

# LTC2380/LTC2379/LTC2378/ LTC2377/LTC2376: 18-Bit/16-Bit, 2Msps/1.6Msps/1Msps/ 500ksps/250ksps Low Power, Low Noise ADCs

## DESCRIPTION

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 following text refers to the LTC2379-18 but applies to all parts in the family, the only difference being the maximum sample rates and the number of bits. The LTC2379-18 supports a  $\pm 5V$  fully differential input range with a 101dB SNR, consumes only 18mW and achieves  $\pm 2LSB$  INL max with no missing codes at 18-bits. The [DC1783A](#) demonstrates the DC and AC performance of the LTC2379-18 in conjunction with the DC590 QuikEval™ and DC718 PScope™ data collection boards. Use the DC590 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 demonstration circuit 1783A is intended to demonstrate recommended grounding, component placement and selection, routing and bypassing for this ADC. Several suggested driver circuits for the analog inputs will be presented.

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

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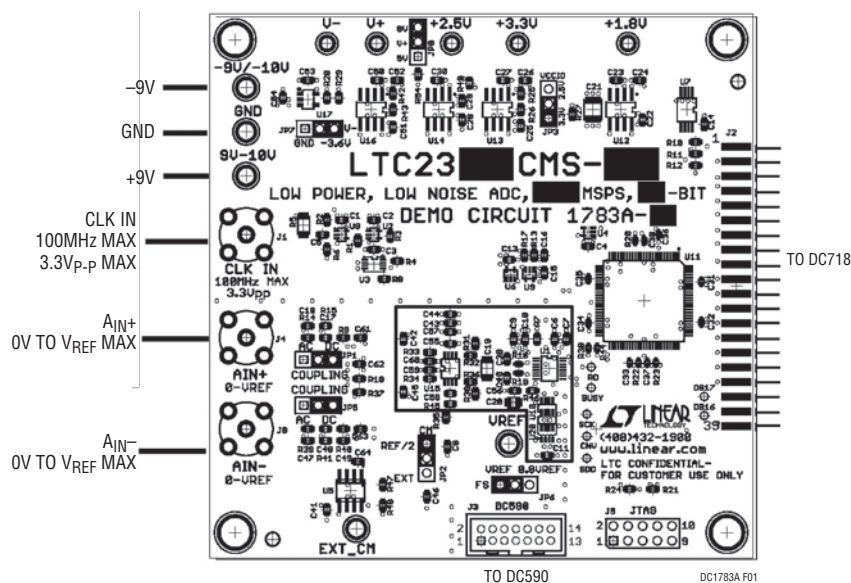


Figure 1. DC1783A Connection Diagram

## DESCRIPTION

Table 1. DC1783A Assembly Options

| ASSEMBLY VERSION | U1 PART NUMBER | MAX CONVERSION RATE | NUMBER OF BITS | MAX CLK IN FREQUENCY |
|------------------|----------------|---------------------|----------------|----------------------|
| DC1783A-A        | LTC2380CMS-16  | 2Msps               | 16             | 100MHz               |
| DC1783A-B        | LTC2378CMS-16  | 1Msps               | 16             | 50MHz                |
| DC1783A-C        | LTC2377CMS-16  | 500ksps             | 16             | 25MHz                |
| DC1783A-D        | LTC2376CMS-16  | 250ksps             | 16             | 12.5MHz              |
| DC1783A-E        | LTC2379CMS-18  | 1.6Msps             | 18             | 99.2MHz              |
| DC1783A-F        | LTC2378CMS-18  | 1Msps               | 18             | 62MHz                |
| DC1783A-G        | LTC2377CMS-18  | 500ksps             | 18             | 31MHz                |
| DC1783A-H        | LTC2376CMS-18  | 250ksps             | 18             | 15.5MHz              |

## QUICK START PROCEDURE

### DC718

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 DC1783A to a DC718 USB High Speed Data Collection Board using connector J2. Then, connect the DC718 to a host PC with a standard USB A/B cable. Apply  $\pm 9V$  to the indicated terminals. Then apply a low jitter signal source to J4. The default setup uses a single-ended to differential converter so that it is only necessary to apply a single-ended input signal to J4. 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 PScope 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 DC1783A and configure itself automatically.

Click the COLLECT button (See Figure 6) to begin acquiring data. The Collect button then changes to Pause, which can be clicked to stop data acquisition.

### DC590 SETUP

**IMPORTANT!** To avoid damage to the DC1783A, make sure that  $V_{CCIO}$  (JP6) is set to 3.3V before connecting the DC590 to the DC1783A.

To use the DC590 with the DC1783A, it is necessary to apply  $-9V$  and ground to the  $-9V$  and GND terminals or disable amplifier U15 by moving R32 and R36 to R31 and R38 respectively. If U15 is disabled, it is required that J4 and J8 are both driven. If U15 is not disabled then it is only necessary to drive J4. Connect the DC590 to a host PC with a standard USB A/B cable. Connect the DC1783A to a DC590 USB serial controller using the supplied 14-conductor ribbon cable. Apply a signal source to J4 or J4 and J8 depending on how the DC1783A is configured.

Run the evaluation software supplied with the DC590 or download it from [www.linear.com](http://www.linear.com). The correct control panel will be loaded automatically. Click the COLLECT button (Figure 7) to begin reading the ADC.

### DC1783A SETUP

#### DC Power

The DC1783A requires  $\pm 9VDC$  and draws 100mA. Most of the supply current is consumed by the CPLD, opamps, regulators and discrete logic on the board. The 9VDC input voltage powers the ADC through LT1763 regulators which provide protection against accidental reverse bias. Additional regulators provide power for the CPLD and opamps. See Figure 1 for connection details.

dc1783afb



## QUICK START PROCEDURE

### Data Collection

For SINAD, THD or SNR testing a low noise, low distortion generator such as the B&K Type 1051 or Stanford Research DS360 should be used. A low jitter RF oscillator such as the HP8644 or DC1216A-A is used as the clock source.

This demo board is tested in house by attempting to duplicate the FFT plot shown on the front page of the LTC2379-18 data sheet. This involves using a 100MHz clock source, along with a sinusoidal generator at a frequency of 2kHz. The input signal level is approximately  $-1\text{dBFS}$ . The input is level shifted and filtered with the circuit shown in Figure 5. A typical FFT obtained with DC1783A is shown in Figure 6. Note that to calculate the real SNR, the signal level (F1 amplitude =  $-1.080\text{dB}$ ) has to be added back to the SNR that PScope displays. With the example shown in Figure 6 this means that the actual SNR would be  $101.07\text{dB}$  instead of the  $99.99\text{dB}$  that PScope displays. Taking the RMS sum of the recalculated SNR and the THD yields a SINAD of  $100.7\text{dB}$  which is fairly close to the typical number for this ADC.

There are a number of scenarios that can produce misleading results when evaluating an ADC. One that is common is feeding the converter with a frequency, that

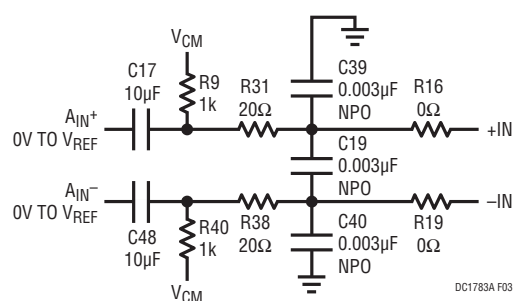


Figure 3. AC-Coupled Differential Driver

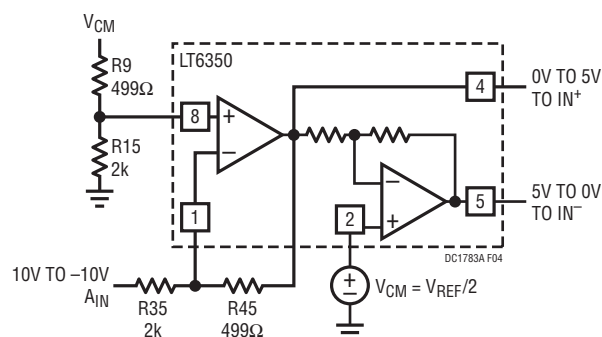


Figure 4.  $\pm 10\text{V}$  Single-Ended to 0V to 5V Differential DC-Coupled Driver

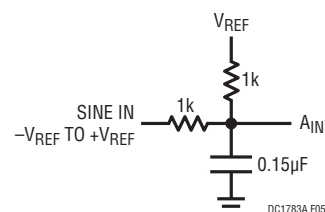


Figure 5. Level Shift and Filter Circuit Used for Board Testing

is a sub-multiple of the sample rate, and which will only exercise a small subset of the possible output codes. The proper method is to pick an  $M/N$  frequency for the input sine wave frequency.  $N$  is the number of samples in the FFT.  $M$  is a prime number between one and  $N/2$ . Multiply  $M/N$  by the sample rate to obtain the input sine wave frequency. Another scenario that can yield poor results is if you do not have a signal generator capable of ppm frequency accuracy or if it cannot be locked to the clock frequency. You can use an FFT with windowing to reduce the leakage or spreading of the fundamental, to get a close approximation of the ADC performance. If an amplifier or clock source with poor phase noise is used, the windowing will not improve the SNR.

## QUICK START PROCEDURE

### Layout

As with any high performance ADC, this part is sensitive to layout. The area immediately surrounding the ADC on the DC1783A should be used as a guideline for placement, and routing of the various components associated with the ADC. Here are some things to remember when laying out a board for the LTC2379-18. A ground plane is necessary to obtain maximum performance. Keep bypass capacitors as close to supply pins as possible. Use individual low impedance returns for all bypass capacitors. Use of a symmetrical layout around the analog inputs will minimize the effects of parasitic elements. Shield analog input traces with ground to minimize coupling from other traces. Keep traces as short as possible.

### Component Selection

When driving a low noise, low distortion ADC such as the LTC2379-18, 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. Because of their low voltage coefficients, to further reduce distortion NPO or silver mica capacitors should be used. Any buffer used to drive the LTC2379-18 should have low distortion, low noise and a fast settling time such as the LT6350.

### DC1783A JUMPERS

#### Definitions

**JP1:** Selects AC- or DC-coupling of  $A_{IN}^+$ . The default setting is DC.

**JP2:**  $V_{CM}$  sets the DC bias for  $A_{IN}^+$  and  $A_{IN}^-$  when the inputs are AC-coupled.  $V_{REF}/2$  is the default setting.

**JP3:**  $V_{CCIO}$  sets the output levels at J2 to either 3.3V or 2.5V. Use 3.3V to interface to the DC718 which is the default setting.

**JP5:** Selects AC- or DC-coupling of  $A_{IN}^-$ . The default setting is DC.

**JP6:** FS selects whether the digital gain compression is on or off. In the  $V_{REF}$  position digital gain compression is off and the analog input range at  $A_{IN}^+$  is 0V to  $V_{REF}$ . In the  $0.8V_{REF}$  position digital gain compression is turned on and the analog input range at  $A_{IN}^+$  is  $0.1V_{REF}$  to  $0.9V_{REF}$ .

**JP7:** Selects  $-3.6V$  or ground for  $V^-$ . The default is  $-3.6V$ . Setting JP7 to ground is useful for evaluating single supply operation of the buffer when operating the ADC with digital gain compression turned on.

**JP8:** Selects 8V or 5V for  $V^+$ . The default is 8V. Setting JP8 to 5V is useful for evaluating single 5V supply operation of the buffer when operating the ADC with digital gain compression turned on.

QUICK START PROCEDURE

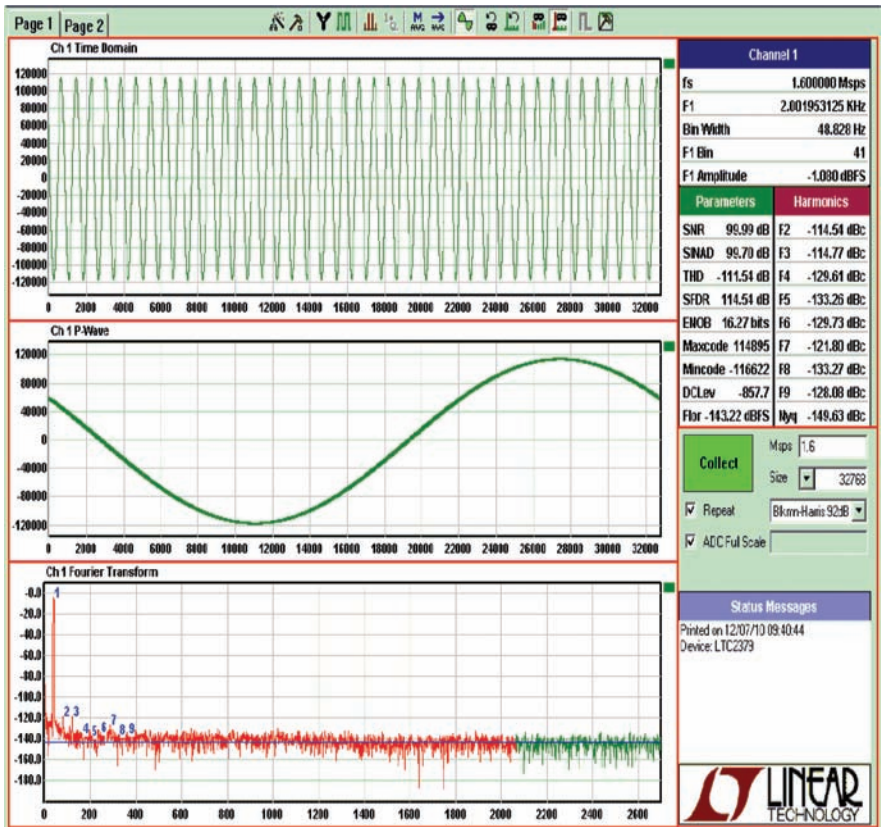


Figure 6. Pscope Screen Shot

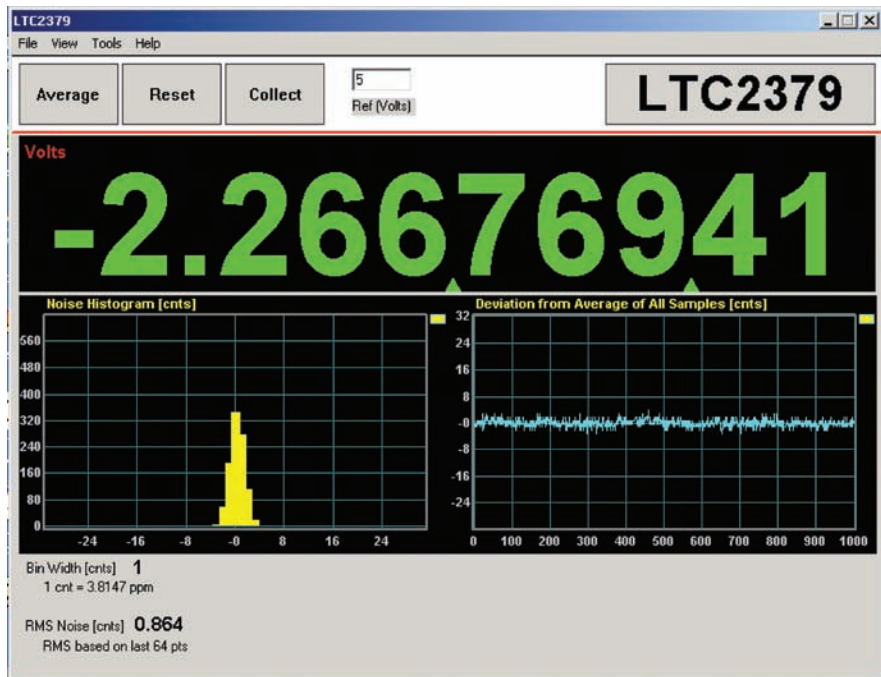


Figure 7. QuikEval Screen Shot

## PARTS LIST

| ITEM | QTY | REFERENCE                                                      | PART DESCRIPTION                       | MANUFACTURER/PART NUMBER          |
|------|-----|----------------------------------------------------------------|----------------------------------------|-----------------------------------|
| 1    | 17  | C1-C5, C7, C10, C11, C13-C16, C41, C43, C56, C57, C60          | Capacitor, X5R, 0.1μF, 16V, 10%, 0603  | AVX, 0603YD104KAT                 |
| 2    | 12  | C6, C9, C17, C24, C26, C29, C45, C48, C52, C53, C61, C63       | Capacitor, X5R, 10μF, 6.3V, 20%, 0603  | TDK, C1608X5R0J106MT              |
| 3    | 13  | C8, C12, C22, C25, C28, C44, C46, C51, C54, C55, C59, C62, C64 | Capacitor, X7R, 1μF, 16V, 10%, 0603    | TDK, C1608X7R1C105K               |
| 4    | 0   | C18, C47, C49, C58                                             | Capacitor, 0603                        | OPT                               |
| 5    | 1   | C19                                                            | Capacitor, C0G, 3300pF, 50V, 10%, 1206 | AVX, 12065A332KAT2A               |
| 6    | 1   | C20                                                            | Capacitor, X5R, 47μF, 6.3V, 20%, 0805  | Taiyo Yuden, JMK212BJ476MG-T      |
| 7    | 1   | C21                                                            | Capacitor, X5R, 22μF, 16V, 20%, 1210   | Taiyo Yuden, EMK325BJ226MM-T      |
| 8    | 4   | C23, C27, C30, C50                                             | Capacitor, X7R, 0.01μF, 16V, 10%, 0603 | AVX, 0603YC103KAT                 |
| 9    | 2   | C39, C40                                                       | Capacitor, C0G, 3300pf, 50V, 10%, 0603 | Kemet, C0603C332K5GACTU           |
| 10   | 8   | C31-C38                                                        | Capacitor, X7R, 0.1μF, 16V, 10%, 0402  | TDK, C1005X7R1C104KT              |
| 11   | 1   | C42                                                            | Capacitor, C0G, 15pF, 50V, 10%, 0603   | AVX, 06035A150KAT2A               |
| 12   | 5   | E1, E4, E6, E7, E10                                            | TP, Turret, 0.094"                     | Mill-Max, 2501-2-00-80-00-00-07-0 |
| 13   | 5   | E2, E3, E5, E8, E9                                             | TP, Turret, 0.064"                     | Mill-Max, 2308-2-00-80-00-00-07-0 |
| 14   | 3   | J1, J4, J8                                                     | Connector, BNC-5 Pins                  | Connex, 112404                    |
| 15   | 1   | J2                                                             | Connector, 40 Pins SMT, CON-EDGE40-100 | Samtec, TSW-120-07-L-D            |
| 16   | 1   | J3                                                             | Header, 2mm × 7mm, 0.079"              | Molex, 87831-1420                 |
| 17   | 1   | J5                                                             | Header, 2mm × 5mm, 0.100", HD2X5-100   | Samtec, TSW-105-07-L-D            |
| 18   | 7   | JP1-JP3, JP5-JP8                                               | Jumper, 1mm × 3mm, 0.100", HD1X3-100   | Samtec, TSW-103-07-L-S            |
| 19   | 4   | R1, R3, R4, R8                                                 | Resistor, Chip, 33Ω, 1%, 0603          | NIC, NRC06F33R0TRF                |
| 20   | 10  | R2, R6, R7, R13, R24, R29, R40, R43, R48, R49                  | Resistor, Chip, 1k, 1%, 0603           | NIC, NRC06F1001TRF                |
| 21   | 1   | R5                                                             | Resistor, Chip, 49.9Ω, 1%, 1206        | NIC, NRC12F49R9TRF                |
| 22   | 3   | R10, R11, R12                                                  | Resistor, Chip, 4.99k, 1%, 0603        | NIC, NRC06F4991TRF                |
| 23   | 6   | R14, R33, R34, R39, R45, R46                                   | Resistor, Chip, 0Ω, 1%, 0603           | NIC, NRC06F0000TRF                |
| 24   | 1   | R18                                                            | Resistor, Chip, 1k, 1%, 0603           | NIC, NRC06F1001TRF                |
| 25   | 2   | R16, R19                                                       | Resistor, Chip, 0Ω, 1%, 0402           | NIC, NRC04F0000TRF                |
| 26   | 2   | R17, R28                                                       | Resistor, Chip, 2k, 1%, 0603           | NIC, NRC06F2001TRF                |
| 27   | 3   | R20, R22, R23                                                  | Resistor, Chip, 1k, 1%, 0402           | NIC, NRC04F1001TRF                |
| 28   | 1   | R21                                                            | Resistor, Chip, 10k, 1%, 0603          | NIC, NRC06F1002TRF                |

# DEMO MANUAL DC1783A

## PARTS LIST

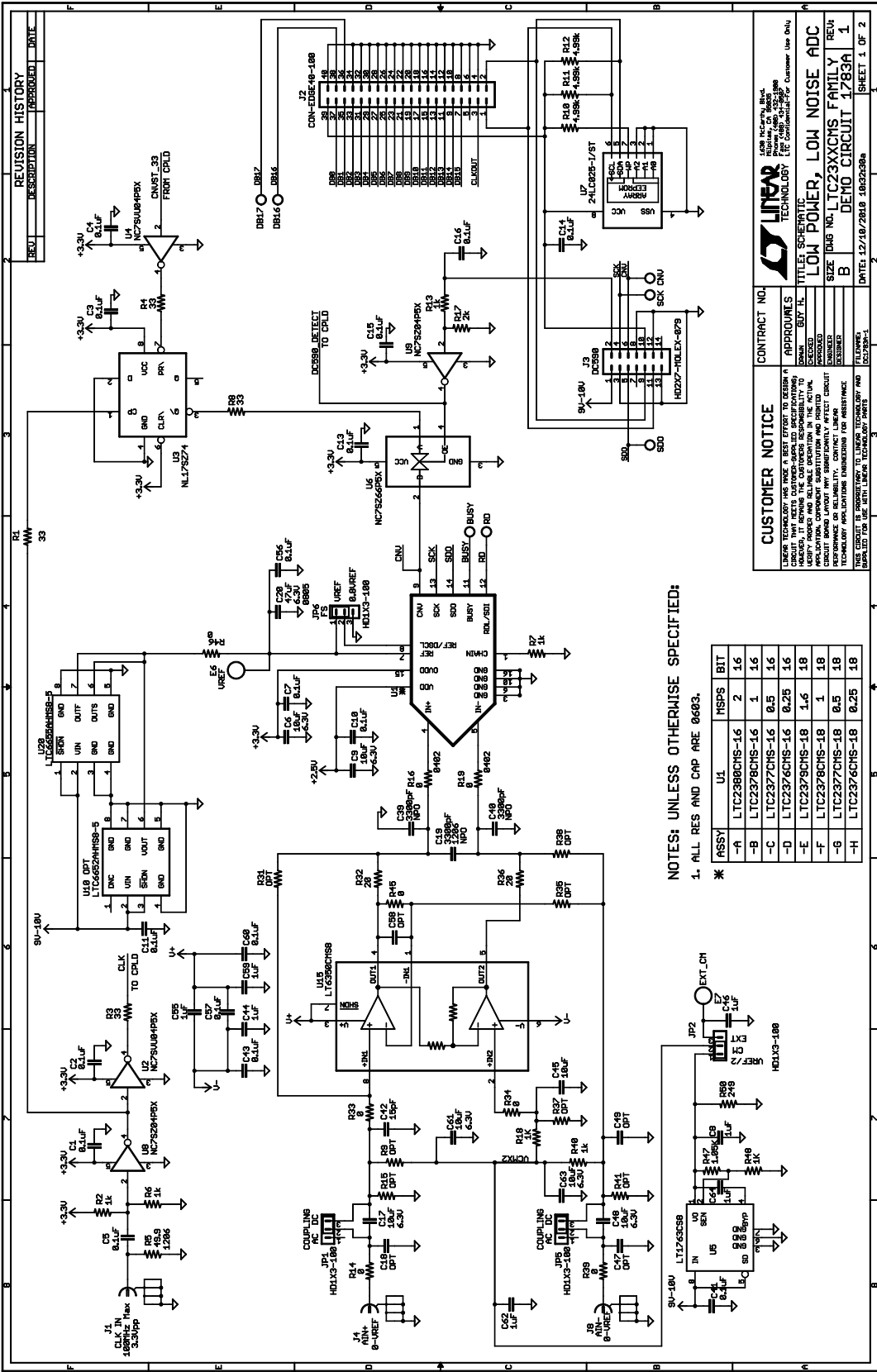
| ITEM | QTY | REFERENCE                                      | PART DESCRIPTION                                | MANUFACTURER/PART NUMBER         |
|------|-----|------------------------------------------------|-------------------------------------------------|----------------------------------|
| 29   | 1   | R25                                            | Resistor, Chip, 1.69k, 1%, 0603                 | NIC, NRC06F1691TRF               |
| 30   | 1   | R26                                            | Resistor, Chip, 1.54k, 1%, 0603                 | NIC, NRC06F1541TRF               |
| 31   | 1   | R27                                            | Resistor, Chip, 2.80k, 1%, 0603                 | NIC, NRC06F2801TRF               |
| 32   | 1   | R30                                            | Resistor, Chip, 10k, 1%, 0402                   | NIC, NRC04F1002TRF               |
| 33   | 0   | R9, R15, R31, R35, R37, R38, R41               | Resistor, 0603                                  | OPT                              |
| 34   | 2   | R32, R36                                       | Resistor, Chip, 20 $\Omega$ , 1%, 0603          | NIC, NRC06F20R0TRF               |
| 35   | 1   | R42                                            | Resistor, Chip, 5.62k, 1%, 0603                 | NIC, NRC06F5621TRF               |
| 36   | 1   | R47                                            | Resistor, Chip, 1.05k, 1%, 0603                 | NIC, NRC06F1051TRF               |
| 37   | 1   | R50                                            | Resistor, Chip, 249 $\Omega$ , 1%, 0603         | NIC, NRC06F2490TRF               |
| 38   | 1   | R54                                            | Resistor, Chip, 6.49k, 1%, 0603                 | NIC, NRC06F6491TRF               |
| 39   | 2   | U2, U4                                         | IC, Tinylogic ULP-A Unbuffered Inverter, SC70-5 | Fairchild, NC7SVU04P5X           |
| 40   | 1   | U3                                             | IC, Single D Flip Flop, US8                     | ON Semi., NL17SZ74               |
| 41   | 3   | U5, U13, U16                                   | IC, LT1763CS8, S08                              | Linear Technology, LT1763CS8     |
| 42   | 1   | U6                                             | IC, Single SPST Bus Switch, SC70-5              | Fairchild, NC7SZ66P5X            |
| 43   | 1   | U7                                             | IC, Serial EEPROM, TSSOP                        | Microchip, 24LC025-I/ST          |
| 44   | 2   | U8, U9                                         | IC, Tinylogic UHS Inverter, SC70-5              | Fairchild, NC7SZ04P5X            |
| 45   | 0   | U10                                            | IC, LTC6652AHMS8-5, MS8                         | OPT                              |
| 46   | 1   | U11                                            | IC, Max II Family, TQFP100                      | Altera, EPM240GT100C5N           |
| 47   | 1   | U12                                            | IC, LT1763CS8-1.8, S08                          | Linear Technology, LT1763CS8-1.8 |
| 48   | 1   | U14                                            | IC, LT1763CS8-2.5, S08                          | Linear Technology, LT1763CS8-2.5 |
| 49   | 1   | U15                                            | IC, LT6350CMS8, MS8                             | Linear Technology, LT6350CMS8    |
| 50   | 1   | U17                                            | IC, LT1964ES5-SD, SOT23-5                       | Linear Technology, LT1964ES5-SD  |
| 51   | 1   | U20                                            | IC, LTC6655HMS8-5, MS8                          | Linear Technology, LTC6655HMS8-5 |
| 52   | 4   | MTG1, MTG2, MTG3, MTG4                         | Stand-Off, Nylon (Snap On), 0.25" Tall          | Keystone, 8831 (Snap On)         |
| 53   | 7   | Shunts as Shown on Assy Dwg (JP1-JP3, JP5-JP8) | Shunt, 0.100" Center                            | Samtec, SNT-100-BK-G             |
| 54   | 1   | Stencil for Top Side                           |                                                 | DC1783A                          |

## PARTS LIST

| ITEM                             | QTY | REFERENCE | PART DESCRIPTION               | MANUFACTURER/PART NUMBER         |
|----------------------------------|-----|-----------|--------------------------------|----------------------------------|
| <b>LTC2380CMS-16 – DC1783A-A</b> |     |           |                                |                                  |
| 1                                | 1   | DC1783A   | General BOM                    |                                  |
| 2                                | 1   | U1        | IC, LTC2380CMS-16, MS16        | Linear Technology, LTC2380CMS-16 |
| <b>LTC2378CMS-16 – DC1783A-B</b> |     |           |                                |                                  |
| 1                                | 1   | DC1783A   | General BOM                    |                                  |
| 2                                | 1   | U1        | IC, LTC2378CMS-16, MS16        | Linear Technology, LTC2378CMS-16 |
| <b>LTC2377CMS-16 – DC1783A-C</b> |     |           |                                |                                  |
| 1                                | 1   | DC1783A   | General BOM                    |                                  |
| 2                                | 1   | U1        | IC, LTC2377CMS-16, MS16        | Linear Technology, LTC2377CMS-16 |
| <b>LTC2376CMS-16 – DC1783A-D</b> |     |           |                                |                                  |
| 1                                | 1   | DC1783A   | General BOM                    |                                  |
| 2                                | 1   | U1        | IC, LTC2376CMS-16, MS16        | Linear Technology, LTC2376CMS-16 |
| <b>LTC2379CMS-18 – DC1783A-E</b> |     |           |                                |                                  |
| 1                                | 1   | DC1783A   | General BOM                    |                                  |
| 2                                | 1   | U1        | IC, LTC2379CMS-18, MS16        | Linear Technology, LTC2379CMS-18 |
| 3                                | 1   | R44       | Resistor, Chip, 300Ω, 1%, 0402 | NIC, NRC06F3000TRF               |
| <b>LTC2378CMS-18 – DC1783A-F</b> |     |           |                                |                                  |
| 1                                | 1   | DC1783A   | General BOM                    |                                  |
| 2                                | 1   | U1        | IC, LTC2378CMS-18, MS16        | Linear Technology, LTC2378CMS-18 |
| 3                                | 1   | R44       | Resistor, Chip, 300Ω, 1%, 0402 | NIC, NRC06F3000TRF               |
| <b>LTC2377CMS-18 – DC1783A-G</b> |     |           |                                |                                  |
| 1                                | 1   | DC1783A   | General BOM                    |                                  |
| 2                                | 1   | U1        | IC, LTC2377CMS-18, MS16        | Linear Technology, LTC2377CMS-18 |
| 3                                | 1   | R44       | Resistor, Chip, 300Ω, 1%, 0402 | NIC, NRC06F3000TRF               |
| <b>LTC2376CMS-18 – DC1783A-H</b> |     |           |                                |                                  |
| 1                                | 1   | DC1783A   | General BOM                    |                                  |
| 2                                | 1   | U1        | IC, LTC2376CMS-18, MS16        | Linear Technology, LTC2376CMS-18 |
| 3                                | 1   | R44       | Resistor, Chip, 300Ω, 1%, 0402 | NIC, NRC06F3000TRF               |

DEMO MANUAL DC1783A

SCHEMATIC DIAGRAM



dc1783afb



# DEMO MANUAL DC1783A

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- Тестирование поставляемой продукции.
- Поставку компонентов, требующих военную и космическую приемку.
- Входной контроль качества.
- Наличие сертификата ISO.

В составе нашей компании организован Конструкторский отдел, призванный помогать разработчикам, и инженерам.

Конструкторский отдел помогает осуществить:

- Регистрацию проекта у производителя компонентов.
- Техническую поддержку проекта.
- Защиту от снятия компонента с производства.
- Оценку стоимости проекта по компонентам.
- Изготовление тестовой платы монтаж и пусконаладочные работы.



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