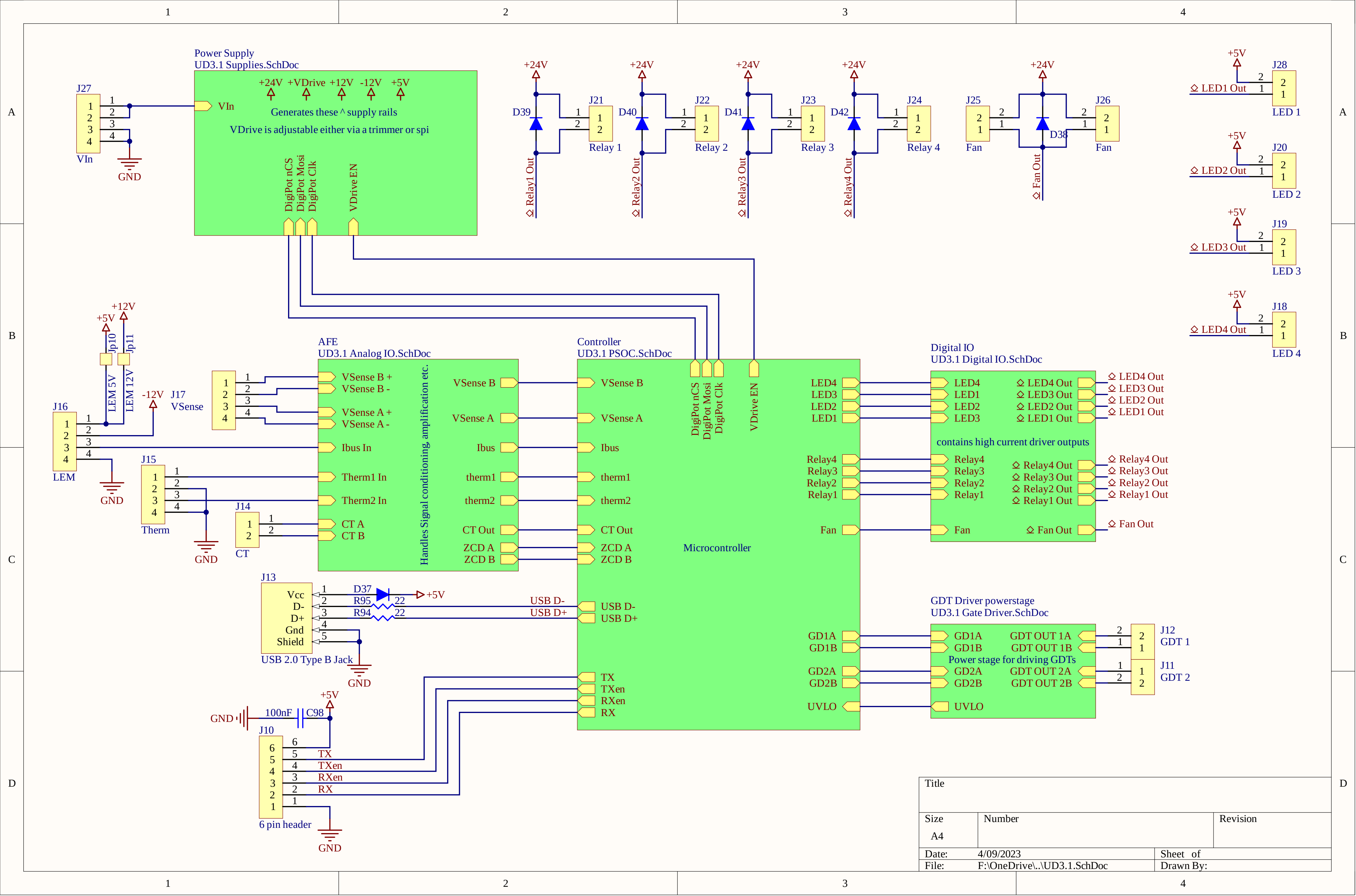

Power Supply
UD3.1 Supplies.SchDoc
+24V +VDrive +12V -12V +5V
Generates these ^ supply rails
VDrive is adjustable either via a trimmer or spi
VIn
DigiPot nCS
DigiPot Mosi
DigiPot Clk
VDrive EN
J27
VIn
GND
D39 D40 D41 D42 D38
J21 Relay 1
J22 Relay 2
J23 Relay 3
J24 Relay 4
J25 Fan
J26 Fan
Relay1 Out
Relay2 Out
Relay3 Out
Relay4 Out
Fan Out
J28 LED 1
J20 LED 2
J19 LED 3
J18 LED 4
LED1 Out
LED2 Out
LED3 Out
LED4 Out
+5V +12V
Jp10 Jp11
LEM 5V
LEM 12V
-12V
J16 LEM
J17 VSense
J15 Therm
J14 CT
AFE
UD3.1 Analog IO.SchDoc
VSense B +
VSense B -
VSense A +
VSense A -
Ibus In
Therm1 In
Therm2 In
CT A
CT B
Handles Signal conditioning, amplification etc.
VSense B
VSense A
Ibus
therm1
therm2
CT Out
ZCD A
ZCD B
Controller
UD3.1 PSOC.SchDoc
Microcontroller
USB D-
USB D+
TX
TXen
RXen
RX
LED4 LED3 LED2 LED1
Relay4 Relay3 Relay2 Relay1
Fan
GD1A GD1B GD2A GD2B
UVLO
Digital IO
UD3.1 Digital IO.SchDoc
contains high current driver outputs
LED4 Out LED3 Out LED2 Out LED1 Out
Relay4 Out Relay3 Out Relay2 Out Relay1 Out
Fan Out
GDT Driver powerstage
UD3.1 Gate Driver.SchDoc
Power stage for driving GDTs
GDT OUT 1A
GDT OUT 1B
GDT OUT 2A
GDT OUT 2B
J12 GDT 1
J11 GDT 2
J13
Vcc D- D+ Gnd Shield
USB 2.0 Type B Jack
D37
R95 22
R94 22
GND
100nF C98
J10
6 pin header
Title
Size A4
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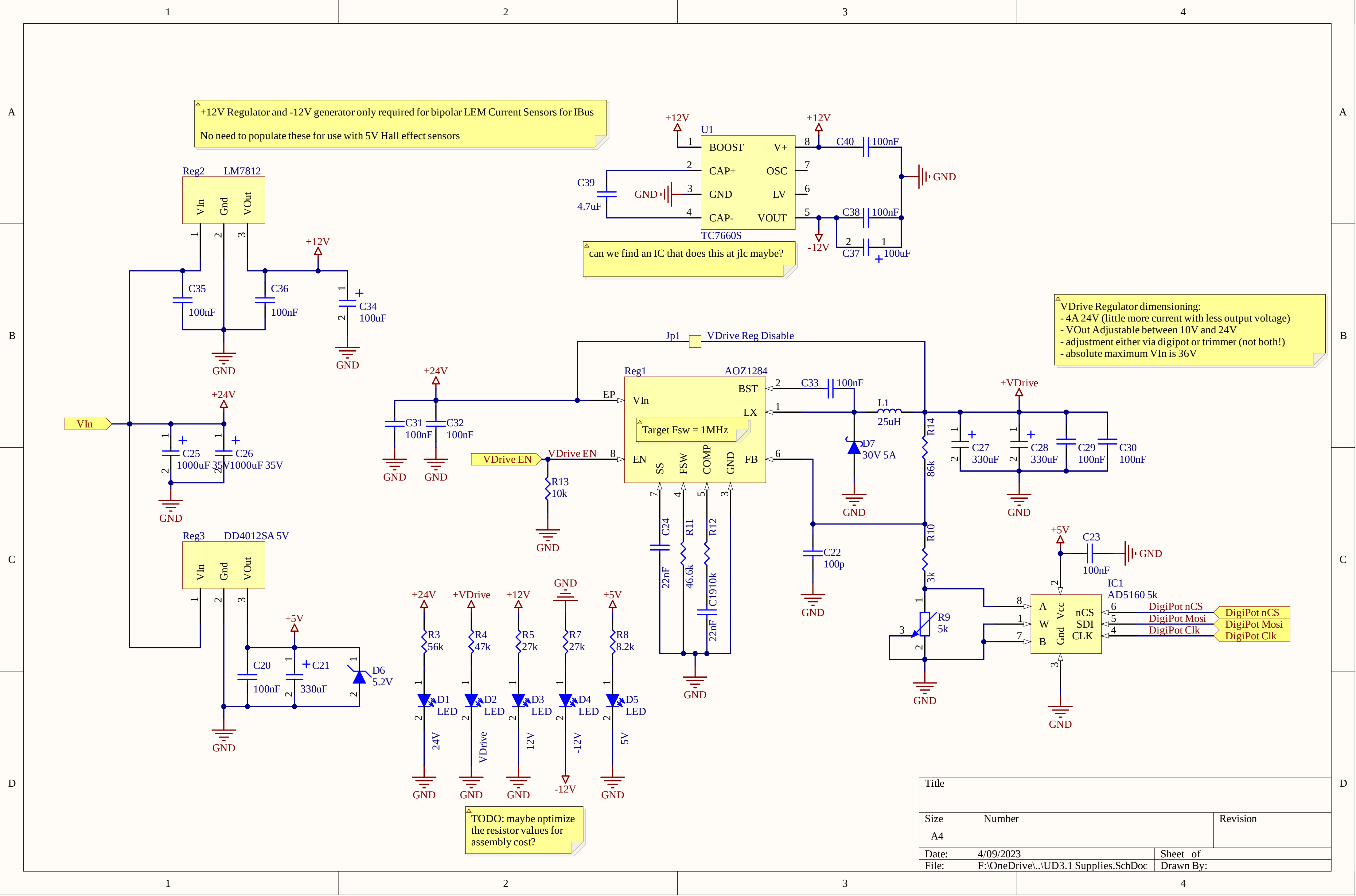

+12V Regulator and -12V generator only required for bipolar LEM Current Sensors for IBus
No need to populate these for use with 5V Hall effect sensors
Reg2 LM7812
VIn Gnd VOut
C35 100nF
C36 100nF
C34 100uF
+12V
GND
+24V
VIn
C25 1000uF 35V
C26 1000uF 35V
Reg3 DD4012SA 5V
C20 100nF
C21 330uF
D6 5.2V
+5V
U1 TC7660S
BOOST V+
CAP+ OSC
GND LV
CAP- VOUT
C39 4.7uF
C40 100nF
C38 100nF
C37 100uF
-12V
can we find an IC that does this at jlc maybe?
VDrive Regulator dimensioning:
- 4A 24V (little more current with less output voltage)
- VOut Adjustable between 10V and 24V
- adjustment either via digipot or trimmer (not both!)
- absolute maximum VIn is 36V
Jp1 VDrive Reg Disable
Reg1 AOZ1284
EP VIn BST LX EN SS FSW COMP GND FB
Target Fsw = 1MHz
C31 100nF
C32 100nF
VDrive EN
R13 10k
C33 100nF
L1 25uH
D7 30V 5A
+VDrive
C27 330uF
C28 330uF
C29 100nF
C30 100nF
R14 86k
R10 3k
C24 22nF
R11 46.6k
R12 1910k
C19 22nF
C22 100p
+5V
C23 100nF
IC1 AD5160 5k
A W B Vcc Gnd nCS SDI CLK
R9 5k
DigiPot nCS
DigiPot Mosi
DigiPot Clk
R3 56k
R4 47k
R5 27k
R7 27k
R8 8.2k
D1 LED
D2 LED
D3 LED
D4 LED
D5 LED
24V
VDrive
12V
-12V
5V
TODO: maybe optimize the resistor values for assembly cost?
Title
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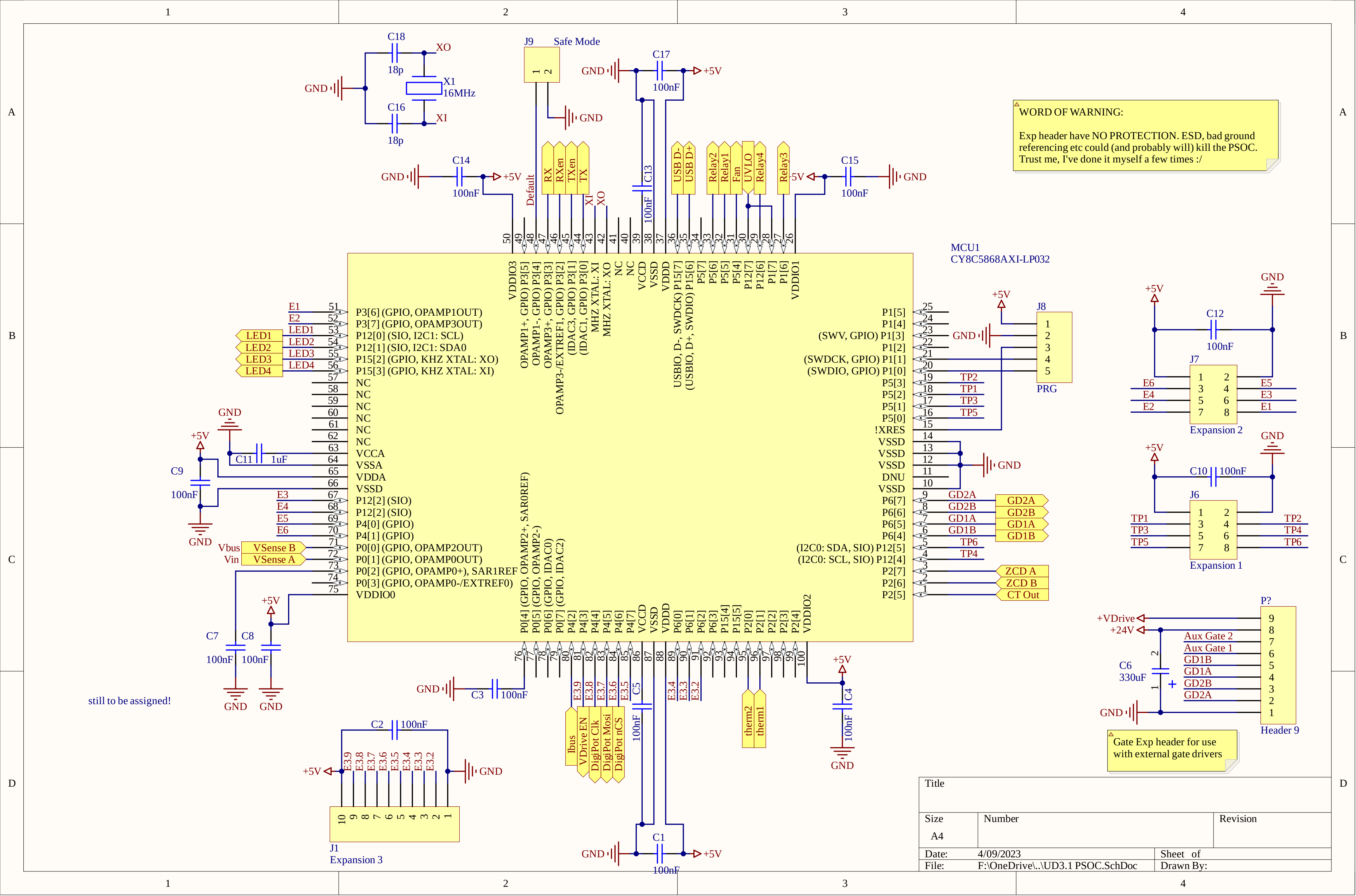

WORD OF WARNING:
Exp header have NO PROTECTION. ESD, bad ground referencing etc could (and probably will) kill the PSOC. Trust me, I've done it myself a few times :/
MCU1
CY8C5868AXI-LP032
J9 Safe Mode
X1 16MHz
C18 18p
C16 18p
XO
XI
C17 100nF
C14 100nF
C15 100nF
C13 100nF
C11 1uF
C9 100nF
C7 100nF
C8 100nF
C3 100nF
C5 100nF
C4 100nF
C1 100nF
C2 100nF
C12 100nF
C10 100nF
C6 330uF
J8 PRG
J7 Expansion 2
J6 Expansion 1
J1 Expansion 3
P? Header 9
+VDrive
+24V
Aux Gate 2
Aux Gate 1
GD1B
GD1A
GD2B
GD2A
RX
RXen
TXen
TX
Default
USB D-
USB D+
Relay2
Relay1
Fan
UVLO
Relay4
Relay3
LED1
LED2
LED3
LED4
VSense B
VSense A
Vbus
Vin
ZCD A
ZCD B
CT Out
Ibus
VDrive EN
DigiPot Clk
DigiPot Mosi
DigiPot nCS
therm2
therm1
TP1
TP2
TP3
TP4
TP5
TP6
E1
E2
E3
E4
E5
E6
E3.2
E3.3
E3.4
E3.5
E3.6
E3.7
E3.8
E3.9
+5V
GND
still to be assigned!
Gate Exp header for use with external gate drivers
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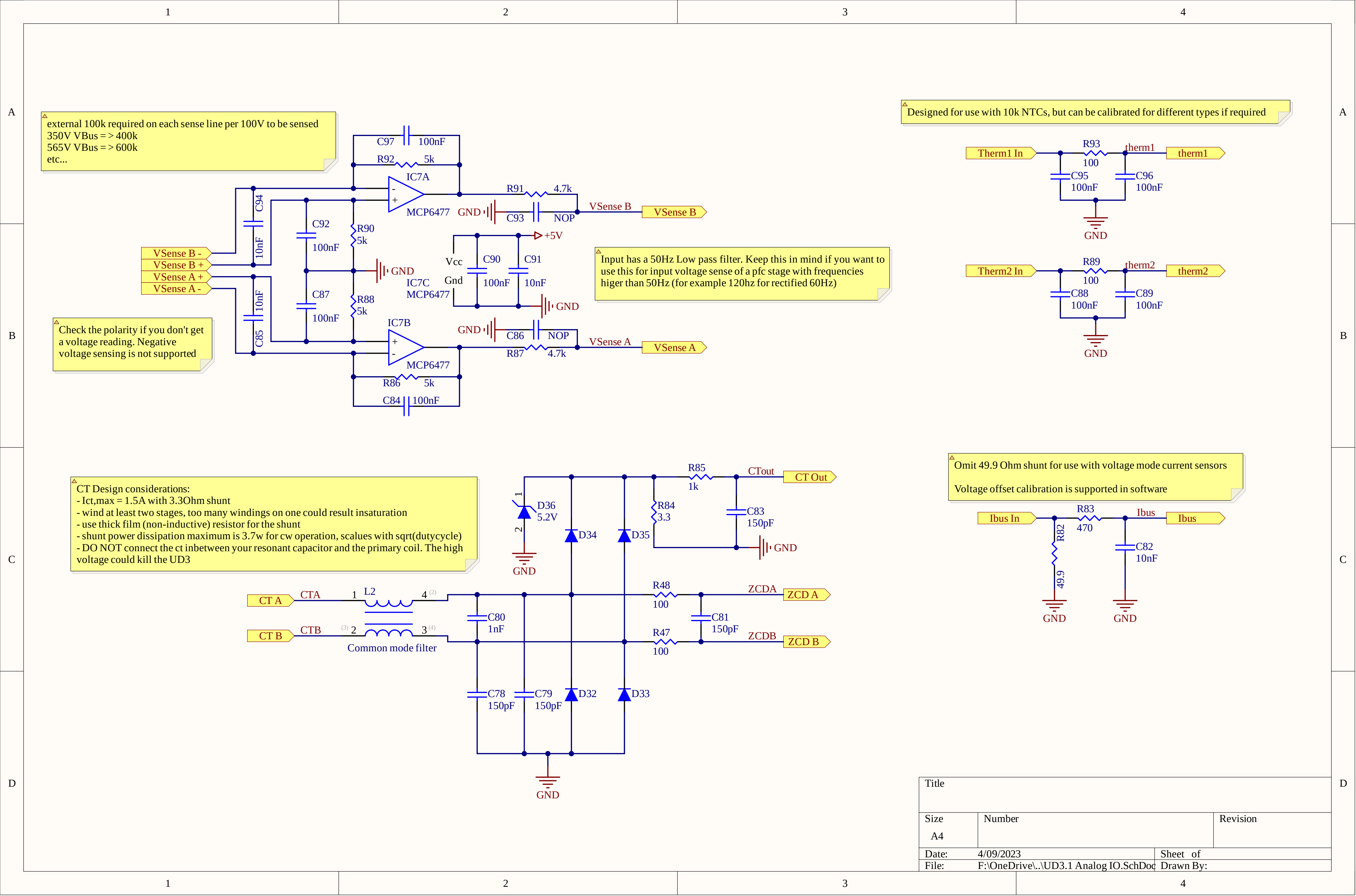

external 100k required on each sense line per 100V to be sensed
350V VBus = > 400k
565V VBus = > 600k
etc...
Check the polarity if you don't get a voltage reading. Negative voltage sensing is not supported
VSense B -
VSense B +
VSense A +
VSense A -
C94 10nF
C85 10nF
C92 100nF
C87 100nF
C97 100nF
R92 5k
IC7A MCP6477
R90 5k
R88 5k
IC7B MCP6477
IC7C MCP6477
Vcc
Gnd
R86 5k
C84 100nF
R91 4.7k
C93 NOP
R87 4.7k
C86 NOP
C90 100nF
C91 10nF
+5V
GND
VSense B
VSense A
Input has a 50Hz Low pass filter. Keep this in mind if you want to use this for input voltage sense of a pfc stage with frequencies higer than 50Hz (for example 120hz for rectified 60Hz)
Designed for use with 10k NTCs, but can be calibrated for different types if required
Therm1 In
R93 100
therm1
C95 100nF
C96 100nF
Therm2 In
R89 100
therm2
C88 100nF
C89 100nF
Omit 49.9 Ohm shunt for use with voltage mode current sensors
Voltage offset calibration is supported in software
Ibus In
R83 470
Ibus
R82 49.9
C82 10nF
CT Design considerations:
- Ict,max = 1.5A with 3.3Ohm shunt
- wind at least two stages, too many windings on one could result insaturation
- use thick film (non-inductive) resistor for the shunt
- shunt power dissipation maximum is 3.7w for cw operation, scalues with sqrt(dutycycle)
- DO NOT connect the ct inbetween your resonant capacitor and the primary coil. The high voltage could kill the UD3
CT A
CTA
CT B
CTB
L2
Common mode filter
D36 5.2V
D34
D35
D32
D33
R84 3.3
R85 1k
CTout
CT Out
C83 150pF
C80 1nF
C78 150pF
C79 150pF
R48 100
R47 100
C81 150pF
ZCDA
ZCD A
ZCDB
ZCD B
Title
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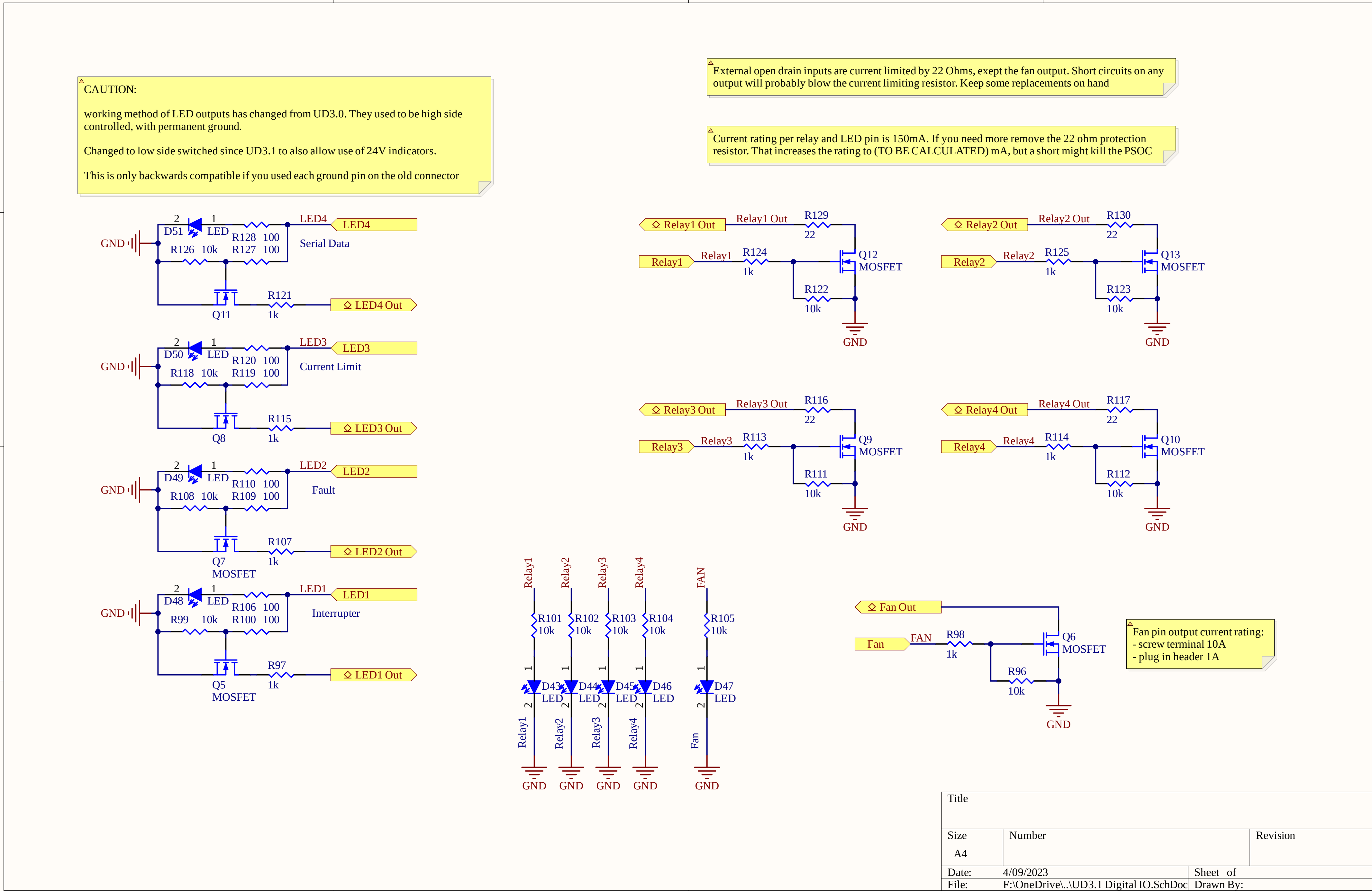
CAUTION:
working method of LED outputs has changed from UD3.0. They used to be high side controlled, with permanent ground.
Changed to low side switched since UD3.1 to also allow use of 24V indicators.
This is only backwards compatible if you used each ground pin on the old connector
External open drain inputs are current limited by 22 Ohms, exept the fan output. Short circuits on any output will probably blow the current limiting resistor. Keep some replacements on hand
Current rating per relay and LED pin is 150mA. If you need more remove the 22 ohm protection resistor. That increases the rating to (TO BE CALCULATED) mA, but a short might kill the PSOC
Fan pin output current rating:
- screw terminal 10A
- plug in header 1A
LED4
Serial Data
LED4 Out
LED3
Current Limit
LED3 Out
LED2
Fault
LED2 Out
LED1
Interrupter
LED1 Out
Relay1 Out
Relay1
Relay2 Out
Relay2
Relay3 Out
Relay3
Relay4 Out
Relay4
Fan Out
Fan
FAN
GND
MOSFET
Title
Size
A4
Number
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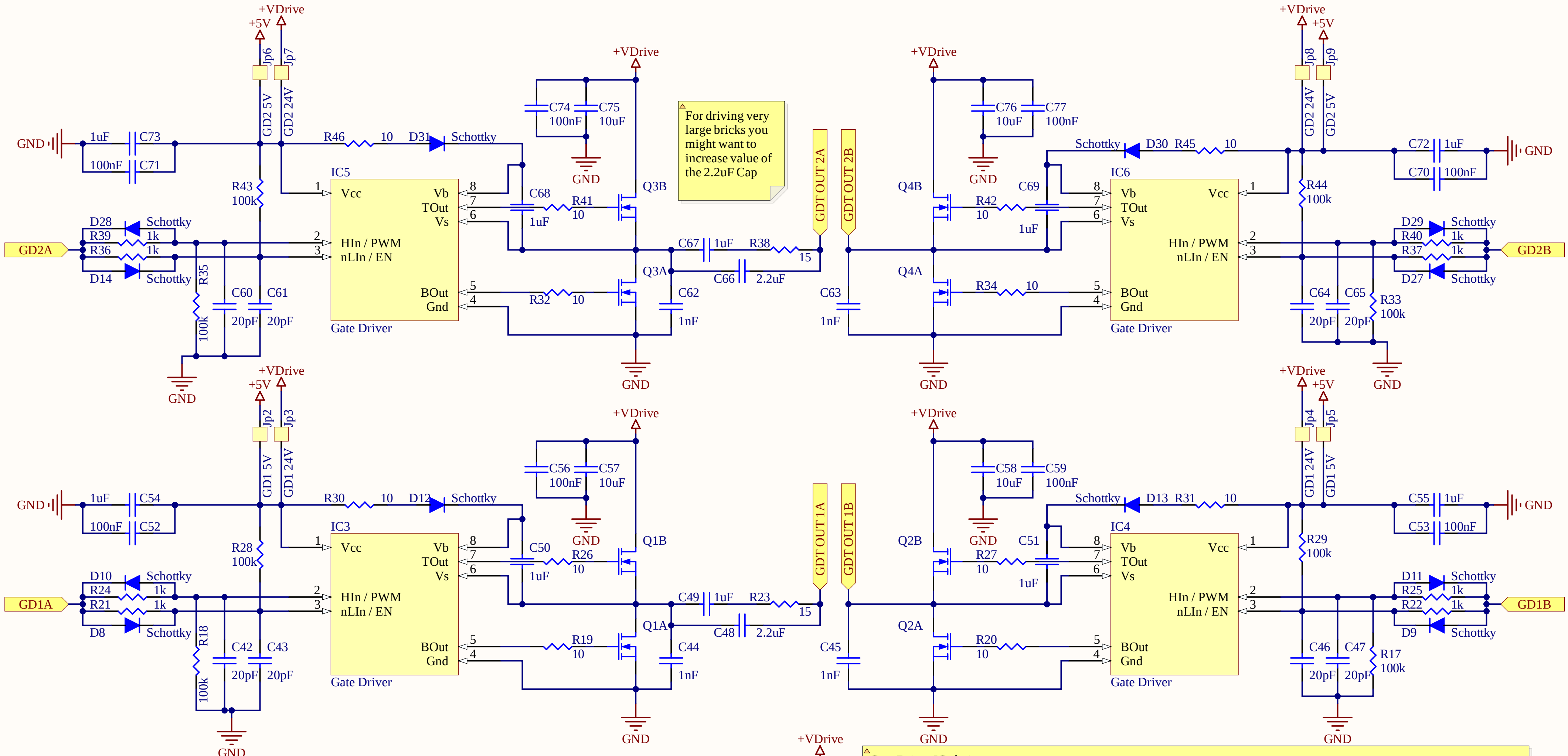


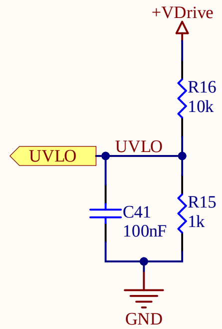


GDT power stage current requirement calculation:

with $I_{charge}(t) = I_{ch}(t) = \frac{U}{R} \cdot e^{-\frac{t}{\tau}}$ and $I_{ch,rms} = \sqrt{\frac{1}{T}\int_T I_{ch}^2\, dx}$

$$
\begin{aligned}
I_{ch,rms} &= \sqrt{\frac{1}{T}\int_T \left(\frac{U}{R}\cdot e^{-\frac{t}{\tau}}\right)^2 dx} \\
&= \sqrt{\frac{1}{T}\cdot\frac{U^2}{R^2}\int_T e^{-\frac{2t}{\tau}}\, dx} \\
&= \sqrt{\frac{U^2}{R^2\cdot T}\cdot\left(-\frac{\tau}{2}\right)\cdot\left[e^{-\frac{2t}{\tau}}\right]_0^T dx} \\
&= \sqrt{-\frac{U^2\cdot\tau}{2\cdot R^2\cdot T}\cdot\left(e^{-\frac{2T}{\tau}} - e^{-\frac{2\cdot 0}{\tau}}\right) dx} \\
\text{with } T >> \tau &= \sqrt{-\frac{U^2\cdot\tau}{2\cdot R^2\cdot T}\cdot(0-1)\, dx} \\
&= \sqrt{\frac{U^2\cdot\tau}{2\cdot R^2\cdot T}\, dx}
\end{aligned}
$$

Mosfet Selection:
You can more or less use any dual N-Fet you can find. I do however recommend you stay at less than 0.5W dissipation per mosfet.

If you don't want to calculate anything (which I totally understand :P) you should go with <50mOhm Rds,on.

Gate Driver IC choice:
You can use most of the Bootstrap drivers available on LCSC. Just make sure that you have:
-either one inverting low input and a not inverting high input OR
-a PWM input

Depending on the chosen Part you will need to fit different support components:
- When the Part doesn't have built in deadtime you will need to fit the schottky diodes as well as capacitors to ground on the input lines
-When using parts with a pwm input you have to omit the resistor between the inpout signal and the enable input of the driver.

| Title | | |
|---|---|---|
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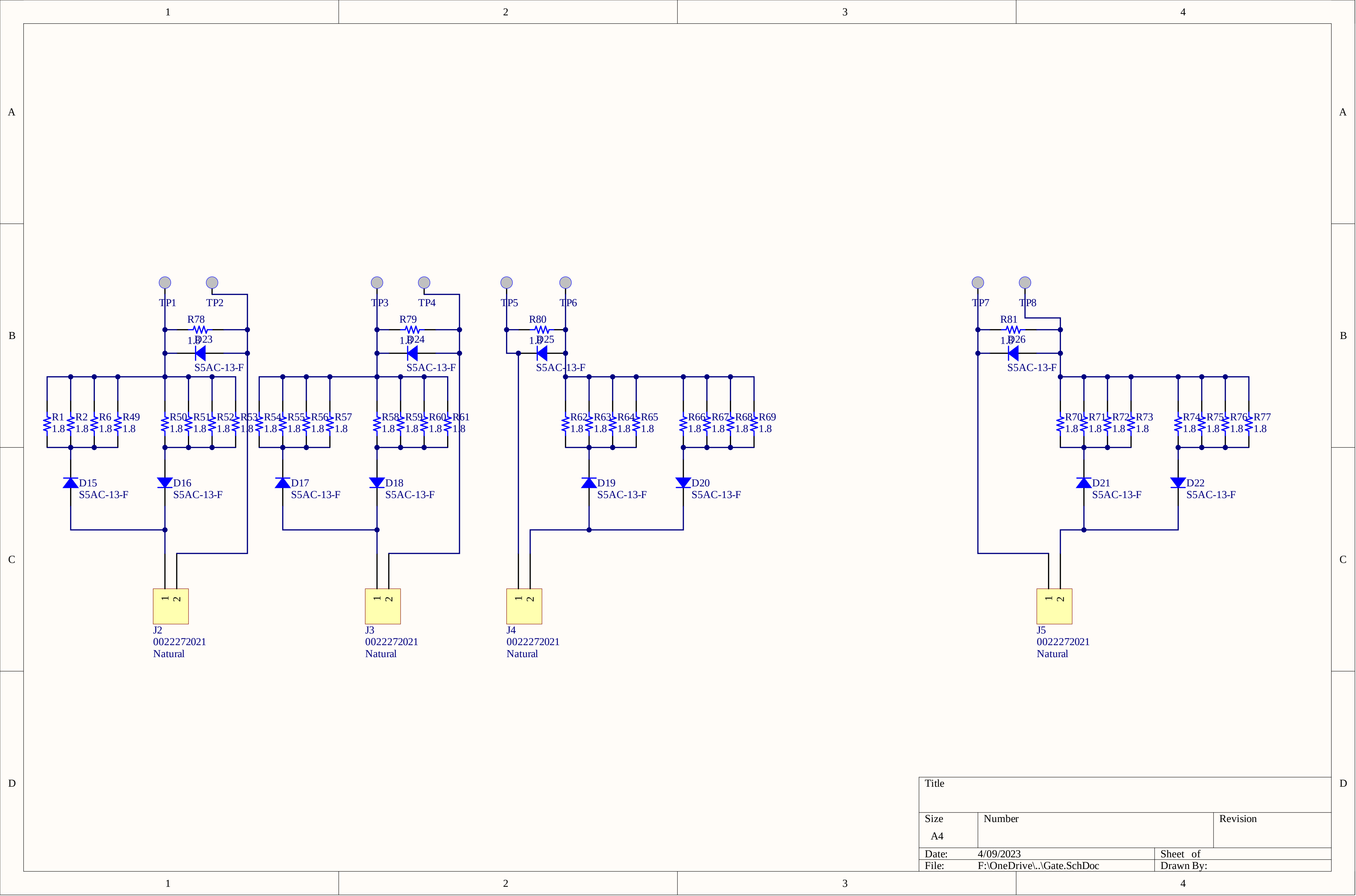

TP1
TP2
R78
1.8
D23
S5AC-13-F
R1 1.8
R2 1.8
R6 1.8
R49 1.8
R50 1.8
R51 1.8
R52 1.8
R53 1.8
D15 S5AC-13-F
D16 S5AC-13-F
J2
0022272021
Natural
TP3
TP4
R79
1.8
D24
S5AC-13-F
R54 1.8
R55 1.8
R56 1.8
R57 1.8
R58 1.8
R59 1.8
R60 1.8
R61 1.8
D17 S5AC-13-F
D18 S5AC-13-F
J3
0022272021
Natural
TP5
TP6
R80
1.8
D25
S5AC-13-F
R62 1.8
R63 1.8
R64 1.8
R65 1.8
R66 1.8
R67 1.8
R68 1.8
R69 1.8
D19 S5AC-13-F
D20 S5AC-13-F
J4
0022272021
Natural
TP7
TP8
R81
1.8
D26
S5AC-13-F
R70 1.8
R71 1.8
R72 1.8
R73 1.8
R74 1.8
R75 1.8
R76 1.8
R77 1.8
D21 S5AC-13-F
D22 S5AC-13-F
J5
0022272021
Natural
Title
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C67
C48
Q3
Q4
Q1
Q2
R15
L3
C93
C82
C13
C14
C15
C16
X1
C17
C18
C9
C10
C11
C12
C1
C2
C3
C4
C5
C6
C7
C8
C98
R94
R95
D37
D38
D39
D40
D41
D42
D1
D2
D3
D4
D5
R3
R4
R5
R7
R8
R9
D6
C19
C20
C21
IC1
C22
R10
C23
C24
R11
R12
R13
C25
C26
C27
C28
C29
C30
R14
C31
C32
L1
C33
Reg1
Jp1
C34
C35
C36
C37
C38
Reg2
C40
J13
J23
J24
J21
J22
J10
J7
J26
Reg3
Q5
D43
D44
D45
D46
D47
R96
R97
Q6
R98
R99
R100
R101
R102
R103
R104
R105
R106
D48
Q7
R107
R108
R109
R110
D49
R111
R112
Q8
Q9
Q10
R113
R114
R115
R116
R117
R118
R119
R120
D50
Q11
R121
R122
R123
Q12
Q13
R124
R125
R126
R127
R128
D51
R129
R130
J25
J9
J8
J6
MCU1
P1
J11
J12
J15
J14
J1
D7
U1