NDAC6416 DAC/ADC Daughter Board

Michael Yantis

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Version 0.0.1

REVISION HISTORY		
DATE	**VERSION**	**DESCRIPTION**
03/31/18	0.0.1	Initial version

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INTRODUCTION

PRODUCT PERSPECTIVE

The NDAC6416 originated as an analog music synthesizer controller. The multitude of digital-to-analog and analog-to-digital converters and multiple frequency counter channels also provides a powerful data acquisition system or process control and industrial automation component.

FEATURES

1. Connection to STM32 Nucleo-144 development boards.
2. 64-channel 16-bit voltage out digital-to-analog converters. Software programmable output ranges of 0 to 5V, 0 to 10V, +/-5V, +/-10V and +/-2.5V at 16 to 42 mA.
3. 16-channel 16-bit analog-to-digital converters. Software programmable input ranges of 0 to 5V, 0 to 10V, +/-5V, and +/-10V. Maximum conversion time and sampling rate is guaranteed at 100ksps .
4. 8-channel frequency counter with comparator inputs. Channels are sampled continuously, simultaneously and independently. Input range is +/-18V. Channels are timed against a 108Mhz clock.
5. 8 digital general purpose input/output channels with 0-3.3V range.

USER OVERVIEW

Electronic test groups, laboratory equipment technicians, analog music synthesizer owners and technicians, and process control and industrial automation technicians.

OPERATING ENVIRONMENT

The NDAC6416 connects to an STM32 Nucleo-144 board running C++ ARM code in an RTOS environment. The Nucleo-144 has a high-speed USB port which allows communication with a PC. ST Micro provides PC USB drivers to allow communication over a COM port. Users must provide USB cable (micro B), a +/-12V 1 amp power supply (Phoenix plug 178845 included), and 5V 1 Amp USB micro B power supply.

Code is developed on a PC in the MBED-CLI environment and downloaded to the Nucleo-144 board, also, we provide pre-compiled debug and release bin files to download. Find source code, installation information and bin files here.

CONSTRAINTS: IMPLEMENTATION / DESIGN

Care must be taken to avoid shorting or over voltage to digital and analog inputs and outputs, to provide correct power supply inputs and to correctly connect the daughter board to the Nucleo-144 board.

DOCUMENTATION

The NDAC6416 is 2.8”x4.3” 4-layer PCB: IPC Class 2, FR-4/Aluminum/Polymide, Hasl/Hasl lead-free/ENIG.

DESCRIPTION

PURPOSE

Document describes:

1. Necessary STM32 NUCLEO_F767ZI modifications.
2. Connecting the NDAC6416 DAC/ADC daughter board to the STM32 Nucleo-144 development board.
3. PCB layout and location of the jumpers and connectors.
4. NDAC6416 jumpers.
5. NDAC6416 connectors.
6. Schematic layout.
7. Using the board to drive an analog synthesizer.
8. Describe the analog acquisition system and the frequency counter channels.
9. How to attach a PC to the Nucleo board.

Users following this manual will be able to use a PC to access the analog signals and frequency counters of the NDAC6416.

PROJECT SCOPE

Describe relevant benefits, objectives, and goals and how they relate to corporate goals and strategies.

REFERENCES

1. ST Micro NUCLEO_F767ZI documentation
2. LTC2668 16-channel 16-bit DAC specification.
3. LTC1859 8-channel 16-bit ADC specification.
4. Mbed-OS code for controlling the NDAC6416 ADC/DAC expansion board.

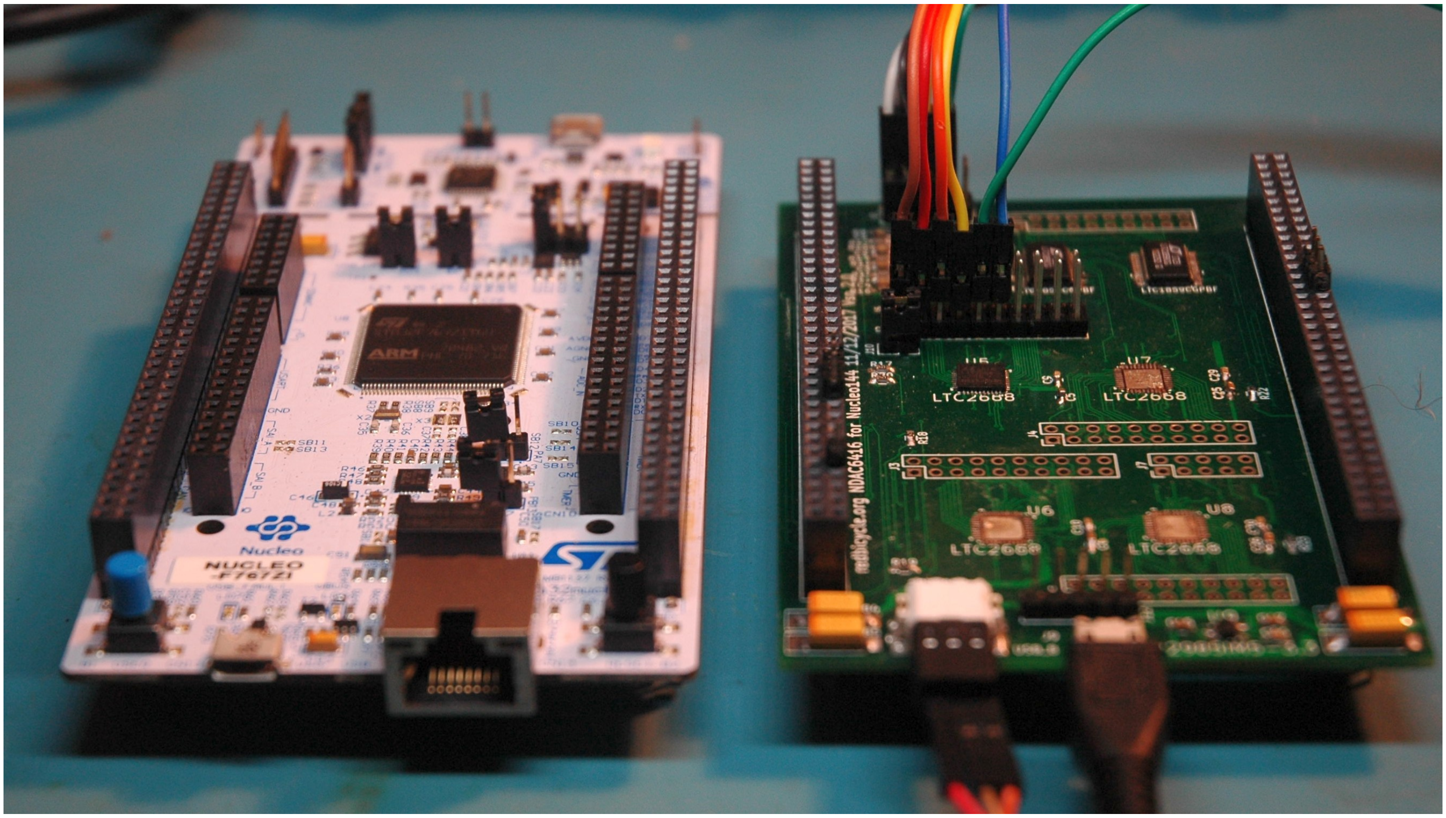
STM32 NUCLEO_F767ZI Modifications

1. Install two 2x35 100 mil PC/104 elevated socket strip ESQ-135-39-G-D-LL, one at CN11 and the other at CN12.
2. The following zero-ohm resistors must be removed (GPIO and timer channels which normally are Ethernet dedicated are needed by the NDAC6416): sb13, sb160, sb164, sb178, sb181, and sb183.
3. Jumper configuration:
    1. CN4 ST-Link jumpers on.
    2. JP3 E5V (pins 1 and 2) jumper on (the 5V supply comes from the NDAC6416). U5V and VIN are off.
    3. JP4 and JP5 on.
    4. JP6 and JP7 off.

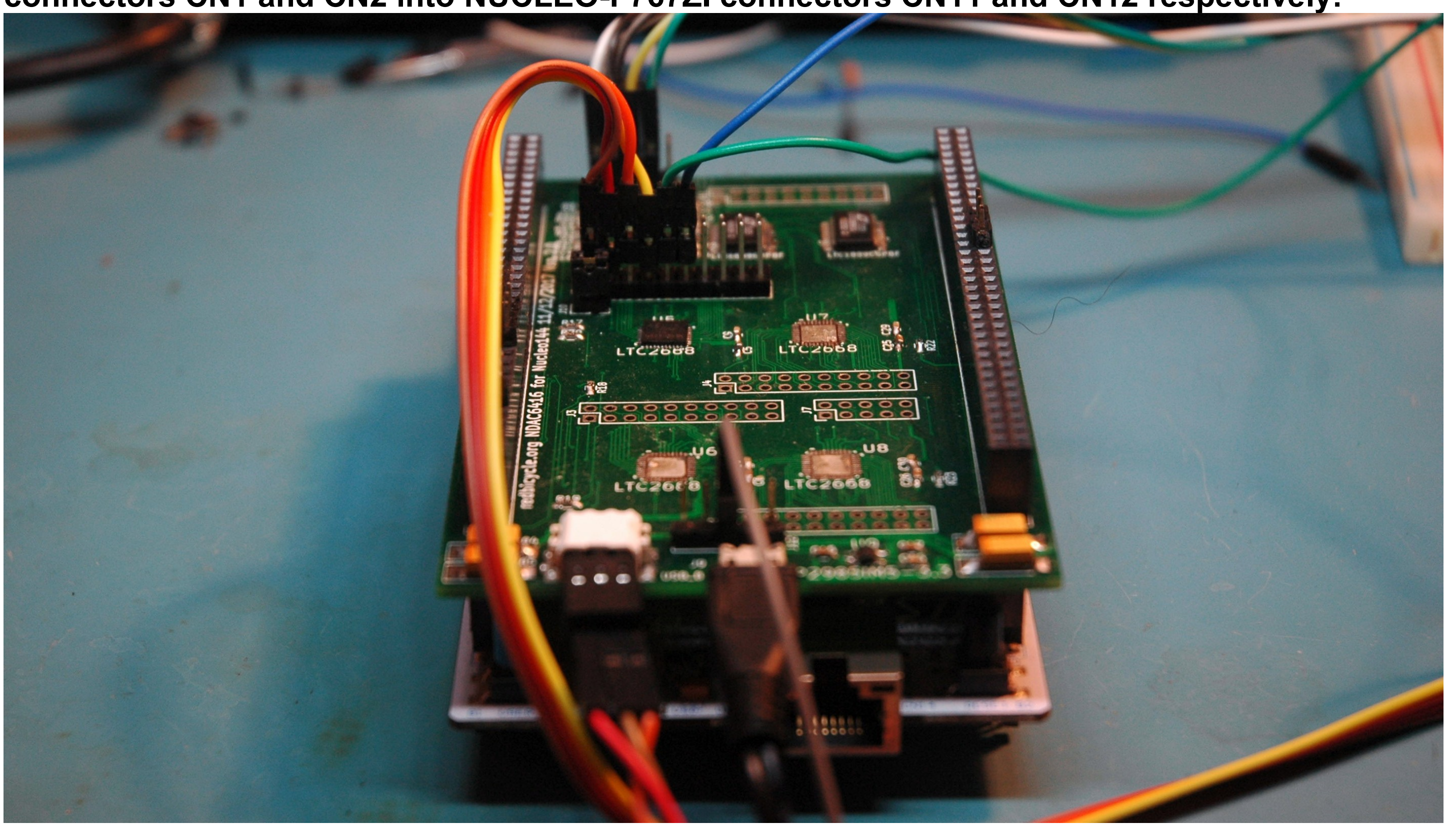
Mating the NDAC64 to the NUCLEO-F767ZI

The STM32 Nucleo-144 development board with STM32F767ZI MCU is available from ST Micro for $22.54. The STM32F767ZI microcontroller has 2 Mbytes of Flash, 512 Kbytes of SRAM, ARM 32-bit Cortex-M7 CPU at 216 MHz, 18 timers, up to 168 I/O ports, and connectors CN10 and CN11 2x35 100 mil connectors which connect to the NDAC6416.

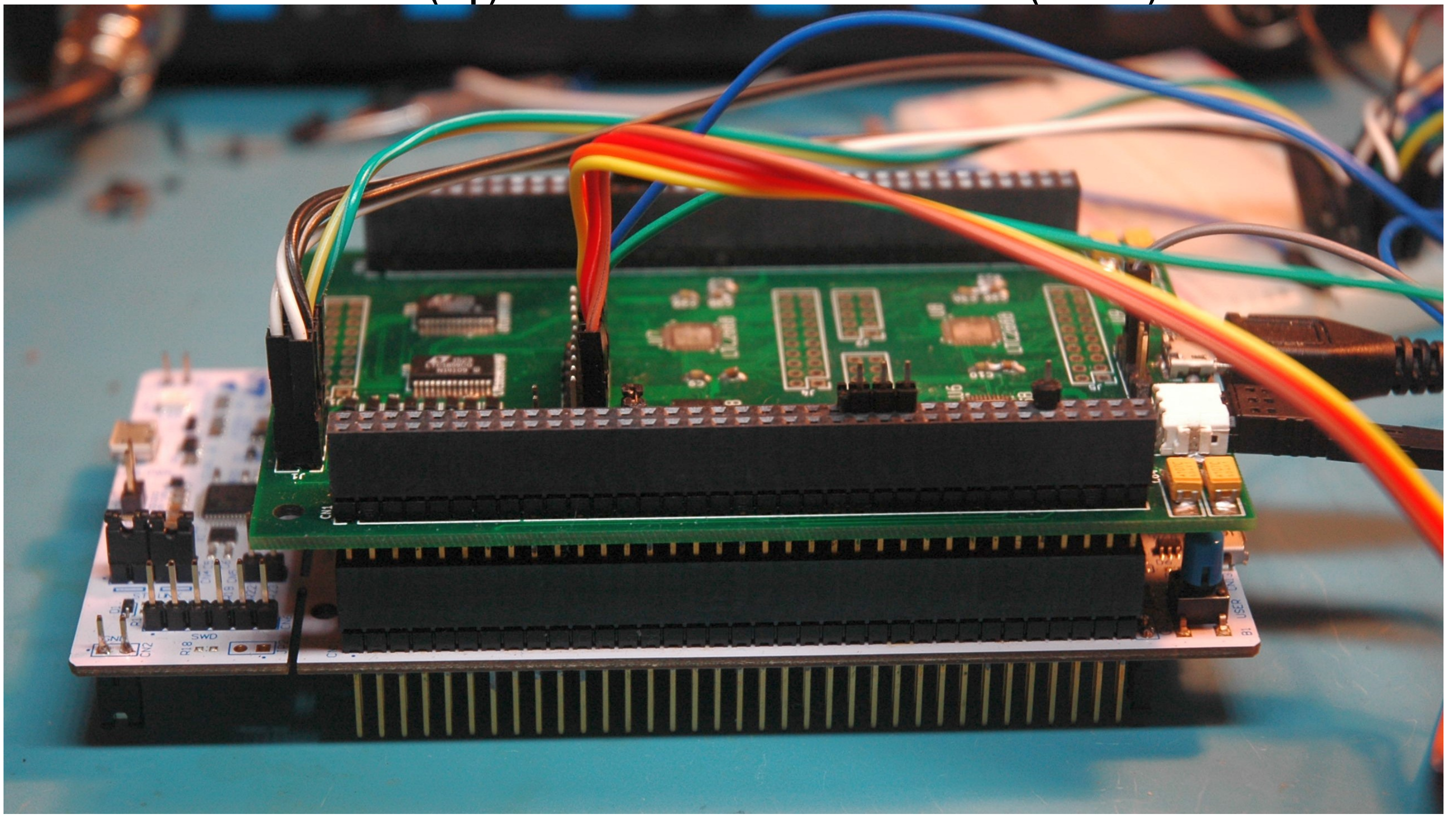
On the left is the NUCLEO-F767ZI and on the right the NDAC6416:



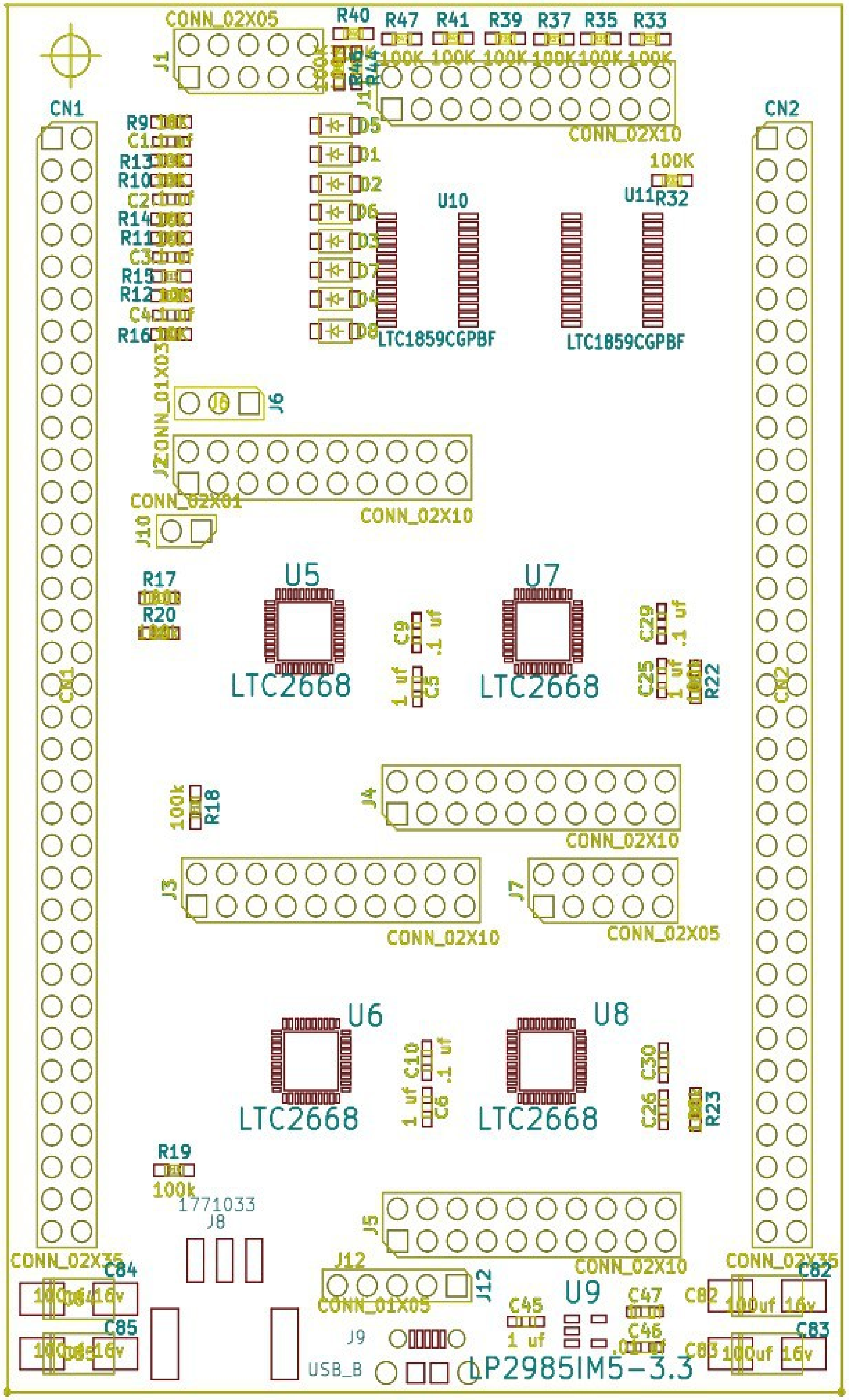
Mount the NDAC6416 on top of the NUCLEO-F767ZI by inserting the tails of NDAC6416 connectors CN1 and CN2 into NUCLEO-F767ZI connectors CN11 and CN12 respectively:



Side-view of the NDAC6416 (top) connected to the NUCLEO-F767ZI (bottom):



PCB Layout with location of jumpers and connectors



Jumpers

1. J6:

   Users may choose:

   1. to power the NDAC6416 and the NUCLEO boards from the 5V supply coming from NDAC6416 USB connector J9 --or--
   2. to power both boards from the NUCLEO 5V supply

   The best choice is '1' as '2' requires the NUCLEO CN1 supply the power. It is better to have CN1 supply power only to the ST Link portion of the NUCLEO not to the CPU. This assures power is adequate and prevents USB enumeration problems.

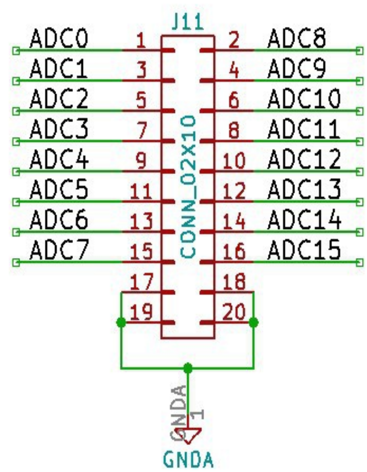
   Choice '1' requires a jumper between pins 1 and 2 of J6. Choice '2' jumper pins 2 and 3. Note: pin 1 is the pin closest to the J6 lettering on the front silk screen.

2. J10:

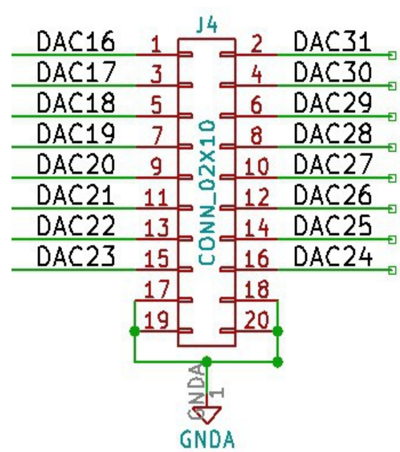
   Digital and Analog ground should meet at only one place. If you have one supply providing both +/- 12V and 5V you may want the grounds to meet there in which case J10 off. Otherwise the J10 jumper should be on so the grounds meet at J10.

Connectors

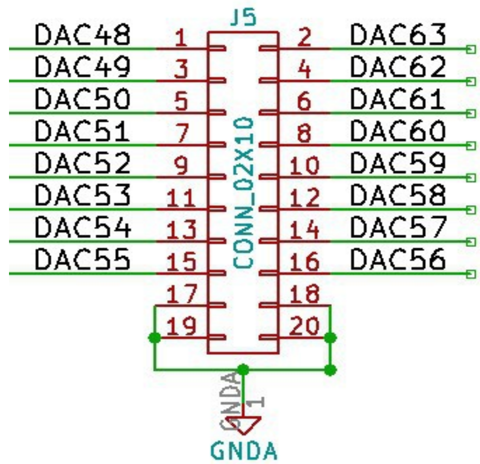
1. J11 (Analog-to-digital channels 0-15)



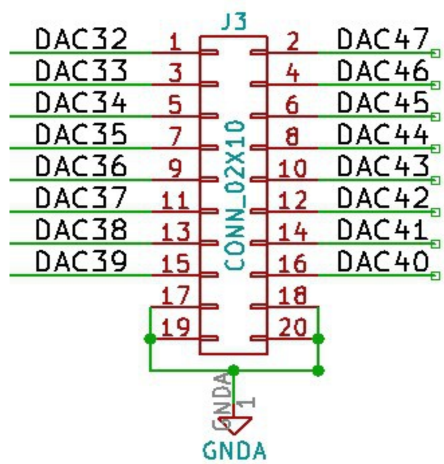
2. J4 (Digital-to-analog channels 16-31)



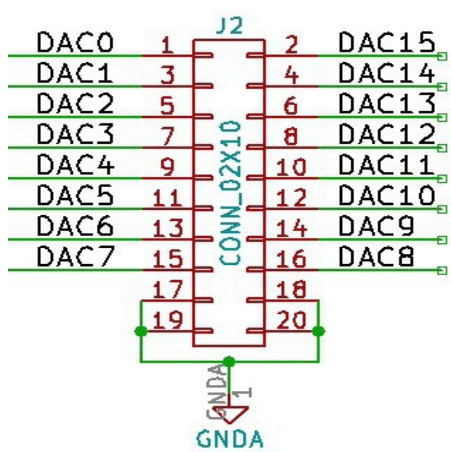
3. J5 (Digital-to-analog channels 48-63)



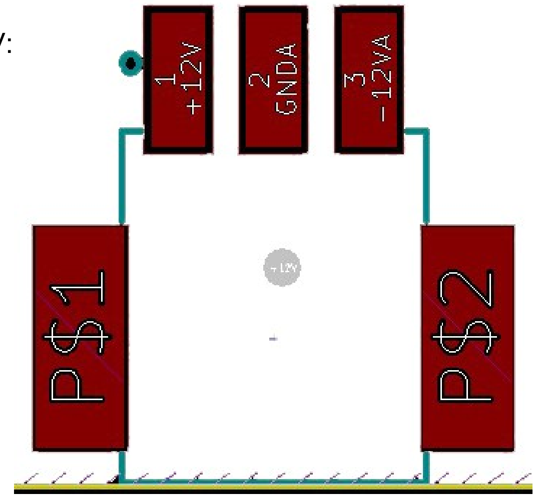
4. J3 (Digital-to-analog channels 32-47)



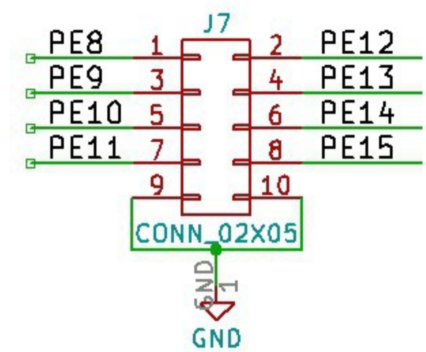
5. J2 (Digital-to-analog channels 0-15)



6. J8 ((Phoenix connector 1771033 which mates with the Phoenix plug 178845) provides +12V, GNDA and -12V:

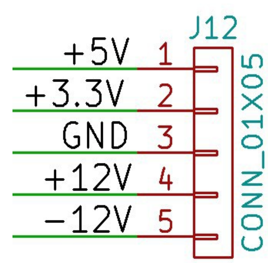


7. J7 8 channel digital input/output. The STM32 GPIO port E channel 8-15. Programmable input or output.

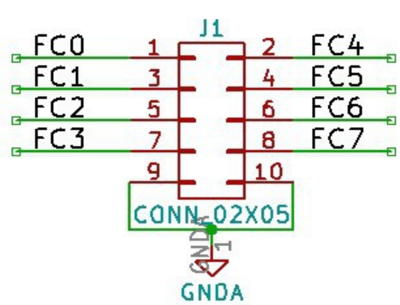


8. J9 is a USB_Micro-B connector and provides +5 Volt supply. Power supply should be 1 Amp.

9. J12 provides test points to +5V, 3.3V, GND, +12V and -12V:



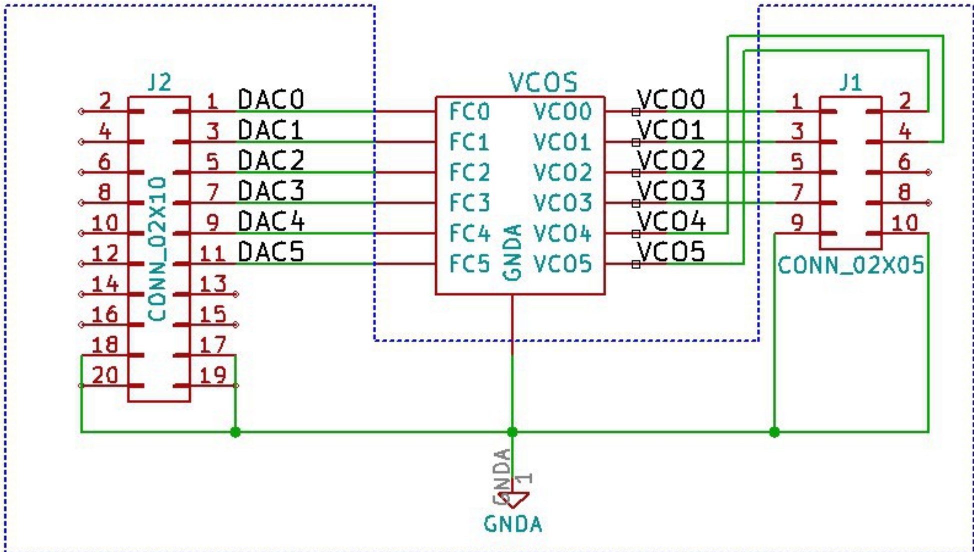
10. J1 (Frequency counter channels 0-7)



Controlling an Analog Synthesizer Voltage Controlled Oscillators

Software for the NDAC6416 provides a “Tuneup” function which tunes six VCOs. The outputs of the VCOs is fed into six frequency counter channels. The output of six DACs are sent to the frequency control inputs of the six VCOs. “Tuneup” offsets the outputs so each VCO is generating the correct frequencies throughout its range. Once tuned, background tasks makes small adjustments in case the VCOs drift.

The software uses the following connections to accomplish the tuneup:



Analog Control Applications

Many applications require DAC voltages to precisely change in real-time. Software provides an “Envelope” class which allows users to select a series of beginning and ending voltages. They are interpolated to provide smooth lines precisely generated in real-time. Code can easily be written to trigger an Envelope from the digital inputs or ADC inputs.

APPENDICES

APPENDIX A: GLOSSARY OF TERMS

PCB printed circuit board
ADC analog-to-digital
DAC digital-to-analog
GPIO general purpose input/output
VCO voltage controlled oscillator

APPENDIX B: ANALYSIS DOCUMENTATION

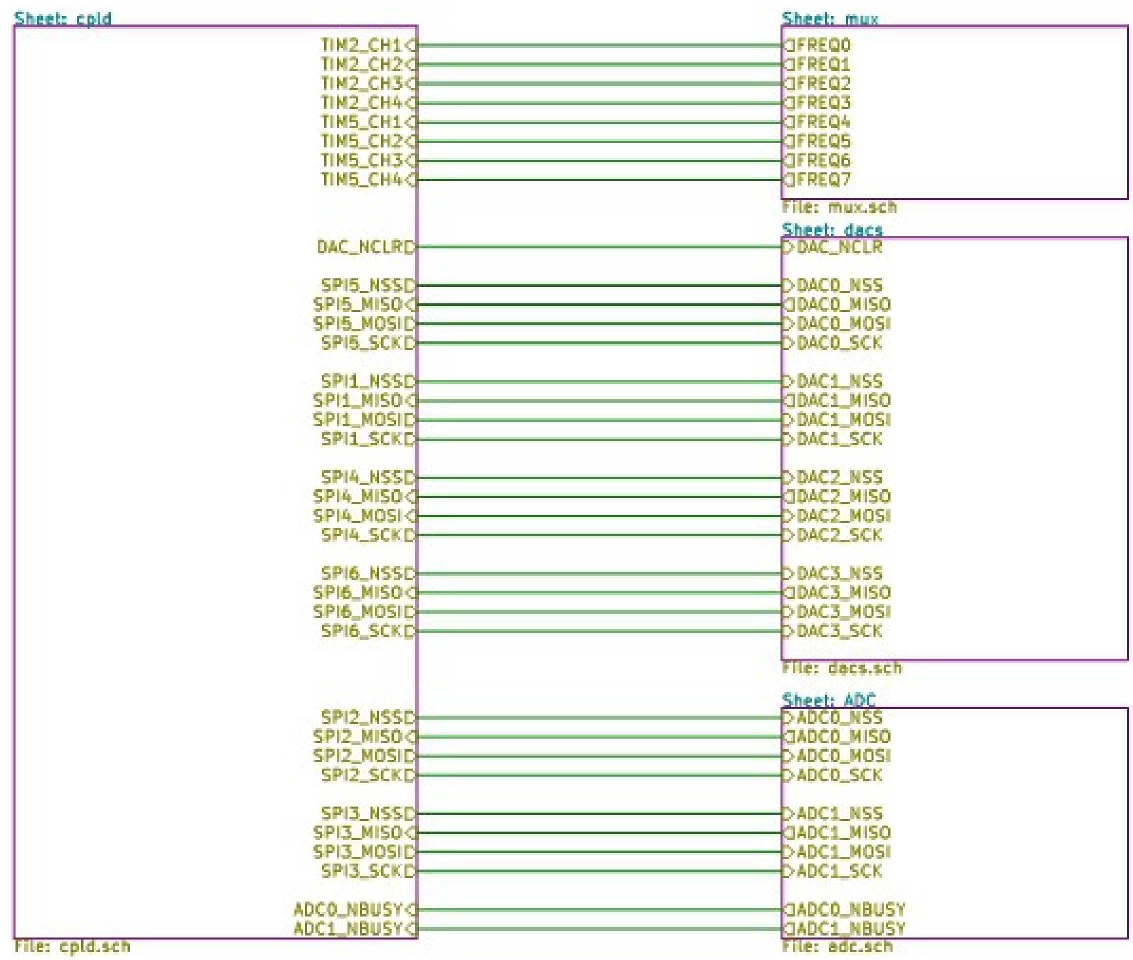
ndac6416schematic.doc and ndac6416schematic.pdf are derived from ndac6416.sch
ndac6416.sch is the Kicad schematics type file
ndac6416.kicad_pcb is the Kicad PCB type file

APPENDIX C: ISSUES

List all unresolved issues, TBDs, pending decisions, findings required, conflicts, etc.

ISSUES	
ID	DESCRIPTION

APPENDIX D: Schematic

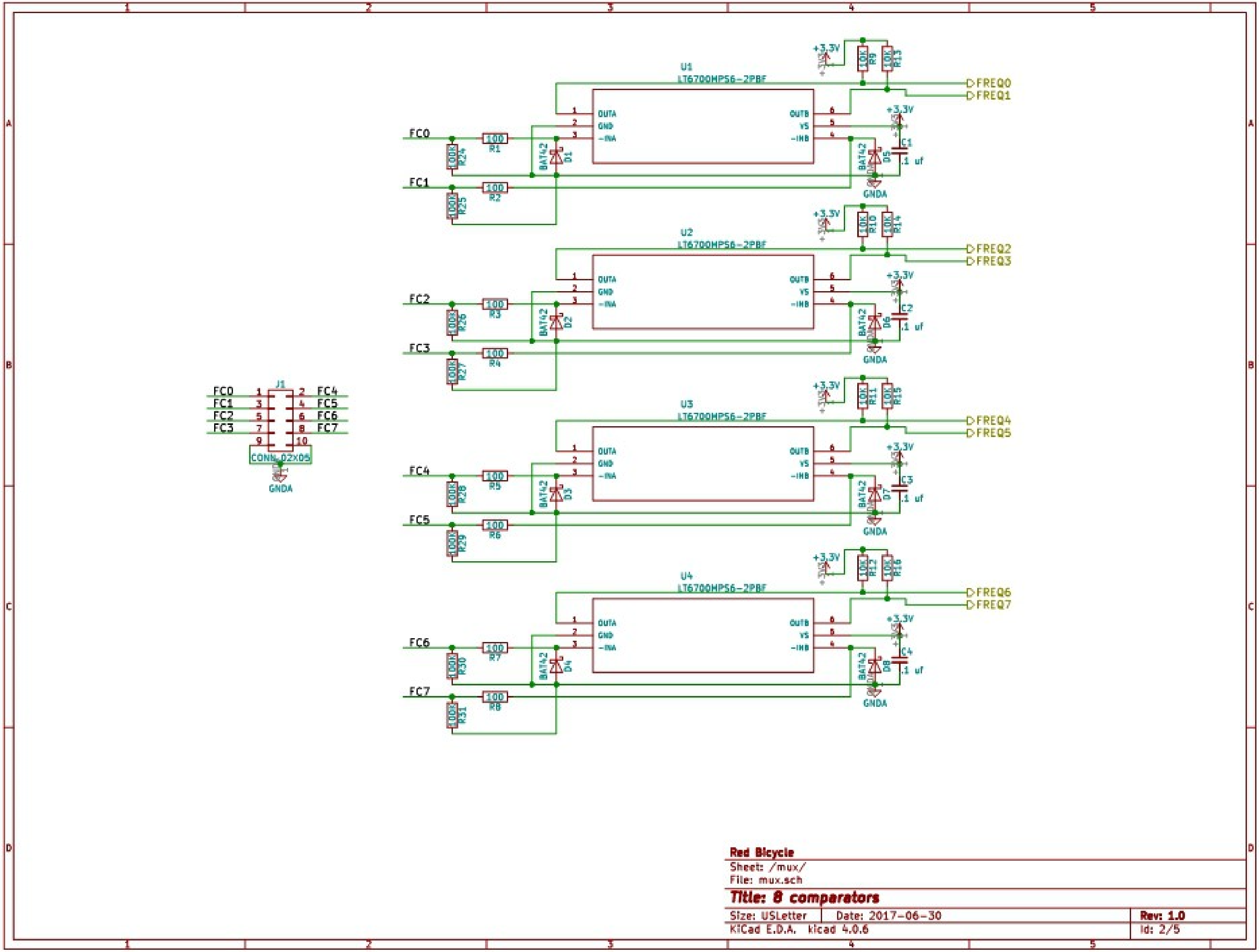


64 16-bit DACs and 16 16-bit ADCs for Nucleo 144 boards.
redbicycle.org

Sheet: /
File: ndac6416.sch

Title: Nucleo 144 DACs and ADCs

Size: USLetter | Date: 2017-06-30 | **Rev: 1.0**
KiCad E.D.A. kicad 4.0.6 | Id: 1/5



U1
LT6700HPS6-2PBF
U2
LT6700HPS6-2PBF
U3
LT6700HPS6-2PBF
U4
LT6700HPS6-2PBF
OUTA
GND
-INA
OUTB
VS
-INB
FREQ0
FREQ1
FREQ2
FREQ3
FREQ4
FREQ5
FREQ6
FREQ7
+3.3V
GNDA
BAT42
.1 uf
FC0
FC1
FC2
FC3
FC4
FC5
FC6
FC7
J1
CONN_02X05
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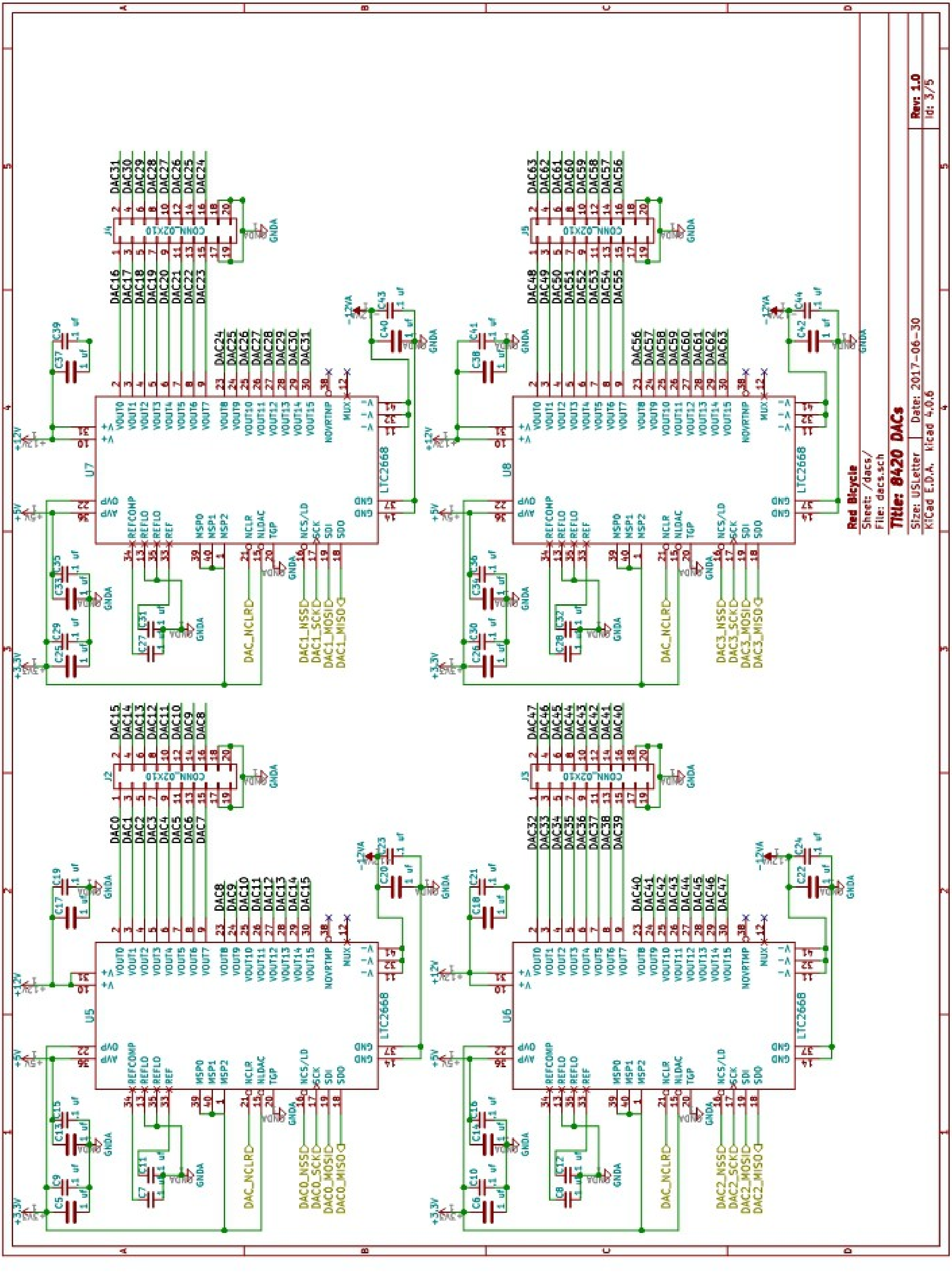

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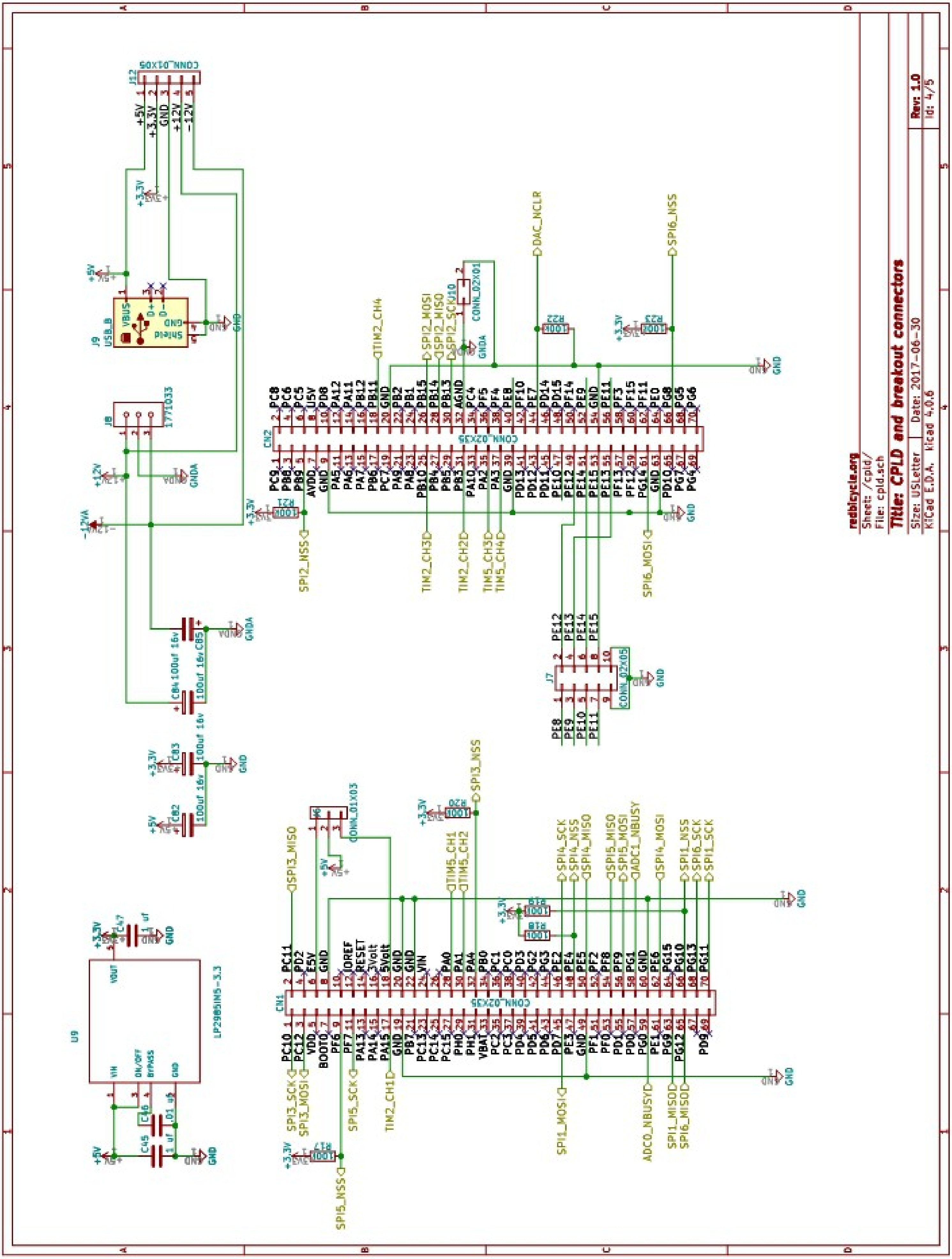
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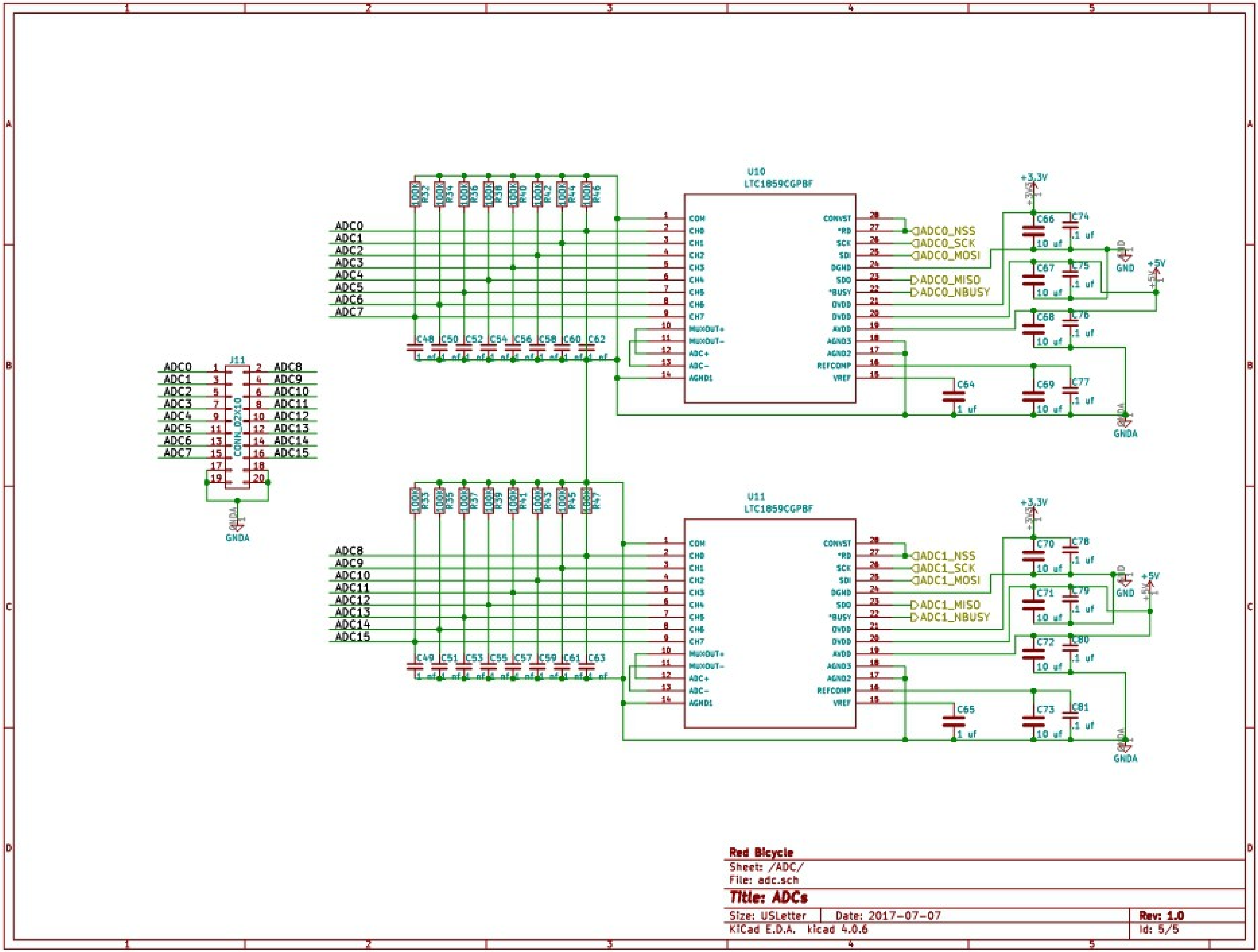

U10
LTC1859CGPBF
U11
LTC1859CGPBF
J11
CONN_02X10
ADC0_NSS
ADC0_SCK
ADC0_MOSI
ADC0_MISO
ADC0_NBUSY
ADC1_NSS
ADC1_SCK
ADC1_MOSI
ADC1_MISO
ADC1_NBUSY
+3.3V
+5V
GND
GNDA
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Rev: 1.0
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