POWER CONVERTER

This representation gives an overview of a power converter system.
Each block is responsible for a different task and they are linked together through inputs and outputs.
An external block to the system is the Debugger which will be connected to the power converter through an specialized shield.

POWER BLOCK – Power Electronics components, Power Connectors and measuring elements
MEASUREMENT BLOCK – Isolated measurement amplifiers
MICROCONTROLLER BLOCK – Arduino shield to connect with an outside microcontroller
DRIVER BLOCK – Optocoupler, MOSFET Driver and local feeders
FEEDER BLOCK – Connectors for outside energy input
DEBUGGER BLOCK – Allows the easy debugging of the system
EXTERNAL COMMUNICATION BLOCK – To be implemented

DEBUG SHIELD

Sheet: debug_block

DEBUGGER BLOCK

VmiL+ VmiL− VmiH+ VmiH− VmVL+ VmVL− VmVH+ VmVH− GNDVLow PWMH1 PWML1 GNDPWR

ViL+ ViL− ViH+ ViH− VL+ VL− VH+ VH− VgH VsH VgL VsL Hin Lin GNDVHigh

File: debug_block.sch

Sheet: Measurement Block

MEASUREMENT BLOCK

ViL+ ViL− ViH+ ViH− VL+ VL− VH+ VH− +5VHigh GNDVHigh

VmiL+ VmiL− VmiH+ VmiH− VmVL+ VmVL− VmVH+ VmVH− +5VLow GNDVLow

File: measurement_block.sch

Sheet: Power Block

POWER BLOCK

ViL+ ViL− ViH+ ViH− VL+ VL− VH+ VH− Vlow Vhigh GNDPower VgH VsH VgL VsL

File: power_block.sch

Sheet: Feeder Block

FEEDER BLOCK

GNDVLow +5VLow GNDVHigh +5VHigh +15VHigh GNDPower Vhigh Vlow +5VAd GNDAd

File: feeder_block.sch

Sheet: Microcontroller Block

MICROCONTROLLER BLOCK

GNDVLow +5VLow VmVH− VmVH+ VmVL− VmVL+ VmiH− VmiH+ VmiL− VmiL+ +5VAd GNDAd GNDPWM PWML1 PWMH1

File: microcontroller_block.sch

Sheet: Driver Block

DRIVER BLOCK

+15VHigh +5VHigh GNDVHigh VsL VgL VsH VgH Hin Lin GNDPWM PWML1 PWMH1

File: driver_block.sch

Sheet: External Connection Block

EXTERNAL COMMUNICATION BLOCK

TO BE IMPLEMENTED

File: external_connection_block.sch

LIST OF VARIABLES

MEASUREMENTS
V(m)iL+/− : Measurements for Low side current
V(m)iH+/− : Measurements for High side current
V(m)L+/− : Measurements for Low side Voltage
V(m)H+/− : Measurements for High side Voltages

CONTROLS
PWML/H1 : PWM control generated by uController
L/Hin : Inputs of the Driver System
VgL/H : Gate Voltage at the Low or High side transistors
VsL/H : Source Voltage at the Low or High side transistors

GROUNDS
GNDPWM : Ground of the PWM pulses generated by uController
GNDVHigh : Ground of the High Voltage side
GNDVLow : Ground of the Low Voltage side

Sheet: /
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## BLOCK INPUTS

VL+ → VL+
VL− → VL−
VH+ → VH+
VH− → VH−

ViL+ → ViL+
ViL− → ViL−
ViH+ → ViH+
ViH− → ViH−

+5VHigh → +5VHigh
GNDVHigh → GNDVHigh
+5VLow → +5VLow
GNDVLow → GNDVLow

## DETAILS OF THE MEASUREMENT BLOCK

This blocks senses
current and voltage
of the power block.
It uses four isolated amplifiers
AMC1100 or AMC1200.
These amplifiers are are fed with +5V.

There are 4 measurements being isolated:

ViL+/ViL− become VmiL+/VmiL − low side current
ViH+/ViH− become VmiH+/VmiH − high side current
VL+/VL− become VmL+/VmL − low side voltage
VH+/VH− become VmH+/VmH − high side voltage

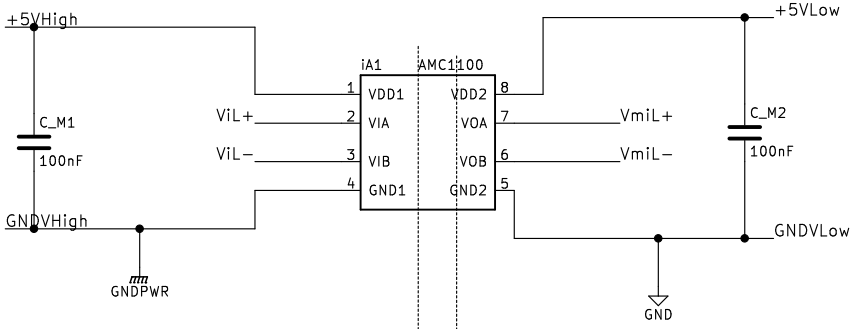
## BLOCK OUTPUTS

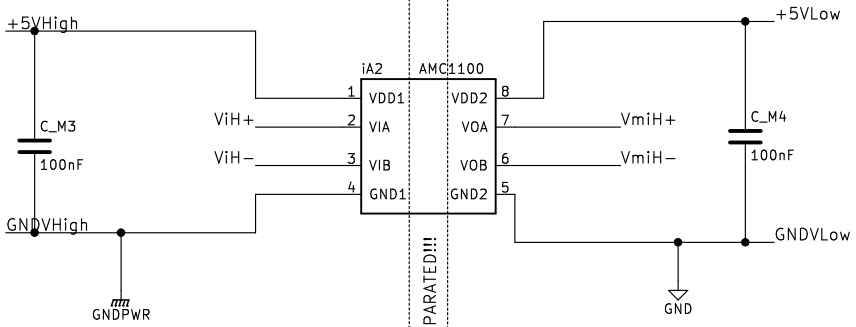
VmiL+ → VmiL+
VmiL− → VmiL−
VmiH+ → VmiH+
VmiH− → VmiH−

VmVL+ → VmVL+
VmVL− → VmVL−
VmVH+ → VmVH+
VmVH− → VmVH−

## CURRENT SENSING BLOCK

Senses the current isolated from the high power side.
The nominal gain is 8.

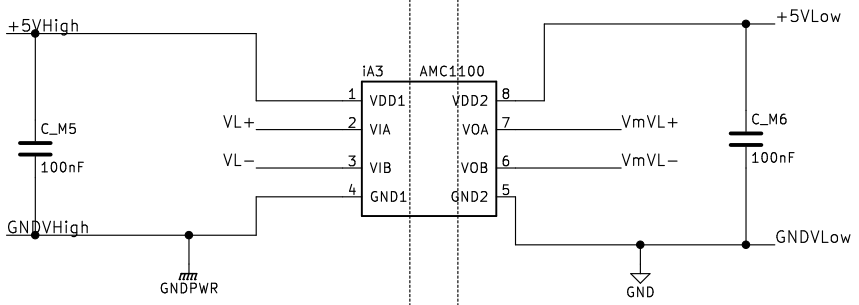


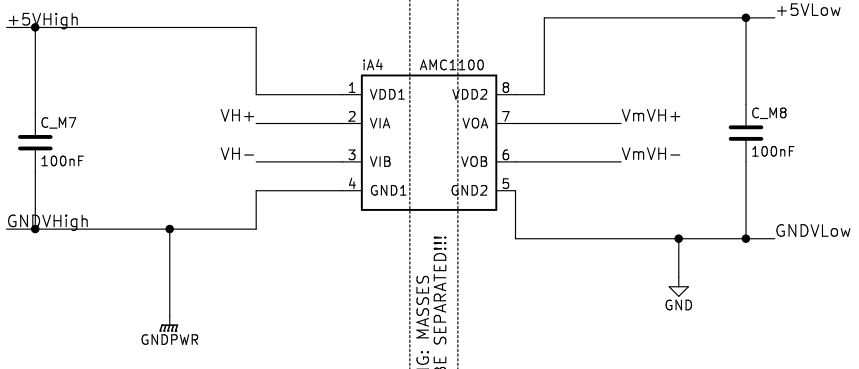




WARNING: MASSES MUST BE SEPARATED!!!

## VOLTAGE SENSING BLOCK

Senses the voltage isolated
from the high power side.
The nominal gain is 8.

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Sheet: /Measurement Block/
File: measurement_block.sch

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BLOCK INPUTS

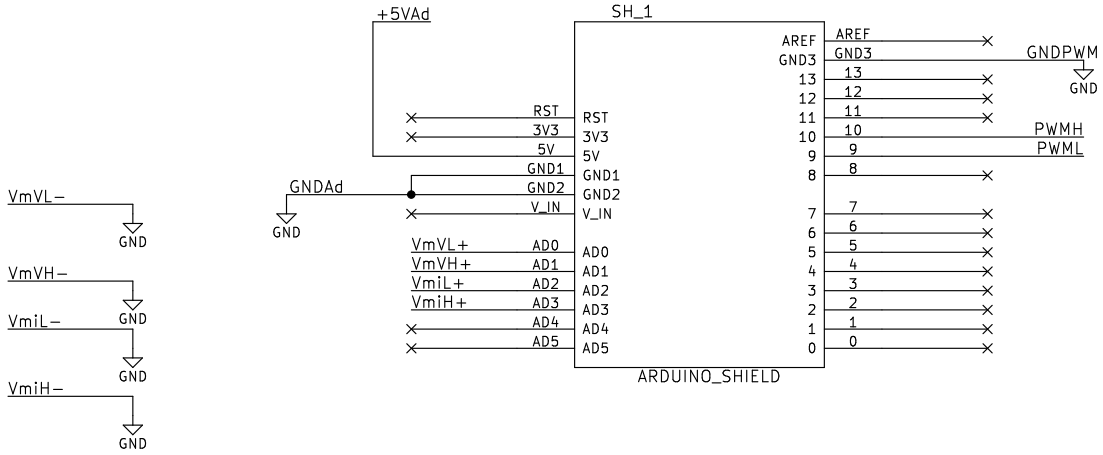
VmVL+ VmVL+
VmVL− VmVL−
VmVH+ VmVH+
VmVH− VmVH−
VmiL+ VmiL+
VmiL− VmiL−
VmiH+ VmiH+
VmiH− VmiH−
+5VLow +5VLow
GNDVLow GNDVLow

DETAILS OF THE MICROCONTROLLER BLOCK

This blocks connects the power converter with an Arduino Uno shield. The voltage and current measurements are inputs and the PWMs are the outputs.

BLOCK OUTPUTS

PWMH PWMH1
PWML PWML1
GNDPWM GNDPWM
+5VAd +5VAd
GNDAd GNDAd




Sheet: /Microcontroller Block/
File: microcontroller_block.sch

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BLOCK INPUTS

BLOCK OUTPUTS

TO BE IMPLEMENTED

Sheet: /External Connection Block/
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## BLOCK INPUTS

Vlow
Vhigh
GNDPower
+5VAd
GNDAd

## FEEDER DETAILS

This is the global feeder circuit.
In this version it is composed by 78x5's.
Later versions should replace this by a more robust solution.

## BLOCK OUTPUTS

+5VLow
GNDVLow
+15VHigh
+5VHigh
GNDVHigh

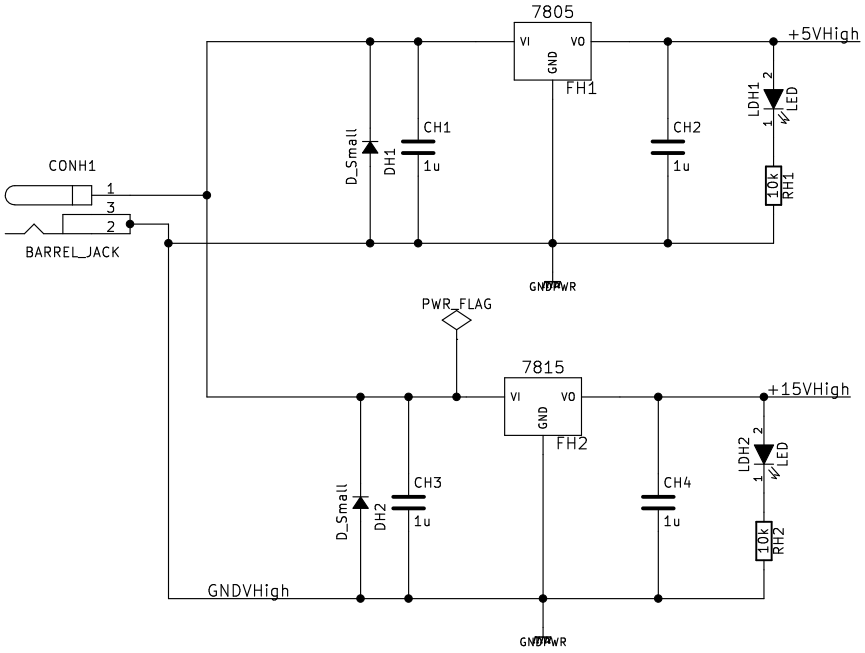
## GLOBAL FEEDER

Later solutions should include a global feeder capable of generating energy from the system input/output.

TO BE COMPLETED

## HIGH VOLTAGE SIDE FEEDERS

These 78x5's generate +5V and +15V with a high voltage side reference.

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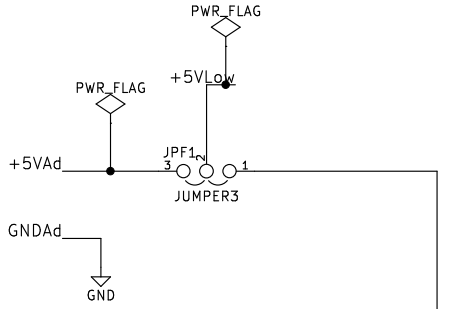
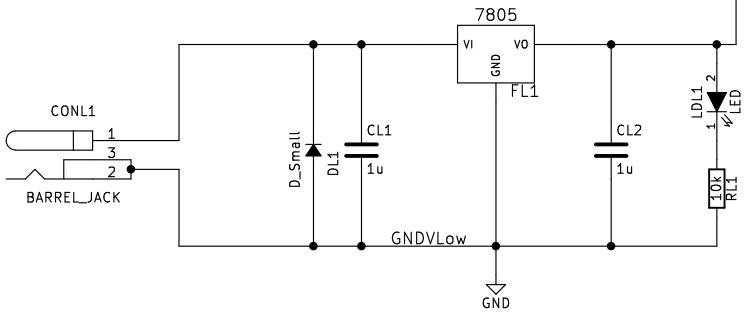
## LOW VOLTAGE SIDE FEEDER

This 7805 generates
+5V low voltage side reference.
The low side can be fed from the Arduino or from a local source.

ARDUINO FEEDER




LOCAL LOW VOLTAGE FEEDER

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| Sheet: /Feeder Block/<br>File: feeder_block.sch | | |
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BLOCK INPUTS

PWMH1 — PWMH
PWML1 — PWML
GNDPWM — GNDPWM
+5VHigh — +5VHigh
+15VHigh — +15VHigh
GNDVHigh — GNDPWR

DETAILS OF THE DRIVER BLOCK

This circuit connects the microcontroller to the power transistors.
It uses an optocoupler to separate the grounds from both sides.

Based on these components the system can go up to 150kHz to 200kHz

BLOCK OUTPUTS

VgH — VgH
VsH — VsH
VgL — VgL
VsL — VsL
Hin — Hin
Lin — Lin

WARNING: MASSES MUST BE SEPARATED!!!

ADAPTABLE JUMPERS

These jumpers allows the user to choose between a 5V or a 3.3V input.

PWMH
PWML
GNDPWM
RO1 470
RO2 470
RO3 220
RO4 220
JPO1 JUMPER
JPO2 JUMPER
JPO3 JUMPER
JPO4 JUMPER

OPT1
TLP2631
+5VHigh
330 ROH1
330 ROH2
CO1 C
Hin
Lin
GNDPWR

POWER DRIVER

The power driver chosen for this converter is the IR2186 capable of driving a transitor up to 4A at a time. This solution comprises a bootstrap which allows driving both the high and low side transistors from the same IC.

DIODE DD1
DR1 IRS2186
HIN
LIN
Vss
COM
LO
Vcc
Vb
HO
Vs
CD1 100n
CD2 100n
CD3 500n
+15VHigh
VgH
VsH
VgL
VsL

<– LOW VOLTAGE SIDE
–> HIGH VOLTAGE SIDE

OPTOCOUPLER

The optocoupler chosen for this converter is a TLP2631 which has a VCC of +5V and can go up to 200kHz for low power applications

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## BLOCK INPUTS

VgHD — VgH
VsHD — VsH
VgLD — VgL
VsLD — VsL

## DETAILS OF THE POWER BLOCK

This topology employs capacitors
both at the input and the output.
The inductance in the middle allows it
to be a fully reversible buck-boost.

This version of the converter uses 200V
MOSFETS capable of handling up to 20A.
This converter was designed to have an
output up to 120V making its input
reasonable up to 60V.
The power in this structure should
NOT go beyond 500W.

## BLOCK OUTPUTS

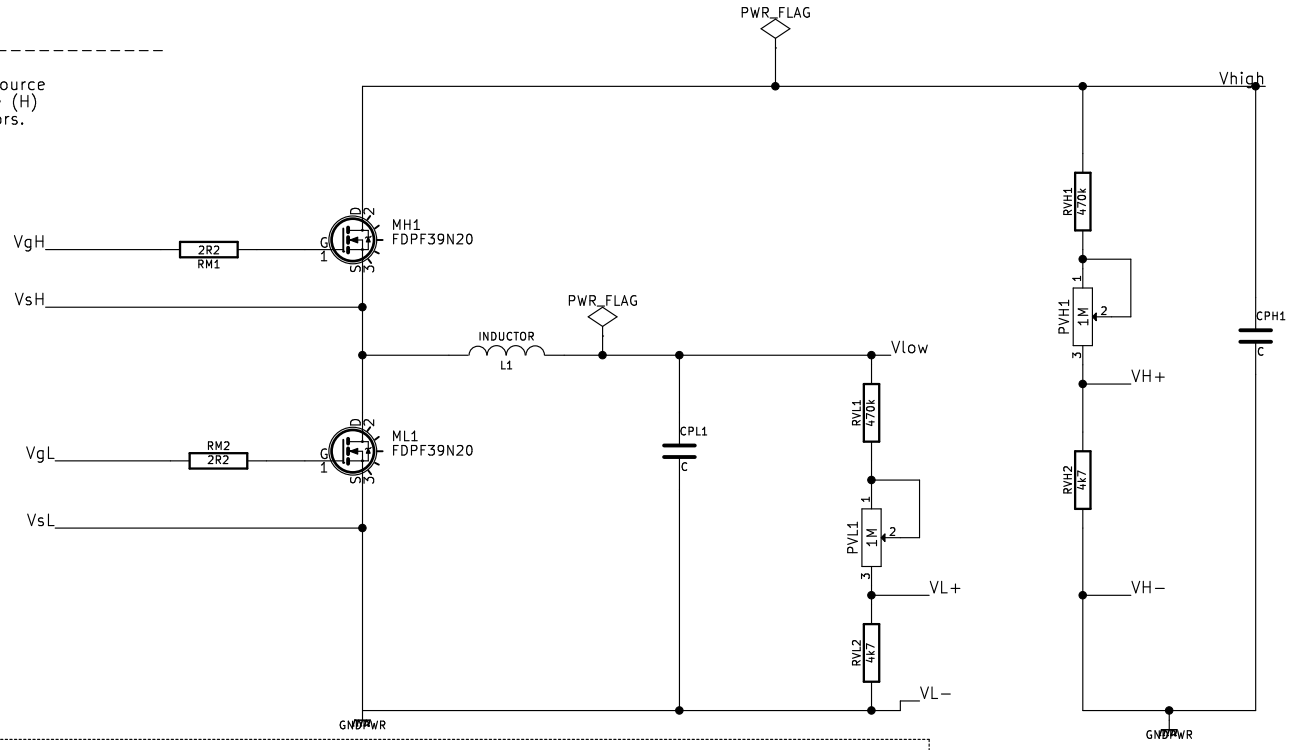
ViL+ — ViL+
ViL− — ViL−
ViH+ — ViH+
ViH− — ViH−

VL+ — VL+
VL− — VL−
VH+ — VH+
VH− — VH−

Vlow — Vlow
Vhigh — Vhigh
GNDPower — GNDPWR

## CONVERTER INPUT

The inputs are the gate-source
voltages for the high-side (H)
and low-side (L) transistors.
(VgH-VsH/VgL-VsL)




## MEASUREMENTS

There are 4 measurements spread
among the power elements:

ViL+ and ViL− is the voltage drop
of the shunt resistance reading low side current
EQUIVALECE: 1 Amp = 20mV

ViH+ and ViH− is the voltage drop
of the shunt resistance reading high side current
EQUIVALECE: 1 Amp = 20mV

VL+ and VL− is the voltage drop
of the resistance reading low side voltage
EQUIVALECE: 100V = 0.33V to 1V

VH+ and VH− is the voltage drop
of the resistance reading high side voltage
EQUIVALECE: 200V = 0.66V to 2V

## ENERGY CONNECTORS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| Sheet: /Power Block/ | | |
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## BLOCK INPUTS

VmVL+ → VmVL+
VmVL− → VmVL−
VmVH+ → VmVH+
VmVH− → VmVH−
PWMH1 → PWMH
PWMGND → PWMGND
GNDVLow → GNDVLow

VmiL+ → VmiL+
VmiL− → VmiL−
VmiH+ → VmiH+
VmiH− → VmiH−
PWML1 → PWML

VL+ → VL+
VL− → VL−
VH+ → VH+
VH− → VH−
VgH → VgH
VsH → VsH
VgL → VgL
VsL → VsL
GNDVHigh → GNDVHigh

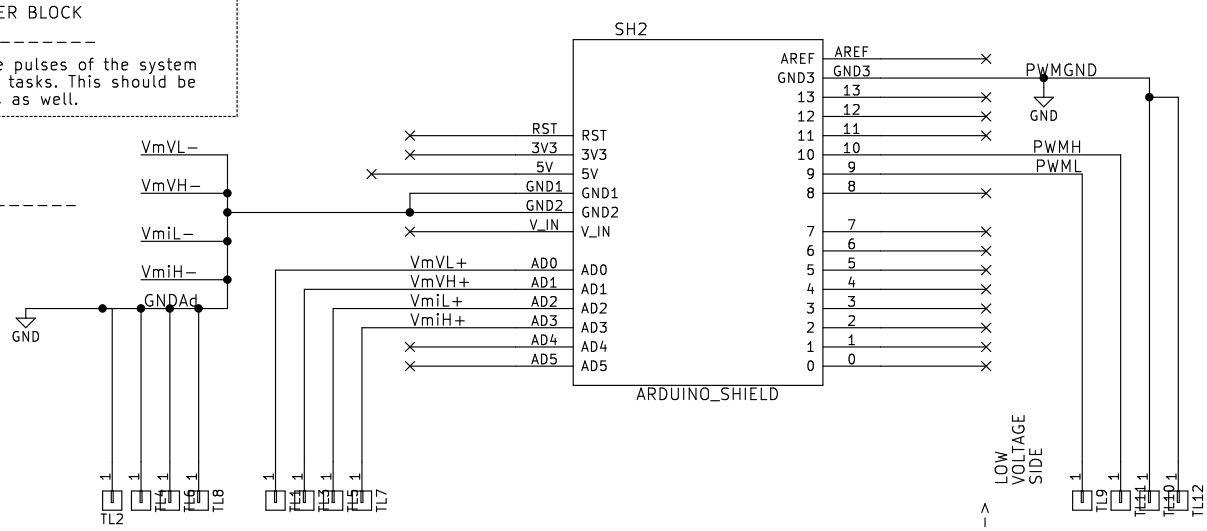
ViL+ → ViL+
ViL− → ViL−
ViH+ → ViH+
ViH− → ViH−
Hin → Hin
Lin → Lin

## DETAILS OF THE MICROCONTROLLER BLOCK

This blocks connects most of the pulses of the system to connectors to ease debugging tasks. This should be starndard for other power boards as well.

## LOW VOLTAGE DEBUG CONNECTOR

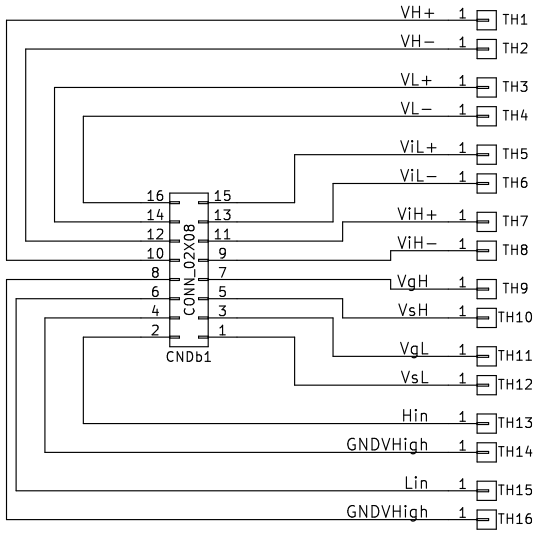
This connector is dedicated to low−voltage measurements and pulses.




WARNING: MASSES MUST BE SEPARATED!!!

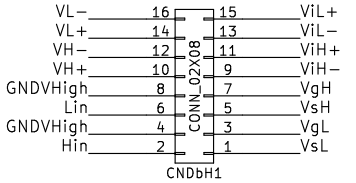
## HIGH VOLTAGE DEBUG CONNECTOR

This connector is dedicated to high−voltage measurements and pulses.




## POWER DEBUG CONNECTOR

This connector allows the easy debugging of the high power side of the system

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