VUE32 - Projet VUE's electric vehicle controller

http://projetvue.com/
http://openecosys.sf.net/

Signals
VUE_PIC32_v1_0_Signals.SchDoc

PIC32_MCU
VUE_PIC32_v1_0_PIC32.SchDoc

USB-Serial
VUE_PIC32_v1_0_USB-Serial.SchDoc

Analog_4X
VUE_PIC32_v1_0_Analog_4X.SchDoc

Spd
VUE_PIC32_v1_0_Speed_Sensor.SchDoc

REPEAT(PowerOut,1,4);
VUE_PIC32_v1_0_PowerOut.SchDoc

Repeat(Motor2A_,1,2)
VUE_PIC32_v1_0_Motor_2A.SchDoc

Repeat(CAN,1,2)
VUE_PIC32_v1_0_CAN.SchDoc

Low power connector

High power connector

Fiducials and mouting holes

Supplies
VUE_PIC32_v1_0_Supplies.SchDoc

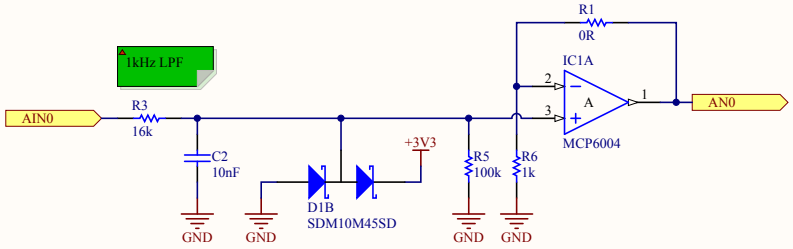
Véhicule Urbain Électrique

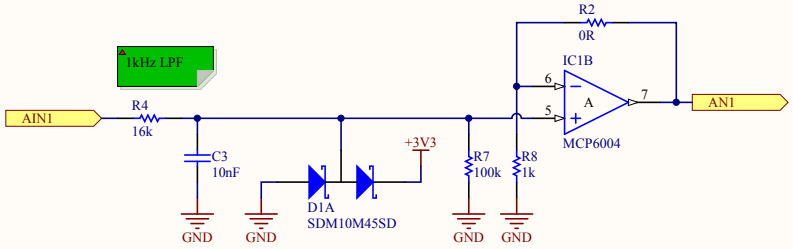
From v0.1:
+ Fiducials
X Swapped motor inputs
+ USB filtering
X I2C connector

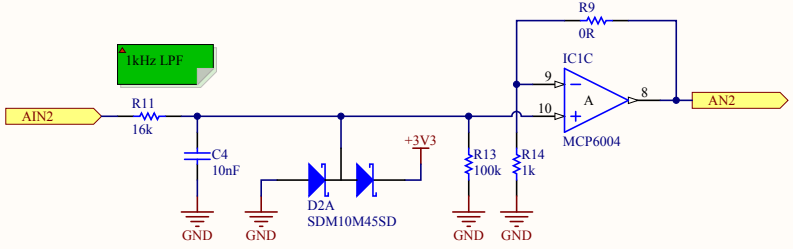
Lead Designer: JFDuval
jfduval@aqra.ca

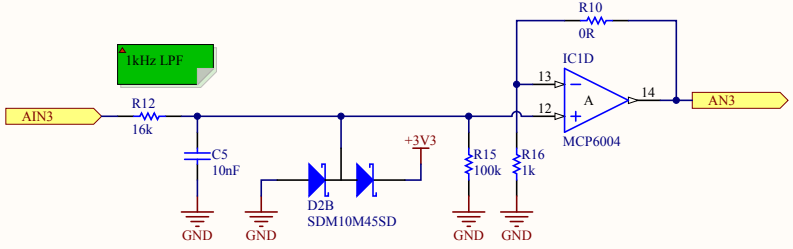
open source hardware

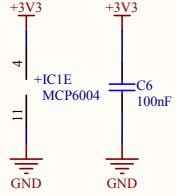
Title	*[VUE32 - Main]*	
Size: A4	Number	Revision: 1.0
Date: 2012-10-11	08:22:21	Sheet of
File: C:\Dropbox\..\VUE_PIC32_v1_0.SchDoc		Drawn By: JFDuval









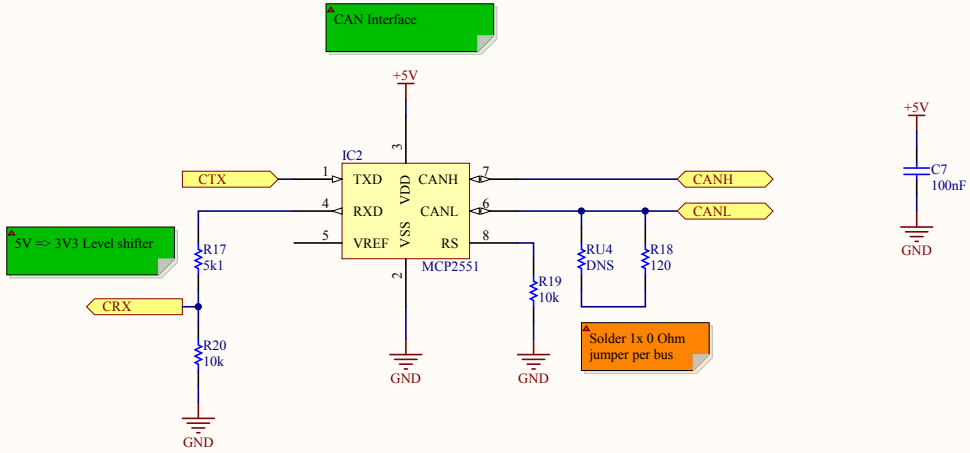


From v0.1:
+ 100k pull-downs
X Lower fc (800Hz)

By default the gain is 1. To change it, change the 0R feedback resistors.
G = 1 + Rf/Rg

With 100k pull-downs, the gain is G = 100k/(100k + 16k) = 0.86. Using 470k is recommended (G = 0.97).

Title	*[VUE32 - 4 ch. analog inputs]*		
Size: A4	Number:		Revision: 1.0
Date: 2012-10-11	08:22:21	Sheet of	
File: C:\Dropbox\..\VUE_PIC32_v1_0_Analog.SchDoc		Drawn By:	JFDuval



From v0.1:
Identical.

Title	*[VUE32 - CAN 2.0]*	
Size: A4	Number:	Revision: 1.0
Date: 2012-10-11 08:22:21	Sheet of	
File: C:\Dropbox\..\VUE_PIC32_v1_0_CAN.SchDoc	Drawn By: JFDuval	

2A Motor Driver

+12V

IC3 A4953

IN1_M R21 1k

IN2_M R23 1k

IN1 IN2 VREF VBB GND EP OUT1 OUT2 LSS

MA_M MB_M

+3V3

R24 1k5

R25 10k

R26 0R15

GND

Current sensor

C8 2n7

R22 62k

+3V3

IC4 + MCP6001

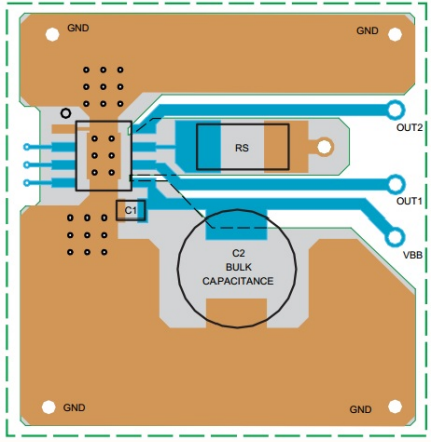
MCS

G=7.2 1kHz LPF

R27 10k

GND

Recommanded layout:



Current sensor:
1A * 0.15Ohm = 150mV
150mV*7.2V/V = 1.08V
1.08V/3.3V = 0.327
0.327*4096 = 1340 bits/A
=> 1 bit = 746µA

Datasheet: "100uF Electrolytic + 220nF X5R"

Truth table:

[IN1]	[IN2]	
0	0	= Coast
1	0	= CW
0	1	= CCW
1	1	= Brake to VCC

PWM Max Freq: 30kHz

I_Trip_Max = Vref/(Av * Rs)
Vref = 2A*(9.5*0.15Ohm) = 2.85V
(10k/(1.5k+10k))*3.3 = 2.87V => 2.01A

+12V C9 100uF GND

+12V C10 100nF GND

+3V3 C11 100nF GND

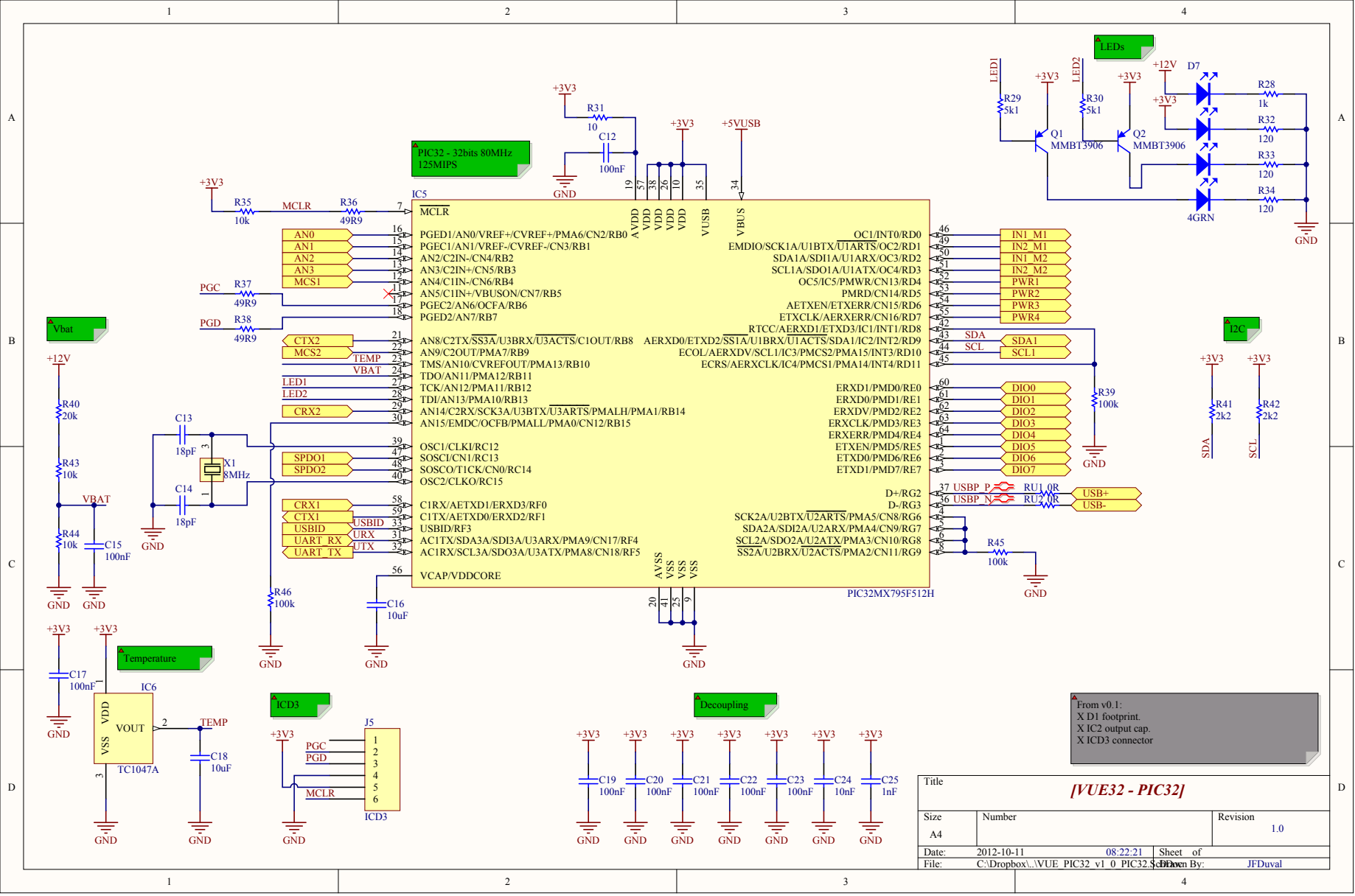
From v0.1:
Identical.

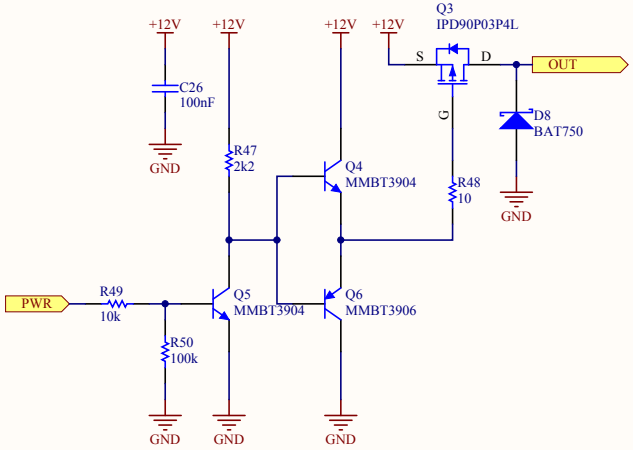
Title: *[VUE32 - 2A H-Bridge motor driver]*

Size	Number	Revision
A4		1.0

Date: 2012-10-11 08:22:21 Sheet of

File: C:\Dropbox\..\VUE_PIC32_v1_0_Motor_2A.SchDoc Drawn By: JFDuval


LEDs
LED1
LED2
+12V
D7
R28
1k
R32
120
R33
120
R34
120
4GRN
R29
5k1
R30
5k1
Q1
MMBT3906
Q2
MMBT3906
GND
PIC32 - 32bits 80MHz
125MIPS
IC5
R31
10
C12
100nF
+3V3
+5VUSB
R35
10k
MCLR
R36
49R9
R37
49R9
PGC
R38
49R9
PGD
AN0
AN1
AN2
AN3
MCS1
CTX2
MCS2
TEMP
VBAT
LED1
LED2
CRX2
SPDO1
SPDO2
CRX1
CTX1
USBID
UART_RX
UART_TX
PGED1/AN0/VREF+/CVREF+/PMA6/CN2/RB0
PGEC1/AN1/VREF-/CVREF-/CN3/RB1
AN2/C2IN-/CN4/RB2
AN3/C2IN+/CN5/RB3
AN4/C1IN-/CN6/RB4
AN5/C1IN+/VBUSON/CN7/RB5
PGEC2/AN6/OCFA/RB6
PGED2/AN7/RB7
AN8/C2TX/SS3A/U3BRX/U3ACTS/C1OUT/RB8
AN9/C2OUT/PMA7/RB9
TMS/AN10/CVREFOUT/PMA13/RB10
TDO/AN11/PMA12/RB11
TCK/AN12/PMA11/RB12
TDI/AN13/PMA10/RB13
AN14/C2RX/SCK3A/U3BTX/U3ARTS/PMALH/PMA1/RB14
AN15/EMDC/OCFB/PMALL/PMA0/CN12/RB15
OSC1/CLKI/RC12
SOSCI/CN1/RC13
SOSCO/T1CK/CN0/RC14
OSC2/CLKO/RC15
C1RX/AETXD1/ERXD3/RF0
C1TX/AETXD0/ERXD2/RF1
USBID/RF3
AC1TX/SDA3A/SDI3A/U3ARX/PMA9/CN17/RF4
AC1RX/SCL3A/SDO3A/U3ATX/PMA8/CN18/RF5
VCAP/VDDCORE
AVDD
VDD
VUSB
VBUS
AVSS
VSS
OC1/INT0/RD0
EMDIO/SCK1A/U1BTX/U1ARTS/OC2/RD1
SDA1A/SDI1A/U1ARX/OC3/RD2
SCL1A/SDO1A/U1ATX/OC4/RD3
OC5/IC5/PMWR/CN13/RD4
PMRD/CN14/RD5
AETXEN/ETXERR/CN15/RD6
ETXCLK/AERXERR/CN16/RD7
RTCC/AERXD1/ETXD3/IC1/INT1/RD8
AERXD0/ETXD2/SS1A/U1BRX/U1ACTS/SDA1/IC2/INT2/RD9
ECOL/AERXDV/SCL1/IC3/PMCS2/PMA15/INT3/RD10
ECRS/AERXCLK/IC4/PMCS1/PMA14/INT4/RD11
ERXD1/PMD0/RE0
ERXD0/PMD1/RE1
ERXDV/PMD2/RE2
ERXCLK/PMD3/RE3
ERXERR/PMD4/RE4
ETXEN/PMD5/RE5
ETXD0/PMD6/RE6
ETXD1/PMD7/RE7
D+/RG2
D-/RG3
SCK2A/U2BTX/U2ARTS/PMA5/CN8/RG6
SDA2A/SDI2A/U2ARX/PMA4/CN9/RG7
SCL2A/SDO2A/U2ATX/PMA3/CN10/RG8
SS2A/U2BRX/U2ACTS/PMA2/CN11/RG9
PIC32MX795F512H
IN1_M1
IN2_M1
IN1_M2
IN2_M2
PWR1
PWR2
PWR3
PWR4
SDA
SCL
SDA1
SCL1
DIO0
DIO1
DIO2
DIO3
DIO4
DIO5
DIO6
DIO7
USBP_P
USBP_N
RU1 0R
RU2 0R
USB+
USB-
R39
100k
I2C
R41
2k2
R42
2k2
Vbat
R40
20k
R43
10k
R44
10k
C15
100nF
C13
18pF
C14
18pF
X1
8MHz
R46
100k
C16
10uF
R45
100k
Temperature
IC6
TC1047A
VOUT
C17
100nF
C18
10uF
ICD3
J5
MCLR
Decoupling
C19
100nF
C20
100nF
C21
100nF
C22
100nF
C23
100nF
C24
10nF
C25
1nF
From v0.1:
X D1 footprint.
X IC2 output cap.
X ICD3 connector
Title
[VUE32 - PIC32]
Size
A4
Number
Revision
1.0
Date:
2012-10-11
08:22:21
Sheet of
File:
C:\Dropbox\..\VUE_PIC32_v1_0_PIC32.SchDoc
Drawn By:
JFDuval



Max RDSon : 4.1mOhm
DPAK: 62C/W
$P = RI^2 = 0.0041*10A^2 = 410mW$
T = 25C + P*62C/W = 25C + 25.42C
T = 50.42C Good

Tested on v1.0:
PowerOut 4 w/ full enclosure

t(s)	I(A)	T(C)
0	0.0	22
60	9.6	22
420	9.6	40
3120	9.6	57
3600	9.6	58

End

For detailed results, refer to the QA sheet.

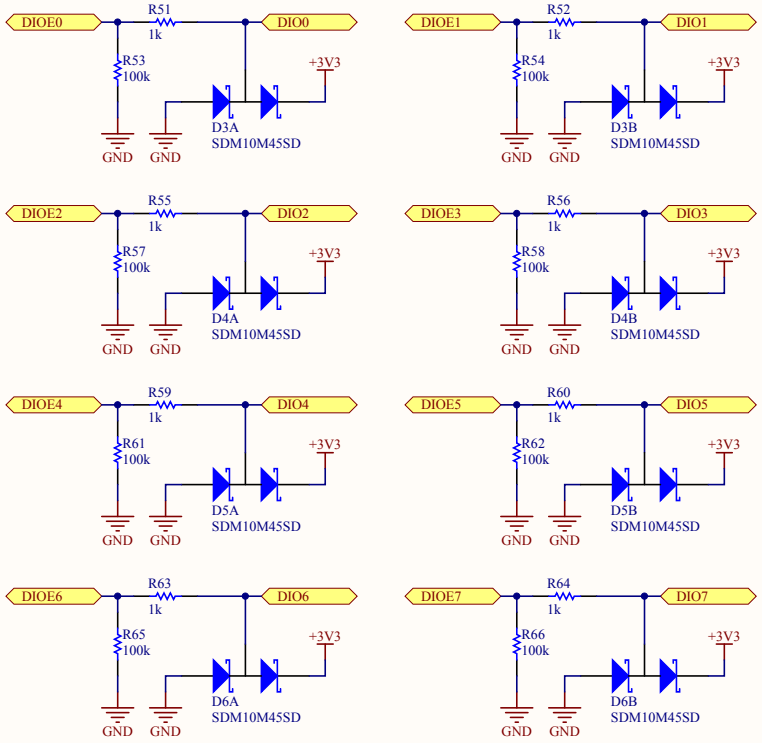
Maximum current determined by layout. As a rule of thumb, #1 is rated for 10A and Out1 > Out2 > Out 3 > Out 4. Now that this is said, Out 4 was fully tested at 9.6A and was below 60C after an hour.

Connect the load between OUT and GND. When PWR = 1, OUT = 12V. For additional information see LTSpice : high_side_p_mos_switch_0_1.asc.

Not caracterized for PWM!

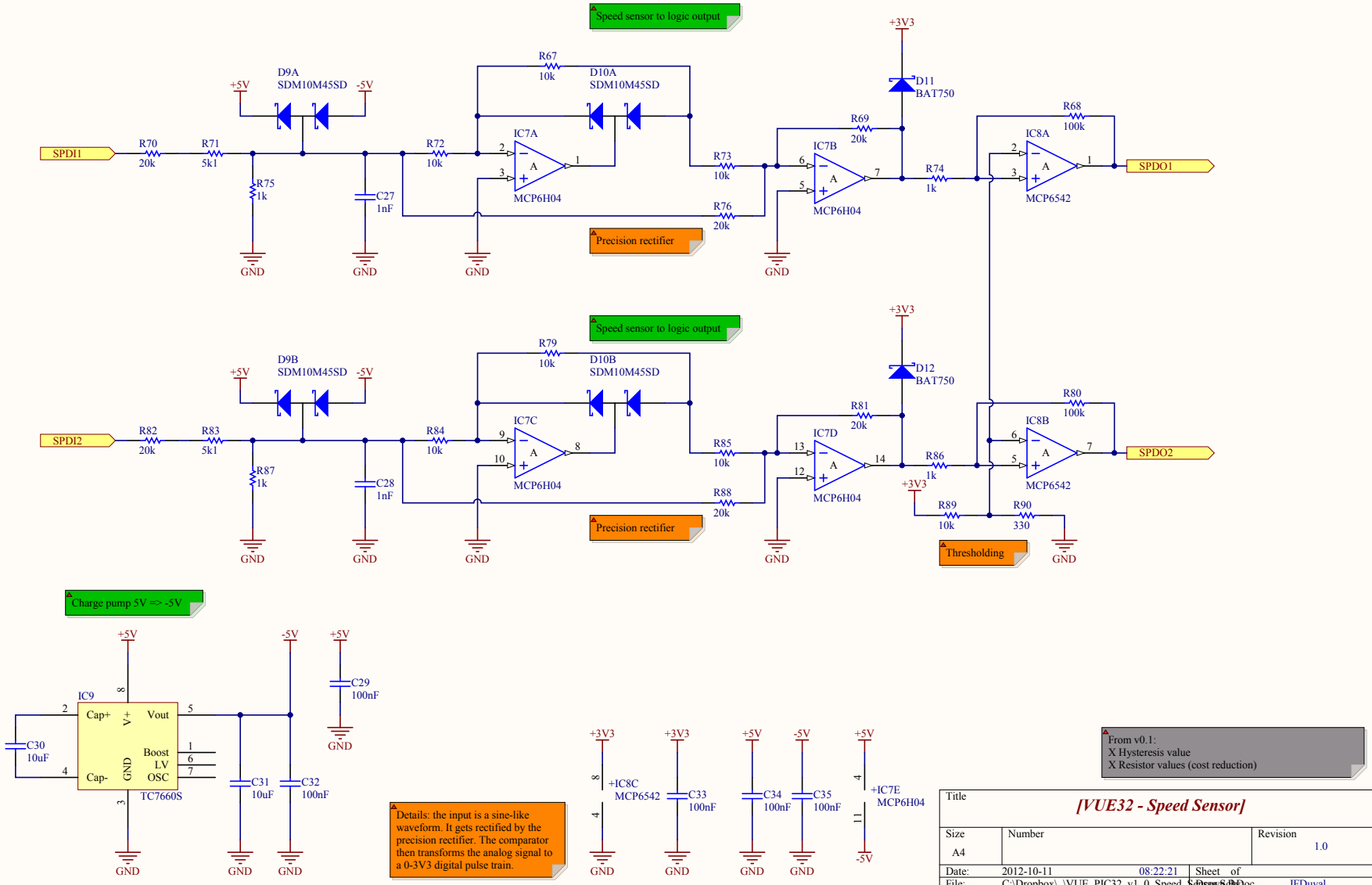
From v0.1:
Identical.

Title	*[VUE32 - (Up to) 10A switched output]*	
Size: A4	Number	Revision: 1.0
Date: 2012-10-11 08:22:21		Sheet of
File: C:\Dropbox\..\VUE_PIC32_v1_0_PowerOut_Sch.SchDoc		Drawn By: JFDuval



From v0.1:
Identical.

Title	***[VUE32 - Digital I/Os]***	
Size: A4	Number:	Revision: 1.0
Date: 2012-10-11 08:22:21	Sheet of	
File: C:\Dropbox\..\VUE_PIC32_v1_0_Signals_Shi...	Drawn By: JFDuval	


Speed sensor to logic output
D9A
SDM10M45SD
D10A
SDM10M45SD
+5V
-5V
SPDI1
R70
20k
R71
5k1
R72
10k
R67
10k
R73
10k
R74
1k
R75
1k
R76
20k
R68
100k
R69
20k
C27
1nF
IC7A
MCP6H04
IC7B
MCP6H04
IC8A
MCP6542
D11
BAT750
+3V3
SPDO1
Precision rectifier
GND
Speed sensor to logic output
D9B
SDM10M45SD
D10B
SDM10M45SD
SPDI2
R82
20k
R83
5k1
R84
10k
R79
10k
R85
10k
R86
1k
R87
1k
R88
20k
R80
100k
R81
20k
C28
1nF
IC7C
MCP6H04
IC7D
MCP6H04
IC8B
MCP6542
D12
BAT750
SPDO2
Precision rectifier
R89
10k
R90
330
Thresholding
Charge pump 5V => -5V
IC9
Cap+
Cap-
Vout
Boost
LV
OSC
V+
GND
TC7660S
C30
10uF
C31
10uF
C32
100nF
C29
100nF
C33
100nF
C34
100nF
C35
100nF
+IC8C
MCP6542
+IC7E
MCP6H04
Details: the input is a sine-like waveform. It gets rectified by the precision rectifier. The comparator then transforms the analog signal to a 0-3V3 digital pulse train.
From v0.1:
X Hysteresis value
X Resistor values (cost reduction)
Title
[VUE32 - Speed Sensor]
Size
A4
Number
Revision
1.0
Date:
2012-10-11
08:22:21
Sheet of
File:
C:\Dropbox\..\VUE_PIC32_v1_0_Speed_Sensor.SchDoc
Drawn By:
JFDuval

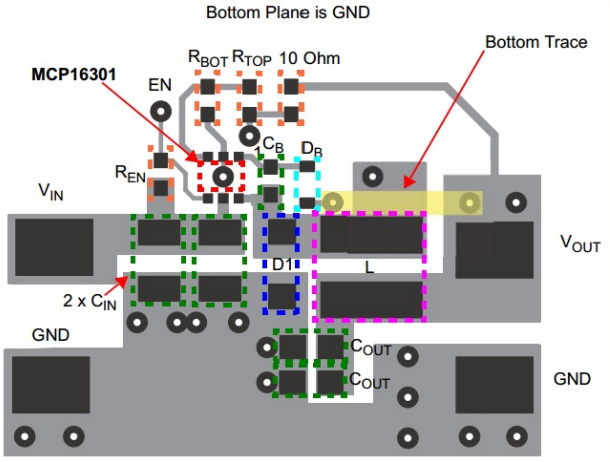
SMPS 12V => 5V

+12V
D13
BAT750
L2
200mA
+12VL
C36
470uF
GND
Brownout and short protection
C38
10uF
D14
BAT750
D15
BAT750
C37
100nF
L3
22uH
D16
BAT750
IC11
VIN
BOOST
SW
EN
GND
VFB
MCP16301
R91
52k3
R94
10k
C39
10uF
C40
10uF
+5V_DCDC
Autoswitch Power Mux. If the DC/DC 12V=>5V supply is available, it powers the circuit. Otherwise, USB (5VUSB) is used.
IC10
D0
D1
Vsns
Ilim
In1
Out
In2
Gnd
TPS2111A
+5VUSB
+5V
C43
100nF
R92
1k
R93
1k
C41
100nF
C42
100nF
Ilim = 500/Rilim = 1A
Can't do hot swap. Vsns should be on a voltage divider. See datasheet's Fig. 14.

Linear 5V => 3V3
+5V
D17
BAT750
+3V3
IC12 MCP1700T
VI
GND
VO
C44
10uF

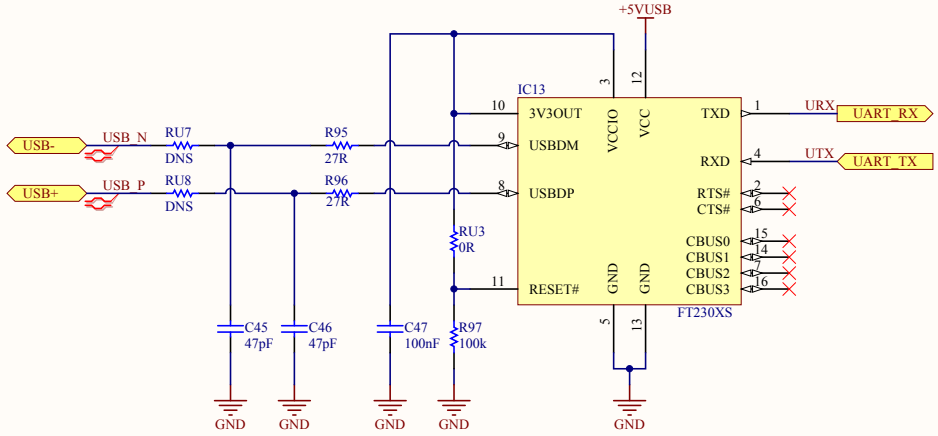
Protections
+12V
D18
12V
+12VL
D19
12V
+5V
D20
5V
+3V3
D21
3V3
+5V_DCDC
RU5
DNS
+5V
+5VUSB
RU6
DNS
+5V
Solder to fix one option. (In that case, remove the TSP2111)

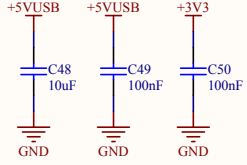
Bottom Plane is GND



From v0.1:
Identical.

Title	[VUE32 - Supplies]		
Size A4	Number		Revision 1.0
Date: 2012-10-11	08:22:21	Sheet of	
File: C:\Dropbox\..\VUE_PIC32_v1_0_Supplies.SchDoc		Drawn By:	JFDuval





To use this FT230X instead of the onboard USB:

=> Solder RU7 and RU8
=> Remove RU1, RU2 and RU3

From v0.1:
X Cheaper and better FT230XS (rather than FT232)

Title	*[VUE32 - USB-Serial]*	
Size: A4	Number:	Revision: 1.0
Date: 2012-10-11 08:22:22	Sheet of	
File: C:\Dropbox\..\VUE_PIC32_v1_0_USB-Serial.SchDoc	Drawn By: JFDuval	