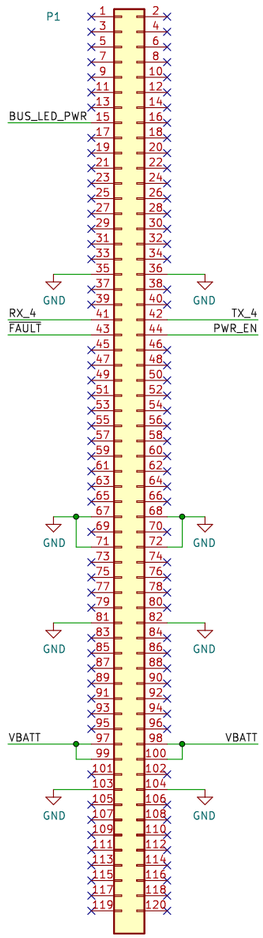
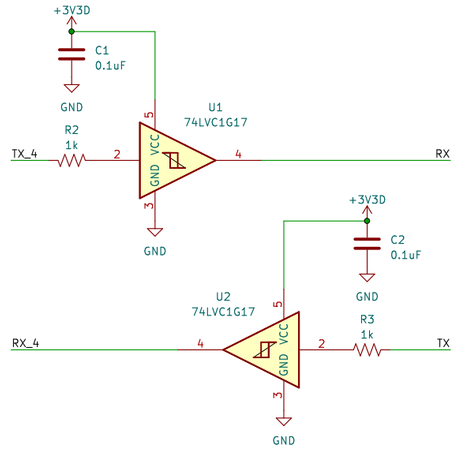
## EDGE CONNECTOR

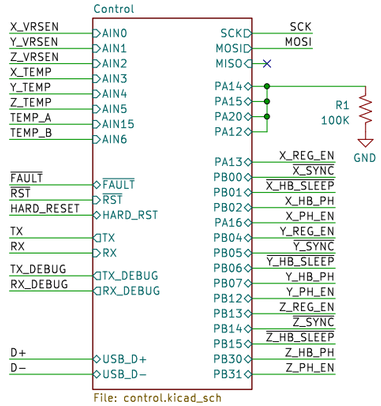



## VERIFY CONNNECTOR

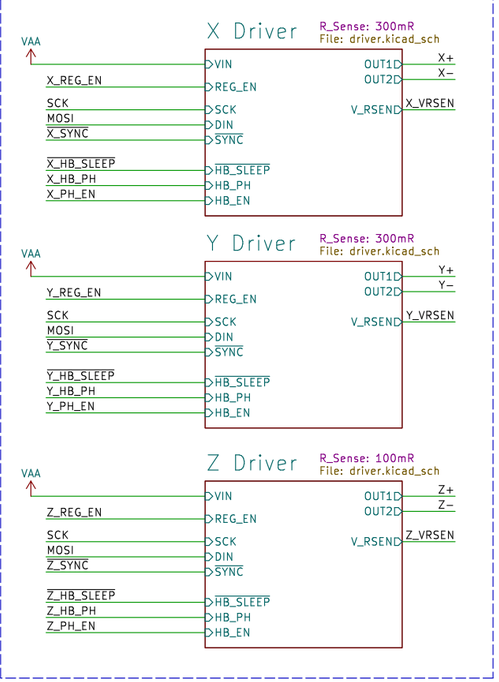
## UART BUFFER



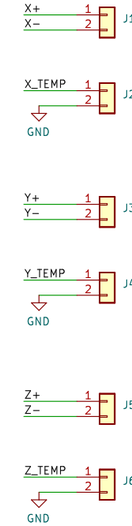

## MTQ CONTROLLER




## MTQ DRIVERs



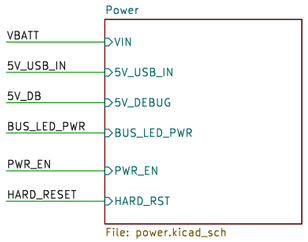

## CONNECTORS TO MTQs




## POWER

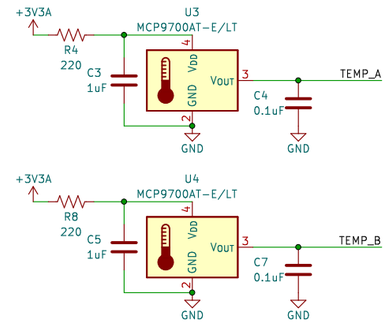
VBATT (7.2–8.4V) main power input
Feeds all subsequten domains through LDOs

5V_USB & 5V_DEBUG is diode OR'd to VAA
for programming/debug power.

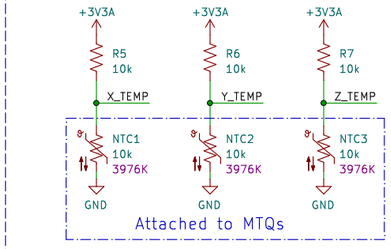



## TEMP SENSORS

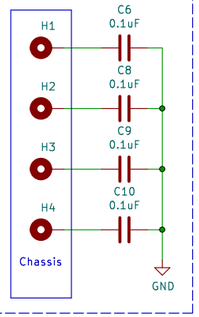
–40–125degC operational
VOUT=10mV/degC, 500mV offset
6uA quiesent



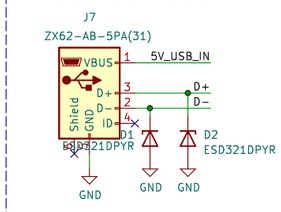

## NTC BIAS

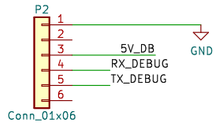


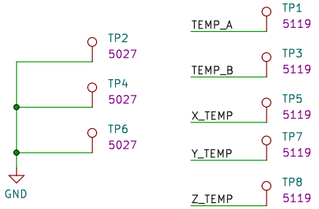

## Mounting Holes




## USB Connector




**TECHNOLOGY DEVELOPMENT & ENGINEERING CENTER EAST**
11401 HOOVER ROAD, MILAN, OHIO 44846

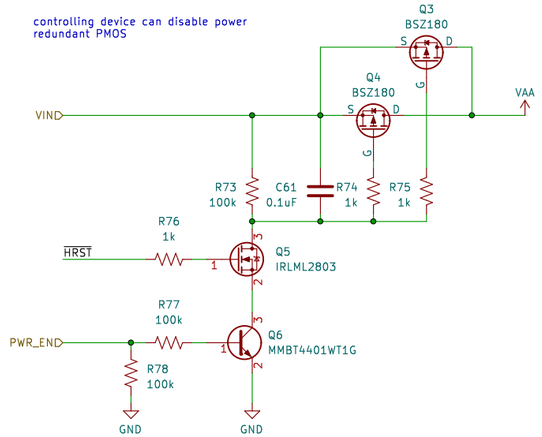
TITLE: SCHEMATIC, CUBESAT MAGNETORQER DRIVER

| SIZE | DWG NO. | REV |
|---|---|---|
| B | RD21-6005 | A |

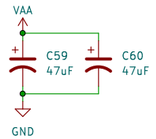
| | | | | |
|---|---|---|---|---|
| DRAWN BY | CH | ENGINEER | CH | 2023-06-28 |
| FILE NAME | magnetotorqer-drive-board.kicad_sch | KiCad E.D.A. kicad 7.0.5 | | SHEET 100 OF 15 |

## POWER SWITCH

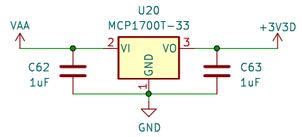
controlling device can disable power
redundant PMOS



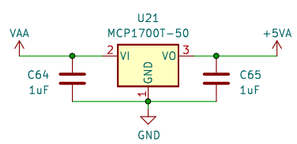

## INPUT BULK CAPS



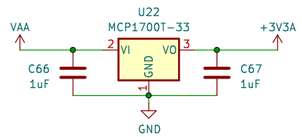

## 3V3 DIGITAL 250mA MAX



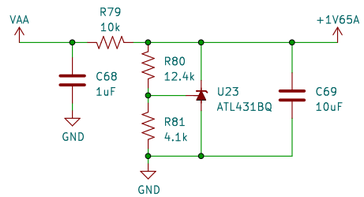

## 5V ANALOG 250mA MAX




## 3V3 ANALOG 250mA MAX

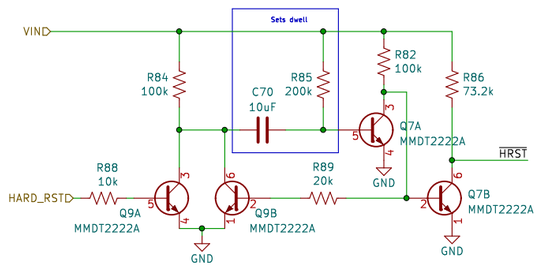



## 1V65 REF

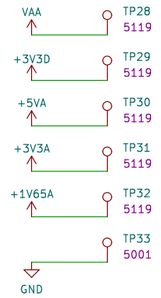



## Hard Reset One-Shot

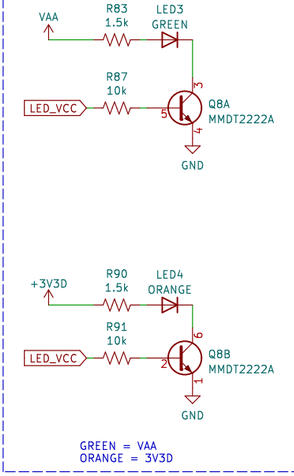
controlling device can hard-reset via toggling EN,
device can hard-reset itself with this circuitry




## TEST POINTS

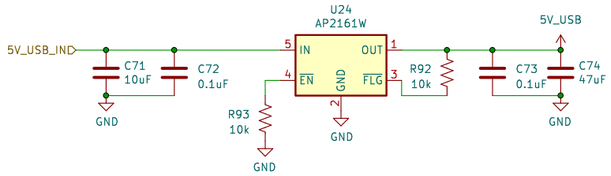



## DEBUG LEDs

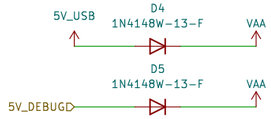



## 5V_USB POWER SW

Protects USB host




## Debug/Programming Power OR's



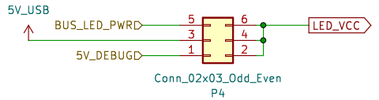

USB or 5V_DEBUG may be applied
for programming/debug w/o VBATT

5V_A won't work when these
are applied (LDO dropout)

not reccomended to operate adj.
bucks with this low power as well.

## LED_VCC SELECT HEADER

led power options for different configurations



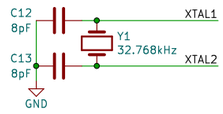

**TECHNOLOGY DEVELOPMENT & ENGINEERING CENTER EAST**
11401 HOOVER ROAD, MILAN, OHIO 44846

TITLE: SCHEMATIC, CUBESAT MAGNETORQER DRIVER

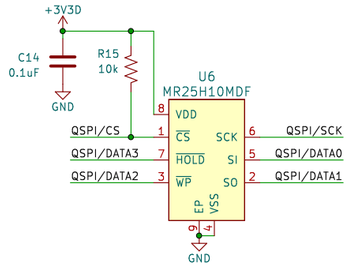
| SIZE | DWG NO. | REV |
|---|---|---|
| B | RD21-6005 | A |

| DRAWN BY | CH | ENGINEER | CH | 2023-06-28 |
|---|---|---|---|---|
| FILE NAME | power.kicad_sch | | KiCad E.D.A. kicad 7.0.5 | SHEET 200 OF 15 |

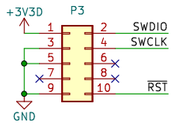
## Crystal



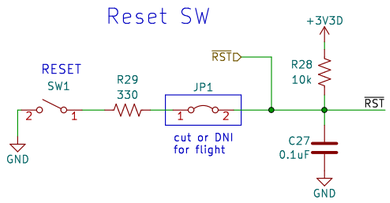

## MRAM FLASH (1 MB)



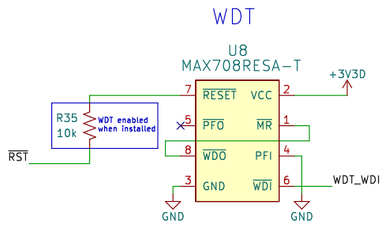

## JTAG Port



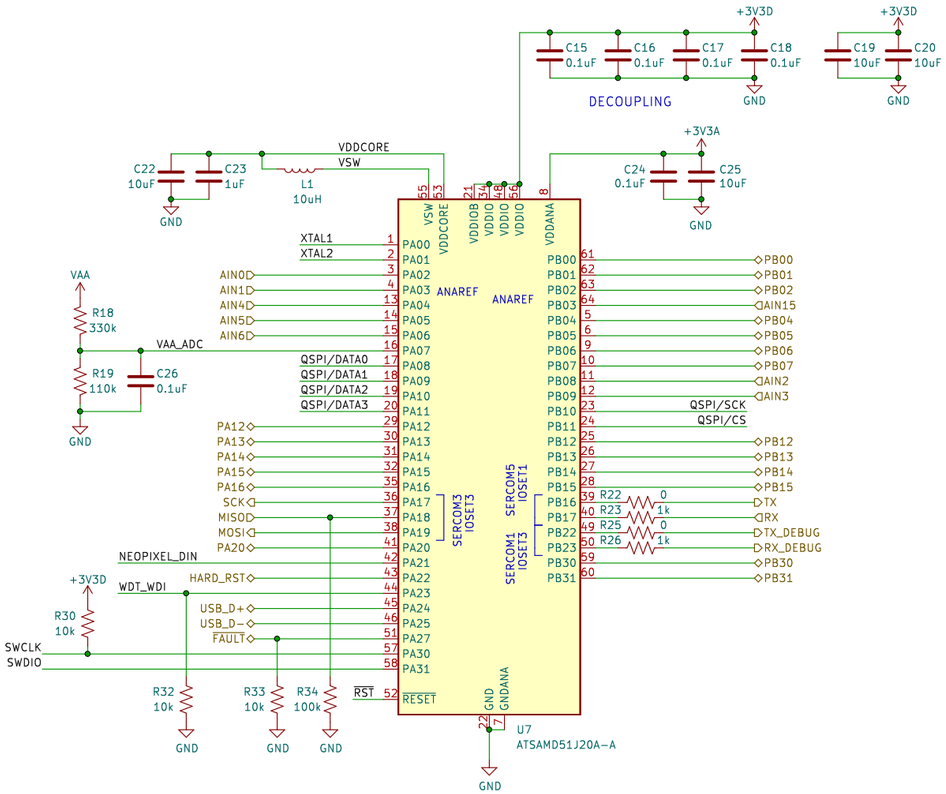

## Reset SW



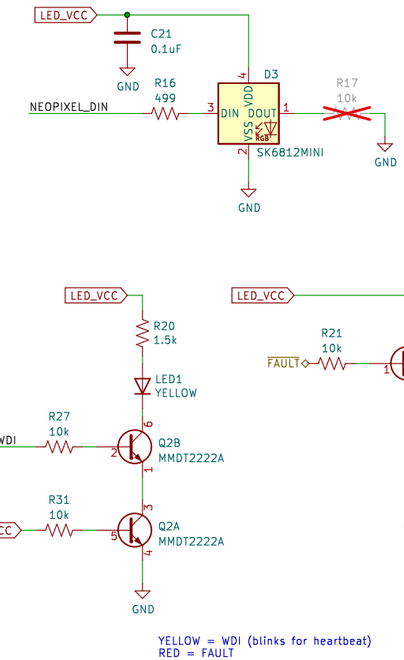

## WDT




## ATSAMD51 MCU




## STATUS LEDs



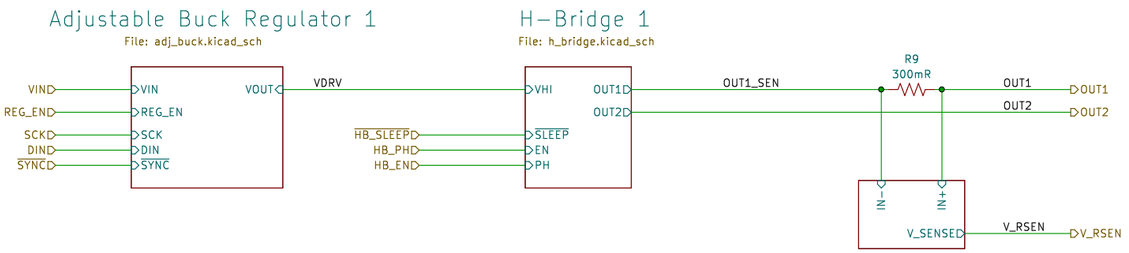

| | | | | |
|---|---|---|---|---|
| TECHNOLOGY DEVELOPMENT & ENGINEERING CENTER EAST<br>11401 HOOVER ROAD, MILAN, OHIO 44846 | | | | |
| TITLE: SCHEMATIC, CUBESAT MAGNETORQER DRIVER | | | | |
| SIZE: B | DWG NO.: RD21-6005 | | | REV: A |
| DRAWN BY | CH | ENGINEER | CH | 2023-06-28 |
| FILE NAME | control.kicad_sch | | KiCad E.D.A. kicad 7.0.5 | SHEET 300 OF 15 |

# MTQ DRIVER

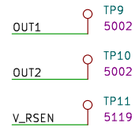
## PARAMATERS

X/Y MTQ 80-145R, 0.2W
50mA MAX
Z MTQ 30-55R, 0.57W
137mA MAX

Control of VDRV is 0-5V
so control can exceed max power of MTQs.




## TEST POINTS

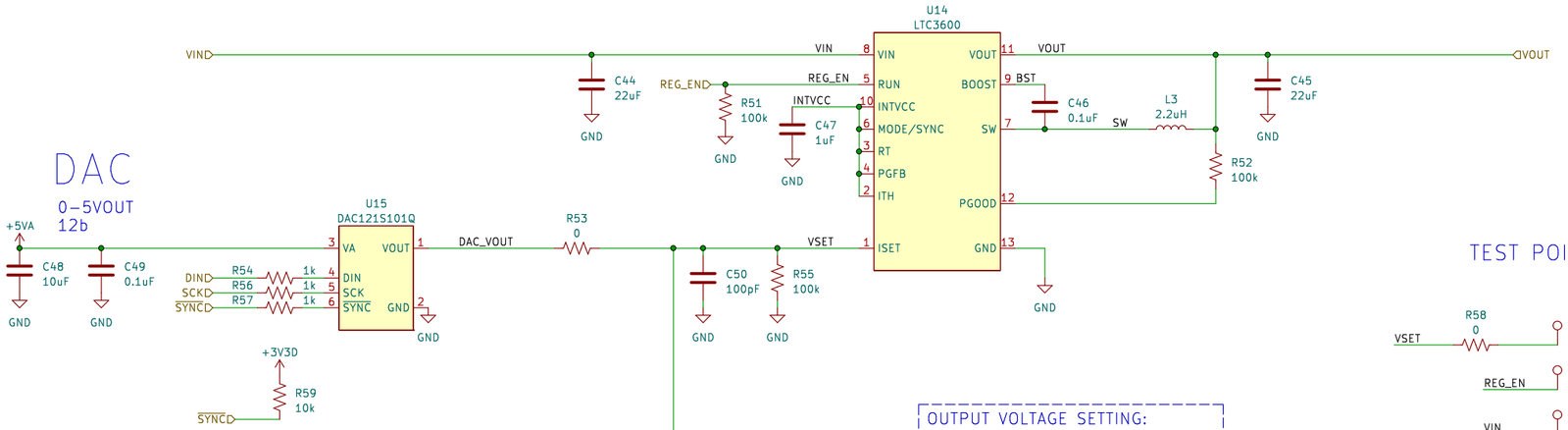



| | | | | |
|---|---|---|---|---|
| TECHNOLOGY DEVELOPMENT & ENGINEERING CENTER EAST<br>11401 HOOVER ROAD, MILAN, OHIO 44846 | | | | |
| TITLE: SCHEMATIC, CUBESAT MAGNETORQER DRIVER | | | | |
| SIZE: B | DWG NO.: RD21-6005 | | | REV: A |
| DRAWN BY | CH | ENGINEER | CH | 2023-06-28 |
| FILE NAME | driver.kicad_sch | | KiCad E.D.A. kicad 7.0.5 | SHEET 400 OF 15 |

# ADJUSTABLE BUCK

PARAMATERS

VIN 6–9V
VOUT 0–5V
IOUT = 200mA
$f_{SW}$ = 1MHz



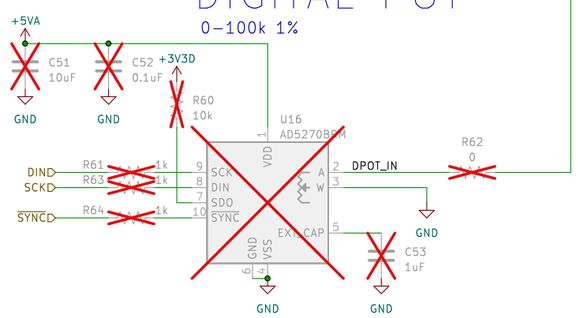

## DAC

0–5VOUT
12b

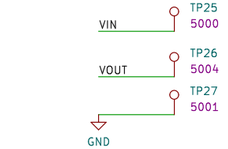



## DIGITAL POT

0–100k 1%




## TEST POINTS




OUTPUT VOLTAGE SETTING:

ISET pin voltage may be controlled
by an external resistor, or an applied power
supply that has the capability to sink 50uA.

DAC121 (12b) or AD527(9b) control.
DAC121 has rad data, can't simulate if
it will work (no model) but probably will.
AD527 doesn't have data but has been simulated.

No schedule for a re–spin, so
control methods are included.

TECHNOLOGY DEVELOPMENT & ENGINEERING CENTER EAST
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|---|---|---|
| B | RD21-6005 | A |

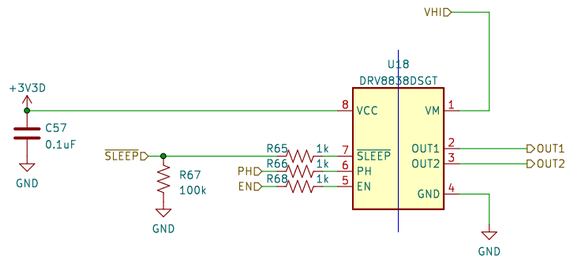
| | | | | |
|---|---|---|---|---|
| DRAWN BY | CH | ENGINEER | CH | 2023-06-28 |
| FILE NAME | adj_buck.kicad_sch | KiCad E.D.A. kicad 7.0.5 | | SHEET 401 OF 15 |

# H-BRIDGE DRIVER

for bi-directional control

PARAMATERS

VHI = 0-5V
IOUT = 150mA MAX




NOTES:

FET body diodes
clamp drive voltage
no need for output TVS

TECHNOLOGY DEVELOPMENT & ENGINEERING CENTER EAST
11401 HOOVER ROAD, MILAN, OHIO 44846

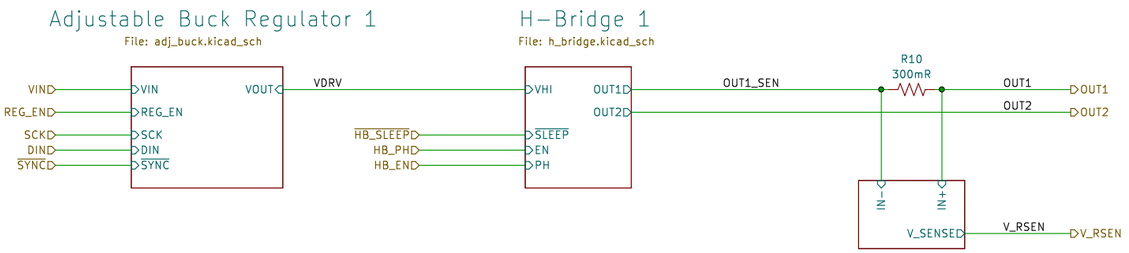
| | | | | |
|---|---|---|---|---|
| TITLE: SCHEMATIC, CUBESAT MAGNETORQER DRIVER | | | | |
| SIZE: B | DWG NO.: RD21-6005 | | | REV: A |
| DRAWN BY | CH | ENGINEER | CH | 2023-06-28 |
| FILE NAME | h_bridge.kicad_sch | | KiCad E.D.A. kicad 7.0.5 | SHEET 402 OF 15 |

# MTQ DRIVER

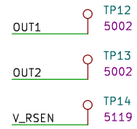
## PARAMATERS

X/Y MTQ 80-145R, 0.2W
50mA MAX
Z MTQ 30-55R, 0.57W
137mA MAX

Control of VDRV is 0-5V
so control can exceed max power of MTQs.




## TEST POINTS




TECHNOLOGY DEVELOPMENT & ENGINEERING CENTER EAST
11401 HOOVER ROAD, MILAN, OHIO 44846

TITLE
SCHEMATIC, CUBESAT MAGNETORQER DRIVER

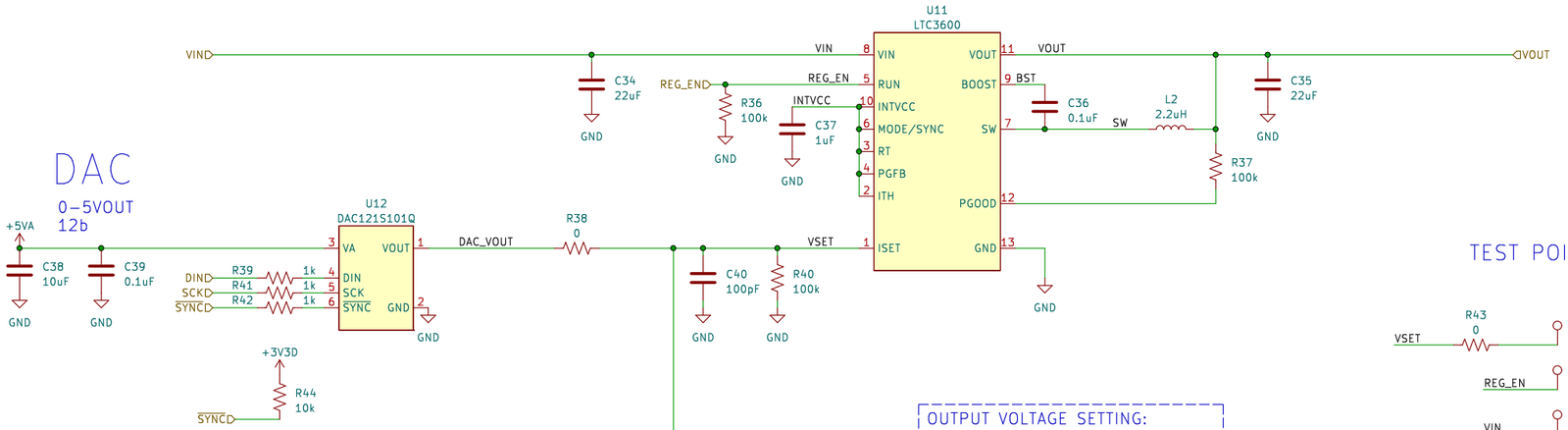
| SIZE | DWG NO. | REV |
|---|---|---|
| B | RD21-6005 | A |

| | | | | |
|---|---|---|---|---|
| DRAWN BY | CH | ENGINEER | CH | 2023-06-28 |
| FILE NAME | driver.kicad_sch | KiCad E.D.A. kicad 7.0.5 | | SHEET 500 OF 15 |

# ADJUSTABLE BUCK

PARAMATERS

VIN 6–9V
VOUT 0–5V
IOUT = 200mA
$f_{SW}$ = 1MHz



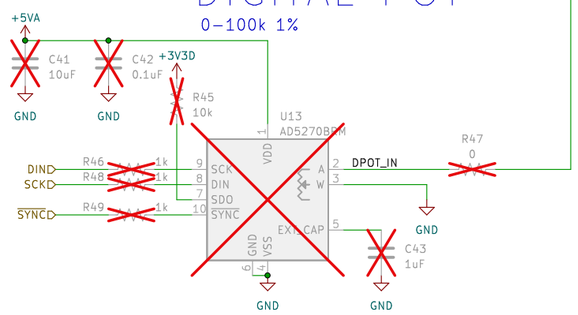

## DAC

0–5VOUT
12b

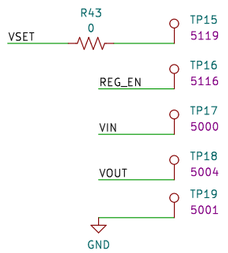



## DIGITAL POT

0–100k 1%




## TEST POINTS




## OUTPUT VOLTAGE SETTING:

ISET pin voltage may be controlled
by an external resistor, or an applied power
supply that has the capability to sink 50uA.

DAC121 (12b) or AD527(9b) control.
DAC121 has rad data, can't simulate if
it will work (no model) but probably will.
AD527 doesn't have data but has been simulated.

No schedule for a re–spin, so
control methods are included.

**TECHNOLOGY DEVELOPMENT & ENGINEERING CENTER EAST**
11401 HOOVER ROAD, MILAN, OHIO 44846

TITLE: SCHEMATIC, CUBESAT MAGNETORQER DRIVER

| SIZE | DWG NO. | REV |
|---|---|---|
| B | RD21-6005 | A |

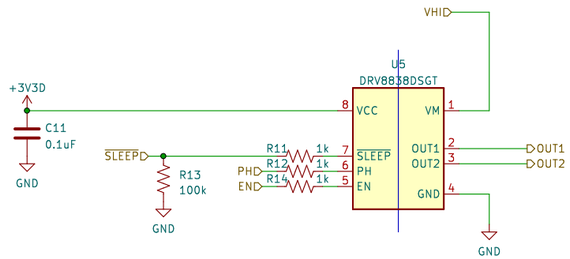
| | | | | |
|---|---|---|---|---|
| DRAWN BY | CH | ENGINEER | CH | 2023-06-28 |
| FILE NAME | adj_buck.kicad_sch | KiCad E.D.A. kicad 7.0.5 | | SHEET 501 OF 15 |

# H-BRIDGE DRIVER

for bi-directional control

PARAMATERS

VHI = 0-5V
IOUT = 150mA MAX




NOTES:

FET body diodes
clamp drive voltage
no need for output TVS

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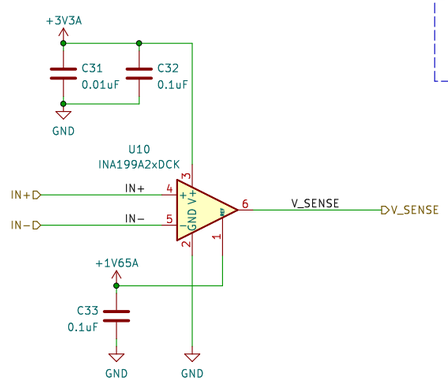
11401 HOOVER ROAD, MILAN, OHIO 44846

| | | | | |
|---|---|---|---|---|
| TITLE: SCHEMATIC, CUBESAT MAGNETORQER DRIVER | | | | |
| SIZE: B | DWG NO.: RD21-6005 | | | REV: A |
| DRAWN BY | CH | ENGINEER | CH | 2023-06-28 |
| FILE NAME | h_bridge.kicad_sch | | KiCad E.D.A. kicad 7.0.5 | SHEET 502 OF 15 |

# CURRENT SENSE AMPLIFIER




NOTES

100v/v gain
Pick sense resistor for 15mV full deflection (max current)
1.65V offset, Vout ranges 150mV–3.15V

INA199 rad data:
https://doi.org/10.1109/REDW.2019.8906629

TECHNOLOGY DEVELOPMENT & ENGINEERING CENTER EAST
11401 HOOVER ROAD, MILAN, OHIO 44846

TITLE
SCHEMATIC, CUBESAT MAGNETORQER DRIVER

| SIZE | DWG NO. | REV |
|---|---|---|
| B | RD21-6005 | A |

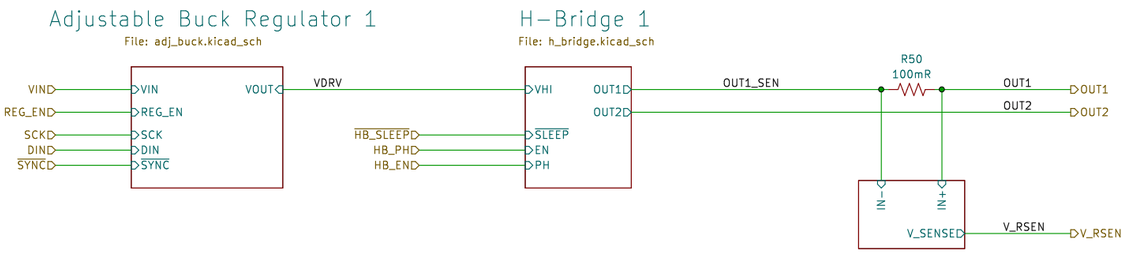
| | | | | |
|---|---|---|---|---|
| DRAWN BY | CH | ENGINEER | CH | 2023-06-28 |
| FILE NAME | i_fb.kicad_sch | | KiCad E.D.A. kicad 7.0.5 | SHEET 503 OF 15 |

# MTQ DRIVER

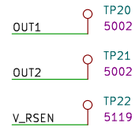
## PARAMATERS

X/Y MTQ 80-145R, 0.2W
50mA MAX
Z MTQ 30-55R, 0.57W
137mA MAX

Control of VDRV is 0-5V
so control can exceed max power of MTQs.




## TEST POINTS

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TITLE
SCHEMATIC, CUBESAT MAGNETORQER DRIVER

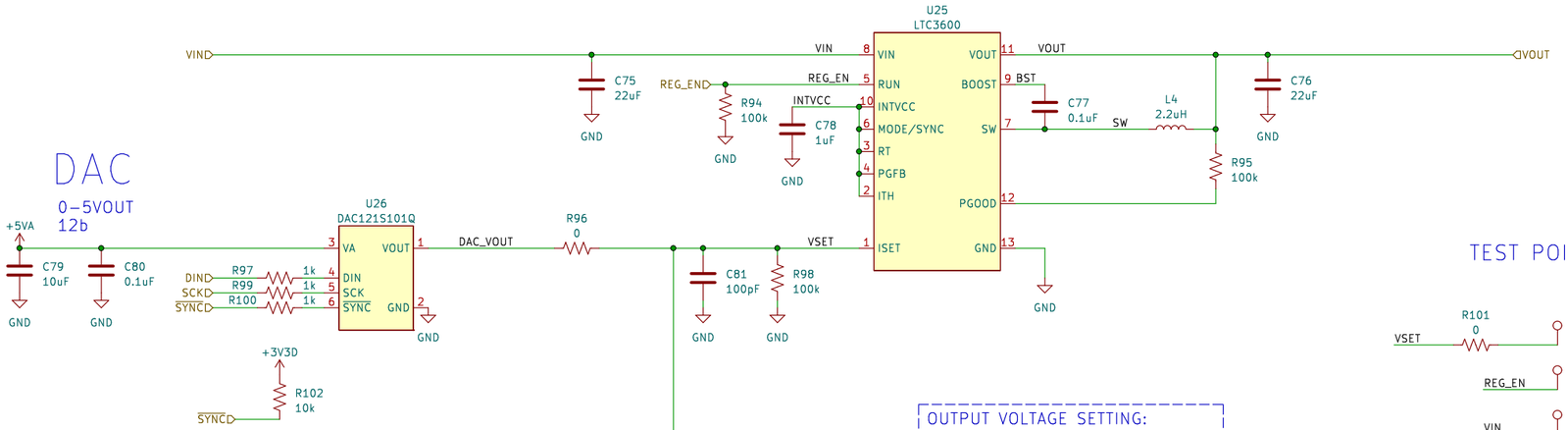
| SIZE | DWG NO. | REV |
|---|---|---|
| B | RD21-6005 | A |

| | | | | |
|---|---|---|---|---|
| DRAWN BY | CH | ENGINEER | CH | 2023-06-28 |
| FILE NAME | driver.kicad_sch | KiCad E.D.A. kicad 7.0.5 | | SHEET 600 OF 15 |

# ADJUSTABLE BUCK

PARAMATERS

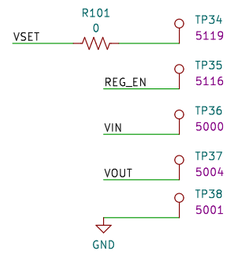
VIN 6–9V
VOUT 0–5V
IOUT = 200mA
$f_{SW}$ = 1MHz




## DAC

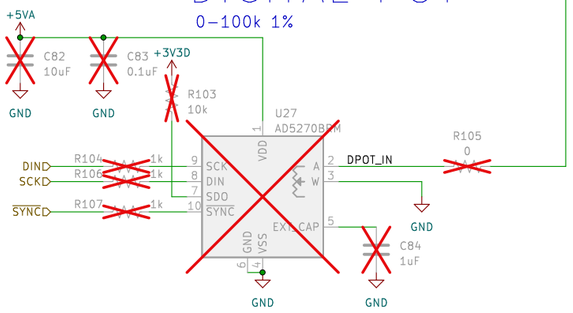
0–5VOUT
12b

## TEST POINTS




## DIGITAL POT

0–100k 1%




OUTPUT VOLTAGE SETTING:

ISET pin voltage may be controlled
by an external resistor, or an applied power
supply that has the capability to sink 50uA.

DAC121 (12b) or AD527(9b) control.
DAC121 has rad data, can't simulate if
it will work (no model) but probably will.
AD527 doesn't have data but has been simulated.

No schedule for a re–spin, so
control methods are included.

TECHNOLOGY DEVELOPMENT & ENGINEERING CENTER EAST
11401 HOOVER ROAD, MILAN, OHIO 44846

TITLE: SCHEMATIC, CUBESAT MAGNETORQER DRIVER

| SIZE | DWG NO. | REV |
|---|---|---|
| B | RD21-6005 | A |

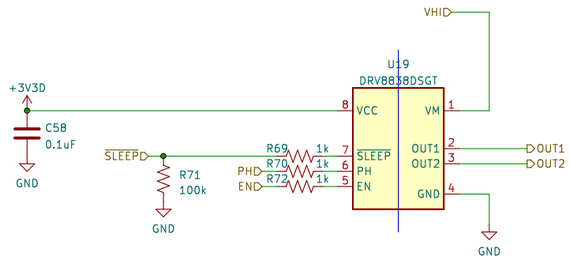
| DRAWN BY | CH | ENGINEER | CH | 2023-06-28 |
|---|---|---|---|---|
| FILE NAME | adj_buck.kicad_sch | KiCad E.D.A. kicad 7.0.5 | | SHEET 601 OF 15 |

# H-BRIDGE DRIVER

for bi-directional control

PARAMATERS

VHI = 0-5V
IOUT = 150mA MAX



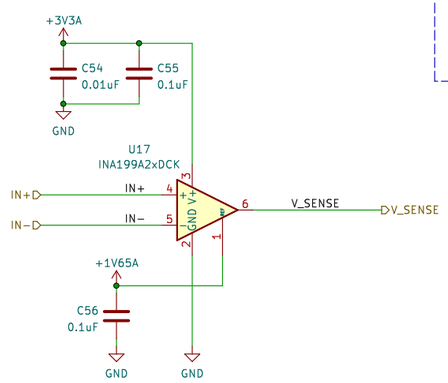

NOTES:

FET body diodes
clamp drive voltage
no need for output TVS

**TECHNOLOGY DEVELOPMENT & ENGINEERING CENTER EAST**
11401 HOOVER ROAD, MILAN, OHIO 44846

| | | | | |
|---|---|---|---|---|
| TITLE: SCHEMATIC, CUBESAT MAGNETORQER DRIVER | | | | |
| SIZE: B | DWG NO.: RD21-6005 | | | REV: A |
| DRAWN BY | CH | ENGINEER | CH | 2023-06-28 |
| FILE NAME | h_bridge.kicad_sch | | KiCad E.D.A. kicad 7.0.5 | SHEET 602 OF 15 |

# CURRENT SENSE AMPLIFIER




NOTES

100v/v gain
Pick sense resistor for 15mV full deflection (max current)
1.65V offset, Vout ranges 150mV–3.15V

INA199 rad data:
https://doi.org/10.1109/REDW.2019.8906629

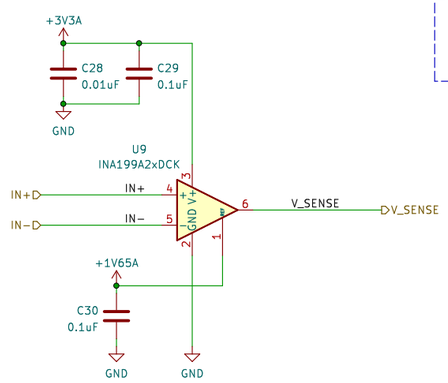
**TECHNOLOGY DEVELOPMENT & ENGINEERING CENTER EAST**
11401 HOOVER ROAD, MILAN, OHIO 44846

TITLE
SCHEMATIC, CUBESAT MAGNETORQER DRIVER

| SIZE | DWG NO. | REV |
|---|---|---|
| B | RD21-6005 | A |

| | | | | |
|---|---|---|---|---|
| DRAWN BY | CH | ENGINEER | CH | 2023-06-28 |
| FILE NAME | i_fb.kicad_sch | KiCad E.D.A. kicad 7.0.5 | | SHEET 603 OF 15 |

# CURRENT SENSE AMPLIFIER




NOTES

100v/v gain
Pick sense resistor for 15mV full deflection (max current)
1.65V offset, Vout ranges 150mV–3.15V

INA199 rad data:
https://doi.org/10.1109/REDW.2019.8906629

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TITLE
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| SIZE | DWG NO. | REV |
|---|---|---|
| B | RD21-6005 | A |

| | | | | |
|---|---|---|---|---|
| DRAWN BY | CH | ENGINEER | CH | 2023-06-28 |
| FILE NAME | i_fb.kicad_sch | | KiCad E.D.A. kicad 7.0.5 | SHEET 4037 OF 15 |