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 ±5V fully differential input range with a 101dB SNR, consumes only 18mW and achieves ±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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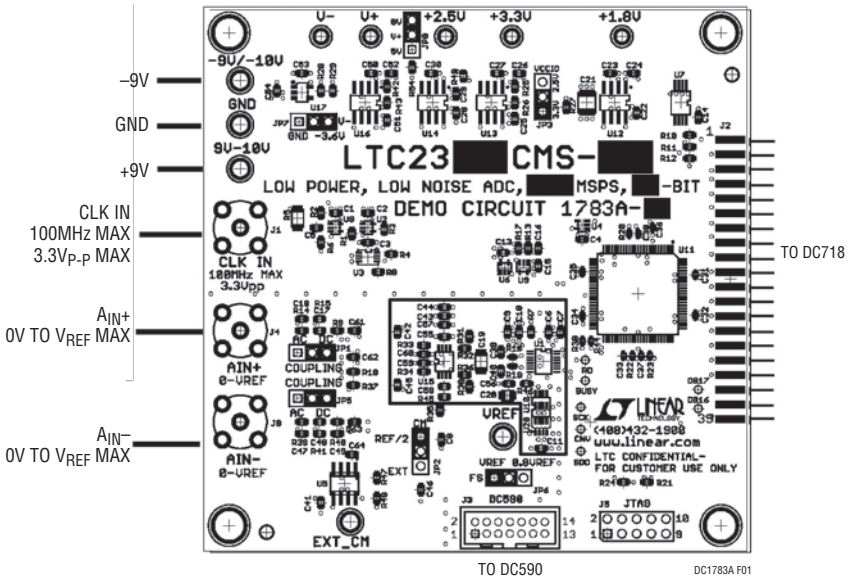


Figure 1. DC1783A Connection Diagram

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 ±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 $3.3V_{P-P}$ sine wave or square wave to connector J1. Note that J1 has a 50Ω 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.

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. 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 ±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.

QUICK START PROCEDURE

Clock Source

You must provide a low jitter $3.3V_{P-P}$ 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 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 (R5) be removed. Slow rising edges may compromise the SNR of the converter in the presence of high-amplitude higher frequency input signals.

Data Output

Parallel data output from this board (0V to 3.3V default), if not connected to the DC718, can be acquired by a logic analyzer, and subsequently imported into a spreadsheet, or mathematical package depending on what form of digital signal processing is desired. Alternatively, the data can be fed directly into an application circuit. Use pin 3 of J2 to latch the data. The data can be latched using either edge of this signal. The data output signal levels at J2 can also be reduced to 0V to 2.5V if the application circuit cannot tolerate the higher voltage. This is accomplished by moving JP3 to the 2.5V position.

Reference

The default reference is a LTC6655 5V reference. Alternatively, if a lower power reference is desired, this reference (U20) can be removed and a LTC6652 5V reference can be installed in the U10 position. This will result in only a small loss in performance in applications where the ADC is continuously converting. If an external reference is used it must settle quickly in the presence of glitches on the REF pin.

Analog Input

The default driver for the analog inputs of the LTC2379-18 on the DC1783A is shown in Figure 2. This circuit converts a single-ended 0V to 5V input signal applied at A_{IN}^+ into a differential signal with a swing of ±5V between the +IN and –IN inputs of the ADC. In addition, this circuit band limits the input frequencies to approximately 800kHz.

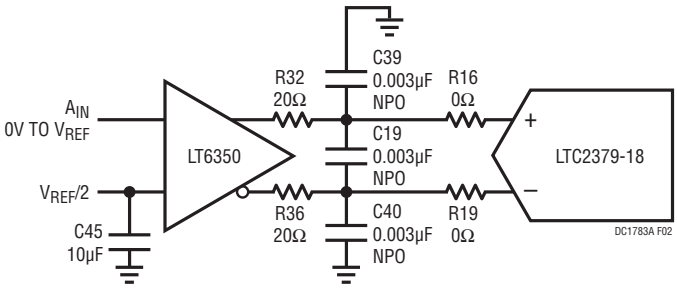


Figure 2. Single-Ended to Differential Converter

Alternatively, if your application circuit produces a differential signal which can drive the ADC but you need to level shift the input signal, the circuit shown in Figure 3 can be used. The circuit in Figure 3 AC-couples the input signal and is usable down to about 10kHz. The lower frequency limit can be extended by increasing C17 and C48.

AC-coupling the input may degrade the distortion performance of the ADC due to nonlinearity of the coupling capacitor (C17). The circuit in Figure 3 can be implemented on the DC1783A by putting JP1 and JP5 in the AC position, moving R32 and R36 to the R31 and R38 positions and adding a 1k resistor at the R9 location. At this point it will be necessary to drive both A_{IN}^+ and A_{IN}^-. One of these RC pairs can be attached to the input of the circuit in Figure 2. This allows a single-ended input signal to be level shifted.

One of the most asked for ADC driver circuits is one that allows the input voltage to swing below ground while using a single supply ADC. The input driver shown in Figure 4 accepts a true bipolar input voltage range of ±10V and converts it to the 0V to 5V input swing of the ADC. The circuit of Figure 4 can be implemented on the DC1783A by replacing R9 with 499Ω, R15 with 2k, R35 with 2k and R45 with 499Ω.

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 –1dBFS. 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 = –1.080dB) 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 101.07dB instead of the 99.99dB that PScope displays. Taking the RMS sum of the recalculated SNR and the THD yields a SINAD of 100.7dB 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

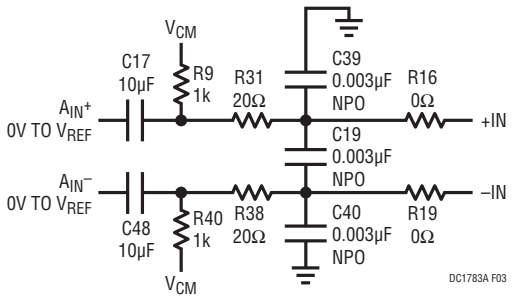


Figure 3. AC-Coupled Differential Driver

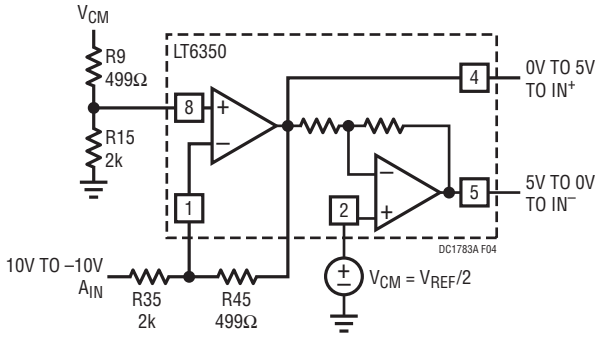


Figure 4. ±10V Single-Ended to 0V to 5V Differential DC-Coupled Driver

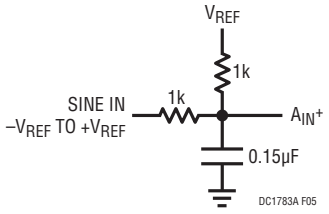


Figure 5. Level Shift and Filter Circuit Used for Board Testing

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

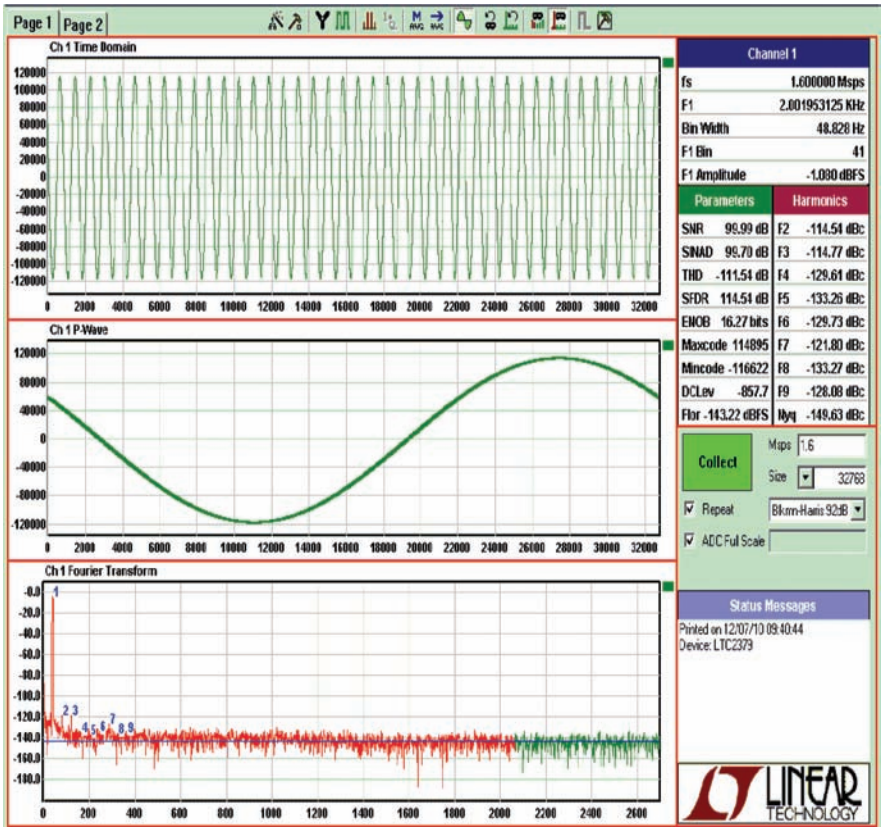


Figure 6. Pscope Screen Shot

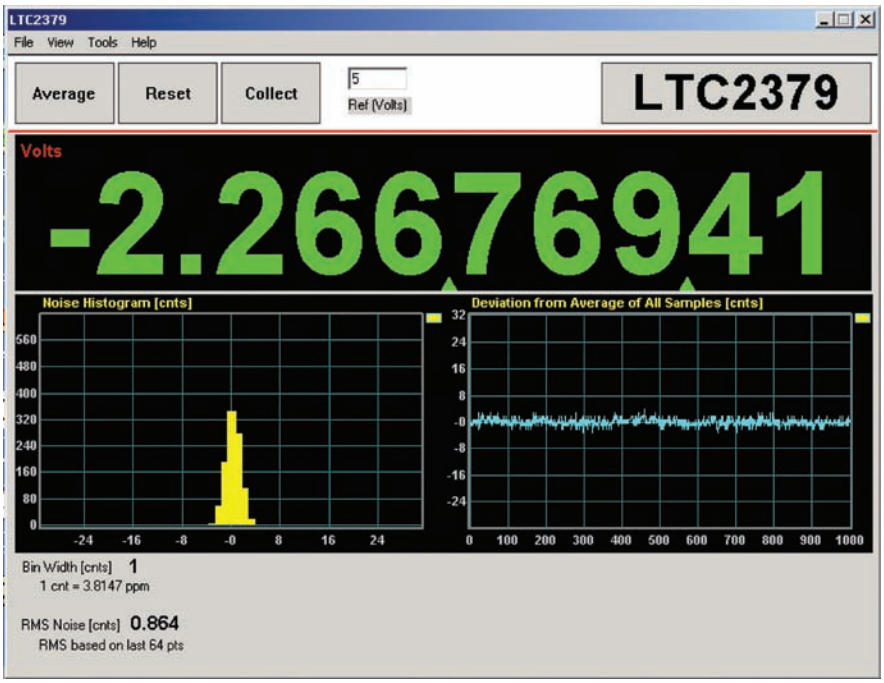


Figure 7. QuikEval Screen Shot

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, COG, 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

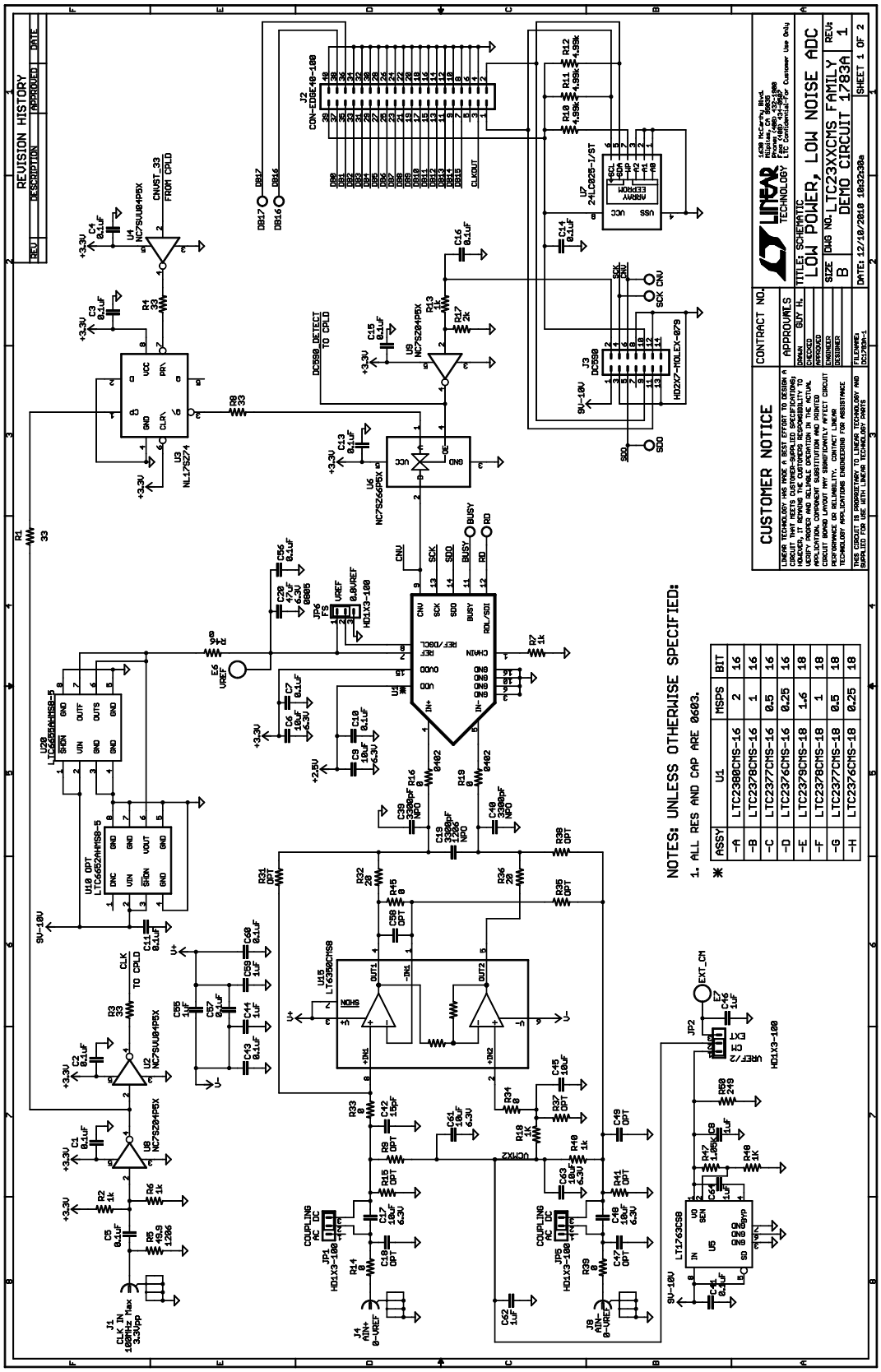
PARTS LIST

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, 20Ω, 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, 249Ω, 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, SO8	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, SO8	Linear Technology, LT1763CS8-1.8
48	1	U14	IC, LT1763CS8-2.5, SO8	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

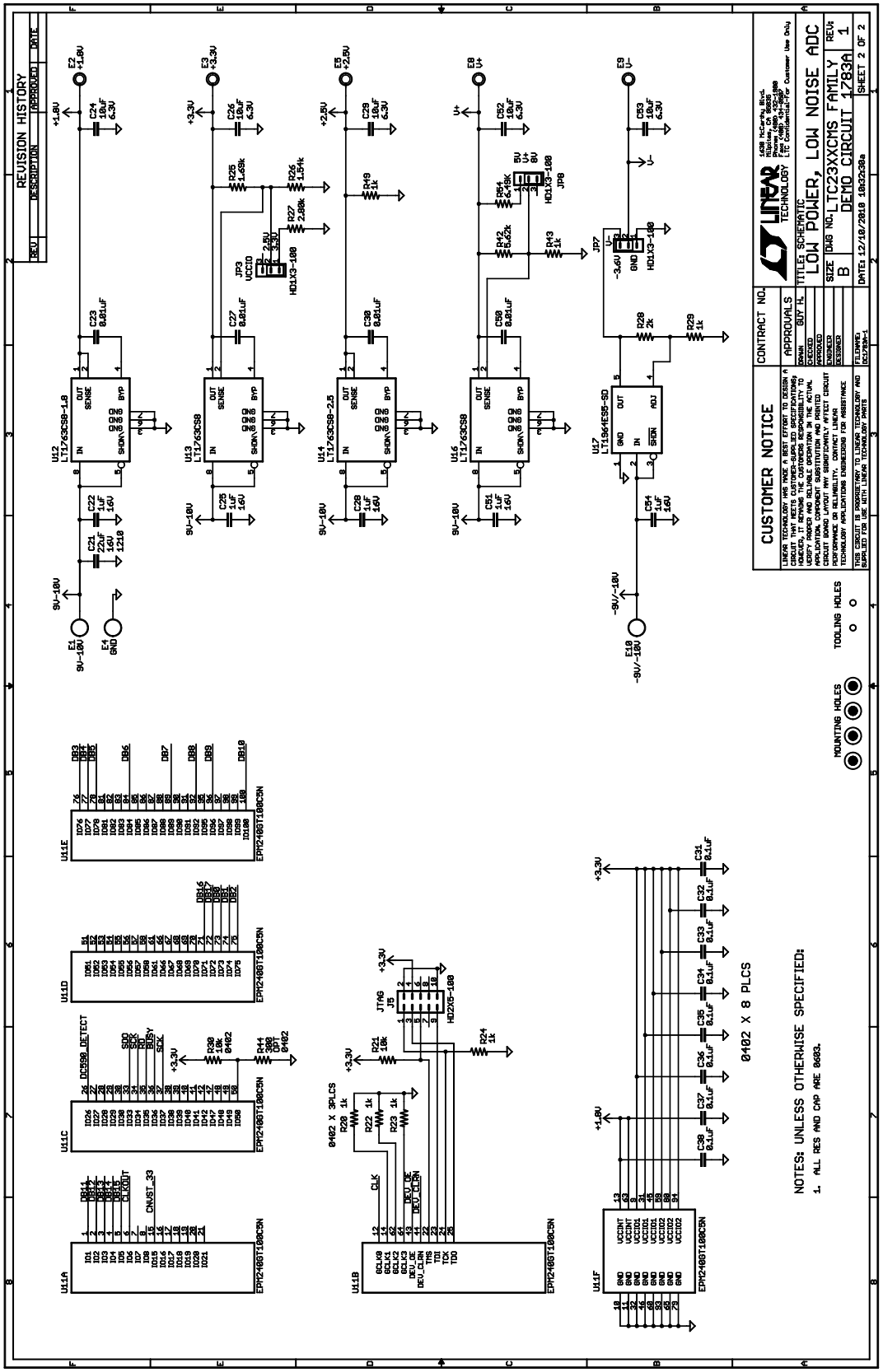
PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
LTC2380CMS-16 – DC1783A-A				
1	1	DC1783A	General BOM	
2	1	U1	IC, LTC2380CMS-16, MS16	Linear Technology, LTC2380CMS-16
LTC2378CMS-16 – DC1783A-B				
1	1	DC1783A	General BOM	
2	1	U1	IC, LTC2378CMS-16, MS16	Linear Technology, LTC2378CMS-16
LTC2377CMS-16 – DC1783A-C				
1	1	DC1783A	General BOM	
2	1	U1	IC, LTC2377CMS-16, MS16	Linear Technology, LTC2377CMS-16
LTC2376CMS-16 – DC1783A-D				
1	1	DC1783A	General BOM	
2	1	U1	IC, LTC2376CMS-16, MS16	Linear Technology, LTC2376CMS-16
LTC2379CMS-18 – DC1783A-E				
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
LTC2378CMS-18 – DC1783A-F				
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
LTC2377CMS-18 – DC1783A-G				
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
LTC2376CMS-18 – DC1783A-H				
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

SCHEMATIC DIAGRAM



SCHEMATIC DIAGRAM



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Стандарт Электрон Связь

Мы молодая и активно развивающаяся компания в области поставок электронных компонентов. Мы поставляем электронные компоненты отечественного и импортного производства напрямую от производителей и с крупнейших складов мира.

Благодаря сотрудничеству с мировыми поставщиками мы осуществляем комплексные и плановые поставки широчайшего спектра электронных компонентов.

Собственная эффективная логистика и склад в обеспечивает надежную поставку продукции в точно указанные сроки по всей России.

Мы осуществляем техническую поддержку нашим клиентам и предпродажную проверку качества продукции. На все поставляемые продукты мы предоставляем гарантию .

Осуществляем поставки продукции под контролем ВП МО РФ на предприятия военно-промышленного комплекса России , а также работаем в рамках 275 ФЗ с открытием отдельных счетов в уполномоченном банке. Система менеджмента качества компании соответствует требованиям ГОСТ ISO 9001.

Минимальные сроки поставки, гибкие цены, неограниченный ассортимент и индивидуальный подход к клиентам являются основой для выстраивания долгосрочного и эффективного сотрудничества с предприятиями радиоэлектронной промышленности, предприятиями ВПК и научно-исследовательскими институтами России.

С нами вы становитесь еще успешнее!

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