PAGE-0: OVERVIEW
PAGE-1: POWER SUPPLY
PAGE-2: MCU + KEYS
PAGE-3: CONSTANT CURRENT ADC
PAGE-4: MOTOR + FAN DRIVER
PAGE-5: PHYSICAL CONNECTORS

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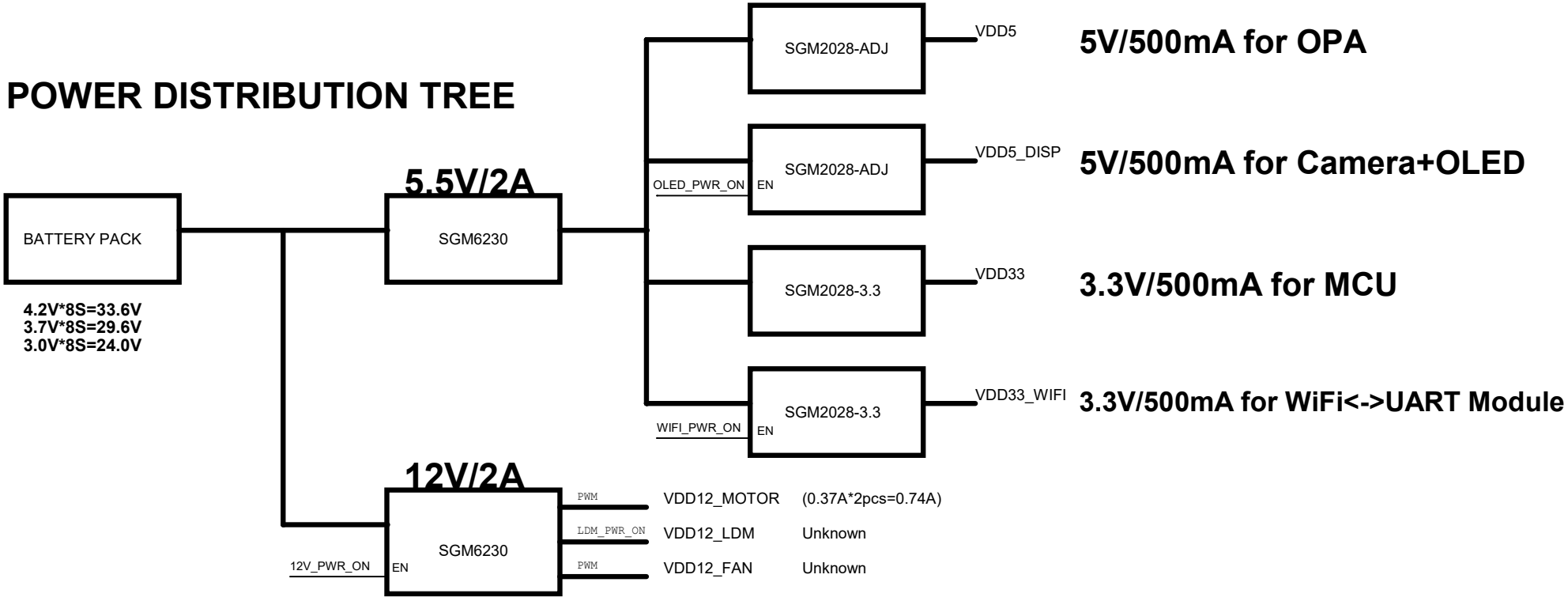
POWER DISTRIBUTION TREE



Title	0-OVERVIEW	
Size A	Document Number FLASH LIGHT	Rev A2
Date: Thursday, June 02, 2022	Sheet 0 of 6	

18650 Battery Pack (3.7V~4.2V)*8S=29.6V~33.6V

The charging cut-off voltage of the 3.7V battery is 4.2V and the discharge cut-off voltage is 3.0V.
4.2V*8S=33.6V, 3.7V*8S=29.6V, 3.0V*8S=24.0V

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The minimum current of zener is 1mA,
but we use 1.5mA in calculations to ensure its in Zener mode completely.

VEN=2K/(20K+2K)*Vin=2.69V~3.0545V

Pre-Power Supply 4.7V@10mA

I=Iz+ILoad (Suppose Iz=1.5mA, Predict ILoad=10.5mA)
(Umin-4V7)/12mA <R< (Umax-4V7)/12mA
(24.0-4.7)/12mA <R< (33.6-4.7)/12mA
1608 <R< 2408
Here choose E96,1%,2K-OHMS

OVC>1A

Izk=1mA
(Umin-4.7)/1mA < R < (Umax-4.7)/1mA
(24-4.7)/1mA < R < (33.6-4.7)/1mA
19.3K < R < 28.9K
Mid-Point: (29.6-4.7)/1mA=24.9K
Waster current I=29.6V/24.9K=1.2mA

Disable in low-power-consumption requirements.

UVP<24V

Izk=1mA
(Umin-24)/1mA < R < (Umax-24)/1mA
(24.1-24)/1mA < R < (33.6-24)/1mA
100 < R < 9600
Mid-Point: (29.6-24)/1mA=5600

OVP>36V
Action Voltage: 38V

Izk=1mA
(38-36)/1mA=2K-Ohms

VEN<6V

I=1mA
(Umin-24V)/10mA < R < (Umax-24V)/10mA
Umin=24.0V Umax=33.6V
(24.0-24.0)/10mA < R < (33.6-24.0)/10mA
0 < R < 960

Here choose E96,1%,825-ohms
Verification:
(33.6-24)/825=11.6mA
(29.6-24)/825=6.8mA
(25-24)/825=1.2mA
(24.1-24)/825=0.12mA

Equation: R1=R2*(Vout/1.206V-1)
Choose R2=47.5K-ohms
So,R1=47.5k*(5V/1.206V-1)=149.432k
We choose 150k from EIA E96 resistor codes,
So verification below
Vout=1.206*(R1/R2+1)=5.01442V

Over Current Indicator

Under Voltage Indicator

Over Voltage Indicator

VIH=0.75Vcc(MIN)=3.525V
VIL=0.25Vcc(MAX)=1.175V

Izk=1mA
(6.8-4.7)/1.5mA=1.4K

I=Izk+ILoad (Izk=1mA,ILoad=3mA)
(Umin-6.8)/4mA < R < (Umax-6.8)/4mA
4.3K < R < 6.7K
Mid-Point: (29.6-6.8)/4mA=5.7K

Izk=1mA
(24.1-4.7)/1mA=19.4K-Ohms
(33.6-4.7)/1mA=28.9K-Ohms

R44 DNP E96,1% R0402: f=0.8/RC
we expect 5Hz frequency, so choose R=100K-OHMS, then
5Hz=0.8/(100K*C)
C=0.0000016F=1.6uF
choose 1.5uF from EIA E96,1%
verification below:
f=0.8/(100K*1.5uF)=0.8/0.15=5.33Hz

5V/500mA
Camera+OLED

3.3V/500mA
MCU On-board

3.3V/500mA
WiFi<->UART Module

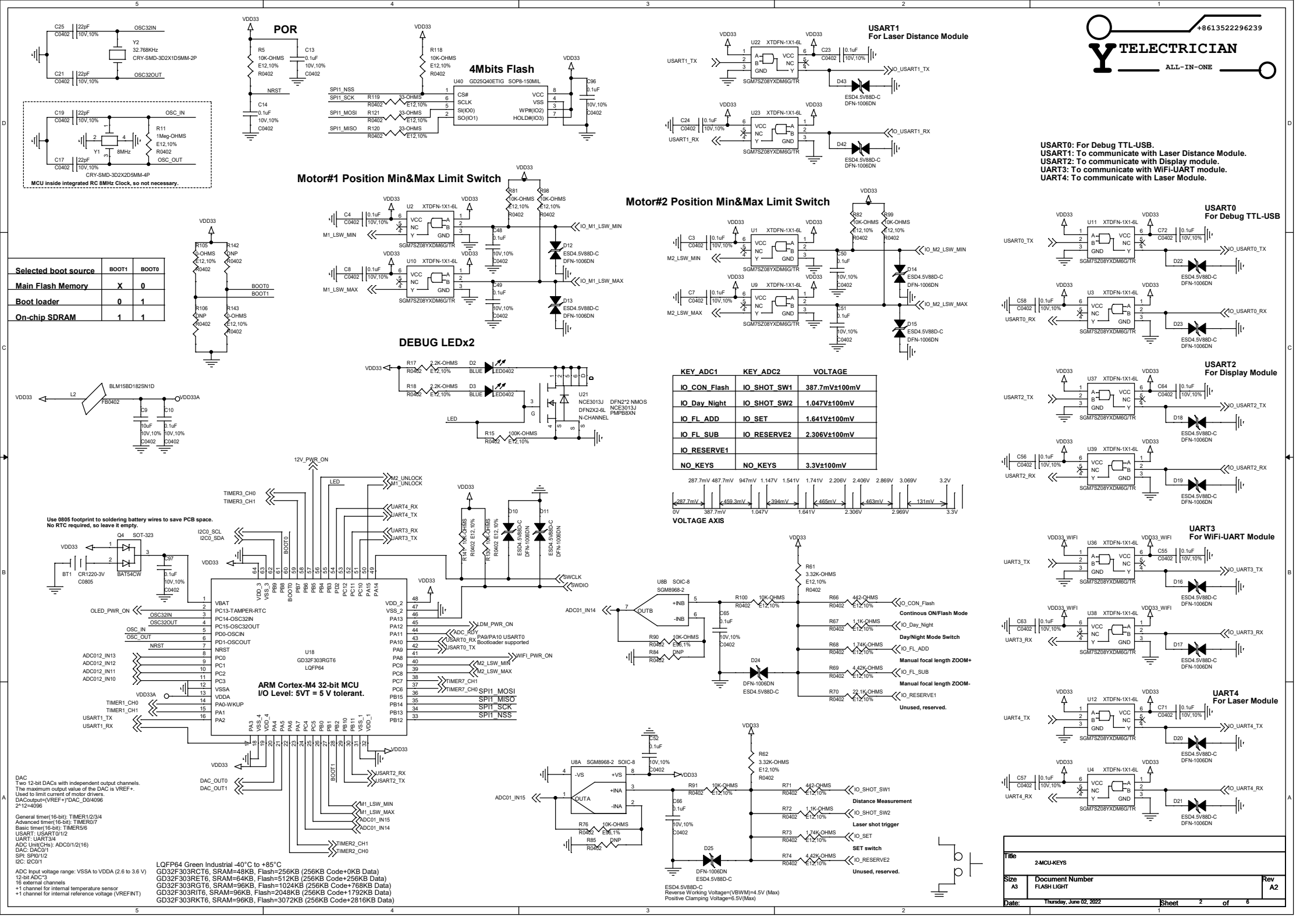
(0.37A*2pcs=0.74A)
12V/2A

VFB=0.8V=(2.37K/(33.2K+2.37K))*Vout
Vout=12V

VFB=0.8V=(5.62K/(33.2K+5.62K))*Vout
Vout=5.5V

500mA, Ultra-Low Dropout,Low Power, RF Linear Regulator
Input Voltage: 2.5V(Min)~5.5V(Max)
Dropout Voltage
54~90mV(Max)@Iout=100mA
162~270mV(Max)@Iout=300mA
270~420mV(Max)@Iout=500mA

Title: 1-POWER-SUPPLY		
Size: A3	Document Number: FLASH LIGHT	Rev: A2
Date: Thursday, June 02, 2022	Sheet 1 of 6	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POR
4Mbits Flash
USART1
For Laser Distance Module
USART0: For Debug TTL-USB.
USART1: To communicate with Laser Distance Module.
USART2: To communicate with Display module.
UART3: To communicate with WiFi-UART module.
UART4: To communicate with Laser Module.
Motor#1 Position Min&Max Limit Switch
Motor#2 Position Min&Max Limit Switch
DEBUG LEDx2
USART0
For Debug TTL-USB
USART2
For Display Module
UART3
For WiFi-UART Module
UART4
For Laser Module
Selected boot source | BOOT1 | BOOT0
Main Flash Memory | X | 0
Boot loader | 0 | 1
On-chip SDRAM | 1 | 1
KEY_ADC1 | KEY_ADC2 | VOLTAGE
IO_CON_Flash | IO_SHOT_SW1 | 387.7mV±100mV
IO_Day_Night | IO_SHOT_SW2 | 1.047V±100mV
IO_FL_ADD | IO_SET | 1.641V±100mV
IO_FL_SUB | IO_RESERVE2 | 2.306V±100mV
IO_RESERVE1
NO_KEYS | NO_KEYS | 3.3V±100mV
VOLTAGE AXIS
Use 0805 footprint to soldering battery wires to save PCB space.
No RTC required, so leave it empty.
ARM Cortex-M4 32-bit MCU
I/O Level: 5VT = 5 V tolerant.
U18
GD32F303RGT6
LQFP64
DAC
Two 12-bit DACs with independent output channels.
The maximum output value of the DAC is VREF+.
Used to limit current of motor drivers.
DACoutput=(VREF+)*DAC_D0/4096
2^12=4096
General timer(16-bit): TIMER1/2/3/4
Advanced timer(16-bit): TIMER0/7
Basic timer(16-bit): TIMER5/6
USART: USART0/1/2
UART: UART3/4
ADC Unit(CHs): ADC0/1/2(16)
DAC: DAC0/1
SPI: SPI0/1/2
I2C: I2C0/1
ADC Input voltage range: VSSA to VDDA (2.6 to 3.6 V)
12-bit ADC*3
16 external channels
+1 channel for internal temperature sensor
+1 channel for internal reference voltage (VREFINT)
LQFP64 Green Industrial -40°C to +85°C
GD32F303RCT6, SRAM=48KB, Flash=256KB (256KB Code+0KB Data)
GD32F303RET6, SRAM=64KB, Flash=512KB (256KB Code+256KB Data)
GD32F303RGT6, SRAM=96KB, Flash=1024KB (256KB Code+768KB Data)
GD32F303RIT6, SRAM=96KB, Flash=2048KB (256KB Code+1792KB Data)
GD32F303RKT6, SRAM=96KB, Flash=3072KB (256KB Code+2816KB Data)
ESD5.4V88D-C
Reverse Working Voltage(VBWM)=4.5V (Max)
Positive Clamping Voltage=6.5V(Max)
Title
2-MCU-KEYS
Size A3
Document Number
FLASH LIGHT
Rev A2
Date: Thursday, June 02, 2022
Sheet 2 of 6

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3.3V REF

Short-circuit current=50mA
(Sourcing and sinking)

SOT-23-3 U15
TPR33XX-S3TR

POTENTIOMETER-1#

(5V-3.3V)/1mA=1700
I choose 1.69K from E96,1%.

3-Collector
S8550
1-Base 2-Emitter

hFE: 120~200
VE>VB>VC
IE=IB+IC, IC=B*IB
IE=(VCC-VE)/R=(VCC-V-)/R=(VCC-V+)/R=(5V-3.3V)/1.69K=1mA

Vb
Va
Vout=Vb-Va

5K//3.4K=2.02381e+3

SOIC-14
SGM8968-4
SGM8968-4XS14G/TR
ESD4.5V88D-C
DFN-1006DN

POTENTIOMETER-2#

PT-100 SENSOR

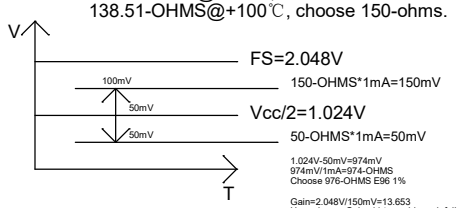
(5V-3.3V)/1mA=1700
I choose 1.69K from E96,1%.

Vb
Va
Vout=Vb-Va

PT100-1
PT100-2

GAIN=11

60.26-OHMS@-100℃, choose 50-ohms.
138.51-OHMS@+100℃, choose 150-ohms.



1.024V-50mV=974mV
974mV/1mA=974-OHMS
Choose 976-OHMS E96 1%

Gain=2.048V/150mV=13.653
Here choose Gain=11 to avoid reach full-scale.
So, 50mV*11=550mV, 150mV*11=1.65V

To avoid reaching the full scale,
here we suppose the maximum voltage is 6V.
So equation calculation below
V=(8.25K/(16.2K+8.25K))*6V=2.025V

2.025V

GAIN=1

SGM58031 (-40℃ to +125℃)
Ultra-Small, Low-Power, 16-Bit ADC with Internal Reference

VDD = 3.3V, Full-Scale (FS) = ±2.048V
Internal Reference=2.048V
Full-Scale Input Voltage Vin=(AIN+)-(AIN-), Type: ±4.096/PGA
Analog Input Voltage AIN+ or AIN- to GND: GND(min)-VDD(max)

LPF f=1/(2*pi*R*C)=159.2Hz

ADDR=GND,So Slave address=1001000

FS=2.048V

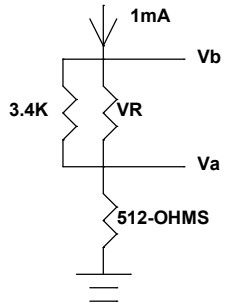
SGM58031XMS10G/TR
MSOP-10
I2C-16BITS-ADC

Standard mode:100kHz
Fast mode :400kHz
High-speed mode:3.4MHz

8uS

When in continuous conversion mode,
he SGM58031 provides a brief (8μs) pulse on the ALERT/RDY pin at the end of each conversion.

When in single-shot shutdown mode,
the ALERT/RDY pin asserts low at the end of a conversion if the COMP_POL bit is set to '0',
and clears ALERT/RDY pin by next conversion.



Differential Floating to avoid ground noise.

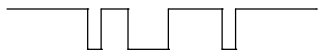
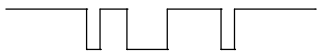
Parallel connect an external resistor to reduce the total resistance below 2K.

FS=2.048V
Gain=2
Pre-Signal=2.048V/2=1.024V
Here I choose Vcc/2 as mid-point to make sure signals swing centered around it, so 1.024V/2=512mV.
So the bottom bias resistor is 512mV/1mA=512-OHMS.

Verification belows:
Va=1mA*512-OHMS=512mV
If VR=2K(maximum value), then Vb=1mA*(2K+512-OHMS)=2.512V, hence Vb-Va=2.512V-512mV=2.0V
If VR=1K(middle value), then Vb=1mA*(1K+512-OHMS)=1.512V, hence Vb-Va=1.512V-512mV=1.0V
If VR=0(minimum value), then Vb=1mA*(0+512-OHMS)=512mV, hence Vb-Va=512mV-512mV=0V

Therefore reset Gain=1.

Title: 3-CONSTANT CURRENT ADC		
Size: A3	Document Number: FLASH LIGHT	Rev: A2
Date: Thursday, June 02, 2022	Sheet 3 of 6	

	CLOCKWISE ROTATE	ANTI-CLOCKWISE ROTATE
IN1		
IN2		

Rotate speed depends on frequency.
Torque depends on duty cycle.

DCU10025P12
Rated Voltage: 12V
No-Load Current: 4.6mA
Maximum continous current: 0.188A
Locked rotor current: 0.37A
Coil resistance: 32.4-OHMS

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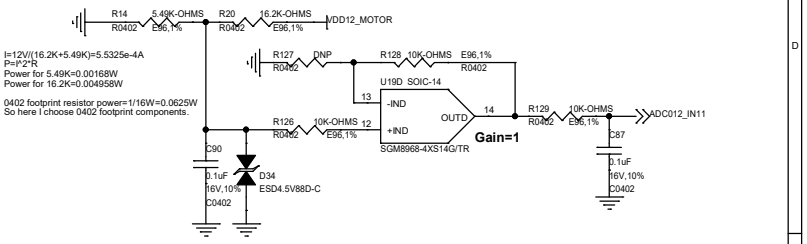
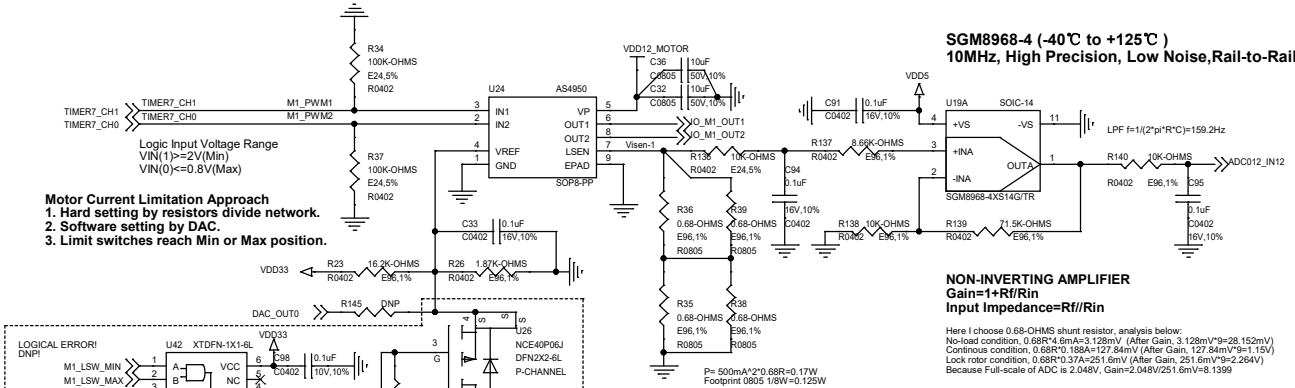
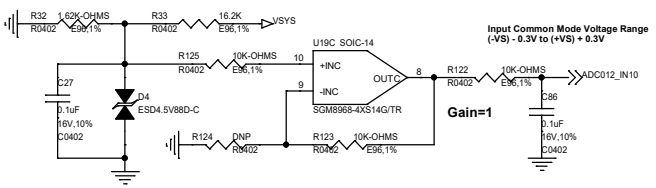
To reach the full scale 3.3V,
here I suppose the maximum voltage is 13V.
So equation calculation below
V=(5.49K/(16.2K+5.49K))*13V=3.29V

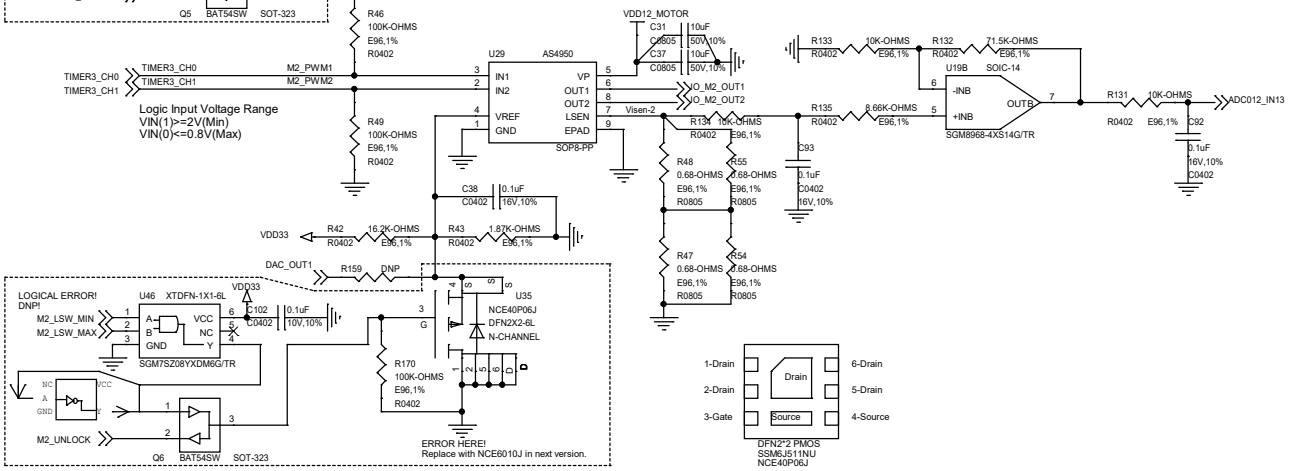


SGM8968-4 (-40℃ to +125℃)
10MHz, High Precision, Low Noise,Rail-to-Rail I/O, CMOS Operational Amplifiers

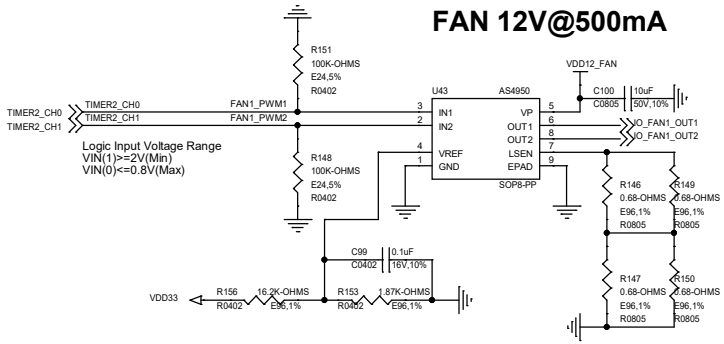


To reach the full scale 3.3V,
here we suppose the maximum voltage is 36V.
So equation calculation below
V=(1.62K/(16.2K+1.62K))*36V=3.273V

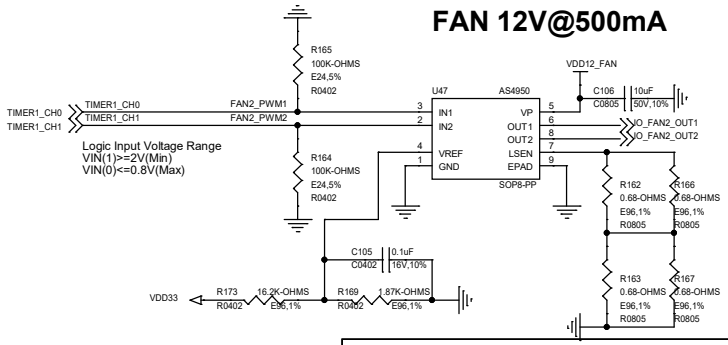




FAN 12V@500mA

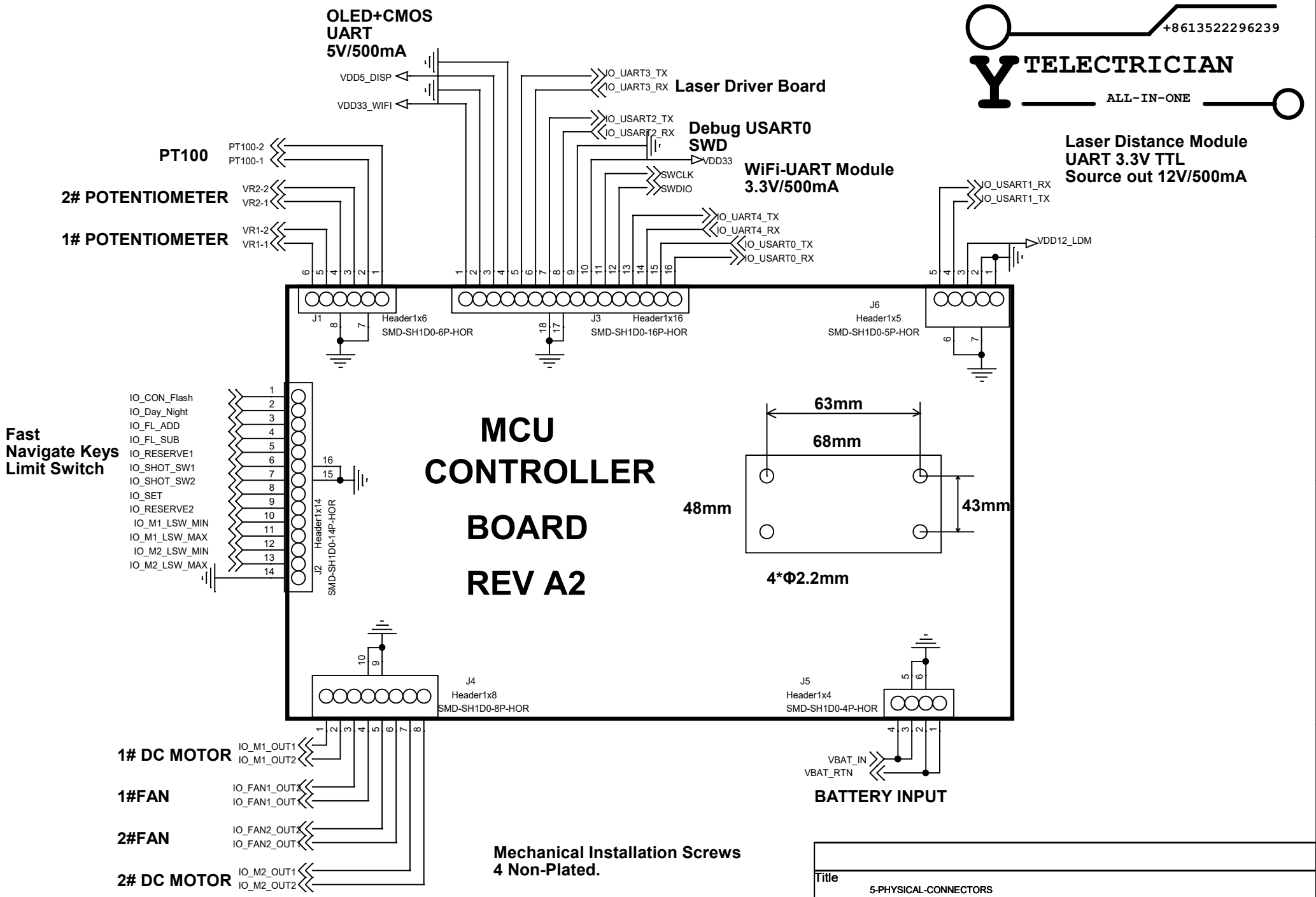


FAN 12V@500mA



IN1	IN2	(Visen*10) > VREF	OUT1	OUT2	Function
0	1	FALSE	L	H	Reverse
1	0	FALSE	H	L	Forward
0	1	TRUE	H/L	L	Chop (mixed decay), reverse
1	0	TRUE	L	H/L	Chop (mixed decay), forward
1	1	FALSE	L	L	Brake (slow decay)
0	0	FALSE	Z	Z	Coast, enters Low Power Standby mode after 1 ms

Title	4-MOTOR+FAN DRIVER	
Size A3	Document Number FLASH LIGHT	Rev A2
Date: Monday, June 06, 2022	Sheet 4 of 6	


OLED+CMOS
UART
5V/500mA
VDD5_DISP
VDD33_WIFI
IO_UART3_TX
IO_UART3_RX
Laser Driver Board
IO_USART2_TX
IO_USART2_RX
Debug USART0
SWD
VDD33
SWCLK
SWDIO
WiFi-UART Module
3.3V/500mA
IO_UART4_TX
IO_UART4_RX
IO_USART0_TX
IO_USART0_RX
IO_USART1_RX
IO_USART1_TX
VDD12_LDM
Laser Distance Module
UART 3.3V TTL
Source out 12V/500mA
PT100
PT100-2
PT100-1
2# POTENTIOMETER
VR2-2
VR2-1
1# POTENTIOMETER
VR1-2
VR1-1
J1
Header1x6
SMD-SH1D0-6P-HOR
J3
Header1x16
SMD-SH1D0-16P-HOR
J6
Header1x5
SMD-SH1D0-5P-HOR
Fast
Navigate Keys
Limit Switch
IO_CON_Flash
IO_Day_Night
IO_FL_ADD
IO_FL_SUB
IO_RESERVE1
IO_SHOT_SW1
IO_SHOT_SW2
IO_SET
IO_RESERVE2
IO_M1_LSW_MIN
IO_M1_LSW_MAX
IO_M2_LSW_MIN
IO_M2_LSW_MAX
J2
Header1x14
SMD-SH1D0-14P-HOR
MCU
CONTROLLER
BOARD
REV A2
63mm
68mm
48mm
43mm
4*Φ2.2mm
J4
Header1x8
SMD-SH1D0-8P-HOR
J5
Header1x4
SMD-SH1D0-4P-HOR
1# DC MOTOR
IO_M1_OUT1
IO_M1_OUT2
1#FAN
IO_FAN1_OUT2
IO_FAN1_OUT
2#FAN
IO_FAN2_OUT2
IO_FAN2_OUT
2# DC MOTOR
IO_M2_OUT1
IO_M2_OUT2
VBAT_IN
VBAT_RTN
BATTERY INPUT
Mechanical Installation Screws
4 Non-Plated.
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TELECTRICIAN
ALL-IN-ONE
Title
5-PHYSICAL-CONNECTORS
Size
A
Document Number
FLASH LIGHT
Rev
A2
Date:
Thursday, June 02, 2022
Sheet
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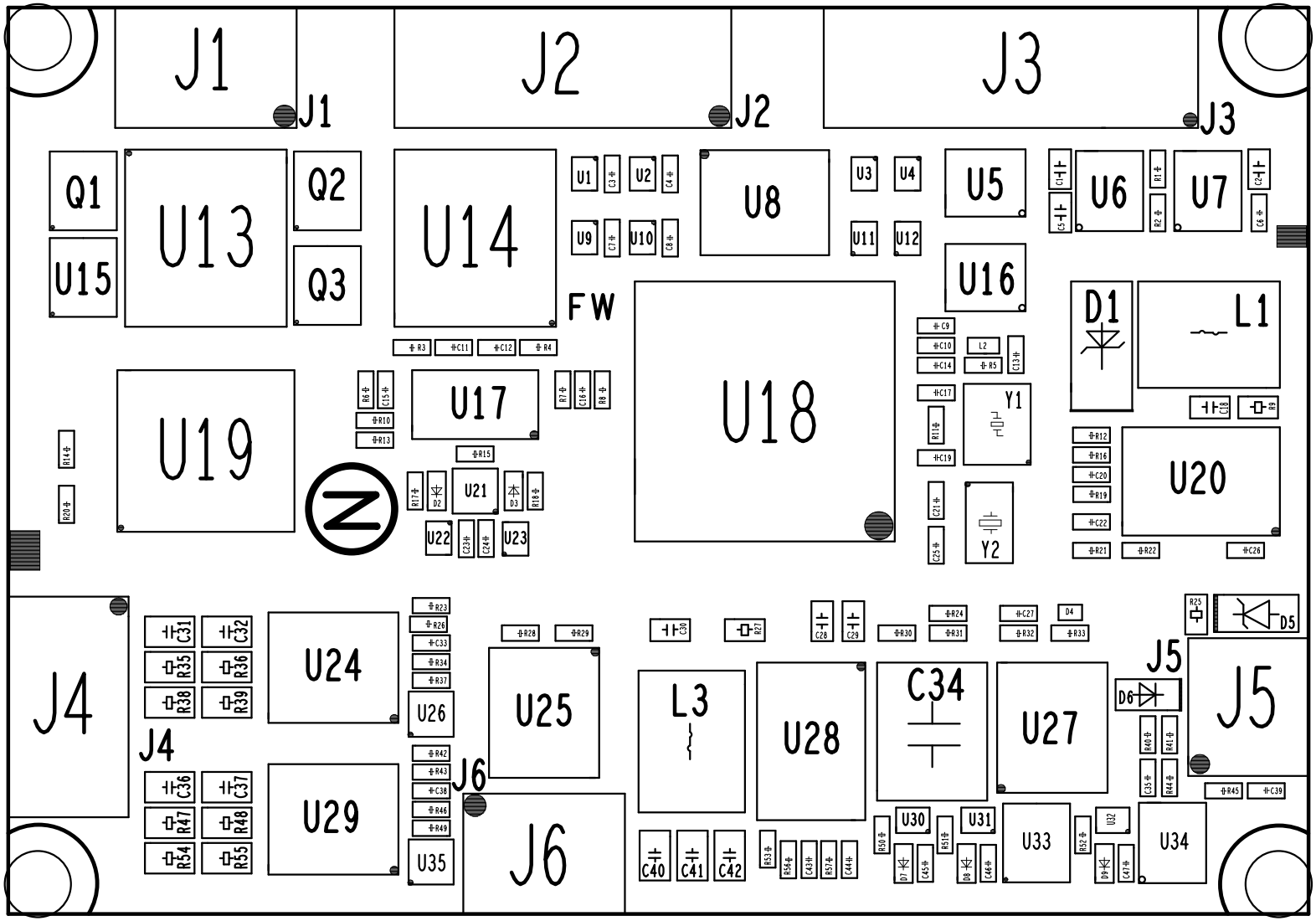
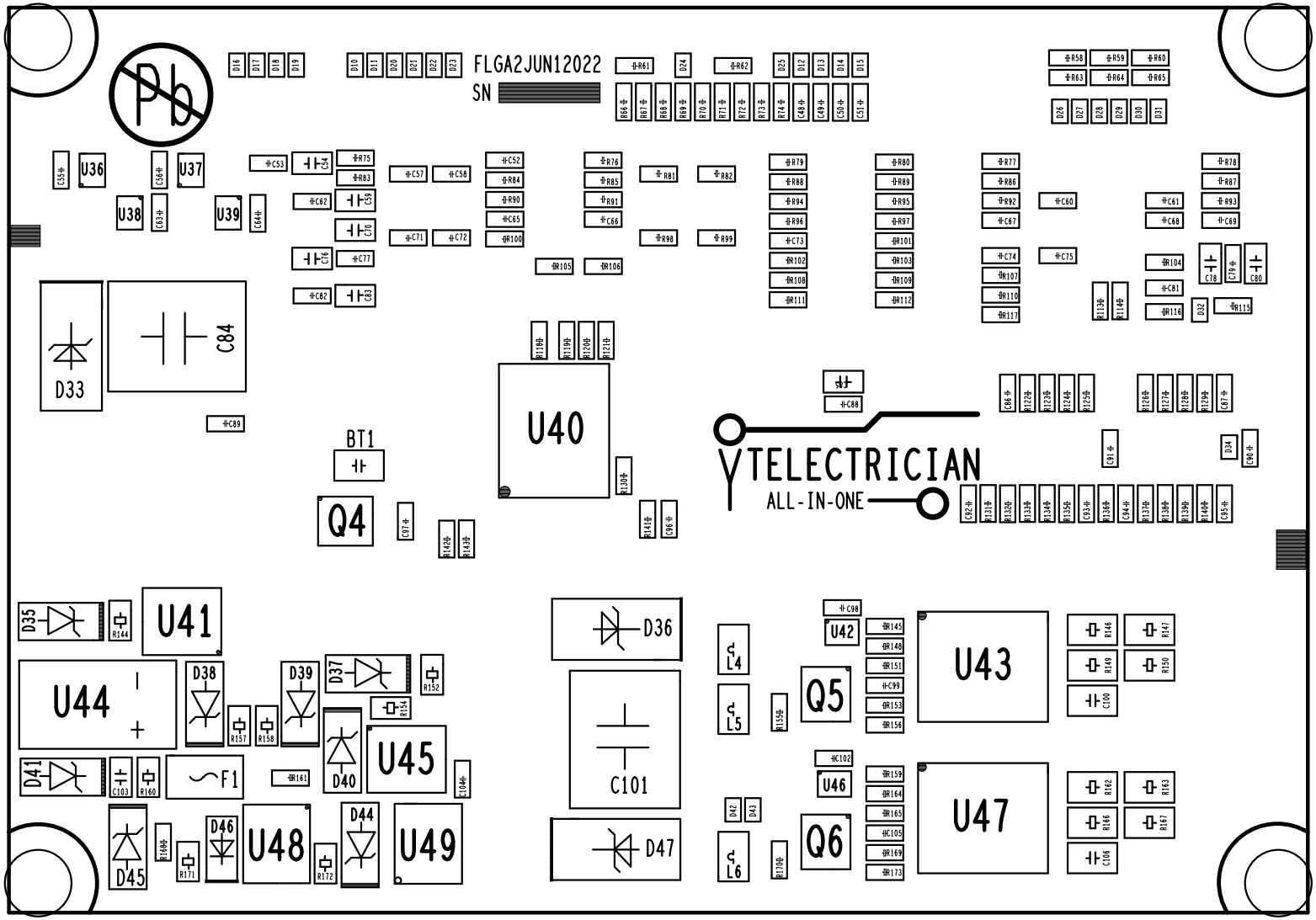
of
6

SILKSCREEN_TOP REFERENCE DESCRIPTION



SILKSCREEN_BOTTOM REFERENCE DESCRIPTION



ASSEMBLY REFERENCE DIAGRAM

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PROJECT:FLASH-LIGHT-GUN-REV-A2

JUNE 1,2022