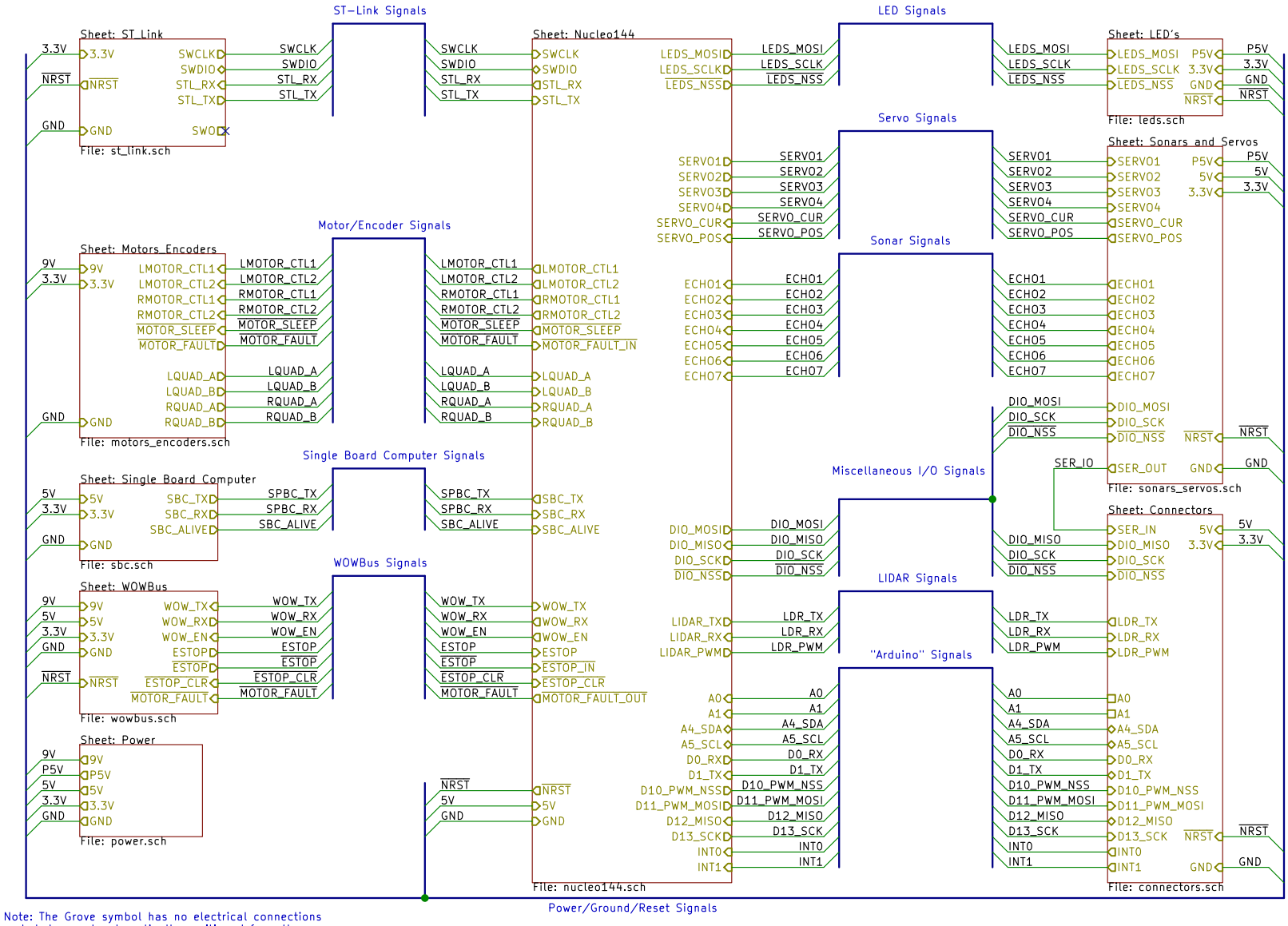

Note: The Grove symbol has no electrical connections but does get automatically positioned from the mechanical model. Each Grove module has two mounting holes that are positioned this way.

GV81 GROVE;20x20
GV82 GROVE;20x20
GV83 GROVE;20x20
GV85 GROVE;20x20
GV86 GROVE;20x20

H1 HOLE;M2.5
H2 HOLE;M2.5
H3 HOLE;M2.5
H4 HOLE;M2.5
H5 HOLE;M2.5
H6 HOLE;M2.5

TO DO:
1. Work on Ground bottleneck.
2. Ground stitch.

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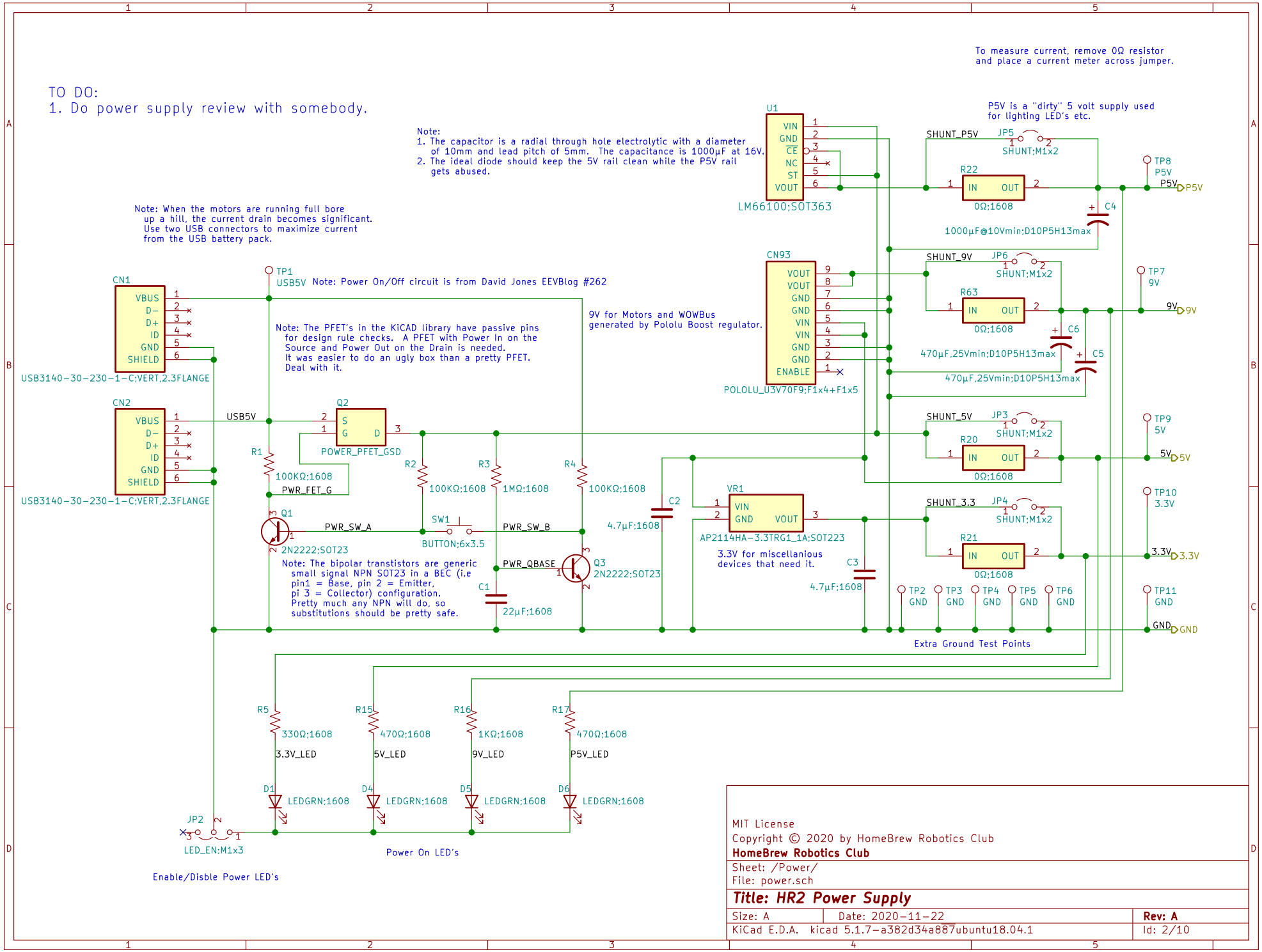
Sheet: /
File: master_board.sch

Title: HR2 Overview

Size: A	Date: 2020-11-22	**Rev: A**
KiCad E.D.A. kicad 5.1.7-a382d34a887ubuntu18.04.1		Id: 1/10


TO DO:
1. Do power supply review with somebody.
To measure current, remove 0Ω resistor and place a current meter across jumper.
P5V is a "dirty" 5 volt supply used for lighting LED's etc.
Note:
1. The capacitor is a radial through hole electrolytic with a diameter of 10mm and lead pitch of 5mm. The capacitance is 1000µF at 16V.
2. The ideal diode should keep the 5V rail clean while the P5V rail gets abused.
Note: When the motors are running full bore up a hill, the current drain becomes significant. Use two USB connectors to maximize current from the USB battery pack.
Note: The PFET's in the KiCAD library have passive pins for design rule checks. A PFET with Power In on the Source and Power Out on the Drain is needed. It was easier to do an ugly box than a pretty PFET. Deal with it.
9V for Motors and WOWBus generated by Pololu Boost regulator.
Note: The bipolar transtistors are generic small signal NPN SOT23 in a BEC (i.e pin1 = Base, pin 2 = Emitter, pi 3 = Collector) configuration. Pretty much any NPN will do, so substitutions should be pretty safe.
3.3V for miscellanious devices that need it.
Extra Ground Test Points
Enable/Disble Power LED's
Power On LED's
U1
LM66100;SOT363
SHUNT_P5V
JP5
SHUNT;M1x2
R22
0Ω;1608
TP8
P5V
C4
1000µF@10Vmin;D10P5H13max
CN93
POLOLU_U3V70F9;F1x4+F1x5
SHUNT_9V
JP6
R63
TP7
9V
C6
470µF,25Vmin;D10P5H13max
C5
CN1
USB3140-30-230-1-C;VERT,2.3FLANGE
TP1
USB5V
CN2
USB5V
Q2
POWER_PFET_GSD
R1
100KΩ;1608
PWR_FET_G
R2
100KΩ;1608
R3
1MΩ;1608
R4
100KΩ;1608
Q1
2N2222;SOT23
PWR_SW_A
SW1
BUTTON;6x3.5
PWR_SW_B
PWR_QBASE
Q3
2N2222;SOT23
C1
22µF;1608
C2
4.7µF;1608
VR1
AP2114HA-3.3TRG1_1A;SOT223
C3
4.7µF;1608
SHUNT_5V
JP3
R20
TP9
5V
SHUNT_3.3
JP4
R21
TP10
3.3V
TP2 GND
TP3 GND
TP4 GND
TP5 GND
TP6 GND
TP11
GND
R5
330Ω;1608
3.3V_LED
R15
470Ω;1608
5V_LED
R16
1KΩ;1608
9V_LED
R17
470Ω;1608
P5V_LED
D1
D4
D5
D6
LEDGRN;1608
JP2
LED_EN;M1x3
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Sheet: /Power/
File: power.sch
Title: HR2 Power Supply
Size: A
Date: 2020-11-22
Rev: A
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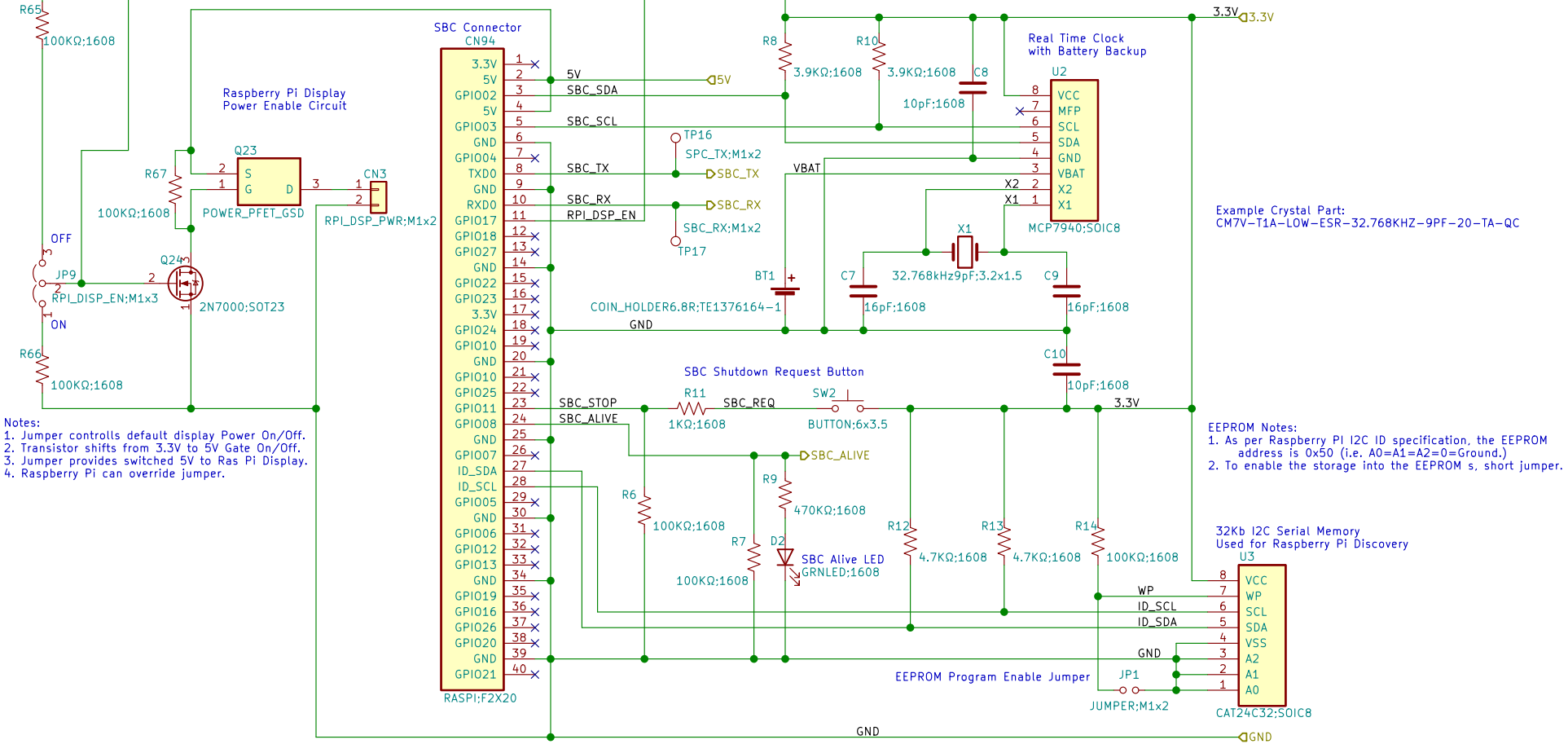
SBC (Single Board Computer) Connector Notes:
1. Any SBC that is compatible with the defacto 40-pin Raspbery Pi Standard is allowed.
2. 5V power is provided by the 2 5V pins.
3. The SBC_ALIVE is High (3.3V) when the operating system is up and running.
4. The SBC_SHUTDOWN is pulled High to ask the operating system to shutdown.
5. The SBC_TX/SBC_RX provide a dedicated serial connection to the Nucleo.

Real Time Clock Notes:
1. Real Time Clock is needed to set the operatiing system time need for ROS (Robot Operating System.)
2. The crystal load capacitor calculations are:
   A. Cld = (C1 x C2) / (C1 + C2), where:
      Cld = crystal load capacitence (i.e. 7-9pF) assume 8pF
      C1 and C2 are two capactors connected to ground, one to each crystal side.
   B. Assume C1 = C2 and call it C.
   C. Cld = (C1 x C2) / (C1 + C2) = (C x C) / (C + C) = C^2 / 2C = C / 2.
   D. C = 2 □ Cload = 2 □ 8pF = 16pF.



Sheet: /Single Board Computer/
File: sbc.sch

Title: HR2 Single Board Computer

Size: A	Date: 2020-11-22	**Rev: A**
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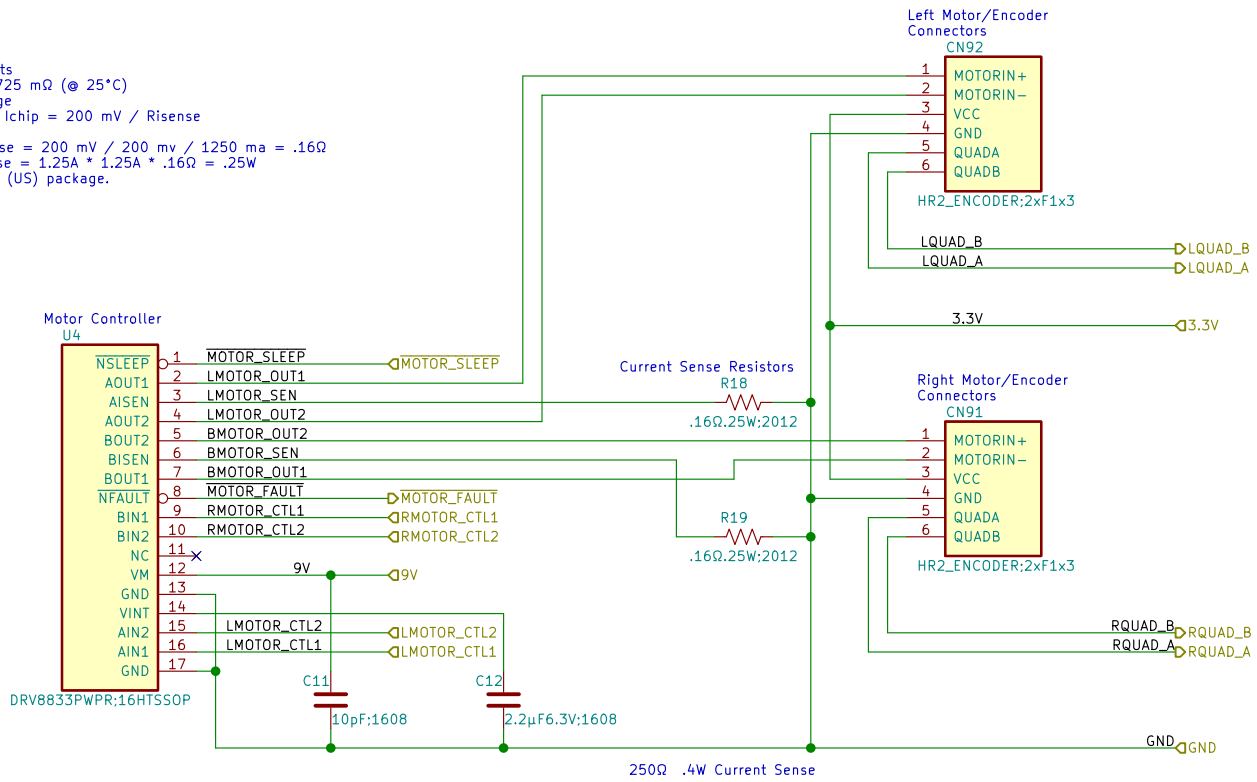
Motor Notes:
1. Full Name: 120:1 Mini Plastic Gearmotor HP,
   Offset 3mm D-Shaft Output, Extended Motor Shaft
2. Vendor Number: Pololu #1520
3. Size 36.5 x 20 x 27.4 mm
3. Weight: 19 g
4. Shaft diamter: 3 mm (D Shaft)
5. Typical operating voltage: 4.5V
6. No-load speed @ 4.5V = 150 rpm
7. No-Load current @ 4.5V = 130 mA
8. Stall current @ 4.5V = 1250 mA = 1.25 A
9. Stall Torque @ 4.5V = 25 ozf-in = 25 / 141.612 N-m = 17.64 N-m

DRV8833PWPR Notes:
1. Manufacturer: Texas Instruments
2. On-Resistance: HS + LS = 1725 mΩ (@ 25°C)
3. Peak Current: 1 A per H-Bridge
4. Section 7.3.3 Current Control: Ichip = 200 mV / Risense
5. Risense = 200 mV / Ichip
6. With Imax = 1.25 A => Risense = 200 mV / 200 mv / 1250 ma = .16Ω
7. Power = Imax * Imax * Risense = 1.25A * 1.25A * .16Ω = .25W
8. Use an 2012 (metric) = 0805 (US) package.



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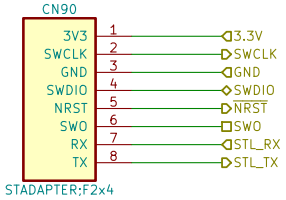
Sheet: /Motors_Encoders/
File: motors_encoders.sch

Title: HR2 Motors and Encoders

Size: A	Date: 2020-11-22	**Rev: A**
KiCad E.D.A. kicad 5.1.7-a382d34a887ubuntu18.04.1		Id: 4/10



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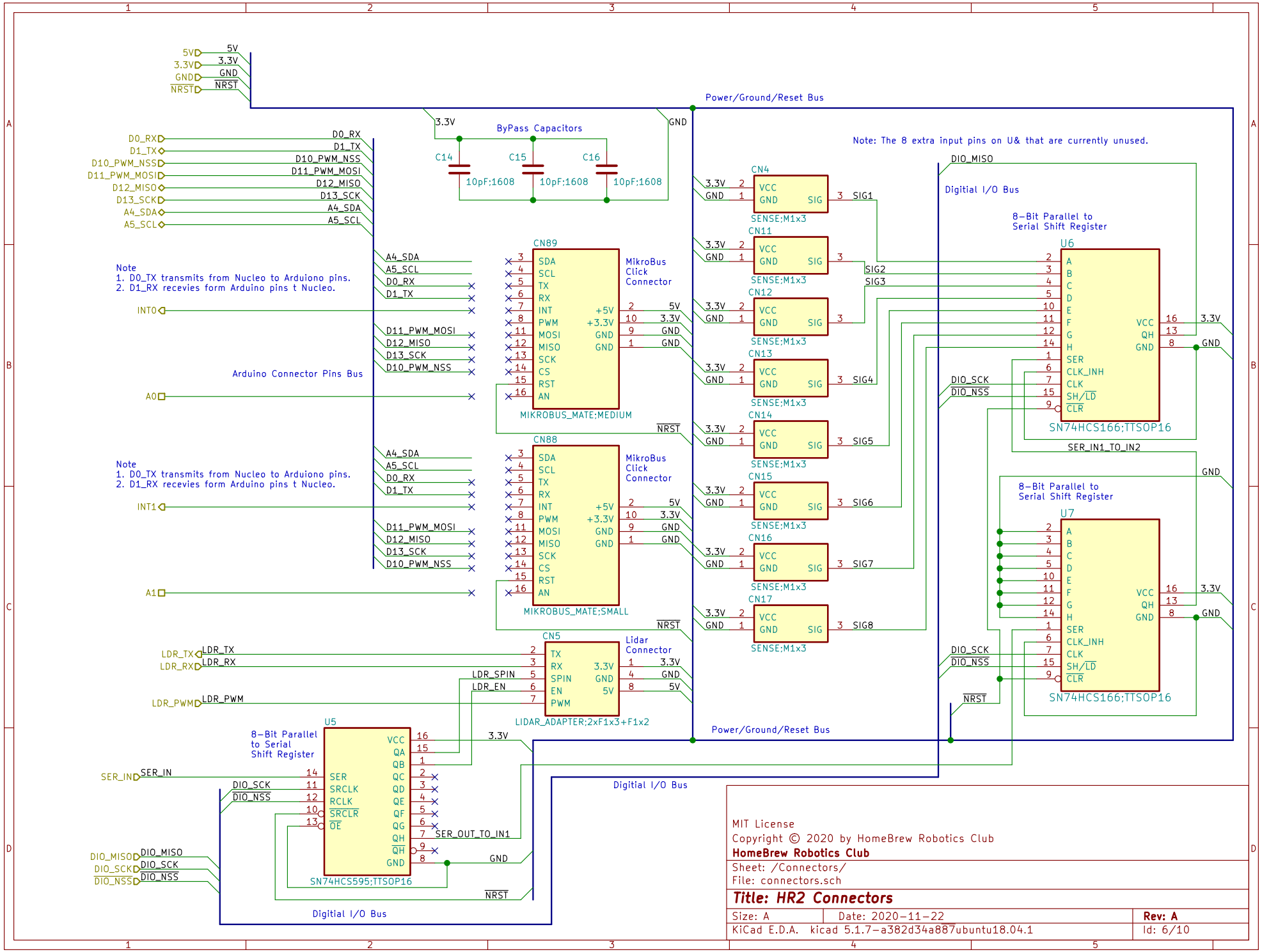
Sheet: /ST_Link/
File: st_link.sch

Title: HR2 ST-Link

Size: A4	Date: 2020-11-22	**Rev: A**
KiCad E.D.A. kicad 5.1.7-a382d34a887ubuntu18.04.1		Id: 5/10


5V
3.3V
GND
NRST
Power/Ground/Reset Bus
ByPass Capacitors
C14
C15
C16
10pF;1608
10pF;1608
10pF;1608
D0_RX
D1_TX
D10_PWM_NSS
D11_PWM_MOSI
D12_MISO
D13_SCK
A4_SDA
A5_SCL
Note
1. D0_TX transmits from Nucleo to Arduiono pins.
2. D1_RX recevies form Arduino pins t Nucleo.
INT0
INT1
A0
A1
Arduino Connector Pins Bus
CN89
CN88
MikroBus
Click
Connector
SDA
SCL
TX
RX
INT
PWM
MOSI
MISO
SCK
CS
RST
AN
+5V
+3.3V
MIKROBUS_MATE;MEDIUM
MIKROBUS_MATE;SMALL
Note: The 8 extra input pins on U& that are currently unused.
CN4
CN11
CN12
CN13
CN14
CN15
CN16
CN17
VCC
GND
SIG
SENSE;M1x3
SIG1
SIG2
SIG3
SIG4
SIG5
SIG6
SIG7
SIG8
DIO_MISO
Digitial I/O Bus
8-Bit Parallel to
Serial Shift Register
U6
U7
A
B
C
D
E
F
G
H
SER
CLK_INH
CLK
SH/LD
CLR
QH
SN74HCS166;TTSOP16
DIO_SCK
DIO_NSS
SER_IN1_TO_IN2
LDR_TX
LDR_RX
LDR_PWM
LDR_SPIN
LDR_EN
CN5
TX
RX
SPIN
EN
PWM
Lidar
Connector
LIDAR_ADAPTER;2xF1x3+F1x2
U5
8-Bit Parallel
to Serial
Shift Register
SER
SRCLK
RCLK
SRCLR
OE
QA
QB
QC
QD
QE
QF
QG
QH
SN74HCS595;TTSOP16
SER_IN
SER_OUT_TO_IN1
DIO_MISO
DIO_SCK
DIO_NSS
Digitial I/O Bus
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Sheet: /Connectors/
File: connectors.sch
Title: HR2 Connectors
Size: A
Date: 2020-11-22
Rev: A
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Id: 6/10

Note:
1. The P5V voltage rail is connected to 5V through an ideal diode and with 1000µF surge capacitor on the output. If all of the LED's turn on at once, there may be a small drop in the P5V rail, but not for long. The 5V rail should be pretty safe from voltage drops.

Note:
1. The LED's are controlled by a 16-bit shift regester that is filled using an SPI controller. The 3.3V outputs are fed into FET's that drive the LED's.

16-Bit SPI LED Shift Register

U11 SN74HCS595;TTSOP16

U12 SN74HCS595;TTSOP16

Power Bus

Notes:
1. GRNRA = Green Right Angle Green
2. Nominal Part:
   Mfg Part #: TLPG5600
   Digi-Key part #: TLPG5600-ND
   Forward Voltage Drop: 2.4V
   Absolute max. current: 200mA
   Target maximum current: I=20mA

Notes (cont.):
3. LED's are labeled from 1 to 16 in a counter-clockwise direction starting in the NW quadrant nearest the X axis.

ByPass Capacitors

C20 10pF:1608

C21 10pF:1608

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Sheet: /LED's/
File: leds.sch

Title: HR2 LED's

Size: A4	Date: 2020-11-22	**Rev: A**
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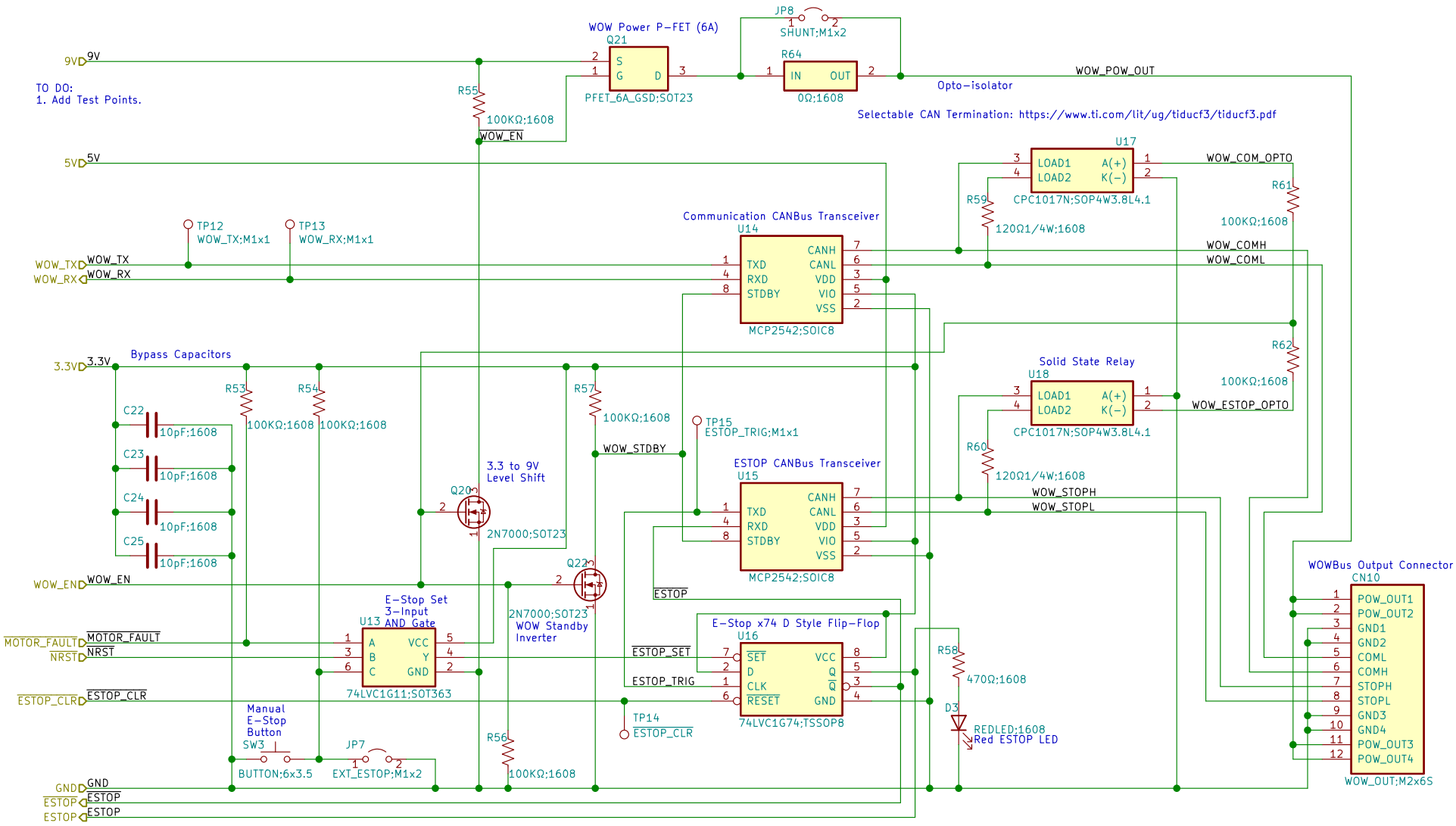

WOWBus Notes:

1. WOWBus is an an expansion bus.
2. WOWBus stands for Wayne's Omnipotent Wonderful Bus (heavy sarcasm.)
3. WOWBus uses 2x6 ribbon daisy chain cables for interconnect.
4. WOWBus has a nominal 9V rail, but this can droop due to resistive losses down the daisy chain.
5. The WOWBus connector is designed to mirror image power, ground, and signaling.
6. If a WOWBus connector is accidently reversed on a daisy cable, nothing shorts out.
7. However, an accidentally reversed cable, will basically make the bus non-fuctional until corrected.
8. The WOWBus has two "CAN bus" (ISO-11898-2) physical differential pairs for siginalling.
9. The first differential pair is used as a multi-drop bidirectional data transfer.
10. The second differential pair is used to signal Emergency Stop.
11. When the WOWBus is enabled, it powers up both the transceivers and the differential pair termination resistors.
12. The expansions boards are responsible for providing the bus terminator resistors for for the other end of the differential pairs.
13. The Bus powers up in the EStop conndition and must be explicitly cleared out.
14. When ESTOP occurs, it latches up and must be explicitly cleared.

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Sheet: /WOWBus/
File: wowbus.sch

Title: HR2: WOWBus

Size: A	Date: 2020-11-22	**Rev: A**
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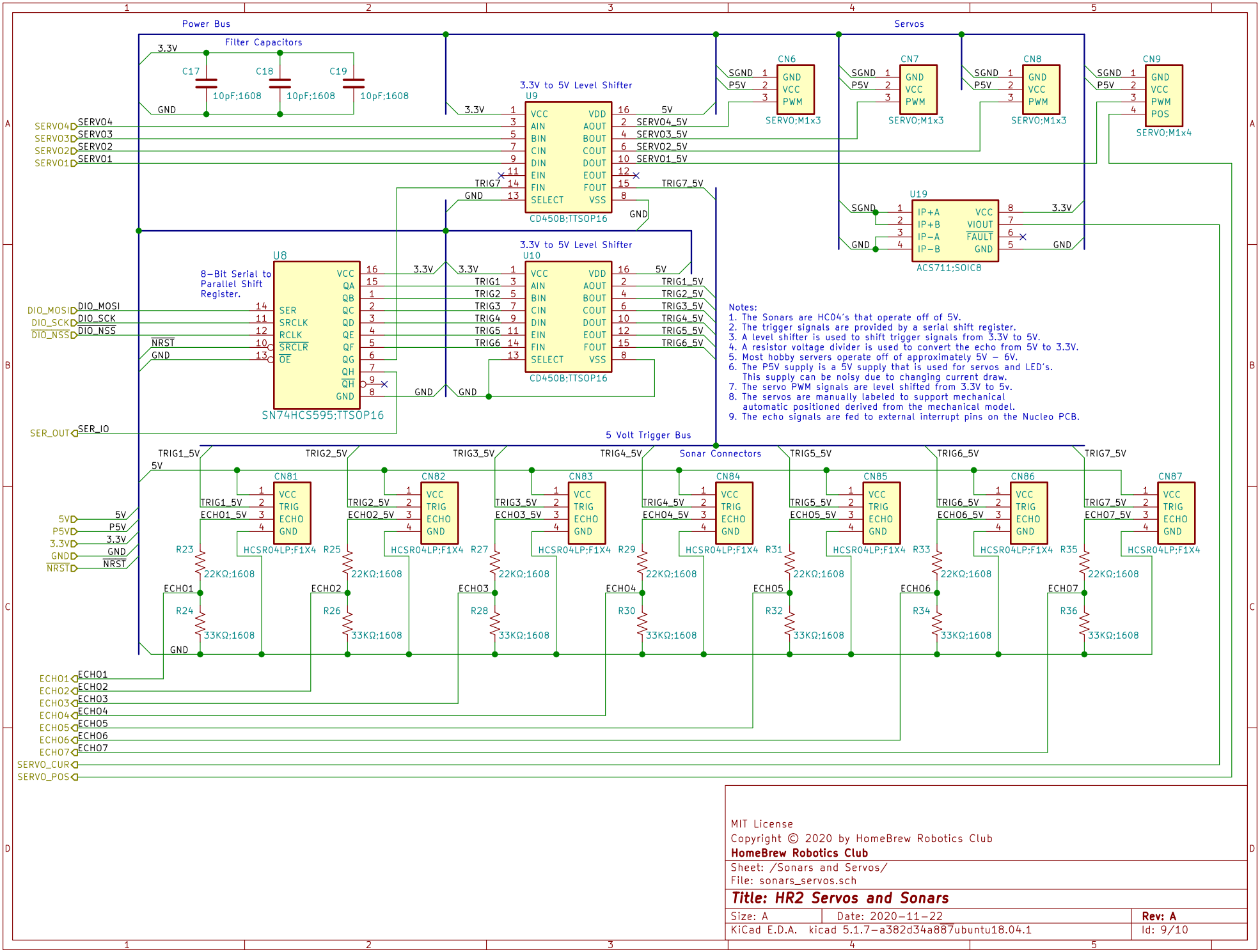

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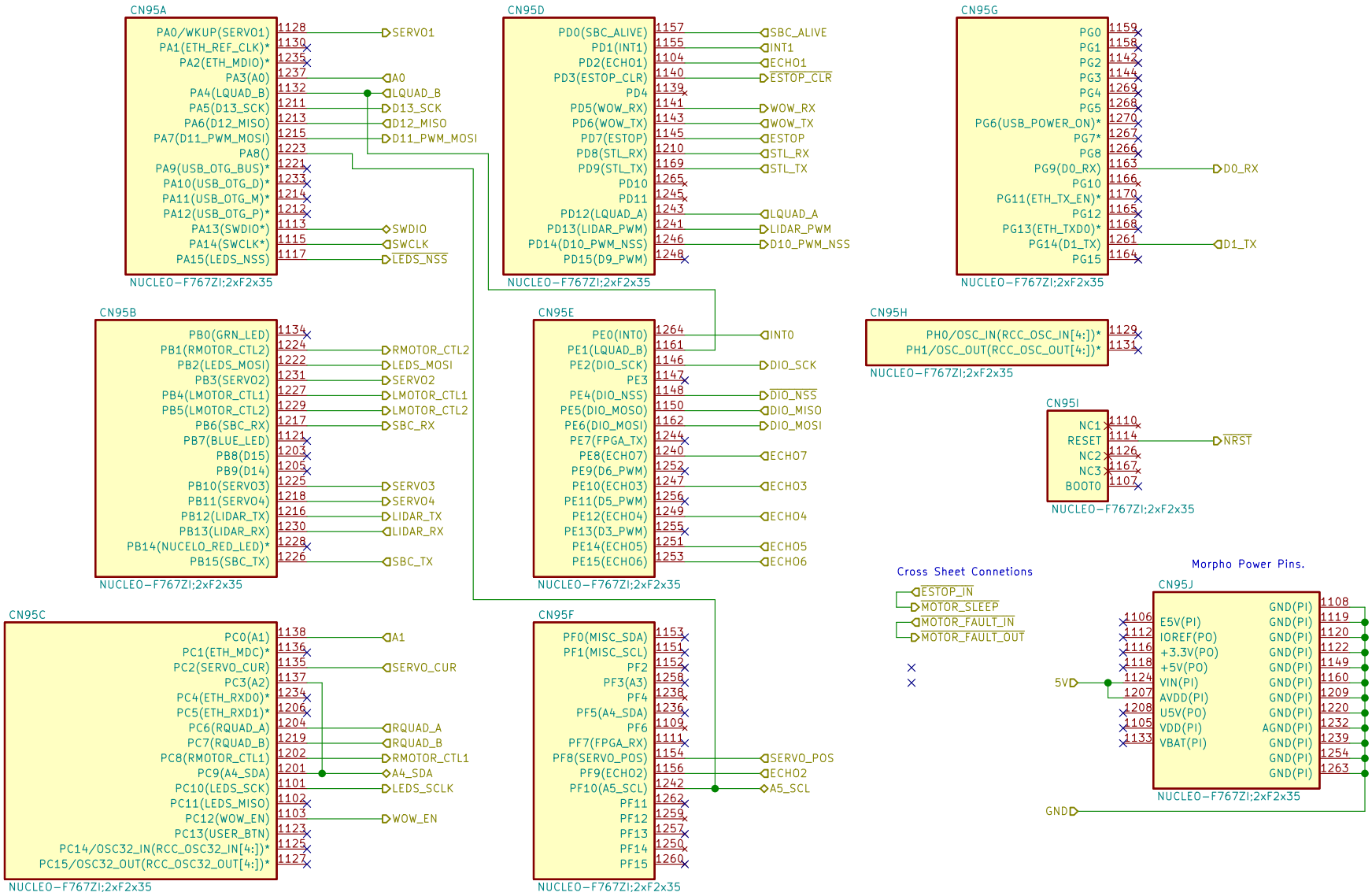
Sheet: /Sonars and Servos/
File: sonars_servos.sch

Title: HR2 Servos and Sonars

Size: A	Date: 2020-11-22	**Rev: A**
KiCad E.D.A. kicad 5.1.7-a382d34a887ubuntu18.04.1		Id: 9/10



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Sheet: /Nucleo144/
File: nucleo144.sch

Title: HR2 Nucleo

Size: A	Date: 2020-11-22	**Rev: A**
KiCad E.D.A. kicad 5.1.7-a382d34a887ubuntu18.04.1		Id: 10/10