AC/DC input selector and rectifier with two rellays in parallel
(lower voltage shall be normally closed)

1N4148 D1
K1 MT2
SELIN
R4 10K
Q1 OFF: Default input AC
Q1 ON: Secondary input AC
(optional)
+12V
DMN3404L Q1
GND
J1 12VAC ARK5
J2 24VAC ARK5
5A-slow
F1
GBU403 D3
Shall be mounted to heat-sink
PWR_FLAG
+VDC
4m7/50V C8
4m7/50V C10
3u3/50V C12
3u3/50V C14
K2 MT2
Shutdown discharge
ESD protection
Overvoltage protection
(fuse blow @ 51V)
10n/100V C56
SMCJ51A D2
R8 100R
DMN3404L Q4
DISCHARGE
R9 10K

General purpose linear
power supply for PSU circuit

D5 1N4148
Shall be mounted
to heat-sink
+VIN
LM317 U4
R19 1K2
R20 10K
1N4148 D6
220n/50V C20
220n/50V C27
100n/50V C26
+12V

Pre-regulator for low voltage
low power regulators

+12V
L7805 U7
+5V
220n/50V C29
100n C31

Fan output terminal
for binary or PWM control

+12V
100n C49
DNP C49
1N4148 D7
J3 ARK5
FAN
10K R23
DMN3404L Q7

Assemble only on primary channel
(allows none, series or parallel interconnection
with secondary identical power supply twin)

D8 1N4148
K3 MT2
R24 10K COOP
Q2 DMN3404L
D9 1N4148
K5 MT2
R26 10K MODE
Q3 DMN3404L
K4 MT2
K6 MT2
+VOUT
J4 ARK5 VOUT GND
Secondary interconnect
J5 ARK5 VOUT GND
Primary output

COOP	MODE	FUNC
OFF	NR	Separate
ON	OFF	Series
ON	ON	Parallel

MCU power supply

TPS793333-EP U5
+5V
+3V3
100n C21
100n C23
100n C25

Voltage reference for ADC and DAC

ADR391 U6
+3V3
+VREF
100n C28
1u/1a C30

Inverting charge pump for opamp negative rails

LM2664 U8
+5V
-5V
10u C32
100n C34
3u3 C40
3u3 C42

Input EMI PI filter fc=80kHz
Overvoltage protection Vmax=40V

+VDC
4u7 L1
1u/50V C3
3u3/50V C4
3u3/50V C5
3u3/50V C9
3u3/50V C11
3u3/50V C13
3u3/50V C53
1u/50V C15
R28 2R2
R29 2R2
R13 10K
BZT52C16 D16
1K R45
DNP C22
BZT52C39 D4
Q5 SQ2361ES
R21 10R
100n/50V C24
R30 47K
BZT52C16 D17
SQ2361ES Q6
R46 1K
+VIN
D10 OKLED
R27 10K
PWR_FLAG

Buzzer for acoustic
indication interface

+5V
BZ1 Buzzer
1K R43
DMN3404L Q9
R44 10K
BUZ
GND

SPI bus isolation wit optional isolation bypass footprints

+3V3
100n C46
100n C47
SCK
SI
SO
SS
U10 ADUM3154
10K R25
DNP R17
DNP R38
DNP R39
DNP R40
DNP R41
U13
U14
TPD2S017
ISO_GND
ISO_VCC
ISO_NCS
ISO_CLK
ISO_MISO
ISO_MOSI
PWR_FLAG
R42 DNP
DNP C57
SH
J6 RJ45_Shielded

!! Non-isolated !!
USB connection

USBEN
R36 10K
Q8 DMP3098L
USBP
USBM
R37 1K5
J7 USB_B
U11 TPD2S017

Main adjustable voltage and current regulator.

Shall be mounted
to heat-sink
U2 LT3086-7
+VIN
3u3/50V C54
100n/50V C6
REG_EN
R5 10K
V_TGET
ILIM
SET
SHDN
TEMP
Iout =
(Viget - Viset) / (3 * 330)
Vin =
Vvinget * 106.8/6.8
Vout =
Vvget * 106.8 / 6.8
+VOUT
3u3/50V C16
3u3/50V C51
3u3/50V C52
3u3/50V C17
10K/.1% R11
100K/.1% R14
6K8/.1% R15
D12 SMCJ51A
10n/100V C55
U3B AD8672
100R R10
V_VGET
BZT52C3V3 D14
V_IGET
100R R1
R31 20K/.1%
R32 10K/.1%
U1B AD8672
BZT52C3V3 D13
100n C58
V_ISET
R2 20K/.1%
R3 10K/.1%
Viset =
Iout * - 0.99 + 2.4
U1A AD8672
330R/.1% R6
1K R7
1n C7
100n C1
100n C2
-5V
Vvset =
Vout * -0.06 + 2.454
R12 100R/.1%
R18 10K/.1%
2K/.1% R16
V_VSET
U3A AD8672
100n C18
100n C19
OPA330xxDBV U12
R33 100K/.1%
R34 6K8/.1%
100n C50
100R R35
47K R47
V_VINGET
100n C59
BZT52C3V3 D11

U9
STM32F373RCTx
Conn_01x04 J8
SWD
SWC
NRST
BOOT0
18p/C0G C36
8M Y1
18p/C0G C37
OSC_IN
OSC_OUT
4*100n C33
VREF+
VREFSD+
VBAT
VDD
VDDA
VDDSD
VSS
VSSA
VSSSD
100n C35
100n C38
100n C39
100n C41
100n C43
100n C44
100n C45
+VREF
PA0 FAN
PA1
PA2
PA3
PA4 V_ISET
PA5 V_VSET
PA6 DISCHARGE
PA7 SELIN
PA8
PA9
PA10
PA11 USBM
PA12 USBP
PA15
PD2
PD8
PB0 V_VGET
PB1 V_TGET
PB2 V_IGET
PB14 MODE
PB15 COOP
PC1 BUZ
PC5 REG_EN
PC6 SS
PC7 SCK
PC8 SO
PC9 SI
PF6 USBEN
PE8
PE9 V_VINGET

Parameter table:
Operating temperature 0°C – 40°C
Operating environment 20% – 80%RH, non-condensing
Dual switchable power input up to 24VAC or 34VDC +-10%
5A slow-blow fuse
Transient voltage protection
On-demand input filtering capacitors discharge
Input EMI PI filter fc = 80kHz
Reverse voltage protection
Input overvoltage protection Vprot = 40V, Vfuseblow = 51V
ESD protection on all external inputs/outputs+-8kV contact

Heat-sink temperature sensing
PWM fan control with PID+FeedForward regulation
Over-temperature shutdown

Linear voltage regulator
Output voltage 1V – 38V, 10mV steps
Output current 0A – 2.2A, 1mA steps
Output time constant TODO

USB CDC and Isolated SPI interface

Failure mode indications (FMIs):
Low supply voltage
High supply voltage
Ripple on voltage supply
Overload
Overtemperature
Invalid output voltage
Ripple on output voltage

Test plan:
Switch on/off:
Period = 5s; Duty = 50%; Cycles = 100x @ 0°C, 100x @ 40°C; Vout = 12V; Rload = 12R;
Criteria: Survives; No Vout spikes (single period oscillogram);
Result: TODO
Input voltage rising and falling:
Slope: 1V/s; Vmin = 0V; Vmax = 60V; Vout = 12V; Rload = 12R;
Criteria: Survives; Monitor Vin, Vout, Iout, Temp; Overvoltage shutdown reacts at 40V;
Result: TODO
Temperature characterization:
Voltage steps 3V, 5V, 12V, 16V, 24V, 32V; Current steps: 0A (open), 0.1A, 0.5A, 1A, 2A;
Temperatures: 0°C, 20°C, 40°C; Stay time: 30s; Readout at 1s, 15s, 30s
Criteria: Get full characterization matrix for calibration;
Max load:
Vout = 5V; I_load = 2A; Stay time = 1h
Criteria: Temperature of heatsink below 125°C
Status: TODO
Vout ripple:
Vout = 5V, 12V, 24V, 32V; Iout = 0.1A, 1A, 2A; Tambient = 25°C
Criteria: voltage ripple values
Status: TODO

Power tracks shall be routed through bypass capacitors into IC
Bypass capacitors shall be sorted by capacitance, smallest being closest to IC
Electrolytic bulk capacitors shall be mounted away from heat sources
Keep the external connections and ESD protection close to each other, separated from unprotected lines

Calculations
file646C8F96.sch

Ing. Stanislav Subrt

Sheet: /
File: Dev.sch

Title: Power supply unit

Size: A3	Date: 2019-01-02	**Rev: 3**
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'Input parameters
Voutmin=1V
?Voutmin = 1 V
Voutmax=32V
?Voutmax = 32 V
Iset=50e-6A
?Iset = 50 µA

'Rset calculation
Rsetoptimal=(Voutmin-0.4V)/Iset?'Optimal resistance may be different from what is available
?Rsetoptimal = 12 kOhm
Rset=10kOhm????'Chosen Rset value
?Rset = 10 kOhm
Voutminreal=0.4V+Rset*Iset
?Voutminreal = 0.9 V

'Rlow calculation
Rlowoptimal=Rset*0.4V/(Voutmax-0.4V-Rset*Iset)?'Optimal resistance may be different from what is available
?Rlowoptimal = 0.128617363 kOhm
Rlow=130Ohm
?Rlow = 130 Ohm
Voutmaxreal=0.4V+Rset*Iset+Rset*0.4V/Rlow
?Voutmaxreal = 31.669230769 V

'Transfer function of Vlow to Vout
Vlow(Vout)=0.4V-(Vout-Voutminreal)*(0.4V)/(Voutmaxreal-Voutminreal)
?Function Vlow(Vout) is defined

Divider=12kOhm/2kOhm
?Divider = 6
A=Divider*-1*(0.4V)/(Voutmaxreal-Voutminreal)
?A = -0.078
B=Divider*(0.4V+Voutminreal*(0.4V)/(Voutmaxreal-Voutminreal))
?B = 2.4702 V
Vvset(Vout)=A*Vout+B
?Function Vvset(Vout) is defined

'Input parameters
Ioutmin=0
?Ioutmin = 0
Ioutmax=2.5A
?Ioutmax = 2.5 A
Vilim=0.8V
?Vilim = 0.8 V
'Current limit set resistor
Riset=1000*Vilim/Ioutmax
?Riset = 320 Ohm
Riset=330Ohm
?Riset = 330 Ohm
Ioutmaxreal=1000*Vilim/Riset
?Ioutmaxreal = 2.424242424 A
Vx(Iout)=Vilim-Iout*Vilim/Ioutmaxreal
?Function Vx(Iout) is defined
Viset(Iout)=2.4V-0.99Ohm*Iout?'Takes voltage divider before opamp into account
?Function Viset(Iout) is defined

Sheet: /Calculations/
File: file646C8F96.sch

Title:

Size: A4	Date:	**Rev:**
KiCad E.D.A. kicad (5.0.2)-1		Id: 2/2