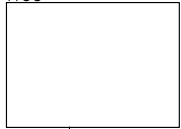
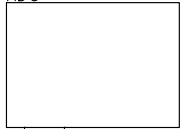


MCU



mcu.sch

ADC



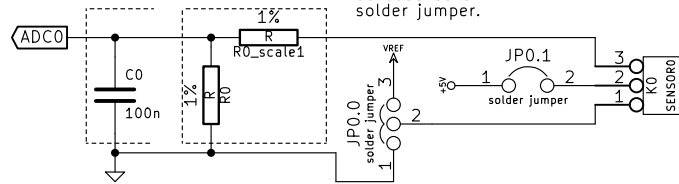
adc.sch

Matthias Kolja Miehle <miehl@w3hs.net>	
File: msb_sensor.sch	
Sheet: /	
Title: MSB Sensor	
Size: A4	Date: 18 dec 2012
KiCad E.D.A.	Rev: 4
	Id: 1/3

ADC Wiring for different Sensor Types

RC low pass
(C0 + R0_scale)

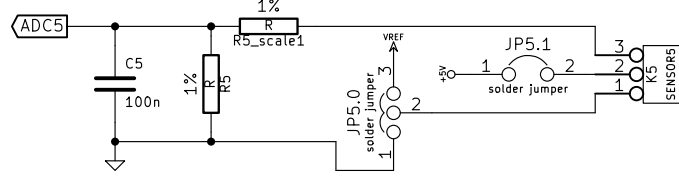
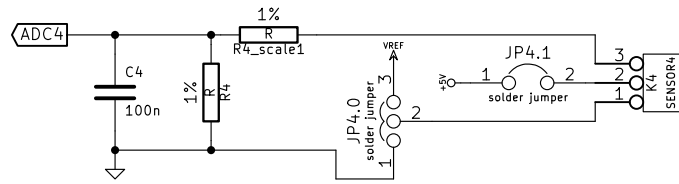
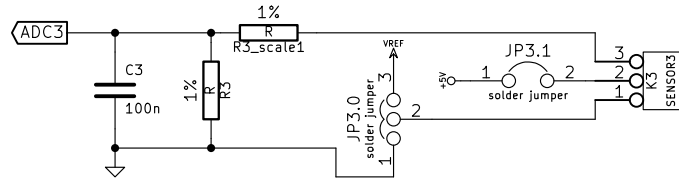
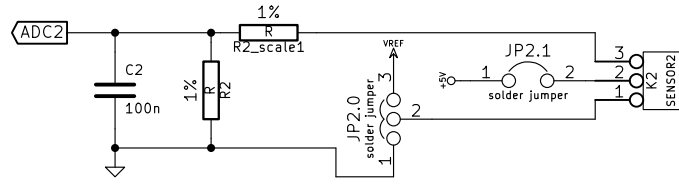
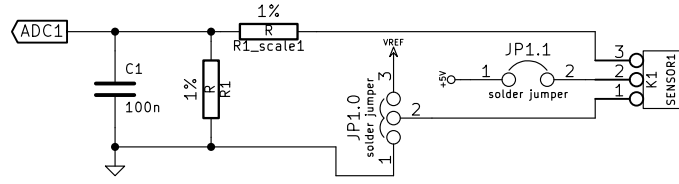
voltage divider
The footprint for R_scale can also be used as a solder jumper.



possible configurations

ADC
none / +5V
none / GND / VREF

current sensor has the highest accuracy at 5V VCC ±0.5V



Connector Configurations

VOLTAGE	CURRENT	TEMPERATURE
3: ADC	3: ADC	3: ADC
2: none	2: +5V	2: none
1: none	1: GND	1: VREF

Cut-Off Frequencies
V: 49900 Ohm → 32 Hz
I: 8060 Ohm → 197 Hz
T: 1200 Ohm @ 52°C → 1326 Hz

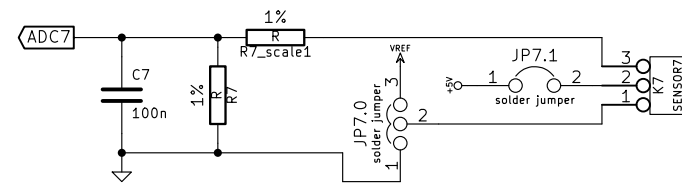
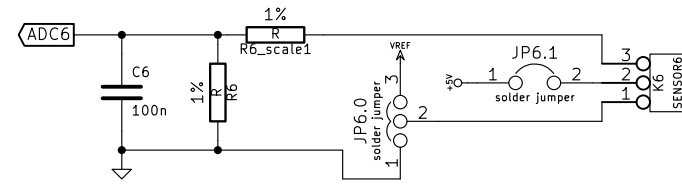
3 Possible Configurations for the Channels to Reduce Part Costs

VOLTAGE	TEMPERATURE
measure 0..5x4.2V i.e. 5S battery 2LSB error=10.5mV	measure 0..120°C
R = 8060 Ohm R_scale = 49900 Ohm V_in,max = 21.5 V I_in,max = 0.372 mA	R = 8060 Ohm R_scale = 0 Ohm V_in,max = VREF I_in,max = 0.33 mA P_heat = 145mW @ 120°C self-heat = 147°C error_max = 12.6°C error_calib = 1.96°C
CURRENT measure 0..150A 2LSB error=37mA	R = 49900 Ohm R_scale = 0 Ohm V_in,max = VREF I_in,max = 0.06 mA P_heat = 5mW @ 120°C self-heat = 5°C error_max = 12.6°C error_calib = 7.26°C
R = 8060 Ohm R_scale = 8060 Ohm V_in,max = 6 V I_in,max = 0.372 mA	→ R = 8060 If one is going to calibrate the sensor.
	→ R = 49900 If one won't calibrate and 12.6°C error is tolerable.
	ADVICE: Use a PT10000, e.g. HYG NTC 103

Sensors Used

CURRENT SENSOR
ACS758LCB-100U-PFF-T (max 100A, 40mV/A, -40..+50°C)
absolute_max rating: I_VOUT = 3mA
VCC = +3..5V (not stabilized), ICC = 10mA

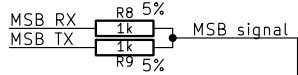
TEMPERATURE SENSOR
PCA 1.2005 10 Bauform PCA/M (PT1000, Platin-Chip-Temperatursens., bedrahtet)



Matthias Kolja Miehle <miehle@w3hs.net>	
File: adc.sch	
Sheet: /ADC/	
Title: MSB Sensor	
Size: A4	Date: 18 dec 2012
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	Id: 2/3

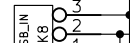
Multiplex Sensor Bus (MSB)

1k Ohm → 5mA
250 Ohm → 20mA



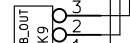
MSB input (cable)

signal
+5V
GND



MSB output (pins)

signal
+5V
GND



The sensor is supplied with power via the MSB connector. May vary from 4..6V.

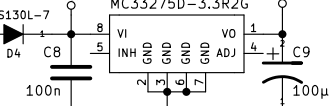
Schottky Diode
VR_max=30V
VF=0.21V@100mA
IF,avg=1A

Voltage Regulator
0.26V drop @ 300mA

+3.3V Supply

max 300mA

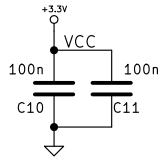
IC0
MC33275D-3.3R2G



abs. min. input voltage
3.3V + 0.26V + 0.21V = 3.77V

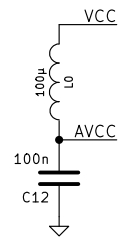
VCC=3.3V
→ MCU voltage MSB compatible

VCC Supply



capacitors placed directly
across MCU pins
3/4 and 5/6

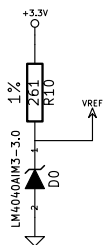
AVCC Supply



MCU: 5.5mA
MSB: 5mA
LEDs: 2x5mA
VREF: 1.15mA
NPN Tr.: 1mA
SD Card: 80mA
TOTAL: 102.65mA

+ 1 Sensor: 10mA (8x)
= 182.65mA

+3V Voltage Reference



series reference
- provides not enough current
→ needs an OP as voltage follower
- low power dissipation

shunt reference
- provides enough current,
but idles at maximum current

$$R = (VCC - AREF) / (IC)$$

VR(IR=0.1mA) = 3V
IR,min=67µA

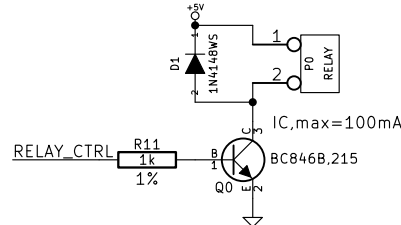
$$\Delta VR / \Delta IR (IR, \min \leq IR \leq 1mA) = 0.6 \cdot 1mA$$

NOTE: pin 3 of the SOT-23 package must be left floating or be connected to pin 2 because of the parasitic Schottky diode between those pins

Temp Sensor: 0.1mA (8x)
MCU: 0.1mA (?)
TOTAL: 0.9mA

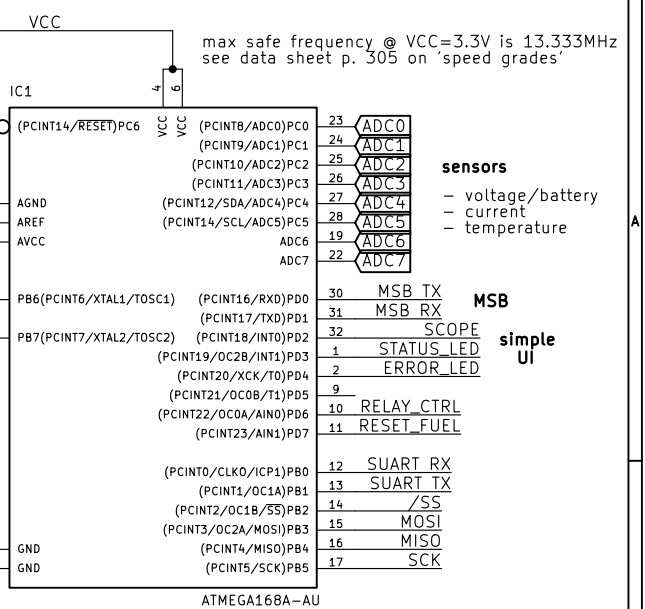
max current with
261R → 1.15mA

Relay Connection for Buzzer



BC846: 100mA switching current
1.3k → 3.3V control voltage
2.2k → 5V control voltage

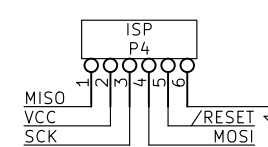
IM03JR: 2A switching current
28mA coil current, 5VDC coil voltage,
3.75V max turn on voltage



sensors
- voltage/battery
- current
- temperature

MSB
simple UI

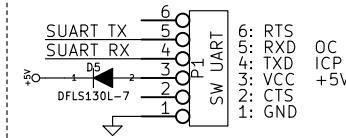
ISP



SPI

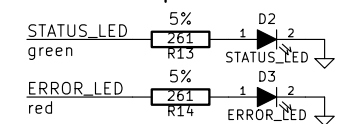
/SS /RESET

Software UART



SW UART connector can power the sensor board
pin configuration = FTDI cable (delock 83116)

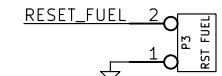
simple UI



$$R = (V_{cc} - V_d) / I_d = (3.3V - 2V) / 5mA = 261 \text{ Ohm}$$

SCOPE SCOPE P2 digital output for debugging
use MSB GND pin as reference

Reset Fuel Indicator to 100%



connector for button to reset the fuel indicator

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File: mcu.sch

Sheet: /MCU/

Title: MSB Sensor

Size: A4

Date: 18 dec 2012

Rev: 4

KiCad E.D.A.

Id: 3/3