# Delta-Bot Control Electronics

Handles supervisory and control tasks for the delta-robot.
Designed to reduce wiring complexity and improve functionality.

Input 75VDC from Teknic IPC PSU.
Filter/protection requirements are minimal.
Provide regulated 12V for IO Logic Level/Fan/etc.
Provide regulated 3.3V for microcontroller etc.

Power Filtering and Regulation

power.sch

STM32 microcontroller.
Handles sampling input sensors, aux outputs.
Generates 4x sets of step/direction control signals.
Interfacing etc for PC/Phone UI.

Processing and Control

microcontroller.sch

Output connectors to Clearpath SDSK servos.
Output power and data connectors (optocoupled).
Motor status line input circuit.
Per-servo current monitoring.

Output Circuits and Connectors

motor_outputs.sch

Output for PWM controlled fan, external temp probes.
Generic outputs for internal or end affector accessories.
Optocoupled outputs for external device control.
Optocoupled inputs for inbound control.

Expansion I/O

expansion_io.sch

## Artwork

DONT PANIC
LOGO01
Bug Symbol
LOGO02
Lamp Symbol
LOGO03
Thermometre
LOGO04
USB Symbol
LOGO05
UART Symbol
LOGO13
WARN Triangle
LOGO06
LOGO08
LOGO10
LOGO07
LOGO09
Lightning Bolt
LOGO12
Hot Fire
LOGO11

## Mechanical Mounts

MNT1
MNT_M3_PLATED
GND
MNT2
MNT_M3_PLATED
GND
MNT3
MNT_M3_PLATED
GND

## Fiducials

FID1
FIDUCIAL
FID2
FIDUCIAL
FID3
FIDUCIAL
FID4
FIDUCIAL

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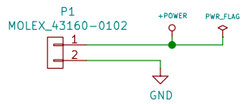
Sheet: /
File: zaphod-controller.sch

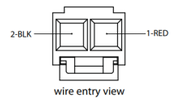
***Title: Delta Overview***

| Size: A4 | Date: 2018-04-30 | **Rev: 1.0** |
|---|---|---|
| KiCad E.D.A. | kicad (5.0.0-rc2-dev-296-g4594fedc2) | Id: 1/5 |

# 75VDC Input Power

SABRE 2-pin connector

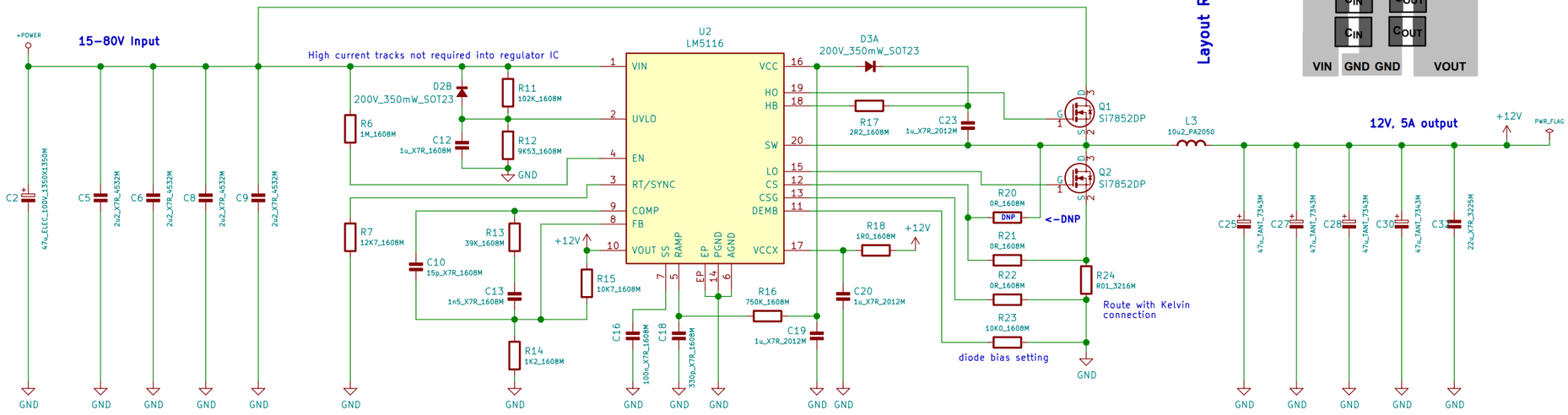


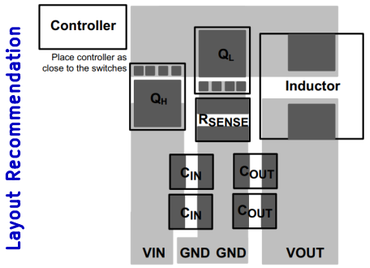

| Pin Assignments | | |
|---|---|---|
| Pin | Color | Name |
| 1 | RED | V+ |
| 2 | BLK | GND |

# 12V Regulation

Follows the TI AN-1713 application note for the LM5116.
250kHz, should achieve >90% efficiency at operating voltage.

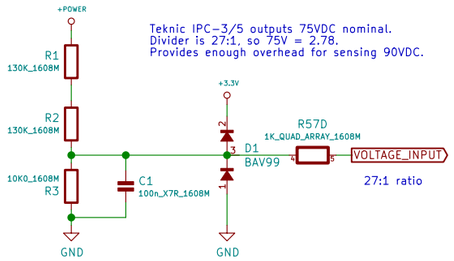



## Layout Recommendation



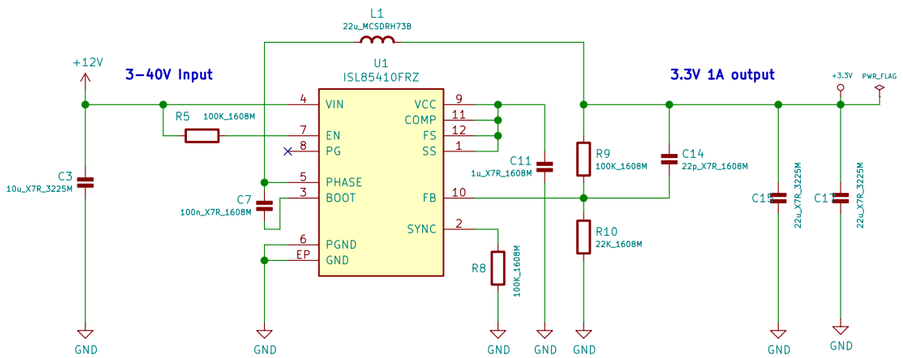

# Input Voltage Monitoring

Teknic IPC-3/5 outputs 75VDC nominal.
Divider is 27:1, so 75V = 2.78.
Provides enough overhead for sensing 90VDC.




# 3.3V Regulation

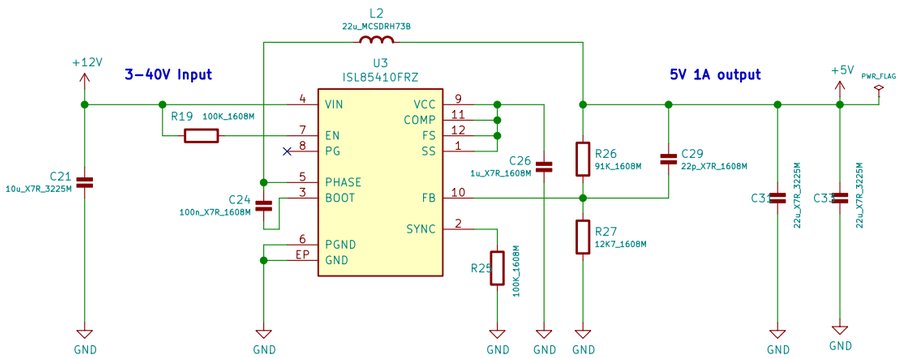
3.3V 1A switchmode regulator.
Follows Pololu D24V10F3 design.




90.9K and 20K are appropriate substitutes

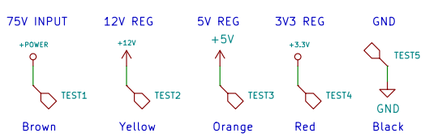
# 5V Regulation

5V 1A switchmode regulator.
Follows Pololu D24V10F5 design.

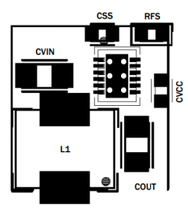



12.4K is an appropriate substitute

# Testpoints




Placement Recommendation

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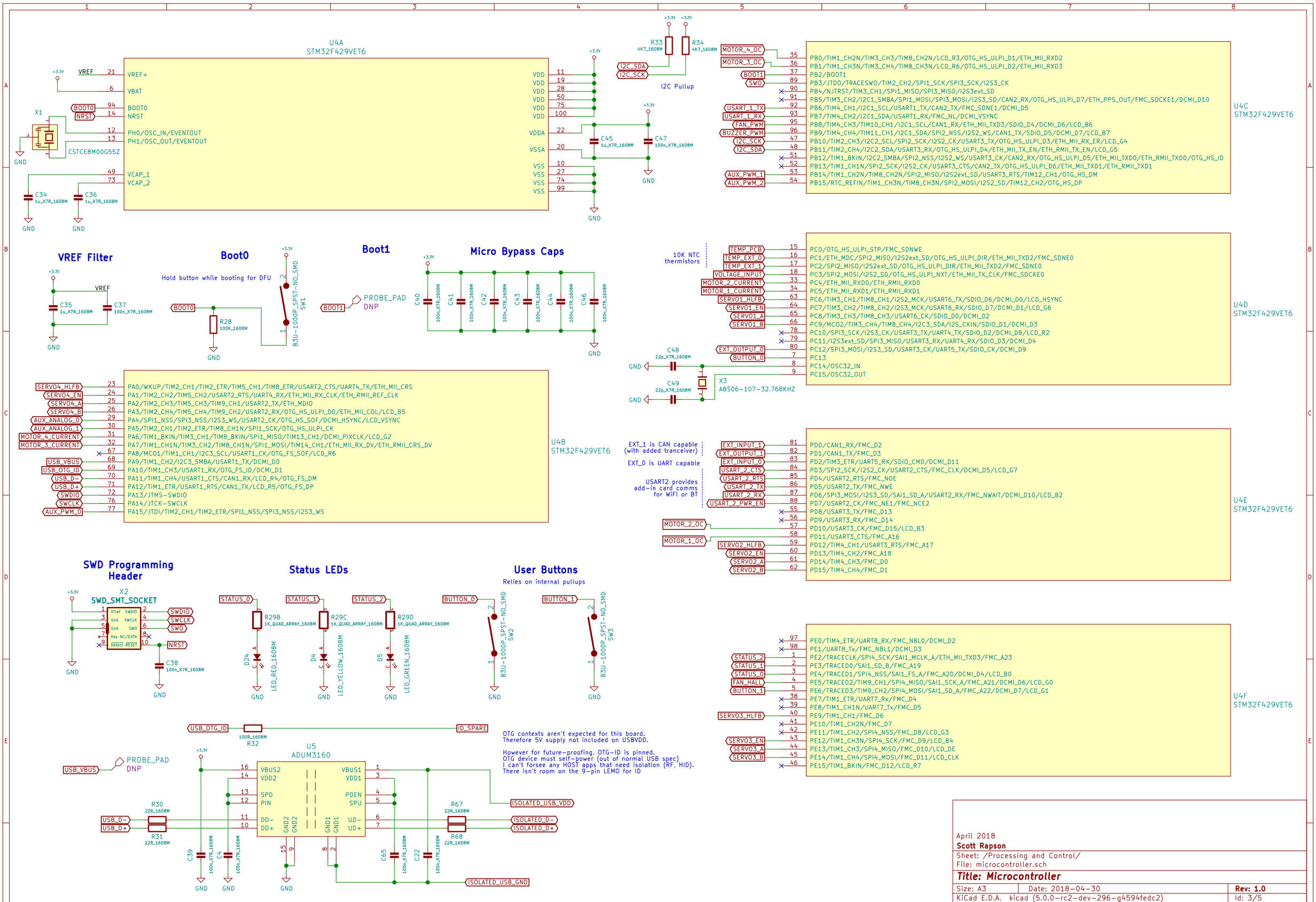
Sheet: /Power Filtering and Regulation/
File: power.sch

***Title: Power Regulation***

| Size: A3 | Date: 2018-04-30 | **Rev: 1.0** |
|---|---|---|
| KiCad E.D.A. kicad (5.0.0-rc2-dev-296-g4594fedc2) | | Id: 2/5 |

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Sheet: /Processing and Control/
File: microcontroller.sch

***Title: Microcontroller***

| Size: A3 | Date: 2018-04-30 | **Rev: 1.0** |
|---|---|---|
| KiCad E.D.A. kicad (5.0.0-rc2-dev-296-g4594fedc2) | | Id: 3/5 |

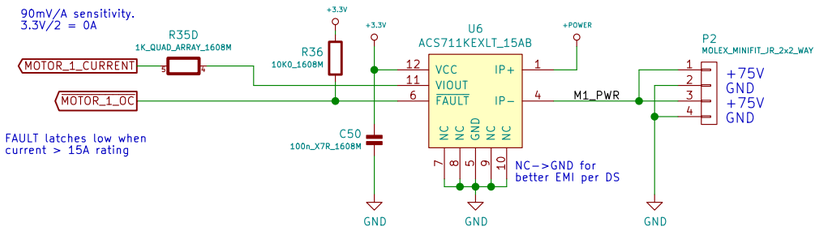
# Servo Power Connectors

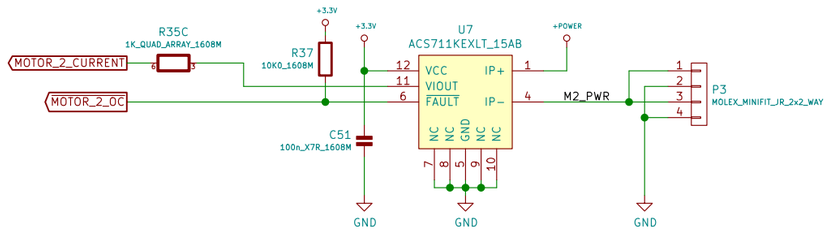
Current monitoring is added for some extra visibility

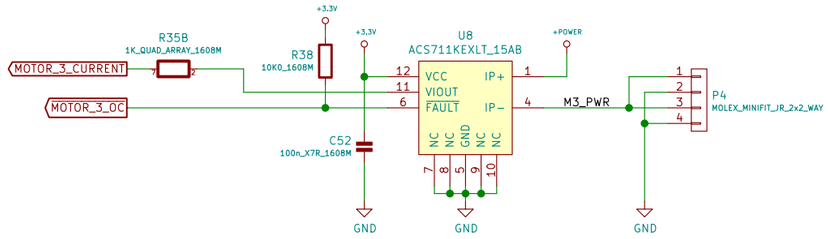
90mV/A sensitivity.
3.3V/2 = 0A

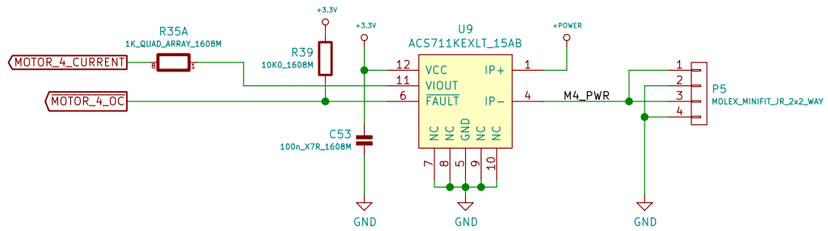
FAULT latches low when current > 15A rating

NC->GND for better EMI per DS

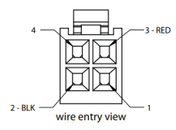



| Pin Assignments | | |
|---|---|---|
| Pin | Color | Name |
| 2 | BLK | GND |
| 3 | RED | V+ |



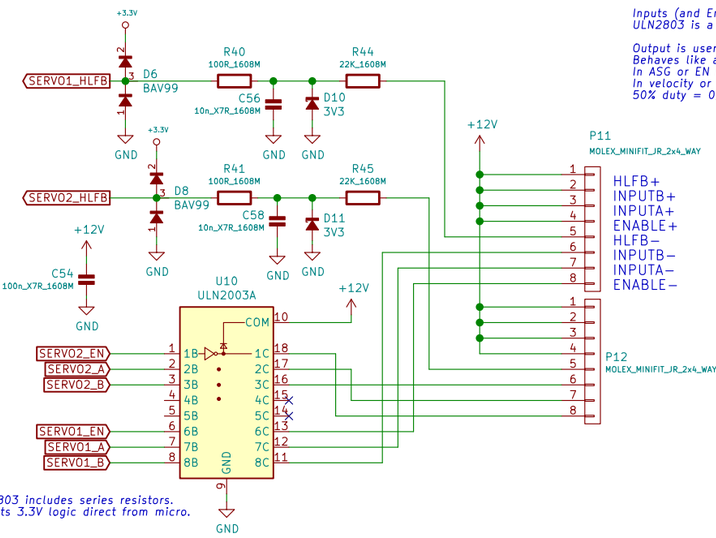

# Servo Data Connectors

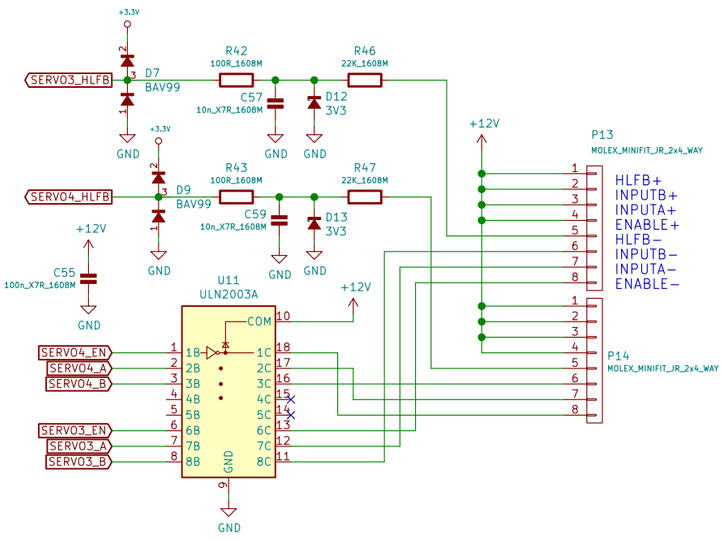
*Servo IO are optocouplers suitable for 5-24V switched logic.*
*12V logic is used. Servo IO self-limits current.*

*Inputs (and Enable) require min 9mA.*
*ULN2803 is a octal NPN (darlington) driver.*

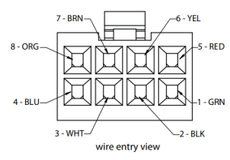
*Output is user-configurable.*
*Behaves like a NPN (also has internal current limit).*
*In ASG or EN modes, acts as a HIGH = GOOD status flag.*
*In velocity or torque mode, outputs 45Hz squarewave.*
*50% duty = 0, 5% = -MAX, 95% = +MAX*

*ULN2803 includes series resistors.*
*Accepts 3.3V logic direct from micro.*




| Pin Assignments | | |
|---|---|---|
| Pin | Color | Name |
| 1 | GRN | HLFB + |
| 2 | BLK | Input B + |
| 3 | WHT | Input A + |
| 4 | BLU | Enable + |
| 5 | RED | HLFB - |
| 6 | YEL | Input B - |
| 7 | BRN | Input A - |
| 8 | ORN | Enable - |

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Sheet: /Output Circuits and Connectors/
File: motor_outputs.sch

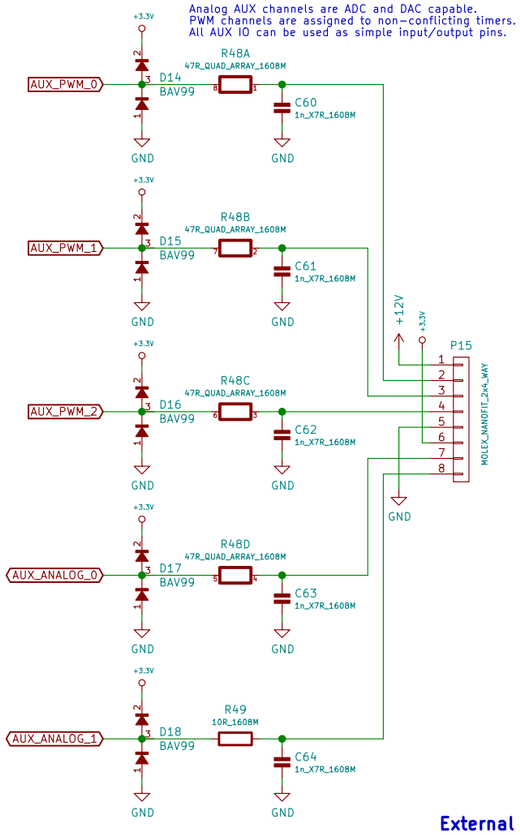
***Title: Servo Interfaces***

| Size: A3 | Date: 2018-04-30 | **Rev: 1.0** |
|---|---|---|
| KiCad E.D.A. kicad (5.0.0-rc2-dev-296-g4594fedc2) | | Id: 4/5 |

## Internal Expansion IO

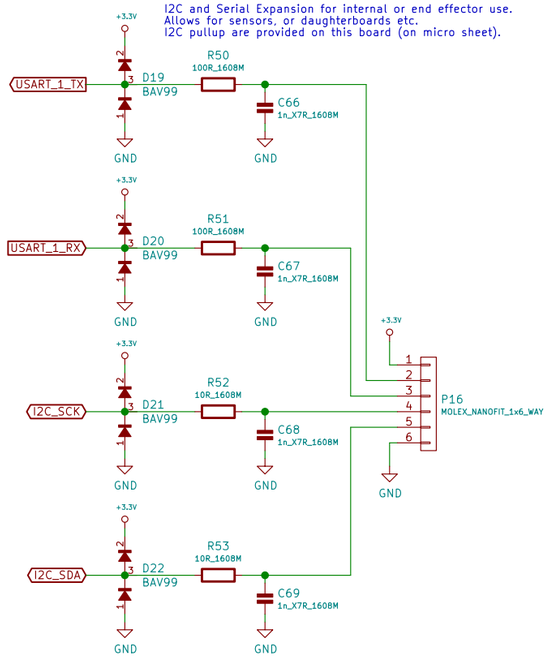
To be used with LED drivers, servos or motors/pumps.

Analog AUX channels are ADC and DAC capable.
PWM channels are assigned to non-conflicting timers.
All AUX IO can be used as simple input/output pins.



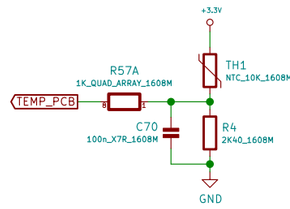

## Internal Expansion Serial

I2C and Serial Expansion for internal or end effector use.
Allows for sensors, or daughterboards etc.
I2C pullup are provided on this board (on micro sheet).

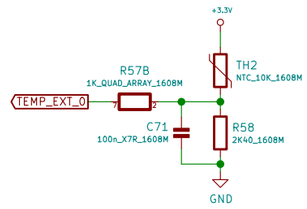



## Temperature Sensors

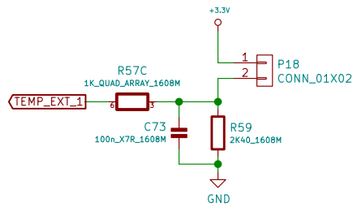
On-board temp sensor




Onboard PSU Temp

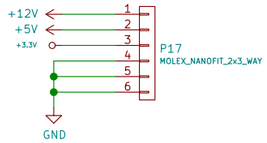



Expansion temp sensor 1




## Power Outputs

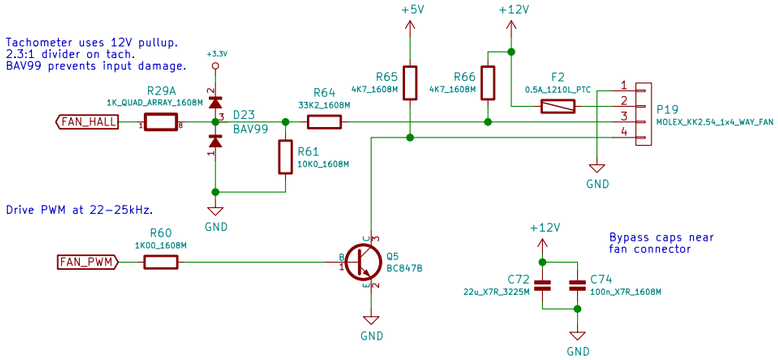
Regulated outputs




## Fan Control Circuit

Tachometer uses 12V pullup.
2.3:1 divider on tach.
BAV99 prevents input damage.

Drive PWM at 22-25kHz.

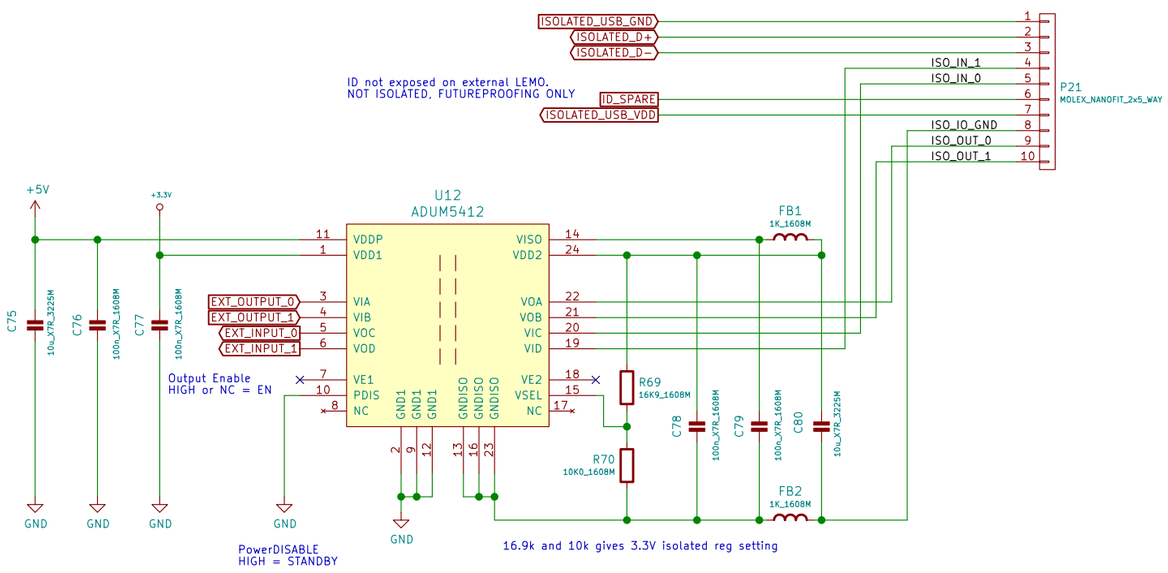



https://electronics.stackexchange.com/questions/153846/arduino-how-to-read-and-control-the-speed-of-a-12v-four-wire-fan

## External Isolated Expansion IO

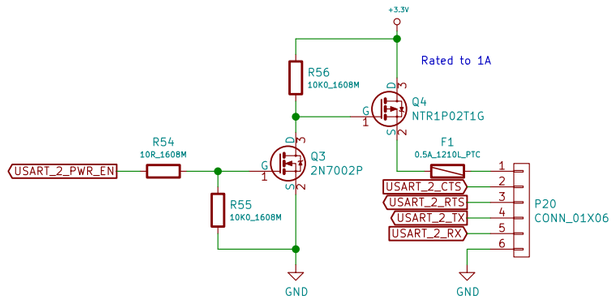
USB FS connection is galvanically isolated.
See microcontroller page for USB circuit.

Provide 2 isolated input/output pairs.
Pair 0 is UART capable, Pair 1 is CAN capable.
Pins can be used as normal IO.
Isolation IC provides internal isolated supply



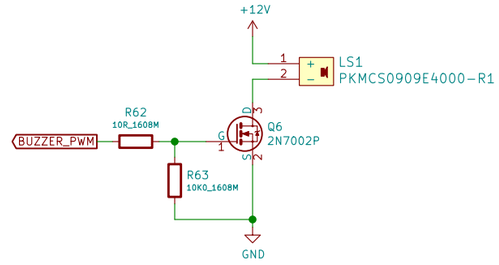

## Add-in Card

Expansion Header for ESP8266/32 or BLE module.
Provide USART with external power control.




## Buzzer

Used for potential indication of state/warnings

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Sheet: /Expansion I/O/
File: expansion_io.sch

***Title: Expansion IO***

| Size: A3 | Date: 2018-04-30 | **Rev: 1.0** |
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