

LTC2606

16-Bit Rail-to-Rail V_{OUT} DAC with I²C Interface

DESCRIPTION

Demonstration circuit 812A features the **LTC[®]2606** 16-bit DAC with I²C interface. This device establishes a new board-density benchmark for 16-bit DACs and advances performance standards for output drive and load regulation in single-supply, voltage output DACs.

DC812A has many features for evaluating the performance of the LTC2606. Onboard 5V, 4.096V and 2.5V precision references are provided, and the LTC2606 may be powered by the 5V reference for evaluating rail-to-rail operation.

Another feature of this board is the onboard LTC2421 20-bit ADC for monitoring DAC output voltage. The 16ppm total error of this device is adequate for taking meaningful measurements of various LTC2606 parameters.

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

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PERFORMANCE SUMMARY Specifications are at T_A = 25°C

| SYMBOL | PARAMETER | CONDITIONS |
|---------------------------|--|-----------------|
| Resolution | | 16 Bits |
| Monotonicity | V _{CC} = 5V, V _{REF} = 4.096V | 16 Bits |
| Differential Nonlinearity | V _{CC} = 5V, V _{REF} = 4.096V | ±1 LSB |
| Integral Nonlinearity | V _{CC} = 5V, V _{REF} = 4.096V | ±12 LSB Typical |
| Load Regulation | V _{CC} = V _{REF} = 5V, Mid-Scale, I _{OUT} = ±15mA | 2 LSB/mA Max |

BOARD PHOTO

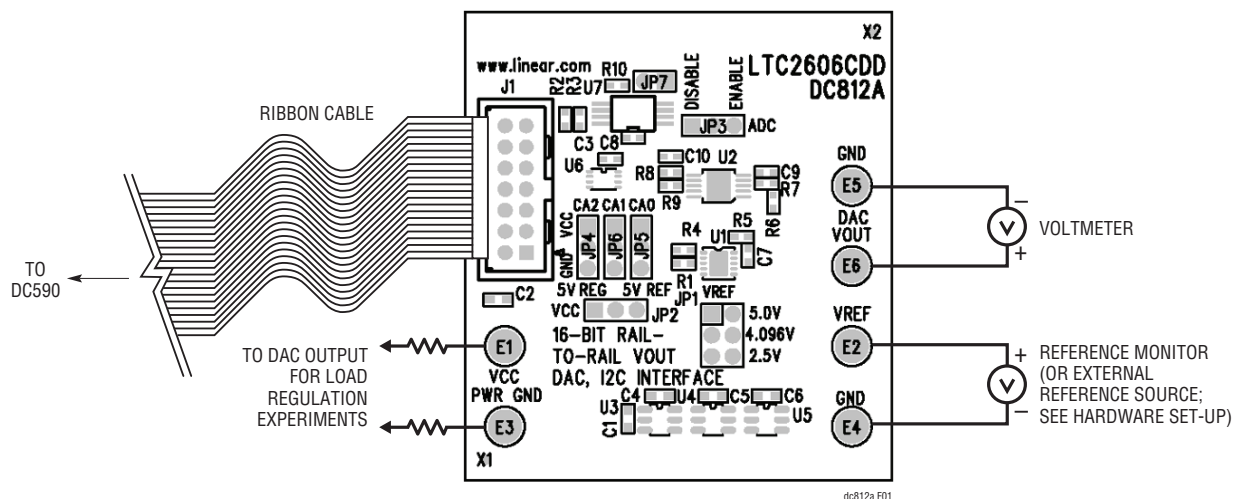


Figure 1. DC812A Connection Diagram

QUICK START PROCEDURE

1. Connect the DC812A to a DC590 USB serial controller using the supplied 14-conductor ribbon cable.
2. Connect the DC590 to a host PC with a standard USB A/B cable.
3. Run the QuikEval™ evaluation software supplied with the DC590 or download it from www.linear.com/software. The correct control panel will be loaded automatically.
4. Click the Collect button to begin outputting codes to the DAC and reading back the resulting output voltage.

Complete software documentation is available from the Help menu item, as features may be added periodically.

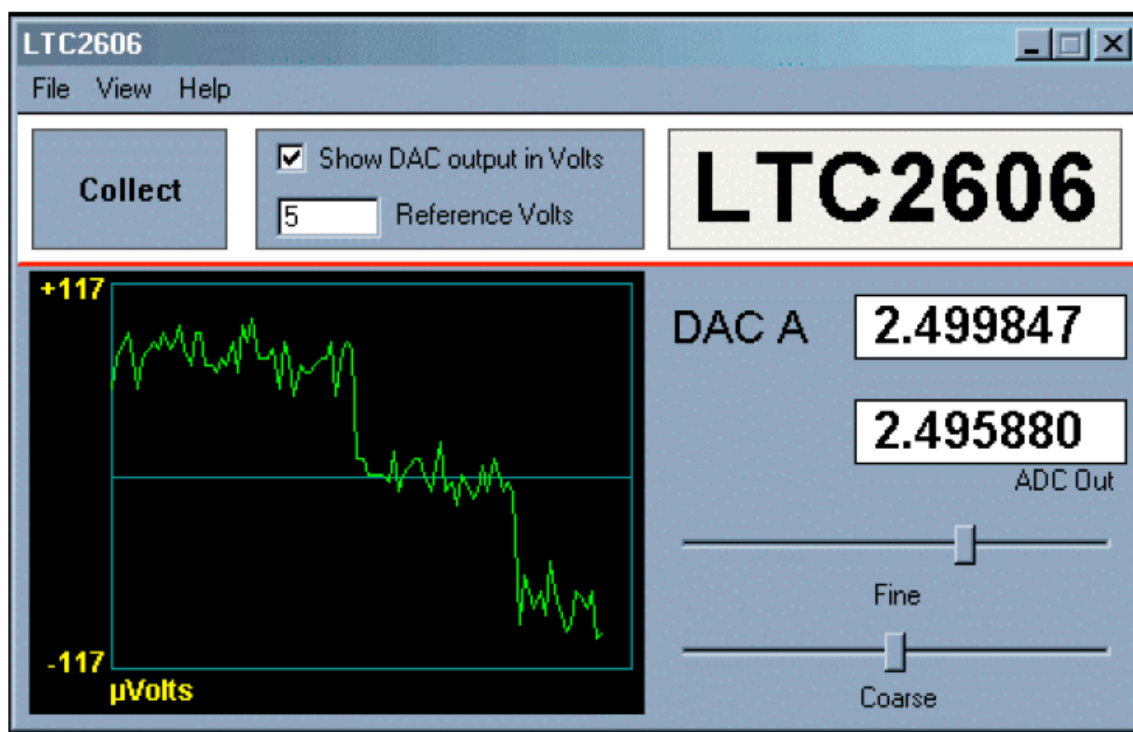


Figure 2. QuikEval Software

HARDWARE SETUP

JUMPER SETTINGS

V_{REF}: V_{REF} Select. Select 5V, 4.096V, or 2.5V reference. To apply an external reference through the V_{REF} turret, remove this jumper.

V_{CC}: V_{CC} Select. V_{CC} is taken either from the onboard 5V reference or the 5V regulated supply from the controller board. Selecting the 5V reference for both the V_{CC} jumper and V_{REF} jumper allows characterization of rail-to-rail operation of the LTC2606.

ADC: ADC Enable/Disable. Set to ENABLE for operation with DC590 serial controller. When using in customer's end application, the ADC can be completely disabled by setting jumper to DISABLE.

For very sensitive noise measurements when using LTC supplied software, set the output voltage and stop reading the voltage via the collect button on the control panel. This will stop the ADC from converting.

ANALOG CONNECTIONS

DAC V_{OUT}: LTC2606 Output.

V_{REF}: The V_{REF} turret is connected directly to the reference terminals of the LTC2606 and LTC2421 ADC. When one of the onboard references is being used, the reference voltage may be monitored at this point. An external reference may also be applied to this turret after removing JP1.

GROUNDING AND POWER CONNECTIONS

Power (V_{CC}): Normally the DC812A is powered by the DC590 controller. V_{CC} can be supplied to this turret, however the power supply on the DC590 must be disabled! Refer to the DC590 Quick Start guide for more details on this mode of operation.

Grounding: Separate power and signal grounds are provided. Any large currents drawn from the DAC outputs should be returned to power ground. Also, if an external power supply is connected, power ground should be used. Signal ground is connected to the exposed ground planes at the top and bottom edges of the board, and to the two turrets labeled GND. Use signal ground as the reference point for measurements and connections to external circuits.

EXPERIMENTS

The following experiments are intended to demonstrate some of the outstanding features of the LTC2606. All can be performed using the onboard LTC2421 to monitor the DAC output voltage. The indicated output voltage will typically agree with an HP3458A voltmeter to five digits. If a DAC will be sinking or sourcing a significant current, then the output voltage should be measured as close to the DAC as possible.

Most of the data sheet specifications use a 4.096V reference, so this is the preferred reference to use for these experiments. Using the 5V reference has the limitation that V_{CC} may be slightly lower than V_{REF}, which may affect the full-scale error. Selecting the 5V reference as the source for V_{CC} overcomes this, however the total current that the LTC2606 can source will be limited to approximately 5mA.

Using an external power supply is highly recommended for these experiments, especially those that draw significant current. Refer to the DC590 Quick Start guide for details.

Resolution

The onboard LTC2421 ADC has an input resolution of 6 μ V. This will easily resolve a 1 LSB (76 μ V for V_{REF} = 5V, 62.5 μ V for V_{REF} = 4.096V) change in the LTC2606 output. Set the DAC output to a voltage close to mid-scale. Select the FINE slider on the control panel with the mouse and use the right and left arrow keys to step the output by single LSBs. The change should be clearly visible in the output graph. Note: It may be necessary to wait for the graph to clear if a large step has just occurred.

EXPERIMENTS

Integral Nonlinearity

A rough measurement of INL can be taken using the onboard ADC. Measure the LTC2606 output at code 256 and 65,535 and calculate the slope and intercept using a spreadsheet. Next, take several readings at intermediate points. The readings should not deviate from the calculated line by more than 64 LSBs, and they will typically be within 12 LSBs.

Load Regulation/DC Output Impedance

Select “5V REG” for the V_{CC} source. Set one of the outputs to mid-scale (code 32768). Source or sink 15mA from one of the DAC outputs by pulling it to power ground or V_{CC} with an appropriate value resistor. The voltage change should be less than 2.25mV, corresponding to an output impedance of 0.15 Ω . Output impedance is typically less

than 0.030 Ω (measure DAC voltage at the output pin if using a voltmeter).

Zero-Scale Error

Set the DAC output to code 0. The measured output should be less than 9mV and will typically be less than 1mV.

Offset Error

Set the DAC output to code 256. The output voltage should be within 9mV of the correct value, or $V_{REF} \times 256/65535$.

Gain Error

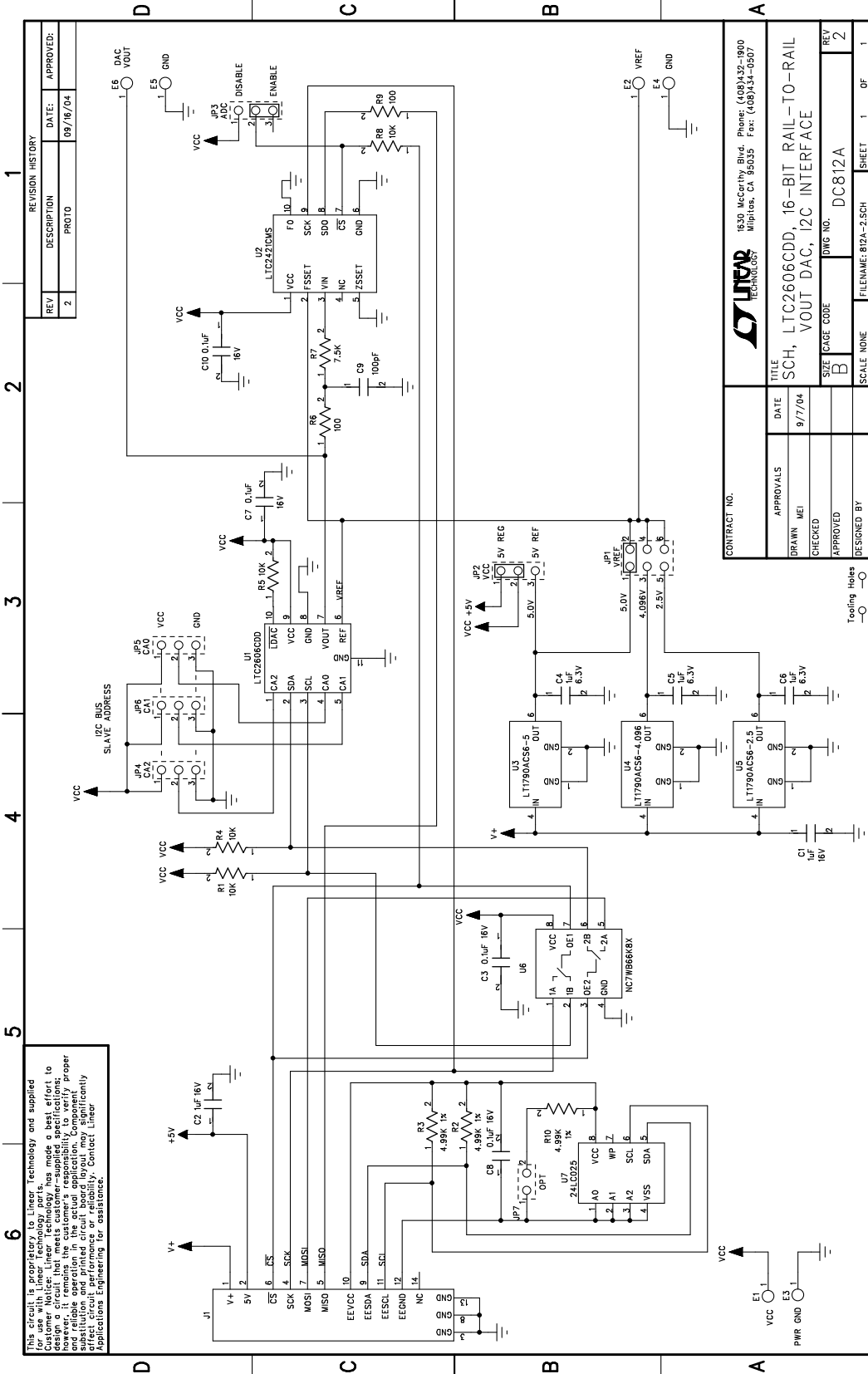
Set the DAC output to code 65,535. The output voltage should be within 0.7% of V_{REF} , and will typically be within 0.2%.

PARTS LIST

| ITEM | QTY | REFERENCE | PART DESCRIPTION | MANUFACTURER/PART NUMBER |
|------------------------------------|-----|---------------|---------------------------------------|-------------------------------------|
| Required Circuit Components | | | | |
| 1 | 1 | U7 | IC, 24LC025 | MICROCHIP, 24LC025 |
| 2 | 3 | C3, C7, C10 | CAP, X7R, 0.1 μ F, 16V, 10%, 0402 | TDK, C1005X7R1C104KT |
| 3 | 1 | C9 | CAP, NPO, 100pF, 50V, 10%, 0402 | AVX, 04025A101KAT |
| 4 | 3 | C4-C6 | CAP, X5R, 1 μ F, 6.3V, 20%, 0603 | AVX, 06036D105MAT |
| 5 | 2 | C1-C2 | CAP, X7R, 1 μ F, 16V, 20%, 0603 | TDK, C1608X7R1C105M |
| 6 | 1 | J1 | HEADER, 2x7P, 2mm | MOLEX, 87831-1420 |
| 7 | 0 | JP7 | DO NOT STUFF | OPTION |
| 8 | 1 | JP1 | HEADER, 2x3P, 2mm | COMM CON, 2202S-06-G2 |
| 9 | 5 | JP2-JP6 | JUMPER, 3-PIN, 2mm | COMM CON, 2802S-03G2 |
| 10 | 1 | U5 | IC, LT1790ACS6-2.5 | LINEAR TECHNOLOGY, LT1790ACS6-2.5 |
| 11 | 1 | U4 | IC, LT1790ACS6-4.096 | LINEAR TECHNOLOGY, LT1790ACS6-4.096 |
| 12 | 1 | U3 | IC, LT1790ACS6-5 | LINEAR TECHNOLOGY, LT1790ACS6-5 |
| 13 | 1 | U2 | IC, LTC2421CMS | LINEAR TECHNOLOGY, LTC2421CMS |
| 14 | 1 | U1 | IC, LTC2606CDD | LINEAR TECHNOLOGY, LTC2606CDD |
| 15 | 1 | U6 | IC, NC7WB66 DUAL LOGIC SWITCH | FAIRCHILD SEMI., NC7WB66K8X |
| 16 | 2 | R6, R9 | RES, 100 Ω , 5%, 1/16W, 0402 | AAC, CR05-101JM |
| 17 | 4 | R1, R4-R5, R8 | RES, 10k Ω , 5%, 1/16W, 0402 | AAC, CR05-103JM |
| 18 | 3 | R2-R3, R10 | RES, 4.99k Ω , 1%, 1/16W, 0402 | AAC, CR05-4991FM |
| 19 | 1 | R7 | RES, 7.5k Ω , 5%, 1/16W, 0402 | AAC, CR05-752JM |
| 20 | 6 | E1-E6 | TURRET | MILL-MAX, 2308-2 |
| 21 | 7 | JP1-JP7 | SHUNT | COMM CON, CCIJ2MM-138G |

dc812af

SCHEMATIC DIAGRAM



| REVISION HISTORY | |
|------------------|-------------|
| REV | DESCRIPTION |
| 2 | PROTD |

| DATE | APPROVED: |
|----------|-----------|
| 09/16/04 | |

| | |
|---|--|
| | |
| 1630 McCarthy Blvd. Phone: (408)321-1800 Milpitas, CA 95035 Fax: (408)321-0507 | |
| CONTRACT NO. | TITLE SCH, LTC2606CDD, 16-BIT RAIL-TO-RAIL VOUT DAC, I2C INTERFACE |
| APPROVALS DRAWN MEI CHECKED APPROVED | DATE 9/17/04 |
| SIZE B | CAGE CODE |
| DWG NO. DC812A | REV 2 |
| SCALE NONE | FILENAME: R12A-2.SCH |
| DESIGNED BY | SHEET 1 OF 1 |

Figure 3. LTC2606CDD, 16-Bit Rail-to-Rail Vout DAC, I2C Interface



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DEMO MANUAL DC812A

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

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