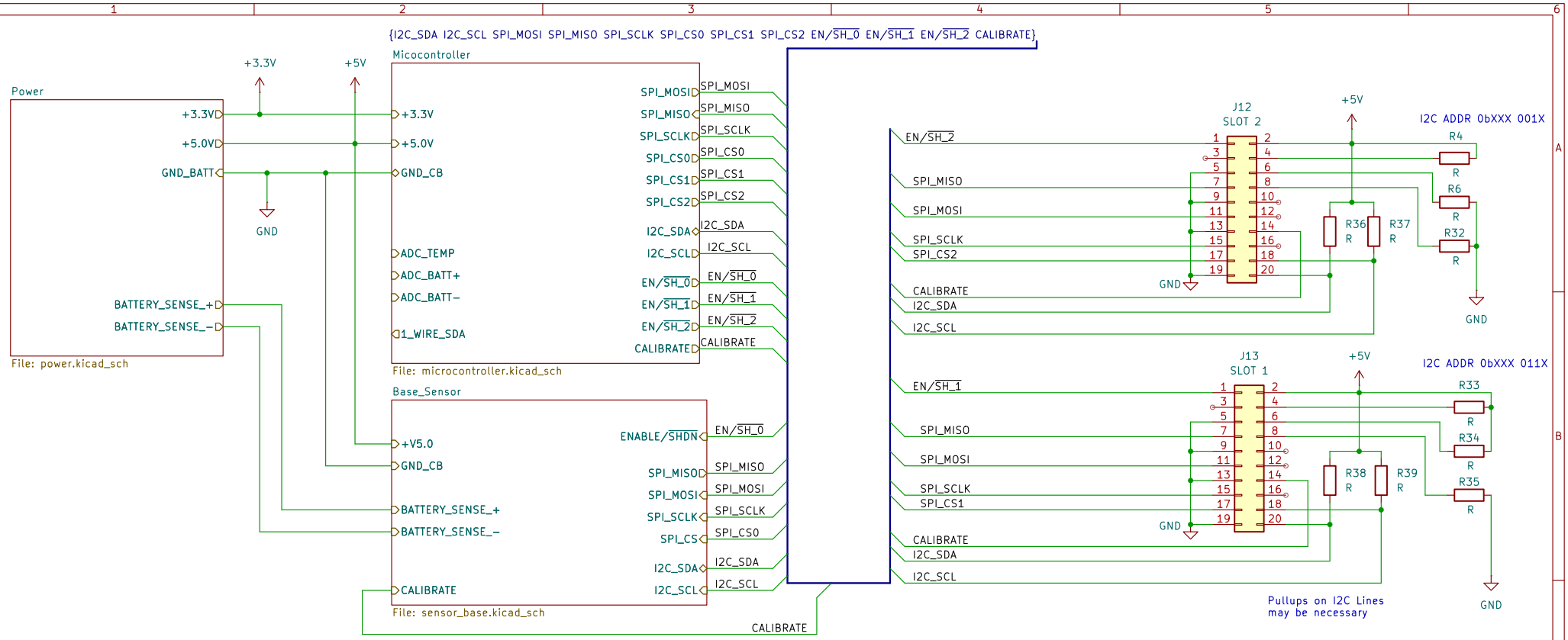

Sensor Module 4

File: sensor_module_4.kicad_sch

Sensor Module 8

File: sensor_module_8.kicad_sch

Digital Sensor Module 4

File: digital_sensor_4.kicad_sch

TODO
- We need to add some input line protection, maybe TVS diodes on all "external" lines.
- Maybe add a fuse or MOV to the battery input to help mediate shorts
- Add a DHT11/20 to the base sensor board for internal leak / humidity tracking
- Flesh out the digital sensor board a bit more

Notes:
INA333 requires that signals be at least 0.1V away from the power rails, both ground and VDD. Input signals must be at least 100mV above ground!
There is a 70pA input offset current which also must have a path to ground. Inputs should provide this path through a resistor or balanced resistors.

General Design requirements:
- Power switching (need to be able to reduce power consumption as much as possible). Everything that draws power must be able to be switched off or must have a shutdown pin.
- Low noise interfaces on sensor inputs.
- High frequency lines should be adequately blocked

Sheet: /
File: digital_waters.kicad_sch

Title:

Size: A4	Date:	**Rev:**
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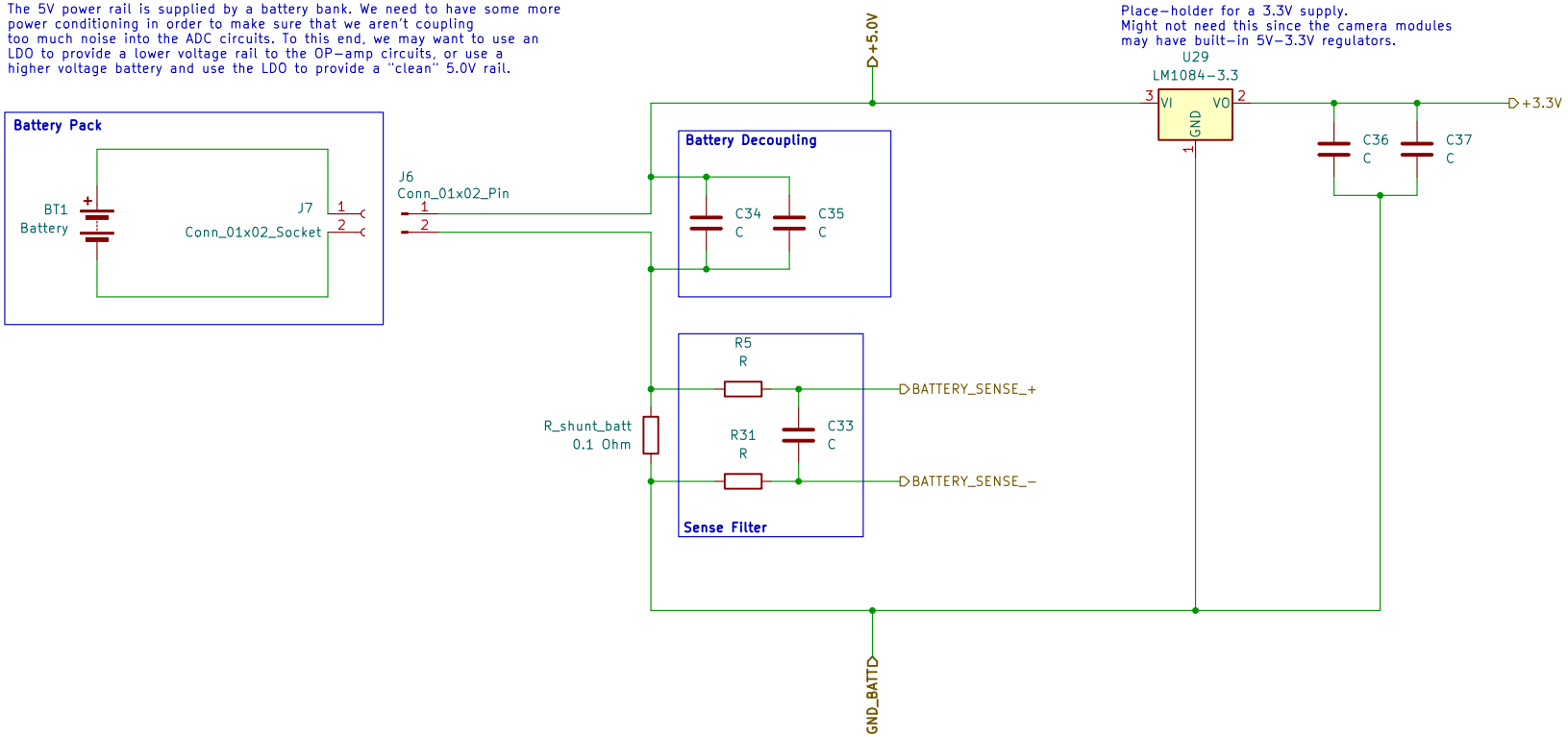
The 5V power rail is supplied by a battery bank. We need to have some more power conditioning in order to make sure that we aren't coupling too much noise into the ADC circuits. To this end, we may want to use an LDO to provide a lower voltage rail to the OP-amp circuits, or use a higher voltage battery and use the LDO to provide a "clean" 5.0V rail.

Place-holder for a 3.3V supply. Might not need this since the camera modules may have built-in 5V-3.3V regulators.



Sheet: /Power/
File: power.kicad_sch

Title:

Size: A4	Date:	**Rev:**
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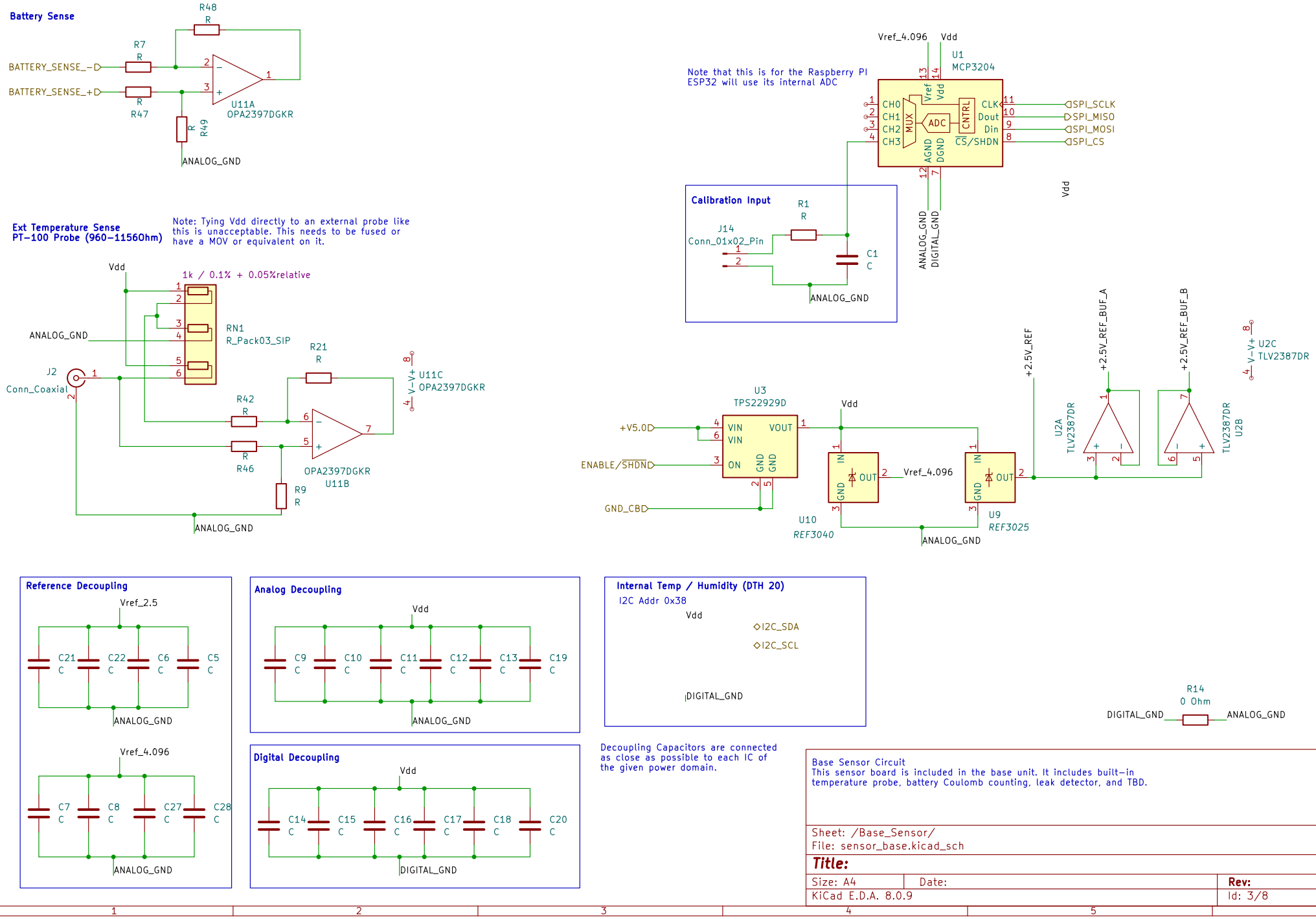
Battery Sense
R48
R
R7
R
BATTERY_SENSE_-
BATTERY_SENSE_+
R
R47
U11A
OPA2397DGKR
R
R49
ANALOG_GND
Note that this is for the Raspberry PI
ESP32 will use its internal ADC
Vref_4.096
Vdd
U1
MCP3204
CH0
CH1
CH2
CH3
MUX
ADC
CNTRL
CLK
Dout
Din
CS/SHDN
SPI_SCLK
SPI_MISO
SPI_MOSI
SPI_CS
AGND
DGND
ANALOG_GND
DIGITAL_GND
Vdd
Calibration Input
J14
Conn_01x02_Pin
R1
R
C1
C
ANALOG_GND
Ext Temperature Sense
PT-100 Probe (960-1156Ohm)
Note: Tying Vdd directly to an external probe like this is unacceptable. This needs to be fused or have a MOV or equivalent on it.
Vdd
1k / 0.1% + 0.05%relative
RN1
R_Pack03_SIP
ANALOG_GND
J2
Conn_Coaxial
R21
R
U11C
OPA2397DGKR
R42
R
R
R46
OPA2397DGKR
U11B
R9
R
ANALOG_GND
U3
TPS22929D
+V5.0
ENABLE/SHDN
GND_CB
VIN
VOUT
ON
GND
Vdd
U10
REF3040
Vref_4.096
U9
REF3025
+2.5V_REF
+2.5V_REF_BUF_A
+2.5V_REF_BUF_B
U2A
TLV2387DR
U2B
U2C
TLV2387DR
ANALOG_GND
Reference Decoupling
Vref_2.5
C21
C22
C6
C5
C
ANALOG_GND
Vref_4.096
C7
C8
C27
C28
C
ANALOG_GND
Analog Decoupling
Vdd
C9
C10
C11
C12
C13
C19
C
ANALOG_GND
Digital Decoupling
Vdd
C14
C15
C16
C17
C18
C20
C
DIGITAL_GND
Internal Temp / Humidity (DTH 20)
I2C Addr 0x38
Vdd
I2C_SDA
I2C_SCL
DIGITAL_GND
Decoupling Capacitors are connected as close as possible to each IC of the given power domain.
R14
0 Ohm
DIGITAL_GND
ANALOG_GND
Base Sensor Circuit
This sensor board is included in the base unit. It includes built-in temperature probe, battery Coulomb counting, leak detector, and TBD.
Sheet: /Base_Sensor/
File: sensor_base.kicad_sch
Title:
Size: A4
Date:
Rev:
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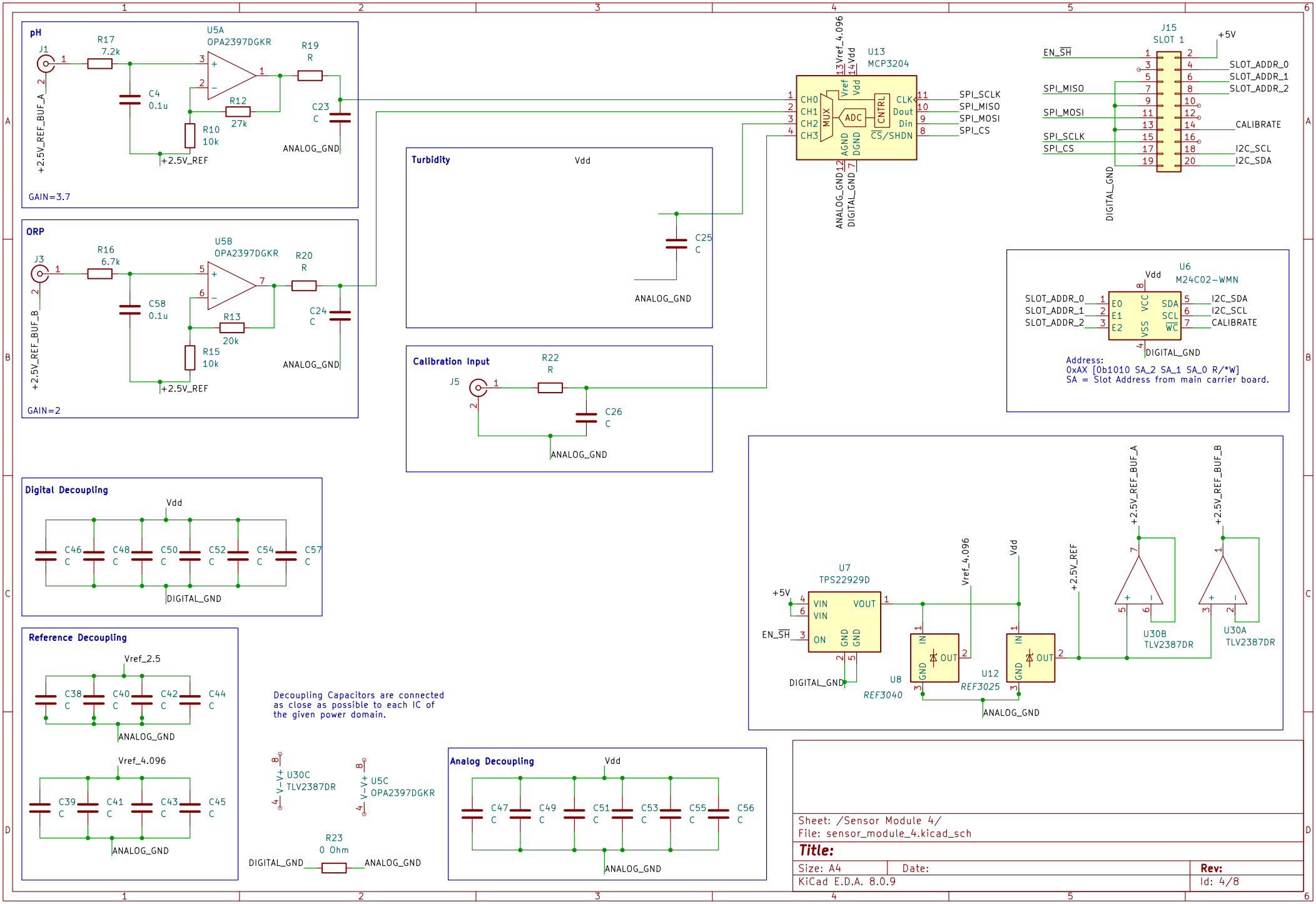
Id: 3/8


pH
J1
R17
7.2k
U5A
OPA2397DGKR
R19
R
C4
0.1u
R12
27k
C23
C
R10
10k
+2.5V_REF_BUF_A
+2.5V_REF
ANALOG_GND
GAIN=3.7
ORP
J3
R16
6.7k
U5B
OPA2397DGKR
R20
R
C58
0.1u
R13
20k
C24
C
R15
10k
+2.5V_REF_BUF_B
+2.5V_REF
ANALOG_GND
GAIN=2
Turbidity
Vdd
C25
C
ANALOG_GND
Calibration Input
J5
R22
R
C26
C
ANALOG_GND
U13
MCP3204
Vref_4.096
Vdd
CH0
CH1
CH2
CH3
MUX
ADC
CNTRL
CLK
Dout
Din
CS/SHDN
AGND
DGND
ANALOG_GND
DIGITAL_GND
SPI_SCLK
SPI_MISO
SPI_MOSI
SPI_CS
J15
SLOT 1
+5V
EN_SH
SPI_MISO
SPI_MOSI
SPI_SCLK
SPI_CS
SLOT_ADDR_0
SLOT_ADDR_1
SLOT_ADDR_2
CALIBRATE
I2C_SCL
I2C_SDA
DIGITAL_GND
U6
M24C02-WMN
Vdd
E0
E1
E2
VSS
VCC
SDA
SCL
WC
DIGITAL_GND
Address:
0xAX [0b1010 SA_2 SA_1 SA_0 R/*W]
SA = Slot Address from main carrier board.
Digital Decoupling
Vdd
C46
C48
C50
C52
C54
C57
DIGITAL_GND
Reference Decoupling
Vref_2.5
C38
C40
C42
C44
ANALOG_GND
Vref_4.096
C39
C41
C43
C45
ANALOG_GND
Decoupling Capacitors are connected as close as possible to each IC of the given power domain.
U30C
TLV2387DR
U5C
OPA2397DGKR
R23
0 Ohm
DIGITAL_GND
ANALOG_GND
Analog Decoupling
Vdd
C47
C49
C51
C53
C55
C56
ANALOG_GND
U7
TPS22929D
+5V
VIN
VOUT
EN_SH
ON
GND
DIGITAL_GND
U8
REF3040
U12
REF3025
Vref_4.096
Vdd
+2.5V_REF
ANALOG_GND
+2.5V_REF_BUF_A
+2.5V_REF_BUF_B
U30B
TLV2387DR
U30A
TLV2387DR
Sheet: /Sensor Module 4/
File: sensor_module_4.kicad_sch
Title:
Size: A4
Date:
Rev:
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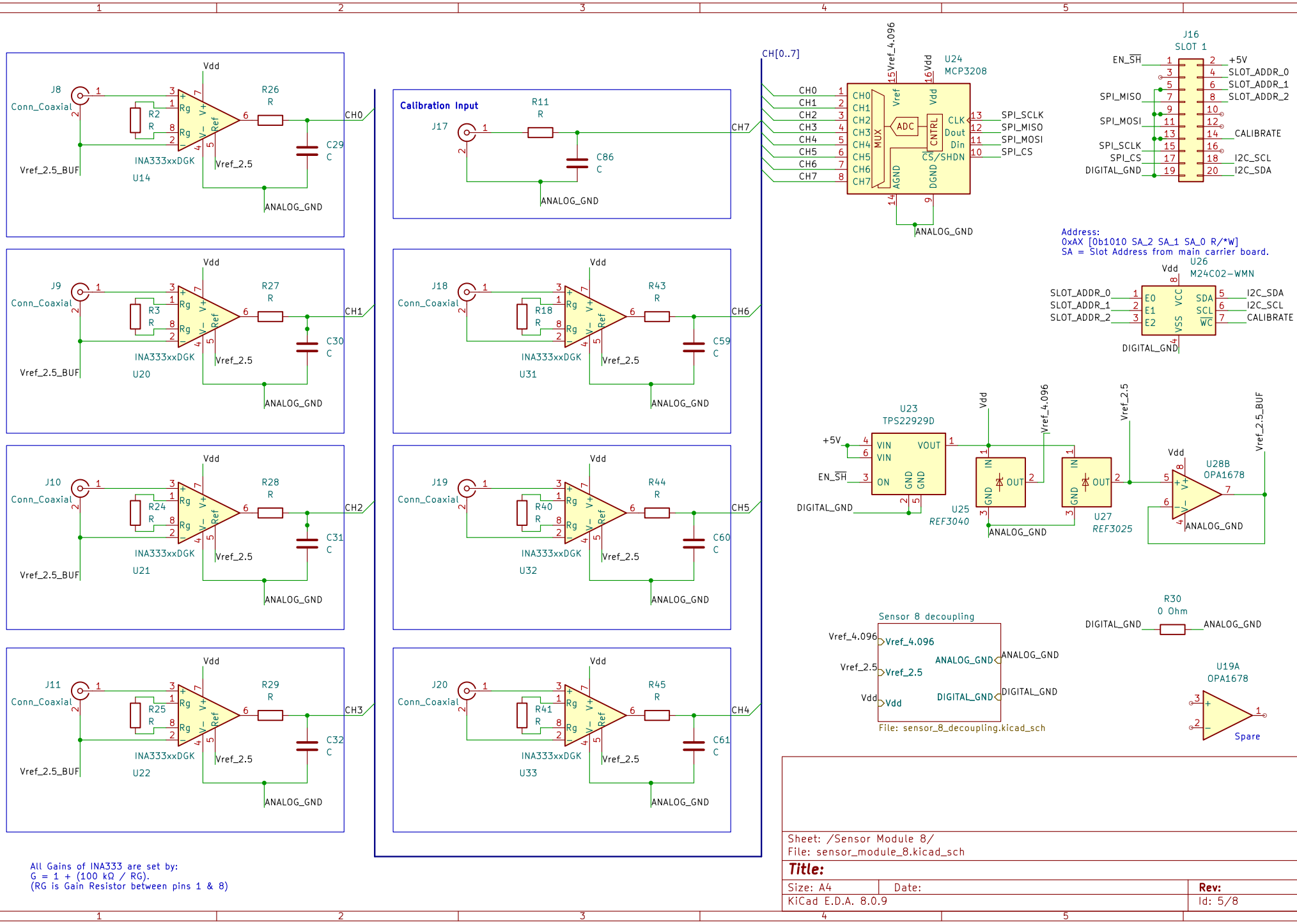

J8
Conn_Coaxial
R2
R
R26
R
C29
C
Vdd
Vref_2.5_BUF
INA333xxDGK
U14
Vref_2.5
ANALOG_GND
CH0
J9
R3
R27
C30
U20
CH1
J10
R24
R28
C31
U21
CH2
J11
R25
R29
C32
U22
CH3
Calibration Input
J17
R11
C86
CH7
J18
R18
R43
C59
U31
CH6
J19
R40
R44
C60
U32
CH5
J20
R41
R45
C61
U33
CH4
CH[0..7]
U24
MCP3208
Vref_4.096
Vdd
CH0
CH1
CH2
CH3
CH4
CH5
CH6
CH7
MUX
ADC
CNTRL
AGND
DGND
CLK
Dout
Din
CS/SHDN
SPI_SCLK
SPI_MISO
SPI_MOSI
SPI_CS
J16
SLOT 1
EN_SH
+5V
SLOT_ADDR_0
SLOT_ADDR_1
SLOT_ADDR_2
SPI_MISO
SPI_MOSI
CALIBRATE
SPI_SCLK
SPI_CS
I2C_SCL
I2C_SDA
DIGITAL_GND
Address:
0xAX [0b1010 SA_2 SA_1 SA_0 R/*W]
SA = Slot Address from main carrier board.
U26
M24C02-WMN
E0
E1
E2
VSS
VCC
SDA
SCL
WC
U23
TPS22929D
VIN
VOUT
ON
GND
U25
REF3040
U27
REF3025
U28B
OPA1678
Vref_2.5_BUF
Sensor 8 decoupling
File: sensor_8_decoupling.kicad_sch
R30
0 Ohm
U19A
OPA1678
Spare
All Gains of INA333 are set by:
G = 1 + (100 kΩ / RG).
(RG is Gain Resistor between pins 1 & 8)
Sheet: /Sensor Module 8/
File: sensor_module_8.kicad_sch
Title:
Size: A4
Date:
Rev:
KiCad E.D.A. 8.0.9
Id: 5/8

This is a placeholder for a CPU module.
Could be a Raspberry Pi or ESP32 or another
microcontroller module with (TBD) GPIO lines,
at least one SPI bus with (3) CS lines, and one
I2C Bus.

◁ADC_BATT+
◁ADC_BATT−
◁ADC_TEMP

◇I2C_SDA
▷I2C_SCL

◁SPI_MISO
▷SPI_MOSI
▷SPI_SCLK
▷SPI_CS0
▷SPI_CS1
▷SPI_CS2

◁+5.0V
◁+3.3V
◇GND_CB

▷EN/$\overline{\text{SH\_0}}$
▷EN/$\overline{\text{SH\_1}}$
▷EN/$\overline{\text{SH\_2}}$

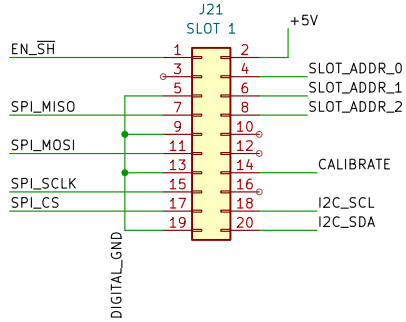
▷CALIBRATE

Sheet: /Micocontroller/
File: microcontroller.kicad_sch

Title:

Size: A4	Date:	**Rev:**
KiCad E.D.A. 8.0.9		Id: 6/8

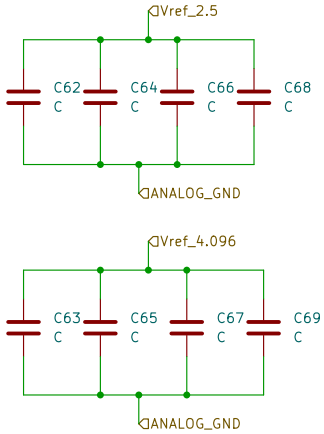
Some sensors will need to come with their own digital breakout boards (DO, CO2, EC, etc.) To support these, this board provides a common interface to the CPU and signal conditioning to those units.



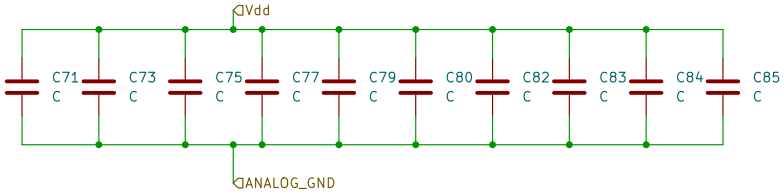
Sheet: /Digital Sensor Module 4/ File: digital_sensor_4.kicad_sch		
Title:		
Size: A4	Date:	**Rev:**
KiCad E.D.A. 8.0.9		Id: 7/8

Decoupling Capacitors are connected as close as possible to each IC of the given power domain.

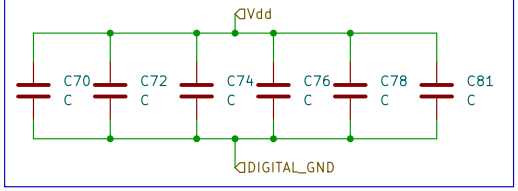
Reference Decoupling



Analog Decoupling



Digital Decoupling



Sheet: /Sensor Module 8/Sensor 8 decoupling/
File: sensor_8_decoupling.kicad_sch

Title:

Size: A4	Date:	**Rev:**
KiCad E.D.A. 8.0.9		Id: 8/8