

RoboRIO Breakout Board
Team 3044, 0xBE4
Ballston Spa, NY 12020
1/4/2016

Team 3044 (0xBE4) developed a breakout board for the RoboRIO controller used with FIRST FRC robots. We did this for the following reasons:

- Our experience was PWM and other connectors plugged into the 3-pin headers had a tendency to work their way loose during normal robot operation. Clamping them down was awkward.
- For all digital I/O, we would like to have a visual indication of the digital state of the line. This is a big help when trying to debug the robot. A visual indicator goes a long way to answering the question of whether the problem is in software or hardware.
- We want to make use of the MXP expansion port as robots move toward more digital I/O.
- We want to make +12V available for sensors without creating wiring clutter.
- We want to avoid the use of connectors that require delicate crimp connectors that are difficult to debug.

The breakout board we developed has the following features:

- All of the headers (the connectors with standing pins) are captured by the breakout board and brought up to Weidmuller spring-loaded connectors on the PCB. This includes the I2C port, the RS232 port, the digital I/O, the RSL, the relay outputs, the analog inputs, and the PWM outputs.
- The MXP port is also captured by the breakout board.
- All digital I/O lines have +5V and +12V available at the corresponding Weidmuller connector.
- All digital I/O lines have an LED that indicates the state of the line.
- +12V power is brought directly to the breakout board, with a dedicated connector to transfer +12V power to the actual RoboRIO.
- The +12V power for the RoboRIO and the breakout board is protected by two 5A fuses, one for the RoboRIO, and the second for the breakout board.
- Each +12V channel is indicated by an LED to help with troubleshooting power problems.
- Eight (8) of the digital I/O for the MXP expansion port are configured for shaft encoders, capturing two digital I/O lines in each Weidmuller connector.
- Holes in the PCB are available for standoffs to support the PCB beyond the footprint of the RoboRIO.
- Holes in the PCB are available for securing wires to the PCB.

The breakout board is not able to modify any control signals that might be used to control motors, consistent with FRC robot rules.

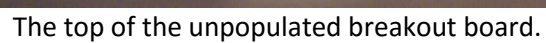
The schematic and PCB layout files are available in compressed form. The PCBs need to be ordered through ExpressPCB (<http://www.expresspcb.com/>).

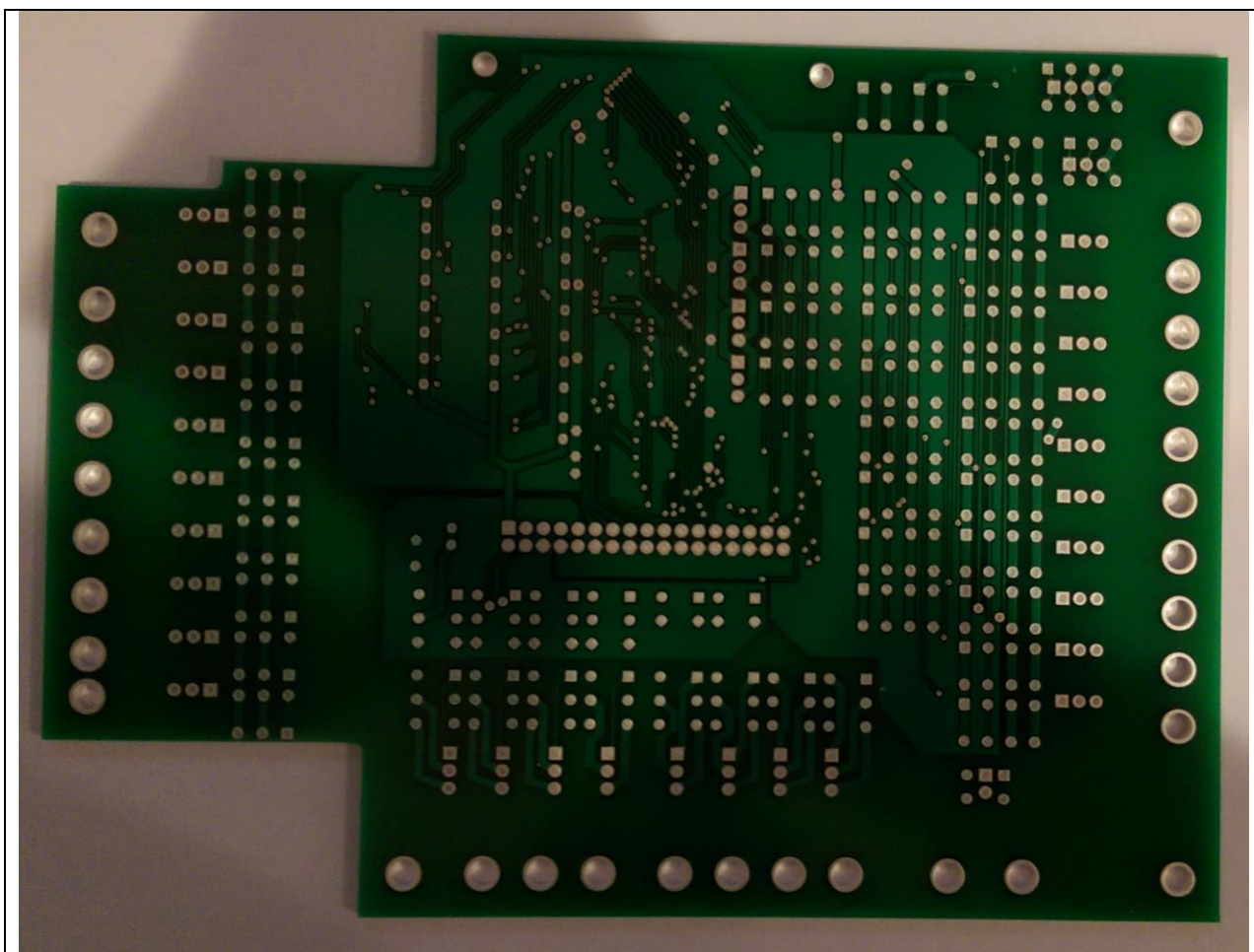
The following pages provide:

- A bill of materials (BOM) for the breakout board.
- Pictures of the unpopulated breakout board.
- Pictures of the populated breakout board.
- A picture of the breakout board installed on the RoboRIO.

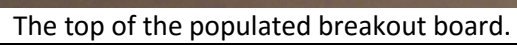
- The recommended assembly order for the breakout board.
- The schematics of the breakout board.
- The PCB traces of the breakout board.

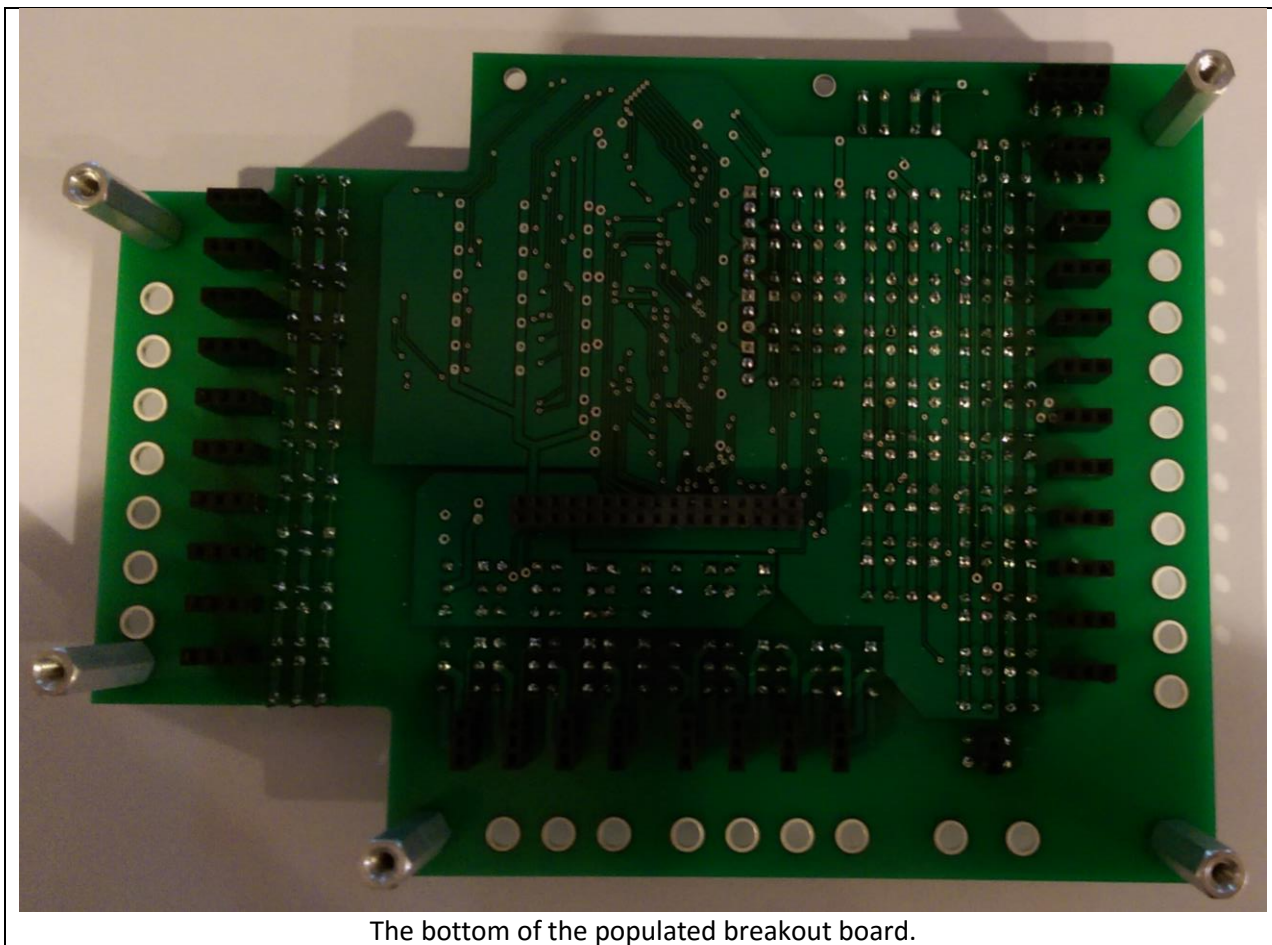
The BOM for the breakout board.			
Quantity	Part	Value	Ordering Info
5	U1, U2, U3, U4, U5	74AHCT04	Digikey 296-4642-1-ND
5	6-32 screw		Digikey 36-9903-ND
7	C1, C2, C3, C4, C5, C6, C7	0.1u	Digikey 445-13749-1-ND
4	J85, J86, J87, J88		Digikey 609-3461-ND
28	D1, D2, D3, D4, D5, D6, D7, D8, D9, D10, D11, D12, D13, D14, D15, D16, D17, D18, D19, D20, D21, D22, D23, D24, D25, D26, D27, D28		Digikey 67-2225-1-ND
26	R1, R2, R3, R4, R5, R6, R7, R8, R9, R10, R11, R12, R13, R14, R15, R16, R17, R18, R19, R20, R21, R22, R23, R24, R25, R26	402	Digikey 985-1260-1-ND
2	R27, 28	2k	Digikey 985-1267-1-ND
	R28	2k	Digikey 985-1267-1-ND
1	L1		Digikey A102196CT-ND
2	4-40 screw		Digikey H703-ND
1	J25		Digi-Key S7035-ND
29	J3, J5, J7, J9, J11, J13, J15, J17, J19, J21, J23, J27, J29, J31, J33, J35, J37, J39, J41, J43, J45, J47, J49, J51, J53, J55, J57, J59, J61		Digikey S7036-ND
1	J1		Digi-Key S7037-ND
1	J63		Digikey SAM1212-17-ND
2	F1, F2	5A	Digikey SF-1206F500-2CT-ND
5	J26, J76, J77, J83, J84		Weidmuller 1825640000
24	J4, J6, J8, J10, J12, J14, J16, J18, J20, J22, J24, J28, J30, J32, J34, J36, J38, J40, J42, J44, J46, J48, J50, J52, J54, J56, J58, J60, J62, J78, J79, J80, J81, J82		Weidmuller 1825650000
23	J2, J6, J8, J10, J12, J14, J16, J18, J20, J22, J24, J64, J65, J66, J67, J68, J69, J70, J71, J72, J73, J74, J75		Weidmuller 1825660000
5	6-32 threaded standoff 0.875in long		Digikey 36-1816-ND
5	6-32 machine screw		Digikey 36-9903-ND
5	6-32 star lock washer		Digikey H240-ND
2	4-40 machine screw		Digikey H703-ND
2	4-40 star lock washer		Digikey H236-ND



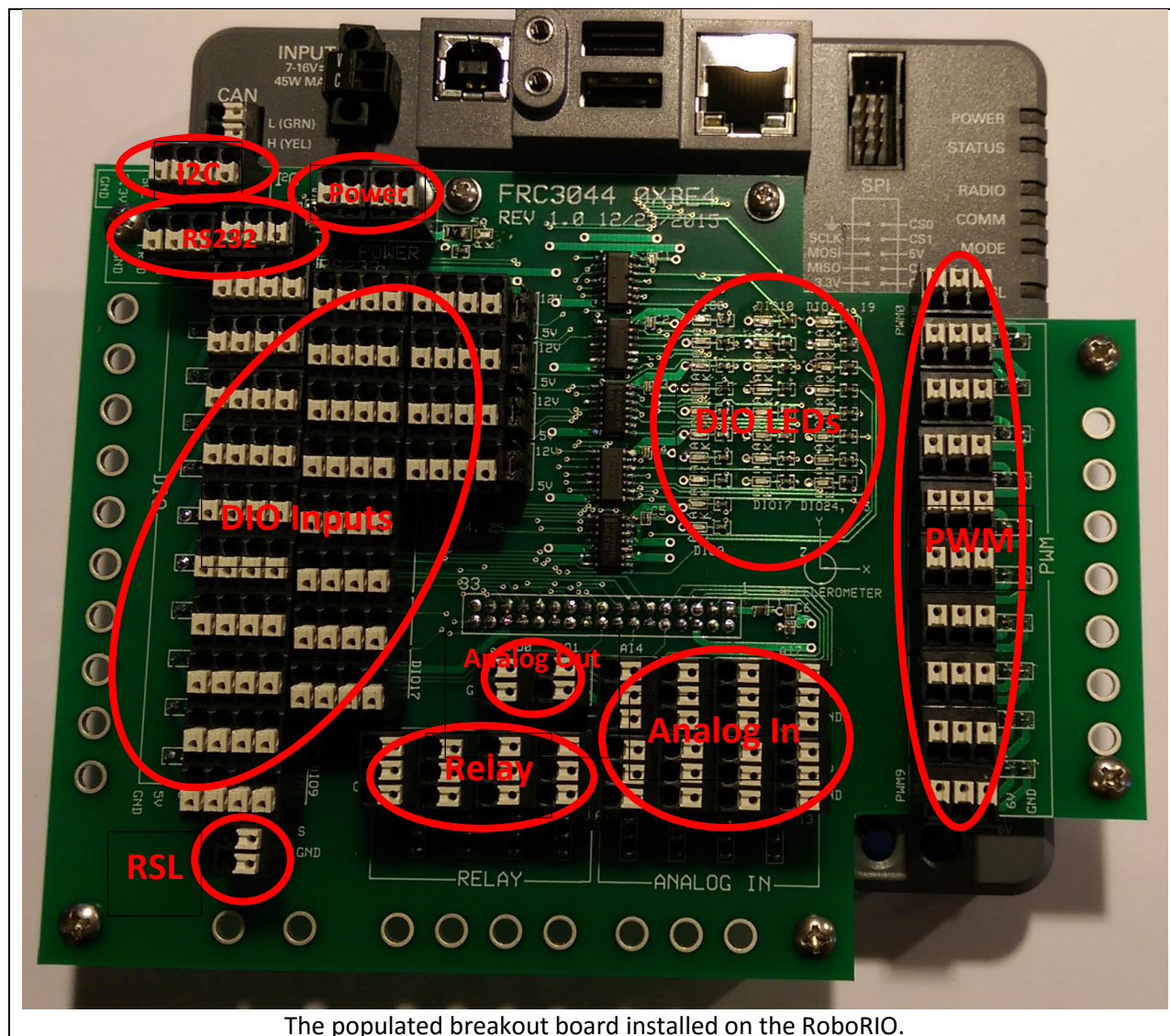


The bottom of the unpopulated breakout board.





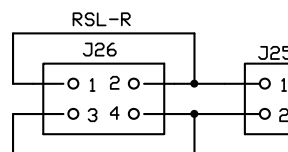
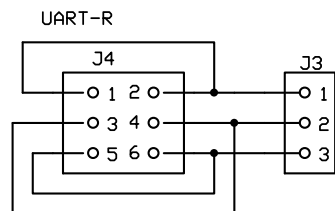
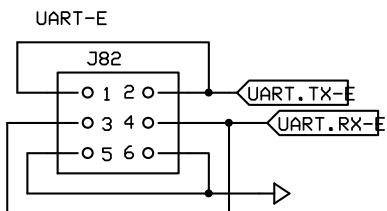
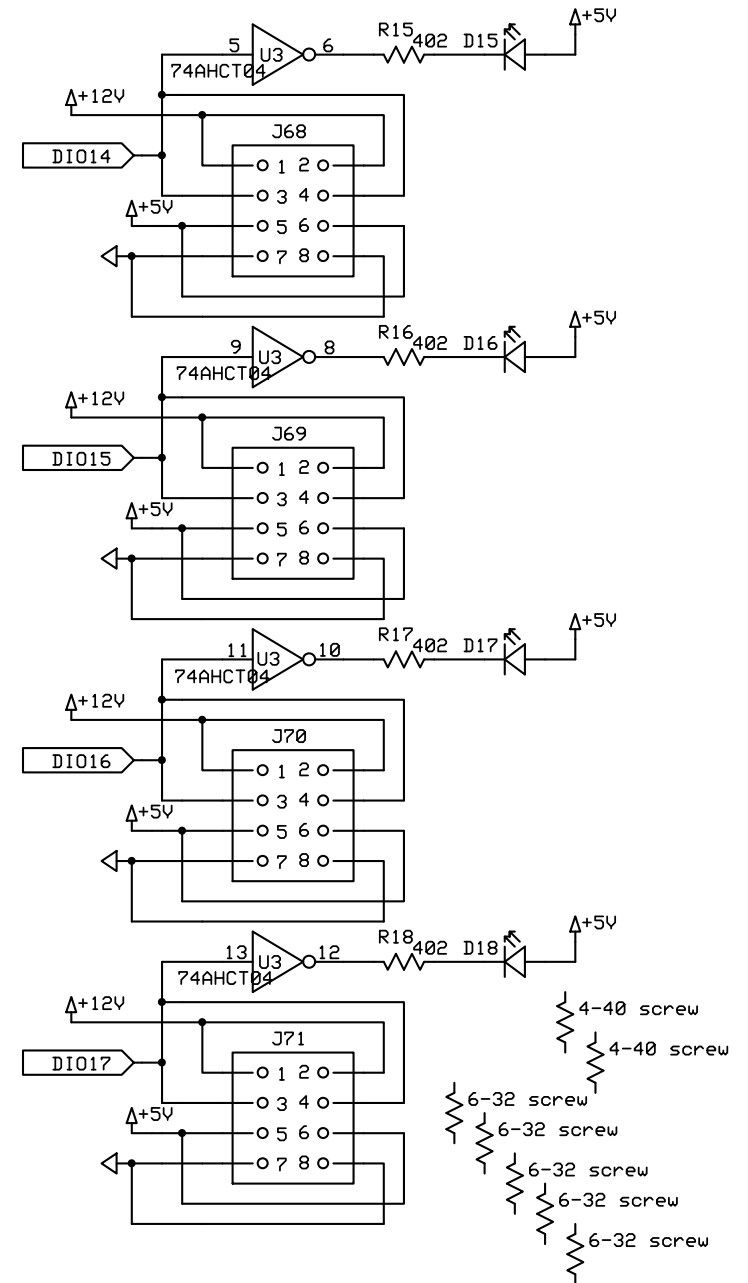
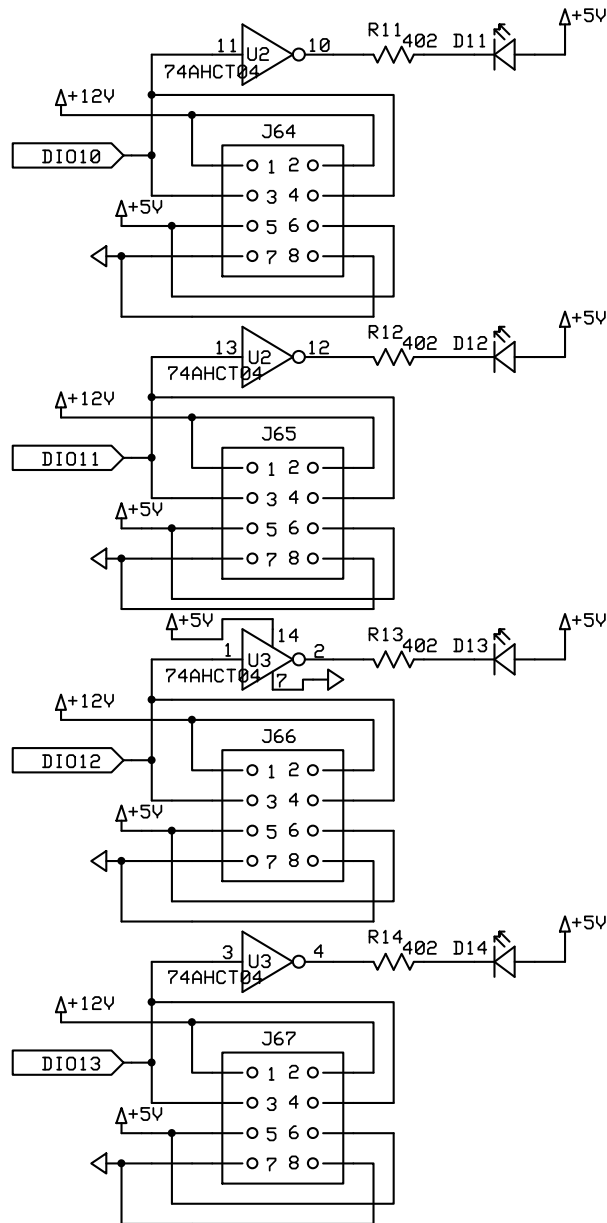
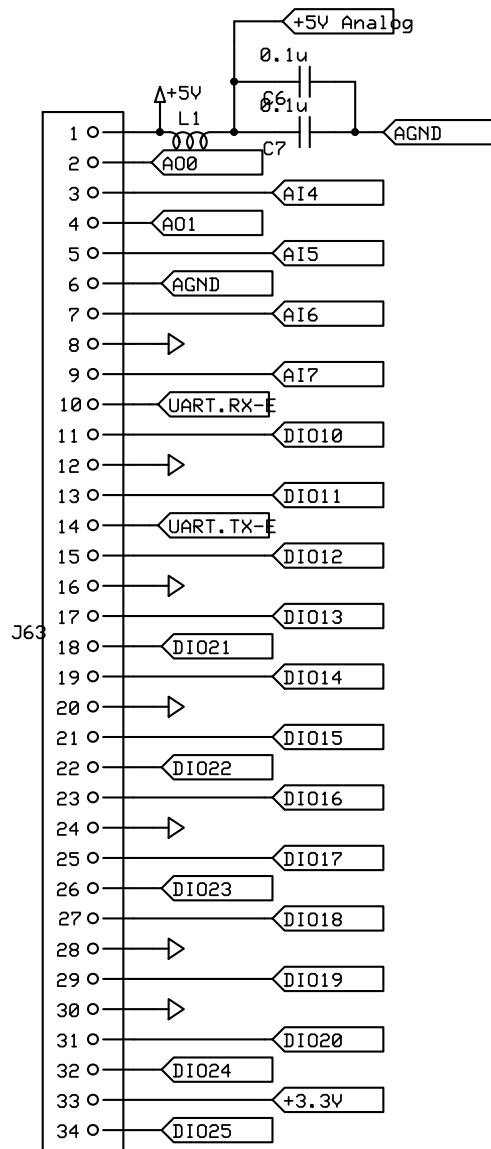
The bottom of the populated breakout board.



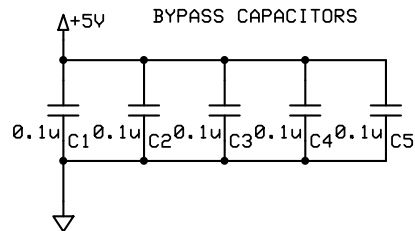
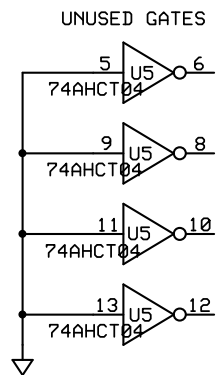
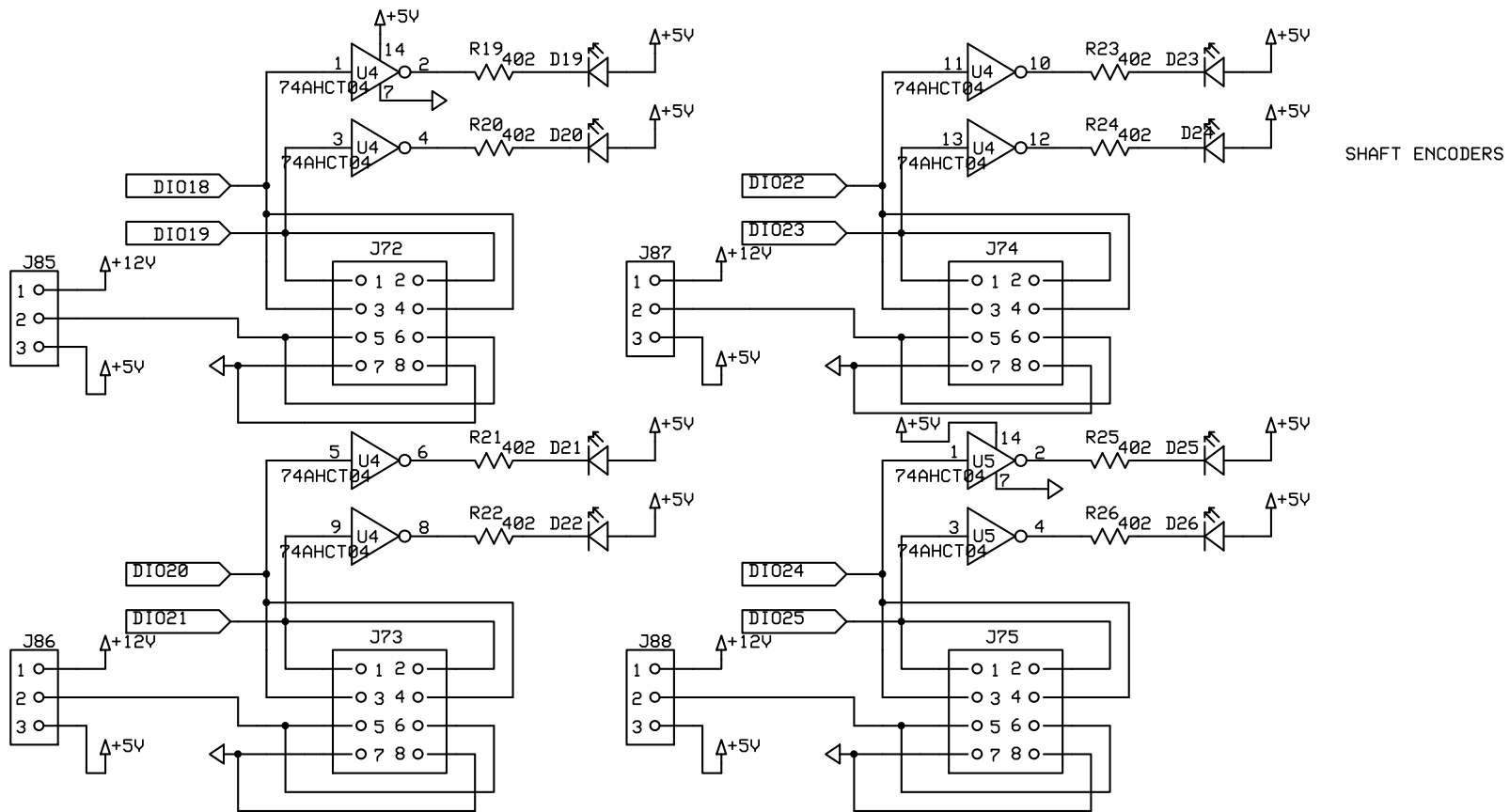
The populated breakout board installed on the RoboRIO.

Assembly order for the PCB is based on populating the components on the bottom of the board first, then adding the components on the top based on how close they are to the board. The smallest components are populated first. Assembly order for the PCB:

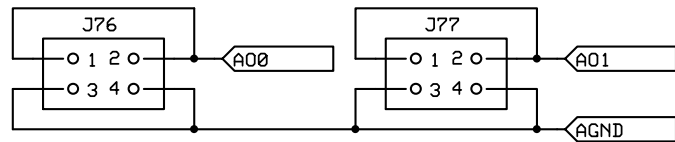
1. Inspect PCB for any shorts. Be particularly careful to inspect vias that are tightly packed.
2. Populate the sockets into the RoboRIO. This included the I2C, RS232, 10 DIO, RSL, 4 relay, 4 analog input, 10 PWM, and the 34 pin MXP expansion port. For the sockets that will be covered with a Weidmuller connector (I2C, RS232, and RSL), trim the pins of the socket as close to the PCB as practical.
3. Install the PCB over the sockets. Use the RoboRIO as the fixture for holding the sockets.
4. Solder the PCB to the sockets.
5. Install the SMT fuses. Check continuity.
6. Install the SMT inductor. Check continuity.
7. Install the 7 SMT capacitors. It is recommended that proper installation of each capacitor be checked as it is installed. To do this, remove the PCB from the RoboRIO and ensure that there is NO continuity between +5V and GND after each capacitor is installed. If there is, there is a problem with the capacitor installation and it must be checked.
8. Install the 2 SMT 2kOhm resistors for the power indication. Verify the quality of the connections by using an Ohmmeter.
9. Install the 26 SMT 402Ohm resistors for the DIO indicators. Verify the quality of the connections by using an Ohmmeter.
10. Install the 2 SMT LEDs associated with the power supply. Verify that each LED works by using a function generator.
11. Install the 26 SMT LEDs associated with the DIO indicators. Verify that each works by using a function generator. Using the function generator through the pads for the ICs will maximize the amount of wiring checked at the same time.
12. Install the 5 SMT ICs. It is suggested to solder one pin to hold the IC in position while the other pins are soldered.
13. Install the 4 0.100" three-pin headers. A second breakout board can be used to help hold the headers in place while soldering. It is recommended that only one pin be soldered each header before checking alignment. Once the alignment is acceptable the other pins can be soldered.
14. For the Weidmuller connectors that cover sockets (the I2C, one RS232 and the RSL), it is necessary to trim the plastic between the pins on the bottom side of the Weidmuller so that the connector sits flat on the PCB. The plastic is trimmed easily with a small pair of diagonal cutters. It is also recommended that the pins from the sockets be trimmed to the extent possible before installing the Weidmuller connectors.
15. Install the Weidmuller connectors. As with the headers, it is recommended that one pin on each connector be soldered first so that the alignment can be checked before soldering the other pins. This will allow you to catch any connectors that are inclined to shift from perpendicular to the board.



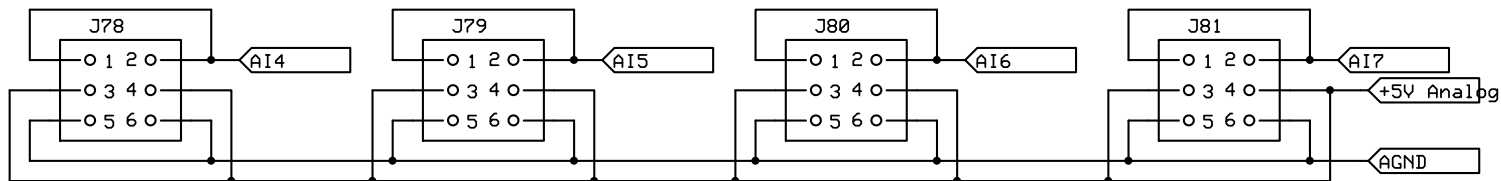
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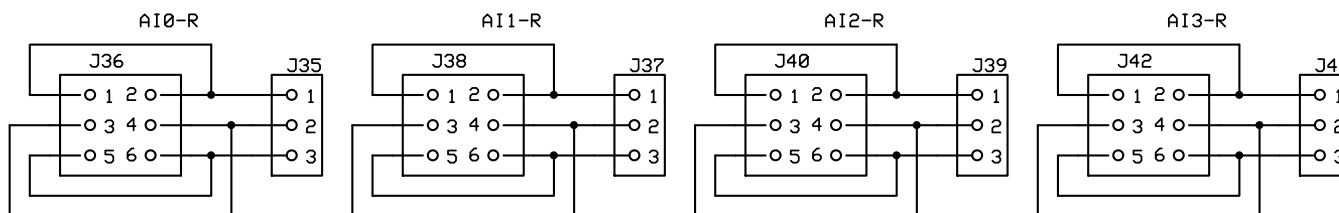
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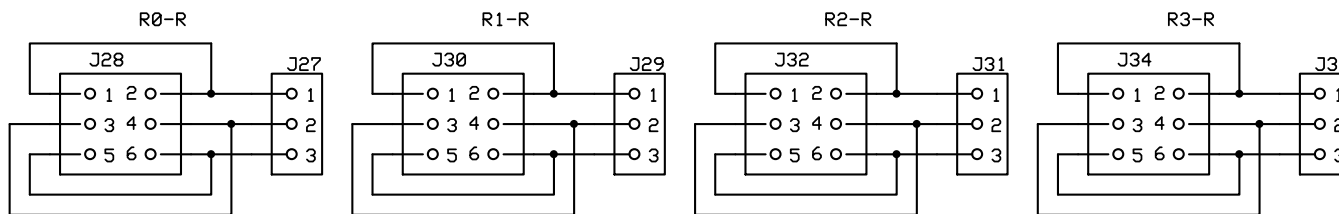
Analog Outputs from MXP



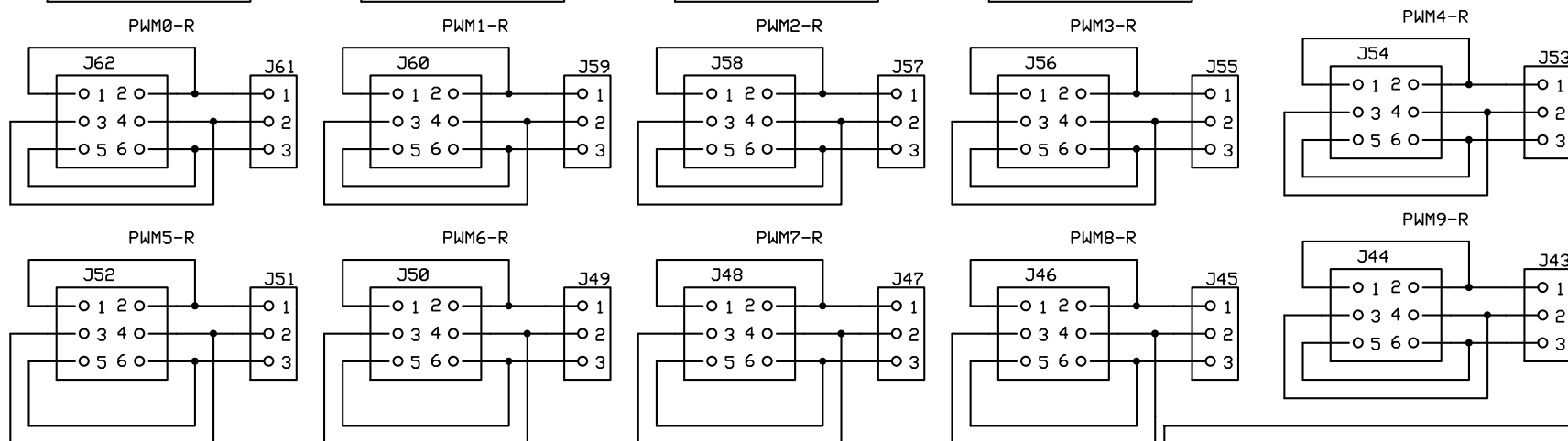
Analog Inputs to MXP



Analog Inputs to RoboRIO



Relay Outputs from RoboRIO



FRC 3044

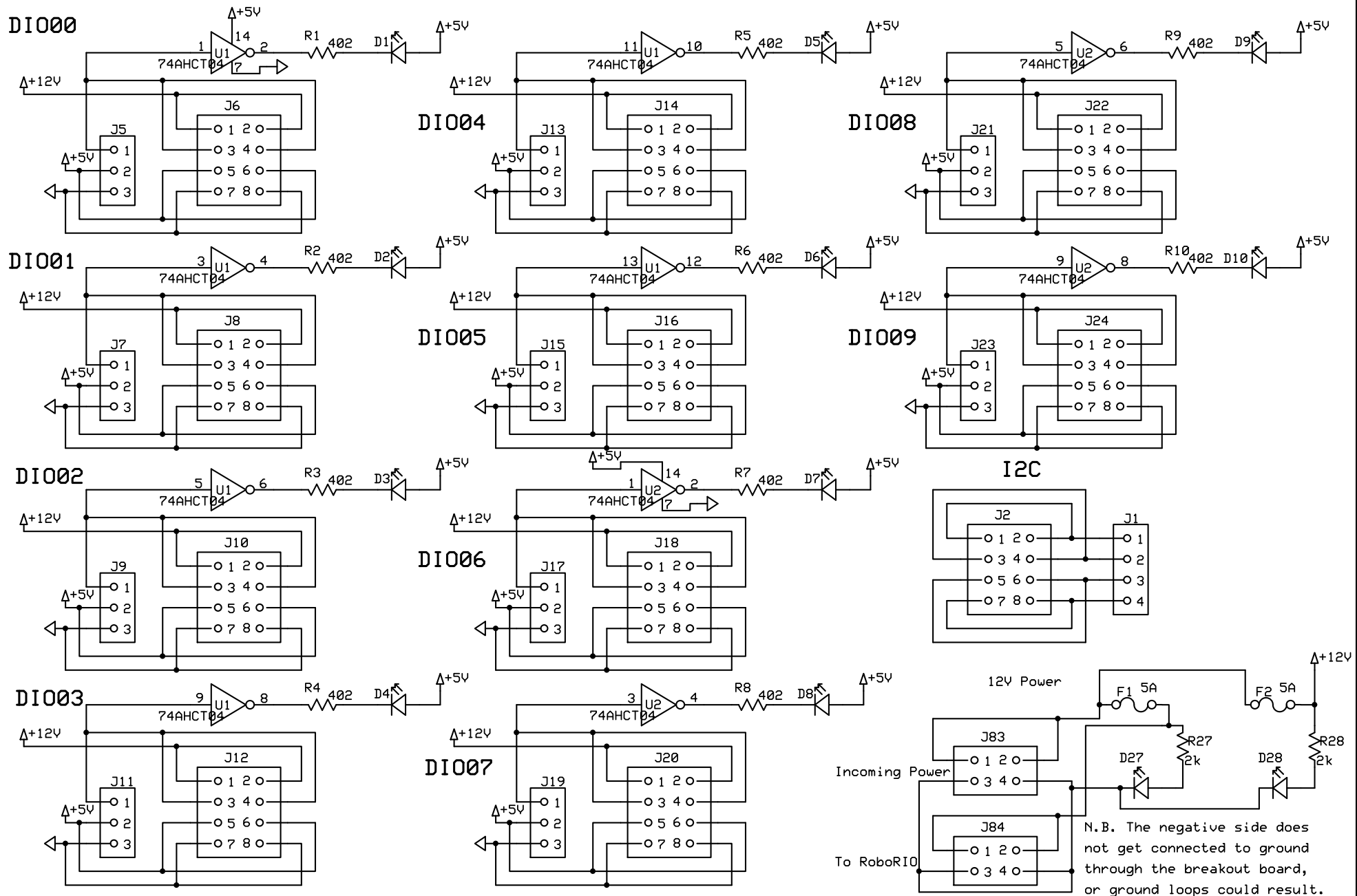
RoboRIO Breakout Board

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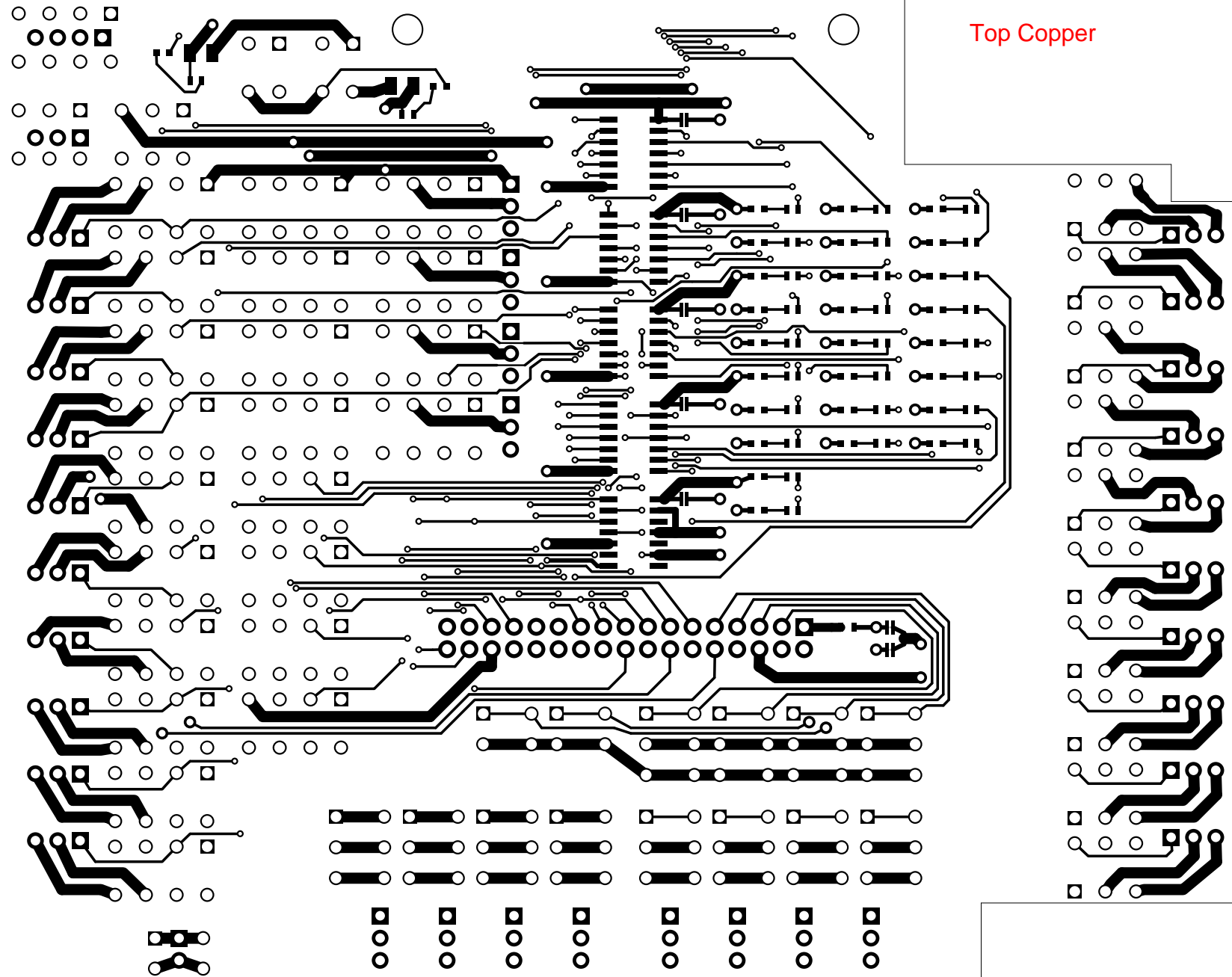
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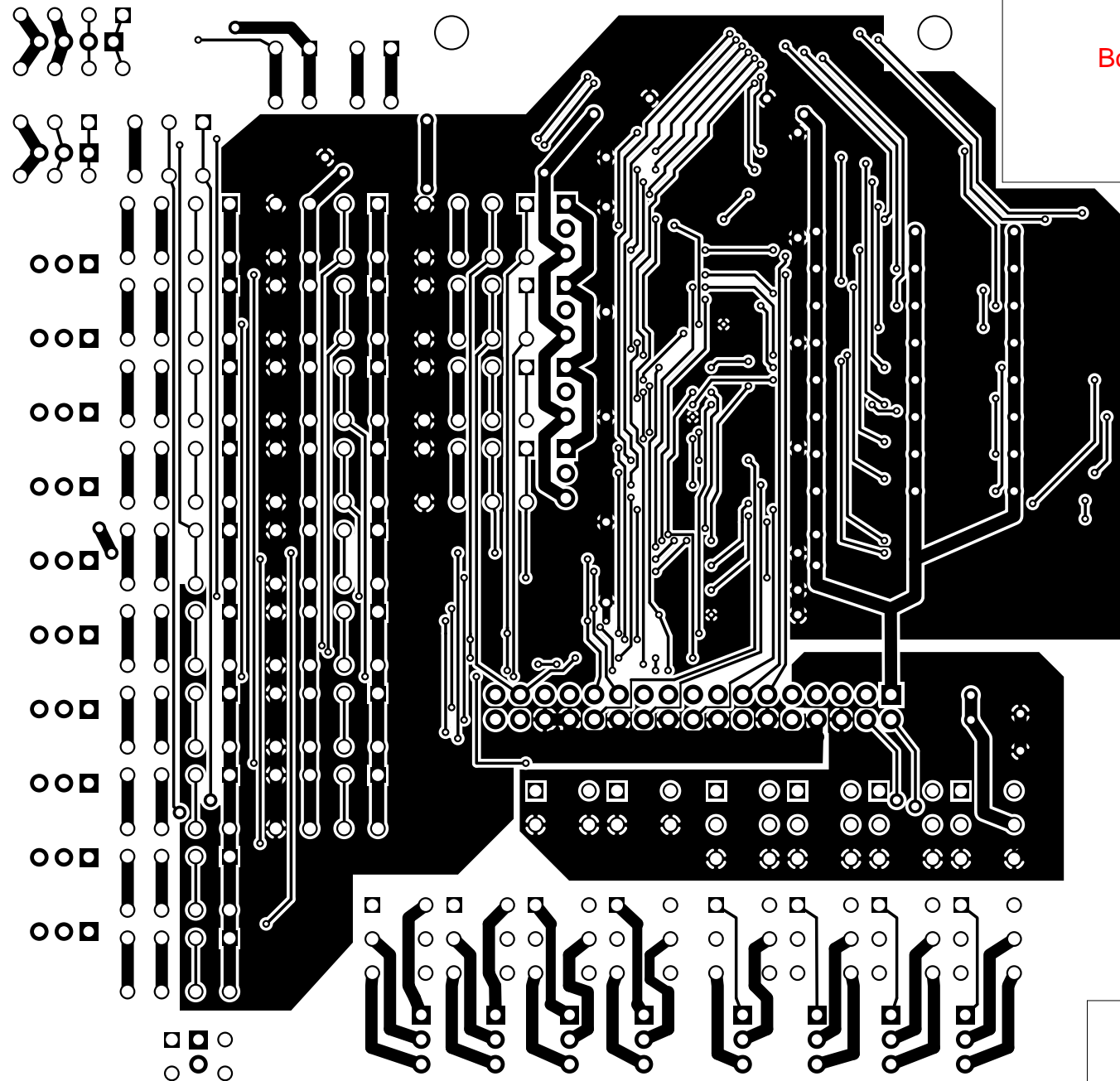
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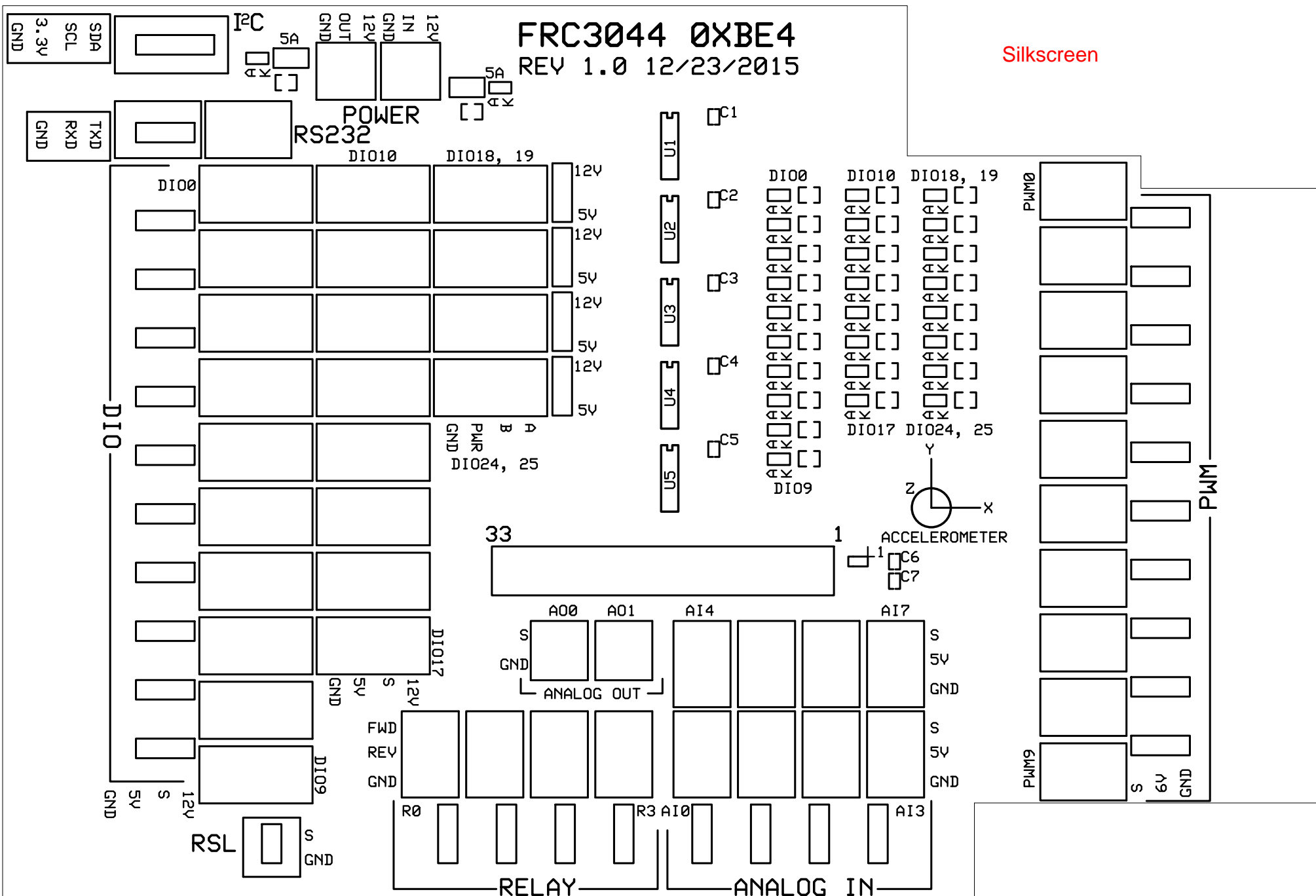
Top Copper



Bottom Copper



Silkscreen



Silkscreen and pads

