

LTC1668

16-Bit, 50Msps DAC

DESCRIPTION

Demonstration circuit 2459A features the **LTC[®]1668**, 16-bit, 50Msps current output DAC in a 28-lead SSOP package. Pin-compatible 14-bit and 12-bit versions are available for lower resolution requirements, but all DC2459A assembly types are populated with the LTC1668.

DC2459A can be connected directly to a digital pattern generator or customer circuit. The DC2459A is also compatible with several popular low cost FPGA development boards for Altera and Xilinx devices. These include the Arrow SoCkit

(Altera Cyclone 5 SoC), C5G (Altera Cyclone 5), DE0 Nano (Altera Cyclone 4), Embedded Micro Mojo (Xilinx Spartan 6), and Numato Labs Mimas (Xilinx Spartan 6) boards¹.

Design files for this circuit board are available at <http://www.linear.com/demo/DC2459A>

LT, LTC, LTM, Linear Technology, Linduino and the Linear logo are registered trademarks of Linear Technology Corporation. All other trademarks are the property of their respective owners.

1. Refer to Design Files for Parts List/Bill of Materials.

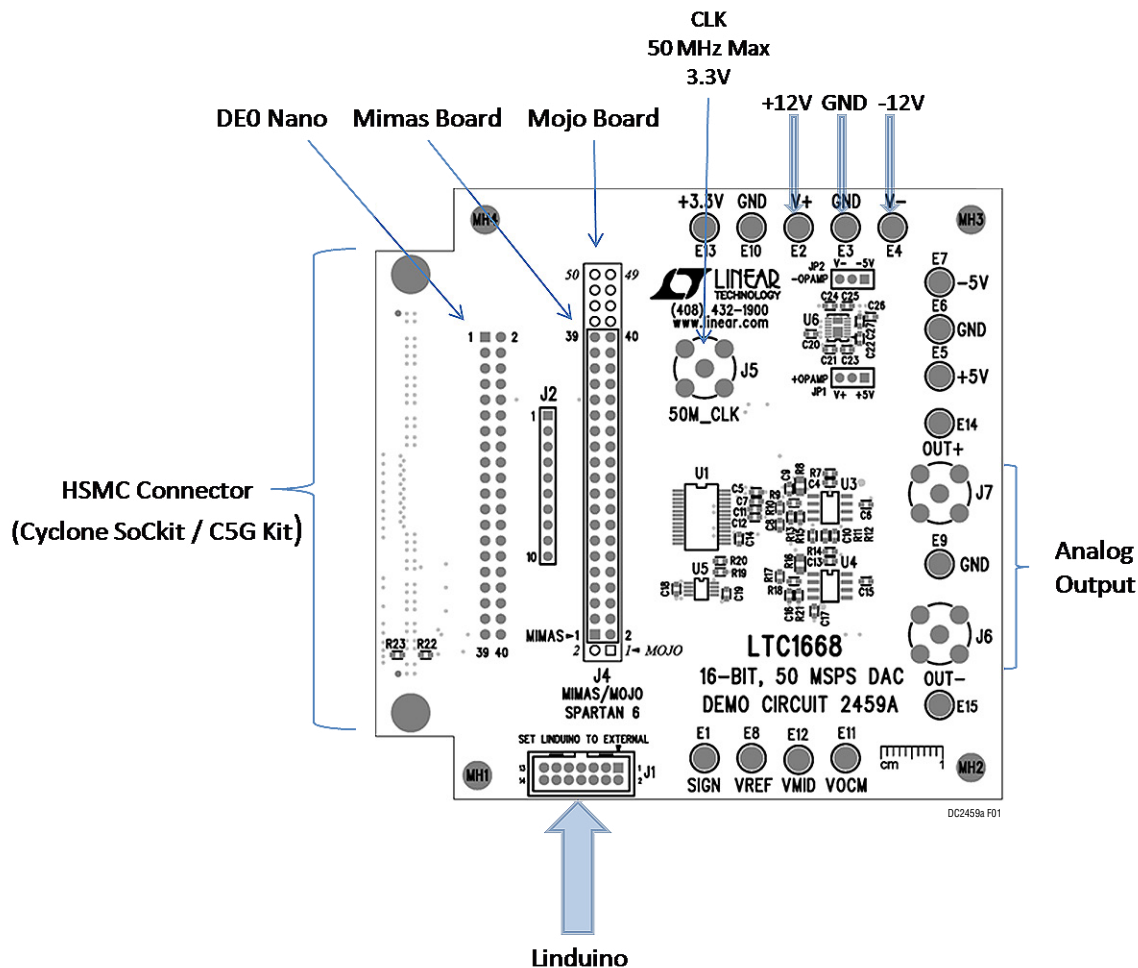


Figure 1. Basic Connections

ASSEMBLY OPTIONS

Table 1. Demonstration Circuit Output Options

ASSEMBLY TYPE	OP AMP	OUTPUT
DC2459A-A	LT1812	Single-Ended: $\pm 1V$ (2V _{p-p})
DC2459A-B	LT6600	Differential: $\pm 0.25V$ (1V _{p-p})
DC2459A-C	LT1468	Single-Ended: $\pm 10V$ (20V _{p-p})

QUICK START PROCEDURE

The LTC1668 is a general purpose DAC with a wide range of applications. Depending on the end application, the best data source for evaluating the LTC1668 may be a digital pattern generator or the actual customer application circuit. However, a basic test of distortion and signal-to-noise ratio using a sinewave output can be a valuable first step in evaluating the performance of the LTC1668. As such, several example FPGA programs are provided that produce a sinewave output.

1. There are several options for providing digital data to the DC2459A, shown in Figures 2 to 6. Connect the DC2459A to a digital pattern generator (which can be the customer application circuit) or supported low cost FPGA board. Do not enable the data source until power is applied to the DC2459A.

When using the Mojo board, install a 0Ω resistor on R28, which is located on the bottom of the board. This routes the clock signal to the correct input for the Mojo board.

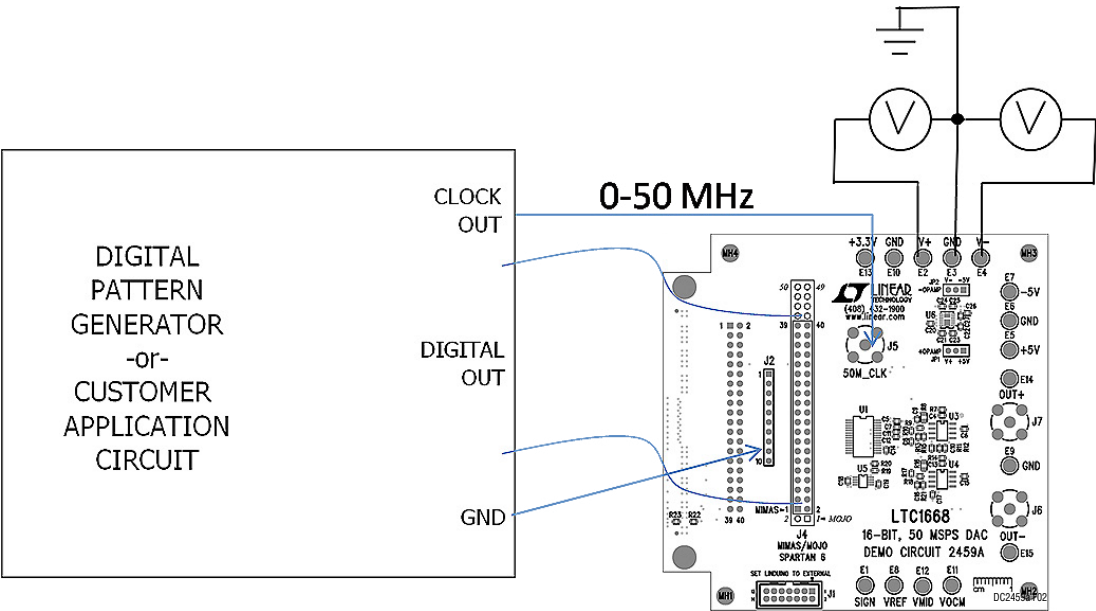


Figure 2. Basic Connection to Digital Pattern Generator

QUICK START PROCEDURE

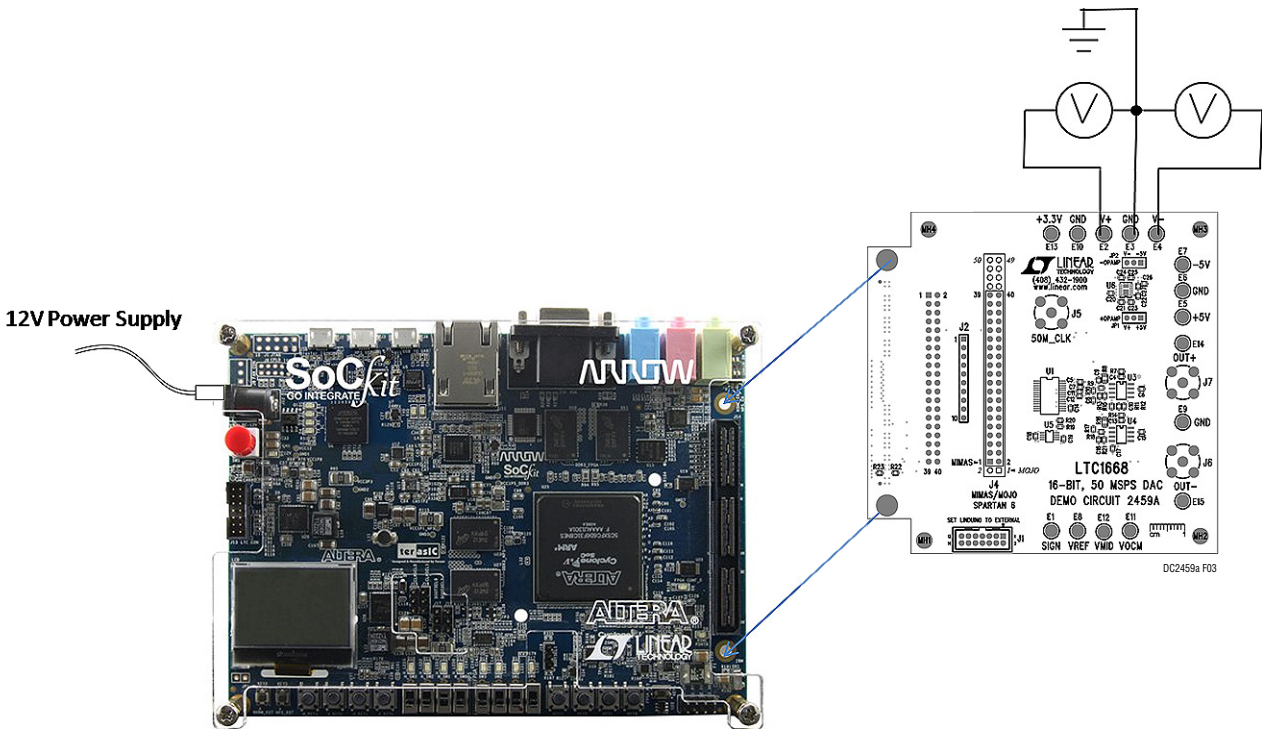


Figure 3. DC2459A Connected to the SoCkit

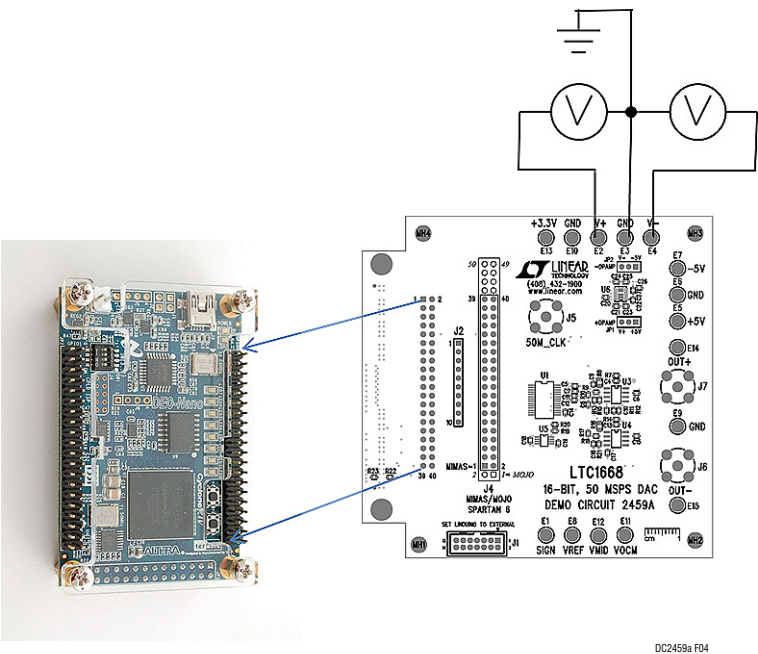


Figure 4. DC2459A Connected to the DE0 Nano

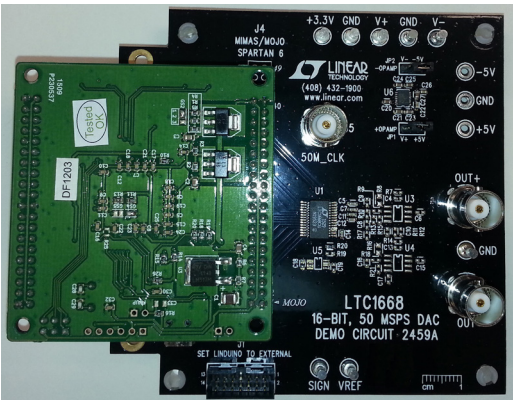
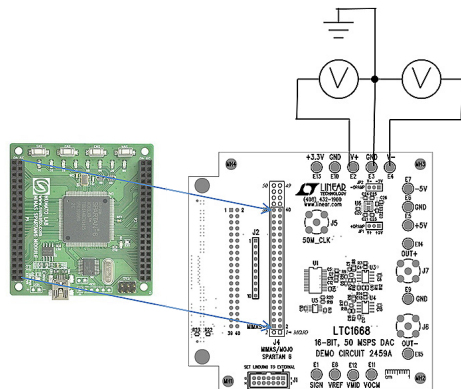
DEMO MANUAL DC2459A

QUICK START PROCEDURE

Table 2. Jumper Configurations

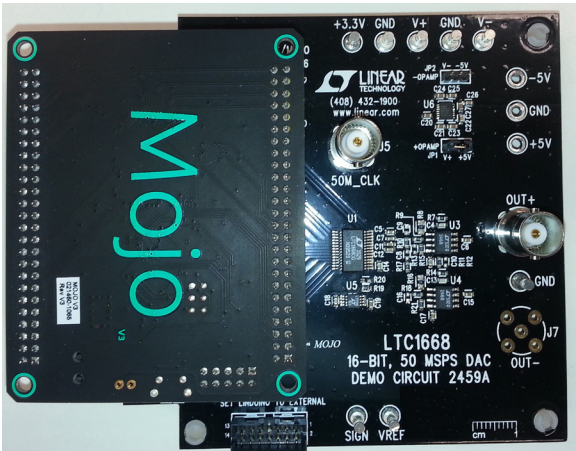
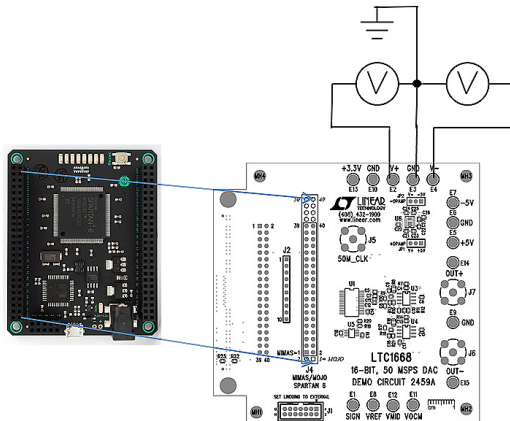
ASSEMBLY TYPE	JP1	JP2
DC2459A-A	5V	-5V
DC2459A-B	5V	-5V
DC2459A-C	V+	V-

2. Ensure JP1 and JP2 are set to the correct position as shown by Table 2.
3. Connect $\pm 12\text{V}$ to the V+ and V- turret posts. Apply a 3.3V, 50MHz clock to J5.
4. Enable the digital data source. If an FPGA board is being used, apply power, and load the bitstream into the FPGA.
5. The FPGA bitstreams default to a 10kHz sinusoidal output. Refer to Table 1 for demo board assembly output configuration and voltages.



DC2459a F05

Figure 5. DC2459A Connected to the Mimas Board



DC2459a F06

Figure 6. DC2459A Connected to the Mojo Board

QUICK START PROCEDURE

Analog Circuit Descriptions

Assembly type A implements a differential resistor loaded output to a differential to single-ended output shown in Figure 7. The circuit delivers good AC distortion performance at signal frequencies of a few MHz down to DC. The capacitor adds a single real pole of filtering and helps reduce distortion by limiting the high frequency signal amplitude at the op amp inputs. The circuit swings $\pm 1V$ around ground.

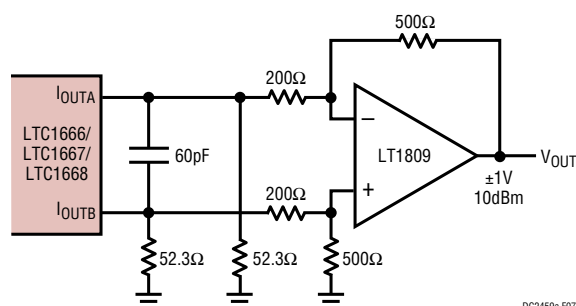


Figure 7. Differential to Single-Ended Op Amp I-V Converter

This demo board option is the simplest configuration and allows the most flexibility for modifications.

Assembly version B implements a differential amplifier using the LT6600-2.5, a 4th order, 2.5MHz lowpass filter as shown in Figure 8. The outputs each swing $\pm 0.25V$ around ground for a total differential output of $1V_{P-P}$.

Assembly version C implements a dual op amp current to voltage converter shown in Figure 9. The circuit delivers good distortion and AC performance to a few kHz. The output swings $\pm 10V$ around ground.

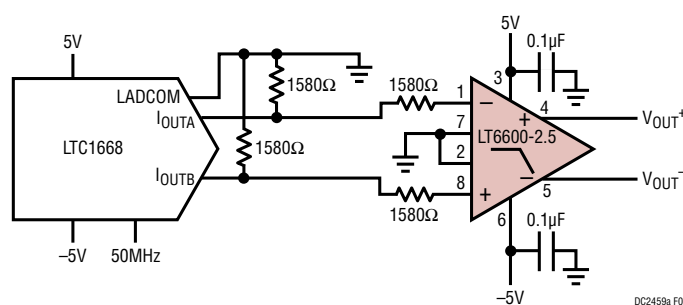


Figure 8. Differential Op Amp I-V Converter

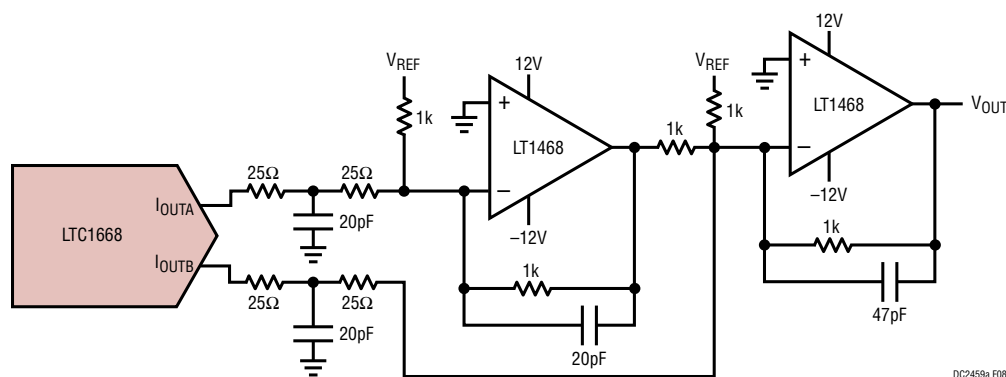


Figure 9. Dual Op Amp Differential to Single-Ended Op Amp I-V Converter

EXTERNAL CONNECTIONS

GND: Four ground turrets are provided. These are connected directly to the ground plane and are the common connection for all supplies and signals.

V⁺ and V⁻: Power Supply Turrets. ±12V supply. The ±5V supplies for the LTC1668 and op amp circuits are derived from this supply.

3.3V: FPGA Power Rail. Do not connect this turret to a power supply, it is for monitoring the 3.3V supply on the connected FPGA board.

50M_CLK: Input Clock. Frequency range is DC to 50MHz. Logic level should be 3.3V when used with an FPGA board. The logic level can be up to 5V when used with a digital pattern generator.

OUT⁺: Voltage from the noninverting DAC output amplifiers. Assembly options A and C use this connector as the single-ended output. Assembly option B uses this connector for the noninverting differential output.

OUT⁻: Voltage from the inverting DAC output amplifier. Assembly option B uses this connector for the inverting differential output.

P1: This connector is used to connect to Altera's SoCkit board. The pins are 3.3V logic level.

J1: Linduino Connector. Provides a SPI interface to the FPGA board. The pins are 3.3V logic level.

J2: All pins are ground. These connections are intended for logic analyzer or digital pattern generator grounds.

J3: This connector is used to connect to the DE0 Nano FPGA board. The pins are 3.3V to 5V (TTL compatible) logic level.

J4: This connector is used for the Mimas board and the Mojo FPGA board. Follow the footprint on the silkscreen to ensure proper placement. The pins are 3.3V to 5V (TTL compatible) logic level.

Setting the Frequency of the FPGA Digital Pattern Generator

The FPGA examples generate a digital sinusoidal output using either a numerically controlled oscillator (NCO, for Altera examples) or direct digital synthesizer (DDS, Xilinx examples). The input to these generators is a 32-bit word that sets the output frequency according to Equation 1. A simple SPI interface allows the 32-bit word to be set using a 4-wire interface from a SPI master such as a Linduino microcontroller. The MISO output returns the previous 32-bit configuration word, shown in Figure 10.

Equation 1:

$$\text{CONFIGURE WORD} = \frac{\text{DESIRED FREQUENCY}}{\text{SYSTEM CLOCK FREQUENCY}} \cdot (2^{32} - 1)$$

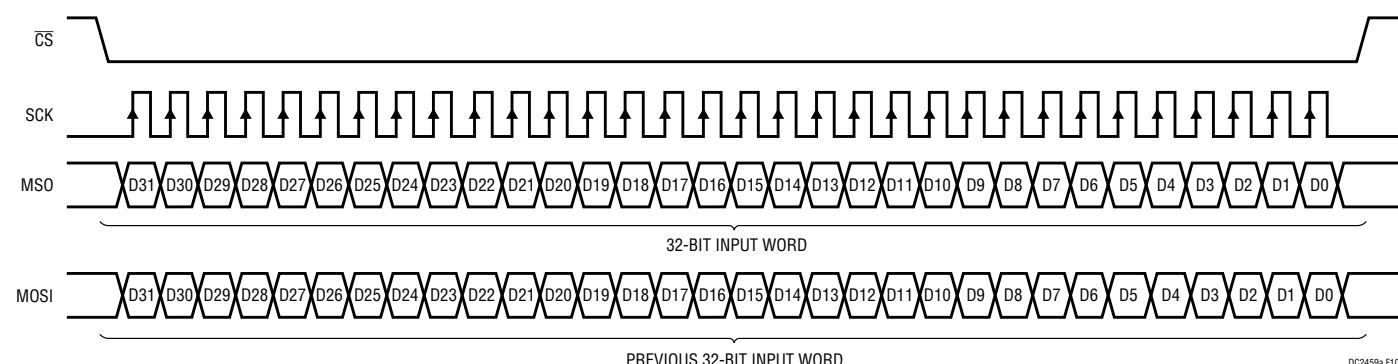


Figure 10. SPI Interface Data Format

EXTERNAL CONNECTIONS

Using the Linduino® as a USB to SPI Interface for LinearLabTools

The Linduino can be used to configure the FPGA via a SPI port with a Python program included in LinearLabTools.

Linduino Interface

1. DC2459A example designs use the default Linduino firmware (DC590 emulator.) If the Linduino has been reprogrammed, follow the procedure in the Linduino (DC2026) demo manual to reprogram the DC590 emulator.
2. Set JP3 to EXT (This causes the Linduino to use the FPGA board's 3.3V supply to set the logic levels.)

Software Installation for LinearLabTools

1. Download and install LinearLabTools from: <http://www.linear.com/solutions/linearlabtools>
2. Follow the Quick Start procedure for installing LinearLabTools.
3. Examples for the DC2459 are written in Python; Anaconda distribution is used as an example below.

Running the LinearLabTools DC2459A Script

1. Open the Spyder IDE. In the File menu select Linear_lab_tools folder → python → app_examples → LTC1668 → DC2459A.py

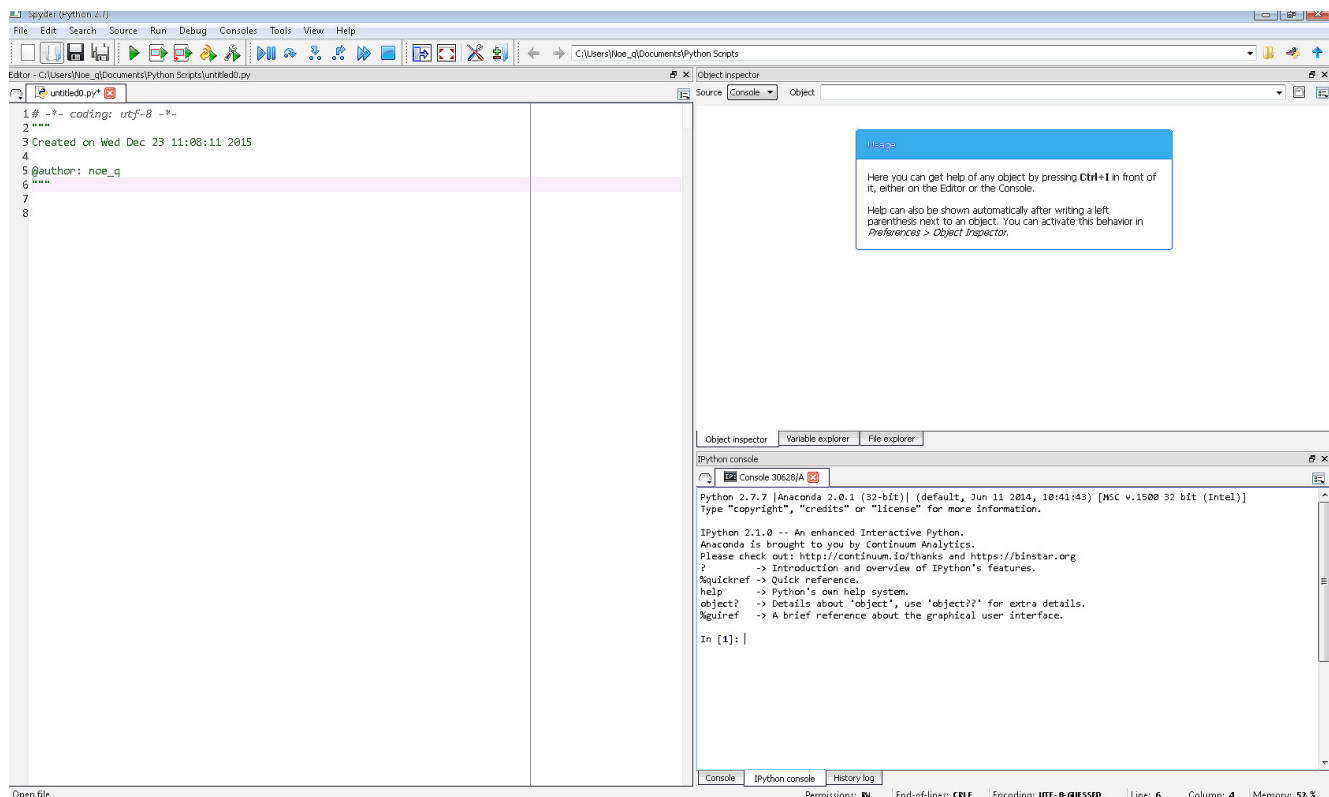
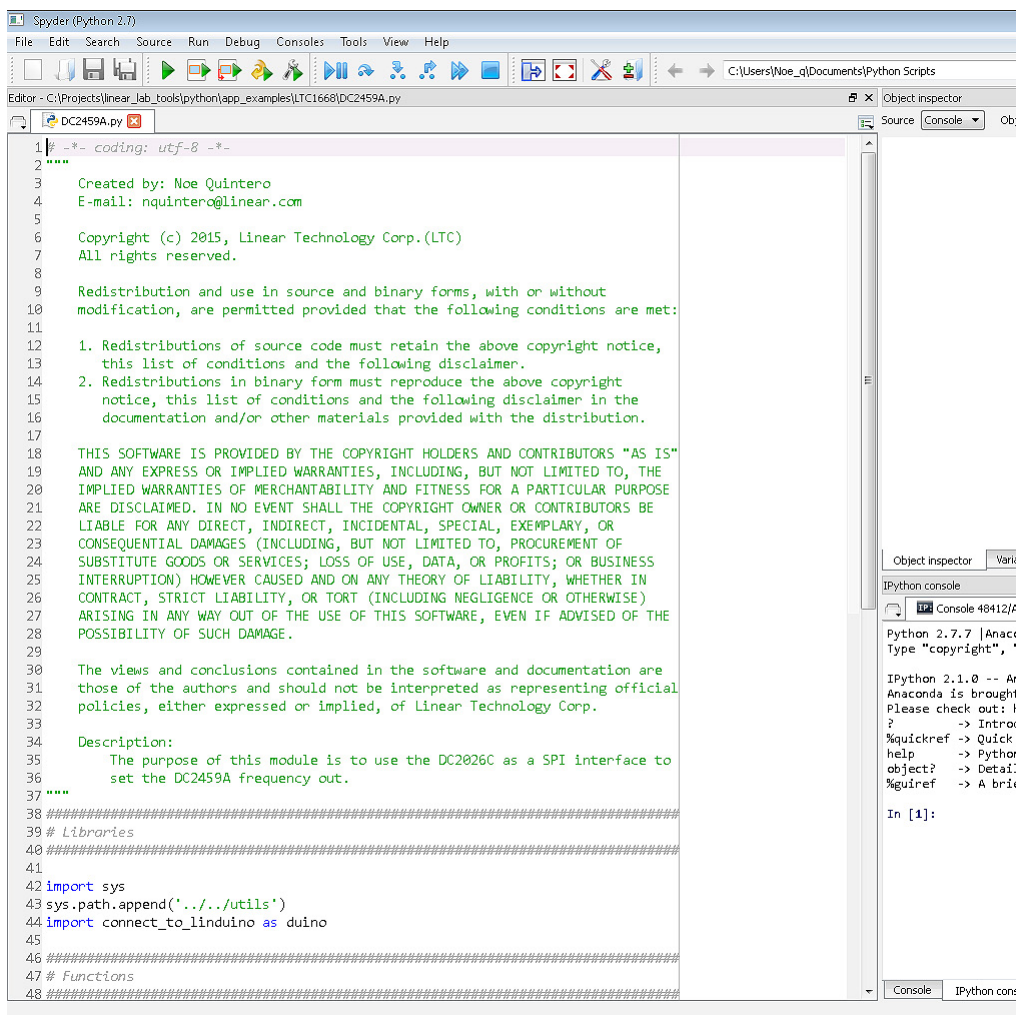


Figure 11. Spyder IDE

EXTERNAL CONNECTIONS

A new tab will appear with the script.



```
1 #-*- coding: utf-8 -*-
2 """
3 Created by: Noe Quintero
4 E-mail: nquintero@linear.com
5
6 Copyright (c) 2015, Linear Technology Corp.(LTC)
7 All rights reserved.
8
9 Redistribution and use in source and binary forms, with or without
10 modification, are permitted provided that the following conditions are met:
11
12 1. Redistributions of source code must retain the above copyright notice,
13 this list of conditions and the following disclaimer.
14 2. Redistributions in binary form must reproduce the above copyright
15 notice, this list of conditions and the following disclaimer in the
16 documentation and/or other materials provided with the distribution.
17
18 THIS SOFTWARE IS PROVIDED BY THE COPYRIGHT HOLDERS AND CONTRIBUTORS "AS IS"
19 AND ANY EXPRESS OR IMPLIED WARRANTIES, INCLUDING, BUT NOT LIMITED TO, THE
20 IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE
21 ARE DISCLAIMED. IN NO EVENT SHALL THE COPYRIGHT OWNER OR CONTRIBUTORS BE
22 LIABLE FOR ANY DIRECT, INDIRECT, INCIDENTAL, SPECIAL, EXEMPLARY, OR
23 CONSEQUENTIAL DAMAGES (INCLUDING, BUT NOT LIMITED TO, PROCUREMENT OF
24 SUBSTITUTE GOODS OR SERVICES; LOSS OF USE, DATA, OR PROFITS; OR BUSINESS
25 INTERRUPTION) HOWEVER CAUSED AND ON ANY THEORY OF LIABILITY, WHETHER IN
26 CONTRACT, STRICT LIABILITY, OR TORT (INCLUDING NEGLIGENCE OR OTHERWISE)
27 ARISING IN ANY WAY OUT OF THE USE OF THIS SOFTWARE, EVEN IF ADVISED OF THE
28 POSSIBILITY OF SUCH DAMAGE.
29
30 The views and conclusions contained in the software and documentation are
31 those of the authors and should not be interpreted as representing official
32 policies, either expressed or implied, of Linear Technology Corp.
33
34 Description:
35 The purpose of this module is to use the DC2026C as a SPI interface to
36 set the DC2459A frequency out.
37 """
38 #####
39 # Libraries
40 #####
41
42 import sys
43 sys.path.append('../utils')
44 import connect_to_linduino as duino
45
46 #####
47 # Functions
48 #####
```

Figure 12. DC2459A Python Script

EXTERNAL CONNECTIONS

2. Run the script by clicking the run button:



The IPython console will show the simple program interface.

```

help      -> Python's own help system.
object?   -> Details about 'object', use 'object??' for
%gui?     -> A brief reference about the graphical user

In [1]: runfile('C:/Projects/linear_lab_tools/python/ap
wdir='C:/Projects/linear_lab_tools/python/app_examples/

Looking for COM ports ...
Available ports: [(27, 'COM28')]

Looking for Linduino ...
Found Linduino!!!!
Command Summary
1-Send raw code
2-Set frequency
3-Exit program

Enter a command: |
  
```

Figure 13. Simple Text Interface

3. To use the interface, enter the commands next to the “Enter a command:” text and hit enter.

```

Enter a command: 2

Enter desired frequency(Hz): 15000
  
```

Figure 14. Entered Data

DEMO MANUAL DC2459A

DEMONSTRATION BOARD IMPORTANT NOTICE

Linear Technology Corporation (LTC) provides the enclosed product(s) under the following **AS IS** conditions:

This demonstration board (DEMO BOARD) kit being sold or provided by Linear Technology is intended for use for **ENGINEERING DEVELOPMENT OR EVALUATION PURPOSES ONLY** and is not provided by LTC for commercial use. As such, the DEMO BOARD herein may not be complete in terms of required design-, marketing-, and/or manufacturing-related protective considerations, including but not limited to product safety measures typically found in finished commercial goods. As a prototype, this product does not fall within the scope of the European Union directive on electromagnetic compatibility and therefore may or may not meet the technical requirements of the directive, or other regulations.

If this evaluation kit does not meet the specifications recited in the DEMO BOARD manual the kit may be returned within 30 days from the date of delivery for a full refund. THE FOREGOING WARRANTY IS THE EXCLUSIVE WARRANTY MADE BY THE SELLER TO BUYER AND IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED, IMPLIED, OR STATUTORY, INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE. EXCEPT TO THE EXTENT OF THIS INDEMNITY, NEITHER PARTY SHALL BE LIABLE TO THE OTHER FOR ANY INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES.

The user assumes all responsibility and liability for proper and safe handling of the goods. Further, the user releases LTC from all claims arising from the handling or use of the goods. Due to the open construction of the product, it is the user's responsibility to take any and all appropriate precautions with regard to electrostatic discharge. Also be aware that the products herein may not be regulatory compliant or agency certified (FCC, UL, CE, etc.).

No License is granted under any patent right or other intellectual property whatsoever. **LTC assumes no liability for applications assistance, customer product design, software performance, or infringement of patents or any other intellectual property rights of any kind.**

LTC currently services a variety of customers for products around the world, and therefore this transaction **is not exclusive**.

Please read the DEMO BOARD manual prior to handling the product. Persons handling this product must have electronics training and observe good laboratory practice standards. **Common sense is encouraged.**

This notice contains important safety information about temperatures and voltages. For further safety concerns, please contact a LTC application engineer.

Mailing Address:

Linear Technology
1630 McCarthy Blvd.
Milpitas, CA 95035

Copyright © 2004, Linear Technology Corporation

dc2459af

Данный компонент на территории Российской Федерации

Вы можете приобрести в компании MosChip.

Для оперативного оформления запроса Вам необходимо перейти по данной ссылке:

<http://moschip.ru/get-element>

Вы можете разместить у нас заказ для любого Вашего проекта, будь то серийное производство или разработка единичного прибора.

В нашем ассортименте представлены ведущие мировые производители активных и пассивных электронных компонентов.

Нашей специализацией является поставка электронной компонентной базы двойного назначения, продукции таких производителей как XILINX, Intel (ex.ALTERA), Vicor, Microchip, Texas Instruments, Analog Devices, Mini-Circuits, Amphenol, Glenair.

Сотрудничество с глобальными дистрибьюторами электронных компонентов, предоставляет возможность заказывать и получать с международных складов практически любой перечень компонентов в оптимальные для Вас сроки.

На всех этапах разработки и производства наши партнеры могут получить квалифицированную поддержку опытных инженеров.

Система менеджмента качества компании отвечает требованиям в соответствии с ГОСТ Р ИСО 9001, ГОСТ РВ 0015-002 и ЭС РД 009

Офис по работе с юридическими лицами:

105318, г.Москва, ул.Щербаковская д.3, офис 1107, 1118, ДЦ «Щербаковский»

Телефон: +7 495 668-12-70 (многоканальный)

Факс: +7 495 668-12-70 (доб.304)

E-mail: info@moschip.ru

Skype отдела продаж:

moschip.ru

moschip.ru_4

moschip.ru_6

moschip.ru_9