OSURC Rover 2015 Drive Daughterboard Rev. 1 Manual

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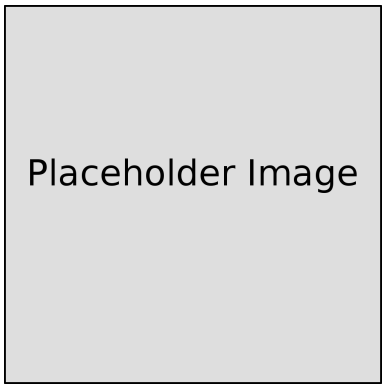


Figure 1: Assembled drive daughterboard

1 General Specifications

This manual covers the drive daughterboard, a component of the electronics of the OSU Robotics Club's 2015 rover. The drive daughterboard acts as an adapter between a brainboard (which contains a microcontroller and support circuitry) and the systems need to drive the robot. It includes:

- 3x UART ports for communication with Sabertooth motor drivers.
- 2x switched 24V ports for powering a signal light and headlight
- A socket for an xbee, to receive the pause signal
- A socket for an RC receiver, to allow manual control of the robot during testing and demonstrations
- A UART port for controlling the camera gimbal
- A port for communicating with the arm daughterboard (including the $\overline{\text{PAUSE}}$ signal)
- 3x $\overline{\text{PAUSE}}$ signal outputs
- 5x expansion ports (with standard PWM cable pinout)
  - 2x 5V output ports (with 5V supply)
  - 3x 3.3V I/O ports (with 3.3V supply)

The daughterboard is powered from a nominal 24V supply, using the same connector and pinout as the brainboards. **Power should be connected to the daughterboard.** The brainboard receives power from the daughterboard.

2 Mechanical Dimensions

The drive daughterboard is a 3.90” square PCB with four .125” holes spaced on a 3.5” square centered within it. Each hole is surrounded by a .340” diameter circular buffer zone suitable for a standoff or washer. The brainboard and RC receiver project from the top of the board, making its highest point approx. 2” above the bottom of the board. There are no components on the rear side, but the leads of through-hole connectors will protrude about 0.05”.

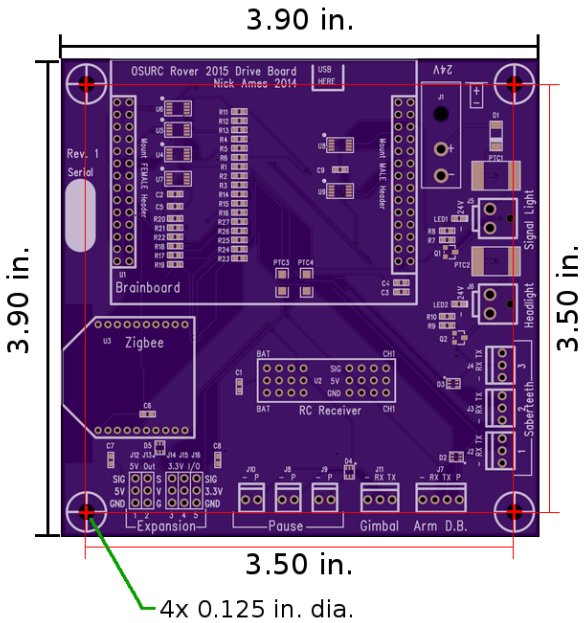


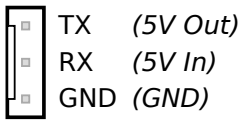
Figure 2: Drive daughterboard PCB dimensions

3 External Connections

3.1 24V Power

Nominal 24V power (up to 32V) is supplied through a vertical 2-pin Molex Mini-Fit Jr. connector, the same type used on the brainboards. The upper (longer) pin is ground, and the lower pin is +24V. The power input should be connected to the daughterboard only; the brainboard receives power from the daughterboard. The drive daughterboard can consume a maximum of 2.5A of current.

3.2 Sabertooth Interfaces



Connector Parts	
Board Header	TE 640454-3 (A19430-ND)
Wire Connector	TE 3-643814-3 (A31018-ND)
Strain Relief	TE 643075-3 (A19231-ND)
Wire	$1\frac{1}{2}$ twisted pairs from cat-5 cable

Figure 3: Sabertooth connectors

The drive daughterboard is designed to control three Sabertooth 2x12 motor drivers equipped with Kangaroo motion-control modules. Each motor driver is assigned its own connector, which carries 5V RS-232 serial data.

3.3 24V Light Ports

Connector Parts	
Board Header	TE 3-644615-2 (A113559-ND))
Wire Connector	TE 3-643820-2 (A31643-ND)
Strain Relief	TE 643067-2 (A19740-ND)
Wire	1 twisted pair from cat-5 cable

Figure 4: Light connectors

Two light ports are provided to control the robot's signal light and an optional headlight. Each port supplies nominal 24V power at up to 1A. *Important Note:* power to the lights is switched on the low (GND) side; the 24V pin is always powered.

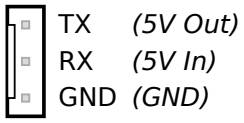
3.4 Xbee Socket

The robot uses a Xbee module to receive the pause signal from the pause button. The Xbee's DIO0 pin is connected to the microcontroller as the $\overline{\text{PAUSE}}$ signal input. No other signal pins on the Xbee are connected, so the Xbee must be programmed before insertion. The Xbee's antenna connector is a U.FL type.

3.5 RC Receiver Socket

For manual control during testing and demonstrations, a Turnigy 9X8C receiver is included on the board. Channels 1, 2, 3, 4, 7, and 8 are connected to the microcontroller. The RC receiver plugs vertically into the board; be sure to line it up so the BAT and CH1 labels match up with those on the board.

3.6 Gimbal Interface

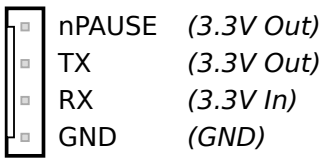


Connector Parts	
Board Header	TE 640454-3 (A19430-ND)
Wire Connector	3-643814-3 (A31018-ND)
Strain Relief	643075-3 (A19231-ND)
Wire	$1\frac{1}{2}$ twisted pairs from cat-5 cable

Figure 5: Sabertooth connectors

To allow the robot to look around, and to stabilize the image during movement, the cameras are mounted on a gimbal. The gimbal is controlled by a separate device. The drive board provides a 5V RS-232 interface to control the gimbal driver.

3.7 Arm Daughterboard Interface

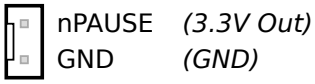


Connector Parts	
Board Header	TE 640454-4 (A19431-ND)
Wire Connector	TE 3-643814-4 (A31019-ND)
Strain Relief	TE 643075-4 (A19232-ND)
Wire	2 twisted pairs from cat-5 cable

Figure 6: Arm daughterboard communication connector

A four-pin connector is provided to communicate the RC receiver commands and $\overline{\text{PAUSE}}$ signal to the arm daughterboard. All three signals are 3.3V level.

3.8 Pause Signal Outputs

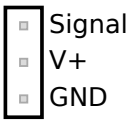


Connector Parts	
Board Header	TE 640454-2 (A19423-ND)
Wire Connector	TE 3-643814-2 (A31017-ND)
Strain Relief	TE 643075-2 (A19230-ND)
Wire	1 twisted pair from cat-5 cable

Figure 7: $\overline{\text{PAUSE}}$ output connectors

To distribute the pause signal to the radio daughterboard, and any other boards that need it, three connectors are provided. Each connector provides the 3.3V $\overline{\text{PAUSE}}$ signal and ground.

3.9 Expansion



Connector Parts	
Board Header	Generic 0.1" 3-pin Male Header

Figure 8: Expansion connectors

In case other inputs or outputs are needed, five expansion connectors are provided. All use standard PWM connector pinout (GND, V+, Signal). Two connectors are 5V outputs (with 5V supplies) and three are 3.3V I/Os (with 3.3V supplies). The 5V and 3.3V supplies on the expansion connectors can supply 200mA each.

4 Microcontroller Connections

Pin	Interface	Interface Signal
PE3/TXE0	Sabertooth 1	TX
PE2/RXE0	Sabertooth 1	RX
PE7/TXE1	Sabertooth 2	TX
PE6/RXE1	Sabertooth 2	RX
PF3/TXF0	Sabertooth 3	TX
PF2/RXF0	Sabertooth 3	RX
PE5	Multiple	nPAUSE
PD7/TXD1	Arm Com.	TX
PD6/RXD1	Arm Com.	RX
PF7	Expansion	1
PF6	Expansion	2
PF5	Expansion	3
PF4	Expansion	4
PF1	Expansion	5
PE0	Xbee	nPAUSE_INPUT
PB3	RC Recevicer	CH1
PB2	RC Recevicer	CH2
PB1	RC Recevicer	CH3
PA7	RC Recevicer	CH4
PA6	RC Recevicer	CH7
PA5	RC Recevicer	CH8
PD3/TXD0	Gimbal	TX
PD2/RXD0	Gimbal	RX
PA2	Headlight	Headlight
PA3	Signal Light	Signal Light

Table 2: Microcontroller connections

5 Assembly Notes

5.1 Soldering

The daughterboards are designed to be reflow soldered. Solder paste should be deposited using a kapton stencil (OSHStencils is an inexpensive source), then surface-mount components should be placed. Next, the solder should be reflowed in an oven. Through-hole parts should be soldered manually.

5.2 Connectors

MTA connectors are insulation-displacement connectors, meaning the wires do not need to be stripped before they are inserted. A special tool (MTA-100: A9982-ND, MTA-156: A9981-ND) is needed to push the wires down into the connector. These tools are a bit expensive, and the business end is quite simple, so we'll probably make our own. In a pinch, a small screwdriver can be used to insert the wires. However, connectors assembled this way should not be used on the robot due to due to reliability concerns.

Twisted pairs from cat-5 cable are used for much of the daughterboard wiring. When multiple pairs are used in a single cable, they should be bundled together with half-inch pieces of heatshrink tubing every three inches or so.

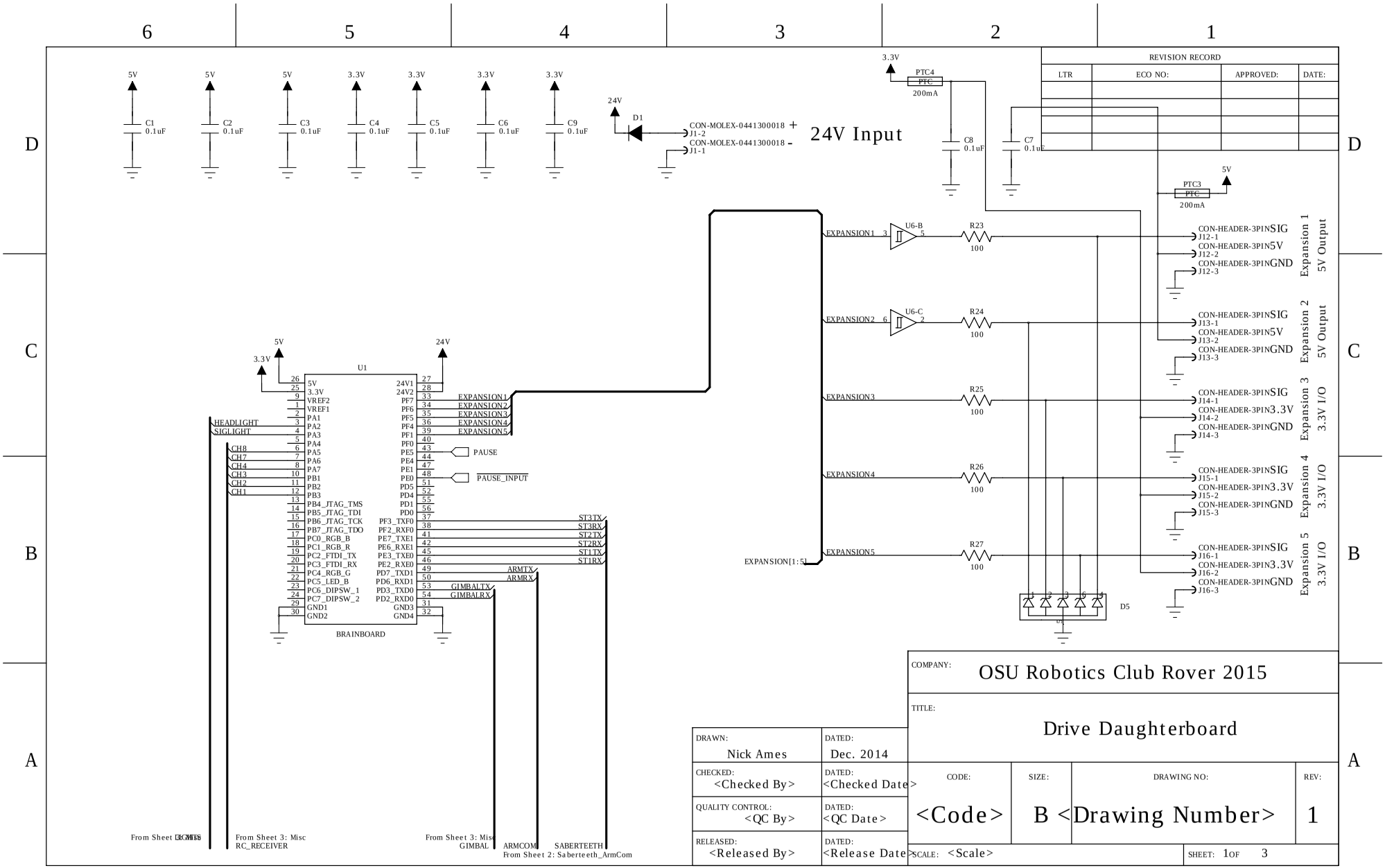
6 Assembly/Ordering Bill of Materials

(This is a summary bill of materials. For a complete BOM, refer to the design files.)

Qty	RefDes	Description	Digikey Part #
9	C1-C9	0.1uF, >=10V Ceramic Capacitor, 603 Package	1276-1012-1-ND
1	D1	Schottky diode, >=4A rating, SC-110APackage	DB2431200LCT-ND
4	D2-D5	5 Channel TVS Array, 5V Working Voltage, SOT-363 Package	ESD5V0S5USE6327INCT-ND
1	J1	2-pin Mini-Fit Jr. Right-Angle Connector	WM7513-ND
4	J2-J4, J11	MTA-100 3-pin connector, vertical header	A19430-ND
4	J2D-J4D, J11D	MTA-100 3-pos strain relief	A19231-ND
4	J2M-J4M, J11M	MTA-100 3-pin connector, 24 AWG wire, w/ tabs	A31018-ND
2	J5, J6	MTA-156 2-pin connector, vertical header	A113559-ND
2	J5D, J6D	MTA-156 2-pos strain relief	A19740-ND
2	J5M, J6M	MTA-156 2-pin connector, 24 AWG wire, w/ tabs	A31643-ND
1	J7	MTA-100 4-pin connector, vertical header	A19431-ND
1	J7D	MTA-100 4-pos strain relief	A19232-ND
1	J7M	MTA-100 4-pin connector, 24 AWG wire, w/ tabs	A31019-ND
3	J8-J10	MTA-100 2-pin connector, vertical header	A19423-ND
3	J8D-J10D	MTA-100 2-pos strain relief	A19230-ND
3	J8M-J10M	MTA-100 2-pin connector, 24 AWG wire, w/ tabs	A31017-ND
5	J12-J16	3-pin Male Header	-
2	LED1, LED2	Yellow LED, 603 Package	160-1448-1-ND
2	PTC1, PTC2	1.1A Hold Current PTC, 2920 Package	507-1744-1-ND
2	PTC3, PTC4	200mA Hold Current PTC, 1206 Package	507-1797-1-ND
2	Q1, Q2	N-ch MOSFET, >30V Vds, 3.3V logic level gate, SOT-23 Package	SI2356DS-T1-GE3CT-ND
14	R1, R4, R11, R14, R15, R17-R20, R23-R27	100 Ohm 5% Resistor, 603 Package	RHM100CGCT-ND
7	R2, R5, R7, R9, R16, R12, R21	1k Ohm 5% Resistor, 603 Package	RHM1.0KCGCT-ND
4	R3, R6, R13, R22	10k Ohm 5% Resistor, 603 Package	RHM10KCGCT-ND
2	R8, R10	330 Ohm 5% Resistor, 603 package	RHM330CGCT-ND
1	U1	Brainboard	-
2	U1FA, U1FB	14-pin Female Header	-
1	U1M	2x14 Male Header	WM8132-ND
1	U2	RC Receiver	-
4	U2J1-U2J4	2x3 Female Header	A106661-ND
1	U3	Xbee	-
2	U3J1, U3J2	10-pin, 2mm female header	S5751-10-ND
6	U4-U9	74LVC3G17 Logic Buffer, TSSOP-8 package	568-7686-1-ND

Table 4: Summary of Assembly/Ordering BOM

7 Schematic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C
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A
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APPROVED:
DATE:
5V
3.3V
24V
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C2 0.1uF
C3 0.1uF
C4 0.1uF
C5 0.1uF
C6 0.1uF
C9 0.1uF
D1
CON-MOLEX-0441300018 J1-2
CON-MOLEX-0441300018 J1-1
24V Input
PTC4 PTC 200mA
C8 0.1uF
C7 0.1uF
PTC3 PTC 200mA
U1
BRAINBOARD
HEADLIGHT
SIGLIGHT
CH8
CH7
CH4
CH3
CH2
CH1
PAUSE
PAUSE_INPUT
EXPANSION1
EXPANSION2
EXPANSION3
EXPANSION4
EXPANSION5
EXPANSION[1:5]
U6-B
U6-C
R23 100
R24 100
R25 100
R26 100
R27 100
CON-HEADER-3PIN SIG J12-1
CON-HEADER-3PIN 5V J12-2
CON-HEADER-3PIN GND J12-3
Expansion 1 5V Output
CON-HEADER-3PIN SIG J13-1
CON-HEADER-3PIN 5V J13-2
CON-HEADER-3PIN GND J13-3
Expansion 2 5V Output
CON-HEADER-3PIN SIG J14-1
CON-HEADER-3PIN 3.3V J14-2
CON-HEADER-3PIN GND J14-3
Expansion 3 3.3V I/O
CON-HEADER-3PIN SIG J15-1
CON-HEADER-3PIN 3.3V J15-2
CON-HEADER-3PIN GND J15-3
Expansion 4 3.3V I/O
CON-HEADER-3PIN SIG J16-1
CON-HEADER-3PIN 3.3V J16-2
CON-HEADER-3PIN GND J16-3
Expansion 5 3.3V I/O
D5
ST3TX
ST3RX
ST2TX
ST2RX
ST1TX
ST1RX
ARMTX
ARMRX
GIMBALTX
GIMBALRX
From Sheet 3: Misc RC_RECEIVER
From Sheet 3: Misc GIMBAL
ARMCOM
SABERTEETH
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DRAWN: Nick Ames
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DATED: <QC Date>
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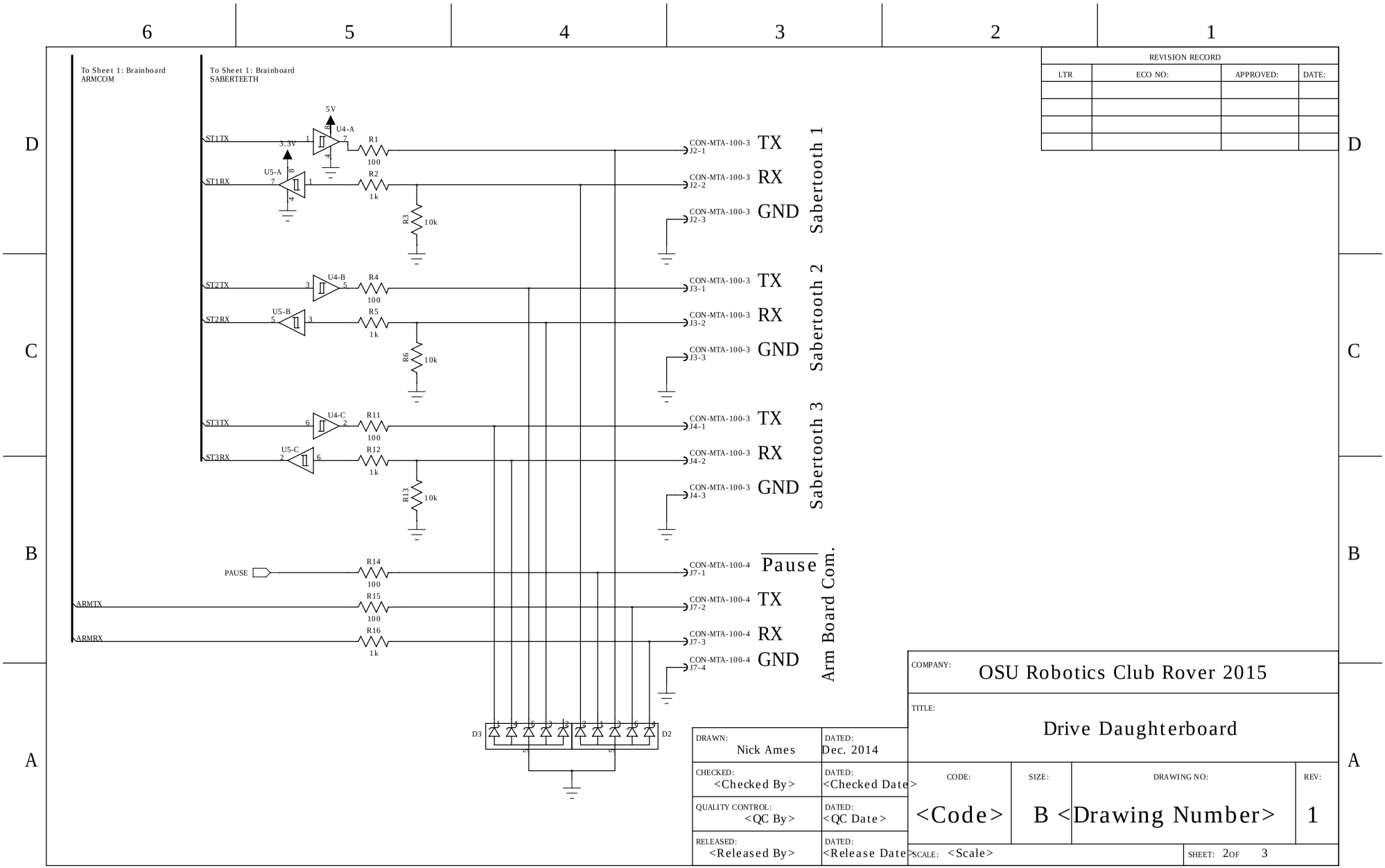
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C
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A
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ARMCOM
To Sheet 1: Brainboard
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3.3V
U4-A
U5-A
U4-B
U5-B
U4-C
U5-C
ST1TX
ST1RX
ST2TX
ST2RX
ST3TX
ST3RX
R1
R2
R3
R4
R5
R6
R11
R12
R13
100
1k
10k
CON-MTA-100-3
J2-1
J2-2
J2-3
J3-1
J3-2
J3-3
J4-1
J4-2
J4-3
TX
RX
GND
Sabertooth 1
Sabertooth 2
Sabertooth 3
PAUSE
R14
CON-MTA-100-4
J7-1
Pause
ARMTX
R15
J7-2
ARMRX
R16
J7-3
J7-4
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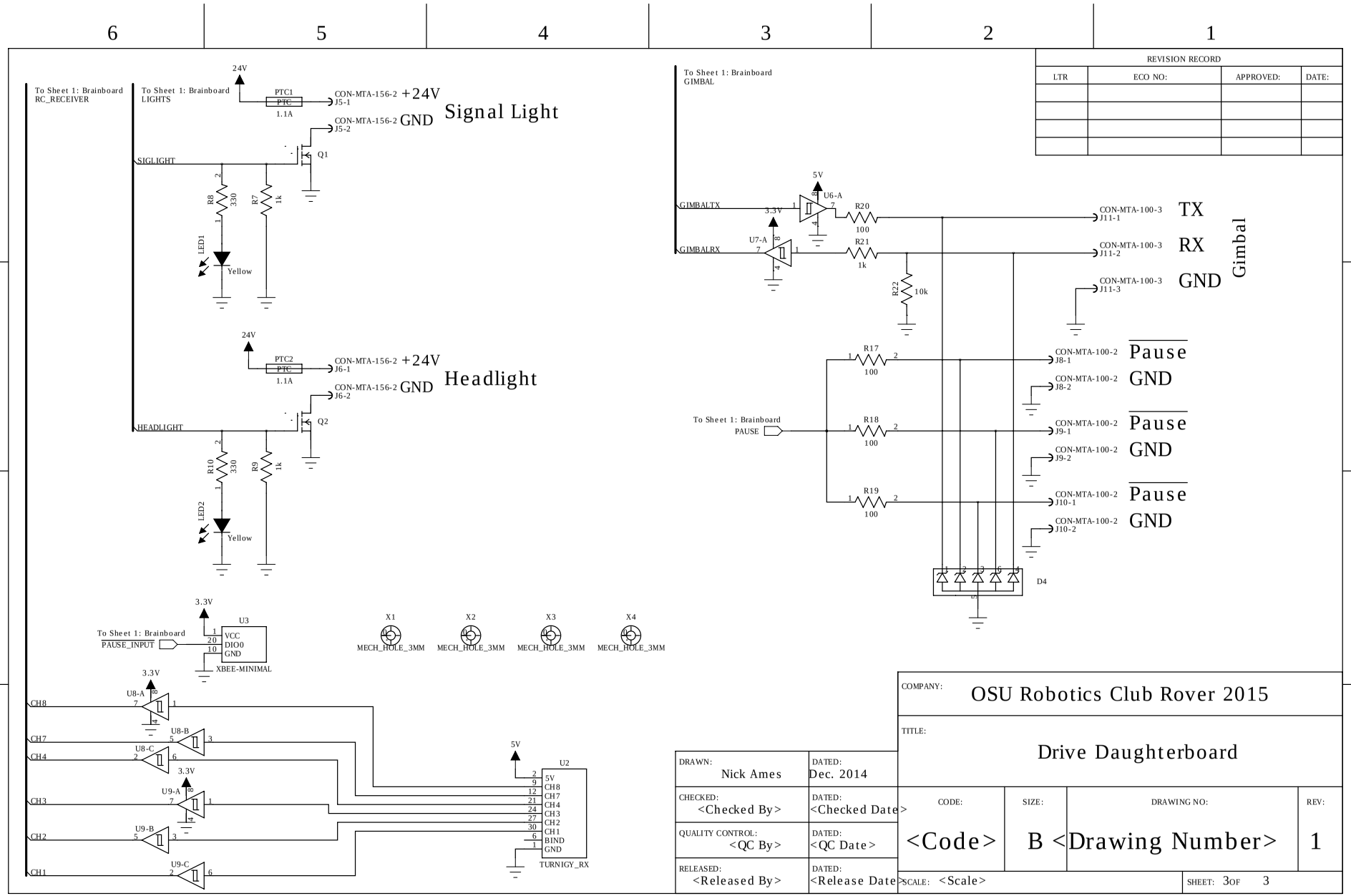
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To Sheet 1: Brainboard LIGHTS
To Sheet 1: Brainboard GIMBAL
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PTC1
PTC
1.1A
CON-MTA-156-2 J5-1
+24V
CON-MTA-156-2 J5-2
GND
Signal Light
SIGLIGHT
Q1
R8 330
R7 1k
LED1
Yellow
PTC2
CON-MTA-156-2 J6-1
CON-MTA-156-2 J6-2
Headlight
HEADLIGHT
Q2
R10 330
R9 1k
LED2
3.3V
U3
VCC
DIO0
GND
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X2
X3
X4
MECH_HOLE_3MM
5V
U6-A
U7-A
GIMBALTX
GIMBALRX
R20 100
R21 1k
R22 10k
CON-MTA-100-3 J11-1
CON-MTA-100-3 J11-2
CON-MTA-100-3 J11-3
TX
RX
GND
Gimbal
R17 100
R18 100
R19 100
CON-MTA-100-2 J8-1
CON-MTA-100-2 J8-2
CON-MTA-100-2 J9-1
CON-MTA-100-2 J9-2
CON-MTA-100-2 J10-1
CON-MTA-100-2 J10-2
Pause
GND
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U8-A
U8-B
U8-C
U9-A
U9-B
U9-C
CH8
CH7
CH4
CH3
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U2
5V
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CH7
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CH3
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