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LTC6360
Driving 18-Bit SAR ADC

DESCRIPTION

The LTC®6360 is a very low noise, high precision, high speed amplifier, suitable for driving SAR ADCs. The LTC6360 features a total output noise of 2.3nV/$\sqrt{Hz}$ combined with 150ns settling time to 16-bit levels (A_V = 1).

While powered from a single 5V supply, the amplifier output can swing to 0V while maintaining high linearity. This is made possible with the inclusion of a very low noise on-chip charge pump that generates a negative voltage to bias the output stage of the amplifier, increasing the allowable negative voltage swing. The LTC2370/LTC2369/LTC2368/LTC2367/LTC2364 are low power, low noise ADCs with serial outputs that can operate from a single 2.5V supply.

Demonstration circuit 1796A demonstrates the DC and AC performance of the LTC6360 driving the LTC2369-18 in conjunction with the DC590B QuikEval™ and DC718 fast DAACS 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 demonstration circuit 1796A is intended to demonstrate recommended grounding, component placement and selection, routing and bypassing for the LTC6360 and the ADC.

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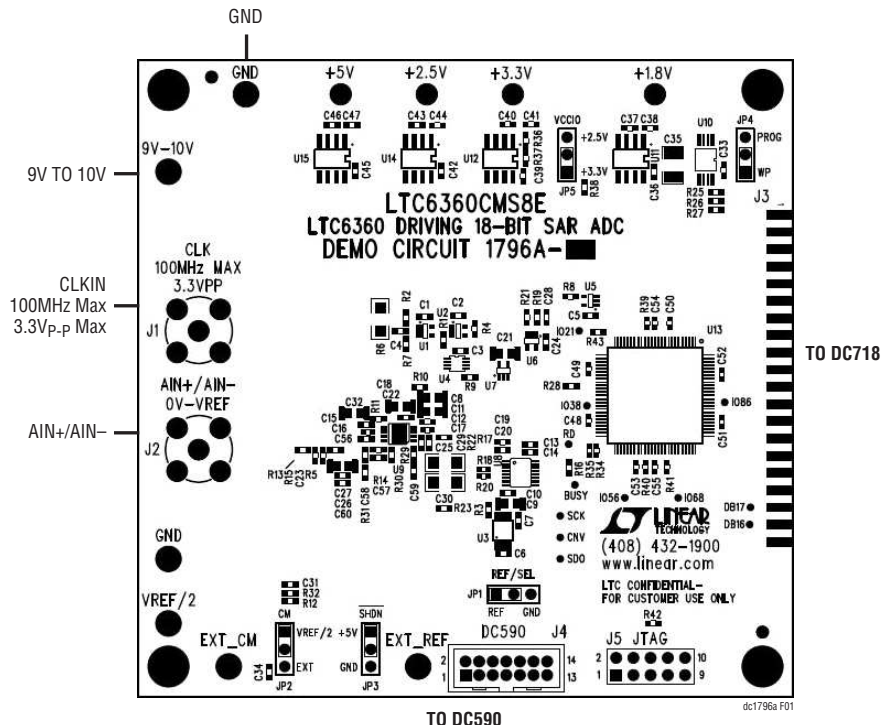
BOARD PHOTO

Figure 1. Demo Circuit 1796A

dc1796af

ASSEMBLY OPTIONS

Table 1. DC1796A Assembly Options

ASSEMBLY VERSION	U1 PART NUMBER	MAX CONVERSION RATE	NUMBER OF BITS	MAX CLKIN FREQUENCY
DC1796A-A	LTC2370CMS-16	2Msps	16	100MHz
DC1796A-B	LTC2368CMS-16	1Msps	16	50MHz
DC1796A-C	LTC2367CMS-16	0.5Msps	16	25MHz
DC1796A-D	LTC2364CMS-16	0.25Msps	16	12.5MHz
DC1796A-E	LTC2369CMS-18	1.6Msps	18	99.2MHz
DC1796A-F	LTC2368CMS-18	1Msps	18	62MHz
DC1796A-G	LTC2367CMS-18	0.5Msps	18	31MHz
DC1796A-H	LTC2364CMS-18	0.25Msps	18	15.5MHz

QUICK START PROCEDURE

This board is tested by measuring the distortion at –1dBFS, 2kHz single-ended input, as shown in Figure 2.

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

To test the boards follow the steps below:

1. Make sure that all the jumpers are set as shown in Figure 2 (DC1796A test diagram).

2. Power up the board by applying +9VDC.

3. Apply the clock signal to connector J1. Set the clock frequency to 99.2MHz (to achieve a 1.6Msps conver-

sion rate for an 18-bit SAR ADC). Refer to the Clock Source section for more detailed information. Set the clock amplitude to $3.3V_{PP}$.

4. For best SNR measurement data, a 2.3kHz cutoff frequency lowpass filter is used in the input signal at J2. See the Analog Input section for more details.

5. Apply a 2kHz, –1dBFS signal to connector J2. There are several ways of level shifting the input signal. In this case, the $V_{REF}/2$ turret on the demo board was used to provide level shifting of the input signal. $V_{REF}/2$ should be properly bypassed to ground to minimize noise on the input signal.

The performance that results from these connections is displayed in Figure 7.
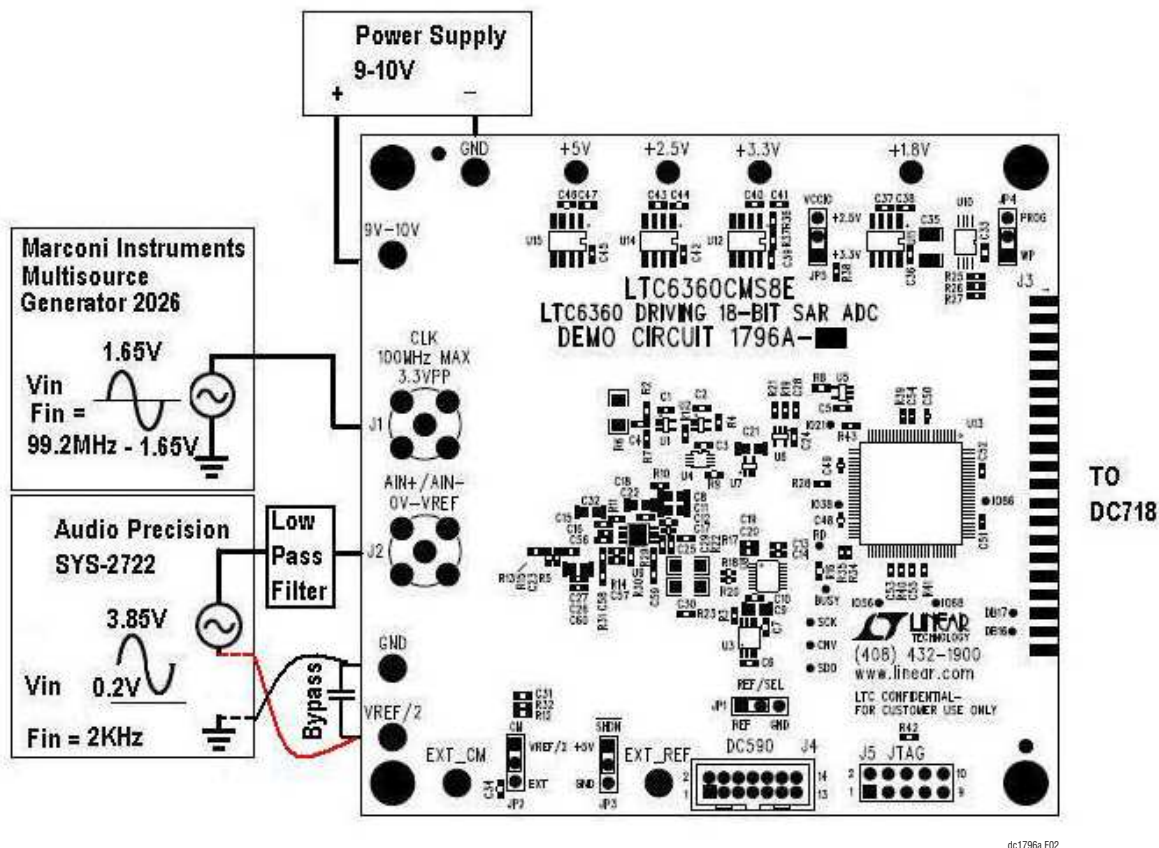
QUICK START PROCEDURE

Figure 2. DC1796A Test Diagram

DC718 SETUP

Connect the DC1796A to a DC718 USB high speed data collection board using connector J3. Then, connect the DC718 to a host PC with a standard USB A/B cable. Apply +9V to the indicated terminals. Run the QuikEval II 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 DC1796A and configure itself automatically.

Click the Collect button (See Figure 7) 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 DC1796A, make sure that VCCIO (JP5) is set to 3.3V before connecting the DC590B to the DC1796A.

Connect the DC590B to a host PC with a standard USB A/B cable. Connect the DC1796A 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.

The correct control panel will be loaded automatically. Click the Collect button to begin reading the ADC (see Figure 8).

DC1796A SETUP

DC Power

The DC1796A requires +9VDC and draws about 60mA. Most of the supply current is consumed by the CPLD, regulators and discrete logic on the board. The +9VDC input voltage powers the LTC6360 and the ADC through LT1763 regulators, which provide protection against accidental reverse bias. Additional regulators provide power for the CPLD.

Clock Source

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 low jitter RF oscillator, such as the Marconi Instruments Multisource Generator 2026, 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 (R6) 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 4.096V reference. An external reference can be used by removing (U3) and populating (R3). If an external reference is used, it must settle quickly in the presence of glitches on the REF pin.

Analog Input

The default driver configuration of the DC1796A is shown in Figure 3. This circuit buffers a single-ended 0V to 4V input signal applied at AIN⁺.

For better distortion, the feedback impedance R22 should be matched to the source impedance. Impedance matching negates the effects of input bias current. However, no impedance matching was used for the results provided in Figure 7, for simplicity of measurements.

Audio Precision SYS-2722 has a 40Ω source input impedance in the configuration used. Adding another 5Ω (a total of 45Ω) with a $C = 1.5\mu F$ to GND in a simple RC filter fixture off the board creates a lowpass filter with a 2.3kHz cutoff frequency. This filter is not added on the board due to various input frequencies that the user might select. It is important to use a very low distortion capacitor for the input filter. Shown in Figure 4, Figure 5 and Figure 6, are other DC1796A driver configurations. In order to create the configurations shown in Figure 5 and Figure 6, component R14 (0Ω) needs to be removed from the board.

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

For component values for various circuit gains, refer to the Application Information section of the LTC6360 data sheet.

dc1796af

LINEAR
TECHNOLOGY

DC1796A SETUP

Figure 3. DC-Coupled Noninverting LTC6360 Drives LTC2369-18 18-Bit SAR ADC

Figure 4. AC-Coupled Noninverting LTC6360 Drives LTC2369-18 18-Bit SAR ADC

DC1796A SETUP

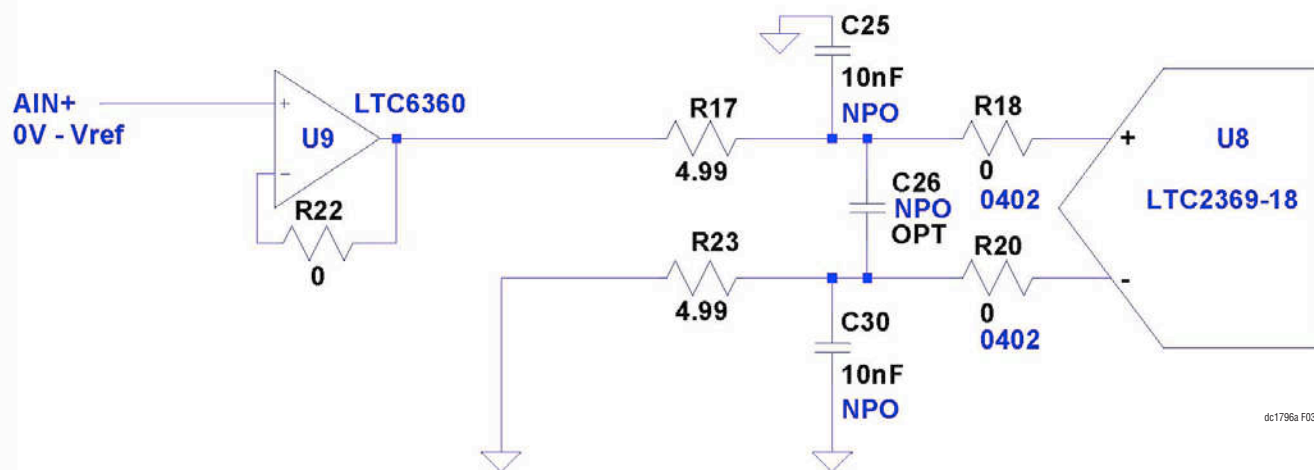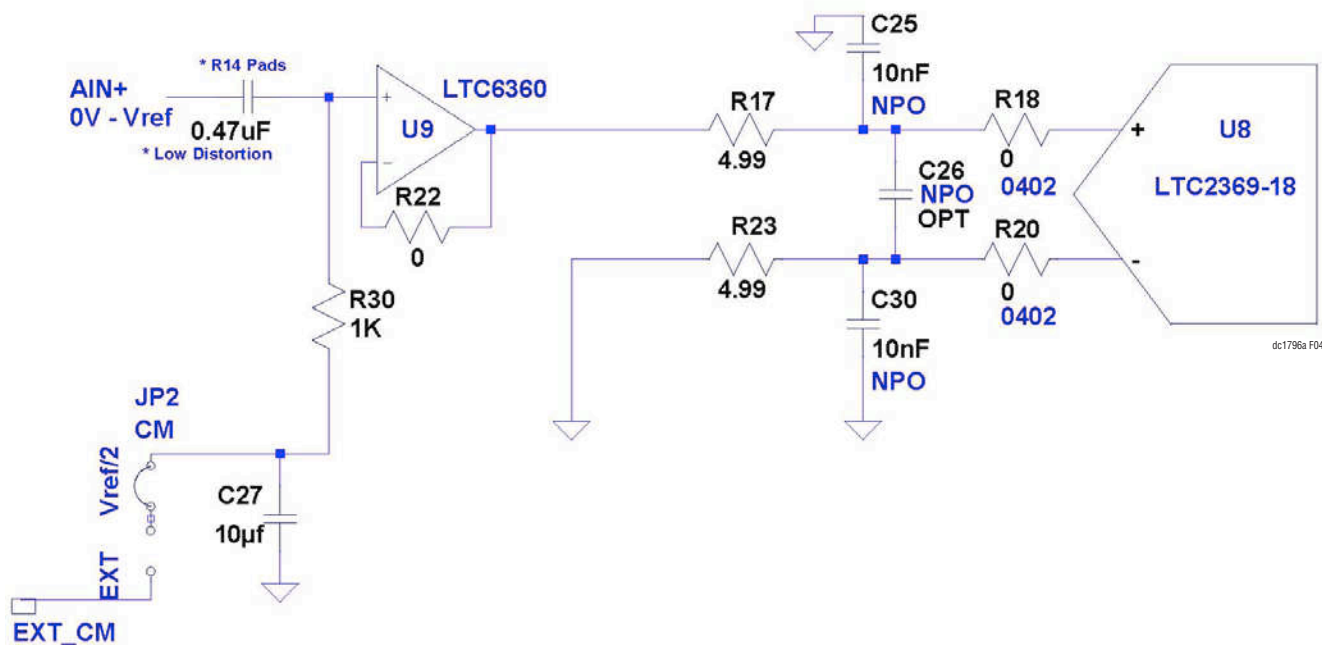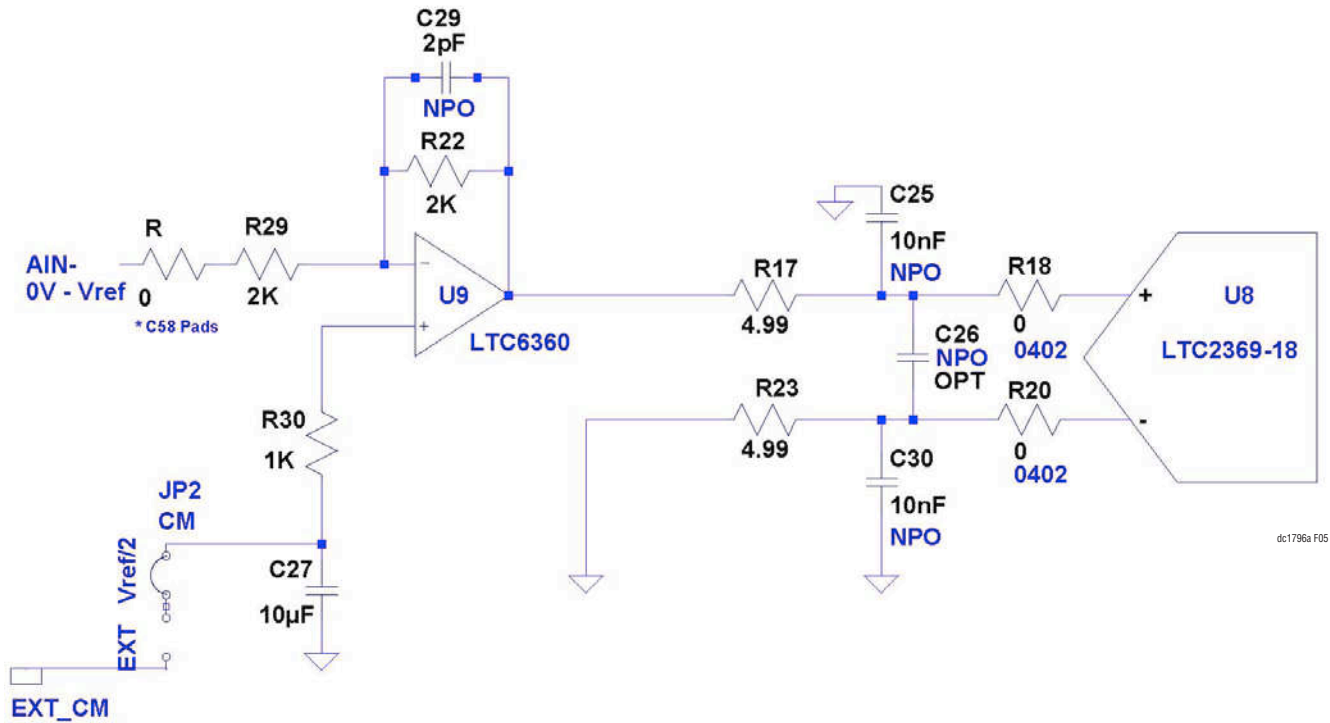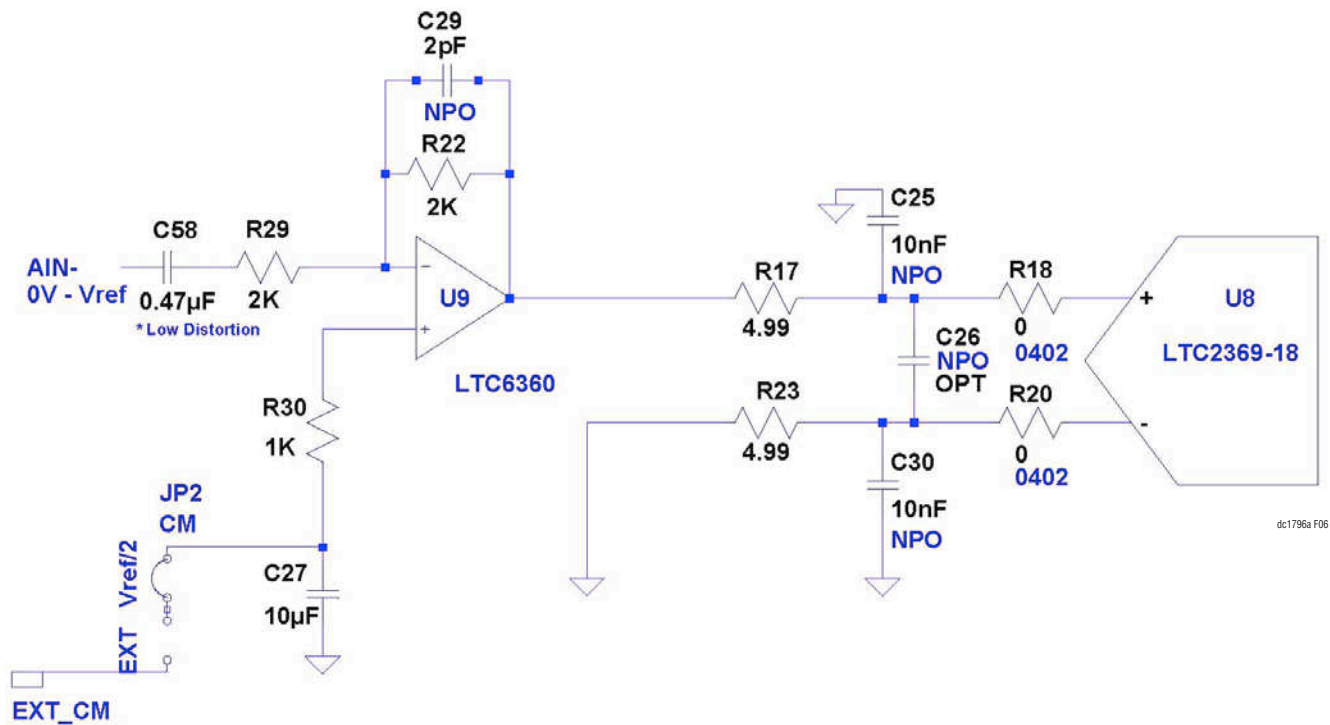**Figure 5. DC-Coupled Inverting LTC6360 Drives LTC2369-18 18-Bit SAR ADC**

Figure 6. AC-Coupled Inverting LTC6360 Drives LTC2369-18 18-Bit SAR ADC

DC1796A SETUP

Layout

As with any high performance ADC, system layout is critical to achieve optimal performance. The area immediately surrounding the ADC on the DC1796A should be used as a guideline for placement and routing of the various components associated with the ADC. The following are some things to consider when laying out a board for the LTC6360 and LTC2369-18:

■ A ground plane is necessary to obtain best 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 critical traces as short as possible.

■ Remove ground plane metal from under the –IN pin of the LTC6360 (Pin 1) to reduce parasitic capacitance at this node.

Component Selection

When driving a low noise, low distortion ADC, such as the LTC2369-18 with the LTC6360, 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.

DC1796A JUMPERS

Definitions

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

JP3: Toggles the LTC6360 ON and OFF. Part ON (+5V) is the default setting.

JP4: Ties the WP pin of the EEPROM 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.
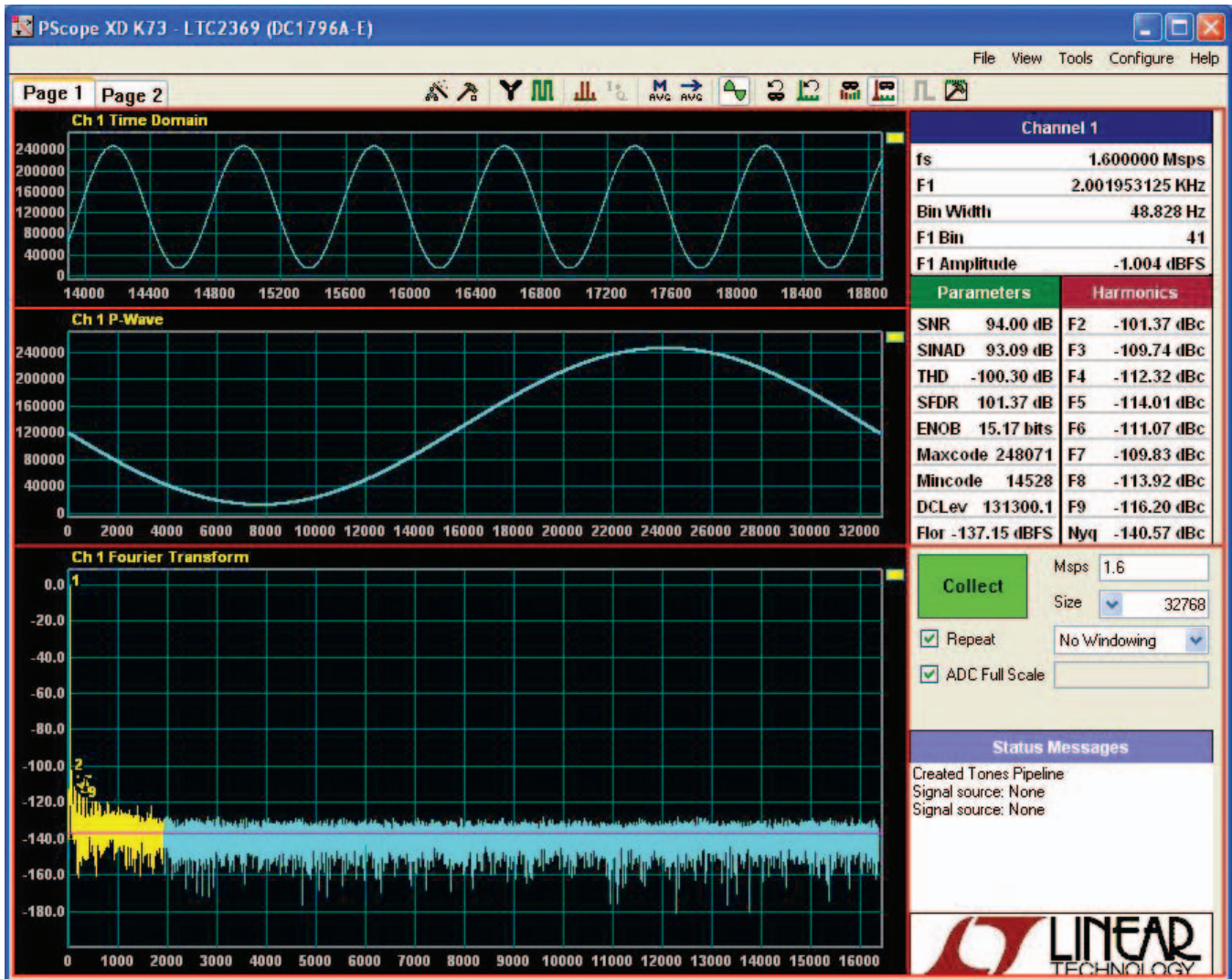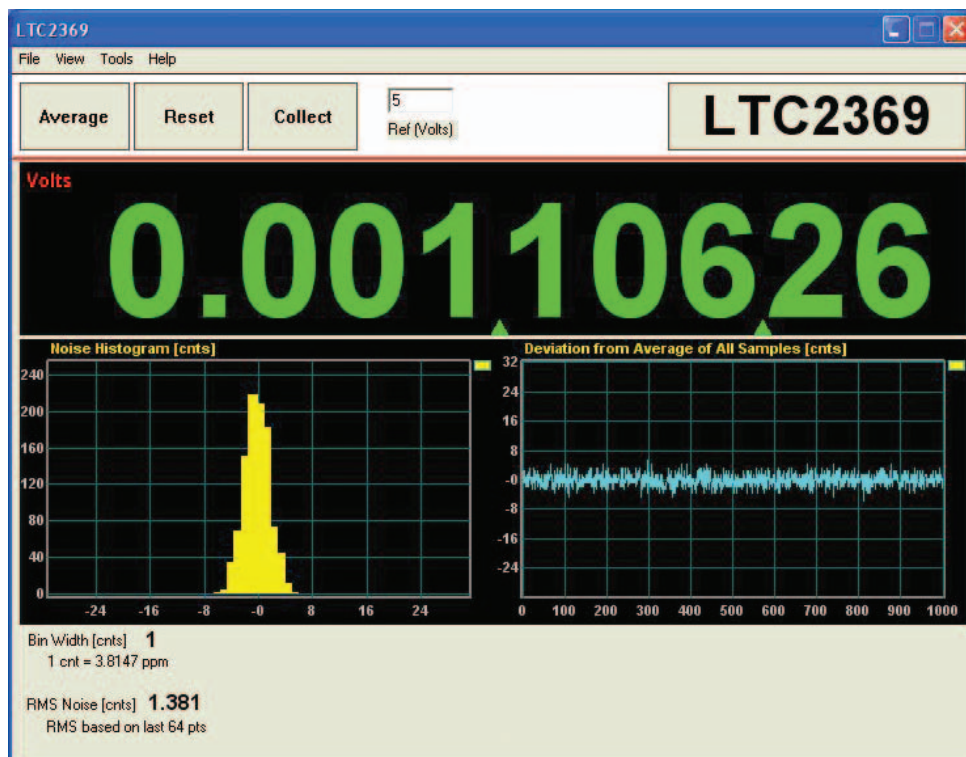
APPLICATION SCREENSHOTS

Figure 7. PScope Screenshot

APPLICATION SCREENSHOTS

dc1796a F08

Figure 8. QuikEval Screenshot

PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
DC1826A Required Circuit Components				
1	17	C1-C6, C10, C12, C14, C15, C20, C21, C22, C24, C26, C28, C33	CAP, X7R, 0.1µF, 25V, 10%, 0603	AVX, 06033C104KAT2A
2	7	C7, C31, C34, C36, C39, C42, C45	CAP, X7R, 1µF, 16V, 10%, 0603	AVX, 0603YC105KAT2A
3	3	C8, C18, C27	CAP, X5R, 10µF, 10V, 20%, 0805	TAIYO YUDEN, LMK212BJ106MG
4	1	C9	CAP, X5R, 47µF, 6.3V, 20%, 0805	TAIYO YUDEN, JMK212BJ476MG-T
5	1	C11	CAP, X7R, 1µF, 16V, 10%, 0805	TDK, C2012X7R1C105K/0.85
6	6	C13, C19, C38, C41, C44, C47	CAP, X5R, 10µF, 6.3V, 20%, 0603	TDK, C1608X5R0J106MT
7	1	C16	CAP, X7R, 470pF 16V, 10%, 0402	AVX, 0402YC471KAT4A
8	1	C17	CAP, X7R, 0.01µF, 16V, 10%, 0402	AVX, 0402YC103KAT2A
9	0	C23, C29, C56, C58, C59 (OPT)	CAP, 0603	OPT
10		C57	CAP, NPO, 50pF, 100V, 5%, 0603	AVX, 06031A500JAT2A
11	2	C25, C30	CAP, NPO, 10000pF, 50V, 1206	PANASONIC, ECJ-3FC1H103J
12	1	C32	CAP, X5R, 3.3µF, 16V, 10%, 0805	MURATA, GRM21BR61C335KA88L
13	1	C35	CAP, X5R, 22µF, 16V, 20%, 1210	TAIYO YUDEN, EMK325BJ226MM-T
14	5	C37, C40, C43, C46, C60	CAP, X7R, 0.01µF, 16V, 10%, 0603	AVX, 0603YC103KAT

PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
15	8	C48-C55	CAP, X7R, 0.1µF, 16V, 10%, 0402	TDK, C1005X7R1C104KT
16	6	E1, E2, E3, E4, E9, E10	TP, TURRET, 0.094"	MILL-MAX, 2501-2-00-80-00-00-07-0
17	4	E5-E8	TP, TURRET, 0.064"	MILL-MAX, 2308-2-00-80-00-00-07-0
18	2	J1, J2	CONN., BNC-5PINS	CONNEX, 112404
19	1	J3	CONN., 40PINS SMT, CON-EDGE40-100	SAMTEC, TSW-120-07-L-D
20	1	J4	HEADER, 2×7, 0.079"	MOLEX, 87831-1420
21	1	J5	HEADER, 2×5, 0.100", HD2X5-100	SAMTEC, TSW-105-07-L-D
22	4	JP2-JP5	JMP, 1×3, 0.100", HD1X3-100	SAMTEC, TSW-103-07-L-S
23	4	XJP2, XJP3, XJP4, XJP5	SHUNT, 0.100" CENTER	SAMTEC, SNT-100-BK-G
24	1	JP1 (PINS 1-2, REF)	SHUNT, 0.100" CENTER, FOR PINS 1-2, REF	SAMTEC, JL-100-25-T
25	5	R1, R4, R8, R9, R28	RES., CHIP, 33Ω, 0603, 1/10W, 1%	NIC, NRC06F33R0TRF
26	8	R2, R7, R12, R16, R19, R24, R32, R43	RES., CHIP, 1.00kΩ, 0603, 1/10W, 1%	NIC, NRC06F1001TRF
27	0	R3, R15, R29, R30, R31 (OPT)	RES., 0603	OPT
28	6	R5, R10, R11, R13, R14, R22	RES., CHIP, 0Ω, 1/16W, 0603	VISHAY, CRCW06030000Z0ED
29	1	R6	RES., CHIP, 49.9Ω, 1/4W, 1%, 1206	NIC, NRC12F49R9TRF
30	2	R17, R23	RES., CHIP, 4.99Ω, 1/10W, 1%, 0603	VISHAY, CRCW06034R99FKEA
31	2	R18, R20	RES., CHIP, 0.0Ω, 1/16W, 0402	VISHAY, CRCW04020000Z0ED
32	1	R21	RES., CHIP, 2.00kΩ, 1/10W, 1%, 0603	NIC, NRC06F2001TRF
33	3	R25, R26, R27	RES., CHIP, 4.99kΩ, 1/10W, 1%, 0603	NIC, NRC06F4991TRF
34	1	R34	RES., CHIP, 10kΩ, 1/16W, 1%, 0402	NIC, NRC04F1002TRF
35	1	R36	RES., CHIP, 1.69kΩ,1/10W, 1%, 0603	NIC, NRC06F1691TRF
36	1	R37	RES., CHIP, 1.54kΩ, 1%, 0603	NIC, NRC06F1541TRF
37	1	R38	RES., CHIP, 2.80kΩ, 1%, 0603	NIC, NRC06F2801TRF
38	3	R39, R40, R41	RES., CHIP, 1kΩ, 1/16W, 1%, 0402	NIC, NRC04F1001TRF
39	1	R42	RES., CHIP, 10kΩ, 1/10W, 1%, 0603	NIC, NRC06F1002TRF
40	2	U1, U6	IC., TINYLOGIC UHS INVERTER, SC70-5	FAIRCHILD, NC7SZ04P5X
41	2	U2, U5	IC., TINYLOGIC ULP-A UNBUFFERED INVERTER, SC70-5	FAIRCHILD, NC7SVU04P5X
42	1	U3	IC., LTC6655CHMS8-4.096, MS8	LINEAR TECHNOLOGY, LTC6655CHMS8-4.096#PBF
43	1	U4	IC., SINGLE D FLIP FLOP, US8	ON SEMI., NL17SZ74
44	1	U7	IC., SINGLE SPST BUS SWITCH, SC70-5	FAIRCHILD, NC7SZ66P5X
45	1	U9	IC., LTC6360CMS8E, MS8E	LINEAR TECHNOLOGY, LTC6360CMS8E#PBF
46	1	U10	IC., SERIAL EEPROM, TSSOP	MICROCHIP, 24LC024-I/ST
47	1	U11	IC., LT1763CS8-1.8, SO8	LINEAR TECHNOLOGY, LT1763CS8-1.8#PBF
48	1	U12	IC., LT1763CS8, SO8	LINEAR TECHNOLOGY, LT1763CS8#PBF
49	1	U13	IC., MAX II FAMILY, TQFP100	ALTERA, EPM240GT100C5N
50	1	U14	IC., LT1763CS8-2.5, SO8	LINEAR TECHNOLOGY, LT1763CS8-2.5#PBF
51	1	U15	IC., LT1763CS8-5, SO8	LINEAR TECHNOLOGY, LT1763CS8-5#PBF
52	4	MH1-MH4	STAND-OFF, NYLON (SNAP-ON), 0.375" TALL	KEYSTONE, 8832(SNAP ON)

PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
DC1796A-A Required Circuit Components				
1	1	DC1796A-2	GENERAL BOM	
2	1	U8	IC., LTC2370CMS-16, MS16	LINEAR TECHNOLOGY, LTC2370CMS-16, MS16
3	1		FAB, PRINTED CIRCUIT BOARD	DEMO CIRCUIT 1796A-2
4	0	R35 (OPT)	RES., CHIP, 300Ω, 1%, 0402	OPT
DC1796A-B Required Circuit Components				
1	1	DC1796A-2	GENERAL BOM	
2	1	U8	IC., LTC2368CMS-16, MS16	LINEAR TECHNOLOGY, LTC2368CMS-16
3	1		FAB, PRINTED CIRCUIT BOARD	DEMO CIRCUIT 1796A-2
4	0	R35 (OPT)	RES., CHIP, 300Ω, 1%, 0402	OPT
DC1796A-C Required Circuit Components				
1	1	DC1796A-2	GENERAL BOM	
2	1	U8	IC., LTC2367CMS-16, MS16	LINEAR TECHNOLOGY, LTC2367CMS-16
3	1		FAB, PRINTED CIRCUIT BOARD	DEMO CIRCUIT 1796A-2
4	0	R35 (OPT)	RES., CHIP, 300Ω, 1%, 0402	OPT
DC1796A-D Required Circuit Components				
1	1	DC1796A-2	GENERAL BOM	
2	1	U8	IC., LTC2364CMS-16, MS16	LINEAR TECHNOLOGY, LTC2364CMS-16
3	1		FAB, PRINTED CIRCUIT BOARD	DEMO CIRCUIT 1796A-2
4	0	R35 (OPT)	RES., CHIP, 300Ω, 1%, 0402	OPT
DC1796A-E Required Circuit Components				
1	1	DC1796A-2	GENERAL BOM	
2	1	U8	IC., LTC2369CMS-18, MS16	LINEAR TECHNOLOGY, LTC2369CMS-18
3	1		FAB, PRINTED CIRCUIT BOARD	DEMO CIRCUIT 1796A-2
4	1	R35	RES., CHIP, 300Ω, 1%, 0402	NIC, NRC04F3000TRF
DC1796A-F Required Circuit Components				
1	1	DC1796A-2	GENERAL BOM	
2	1	U8	IC., LTC2368CMS-18, MS16	LINEAR TECHNOLOGY, LTC2368CMS-18
3	1		FAB, PRINTED CIRCUIT BOARD	DEMO CIRCUIT 1796A-2
4	1	R35	RES., CHIP, 300Ω, 1%, 0402	NIC, NRC04F3000TRF
DC1796A-G Required Circuit Components				
1	1	DC1796A-2	GENERAL BOM	
2	1	U8	IC., LTC2367CMS-18, MS16	LINEAR TECHNOLOGY, LTC2367CMS-18
3	1		FAB, PRINTED CIRCUIT BOARD	DEMO CIRCUIT 1796A-2
4	1	R35	RES., CHIP, 300Ω, 1%, 0402	NIC, NRC04F3000TRF
DC1796A-H Required Circuit Components				
1	1	DC1796A-2	GENERAL BOM	
2	1	U8	IC., LTC2364CMS-18, MS16	LINEAR TECHNOLOGY, LTC2364CMS-18
3	1		FAB, PRINTED CIRCUIT BOARD	DEMO CIRCUIT 1796A-2
4	1	R35	RES., CHIP, 300Ω, 1%, 0402	NIC, NRC04F3000TRF
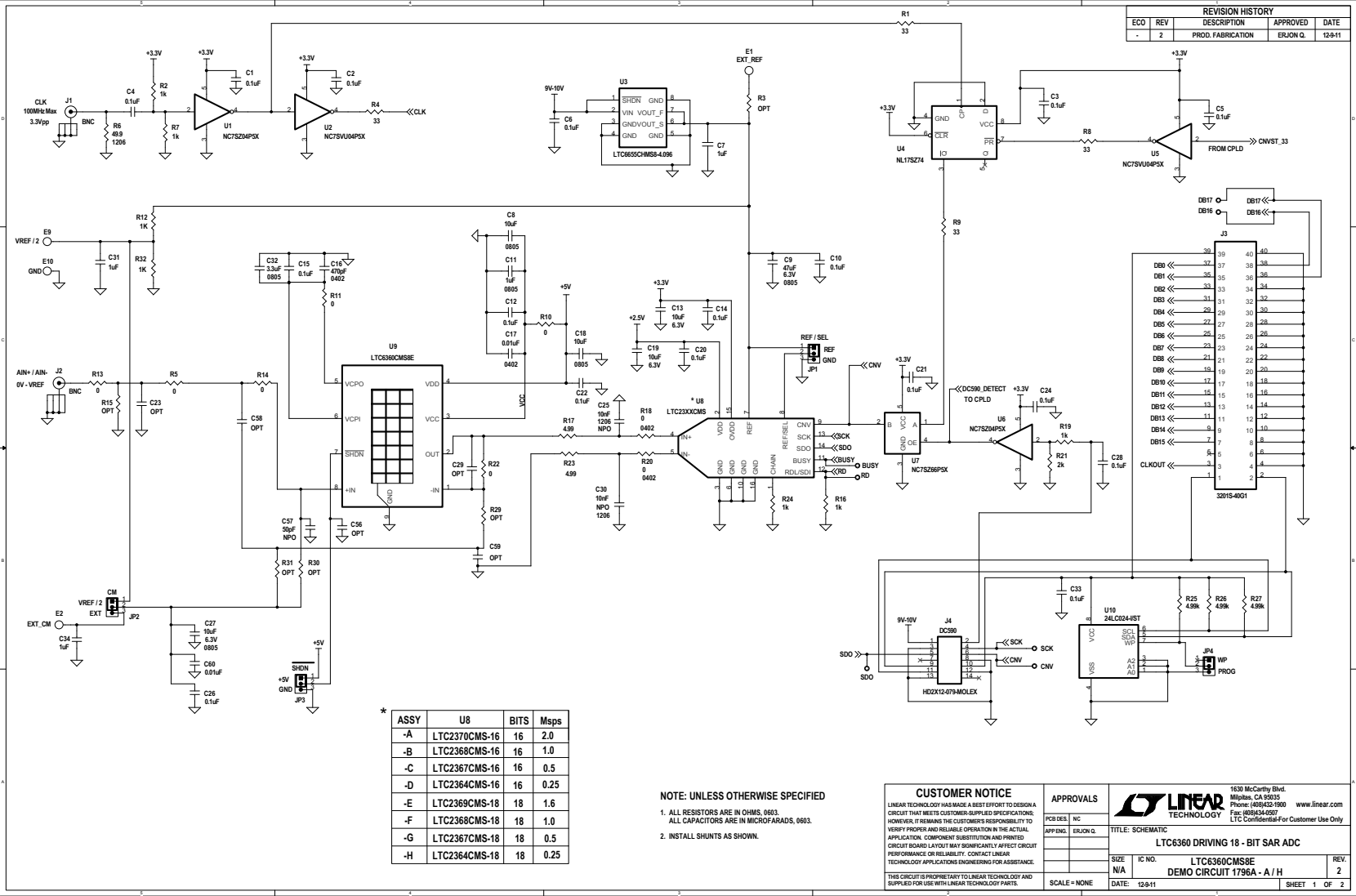
Figure 9. LTC6360 Driving 18-Bit SAR ADC

ASSY	U8	BITS	Msps
-A	LTC2370CMS-16	16	2.0
-B	LTC2368CMS-16	16	1.0
-C	LTC2367CMS-16	16	0.5
-D	LTC2364CMS-16	16	0.25
-E	LTC2369CMS-18	18	1.6
-F	LTC2368CMS-18	18	1.0
-G	LTC2367CMS-18	18	0.5
-H	LTC2364CMS-18	18	0.25

NOTE: UNLESS OTHERWISE SPECIFIED
1. ALL RESISTORS ARE IN OHMS, 0603.
   ALL CAPACITORS ARE IN MICROFARADS, 0603.
2. INSTALL SHUNTS AS SHOWN.

APPROVALS
PCB DES. NC
APP ENG. ERJON Q.

LINEAR TECHNOLOGY

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Fax: (408)434-0507
LTC Confidential-For Customer Use Only

TITLE: SCHEMATIC
LTC6360 DRIVING 18 - BIT SAR ADC

| SIZE N/A | IC NO. | LTC6360CMS8E DEMO CIRCUIT 1796A - A / H | REV. 2 |
| SCALE = NONE | DATE: 12-9-11 | | SHEET 1 OF 2 |

REVISION HISTORY

ECO	REV	DESCRIPTION	APPROVED	DATE
-	2	PROD. FABRICATION	ERJON Q.	12-9-11

Figure 10. LTC6360 Driving 18-Bit SAR ADC

TITLE: SCHEMATIC

LTC6360 DRIVING 18 - BIT SAR ADC

IC NO. LTC6360CMS8E
DEMO CIRCUIT 1796A - A / H

SIZE N/A   REV. 2

DATE: 12-9-11   SHEET 2 OF 2

DEMONSTRATION BOARD IMPORTANT NOTICE

Linear Technology Corporation (LTC) provides the enclosed product(s) under the following **AS IS** conditions:

This demonstration board (DEMO BOARD) kit being sold or provided by Linear Technology is intended for use for **ENGINEERING DEVELOPMENT OR EVALUATION PURPOSES ONLY** and is not provided by LTC for commercial use. As such, the DEMO BOARD herein may not be complete in terms of required design-, marketing-, and/or manufacturing-related protective considerations, including but not limited to product safety measures typically found in finished commercial goods. As a prototype, this product does not fall within the scope of the European Union directive on electromagnetic compatibility and therefore may or may not meet the technical requirements of the directive, or other regulations.

If this evaluation kit does not meet the specifications recited in the DEMO BOARD manual the kit may be returned within 30 days from the date of delivery for a full refund. THE FOREGOING WARRANTY IS THE EXCLUSIVE WARRANTY MADE BY THE SELLER TO BUYER AND IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED, IMPLIED, OR STATUTORY, INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE. EXCEPT TO THE EXTENT OF THIS INDEMNITY, NEITHER PARTY SHALL BE LIABLE TO THE OTHER FOR ANY INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES.

The user assumes all responsibility and liability for proper and safe handling of the goods. Further, the user releases LTC from all claims arising from the handling or use of the goods. Due to the open construction of the product, it is the user's responsibility to take any and all appropriate precautions with regard to electrostatic discharge. Also be aware that the products herein may not be regulatory compliant or agency certified (FCC, UL, CE, etc.).

No License is granted under any patent right or other intellectual property whatsoever. **LTC assumes no liability for applications assistance, customer product design, software performance, or infringement of patents or any other intellectual property rights of any kind.**

LTC currently services a variety of customers for products around the world, and therefore this transaction **is not exclusive**.

Please read the DEMO BOARD manual prior to handling the product. Persons handling this product must have electronics training and observe good laboratory practice standards. **Common sense is encouraged**.

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

Mailing Address:

Linear Technology

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dc1796af

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