Sheet: UI

LFT DISP

RGT DISP

KEYBD

UI

File: UI.sch

Sheet: FPGA

FPGA

BUF

File: FPGA.sch

Sheet: Sensors

Analog to Digital

fo

50x

O2

fo

4.65x

Diff Press

Flow Press

Pat Press

Flow

File: Sensors.sch

PB_Select

Sheet: Speaker_Driver

DRIVER

DRIVER

File: Speaker_Driver.sch

Sheet: Power_Supplies

7V5

Filter

+5V_Sensor

3V3_Sensor

+5V

3V3

1V2

V_Main

USB

3V3-ALWAYS-ON

+5V

File: Power_Supplies.sch

Sheet: Microcontroller

BUF

MCU

USB

JTAG

UART

File: Microcontroller.sch

Sheet: JTAG

BUF

Sel JMPR

BUF

FTDI JTAG

USB-JTAG

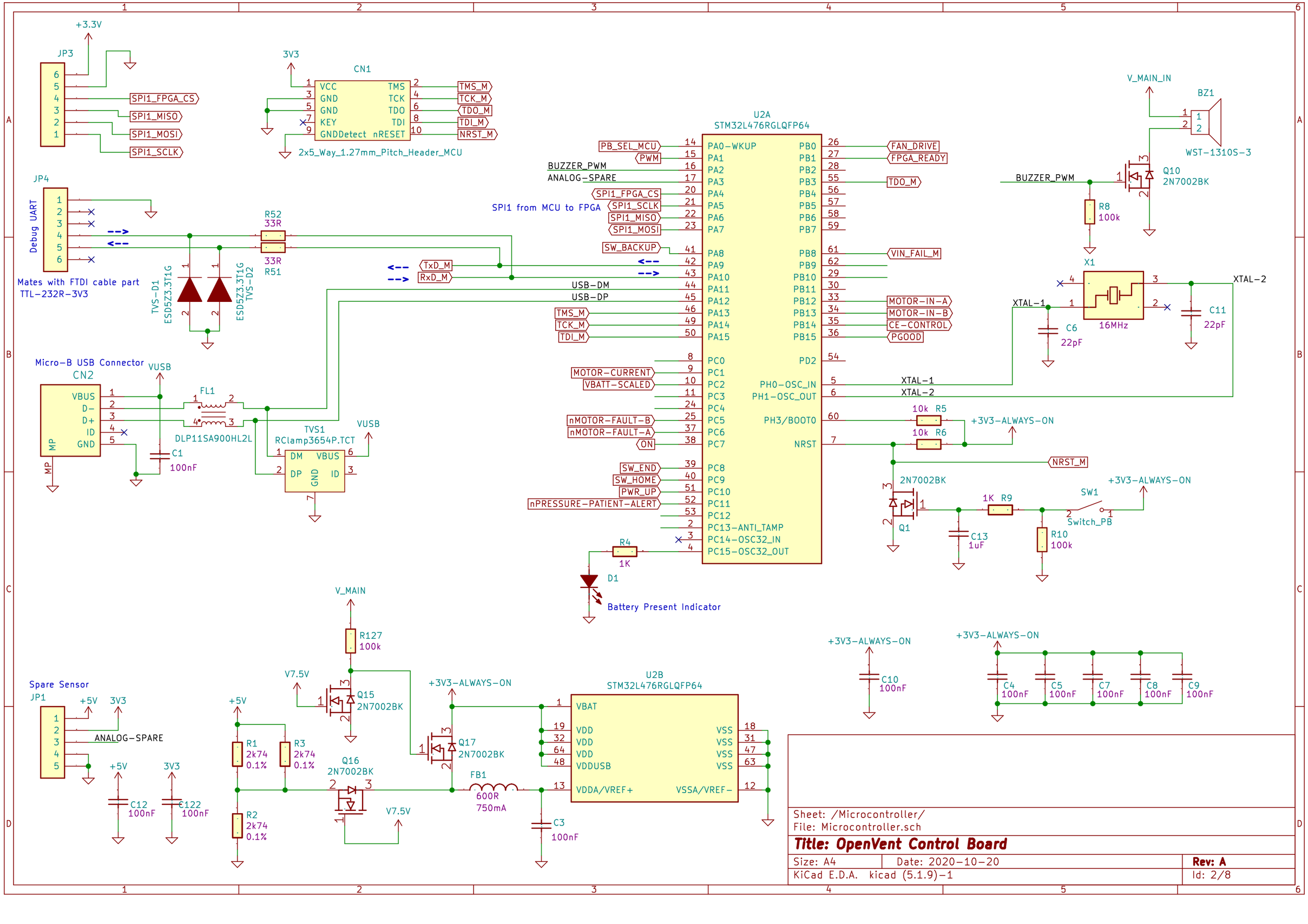
nRST

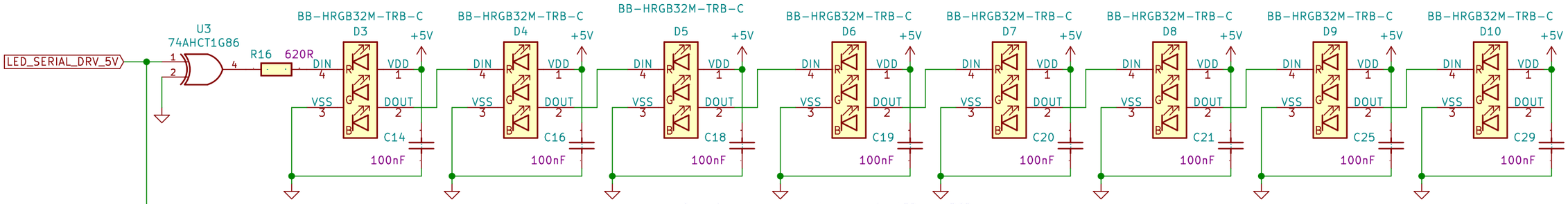
File: JTAG.sch

Sheet: /
File: OpenVent.sch

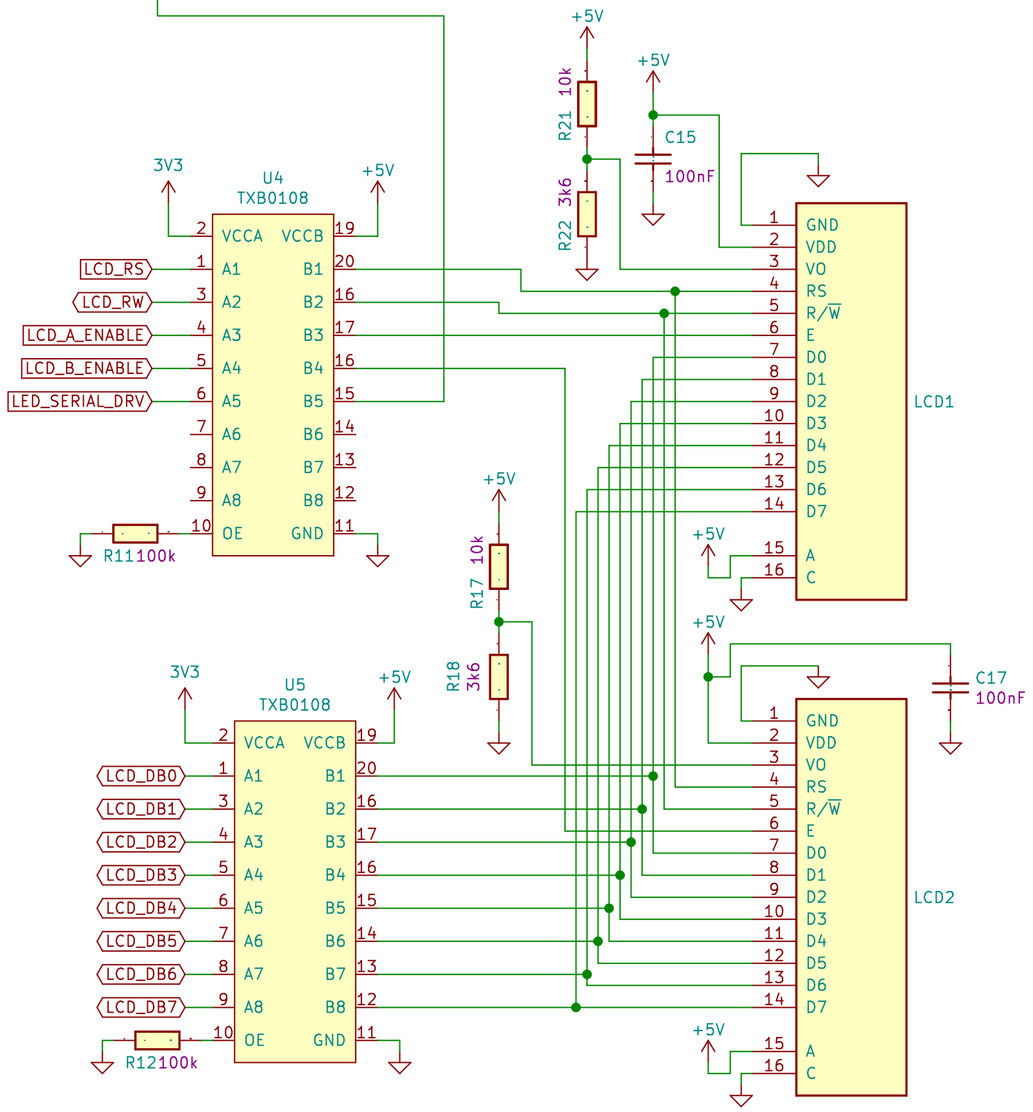
Title: OpenVent Control Board

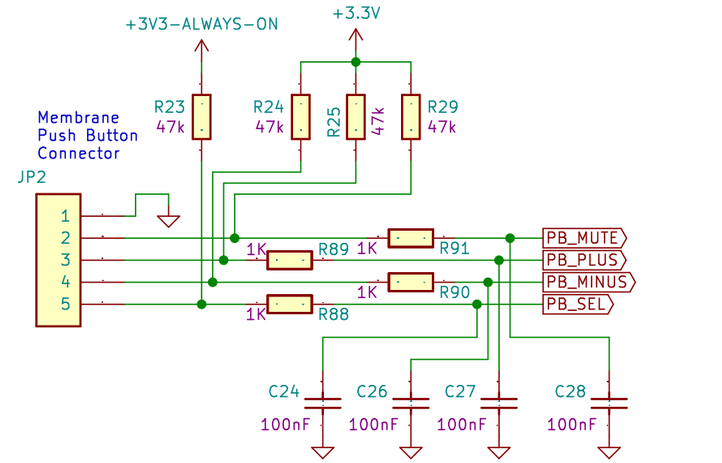
Size: A3	Date: 2020-10-20	Rev: A
KiCad E.D.A. kicad (5.1.9)-1		Id: 1/8

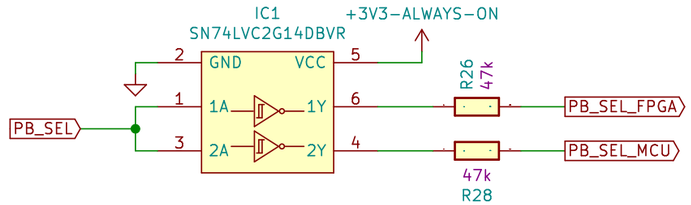

JP3
SPI1_FPGA_CS
SPI1_MISO
SPI1_MOSI
SPI1_SCLK
+3.3V
3V3
CN1
VCC
GND
GND
KEY
GNDDetect
TMS
TCK
TDO
TDI
nRESET
TMS_M
TCK_M
TDO_M
TDI_M
NRST_M
2x5_Way_1.27mm_Pitch_Header_MCU
JP4
Debug UART
Mates with FTDI cable part
TTL-232R-3V3
R52
33R
R51
33R
TVS-D1
ESD5Z3.3T1G
TVS-D2
ESD5Z3.3T1G
U2A
STM32L476RGLQFP64
PB_SEL_MCU
PWM
BUZZER_PWM
ANALOG-SPARE
SPI1_FPGA_CS
SPI1_SCLK
SPI1_MISO
SPI1_MOSI
SPI1 from MCU to FPGA
SW_BACKUP
TxD_M
RxD_M
USB-DM
USB-DP
TMS_M
TCK_M
TDI_M
MOTOR-CURRENT
VBATT-SCALED
nMOTOR-FAULT-B
nMOTOR-FAULT-A
ON
SW_END
SW_HOME
PWR_UP
nPRESSURE-PATIENT-ALERT
R4
1K
D1
Battery Present Indicator
FAN_DRIVE
FPGA_READY
TDO_M
VIN_FAIL_M
MOTOR-IN-A
MOTOR-IN-B
CE-CONTROL
PGOOD
XTAL-1
XTAL-2
10k R5
10k R6
+3V3-ALWAYS-ON
NRST_M
2N7002BK
Q1
1K R9
SW1
Switch_PB
C13
1uF
R10
100k
V_MAIN_IN
BZ1
WST-1310S-3
Q10
2N7002BK
R8
100k
X1
16MHz
C6
22pF
C11
22pF
Micro-B USB Connector
CN2
VBUS
D-
D+
ID
GND
MP
VUSB
FL1
DLP11SA900HL2L
C1
100nF
TVS1
RClamp3654P.TCT
Spare Sensor
JP1
ANALOG-SPARE
C12
100nF
C122
100nF
V_MAIN
R127
100k
V7.5V
Q15
2N7002BK
Q16
2N7002BK
Q17
2N7002BK
R1
2k74
0.1%
R2
2k74
0.1%
R3
2k74
0.1%
FB1
600R
750mA
U2B
STM32L476RGLQFP64
VBAT
VDD
VDDUSB
VDDA/VREF+
VSS
VSSA/VREF-
C3
100nF
C10
100nF
C4
100nF
C5
100nF
C7
100nF
C8
100nF
C9
100nF
Sheet: /Microcontroller/
File: Microcontroller.sch
Title: OpenVent Control Board
Size: A4
Date: 2020-10-20
Rev: A
KiCad E.D.A. kicad (5.1.9)-1
Id: 2/8

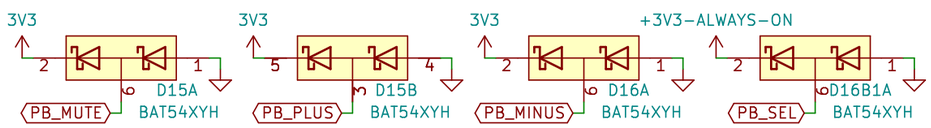


Capacitors to be placed near serial LEDs on PCB









Sheet: /UI/		
File: UI.sch		
Title:		
Size: A4	Date:	**Rev:**
KiCad E.D.A. kicad (5.1.9)-1		Id: 3/8

I/Os ON BANKS 1 AND 2 CAN BE FREELY INTERCHANGED AT LAYOUT EXCEPT CLCK WHICH MUST BE ON A GCLKT_x I/O PIN

+1V2
R31 0 Ohm
3V3
R30 0 Ohm
DO NOT FIT
+3V3_Sensors
3V3
+3V3_Sensors
U8A
GW1N-9LQ100
VCC 1, 25, 51, 75
VCCO0 76, 88
VCCO1 63, 71
VCCO1* 26
VCCO2 38
VCCO3 4, 13
*VCCX 54
VCCX 21
GND 87, 74, 52, 37, 24, 2
3V3

U8E
GW1N-9LQ100
BANK 2
DELTA SIGMA A/D CONVERTER
FEEDBACK VOLTAGE AND
REFERENCE VOLTAGE DRIVE
SPI2 from sensor slave
SPI2_MISO 22
SPI2_MOSI 23
SPI_SCLK 27
SPI2_PRES_CS 28
SPI1 to
MCU master
SPI1_MISO 29
SPI1_MOSI 30
SPI1_SCLK 31
SPI1_FPGA_CS 32
VIN_FAIL_F 33
3V3
2k4 R19
3V3
2k4 R20
I2C_SCL
I2C_SDA 44
IOB6A 55
IOB6B 53
IOB8A 49
IOB8B 50
IOB11A 47
IOB11B 48
IOB13A 45
IOB13B 46
IOB15A
IOB15B 39
IOB17A 40
IOB17B 41
IOB31A 42
IOB31B
IOB43A Vref_DRV
IOB43B DRV_PRES_SENS_VENT
IOB39A DRV_PRES_SENS_PAT
IOB39B DRV_FLOW_SENS
IOB35A DRV_FLOW_SENS_GAIN
IOB35B DRV_O2_SENS
IOB33A F_DRV
IOB33B G_DRV
IOB28A/GCLKT_5 CLCK
IOB28B/GCLKC_5 LED_SERIAL_DRV
IOB29A/GCLKT_4 FPGA_READY
IOB29B/GCLKC_4

nMOTOR-FAULT-A
Q2
2N7002BK
nMOTOR-FAULT-B
Q3
2N7002BK
Motor_Off

CHECK I2C PULL-UP RESISTOR
VALUES ONCE WHOLE I2C CIRCUIT
IS CONFIRMED (2.4K TOO STIFF, 4.75K
IS ENOUGH)

U8D
BANK 3, BANK 0
GW1N-9LQ100
Bank 3
IOL9A/GCLKT_7 6
IOL9B/GCLKC_7 7
IOL15A/GCLKT_6 17
IOL15B/GCLKC_6 18
IOL20A 19
IOL20B 20
IOT8A 99
IOT8B 98
IOT12A 97
IOT12B 96
IOL7B 5
IOL12A/SCLK 10
Bank 0
IOT15A 95
IOT15B 94
IOT17A 93
IOT17B 92
IOT22A 90
IOT22B 89
IOT32A 86
IOT32B 85
IOT20A 91
AD_VREF
Vcap_02_SENS
Vcap_PRES_SENS_VENT
Vcap_PRES_SENS_PAT
Vcap_FLOW_SENS_DRCT
Vcap_FLOW_SENS_GAIN
PB_MUTE
PB_PLUS
SPK1_SENS
SPK_HIGH_REF
SPK2_SENS
SPK_LOW_REF
PB_MINUS

SIGMA DELTA A/D CONVERTER INPUTS

U8F
GW1N-9LQ100
BANK 1
2 x NHD-0216K1Z-FL-YBW
SPK1_FLT_N 68
SPK2_FLT_N 67
SPK1_EN 66
SPK2_EN 65
SPK1_IN1 64
SPK1_IN2 62
SPK2_IN1 61
SPK2_IN2 60
PB_SEL_FPGA 84
Reset_I2C 83
IOR11A/MI/D7
IOR11B/MO/D6
IOR12A/MCS_N/D5
IOR12B/MCLK/D4
IOR13A/FASTRD_N/D3
IOR13B/SI/D2
IOR14A/SO/D1
IOR14B/SSPI_CS_N/D0
IOT37A
IOT37B 82
IOT39A 81
IOT39B
DIN/CLKHOLD_N/IOR15A 59
DOUT/WE_N/IOR15B 58
RPLL_T_IN/IOR5A 73
RPLL_C_IN/IOR5B 72
GCLKT_2/IOR9A 70
GCLKC_2/IOR9B 69
GCLKT_3/IOR17A 57
GCLKC_3/IOR17B 56
IOT41A 80
IOT41B 79
IOT42A 78
IOT42B 77
LCD_A_ENABLE
LCD_B_ENABLE
LCD_RW
LCD_RS
LCD_DB0
LCD_DB1
LCD_DB2
LCD_DB3
LCD_DB4
LCD_DB5
LCD_DB6
LCD_DB7

Debug UART
JP5
1
2
3
4
5
6
R33 33R
R34 33R
RxD_F
TxD_F
To FTDI serial port
TVS-D4
ESD5Z3.3T1G
TVS-D3
ESD5Z3.3T1G

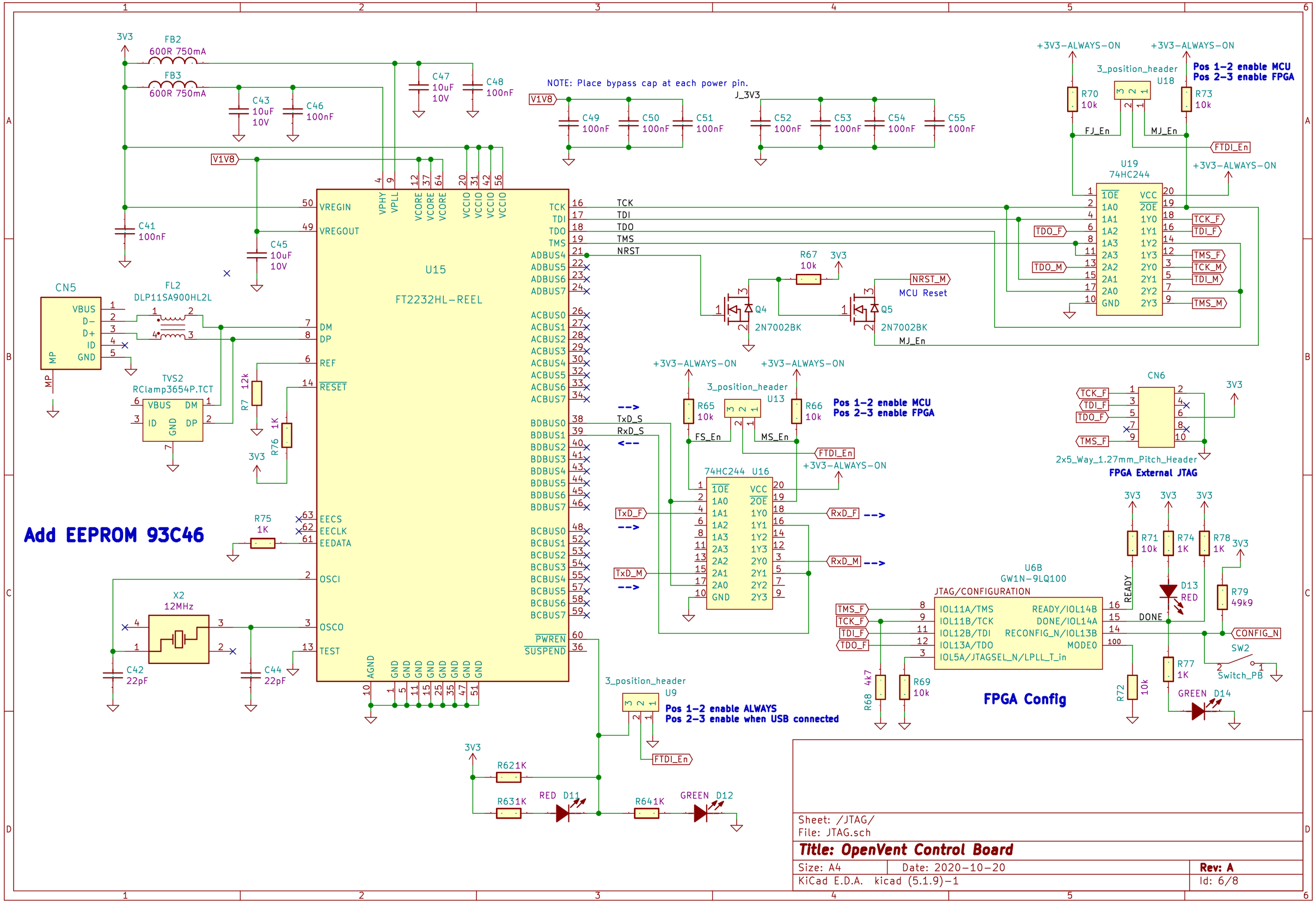
Bypass Caps for Power Block
+5V_Sensors
C36 100nF
C39 100nF
C56 100nF
C59 100nF
C63 10uF 10V
+3V3_Sensors
C37 100nF
C40 100nF
C58 100nF
C60 100nF
C65 10uF 10V
+1V2
C30 100nF
C38 100nF
C57 100nF
C61 100nF
C62 10uF 10V

3V3
R41 10k
CLCK
U14
SiT8008B
OE/ST/NC 1
OUT 3
VDD 4
GND 2
33.554432 MHz
3V3
C23 100nF

Sheet: /FPGA/		
File: FPGA.sch		
Title: OpenVent Control Board		
Size: A4	Date: 2020-10-20	**Rev: A**
KiCad E.D.A. kicad (5.1.9)-1		Id: 4/8

CN4
Off-board Sensirion SFM3020
Flow Rate Sensor - analogue
10nF C32
R27 18k
R32 100k
1M R44
TLV2333IDR
Gain: 8.5
+5V_Sensors
FLOW_SENS_GAIN
U12B
R37 215k
R40 1M
C31 33nF
Differential Pressure Sensor
(at flow sensor)
U11
MPXV4006DP
DO NOT FIT
R35 0 Ohm
R36 0 Ohm
DO NOT FIT
C67 10nF
C72 1uF
FLOW_SENS_DRCT
C69 470pF 100V
Gauge Pressure Sensor (at patient)
MPXV4006GP U10
C70 10nF
C73 1uF
PRES_SENS_PAT
C71 470pF 100V
Gauge Pressure Sensor (at flow sensor)
MPXV4006GP U17
C22 10nF
C68 1uF
PRES_SENS_VENT
C64 470pF 100V
Off-board Sensirion SFM3019 Flow Rate Sensor - digital
CN3
3V3_I2C
C66 100nF
I2C_SCL
I2C_SDA
On-Board STMicroelectronics Absolute Pressure Sensor
U1
LPS25HB
3V3
SPI2_SCLK
SPI2_MOSI
SPI2_MISO
SPI2_PRES_CS
SPI Slave of FPGA
C2 100nF
330nF 16V C34
R46 3k6
180k R48
J2 Conn_01x02
Gain: 50
R45 3k6
TP8
TP9
R47 180k
C33 22uF 10V
U12A
TLV2333IDR
O2_SENS
C35 100nF
+5V_Sensors
FB4 600R 750mA
C74 47nF 2%
U7
74ACT244PW
Vref_DRV
DRV_PRES_SENS_VENT
DRV_PRES_SENS_PAT
DRV_FLOW_SENS_DRCT
DRV_FLOW_SENS_GAIN
DRV_O2_SENS
F_DRV
G_DRV
FPGA ADC analog circuitry
R38 100k
TP1
AD_VREF
C75 47nF 2%
R39 47k 0.1%
R55 47k 0.1%
PRES_SENS_VENT
Vcap_PRES_SENS_VENT
TP2
C76 47nF 2%
R42 47k 0.1%
R56 47k 0.1%
PRES_SENS_PAT
Vcap_PRES_SENS_PAT
TP3
C77 47nF 2%
R43 47k 0.1%
R57 47k 0.1%
FLOW_SENS_DRCT
Vcap_FLOW_SENS_DRCT
TP4
C78 47nF 2%
R49 47k 0.1%
R58 47k 0.1%
FLOW_SENS_GAIN
Vcap_FLOW_SENS_GAIN
TP5
C79 47nF 2%
R50 47k 0.1%
R59 47k 0.1%
O2_SENS
Vcap_O2_SENS
TP6
C80 47nF 2%
R53 47k 0.1%
R60 47k 0.1%
SensorOut_F
Vcap_F
TP7
C81 47nF 2%
R54 47k 0.1%
R61 47k 0.1%
SensorOut_G
Vcap_G
TP10
C82 47nF 2%

Sheet: /Sensors/
File: Sensors.sch
Title: OpenVent Control Board
Size: A4 | Date: 2020-10-20 | **Rev: A**
KiCad E.D.A. kicad (5.1.9)-1 | Id: 5/8


Add EEPROM 93C46
FPGA Config
FPGA External JTAG
Pos 1–2 enable MCU
Pos 2–3 enable FPGA
Pos 1–2 enable ALWAYS
Pos 2–3 enable when USB connected
NOTE: Place bypass cap at each power pin.
U15
FT2232HL-REEL
U6B
GW1N-9LQ100
JTAG/CONFIGURATION
74HC244
MCU Reset
2N7002BK
DLP11SA900HL2L
RClamp3654P.TCT
2x5_Way_1.27mm_Pitch_Header
Sheet: /JTAG/
File: JTAG.sch
Title: OpenVent Control Board
Size: A4
Date: 2020-10-20
Rev: A
KiCad E.D.A. kicad (5.1.9)-1
Id: 6/8

CURRENT COMPARISON

+3V3_Sensors

R81 100k

1.41V

SPK_HIGH_REF

R82 75K

+3V3_Sensors

R80 100k

1.05V

SPK_LOW_REF

R83 47k

U20 DRV8876

Do not fit R92 1K

SPK1_PMODE

3V3

R93 1K

SPK1_EN

R94 10k

SPK1_IN1

SPK1_IN2

3V3

R95 10k

SPK1_FLT_N

R96 62k

SPK1_IMODE

3V3

R86 12k

1.5V

SPK1_SENS

R84 10k

C83 10nF

R102 10k

C85 100nF

PMODE 16
nSLEEP 3
EN_IN1 1
PH_IN2 2
nFAULT 4
IMODE 7
VREF 5
IPROPI 6

VM 11
VCP 12
OUT1 8
OUT2 10
CPH 13
CPL 14
PGND 9
PAD 17
GND 15

V7.5V

+5V

R128 0 Ohm

Do not fit R130 0 Ohm

C87 100nF

C91 100nF

C93 22uF 10V

SPK1_VCP

SPK1_OUTP

SPK1_OUTN

C89 22nF

SPK1_CPH

SPK1_CPL

L1 22uH SLF6028T-221MR26-PF

L2 22uH SLF6028T-221MR26-PF

SPK1_FP

SPK1_FN

R104 3R0

R105 3R0

C95 100nF

C96 100nF

J4 Conn_01x02

SPK1_P

SPK1_N

TO EXTERNAL SPEAKER

Vsen = Iout * Rsens / 1000
1.33V = 133 mA approx 0.8 W
1.5V = 150 mA approx 1 W

Use local power and ground planes
separated from system planes,
connected at one point near power input

U21 DRV8876

Do not fit R97 1K

SPK2_PMODE

3V3

R98 1K

SPK2_EN

R99 10k

SPK2_IN1

SPK2_IN2

3V3

R100 10k

SPK2_FLT_N

R101 62k

SPK2_IMODE

3V3

R87 12k

SPK2_SENS

R85 10k

C84 10nF

R103 10k

C86 100nF

PMODE 16
nSLEEP 3
EN_IN1 1
PH_IN2 2
nFAULT 4
IMODE 7
VREF 5
IPROPI 6

VM 11
VCP 12
OUT1 8
OUT2 10
CPH 13
CPL 14
PGND 9
PAD 17
GND 15

V7.5V

+5V

R129 0 Ohm

Do not fit R131 0 Ohm

C88 100nF

C92 100nF

C94 22uF 10V

SPK2_VCP

SPK2_OUTP

SPK2_OUTN

C90 22nF

SPK2_CPH

SPK2_CPL

L3 22uH SLF6028T-221MR26-PF

L4 22uH SLF6028T-221MR26-PF

SPK2_FP

SPK2_FN

R106 3R0

R107 3R0

C97 100nF

C98 100nF

J3 Conn_01x02

SPK2_P

SPK2_N

TO EXTERNAL SPEAKER

nSLEEP	IN1	IN2	OUT1	OUT2	DESCRIPTION
0	X	X	Hi-Z	Hi-Z	Sleep, (H-bridge Hi-Z)
1	0	0	Hi-Z	Hi-Z	Coast, (H-Bridge Hi-Z)
1	0	1	L	H	Reverse (OUT2->OUT1)
1	1	0	H	L	Forward (OUT1->OUT2)
1	1	1	L	L	Brake, (Low-Side Slow Decay)

Sheet: /Speaker_Driver/
File: Speaker_Driver.sch

Title:

Size: A4 | Date: | Rev:
KiCad E.D.A. kicad (5.1.9)-1 | Id: 7/8

3.3v Digital, 3.3v Analog and 1.2v regulators with soft-start (ramp for FPGA)

motorcurrent has to go to fpga VIA ADC
(NO NEED TO AMPLIFY) RANGES FROM
0 V TO 5 V DEPENDING ON THE CURRENT GOING TO THE MOTOR

CHARGE CURRENT MAY HAVE TO BE
BUFFERED THROUGH AN AMP AND IT
GOES INTO ADC TO FPGA. JEFF WILL LOOK AT IT

2 square inches of copper on
each side of the board for
heat sinking for 5V
Digital Regulator

V7.5V
4k7 R?
R? 4k7
IC? MAX809LEUR+
VCC RESET GND
LDO-EN
R? 4k7

5 Volt Digital

V7.5V
U22
C99 1uF
LDO-EN
VCC VO EN GND GND
R110 100k
R15 0.1 Ohm
+5V
C105 1uF
BD50FC0WEFJ-E2

5 Volt Analog

V7.5V
U?
C? 1uF
LDO-EN
VCC VO EN GND GND
R? 0.1 Ohm
+5V_Sensors
C? 1uF
BD50FC0WEFJ-E2

J1
D3428-6302-AR
V7.5V_IN
VBATT
FAN_DRIVE
SW_HOME
SW_END
nMOTOR-FAULT-B
MOTOR-IN-B
MOTOR-CURRENT
nVIN_FAIL
SW_BACKUP
nMOTOR-FAULT-A
MOTOR-IN-A
PWM
V7.5V_EN
CHG_CURRENT
V_MAIN_IN
V7.5V_IN

1.2 Volt Digital – FPGA Core

+3.3V
IC? TPS74801TDRCRQ1
IN_1 IN_2 BIAS EN SS GND PG OUT_2 OUT_1 FB
C3216X5R1H475K085AB 4.7uF
LDO-EN
560pF
06035C561JAT2A
CONFIG_N
R113 0.1 Ohm
+1V2
ERA3AEB2491V 2.49K
ERA3AEB4991V 4.99K
C107 2.2uF

3.3 Volt Digital

+5V
IC? ADP1715ARMZ-3.3-R7
LDO-EN
EN OUT IN GND_4 GND_3 SS GND_1 GND_2
C? 2.2uF
C? 1.5nF
R13 0.1 Ohm
+3.3V
C? 2.2uF

V7.5V_IN
FL5 BLM31KN102SN1L
L5 22uH
V7.5V
C111 100nF
C113 100nF
C115 47uF
C118 100nF
C120 47uF

V_MAIN_IN
FL6 BLM31KN102SN1L
L6 22uH
V_MAIN
C112 100nF
C114 100nF
C116 47uF
C119 100nF
C121 47uF

V_MAIN
R? HRG3216P-47R0-B-T1
47R 1W
D16B BAT54XYH
VUSB
5V from USB
D17A BAT54XYH

3.3 Volt MCU – Always On

U23
VIN VOUT EN FB GND GND GND GND
LDL212D33R
C103 1uF
R14 0.1 Ohm
+3V3-ALWAYS-ON
C108 1uF

3.3 Volt Analog

+5V_Sensors
IC? ADP1715ARMZ-3.3-R7
LDO-EN
EN OUT IN GND_4 GND_3 SS GND_1 GND_2
C? 2.2uF
C? 1.5nF
R? 0.1 Ohm
+3V3_Sensors
R1211K
GREEN
D18
C? 2.2uF

Power control

V_MAIN
R111 100k
R114 1M
Q9 2N7002BK
V7.5V_EN
PwrOff
PwrOn
R112 1M
R115 47k
V3.3_always
R108 470k
10nF C100
ON
PwrOn_g
Q6 Q7 Q8 Q11 2N7002BK
R109 47k
Rising Edge TriState Control
MCU – Normally hi-Z, activate
by pulling low 5 ms, then high

Power control status to MCU

PWR_ON_n
+3V3-ALWAYS-ON
R117 4k7
R116 470R
D2 GREEN
Power UP LED
Q12 2N7002BK
C109 10nF
R118 470k
+3.3V
PwrOff_g
OFF
Rising Edge TriState Control
FPGA – Normally hi-Z,
activate by pulling low 5 ms,
then high

I2C Reset Circuit

+5V_Sensors
3V3
R119 10k
R120 10k
+3V3_Sensors
Q13 Q14 2N7002BK
Reset_I2C
3V3_I2C

+3V3-ALWAYS-ON
Vin_GOOD
D19 GREEN
R124 10k
R126 10k
VIN_FAIL_M
VIN_FAIL_F
+3.3V
R1251K
nVIN_FAIL
R123 1K
M1 M2 2N7002BK

Sheet: /Power_Supplies/		
File: Power_Supplies.sch		
Title: OpenVent Control Board		
Size: A4	Date: 2020-10-20	**Rev: A**
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