Micro Linear

ML2330*

Selectable Dual 3V/3.3V/5V 8-Bit DACs

GENERAL DESCRIPTION

The ML2330 Selectable Dual 3V/3.3V/5V 8-bit DACs are dual voltage output digital-to-analog converters which can be independently programmed, or powered down to conserve power. The devices are intended for use in portable or low power 3V systems where space is critical.

Programming access to the DACs is provided over a high speed (10Mb/s), 3-wire serial interface which is compatible to the SPI™ and Microwire™ data formats. In addition to independent programming of the DAC output voltages, each device may be powered down, independent of the other DAC, to conserve power. Each DAC draws 2mA maximum quiescent current when operating, and typically less than 1µA when powered down.

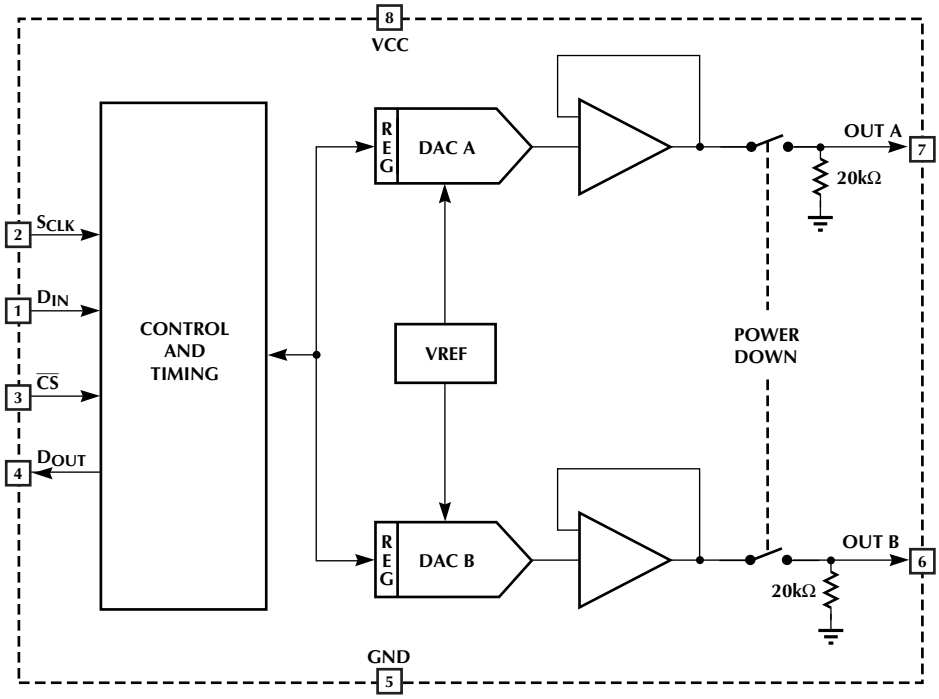
The device comes in an 8-pin SOIC package and in a special Extended Commercial temperature range (–20°C to 70°C) or Industrial temperture range (–40°C to 85°C).

FEATURES

- 3V ±10%, 3.3 ±10% or 5V ±10% operation
- Low supply current (3.5mA max)
- Individual and full power down (down to 1µA)
- 10Mb/s three-wire serial interface, compatible to SPI and Microwire
- 8-pin SOIC package
- Available in Extended Commercial temperature range (–20°C to 70°C) and Industrial temperture range (–40°C to 85°C)
- Guaranteed monotonicity

*Some Packages Are End Of Life Or Obsolete

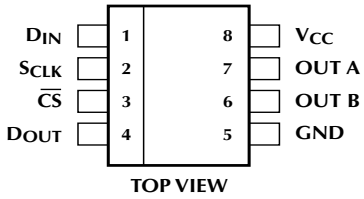
BLOCK DIAGRAM



PIN CONFIGURATION

ML2330

8-Pin SOIC (S08)



PIN DESCRIPTION

PIN	NAME	FUNCTION
1	D_{IN}	Data In
2	S_{CLK}	Serial Clock
3	$\overline{CS}$	Chip Select
4	D_{OUT}	Data Out
5	GND	Ground
6	OUT B	Output of DAC B
7	OUT A	Output of DAC A
8	V_{CC}	Positive Supply

ABSOLUTE MAXIMUM RATINGS

Supply Voltage (V_{CC}) 6.0V
GND ..... –0.3V to V_{CC} + 0.3V
Logic Inputs ..... –0.3V to V_{CC} + 0.3V
Input Current per Pin ..... ±25mA
Storage Temperature ..... –65°C to 150°C
Package Dissipation at T_A = 25°C 750mW
Lead Temperature (Soldering 10 sec.)
SOIC ..... 150°C

OPERATING CONDITIONS

Supply Voltage (V_{CC})
ML2330ES–2 ..... 3V ± 10%
ML2330ES–3 ..... 3.3V ± 10%
ML2330ES–5 ..... 5V ± 10%
Temperature Range
ML2330ES ..... –20°C to 70°C
ML2330IS ..... –40°C to 85°C

ELECTRICAL CHARACTERISTICS

Unless otherwise specified, $T_A = T_{MIN}$ to T_{MAX}, V_{CC} = Operating Supply Voltage Range, f_{CLK} = 10MHz R_L = 1ký, (R_L = 2kΩ for V_{CC} = 5V), C_L = 100pF (Note 1)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
Converter							
Resolution				8			bits
Integral Linearity Error	ILE					±1.5	LSB
Differential Linearity Error	DLE					±1	LSB
Offset Error		V_{CC} = 3.3V or 3.0V	E Suffix	10	20	30	mV
			I Suffix	5	20	35	mV
		V_{CC} = 5V	E Suffix	15	25	35	mV
			I Suffix	10	25	40	mV
Gain Error						±5	%FS
Analog Output							
Output Drive Current	I_{OUTPP}	Full scale output				2	mA
Power Supply Rejection Ratio	PSRR	@00 & FF			40		dB
Digital and DC							
Logic Input Low	V_{IL}	V_{CC} = 3V, 3.3V, or 5V				0.8	V
Logic Input High	V_{IH}	V_{CC} = 3V or 3.3V		2.0			V
		V_{CC} = 5V		2.8			V
Logic Input Low Current	I_{IL}	V_{IN} = GND		–1			µA
Logic Input High Current	I_{IH}	V_{IN} = V_{CC}				1	µA
Logic Output Low	V_{OL}	I = 3.2mA				0.4	V
Logic Output High	V_{OH}	I = 0.4mA		2.4			V
Supply Current	I_{CC}	R_L = □			2.5	3.5	mA
Power Down Current		All digital inputs at static 0V or V_{CC}	V_{CC} = 3V			3	µA
			V_{CC} = 5V			5	µA
AC Performance							
Settling Time	t_S	±1/2 LSB			5	10	µs
Slew Rate					1.4		V/µs
Crosstalk				60			dB

Note 1: Limits are guaratneed by 100% testing, sampling or correlation with worst case test conditions.

TIMING CHARACTERISTICS (Serial Interface)

V_{CC} = Operating Supply Voltage Range, C_L = 50pF, $T_A = T_{MIN}$ to T_{MAX}, unless otherwise noted

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Converter						
$\overline{CS}$ Fall to S_{CLK} Setup Time	t_{CSS}		20			ns
S_{CLK} Rise to $\overline{CS}$ Rise Hold Time	t_{CSH}		50			ns
D_{IN} to S_{CLK} Rise Setup Time	t_{DS}		20			ns
D_{IN} to S_{CLK} Rise Hold Time	t_{DH}		20			ns
S_{CLK} Frequency	f_{CLK}			10		MHz
S_{CLK} Duty Cycle			40		60	%
S_{CLK} to D_{OUT} Valid	t_{DO}	V_{CC} = 3.3V or 5V		30	60	ns
		V_{CC} = 3V		45	90	ns

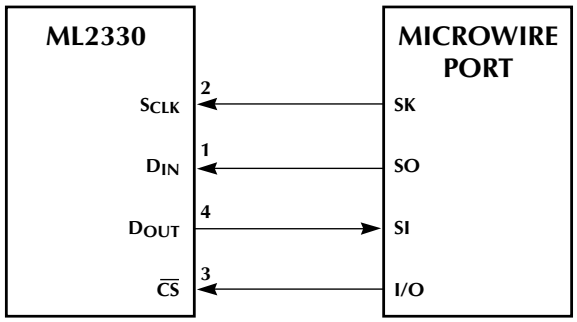


Figure 1a. Connections for Microwire.

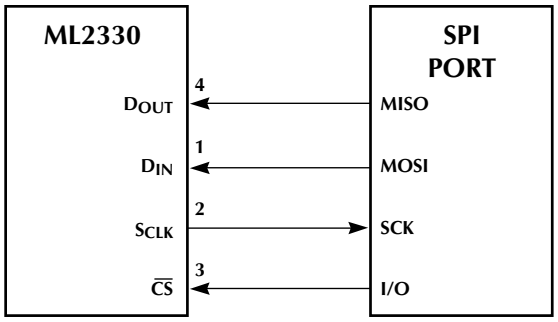


Figure 1b. Connections for SPI.

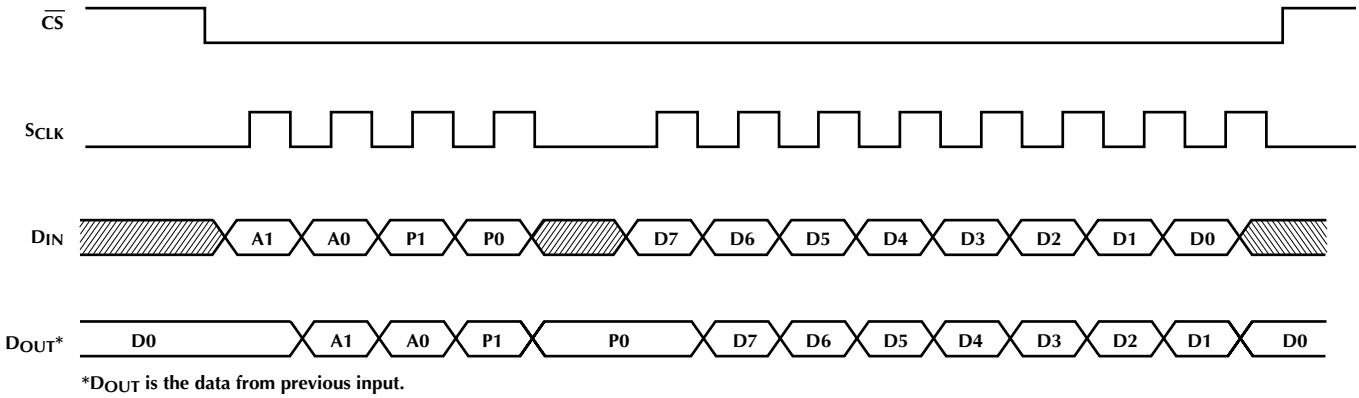


Figure 1c. Interface Timing

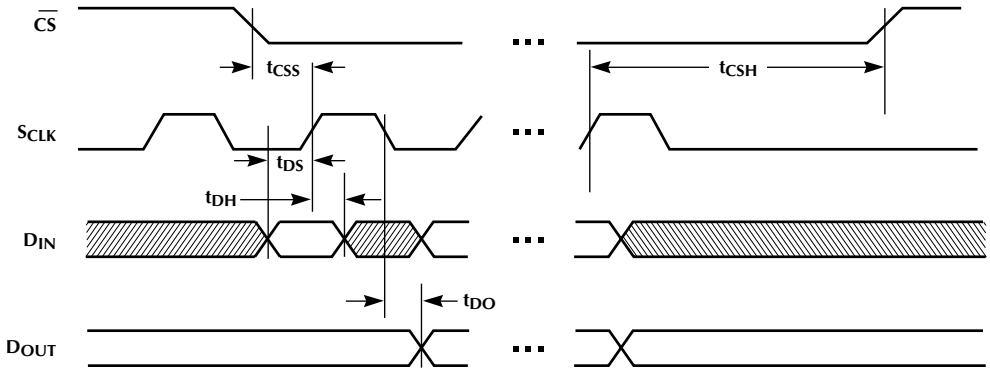


Figure 2. Detail Interface Timing

FUNCTIONAL DESCRIPTION

SERIAL INTERFACE

The ML2330 communicates with microprocessors through a synchronous, full-duplex, 3-wire interface (figure 1A & B). At power on, the control registers are cleared and both DACs have high impedance outputs. Data timing shown in Figure 1C is sent MSB-first and can be transmitted in one 4-bit and one 8-bit packet or in one 12-bit word. If a 16-bit control word is used, the first four bits are ignored. The serial clock (S_{CLK}) synchronizes the data transfer. Data is transmitted and received simultaneously. Figure 2 shows detailed serial interface timing. Note that the clock should be low between updates. D_{OUT} does not go into a high impedance state if the clock idles or $\overline{CS}$ is high.

Serial data is clocked into the data registers in MSB-first format, with the address and configuration information preceding the actual DAC data. Data is sampled on the S_{CLK}'s rising edge while $\overline{CS}$ is low. Data at D_{OUT} is clocked out 12.5 clock cycles later, on the S_{CLK}'s falling edge.

Chip Select ($\overline{CS}$) must be low to enable the read or write operation. If $\overline{CS}$ is high, the interface is disabled and D_{OUT} remains unchanged. $\overline{CS}$ must go low at least 10ns before the first clock pulse to properly clock in the first bit. With $\overline{CS}$ low, data is clocked into the ML2330's internal shift register on the rising edge of the external serial clock. S_{CLK} can be driven at rates up to 10MHz.

SERIAL INPUT DATA FORMAT AND CONFIGURATION CODES

The 12-bit serial input format shown in Figure 3 comprises two DAC address bits (A1, A0), two power down control bits (P1, P0) and eight bits of data (D7 . . . D0).

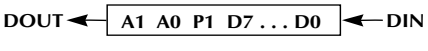


Figure 3. Serial Input Format

The 4-bit address/control code configures the DAC as shown in Table 1.

A1	A0	Function
0	0	No operation
0	1	Select control bits and DAC A
1	0	Select control bits and DAC B
1	1	Select control bits and both DACs

Table 1.1 Address Selection

P1	P0	Function
0	0	Normal
0	1	Power down DAC A
1	0	Power down DAC B
1	1	Power down entire chip

Table 1.2 Power Down Selection

DAC OPERATION

The DACs are implemented using an array of equal current sources that are decoded linearly for the four most significant bits to improve differential linearity and to reduce output glitch around major carries. A voltage difference between on-board bandgap reference voltage and GND is converted to a reference current using an internal resistor to set up the appropriate current level in the DACs. The DACs output current is then converted to a voltage output by an output buffer and a resistive network. The matching among the on-chip resistors preserves the gain accuracy between these conversions.

VOLTAGE REFERENCE

A bandgap voltage reference is incorporated on the ML2330. It is trimmed for zero temperature coefficient at 25°C to minimize output voltage drift over the specified operating temperature range.

OUTPUT BUFFER AND GAIN SETTING

The output buffer converts the DAC output current to a voltage output using a resistive network. The outputs can swing from GND +0.02V to either 2.02V (3V) or 4.02V (5V). The DAC transfer function is:

$$V_{OUT} = \frac{K \times DATA}{256} + 0.02$$

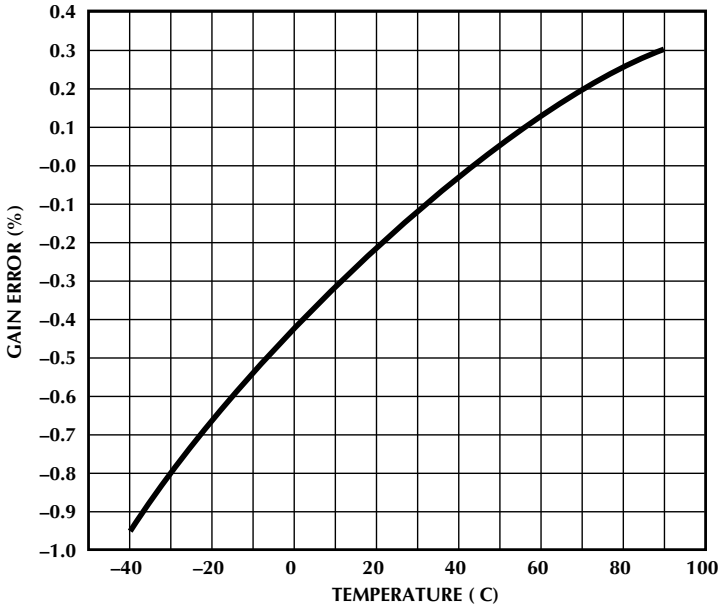
where K = 2 if V_{CC} = 3V and K = 4 if V_{CC} = 5V

In the 3V operation, the amplifier outputs will settle to 1/2LSB in 10µs when loads are greater than 1kÝ (2kÝ for 5V operation) and capacitive loads smaller than 100pF.

GAIN ERROR

The graph below shows how gain error varies with temperature when V_{CC} = 3.3V.

Gain Error vs Temperature

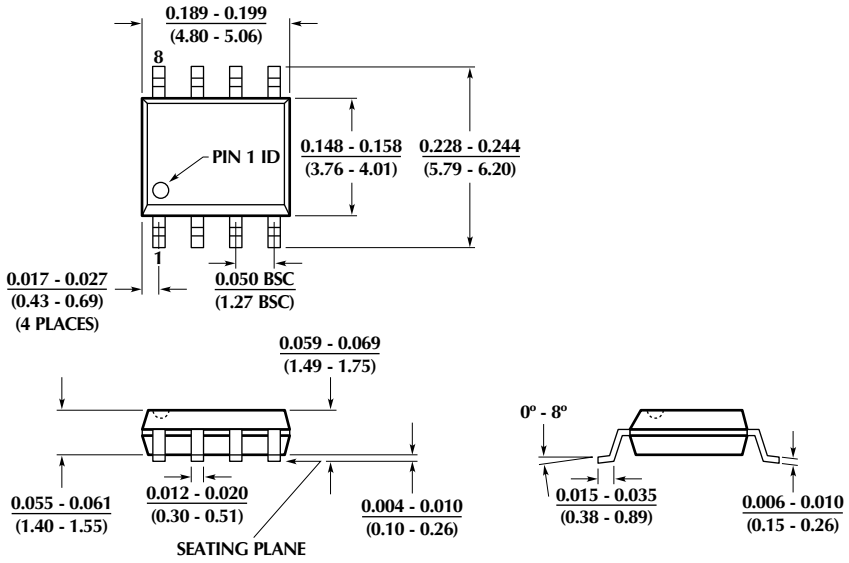


POWER DOWN MODE

There are three power-down modes in the ML2330. By clearing the control bits P1-P0 (Table 3.2), the entire chip will be powered down with a supply current less than 5µA. Individual DACs can also be powered down to save power (1.75mA per DAC).

PHYSICAL DIMENSIONS inches (millimeters)

Package: S08
8-Pin SOIC



ORDERING INFORMATION

PART NUMBER	V_{CC}	TEMPERATURE RANGE	PACKAGE
ML2330ES–2	3V	–20°C to 70°C	8-Pin SOIC (S08)
ML2330ES–3 (End Of Life)	3.3V	–20°C to 70°C	8-Pin SOIC (S08)
ML2330ES–5 (End Of Life)	5V	–20°C to 70°C	8-Pin SOIC (S08)
ML2330IS–2	3V	–40°C to 85°C	8-Pin SOIC (S08)
ML2330IS–3 (Obsolete)	3.3V	–40°C to 85°C	8-Pin SOIC (S08)
ML2330IS–5	5V	–40°C to 85°C	8-Pin SOIC (S08)

DS2330-01

2092 Concourse Drive
San Jose, CA 95131
Tel: 408/433-5200
Fax: 408/432-0295

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