: 2023-05-14	**Rev: 1.2.2**
KiCad E.D.A. kicad (7.0.0)		Id: 5/27

SFH617A-2X009T
CTR 63-125%
Vf = 1.35V

Circuit CTR:
If = (12V-1.35V)/1K = 10.65mA
Ic = 3.3/1K = 3.3mA
CTRc = 3.3/10.65 = 30.9%

Opto is always in saturation



https://cadlab.io/projects/vxdash
https://github.com/martinroger/VXDash

Sheet:
File: Opto_ActLo.kicad_sch

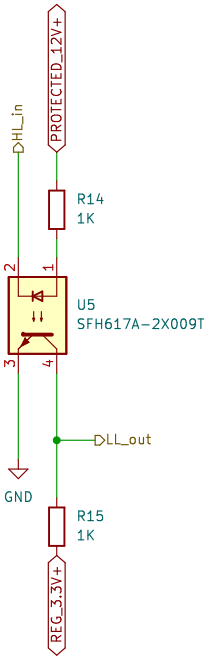
Title: Active Low Optocoupler circuit

Size: A4	Date: 2023-05-14	**Rev: 1.2.2**
KiCad E.D.A. kicad (7.0.0)		Id: 6/27

SFH617A-2X009T
CTR 63-125%
Vf = 1.35V

Circuit CTR:
If = (12V-1.35V)/1K = 10.65mA
Ic = 3.3/1K = 3.3mA
CTRc = 3.3/10.65 = 30.9%

Opto is always in saturation



https://cadlab.io/projects/vxdash
https://github.com/martinroger/VXDash

Sheet:
File: Opto_ActLo.kicad_sch

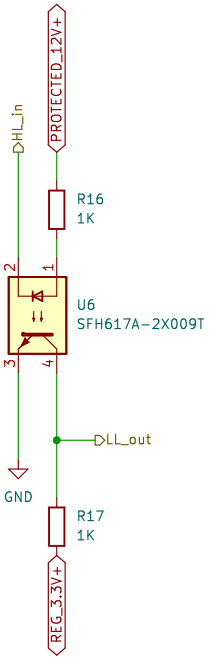
Title: Active Low Optocoupler circuit

Size: A4	Date: 2023-05-14	**Rev: 1.2.2**
KiCad E.D.A. kicad (7.0.0)		Id: 7/27

SFH617A-2X009T
CTR 63-125%
Vf = 1.35V

Circuit CTR:
If = (12V-1.35V)/1K = 10.65mA
Ic = 3.3/1K = 3.3mA
CTRc = 3.3/10.65 = 30.9%

Opto is always in saturation



https://cadlab.io/projects/vxdash
https://github.com/martinroger/VXDash

Sheet:
File: Opto_ActLo.kicad_sch

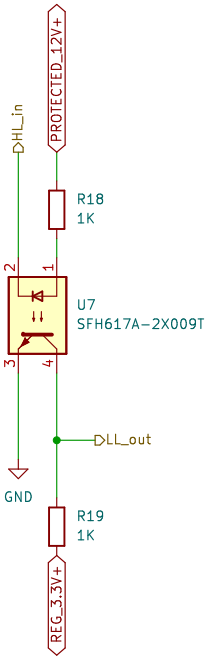
Title: Active Low Optocoupler circuit

Size: A4	Date: 2023-05-14	**Rev: 1.2.2**
KiCad E.D.A. kicad (7.0.0)		Id: 8/27

SFH617A-2X009T
CTR 63-125%
Vf = 1.35V

Circuit CTR:
If = (12V-1.35V)/1K = 10.65mA
Ic = 3.3/1K = 3.3mA
CTRc = 3.3/10.65 = 30.9%

Opto is always in saturation



https://cadlab.io/projects/vxdash
https://github.com/martinroger/VXDash

Sheet:
File: Opto_ActLo.kicad_sch

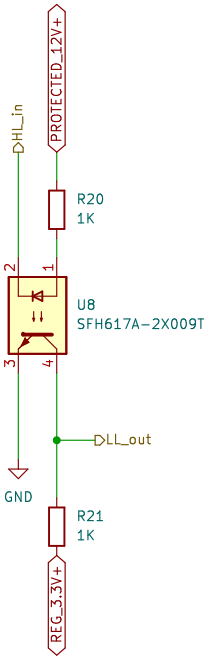
Title: Active Low Optocoupler circuit

Size: A4	Date: 2023-05-14	**Rev: 1.2.2**
KiCad E.D.A. kicad (7.0.0)		Id: 9/27

SFH617A-2X009T
CTR 63-125%
Vf = 1.35V

Circuit CTR:
If = (12V-1.35V)/1K = 10.65mA
Ic = 3.3/1K = 3.3mA
CTRc = 3.3/10.65 = 30.9%

Opto is always in saturation



https://cadlab.io/projects/vxdash
https://github.com/martinroger/VXDash

Sheet:
File: Opto_ActLo.kicad_sch

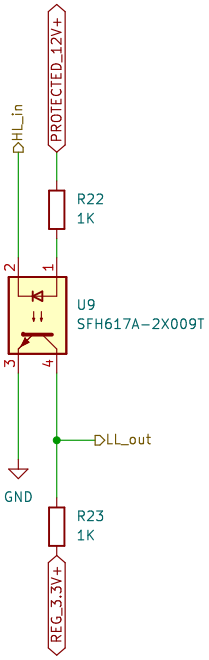
Title: Active Low Optocoupler circuit

Size: A4	Date: 2023-05-14	**Rev: 1.2.2**
KiCad E.D.A. kicad (7.0.0)		Id: 10/27

SFH617A-2X009T
CTR 63-125%
Vf = 1.35V

Circuit CTR:
If = (12V-1.35V)/1K = 10.65mA
Ic = 3.3/1K = 3.3mA
CTRc = 3.3/10.65 = 30.9%

Opto is always in saturation



https://cadlab.io/projects/vxdash
https://github.com/martinroger/VXDash

Sheet:
File: Opto_ActLo.kicad_sch

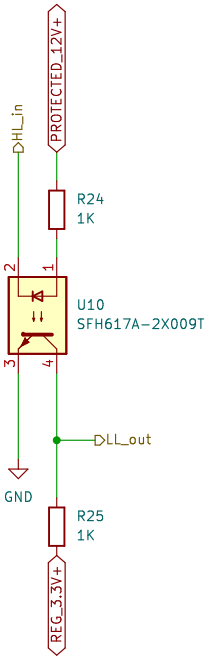
Title: Active Low Optocoupler circuit

Size: A4	Date: 2023-05-14	**Rev: 1.2.2**
KiCad E.D.A. kicad (7.0.0)		Id: 11/27

SFH617A-2X009T
CTR 63-125%
Vf = 1.35V

Circuit CTR:
If = (12V-1.35V)/1K = 10.65mA
Ic = 3.3/1K = 3.3mA
CTRc = 3.3/10.65 = 30.9%

Opto is always in saturation



https://cadlab.io/projects/vxdash
https://github.com/martinroger/VXDash

Sheet:
File: Opto_ActLo.kicad_sch

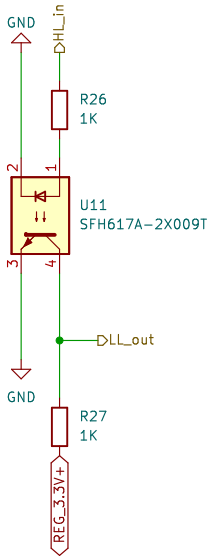
Title: Active Low Optocoupler circuit

Size: A4	Date: 2023-05-14	**Rev: 1.2.2**
KiCad E.D.A. kicad (7.0.0)		Id: 12/27

SFH617A-2X009T
CTR 63-125%
Vf = 1.35V

Circuit CTR:
If = (12V-1.35V)/1K = 10.65mA
Ic = 3.3/1K = 3.3mA
CTRc = 3.3/10.65 = 30.9%

Opto is always in saturation



https://cadlab.io/projects/vxdash
https://github.com/martinroger/VXDash

Sheet:
File: Opto_ActHi.kicad_sch

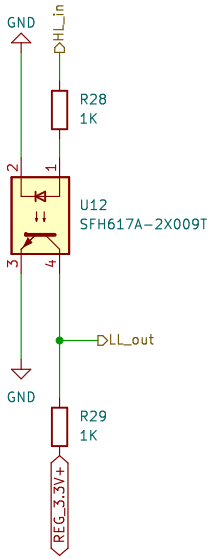
Title: Active Hi Optocoupler circuit

Size: A4	Date: 2023-05-14	**Rev: 1.2.2**
KiCad E.D.A. kicad (7.0.0)		Id: 13/27

SFH617A-2X009T
CTR 63-125%
Vf = 1.35V

Circuit CTR:
If = (12V-1.35V)/1K = 10.65mA
Ic = 3.3/1K = 3.3mA
CTRc = 3.3/10.65 = 30.9%

Opto is always in saturation



https://cadlab.io/projects/vxdash
https://github.com/martinroger/VXDash

Sheet:
File: Opto_ActHi.kicad_sch

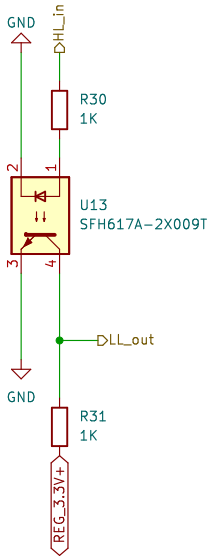
Title: Active Hi Optocoupler circuit

Size: A4	Date: 2023-05-14	**Rev: 1.2.2**
KiCad E.D.A. kicad (7.0.0)		Id: 14/27

SFH617A-2X009T
CTR 63-125%
Vf = 1.35V

Circuit CTR:
If = (12V-1.35V)/1K = 10.65mA
Ic = 3.3/1K = 3.3mA
CTRc = 3.3/10.65 = 30.9%

Opto is always in saturation



https://cadlab.io/projects/vxdash
https://github.com/martinroger/VXDash

Sheet:
File: Opto_ActHi.kicad_sch

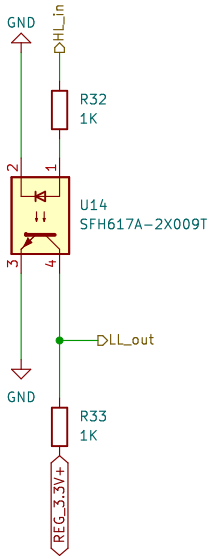
Title: Active Hi Optocoupler circuit

Size: A4	Date: 2023-05-14	**Rev: 1.2.2**
KiCad E.D.A. kicad (7.0.0)		Id: 15/27

SFH617A-2X009T
CTR 63-125%
Vf = 1.35V

Circuit CTR:
If = (12V-1.35V)/1K = 10.65mA
Ic = 3.3/1K = 3.3mA
CTRc = 3.3/10.65 = 30.9%

Opto is always in saturation



https://cadlab.io/projects/vxdash
https://github.com/martinroger/VXDash

Sheet:
File: Opto_ActHi.kicad_sch

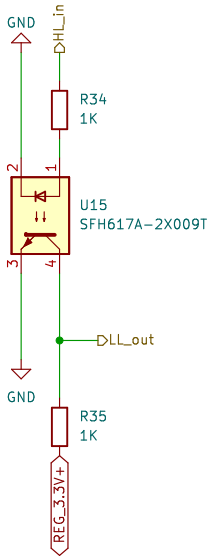
Title: Active Hi Optocoupler circuit

Size: A4	Date: 2023-05-14	**Rev: 1.2.2**
KiCad E.D.A. kicad (7.0.0)		Id: 16/27

SFH617A-2X009T
CTR 63-125%
Vf = 1.35V

Circuit CTR:
If = (12V-1.35V)/1K = 10.65mA
Ic = 3.3/1K = 3.3mA
CTRc = 3.3/10.65 = 30.9%

Opto is always in saturation

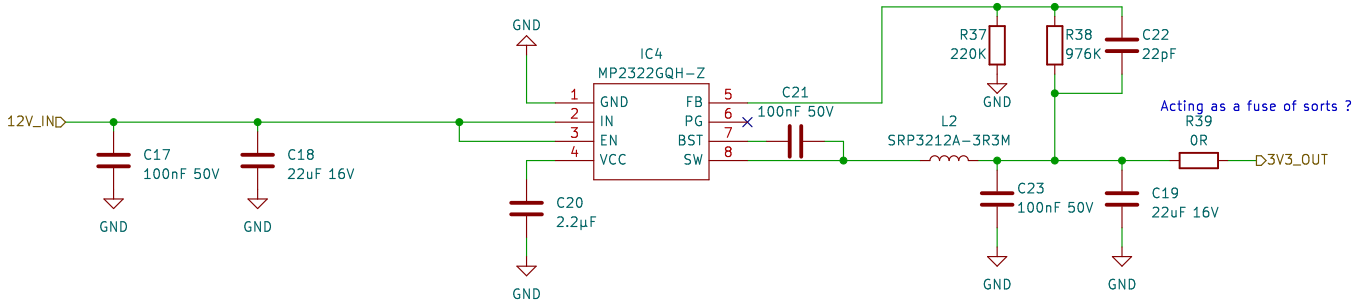


https://cadlab.io/projects/vxdash
https://github.com/martinroger/VXDash

Sheet:
File: Opto_ActHi.kicad_sch

Title: Active Hi Optocoupler circuit

Size: A4	Date: 2023-05-14	**Rev: 1.2.2**
KiCad E.D.A. kicad (7.0.0)		Id: 17/27

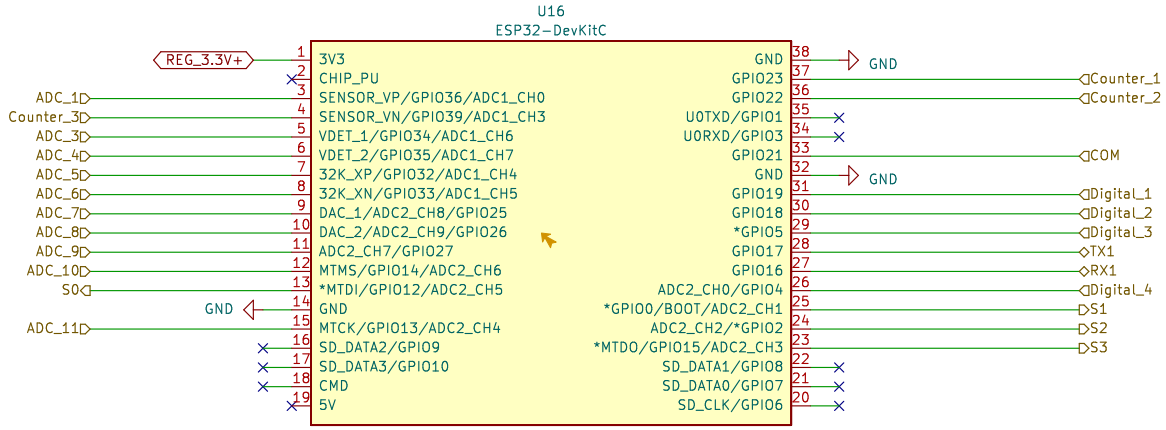


https://cadlab.io/projects/vxdash
https://github.com/martinroger/VXDash

Sheet:
File: 12V_to_3V3_MP2322GQH.kicad_sch

Title: 5 to 3V3 stage

Size: A4	Date: 2023-05-14	**Rev: 1.2.2**
KiCad E.D.A. kicad (7.0.0)		Id: 18/27

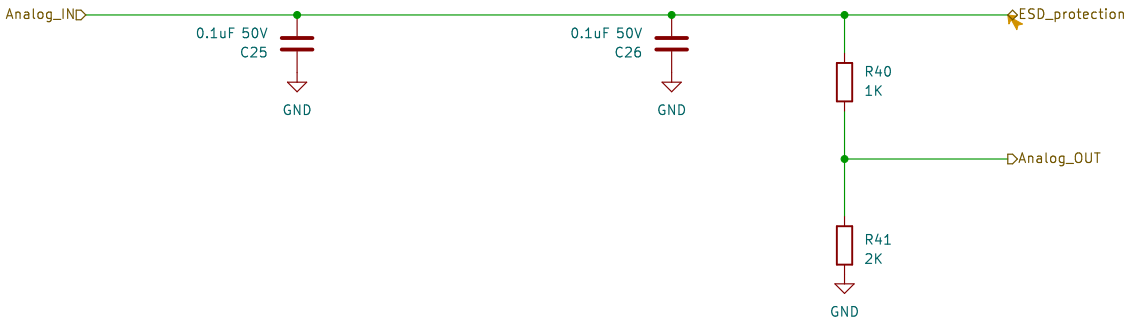


https://cadlab.io/projects/vxdash
https://github.com/martinroger/VXDash

Sheet:
File: ESP32.kicad_sch

Title: ESP32 container

Size: A4	Date: 2023-05-14	**Rev: 1.2.2**
KiCad E.D.A. kicad (7.0.0)		Id: 19/27

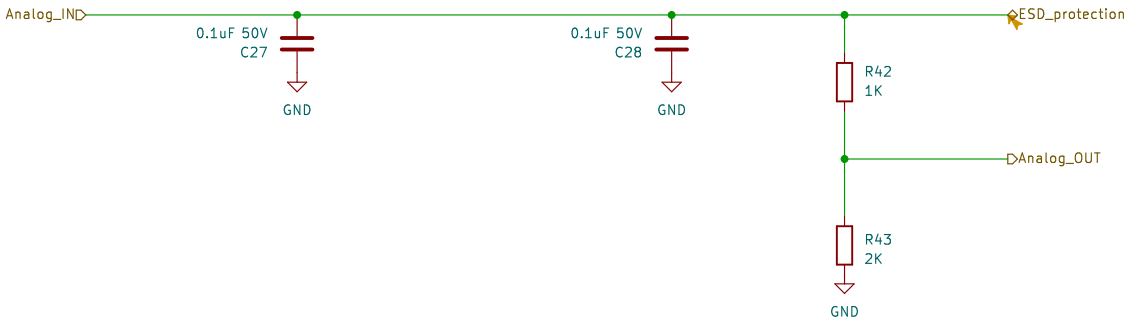


https://cadlab.io/projects/vxdash
https://github.com/martinroger/VXDash

Sheet:
File: AnalogV_Divider.kicad_sch

Title: 0-5V voltage sensing circuit

Size: A4	Date: 2023-05-14	**Rev: 1.2.2**
KiCad E.D.A. kicad (7.0.0)		Id: 20/27



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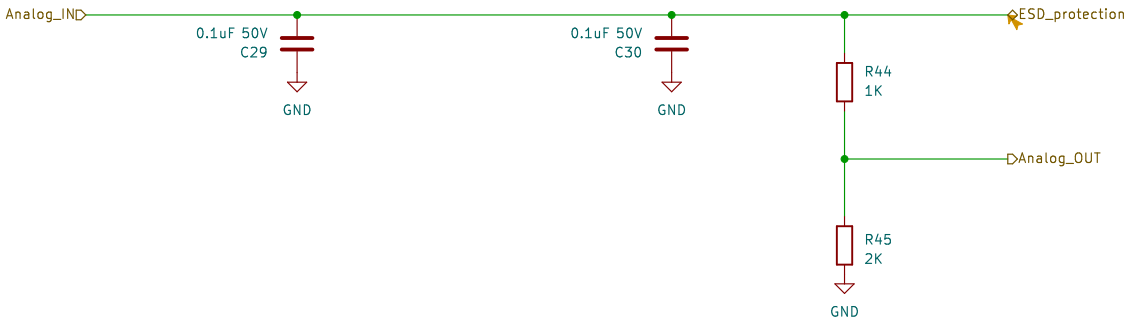
Sheet:
File: AnalogV_Divider.kicad_sch

Title: 0-5V voltage sensing circuit

Size: A4	Date: 2023-05-14	**Rev: 1.2.2**
KiCad E.D.A. kicad (7.0.0)		Id: 21/27



https://cadlab.io/projects/vxdash
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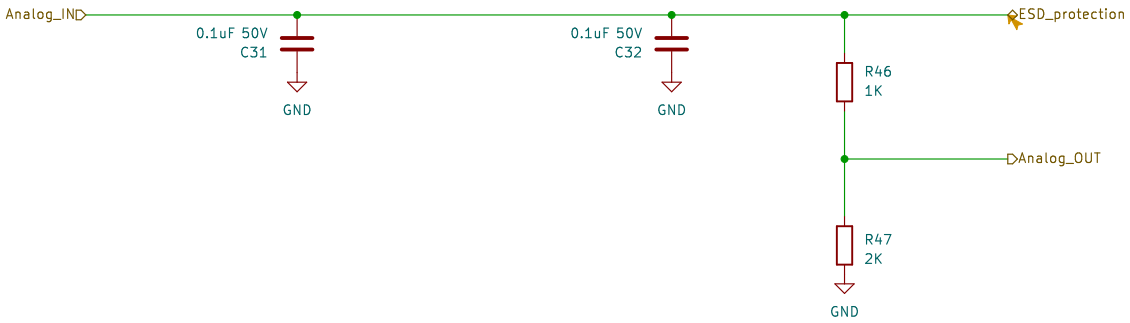
Sheet:
File: AnalogV_Divider.kicad_sch

Title: 0-5V voltage sensing circuit

Size: A4	Date: 2023-05-14	**Rev: 1.2.2**
KiCad E.D.A. kicad (7.0.0)		Id: 22/27



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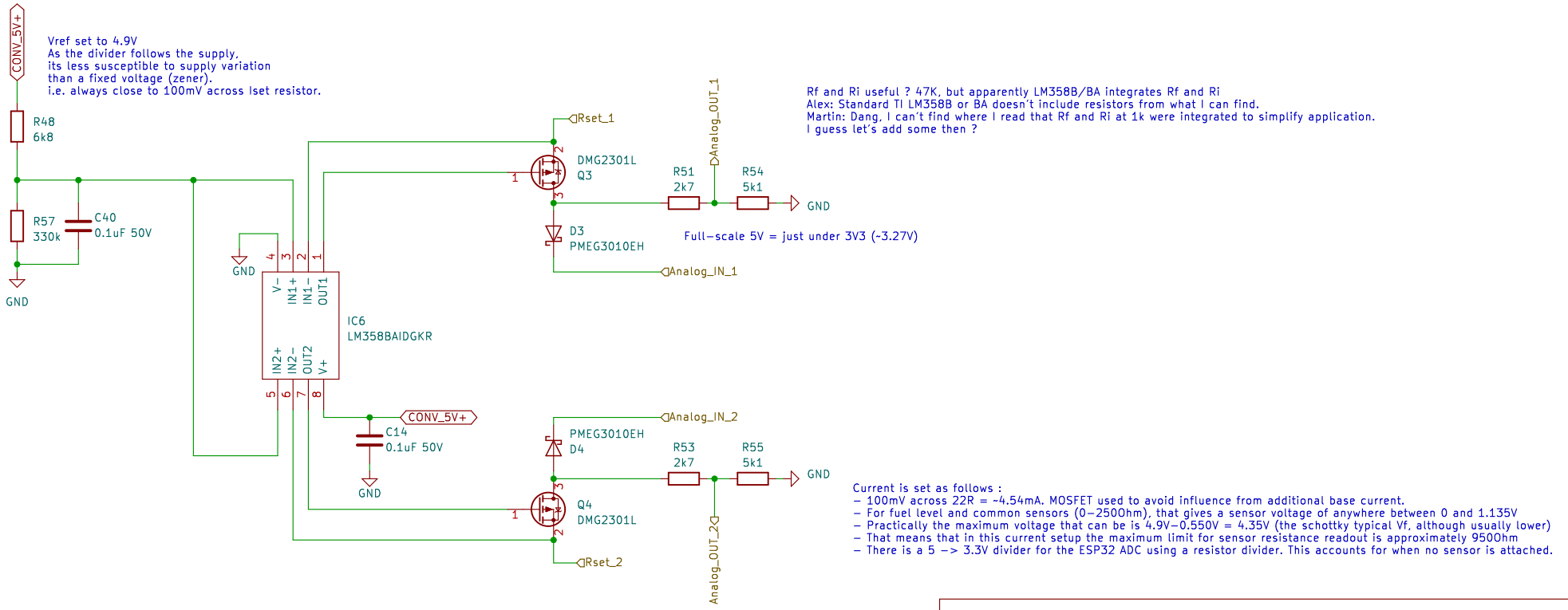
Sheet:
File: AnalogV_Divider.kicad_sch

Title: 0-5V voltage sensing circuit

Size: A4	Date: 2023-05-14	**Rev: 1.2.2**
KiCad E.D.A. kicad (7.0.0)		Id: 23/27

Ideas/issues :
- How to account for variations in the Vf of PMEG3010EH
  Alex: At ~4.5mA, Vf varies by ~120mV from −40 to 80degC. This equates to ~24ohm error over a large temp
  Martin : gotcha
- 5V may not be true 5V −> Zener regulator there too ? evaluate possible swings
  Alex: Used a Vref that follows any variation of 5V. More worried about keeping a set V across the current set resistor.
- Design is a bit limited to be usable on >750ohm sensors like ECU sensors
  Alex: Could be used for sensors up to 900ohm. We could look to add configurable range switchig future versions.
  Martin : Currently I am reserving one I/O for higher impedance sensors. I guess increasing the Iset resistor is also a method, for example to 51R?
- Something better than PMEG3010EH to use ?
  Alex: At ~4.5mA, Vf is only ~200mV which is pretty good!
- No issue with Vset being so close to the Vcc for the LM358? I got a bit confused by the datasheet.



Current is set as follows :
- 100mV across 22R = ~4.54mA. MOSFET used to avoid influence from additional base current.
- For fuel level and common sensors (0−250Ohm), that gives a sensor voltage of anywhere between 0 and 1.135V
- Practically the maximum voltage that can be is 4.9V−0.550V = 4.35V (the schottky typical Vf, although usually lower)
- That means that in this current setup the maximum limit for sensor resistance readout is approximately 950Ohm
- There is a 5 −> 3.3V divider for the ESP32 ADC using a resistor divider. This accounts for when no sensor is attached.

https://cadlab.io/projects/vxdash
https://github.com/martinroger/VXDash

Sheet:
File: Rsensing_Pair.kicad_sch

Title: Dual Op−Amp Constant current source resistive sensor

Size: A4	Date: 2023−05−14	**Rev: 1.2.2**
KiCad E.D.A. kicad (7.0.0)		Id: 24/27

Ideas/issues :
- How to account for variations in the Vf of PMEG3010EH
  Alex: At ~4.5mA, Vf varies by ~120mV from −40 to 80degC. This equates to ~24ohm error over a large temp
  Martin : gotcha
- 5V may not be true 5V −> Zener regulator there too ? evaluate possible swings
  Alex: Used a Vref that follows any variation of 5V. More worried about keeping a set V across the current set resistor.
- Design is a bit limited to be usable on >750ohm sensors like ECU sensors
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  Martin : Currently I am reserving one I/O for higher impedance sensors. I guess increasing the Iset resistor is also a method, for example to 51R?
- Something better than PMEG3010EH to use ?
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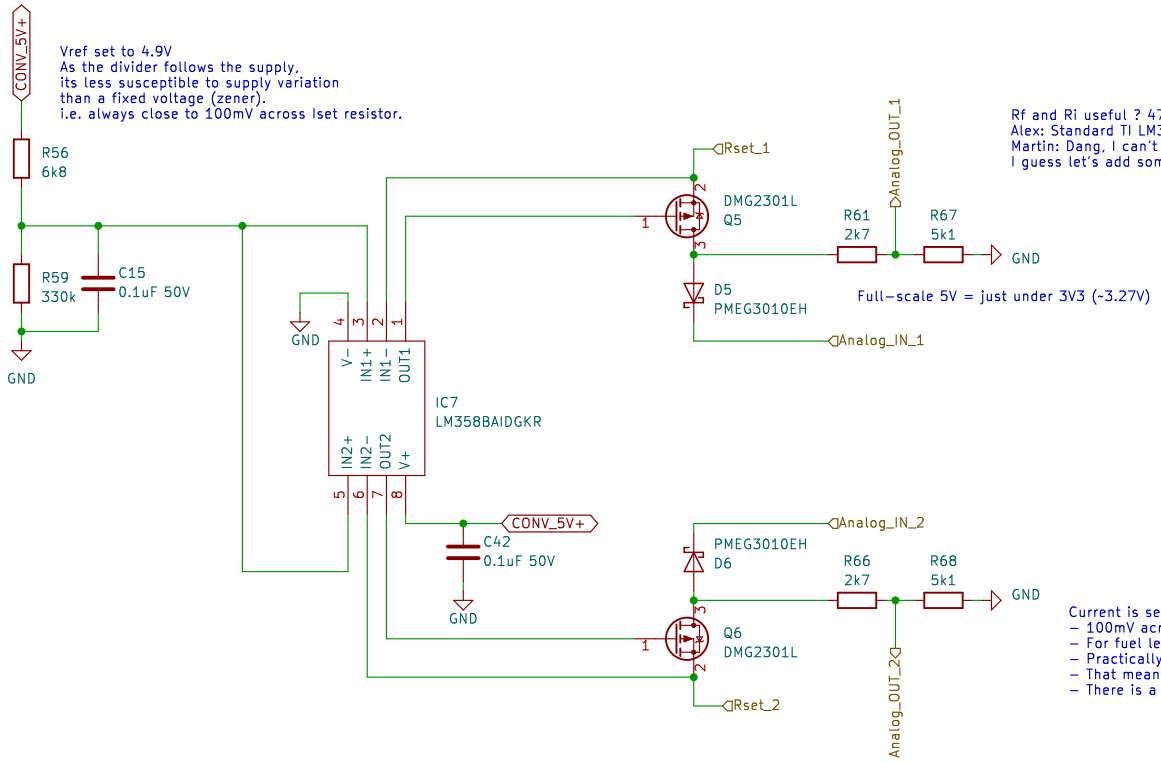

Rf and Ri useful ? 47K, but apparently LM358B/BA integrates Rf and Ri
Alex: Standard TI LM358B or BA doesn't include resistors from what I can find.
Martin: Dang, I can't find where I read that Rf and Ri at 1k were integrated to simplify application.
I guess let's add some then ?

Current is set as follows :
- 100mV across 22R = ~4.54mA. MOSFET used to avoid influence from additional base current.
- For fuel level and common sensors (0−250Ohm), that gives a sensor voltage of anywhere between 0 and 1.135V
- Practically the maximum voltage that can be is 4.9V−0.550V = 4.35V (the schottky typical Vf, although usually lower)
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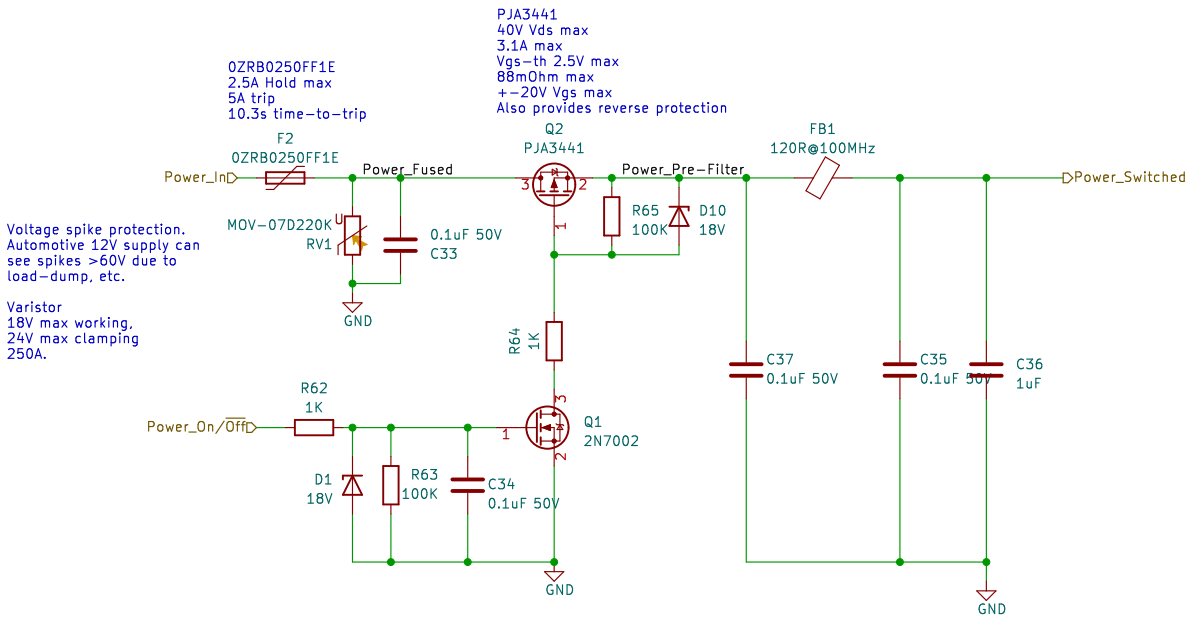
https://cadlab.io/projects/vxdash
https://github.com/martinroger/VXDash

Sheet:
File: Rsensing_Pair.kicad_sch

Title: Dual Op−Amp Constant current source resistive sensor

Size: A4	Date: 2023−05−14	**Rev: 1.2.2**
KiCad E.D.A. kicad (7.0.0)		Id: 25/27



https://cadlab.io/projects/vxdash
https://github.com/martinroger/VXDash

Sheet:
File: Power_Input.kicad_sch

Title: Power switching and protection

Size: A4	Date: 2023-05-14	**Rev: 1.2.2**
KiCad E.D.A. kicad (7.0.0)		Id: 26/27

Ideas/issues :
- How to account for variations in the Vf of PMEG3010EH
  Alex: At ~4.5mA, Vf varies by ~120mV from −40 to 80degC. This equates to ~24ohm error over a large temp
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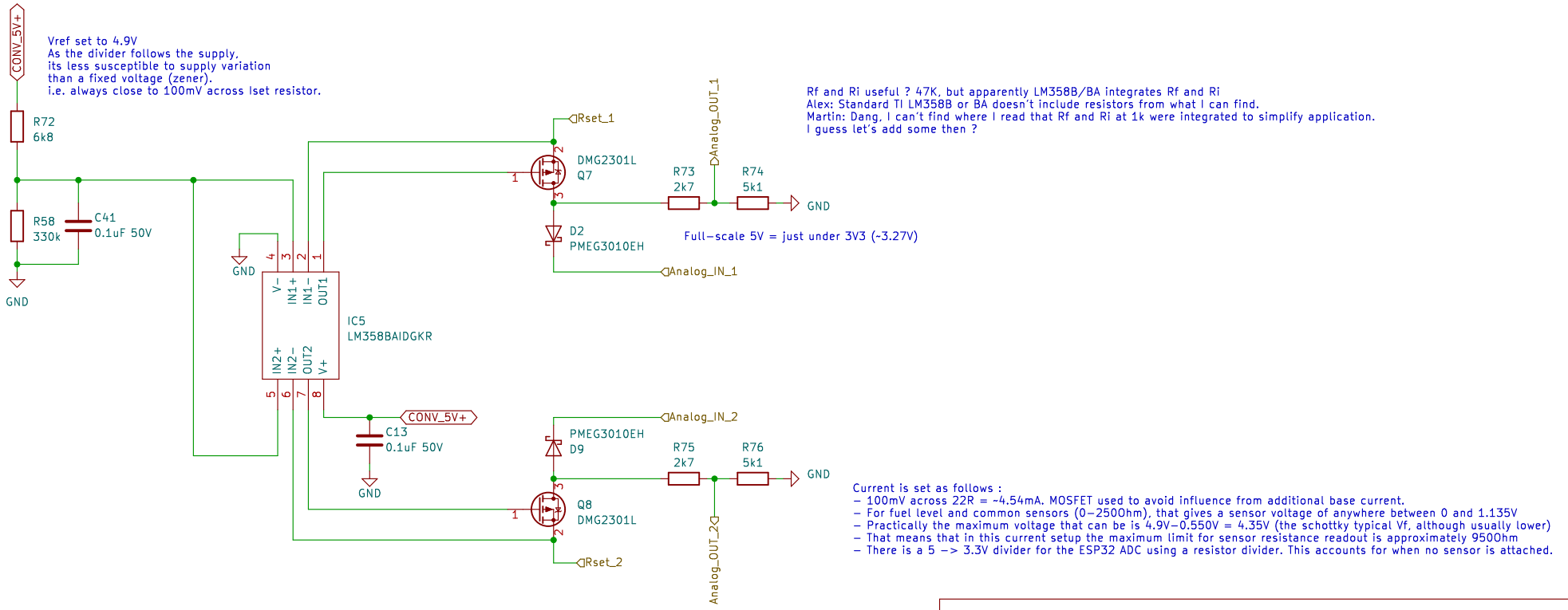

https://cadlab.io/projects/vxdash
https://github.com/martinroger/VXDash

Sheet:
File: Rsensing_Pair.kicad_sch

Title: Dual Op−Amp Constant current source resistive sensor

Size: A4	Date: 2023−05−14	**Rev: 1.2.2**
KiCad E.D.A. kicad (7.0.0)		Id: 27/27