LTC2338/LTC2337/LTC2336/ LTC2328/LTC2327/LTC2326
18-Bit/16-Bit,1Msps/500ksps/250ksps True Bipolar Low Power, Single Supply ADCs

DESCRIPTION

The LTC®2338/LTC2337/LTC2336/LTC2328/LTC2327/ LTC2326 are true bipolar, low power, low noise ADCs with serial outputs that can operate from a single 5V supply. The following text refers to the LTC2338-18 but applies to all parts in the family, the only difference being the maximum sample rates and the number of bits. The LTC2338-18 supports a ±20.48V fully differential input range with a 100dB SNR, consumes only 50mW and achieves ±4LSB INL max with no missing codes at 18 bits. The DC1908A demonstrates the DC and AC performance of the LTC2338-18 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 1908A is intended to demonstrate recommended grounding, component placement and selection, routing and bypassing for this ADC. Suggested driver circuits for the analog inputs will be presented.

Design files for this circuit board are available at http://www.linear.com/demo or scan the QR code on the back of the board.

BOARD PHOTO

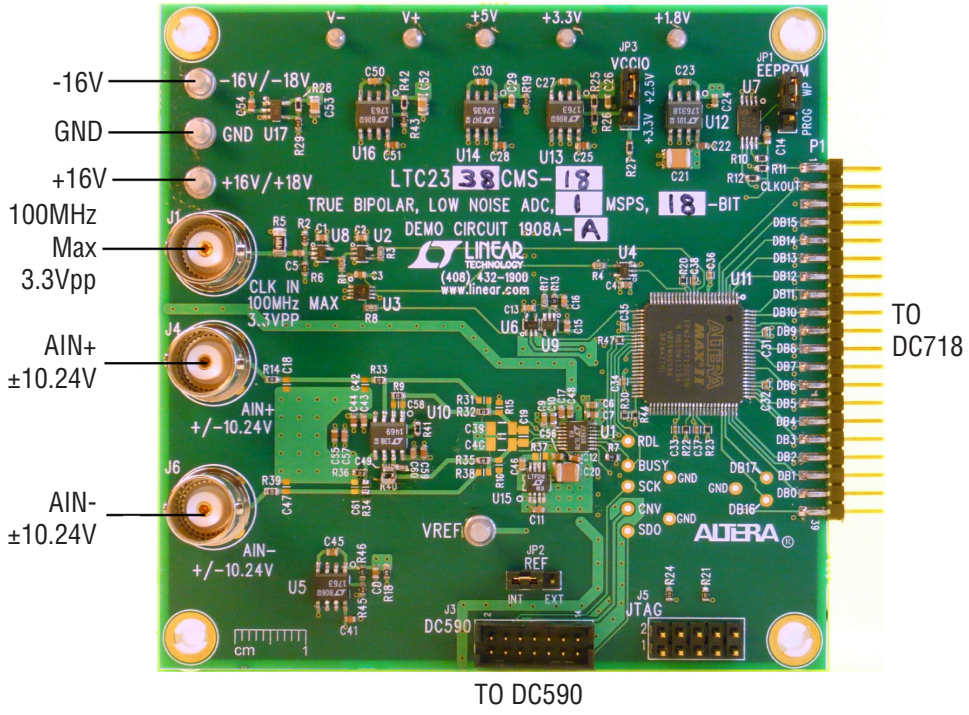


Figure 1. DC1908A Connection Diagram

ASSEMBLY OPTIONS

Table 1. DC1908A Assembly Options

ASSEMBLY VERSION	U1 PART NUMBER	MAX CONVERSION RATE	# OF BITS	MAX CLK FREQUENCY	AIN+ RANGE	AIN– RANGE
DC1908A-A	LTC2338CMS-18	1Msps	18	62MHz	±10.24V	±10.24V
DC1908A-B	LTC2337CMS-18	500ksps	18	31MHz	±10.24V	±10.24V
DC1908A-C	LTC2336CMS-18	250ksps	18	15.5MHz	±10.24V	±10.24V
DC1908A-D	LTC2328CMS-18	1Msps	18	62MHz	±10.24V	Grounded Internally
DC1908A-E	LTC2327CMS-18	500ksps	18	31MHz	±10.24V	Grounded Internally
DC1908A-F	LTC2326CMS-18	250ksps	18	15.5MHz	±10.24V	Grounded Internally
DC1908A-G	LTC2328CMS-16	1Msps	16	50MHz	±10.24V	Grounded Internally
DC1908A-H	LTC2327CMS-16	500ksps	16	25MHz	±10.24V	Grounded Internally
DC1908A-I	LTC2326CMS-16	250ksps	16	12.5MHz	±10.24V	Grounded Internally

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 internal reference. The analog input is DC coupled. Connect the DC1908A to a DC718 USB high speed data collection board using connector P1. Then, connect the DC718 to a host PC with a standard USB A/B cable. Apply ±16V to the indicated terminals. Then apply a low jitter signal source to AIN+ (J4). Connect a low jitter 62MHz $3.3V_{P-P}$ sine wave or square wave to CLK IN (J1). Note that CLK IN 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/software.

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 DC1908A 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.

DC590 SETUP

IMPORTANT! To avoid damage to the DC1908A or DC590, make sure that VCCIO (JP6) of the DC590 is set to 3.3V before connecting the DC590 to the DC1908A.

To use the DC590 with the DC1908A, it is necessary to apply ±16V and ground to the +16V, –16V and GND terminals or disable amplifier U10 by moving R32 and R35 to R31 and R38 respectively. Disabling U10 will require that both AIN+ and AIN– (J6) be driven with a low output impedance signal source. Connect the DC590 to a host PC with a standard USB A/B cable. Connect the DC1908A to a DC590 USB serial controller using the supplied 14-conductor ribbon cable. Apply a signal source to AIN+ or AIN+ and AIN– depending on how the DC1908A is configured. Run the QuikEval software supplied with the DC590 or download it from www.linear.com/software. The correct control panel will be loaded automatically. Click the COLLECT button (See Figure 5) to begin reading the ADC.

DC1908A SETUP

DC Power

The DC1908A requires ±16VDC and draws approximately 100mA from the positive supply. Most of this supply current is consumed by the CPLD, op amps, regulators and discrete logic on the board. The +16VDC input voltage powers the ADC through LT1763 regulators which provide protection against accidental reverse bias. Additional regulators provide power for the CPLD and op amps. See Figure 1 for connection details.

Clock Source

You must provide a low jitter $3.3V_{P-P}$ sine or square wave to CLK IN. The clock input is AC coupled so the DC level of the clock signal is not important. A clock source like the Rohde & Schwarz SMB100A 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.

Analog Input

The default setup for the DC1908A requires that only AIN+ is driven. Versions A, B and C of the DC1908A convert the single-ended signal at AIN+ to a fully-differential signal that is then fed to the ADC as shown in Figure 2. Single-ended versions D, E, F, G, H and I simply buffer the signal applied at AIN+ and feed it to the ADC as shown in Figure 3. To bypass the single-ended-to-differential converter or buffer, disable amplifier U10 by moving R32 and R35 to R31 and R38 respectively. Disabling U10 will require that both AIN+ and AIN– be driven with a low output impedance signal source.

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 CLKOUT (Pin 3) of P1 to latch the data. The data can be latched using either edge of this signal. The data output signal levels at P1 can also be reduced to 0V to 2.5V if the application circuit cannot tolerate the higher voltage. This is accomplished by moving the VCCIO jumper (JP3) to the 2.5V position.

Reference

The default reference is the LTC2338-18 4.096V internal reference. The LTC6655 5V external reference can be used by adding R37 and moving the REF jumper (JP2) to the EXT position. This will increase the input range at AIN+ and AIN– to ±12.5V. Also, an external reference can be used by removing R37 and applying a reference voltage to the VREF (E3) terminal with the REF jumper in the EXT position. If an external reference is used it must settle quickly in the presence of glitches on the REF pin. The analog input range for an external reference is $\pm 2.5 \bullet V_{REF}$.

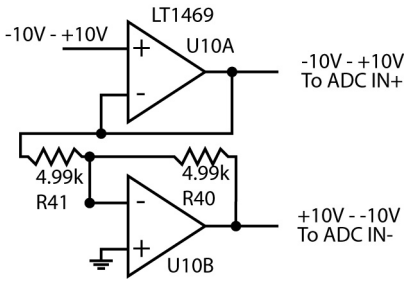


Figure 2. Single-Ended to Differential Converter

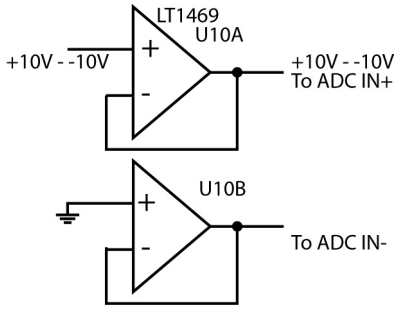


Figure 3. Single-Ended Buffer

DC1908A SETUP

Data Collection

For SINAD, THD or SNR testing a low noise, low distortion generator such as the Stanford Research DS360 should be used. A low jitter RF oscillator such as the Rohde & Schwarz SMB100A 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 LTC2338-18 data sheet. This involves using a 62MHz clock source, along with a sinusoidal generator at a frequency of 2.0kHz. The input signal level is approximately –1dBFS. A typical FFT obtained with DC1908A is shown in Figure 4. Note that to calculate the real SNR, the signal level (F1 amplitude = –1.030dB) has to be added back to the SNR that PScope displays. With the example shown in Figure 4 this means that the actual SNR would be 99.54dB instead of the 98.51dB that PScope displays. Taking the RMS sum of the recalculated SNR and the THD yields a SINAD of 99.27dB which is fairly close to the typical number for this ADC.

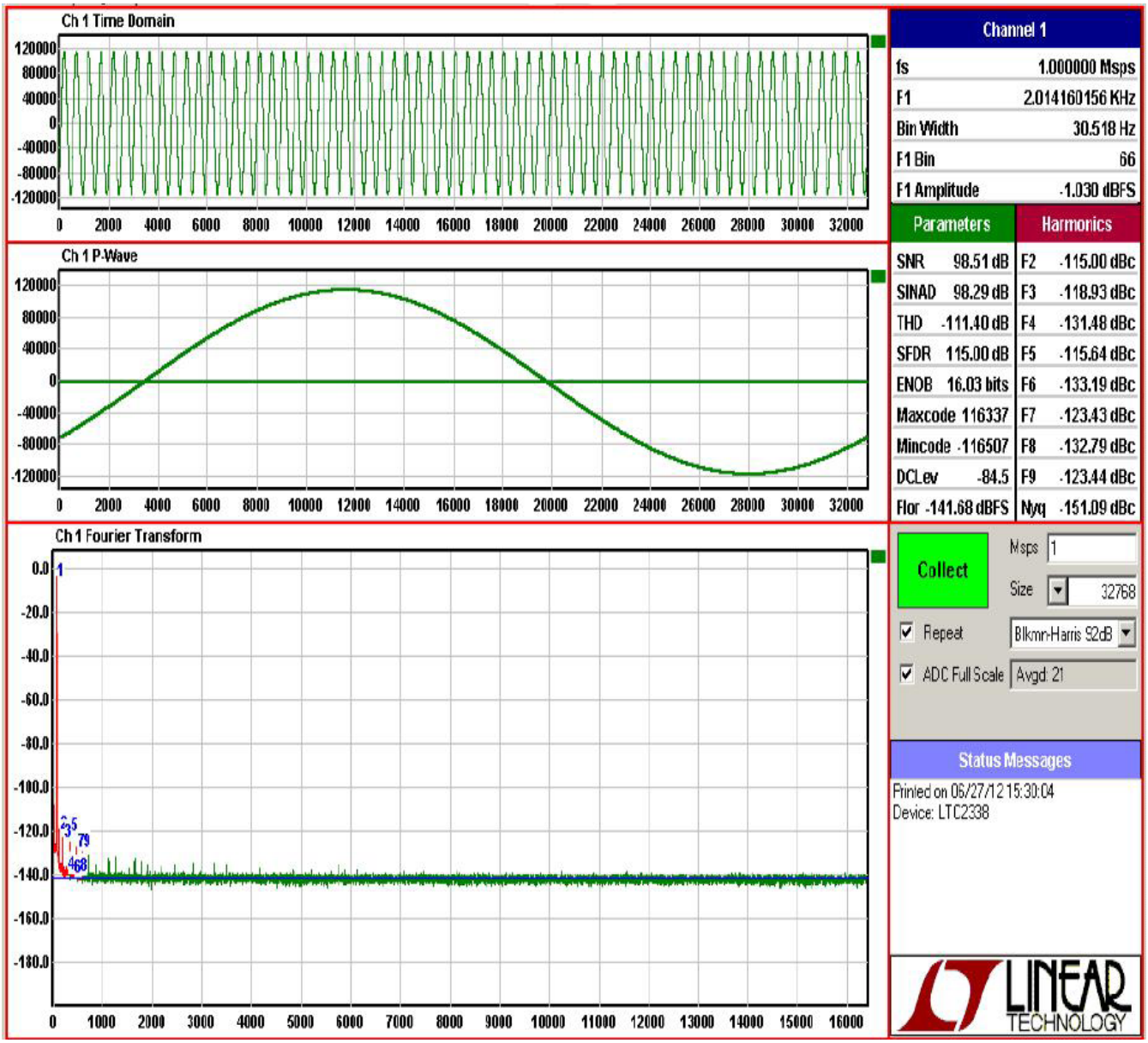


Figure 4. DC1908A PScope Screen Shot

DC1908A SETUP

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 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.

Layout

As with any high performance ADC, this part is sensitive to layout. The area immediately surrounding the ADC on the DC1908A 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 LTC2338-18. 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 LTC2338-18, 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 LTC2338-18 should have low distortion, low noise and a fast settling time such as the LT1469.

DC1980A SETUP

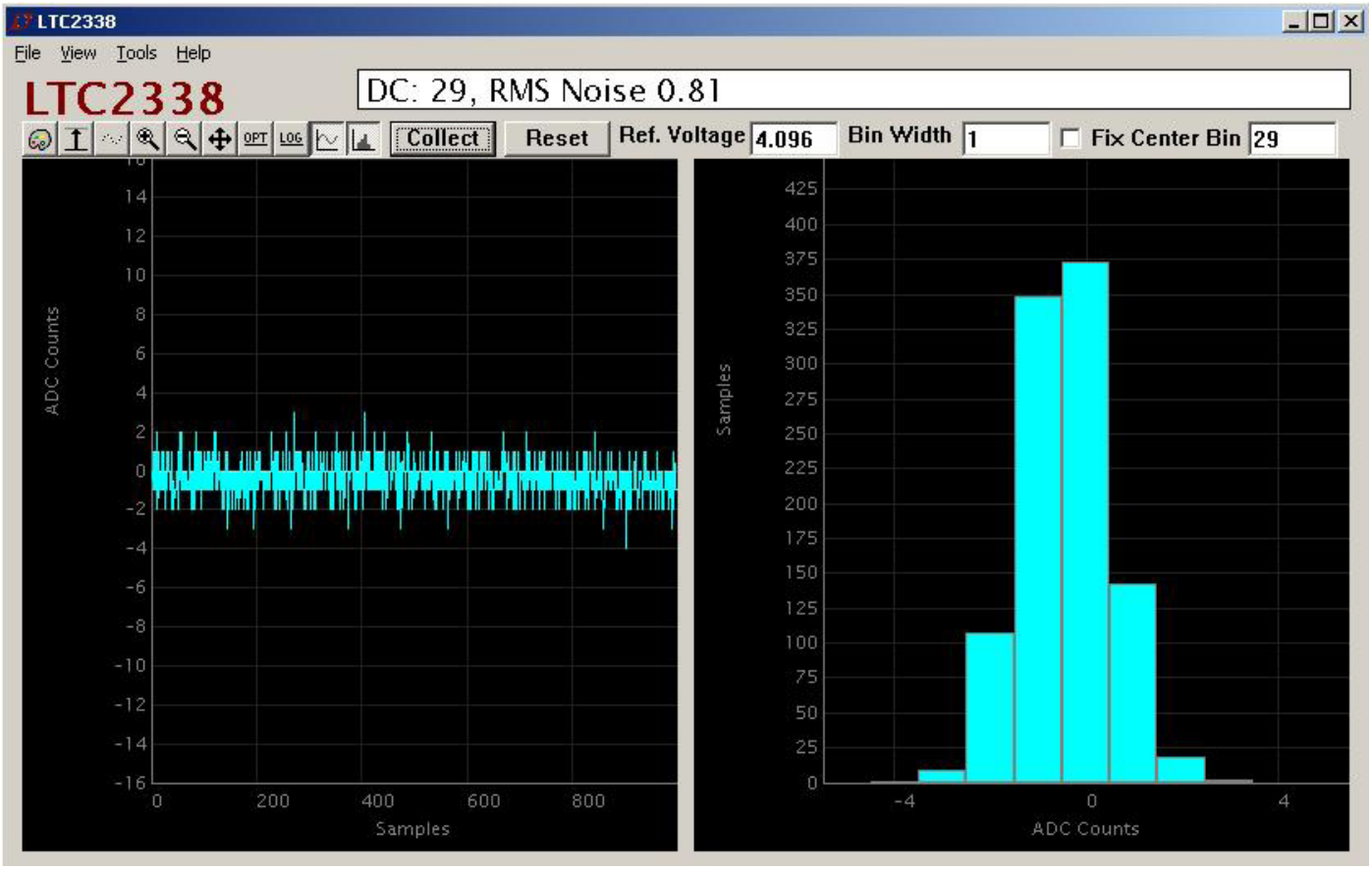


Figure 5. DC1908A QuikEval Screen Shot

DC1980A JUMPERS

Definitions

JP1 – EEPROM For Factory use only. Should be left in the WP position.

JP2 – REF selects whether the LTC2338-18 internal reference or an external reference voltage is used. The default setting is internal.

JP3 – VCCIO sets the output levels at P1 to either 3.3V or 2.5V. Use 3.3V to interface to the DC718 which is the default setting.

PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
1	12	C1, C2, C3, C4, C5, C7, C10, C13, C14, C15, C16, C56	CAP., X7R, 0.1µF, 16V 10% 0603	NIC, NMC0603X7R104K16TRPF
2	6	C6, C9, C24, C26, C29, C48	CAP., X5R, 10µF, 6.3V 20% 0603	NIC, NMC0603X5R106M6.3TRPF4KF
3	2	C8, C45	CAP., X7R, 1µF, 16V 10% 0603	NIC, NMC0603X7R105K16TRPF
4	1	C11	CAP., X5R, 10µF, 10V 20% 0603	SAMSUNG, CL10A106MP8NNNC
5	6	C12, C17, C41, C43, C57, C60	CAP., X7R, 0.1µF, 25V 20% 0603	TDK, C1608X7R1E104M
6	0	C18, C42, C47, C58, C61	CAP., OPT, 0603	OPTION
7	0	C19	CAP., OPT, 0805	OPTION
8	1	C20	CAP., X7R, 47µF, 10V 10% 1210	MURATA, GRM32ER71A476KE15L
9	1	C21	CAP., X5R, 22µF, 25V 20% 1210	MURATA, GRM32ER61E226ME15
10	6	C22, C25, C28, C44, C51, C54	CAP., X7R, 1µF, 25V 10% 0603	TDK, C1608X7R1E105K
11	3	C23, C27, C30	CAP., X7R, 0.01µF, 6.3V 10% 0603	MURATA, GRM188R70J103KA01D
12	8	C31, C32, C33, C34, C35, C36, C37, C38	CAP., X7R, 0.1µF, 16V 10% 0402	NIC, NMC0402X7R104K16TRPF
13	0	C39, C40	CAP., OPT, 1206	OPTION
14	1	C46	CAP., X5R, 2.2µF, 10V 10% 0603	MURATA, GRM188R61A225KE34D
15	1	C49	CAP., NP0, 100pF, 25V 10% 0603	AVX, 06033A101KAT4A
16	1	C50	CAP., X7R, 0.01µF, 25V 10% 0603	MURATA, GRM188R71E103KA01D
17	2	C52, C53	CAP., X5R, 10µF, 25V 10% 0805	MURATA, GRM21BR61E106KA73L
18	2	C55, C59	CAP., X5R, 1µF, 50V 10% 0603	TDK, C1608X5R1H105KT
19	5	E1, E2, E4, E5, E9	TEST POINT, TURRET, 0.061	MILL-MAX, 2308-2-00-80-00-00-07-0
20	4	E3, E6, E7, E8	TEST POINT, TURRET, 0.094, PBF	MILL- MAX, 2501-2-00-80-00-00-07-0
21	3	JP1, JP2, JP3	3-PIN SINGLE ROW HEADER, .100	SAMTEC, TSW-103-07-L-S
22	3	J1, J4, J6	CONNECTOR, BNC	CONNEX, 112404
23	1	J3	HEADER, 2X7, 0.079"	MOLEX, 87831-1420
24	1	J5	HEADER, 2X5, 0.100"	SAMTEC, TSW-105-07-L-D
25	4	MH1, MH2, MH3, MH4	STANDOFF, NYLON 0.25"	KEYSTONE, 8831 (SNAP ON)
26	1	P1	CONNECTOR, 40 PINS, SMT	SAMTEC, TSW-120-07-L-D
27	4	R1, R3, R4, R8	RES., CHIP, 33Ω, 1/10W, 5% 0603	PANASONIC, ERJ-3GEYJ330V
28	7	R2, R6, R19, R24, R29, R43, R45	RES., CHIP, 1k, 1/10W, 1% 0603	YAGEO, RC0603JR-071KL
29	1	R5	RES., CHIP, 49.9Ω, 1/4W, 1% 1206	VISHAY, CRCW120649R9FKEA
30	2	R7, R13	RES., CHIP, 1k, 1/10W, 5% 0603	YAGEO, RC0603JR-071KL
31	6	R9, R14, R32, R33, R36, R39	RES., CHIP, 0Ω, 1/10W, 0603	PANASONIC, ERJ-3GEY0R00V
32	4	R10, R11, R12, R40	RES., CHIP, 4.99k, 1/10W, 1% 0603	PANASONIC, ERJ-3EKF4991V
33	0	R15, R31, R34, R37, R38	RES., CHIP, OPT, 0603	OPTION
34	1	R17	RES., CHIP, 2k, 1/10W, 5% 0603	PANASONIC, ERJ-3GEYJ202V
35	1	R18	RES., CHIP, 249Ω, 1/10W, 1% 0603	YAGEO, RC0603FR-07249RL
36	3	R20, R22, R23	RES., CHIP, 1k, 1/16W, 5% 0402	YAGEO, RC0402JR-071KL
37	1	R21	RES., CHIP, 10k, 1/16W, 5% 0603	AAC, CR16-103JM
38	1	R25	RES., CHIP, 1.69k, 1/10W, 1% 0603	PANASONIC, ERJ-3EKF1691V
39	1	R26	RES., CHIP, 1.54k, 1/10W, 1% 0603	YAGEO, RC0603FR-071K54L
40	1	R27	RES., CHIP, 2.8k, 1/10W, 1% 0603	YAGEO, RC0603FR-072K8L
41	2	R28, R42	RES., CHIP, 11.5k, 1/10W, 1% 0603	YAGEO, RC0603FR-0711K5L
42	1	R30	RES., CHIP, 10k, 1/16W, 5% 0402	AAC, CR05-103JM
43	1	R46	RES., CHIP, 6.19k, 1/10W, 1% 0603	Vishay, CRCW06036K19FKEA
44	1	R47	RES., CHIP, 33Ω, 1/16W, 5% 0402	PANASONIC, ERJ-2GEJ330X

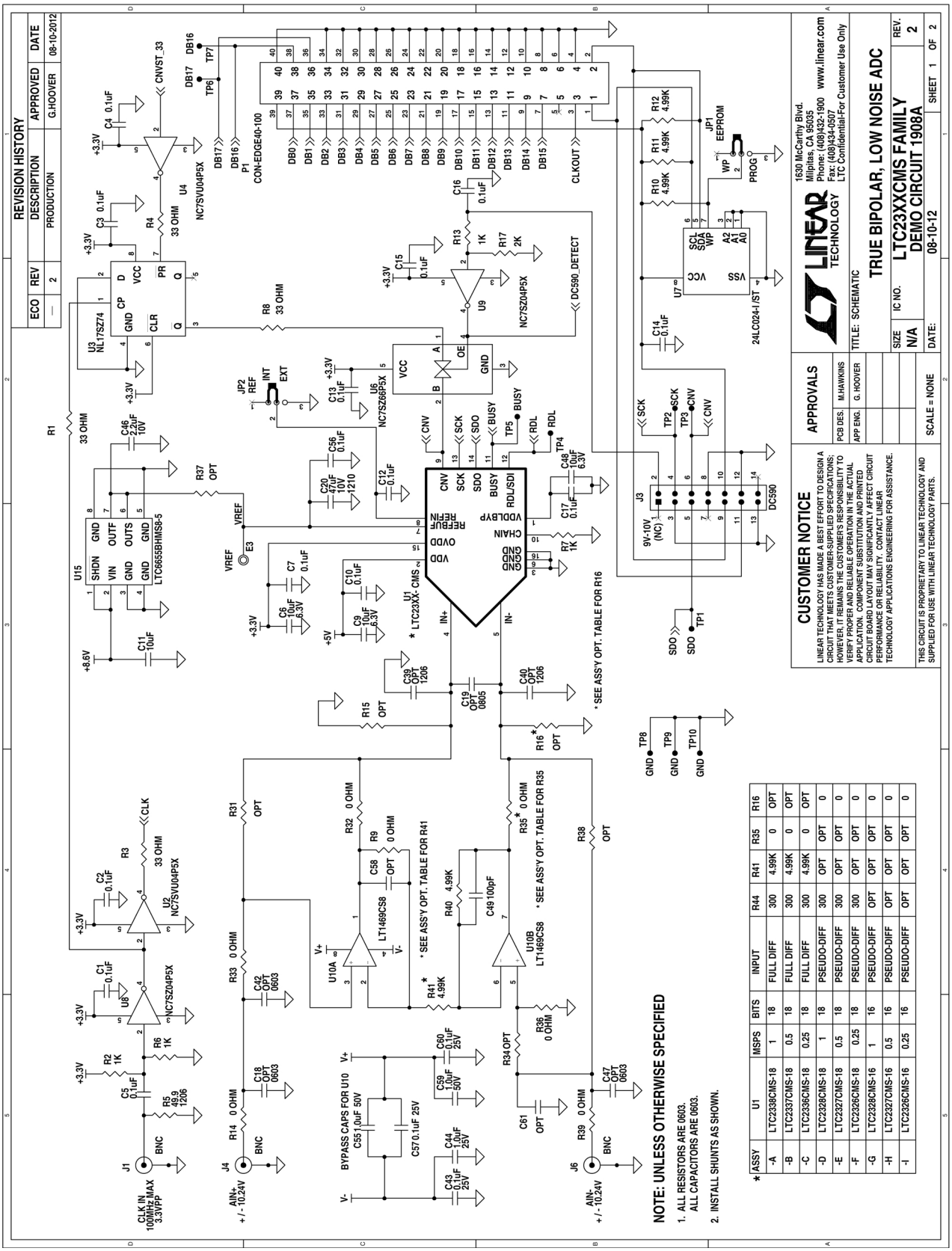
PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
45	2	U2, U4	IC, UNBUFFERED INVERTER, SC70-5	FAIRCHILD, NC7SVU04P5X
46	1	U3	IC, D FLIP-FLOP, US8	ON SEMI., NL17SZ74USG
47	3	U5, U13, U16	IC, MICROPOWER REGULATOR, SO-8	LINEAR TECH., LT1763CS8#PBF
48	1	U6	IC, SINGLE SPST BUS SWITCH, SC70-5	FAIRCHILD, NC7SZ66P5X
49	1	U7	IC, SERIAL EEPROM, TSSOP	MICROCHIP, 24LC024-I/ST
50	2	U8, U9	IC, UHS INVERTER, SC70-5	FAIRCHILD, NC7SZ04P5X
51	1	U10	IC, DUAL OP-AMP	LINEAR TECH., LT1469CS8#PBF
52	1	U11	IC, MAX II CPLD, TQFP100	ALTERA, EPM240GT100C5N
53	1	U12	IC, MICROPOWER REGULATOR, SO-8	LINEAR TECH., LT1763CS8-1.8#PBF
54	1	U14	IC, MICROPOWER REGULATOR, SO-8	LINEAR TECH., LT1763CS8-5#PBF
55	1	U15	IC, VOLTAGE REFERENCE, MSOP	LINEAR TECH., LTC6655BHMS8-5#PBF
56	1	U17	IC, MICROPOWER NEG. REGULATOR, SOT-23	LINEAR TECH., LT1964ES5-SD#PBF
57	3	XJP1, XJP2, XJP3	SHUNT, 0.100	SAMTEC, SNT-100-BK-G
58	1		STENCIL SET (TOP & BOTTOM)	STENCIL 1908A
59	1		FAB, PRINTED CIRCUIT BOARD	DEMO CIRCUIT 1908A (REV2)
DC1908A-A				
1	1		GENERAL BOM	DC1908A
2	1	U1	LOW POWER, LOW NOISE ADC	LINEAR TECH., LTC2338CMS-18
3	0	R16	RE., CHIP, OPT, 0603	OPTION
4	1	R35	RES., CHIP, 0Ω, 1/10W, 0603	PANASONIC, ERJ-3GEY0R00V
5	1	R41	RES., CHIP, 4.99k, 1/10W, 1% 0603	PANASONIC, ERJ-3EKF4991V
6	1	R44	RES., CHIP, 300Ω, 1/16W, 5% 0402	YAGEO, RC0402JR-07300RL
7	1		FAB, PRINTED CIRCUIT BOARD	DEMO CIRCUIT 1908A
DC1908A-B				
1	1		GENERAL BOM	DC1908A
2	1	U1	LOW POWER, LOW NOISE ADC	LINEAR TECH., LTC2337CMS-18
3	0	R16	RE., CHIP, OPT, 0603	OPTION
4	1	R35	RES., CHIP, 0Ω, 1/10W, 0603	PANASONIC, ERJ-3GEY0R00V
5	1	R41	RES., CHIP, 4.99k, 1/10W, 1% 0603	PANASONIC, ERJ-3EKF4991V
6	1	R44	RES., CHIP, 300Ω, 1/16W, 5% 0402	YAGEO, RC0402JR-07300RL
7	1		FAB, PRINTED CIRCUIT BOARD	DEMO CIRCUIT 1908A
DC1908A-C				
1	1		GENERAL BOM	DC1908A
2	1	U1	LOW POWER, LOW NOISE ADC	LINEAR TECH., LTC2336CMS-18
3	0	R16	RE., CHIP, OPT, 0603	OPTION
4	1	R35	RES., CHIP, 0Ω, 1/10W, 0603	PANASONIC, ERJ-3GEY0R00V
5	1	R41	RES., CHIP, 4.99k, 1/10W, 1% 0603	PANASONIC, ERJ-3EKF4991V
6	1	R44	RES., CHIP, 300Ω, 1/16W, 5% 0402	YAGEO, RC0402JR-07300RL
7	1		FAB, PRINTED CIRCUIT BOARD	DEMO CIRCUIT 1908A
DC1908A-D				
1	1		GENERAL BOM	DC1908A
2	1	U1	LOW POWER, LOW NOISE ADC	LINEAR TECH., LTC2328CMS-18
3	1	R16	RES., CHIP, 0Ω, 1/10W, 0603	PANASONIC, ERJ-3GEY0R00V
4	0	R35	RE., CHIP, OPT, 0603	OPTION
5	0	R41	RE., CHIP, OPT, 0603	OPTION

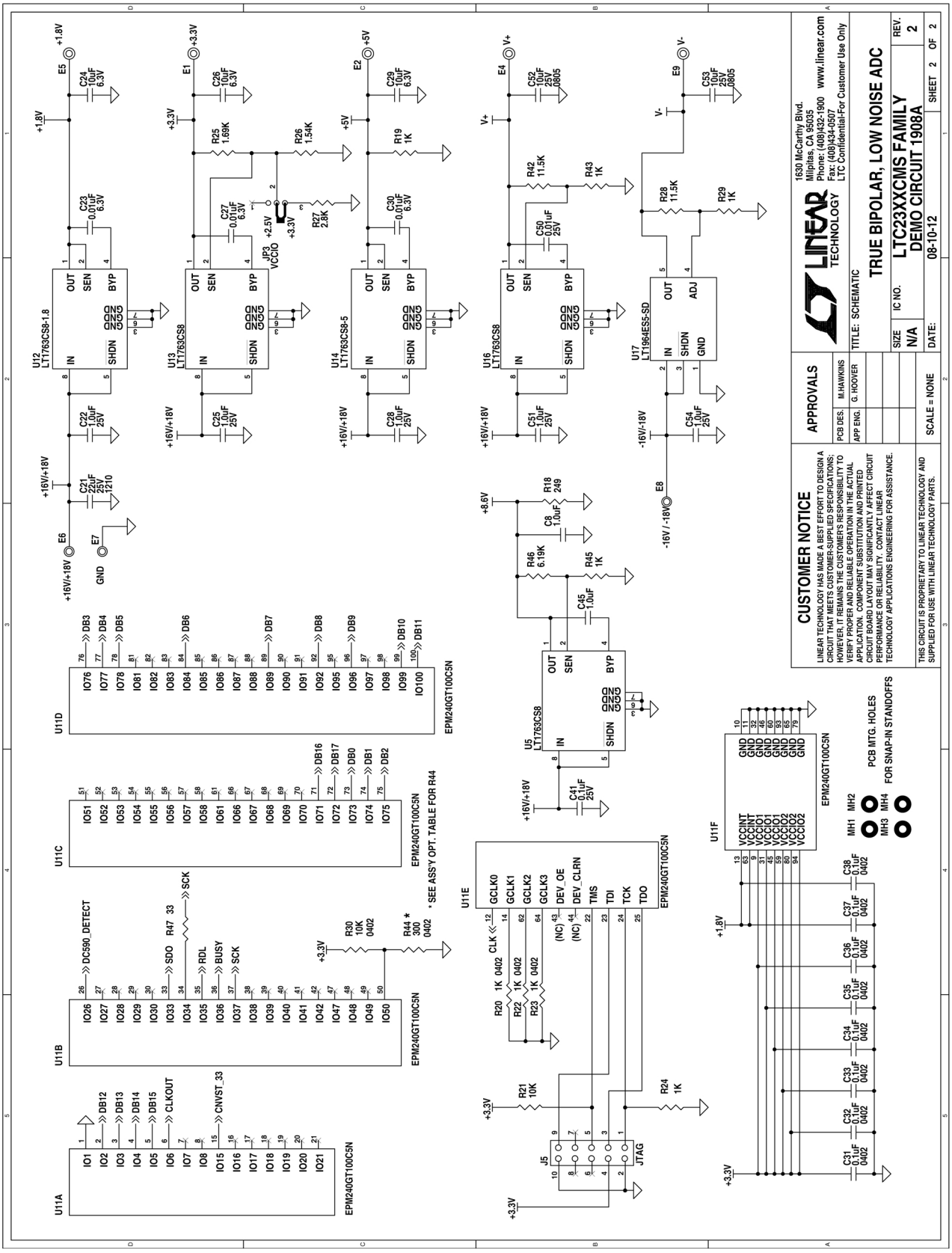
PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
6	1	R44	RES., CHIP, 300Ω, 1/16W, 5% 0402	YAGEO, RC0402JR-07300RL
7	1		FAB, PRINTED CIRCUIT BOARD	DEMO CIRCUIT 1908A
DC1908A-E				
1	1		GENERAL BOM	DC1908A
2	1	U1	LOW POWER, LOW NOISE ADC	LINEAR TECH., LTC2327CMS-18
3	1	R16	RES., CHIP, 0Ω, 1/10W, 0603	PANASONIC, ERJ-3GEY0R00V
4	0	R35	RE., CHIP, OPT, 0603	OPTION
5	0	R41	RE., CHIP, OPT, 0603	OPTION
6	1	R44	RES., CHIP, 300Ω, 1/16W, 5% 0402	YAGEO, RC0402JR-07300RL
7	1		FAB, PRINTED CIRCUIT BOARD	DEMO CIRCUIT 1908A
DC1908A-F				
1	1		GENERAL BOM	DC1908A
2	1	U1	LOW POWER, LOW NOISE ADC	LINEAR TECH., LTC2326CMS-18
3	1	R16	RES., CHIP, 0Ω, 1/10W, 0603	PANASONIC, ERJ-3GEY0R00V
4	0	R35	RE., CHIP, OPT, 0603	OPTION
5	0	R41	RE., CHIP, OPT, 0603	OPTION
6	1	R44	RES., CHIP, 300Ω, 1/16W, 5% 0402	YAGEO, RC0402JR-07300RL
7	1		FAB, PRINTED CIRCUIT BOARD	DEMO CIRCUIT 1908A
DC1908A-G				
1	1		GENERAL BOM	DC1908A
2	1	U1	LOW POWER, LOW NOISE ADC	LINEAR TECH., LTC2328CMS-16
3	1	R16	RES., CHIP, 0Ω, 1/10W, 0603	PANASONIC, ERJ-3GEY0R00V
4	0	R35	RE., CHIP, OPT, 0603	OPTION
5	0	R41	RE., CHIP, OPT, 0603	OPTION
6	1	R44	RES., CHIP, 0402	OPTION
7	1		FAB, PRINTED CIRCUIT BOARD	DEMO CIRCUIT 1908A
DC1908A-H				
1	1		GENERAL BOM	DC1908A
2	1	U1	LOW POWER, LOW NOISE ADC	LINEAR TECH., LTC2327CMS-16
3	1	R16	RES., CHIP, 0Ω, 1/10W, 0603	PANASONIC, ERJ-3GEY0R00V
4	0	R35	RE., CHIP, OPT, 0603	OPTION
5	0	R41	RE., CHIP, OPT, 0603	OPTION
6	1	R44	RES., CHIP, 0402	OPTION
7	1		FAB, PRINTED CIRCUIT BOARD	DEMO CIRCUIT 1908A
DC1908A-I				
1	1		GENERAL BOM	DC1908A
2	1	U1	LOW POWER, LOW NOISE ADC	LINEAR TECH., LTC2326CMS-16
3	1	R16	RES., CHIP, 0Ω, 1/10W, 0603	PANASONIC, ERJ-3GEY0R00V
4	0	R35	RE., CHIP, OPT, 0603	OPTION
5	0	R41	RE., CHIP, OPT, 0603	OPTION
6	1	R44	RES., CHIP, 0402	OPTION
7	1		FAB, PRINTED CIRCUIT BOARD	DEMO CIRCUIT 1908A

SCHEMATIC DIAGRAM



SCHEMATIC DIAGRAM



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