

# LTC6362 Driving 18-Bit SAR ADC

## DESCRIPTION

The LTC<sup>®</sup>6362 is a low power, low noise differential op amp with rail-to-rail input and output swing that has been optimized to drive low power SAR ADCs. The amplifier may be configured to buffer a fully differential input signal or convert a single-ended input signal to a differential output signal.

The LTC2380/LTC2379/LTC2378/LTC2377/LTC2376 are low power, low noise ADCs with serial outputs that can operate from a single 2.5V supply. The DC1805A demonstrates the DC and AC performance of the LTC6362 driving the LTC2379-18 when used in conjunction with the DC590B QuikEval<sup>™</sup> and DC718 fast DACs data collection boards.

Use the DC590B to demonstrate DC performance such as peak-to-peak noise and DC linearity. Use the DC718 if precise sampling rates are required or to demonstrate AC performance such as SNR, THD, SINAD and SFDR. The DC1805A is intended to demonstrate recommended grounding, component placement and selection, routing and bypassing for LTC6362 and the ADC.

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

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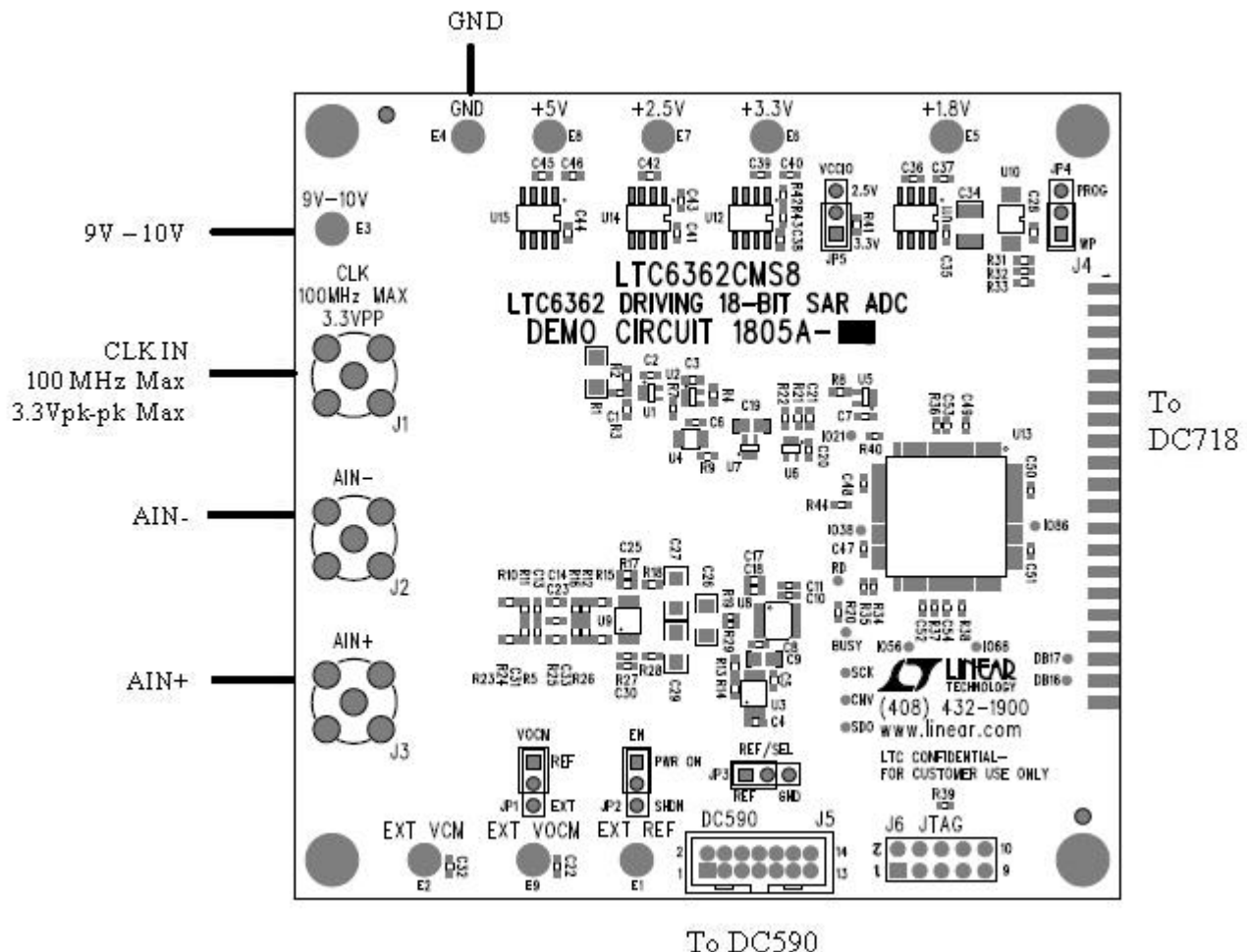


Figure 1. DC1805A Connection Diagram

# DEMO MANUAL DC1805A

## DESCRIPTION

Table 1. DC1805A Assembly Options

| ASSEMBLY VERSION | PART NUMBER   | MAX CONVERSION RATE | NUMBER OF BITS | MAX CLK IN FREQUENCY |
|------------------|---------------|---------------------|----------------|----------------------|
| DC1805A-A        | LTC2380CMS-16 | 2Msps               | 16             | 100MHz               |
| DC1805A-B        | LTC2378CMS-16 | 1Msps               | 16             | 50MHz                |
| DC1805A-C        | LTC2377CMS-16 | 500ksps             | 16             | 25MHz                |
| DC1805A-D        | LTC2376CMS-16 | 250ksps             | 16             | 12.5MHz              |
| DC1805A-E        | LTC2379CMS-18 | 1.6Msps             | 18             | 99.2MHz              |
| DC1805A-F        | LTC2378CMS-18 | 1Msps               | 18             | 62MHz                |
| DC1805A-G        | LTC2377CMS-18 | 500ksps             | 18             | 31MHz                |
| DC1805A-H        | LTC2376CMS-18 | 250ksps             | 18             | 15.5MHz              |

## QUICK START PROCEDURE

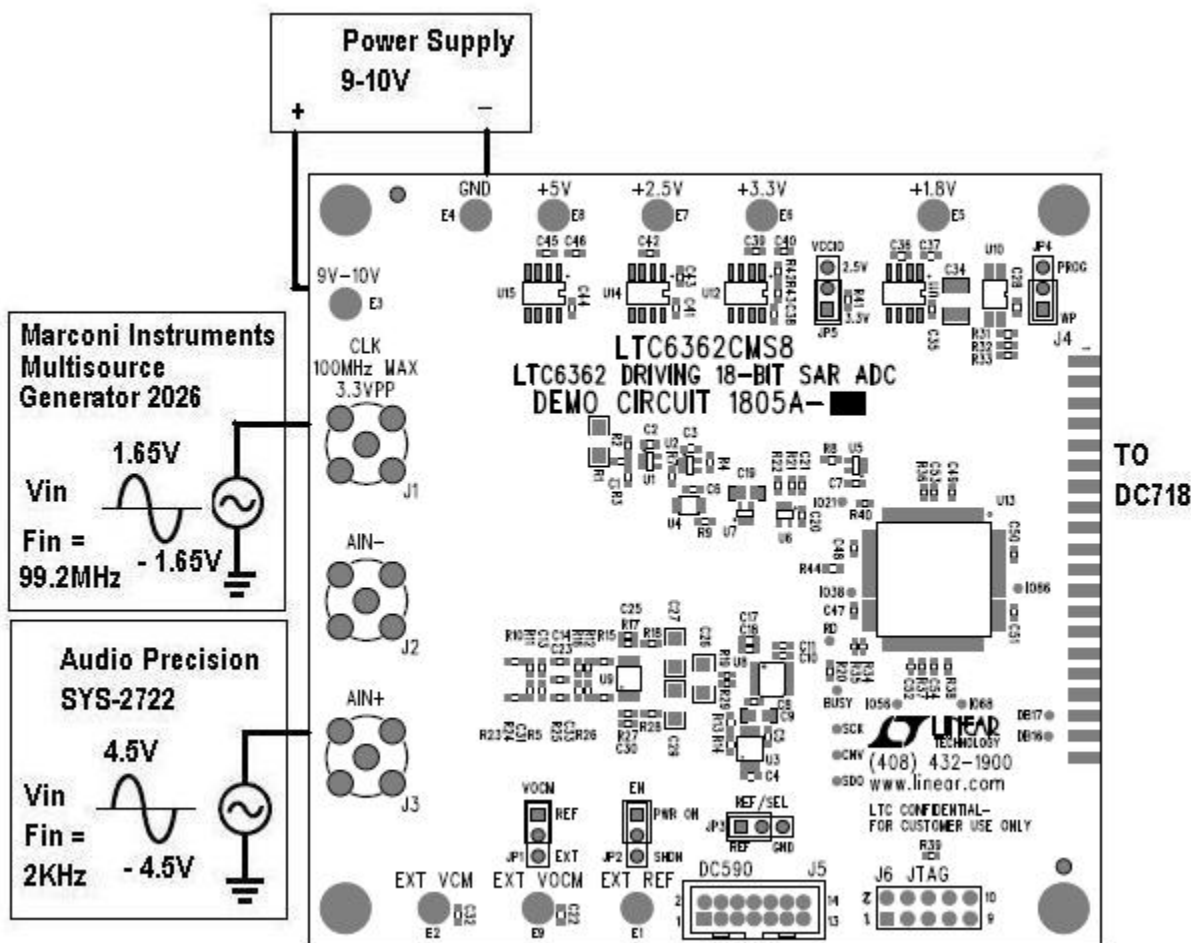


Figure 2. DC1805A Test Diagram

## QUICK START PROCEDURE

This board is tested by measuring the distortion at the differential output given a  $-1\text{dBFS}$ , 2kHz single-ended input as shown in Figure 2.

For SINAD, THD or SNR testing a low noise, low distortion generator such as Audio Precision SYS-2722, B&K Type 1051 or Stanford Research DS360 should be used. A low jitter RF oscillator such as the Marconi Instruments, Multisource Generator 2026 should be used as the clock source.

To test the boards please follow the steps below:

- 1) Make sure that all the jumpers are set as shown in Figure 2 (DC1805A Test Diagram).
- 2) Power up the board by applying 9VDC.

- 3) Apply the clock signal to connector J1. Clock frequency 99.2MHz (to achieve 1.6Msps conversion rate, please refer to the Clock Source section for more detailed information),  $V_{IN}$  3.3V<sub>P-P</sub>.

- 4) A single pole lowpass filter should be used for best SNR measurement data. One option is to create an on-board RC low pass filter by populating R5 with 200 $\Omega$  and C33 with 0.22 $\mu\text{F}$ . It is very important to use a very low distortion capacitor. In order to balance both inputs of the LTC6362 populate R12 with a 200 $\Omega$  resistor in parallel with a 0.22 $\mu\text{F}$  capacitor.

- 5) Apply a 2kHz,  $-1\text{dBFS}$  signal to connector J3.

The performance that results from these connections are displayed in Figure 4.

## DC718 QUICK START PROCEDURE

Check to make sure that all switches and jumpers are set as shown in the connection diagram of Figure 1. The default connections configure the ADC to use the onboard reference and regulators to generate the required common mode voltages. The analog input is DC coupled. Connect the DC1805A to a DC718 USB high speed data collection board using connector J4. Then, connect the DC718 to a host PC with a standard USB A/B cable. Apply 9V to the indicated terminals. Then apply a low jitter signal source to J3. Connect a low jitter 100MHz 3.3V<sub>P-P</sub> sine wave or square wave to connector J1. Note that J1 has a 50 $\Omega$  termination resistor to ground.

Run the QuikEval-II software (Pscope.exe version K72 or later) supplied with the DC718 or download it from [www.linear.com](http://www.linear.com).

Complete software documentation is available from the Help menu. Updates can be downloaded from the Tools menu. Check for updates periodically as new features may be added.

The PScope™ software should recognize the DC1805A and configure itself automatically.

Click the Collect button (see Figure 4) to begin acquiring data. The Collect button then changes to Pause, which can be clicked to stop data acquisition.

## DC590B SETUP

**IMPORTANT! To avoid damage to the DC1805A, make sure that VCCIO (JP5) is set to 3.3V before connecting the DC590B to the DC1805A.**

Connect the DC590B to a host PC with a standard USB A/B cable. Connect the DC1805A to a DC590B USB serial

controller using the supplied 14-conductor ribbon cable. Run the evaluation software supplied with the DC590B or download it from [www.linear.com](http://www.linear.com).

The correct control panel will be loaded automatically. Click the Collect button to begin reading the ADC.

## DC1805A SETUP

### DC Power

The DC1805A requires 9VDC and draws less than 70mA. Most of the supply current is consumed by the CPLD, regulators and discrete logic on the board. The 9VDC input voltage powers the LTC6362 and the ADC through LT®1763 regulators which provide protection against accidental reverse bias. Additional regulators provide power for the CPLD. See Figure 1 for connection details.

### Clock Source

You must provide a low jitter 3.3V<sub>P-P</sub> maximum sine or square wave to J1. The clock input is AC-coupled so the DC level of the clock signal is not important. A generator like the Marconi Instruments, Multisource Generator 2026, HP8644 or the DC1216A-A is recommended. Even a good generator can start to produce noticeable jitter at low frequencies. Therefore it is recommended for lower sample rates to divide down a higher frequency clock to the desired sample rate. The ratio of clock frequency to conversion rate is 62:1 for 18-bit parts and 50:1 for 16-bit parts. If the clock input is to be driven with logic, it is recommended that the 50Ω terminator (R1) be removed. Slow rising edges may compromise the SNR of the converter in the presence of high amplitude higher frequency input signals.

### Reference

The default reference is a LTC6655 5V reference. An external reference can be used by removing (U3) and populating (R6) with 0 resistor. If an external reference is used it must settle quickly in the presence of glitches on the REF pin.

### Analog Input

LTC6362 drives the analog input of the LTC2379-18 on the DC1805A as shown in Figure 3. This circuit converts a single-ended input signal to a differential output signal applied at the ADC inputs. Please refer to the LTC6362 data sheet for various configurations of the LTC6362 interface to the SAR ADC.

AC-coupling the input may degrade the distortion performance of the ADC due to nonlinearity of the coupling capacitor.

### Component Selection

When driving a low noise, low distortion ADC such as the LTC2379-18 with the LTC6362, component selection is important so as to not degrade performance. Resistors should have low values to minimize noise and distortion. Metal film resistors are recommended to reduce distortion caused by self heating. To further reduce distortion, NPO or silver mica capacitors should be used because of their low voltage coefficients.

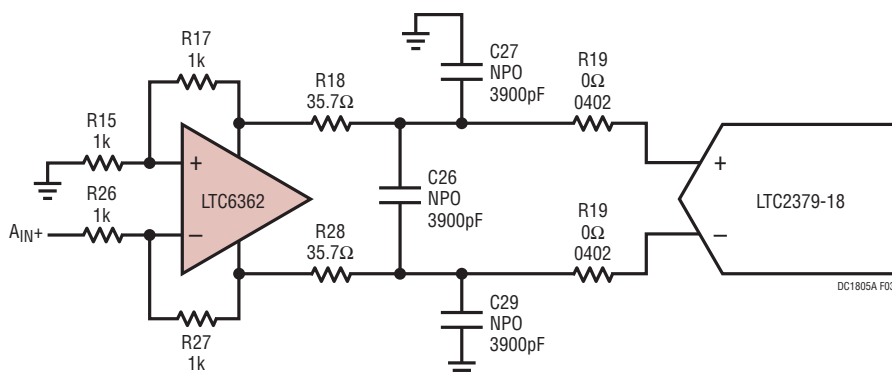


Figure 3. LTC6362 Ground Referenced Single-Ended to Differential Converter



## DC1805A SETUP

### Jumpers

**JP1** – Sets the DC bias for  $V_{OCM}$  of the LTC6362 to be internally biased or externally driven. The voltage on this pin sets the output common mode voltage level.  $V_{REF}/2$  is the default setting.

**JP2** – Toggles the LTC6362 On and Off. Part On (5V) is the default setting.

**JP3** – In the REF position the Digital Gain Compression is off and the analog input range at ADC inputs is 0V to  $V_{REF}$ . In the GND position Digital Gain Compression is turned on and the analog input range at ADC inputs is  $0.1V_{REF}$  to  $0.9V_{REF}$ .

**JP4** – Ties the WP pin to  $V_{CC}$  or GND. WP is the hardware write-protect pin. If tied to  $V_{CC}$ , hardware write protection is enabled. If WP is tied to GND, the hardware write-protection is disabled.

**JP5** – VCCIO sets the output levels at J3 to either 3.3V or 2.5V. Use 3.3V to interface to the DC718 which is the default setting.

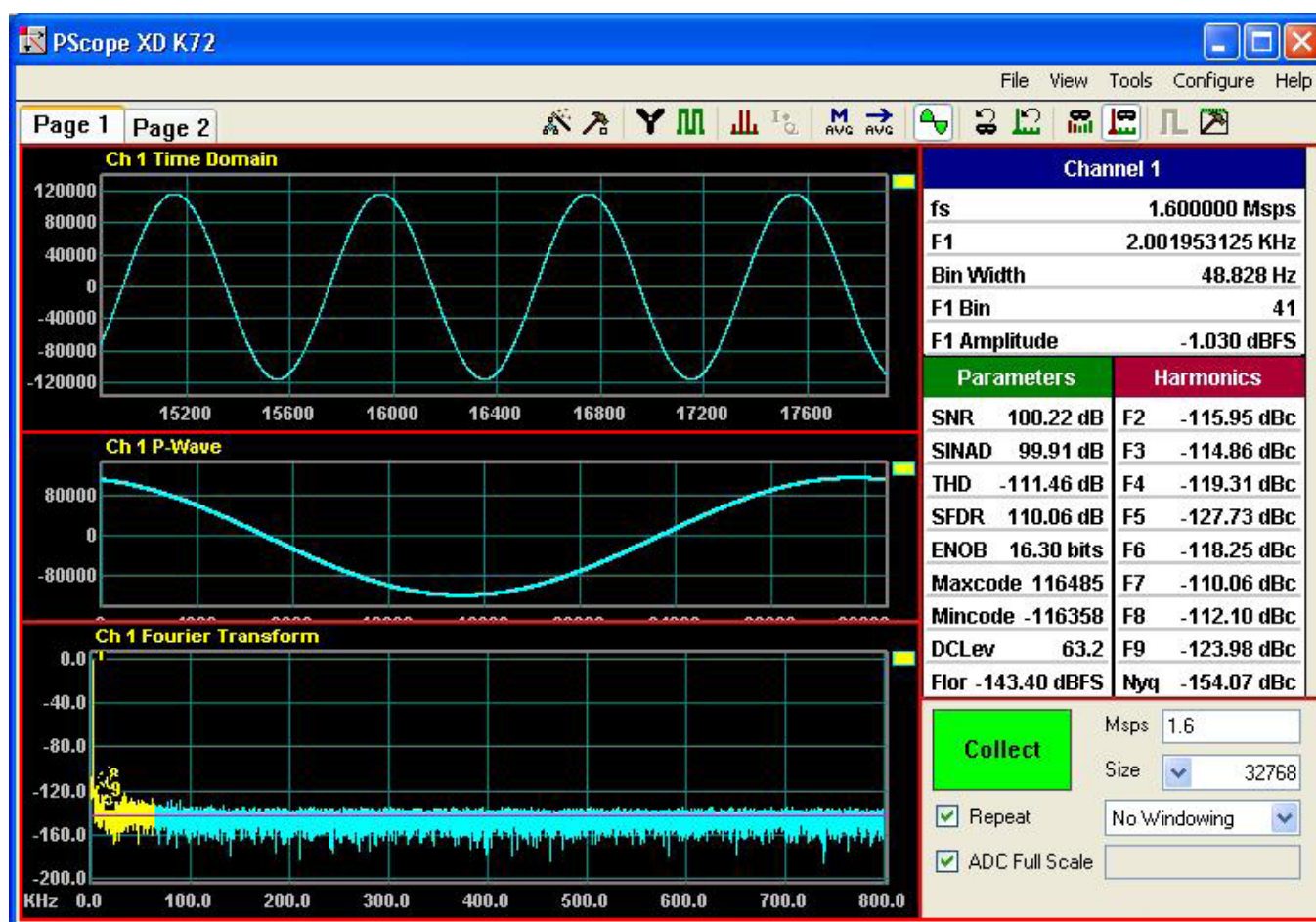


Figure 4. PScope Screenshot

# DEMO MANUAL DC1805A

## PARTS LIST

| ITEM | QTY | REFERENCE                                                     | PART DESCRIPTION                                 | MANUFACTURER/PART NUMBER              |
|------|-----|---------------------------------------------------------------|--------------------------------------------------|---------------------------------------|
| 1    | 14  | C1, C2, C3, C4, C6, C7, C8, C10, C15, C16, C18, C20, C21, C28 | Capacitor, X7R, 0.1µF, 25V, 10%, 0603            | AVX, 06033C104KAT2A                   |
| 2    | 5   | C22, C35, C38, C41, C44                                       | Capacitor, X7R, 1µF, 16V, 10%, 0603              | AVX, 0603YC105KAT2A                   |
| 3    | 1   | C9                                                            | Capacitor, X5R, 47µF 6.3V, 20%, 0805             | Taiyo Yuden, JMK212BJ476MG-T          |
| 4    | 7   | C5, C11, C17, C37, C40, C43, C46                              | Capacitor, X5R, 10µF 6.3V, 20%, 0603             | TDK, C1608X5R0J106MT                  |
| 5    | 1   | C12                                                           | Capacitor, X7R, 4.7µF 10V, 10%, 0805             | AVX, 0805ZC475KAT2A                   |
| 6    | 1   | C19                                                           | Capacitor, X7R, 0.1µF, 25V, 5%, 0805             | AVX, 08053C104JAT2A                   |
| 7    | 1   | C24                                                           | Capacitor, X7R, 0.01µF, 16V, 10%, 0402           | AVX, 0402YC103KAT2A                   |
| 8    | 0   | C13, C14, C23, C25, C30, C31, C32, C33                        | Capacitor, 0603                                  | OPT                                   |
| 9    | 3   | C26, C27, C29                                                 | Capacitor, Ceramic 3900pF, 100V NPO, 1206        | AVX, 12061A392JAT2A                   |
| 10   | 1   | C34                                                           | Capacitor, X5R, 22µF 16V, 20%, 1210              | Taiyo Yuden, EMK325BJ226MM-T          |
| 11   | 4   | C36, C39, C42, C45                                            | Capacitor, X7R, 0.01µF, 16V, 10%, 0603           | AVX, 0603YC103KAT                     |
| 12   | 8   | C47, C48, C49, C50, C51, C52, C53, C54                        | Capacitor, X7R, 0.1µF, 16V, 10%, 0402            | TDK, C1005X7R1C104KT                  |
| 13   | 5   | E1, E2, E3, E4, E5, E6, E7, E8, E9                            | TP, Turret, 0.094"                               | Mill-Max, 2501-2-00-80-00-00-07-0     |
| 14   | 3   | J1, J2, J3                                                    | Connector, BNC-5PINS                             | Connex, 112404                        |
| 15   | 1   | J4                                                            | Connector, 40 Pins SMT, CON-EDGE40-100           | Samtec, TSW-120-07-L-D                |
| 16   | 1   | J5                                                            | Header, 2x7, 0.079"                              | Molex, 87831-1420                     |
| 17   | 1   | J6                                                            | Header, 2x5, 0.100", HD2X5-100                   | Samtec, TSW-105-07-L-D                |
| 18   | 5   | JP1-JP5                                                       | Jumper, 1x3, 0.100", HD1X3-100                   | Samtec, TSW-103-07-L-S                |
| 19   | 1   | R1                                                            | Resistor, Chip 49.9, 1%, 1206                    | NIC, NRC12F49R9TRF                    |
| 20   | 11  | R2, R3, R13, R14, R15, R17, R20, R21, R26, R27, R30           | Resistor, Chip 1k, 1%, 0603                      | NIC, NRC06F1001TRF                    |
| 21   | 5   | R4, R7, R8, R9, R44                                           | Resistor, Chip 33, 1%, 0603                      | NIC, NRC06F33R0TRF                    |
| 22   | 4   | R5, R10, R12, R23                                             | Resistor, Chip 0, 1%, 0603                       | NIC, NRC06F0000TRF                    |
| 23   | 0   | R6, R11, R16, R24, R25                                        | Resistor, 0603                                   | OPT                                   |
| 24   | 2   | R18, R28                                                      | Resistor, Chip 35.7, 1%, 0603                    | Vishay, CRCW060335R7FKEA              |
| 25   | 2   | R19, R29                                                      | Resistor, Chip 0, 1/16W, 1%, 0402                | NIC, C04F0000TRF                      |
| 26   | 1   | R22                                                           | Resistor, Chip 2k, 1%, 0603                      | NIC, NRC06F2001TRF                    |
| 27   | 3   | R31, R32, R33                                                 | Resistor, Chip 4.99k, 1%, 0603                   | NIC, NRC06F4991TRF                    |
| 28   | 1   | R34                                                           | Resistor, Chip 10k, 1%, 0402                     | NIC, NRC04F1002TRF                    |
| 29   | 4   | R36, R37, R38, R40                                            | Resistor, Chip 1k, 1%, 0402                      | NIC, NRC04F1001TRF                    |
| 30   | 1   | R39                                                           | Resistor, Chip 10k, 1%, 0603                     | NIC, NRC06F1002TRF                    |
| 31   | 1   | R41                                                           | Resistor, Chip 2.80k, 1%, 0603                   | NIC, NRC06F2801TRF                    |
| 32   | 1   | R42                                                           | Resistor, Chip 1.69k, 1%, 0603                   | NIC, NRC06F1691TRF                    |
| 33   | 1   | R43                                                           | Resistor, Chip 1.54k, 1%, 0603                   | NIC, NRC06F1541TRF                    |
| 34   | 2   | U1, U6                                                        | IC., Tinylogic UHS Inverter, SC70-5              | Fairchild, NC7SZ04P5X                 |
| 35   | 2   | U2, U5                                                        | IC., Tinylogic ULP-A Unbuffered Inverter, SC70-5 | Fairchild, NC7SVU04P5X                |
| 36   | 1   | U3                                                            | IC., LTC6655CHMS8-5, MS8                         | Linear Technology, LTC6655CHMS8-5#PBF |
| 37   | 1   | U4                                                            | IC., Single D Flip Flop, US8                     | ON Semiconductor, NL17SZ74 (USG)      |
| 38   | 1   | U7                                                            | IC., Single SPST Bus Switch, SC70-5              | Fairchild, NC7SZ66P5X                 |
| 39   | 1   | U9                                                            | IC., LTC6362CMS8, MS8                            | Linear Technology, LTC6362CMS8        |
| 40   | 1   | U10                                                           | IC., Serial EEPROM, TSSOP                        | Microchip, 24LC024-I/ST               |

## PARTS LIST

| ITEM | QTY | REFERENCE                                     | PART DESCRIPTION                        | MANUFACTURER/PART NUMBER             |
|------|-----|-----------------------------------------------|-----------------------------------------|--------------------------------------|
| 41   | 1   | U11                                           | IC., LT1763CS8-1.8, S08                 | Linear Technology, LT1763CS8-1.8#PBF |
| 42   | 1   | U12                                           | IC., LT1763CS8, S08                     | Linear Technology, LT1763CS8#PBF     |
| 43   | 1   | U13                                           | IC., MAX II Family, TQFP100             | Altera, EPM240GT100C5N               |
| 44   | 1   | U14                                           | IC., LT1763CS8-2.5, S08                 | Linear Technology, LT1763CS8-2.5#PBF |
| 45   | 1   | U15                                           | IC., LT1763CS8-5, S08                   | Linear Technology, LT1763CS8-5#PBF   |
| 46   | 4   | MH1-MH4                                       | Stand-Off, Nylon (Snap On), 0.375" Tall | Keystone, 8832 (Snap On)             |
| 47   | 5   | Shunts as Shown on Assembly Drawing (JP1-JP5) | Shunt, .100" Center                     | Samtec, SNT-100-BK-G                 |
| 48   | 2   | Stencil for Top and Bottom                    |                                         | Stencil #DC1805A-2                   |

### DC1805A-A

|   |   |           |                               |                                  |
|---|---|-----------|-------------------------------|----------------------------------|
| 1 | 1 | DC1805A-A | General BOM                   |                                  |
| 2 | 1 | U8        | IC., LTC2380CMS-16, MS16      | Linear Technology, LTC2380CMS-16 |
| 3 | 0 | R35 (OPT) | Resistor, Chip 300Ω, 1%, 0402 | OPT                              |

### DC1805A-B

|   |   |           |                               |                                  |
|---|---|-----------|-------------------------------|----------------------------------|
| 1 | 1 | DC1805A-B | General BOM                   |                                  |
| 2 | 1 | U8        | IC., LTC2378CMS-16, MS16      | Linear Technology, LTC2378CMS-16 |
| 3 | 0 | R35 (OPT) | Resistor, Chip 300Ω, 1%, 0402 | OPT                              |

### DC1805A-C

|   |   |           |                               |                                  |
|---|---|-----------|-------------------------------|----------------------------------|
| 1 | 1 | DC1805A-C | General BOM                   |                                  |
| 2 | 1 | U8        | IC., LTC2377CMS-16, MS16      | Linear Technology, LTC2377CMS-16 |
| 3 | 0 | R35 (OPT) | Resistor, Chip 300Ω, 1%, 0402 | OPT                              |

### DC1805A-D

|   |   |           |                               |                                  |
|---|---|-----------|-------------------------------|----------------------------------|
| 1 | 1 | DC1805A-D | General BOM                   |                                  |
| 2 | 1 | U8        | IC., LTC2376CMS-16, MS16      | Linear Technology, LTC2376CMS-16 |
| 3 | 0 | R35 (OPT) | Resistor, Chip 300Ω, 1%, 0402 | OPT                              |

### DC1805A-E

|   |   |           |                               |                                  |
|---|---|-----------|-------------------------------|----------------------------------|
| 1 | 1 | DC1805A-E | General BOM                   |                                  |
| 2 | 1 | U8        | IC., LTC2379CMS-18, MS16      | Linear Technology, LTC2379CMS-18 |
| 3 | 1 | R35       | Resistor, Chip 300Ω, 1%, 0402 | NIC, NRC04F3000TRF               |

### DC1805A-F

|   |   |           |                               |                                  |
|---|---|-----------|-------------------------------|----------------------------------|
| 1 | 1 | DC1805A-F | General BOM                   |                                  |
| 2 | 1 | U8        | IC., LTC2378CMS-18, MS16      | Linear Technology, LTC2378CMS-18 |
| 3 | 1 | R35       | Resistor, Chip 300Ω, 1%, 0402 | NIC, NRC04F3000TRF               |

### DC1805A-G

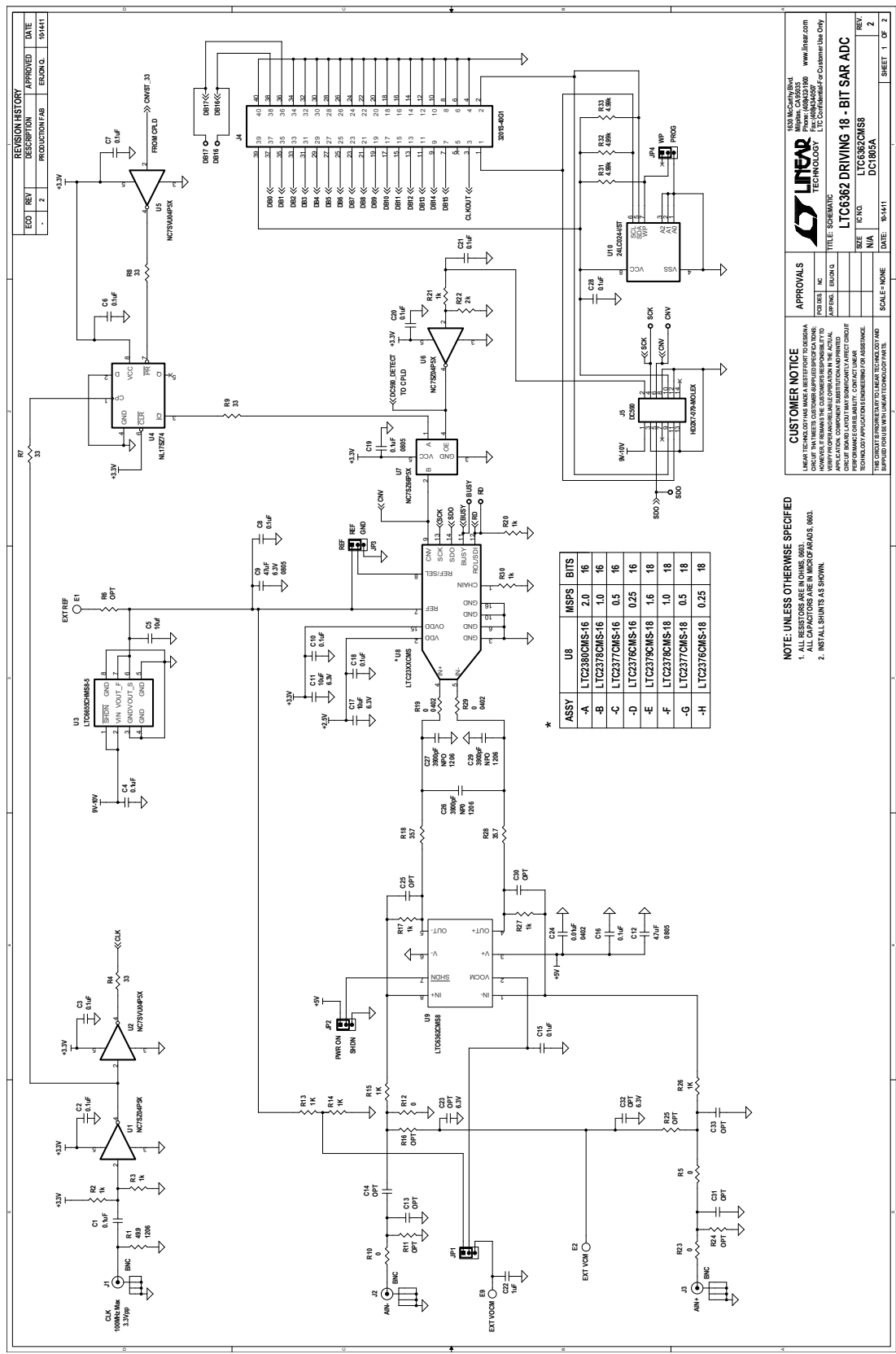
|   |   |           |                               |                                  |
|---|---|-----------|-------------------------------|----------------------------------|
| 1 | 1 | DC1805A-G | General BOM                   |                                  |
| 2 | 1 | U8        | IC., LTC2377CMS-18, MS16      | Linear Technology, LTC2377CMS-18 |
| 3 | 1 | R35       | Resistor, Chip 300Ω, 1%, 0402 | NIC, NRC04F3000TRF               |

### DC1805A-H

|   |   |           |                               |                                  |
|---|---|-----------|-------------------------------|----------------------------------|
| 1 | 1 | DC1805A-H | General BOM                   |                                  |
| 2 | 1 | U8        | IC., LTC2376CMS-18, MS16      | Linear Technology, LTC2376CMS-18 |
| 3 | 1 | R35       | Resistor, Chip 300Ω, 1%, 0402 | NIC, NRC04F3000TRF               |

# DEMO MANUAL DC1805A

## SCHEMATIC DIAGRAM







# DEMO MANUAL DC1805A

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