LTC2605
16-Bit Octal Rail-to-Rail
DAC with I^{2}C Interface

DESCRIPTION

Demonstration circuit 935A features the LTC®2605 octal 16-bit DAC. This device establishes a new board-density benchmark for 16-bit DACs and advances performance standards for output drive, crosstalk and load regulation in single supply, voltage-output multiple DACs.

DC935A has many features for evaluating the performance of the LTC2605. Onboard 5V and 4.096V precision references are provided, and the LTC2605 may be powered by the 5V reference for evaluating rail-to-rail operation.

Another feature of this board is the onboard LTC2428 20-bit ADC for monitoring DAC output voltage. The 16ppm total error of this device is adequate for taking meaningful measurements of various LTC2605 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

PARAMETER	CONDITION	VALUE
Resolution		16 Bits
Monotonicity	V$_{CC}$ = 5V, V$_{REF}$ = 4.096V	16 Bits
Differential Nonlinearity	V$_{CC}$ = 5V, V$_{REF}$ = 4.096V	±1LSB
Integral Nonlinearity	V$_{CC}$ = 5V, V$_{REF}$ = 4.096V	±18LSB Typical
Load Regulation	V$_{CC}$ = V$_{REF}$ = 5V, Mid-Scale I$_{OUT}$ = ±15mA	2LSB/mA Max
DC Crosstalk	Due to Load Current Change on Any Other Channel	3.5µV/mA

dc935af

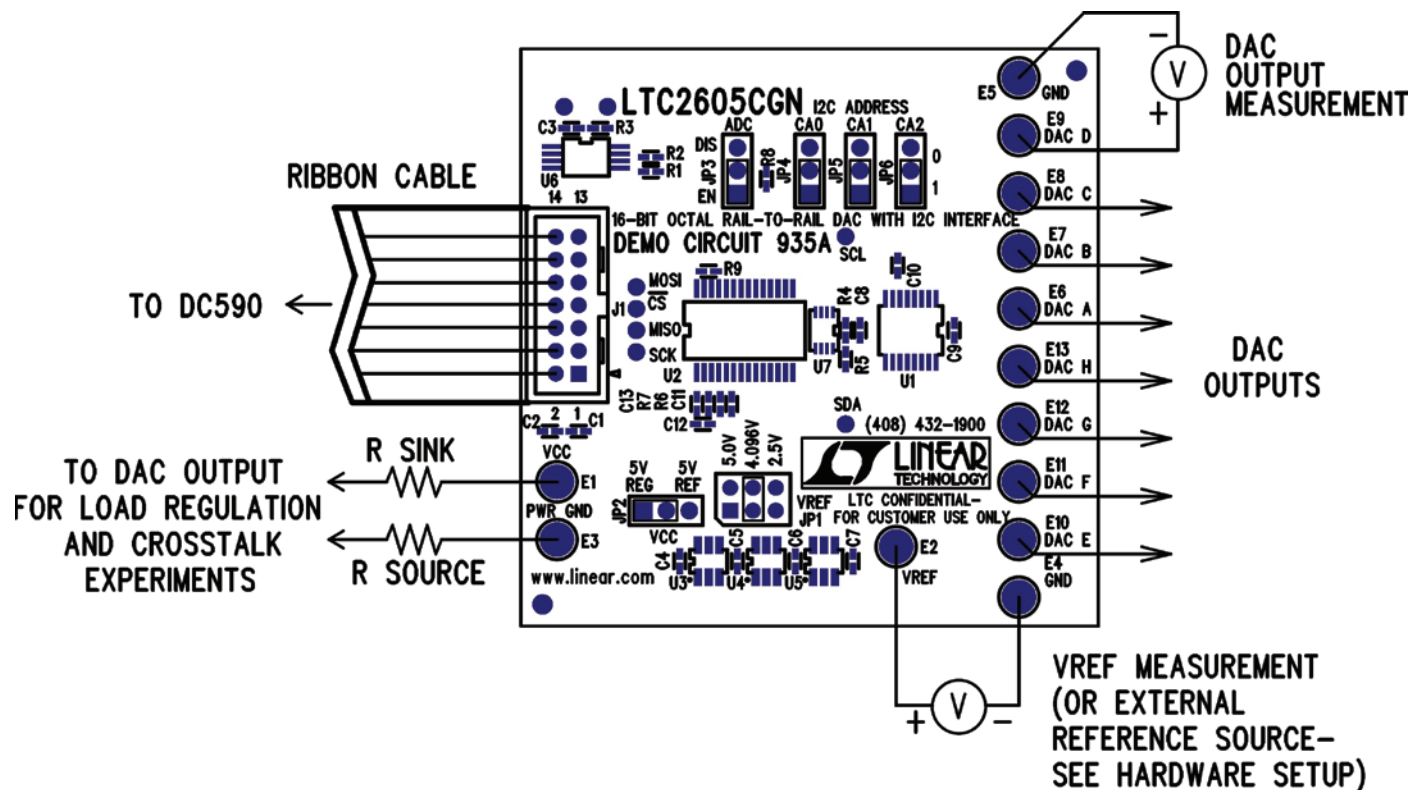# QUICK START PROCEDURE

Figure 1. Proper Measurement Equipment Setup

QUICK START PROCEDURE

Connect DC935A to a DC590 USB serial controller using the supplied 14-conductor ribbon cable. Connect DC590 to a host PC with a standard USB A/B cable. Run the evaluation software supplied with DC590 or download it from www.linear.com/software. The correct control panel will be loaded automatically. Click the COLLECT button to begin outputting codes to the DACs and reading back the resulting output voltage for each DAC.

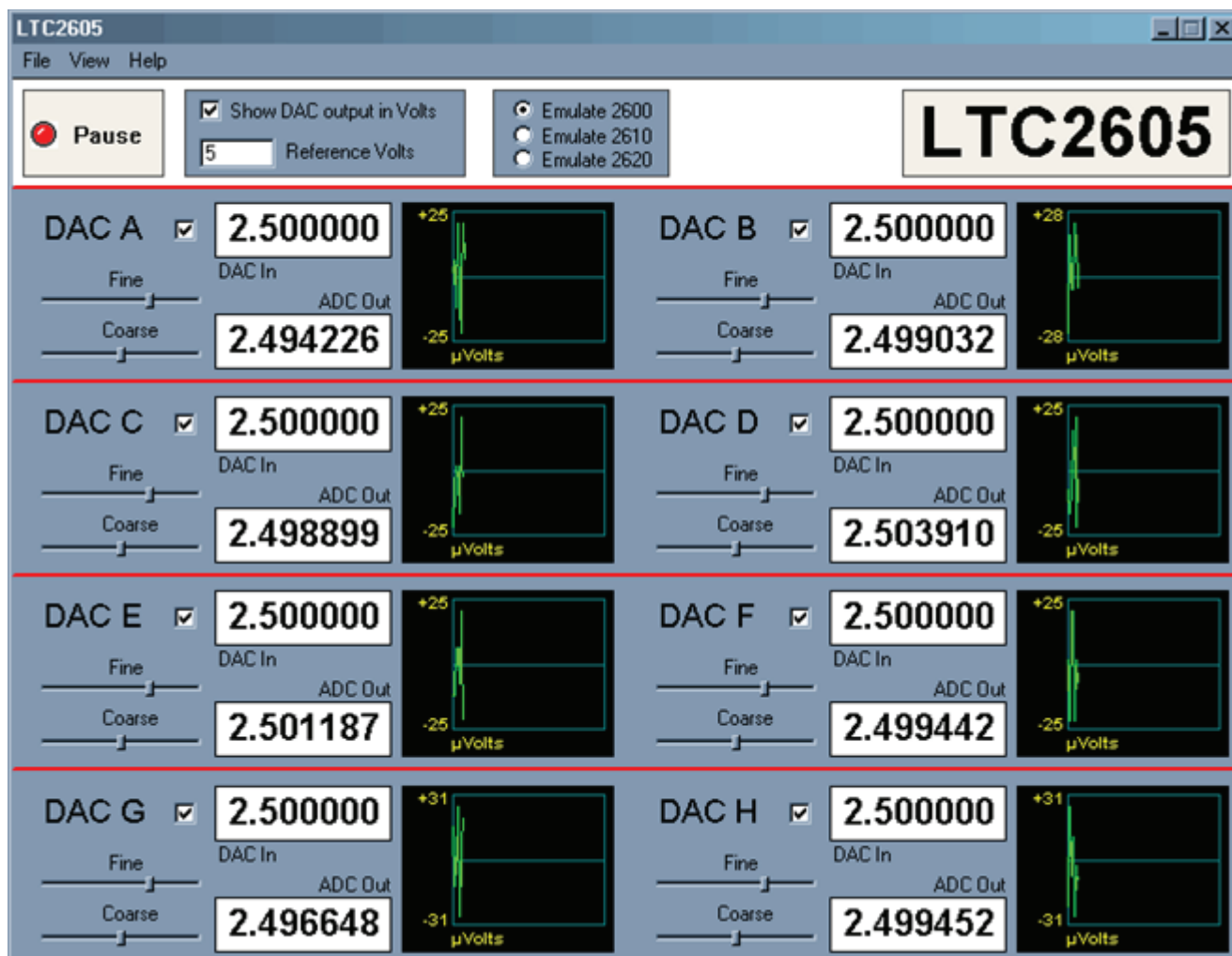Complete software documentation is available from the Help menu item, as features may be added periodically.

Figure 2. DC935A QuikEval Screen Shot

HARDWARE SETUP

Jumpers

JP1 – V_{REF} Select either a 5V, 4.096V or 2.5V precision reference can be selected. To apply an external reference through the V_{REF} Turret, remove this jumper.

JP2 – 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 V_{CC} and V_{REF} allows characterization of rail to rail operation of the LTC2605.

JP3 – ADC Disable. Set to ON for normal operation with the onboard ADC enabled. For very sensitive noise measurements, the ADC may be disabled. The software will then display a positive full-scale reading.

JP4, JP5, JP6 – I^2C Address Selection. These are connected to the CA0, CA1, CA2 pins. The demo software uses the global I^2C address, so these pins have no effect when used with the QuikEval™ software. They can be used in prototyping to set the I^2C address of the LTC2605 – refer to the data sheet for the mapping of CA0, 1, 2 levels to I^2C addresses.

Analog Connections

DAC Outputs – The eight DAC outputs from the LTC2605 are brought out to turrets labeled DAC A through DAC H. These may be connected to external instruments or other circuitry.

DAC outputs are not in alphabetical order on the circuit board.

V_{REF} – The V_{REF} turret is connected directly to the reference terminals of the LTC2605 and LTC2428 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 JP2.

Grounding and Power Connections

Power (V_{CC}) – Normally DC935A is powered by the DC590 controller. V_{CC} can be supplied to this turret, however the power supply on DC590 must be disabled. Refer to 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 LTC2605. All can be performed using the onboard LTC2428 to monitor the DAC output voltage. The indicated output voltage will typically agree with an HP3458A voltmeter to 5 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 regulator as the source for V_{CC} 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 LTC2605 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 LTC2428 ADC has an input resolution of 6µV. This will easily resolve a 1LSB (76µV for V_{REF} = 5V, 62.5µV for V_{REF} = 4.096V) change in the LTC2605 output. Set one of the DAC channels 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. (It may be necessary to wait for the graph to clear if a large step has just occurred. This can be sped up by disabling all other DAC channels in the software by un-checking them.)

Integral Nonlinearity

A rough measurement of INL can be taken using the onboard ADC. Measure one of the LTC2605 outputs 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 64LSBs, and they will typically be within 12LSBs.

Load Regulation/DC Output Impedance

Select "Regulator" for 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 0.15Ω. Output impedance is typically less than 0.030Ω. (Measure DAC voltage at the output pin if using a voltmeter.)

Zero Scale Error

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

Offset Error

Set one of the DACs to code 256. The output voltage should be within 1mV of the correct value, or $V_{REF} \cdot 256/65535$.

Gain Error

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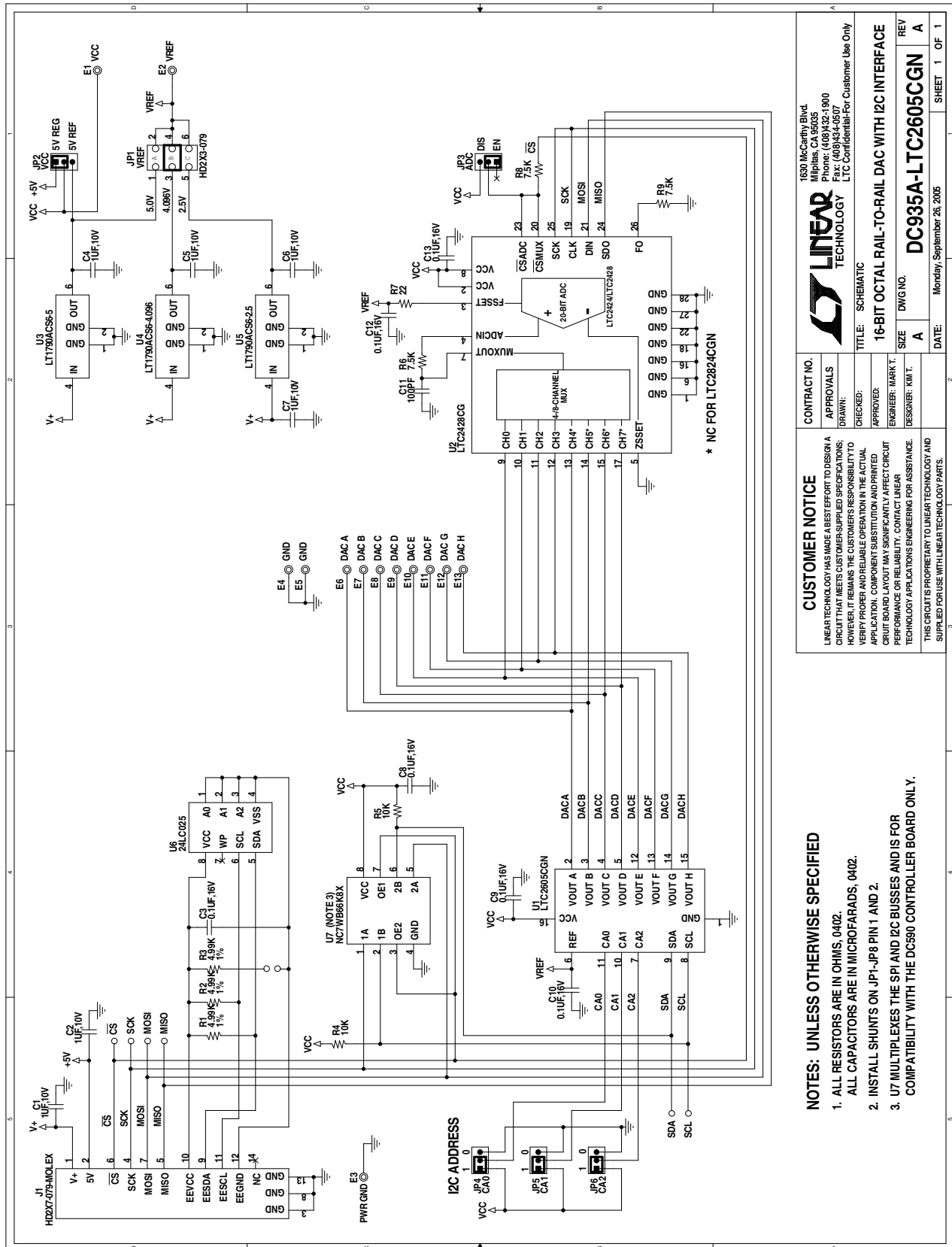
DC Crosstalk

Set all DACs to mid-scale. Connect a 250Ω resistor from one output to V_{CC} or power ground (to sink or source 10mA, respectively, when the 5V reference is being used.) A given output should not change by more than 3.5µV per milliamp of output current in all other DACs combined.

PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
1	6	C1, C2, C4-C7	CAP., X5R, 1µF 10V, 0402	TDK, C1005X5R1A105MT
2	6	C3, C8, C9, C10, C12, C13	CAP., X7R, 0.1µF 16V, 0402	TDK, C1005X7R1C104MT
3	1	C11	CAP., NPO, 100pF 50V, 0402	AVX, 04025A101KAT
4	13	E1-E13	TESTPOINT, TURRET, 0.064"	MILL-MAX, 2308-2
5	1	JP1	JMP, 2×3, .079CC	COMM CON, 2202S-06G2
6	5	JP2, JP3, JP4, JP5, JP6	JMP, 3 PIN 1 ROW .079CC	SAMTEC, TMM-103-02-L-S
7	6	SHUNTS FOR JP1 (3 AND 4), JP2-JP6 (1 AND 2)	SHUNT, .079" CENTER	SAMTEC, 2SN-BK-G
8	1	J1	HEADER, 2×7 PIN, 0.079CC	MOLEX, 87831-1420
9	3	R1, R2, R3	RES., CHIP 4.99k 1/16W 1%, 0402	AAC, CR05-4991FM
10	2	R4, R5	RES., CHIP 10k 1/16W 5%, 0402	AAC, CR05-103JM
11	3	R6, R8, R9	RES., CHIP 7.5k 1/16W 1%, 0402	AAC, CR05-7501FM
12	1	R7	RES., CHIP 22Ω 1/16W 5%, 0402	AAC, CR05-220JM
13	1	U1	I.C., LTC2605CGN, SSOP16GN	LINEAR TECH., LTC2605CGN
14	1	U2	I.C., LTC2428CG, SSOP28G	LINEAR TECH., LTC2428CG
15	1	U3	I.C., LT1790ACS6-5, SOT23-6	LINEAR TECH., LT1790ACS6-5
16	1	U4	I.C., LT1790ACS6-4.096, SOT23-6	LINEAR TECH., LT1790ACS6-4.096
17	1	U5	I.C., LT1790ACS6-2.5, SOT23-6	LINEAR TECH., LT1790ACS6-2.5
18	1	U6	I.C., 24LC025, TSSOP8	MICROCHIP, 24LC025I/ST
19	1	U7	I.C., NC7WB66K8X, US8	FAIRCHILD, NC7WB66K8X

SCHEMATIC DIAGRAM

dc935af

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