OSURC Rover 2015 Arm Daughterboard Rev. 1 Manual

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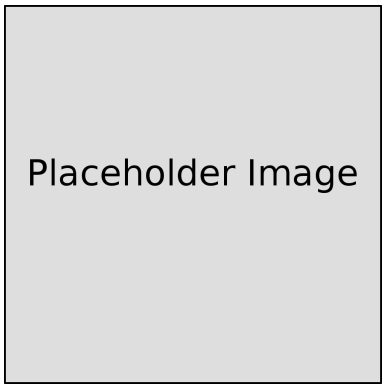


Figure 1: Assembled arm daughterboard

1 General Specifications

This manual covers the arm daughterboard, a component of the electronics of the OSU Robotics Club's 2015 rover. The arm daughterboard holds the stepper drivers for the robot's arm, and provides an interface to the arm's sensors. It includes:

- 5x stepper drivers (Pololu DRV8825 carriers; up to 1.5A per phase)
- 5x limit switch inputs
- 4x interfaces for resistive flex sensors
- A communication interface to the Drive Daughterboard (including the $\overline{\text{PAUSE}}$ signal)

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 Arm 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 stepper drivers and brainboard project from the top of the board, making its highest point approx. 0.75" 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".

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

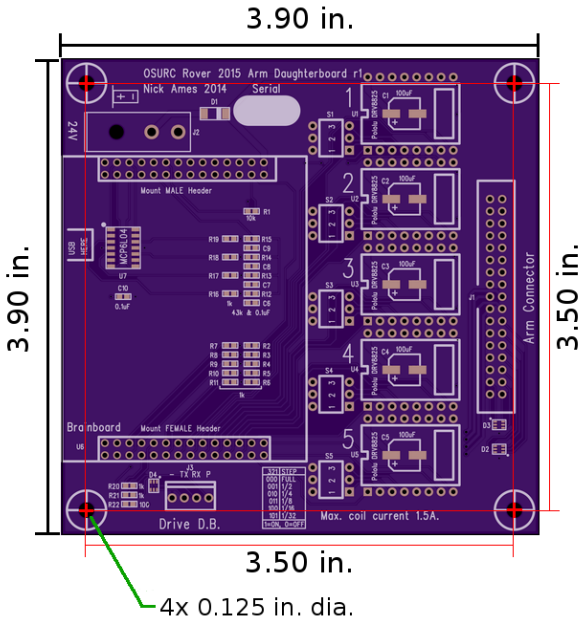
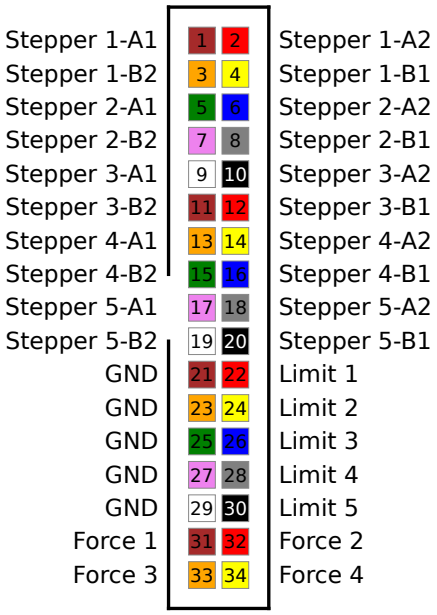


Figure 2: Arm daughterboard PCB dimensions

should be connected to the daughterboard only; the brainboard receives power from the daughterboard. The arm daughterboard can consume a maximum of 4A of current.

3.2 Arm Interface



Connector Parts	
Board Header	Assmann AWP34-7240-T-R (HKC34H-ND)
Wire Connector	Assmann AWHW-34G-0202-T (HRP34H-ND)
Wire	3M 3302/34 300SF (MC34M-5-ND)

Figure 3: Arm connector

3.2.1 Stepper Drivers

The arm daughterboard includes five Pololu DRV8825 stepper driver modules, designated 1-5. Each module has two settings that must be configured: the coil current and the number of microsteps.

Coil current is set using the small trimpot and can be determined by measuring the voltage on the round testpoint near the center of the board. The coil current in amps is equal to twice the test point voltage in volts ($I_{coil} = 2V_{test}$). The maximum allowable coil current is 1.5A. Therefore, the test point voltage should never be set higher than 0.75V. Set the stepper motor current high enough to ensure that steps are never missed, even under maximum speed and the greatest anticipated load.

Microstepping subdivides the physical steps in the stepper motor, allowing smoother movement. The microstep setting of each module is determined by the DIP switch next to it. See table 1 for the settings.

Switches			*Microstep Mode*
3	*2*	*1*	
off	off	off	Full Step
off	off	ON	1/2 (half)
off	ON	off	1/4 (quarter)
off	ON	ON	1/8
ON	off	off	1/16
ON	off	ON	1/32
ON	ON	off	1/32
ON	ON	ON	1/32

Table 1: Stepper driver microstep settings

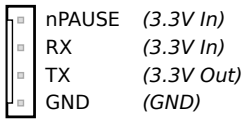
3.2.2 Limit Switches

Limit switches are provided to allow the robot to home the arm axises when it starts up. There are five limit switches, corresponding to the five axises driven by the stepper motors. Each limit switch pin should be connected to an NC (normally-closed) microswitch, with the other terminal of the switch connected to ground. Unconnected limit switches will be interpreted by the microcontroller as being pressed.

3.2.3 Flex Sensors

To identify when an object is grasped, analog inputs for up to four flex sensors are provided. These are designed to be used with Spectrasymbol flex sensors available from Sparkfun (4.5", 2.2"). Each sensor should be connected between the flex input pin and ground. The resistance of the flex sensors can vary dramatically, so the voltage divider resistors on the PCB may need to be changed.

3.3 Drive Daughterboard Interface



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 4: Drive daughterboard interface connector

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

4 Microcontroller Connections

This section contains the complete microcontroller connection table.

Pin	Interface/Device	Interface Signal
PB3	Stepper Drivers	nFAULT
PE4	Stepper Driver 1	Step
PE7	Stepper Driver 1	Dir
PE5	Stepper Driver 1	nEN
PE3	Stepper Driver 2	Step
PE2	Stepper Driver 2	Dir
PE0	Stepper Driver 2	nEN
PD6	Stepper Driver 3	Step
PE1	Stepper Driver 3	Dir
PD7	Stepper Driver 3	nEN
PD5	Stepper Driver 4	Step
PD4	Stepper Driver 4	Dir
PD2	Stepper Driver 4	nEN
PD1	Stepper Driver 5	Step
PD0	Stepper Driver 5	Dir
PD3	Stepper Driver 5	nEN
PA3/ADCA3	Arm	Force Ch. 1
PA2/ADCA2	Arm	Force Ch. 2
PA4/ADCA4	Arm	Force Ch. 3
PA5/ADCA5	Arm	Force Ch. 4
PF6	Arm	Limit Switch 1
PF7	Arm	Limit Switch 2
PF4	Arm	Limit Switch 3
PF0	Arm	Limit Switch 4
PF1	Arm	Limit Switch 5
PF5	Drive Board Com.	nPAUSE input
PF3/TXF0	Drive Board Com.	TX
PF2/RXF0	Drive Board Com.	RX

Table 3: 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 reliability concerns.

Twisted pairs from cat-5 cable are used for the connection to the drive daughterboard. Multiple wires should be bundled together with half-inch pieces of heatshrink tubing every three inches or so.

Ribbon connectors should be assembled using a vise. Line up the ribbon cable in the connector, making sure that the pin one triangle is on the side of the ribbon cable with the brown stripe, and that the cable is exiting from the correct side of the connector. Loosely snap on the retaining clip. Place the part in a vise and tighten the vise to push the retaining clip all the way down. Don't crush the connector.

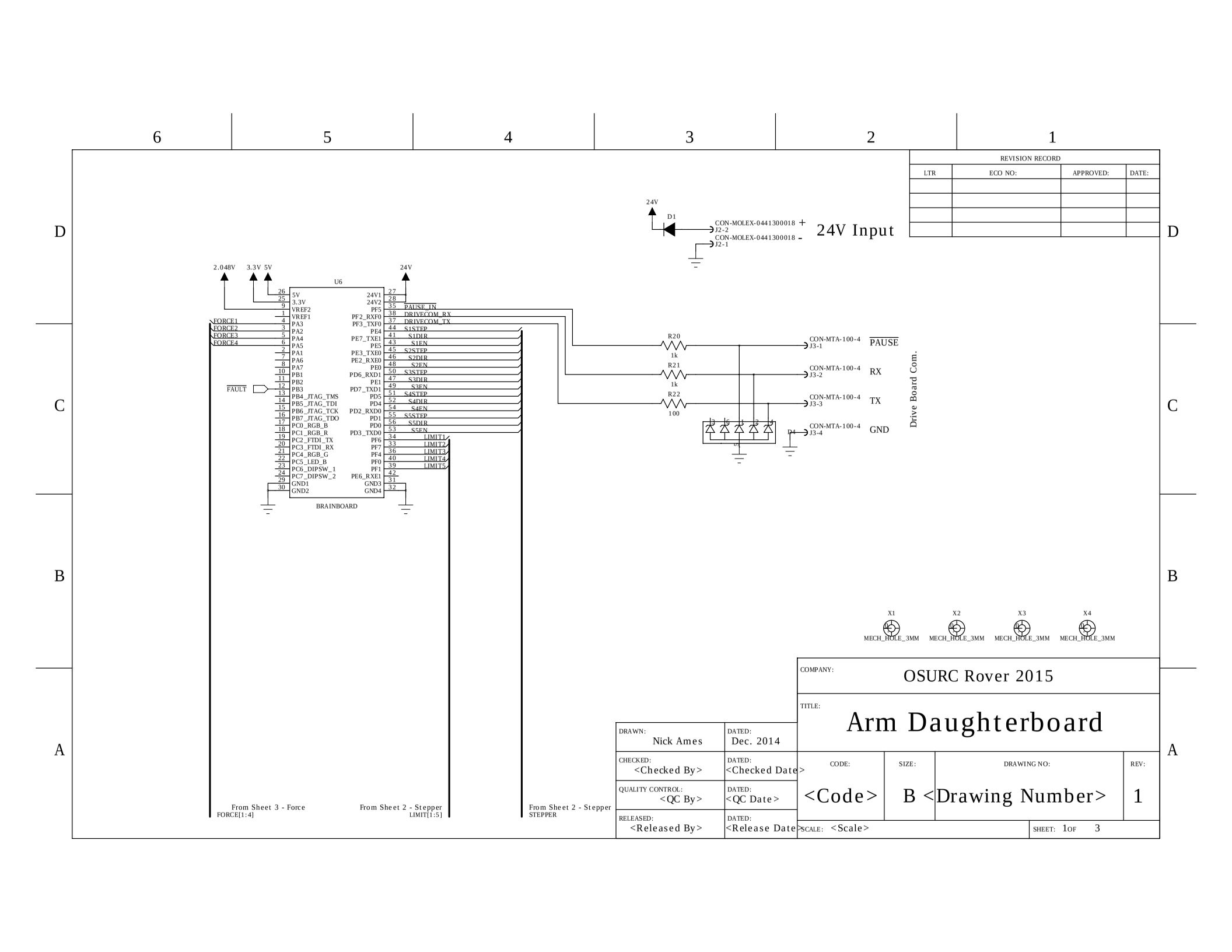
6 Assembly/Ordering Bill of Materials

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

Qty	RefDes	Description	Digikey Part #	Manufacturer	Part #
5	C1-C5	100uF Capacitor	493-2203-1-ND	Nichicon	UWT1V101MCL1GS
5	C6-C10	0.1uF Ceramic Capacitor	1276-1012-1-ND	Samsung	CL10F104ZB8NNNC
1	D1	Schottky diode	DB2431200LCT-ND	Panasonic	DB2431200L
3	D2-D4	5 Channel TVS Array	ESD5V0S5USE6327INCT-ND	Infineon	ESD5V0S5US E6327
1	J2	2-pin Mini-Fit Jr. Connector	WM7513-ND	Molex	441300018
1	J2	34-position ribbon header	HRP34H-ND	Assmann WSW	AWHW-34G-0202-T
1	J2M	34-position ribbon connector	HKC34H-ND	Assmann WSW	AWP34-7240-T-R
1	J2W	34-wire ribbon cable	MC34M-5-ND	3M	3302/34 300SF
1	J3	MTA-100 4-pin header	A19431-ND	TE	640454-4
1	J3D	MTA-100 4-pos strain relief	A19232-ND	TE	643075-4
1	J3M	MTA-100 4-pin connector	A31019-ND	TE	3-643814-4
1	R1	10k Ohm Resistor	RHM10KCGCT-ND	Rohm	MCR03ERTJ103
4	R12-R14	43k Ohm Resistor	RHM43KCGCT-ND	Rohm	MCR03ERTJ433
20	R2-R21	1k Ohm Resistor	RHM1.0KCGCT-ND	Rohm	MCR03ERTJ102
1	R22	100 Ohm Resistor	RHM100CGCT-ND	Rohm	MCR03ERTJ101
5	SW1-SW5	3-pos DIP Switch	CT2103MS-ND	CTS	210-3MS
5	U1-U5	Pololu DRV8825 Module	-	Pololu	2133
5	U1J-U5J	16-pin DIP Socket, 0.6?	A118692-ND	TE	2-382712-1
1	U6	Brainboard Module	-	-	-
2	U6FA-U6FB	14-pin Female Header	-	Generic	-
1	U6M	2x14 Male Header	WM8132-ND	Molex	901310134
1	U7	4 channel, Rail-to-Rail Op-Amp	MCP6L04T-E/SLCT-ND	Microchip	MCP6L04

Table 5: Summary of Assembly/Ordering BOM

7 Schematic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4
3
2
1
D
C
B
A
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D1
CON-MOLEX-0441300018
J2-2
CON-MOLEX-0441300018
J2-1
24V Input
2.048V
3.3V
5V
U6
BRAINBOARD
FORCE1
FORCE2
FORCE3
FORCE4
FAULT
R20
1k
R21
1k
R22
100
CON-MTA-100-4
J3-1
PAUSE
CON-MTA-100-4
J3-2
RX
CON-MTA-100-4
J3-3
TX
CON-MTA-100-4
J3-4
GND
Drive Board Com.
D4
X1
X2
X3
X4
MECH_HOLE_3MM
From Sheet 3 - Force
FORCE[1:4]
From Sheet 2 - Stepper
LIMIT[1:5]
From Sheet 2 - Stepper
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Nick Ames
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Dec. 2014
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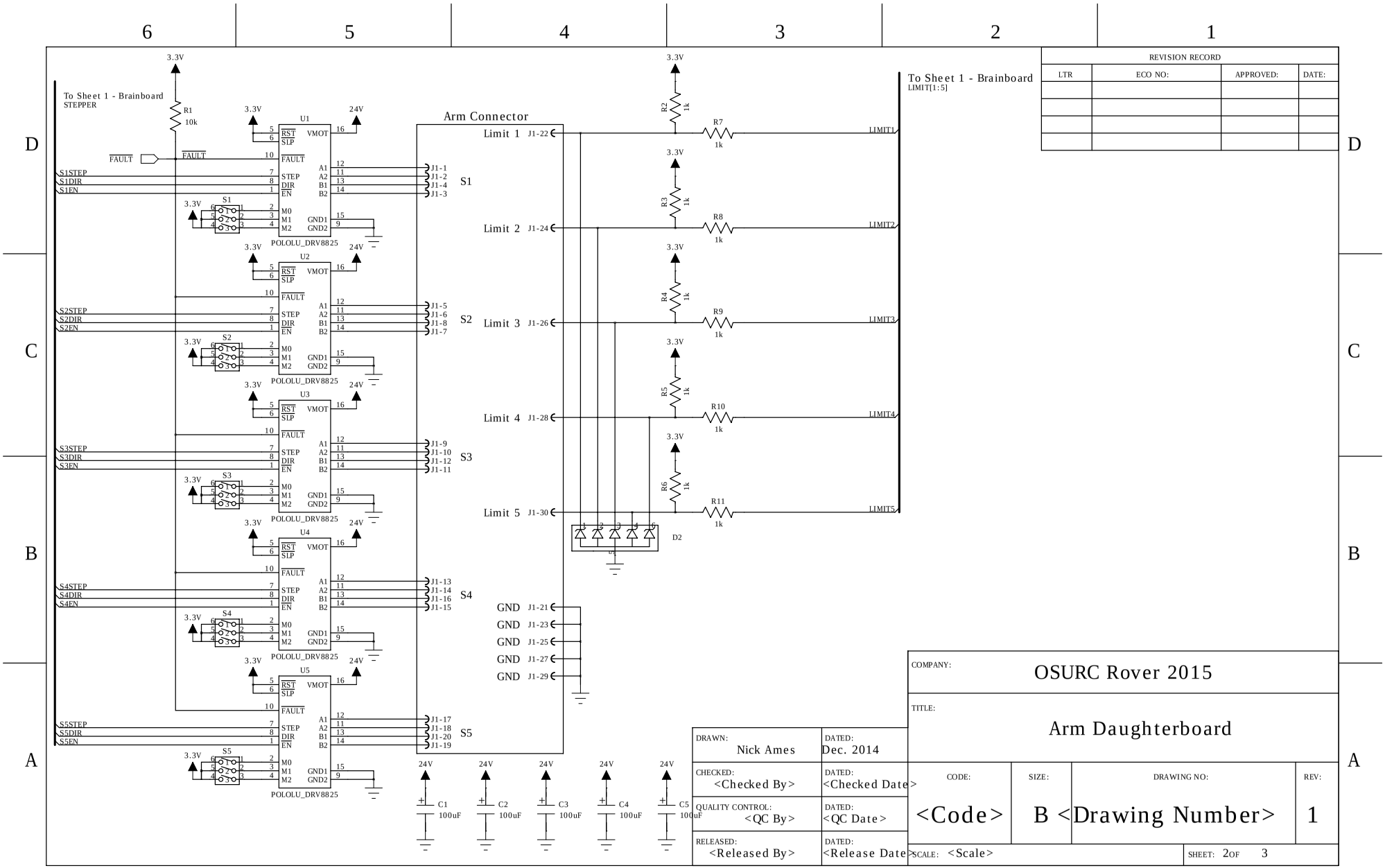
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5
4
3
2
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To Sheet 1 - Brainboard
STEPPER
To Sheet 1 - Brainboard
LIMIT[1:5]
Arm Connector
3.3V
24V
R1
10k
U1
U2
U3
U4
U5
RST
SLP
VMOT
FAULT
STEP
DIR
EN
M0
M1
M2
GND1
GND2
A1
A2
B1
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S1DIR
S1EN
S2STEP
S2DIR
S2EN
S3STEP
S3DIR
S3EN
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S4DIR
S4EN
S5STEP
S5DIR
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J1-14
J1-15
J1-16
J1-17
J1-18
J1-19
J1-20
Limit 1 J1-22
Limit 2 J1-24
Limit 3 J1-26
Limit 4 J1-28
Limit 5 J1-30
GND J1-21
GND J1-23
GND J1-25
GND J1-27
GND J1-29
R2
R3
R4
R5
R6
R7
R8
R9
R10
R11
1k
LIMIT1
LIMIT2
LIMIT3
LIMIT4
LIMIT5
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C1
C2
C3
C4
C5
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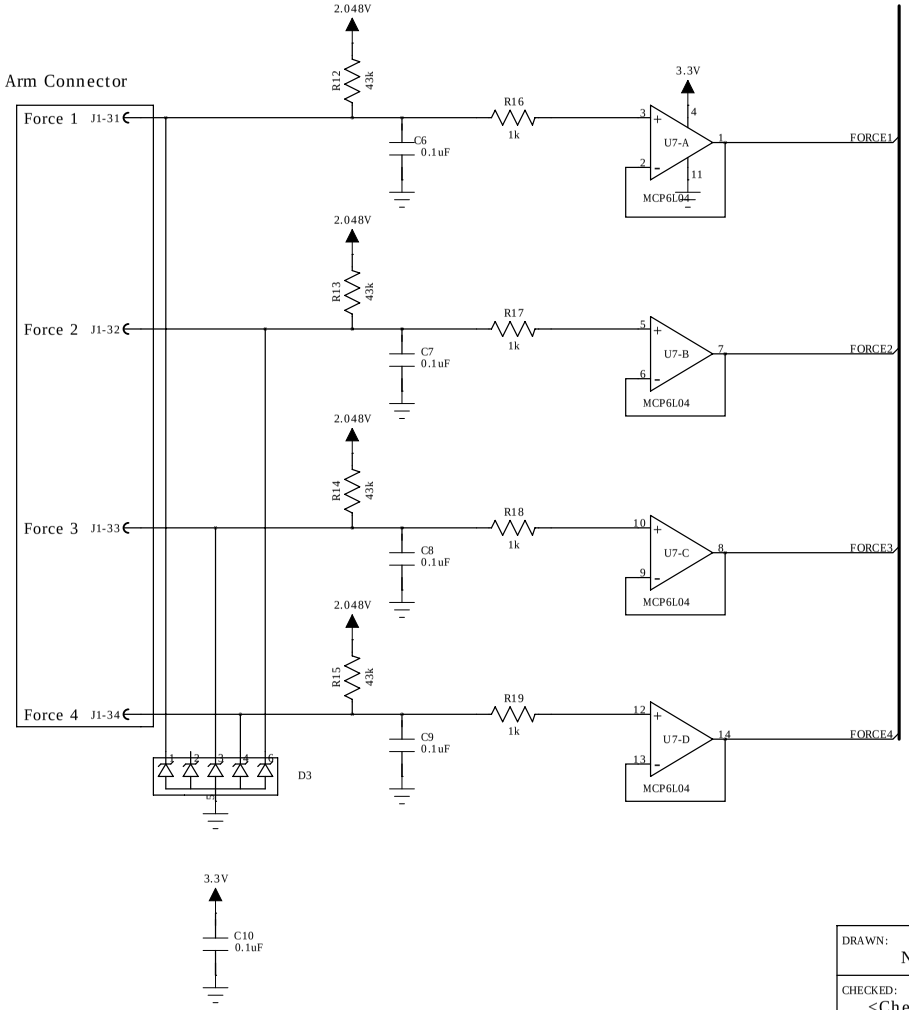

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