Serial Input, Voltage Output 12-/14-Bit DACs

AD5530/AD5531

FEATURES
Pin-Compatible 12- and 14-Bit DACs
Serial Input, Voltage Output
Maximum Output Voltage Range of ±10 V
Data Readback
3-Wire Serial Interface
Clear Function to a User-Defined Voltage
Power-Down Function
Serial Data Output for Daisy-Chaining
16-Lead TSSOP Packages

APPLICATIONS
Industrial Automation
Automatic Test Equipment
Process Control
General-Purpose Instrumentation

GENERAL DESCRIPTION

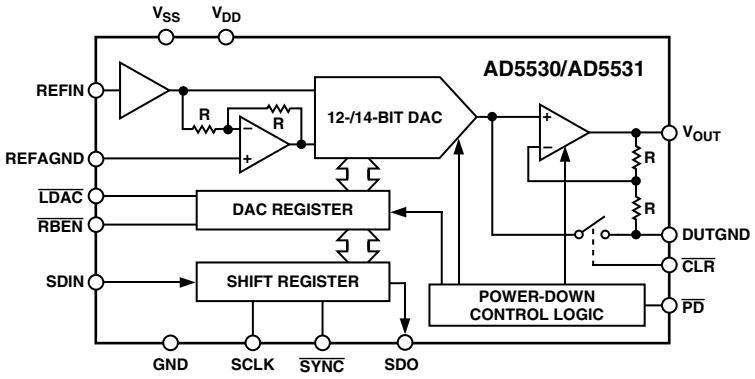
The AD5530 and AD5531 are single 12-/14-bit serial input, voltage output DACs, respectively.

They utilize a versatile 3-wire interface that is compatible with SPI™, QSPI™, MICROWIRE™, and DSP interface standards. Data is presented to the part in the format of a 16-bit serial word. Serial data is available on the SDO pin for daisy-chaining purposes. Data readback allows the user to read the contents of the DAC register via the SDO pin.

The DAC output is buffered by a gain of 2 amplifier and referenced to the potential at DUTGND. $\overline{\text{LDAC}}$ may be used to update the output of the DAC asynchronously. A power-down ($\overline{\text{PD}}$) pin allows the DAC to be put into a low power state, and a $\overline{\text{CLR}}$ pin allows the output to be cleared to a user-defined voltage, the potential at DUTGND.

The AD5530 and AD5531 are available in 16-lead TSSOP packages.

FUNCTIONAL BLOCK DIAGRAM



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MICROWIRE is a trademark of National Semiconductor Corporation.

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AD5530/AD5531–SPECIFICATIONS[1] (V_{DD} = +15 V ±10%; V_{SS} = –15 V ±10%; GND = 0 V; R_L = 5 kΩ and C_L = 220 pF to GND. All specifications T_{MIN} to T_{MAX}, unless otherwise noted.)

Parameter	AD5530	AD5531	Unit	Test Conditions/Comments
ACCURACY				
Resolution	12	14	Bits	
Relative Accuracy	±1	±2	LSB max	
Differential Nonlinearity	±1	±1	LSB max	Guaranteed Monotonic Over Temperature
Zero-Scale Error	±2	±8	LSB max	Typically within ±1 LSB
Full-Scale Error	±2	±8	LSB max	Typically within ±1 LSB
Gain Error	±1	±4	LSB typ	
Gain Temperature Coefficient[2]	0.5	0.5	ppm FSR/°C typ	
	10	10	ppm FSR/°C max	
REFERENCE INPUTS[2]				
Reference Input Range	0/5	0/5	V min/V max	Max Output Range ±10 V
DC Input Resistance	100	100	MΩ typ	
Input Current	±1	±1	µA max	Per Input. Typically ±20 nA.
DUTGND INPUT[2]				
DC Input Impedance	60	60	kΩ typ	
Max Input Current	±0.3	±0.3	mA typ	
Input Range	–4/+4	–4/+4	V min/V max	Max Output Range ±10 V
O/P CHARACTERISTICS[2]				
Output Voltage Swing	±10	±10	V max	
Short Circuit Current	15	15	mA max	
Resistive Load	5	5	kΩ min	To 0 V
Capacitive Load	1200	1200	pF max	To 0 V
DC Output Impedance	0.5	0.5	Ω max	
DIGITAL I/O				
V_{INH}, Input High Voltage	2.4	2.4	V min	
V_{INL}, Input Low Voltage	0.8	0.8	V max	
I_{INH}, Input Current	±10	±10	µA max	Total for All Pins
C_{IN}, Input Capacitance[2]	10	10	pF max	3 pF Typ
SDO V_{OL} Output Low Voltage	0.4	0.4	V max	I_{SINK} = 1 mA
POWER REQUIREMENTS				
V_{DD}/V_{SS}	+15/–15	+15/–15	V nom	±10% For Specified Performance
Power Supply Sensitivity				
ΔFull Scale/ΔV_{DD}	110	110	dB typ	
ΔFull Scale/ΔV_{SS}	100	100	dB typ	
I_{DD}	2	2	mA max	Outputs Unloaded
I_{SS}	2	2	mA max	Outputs Unloaded
I_{DD} in Power-Down	150	150	µA max	Typically 50 µA

NOTES
[1]Temperature range for B Version: –40°C to +85°C.
[2]Guaranteed by design, not subject to production test.

Specifications subject to change without notice.

SPECIFICATIONS[1] (V_{DD} = +12 V ±10%; V_{SS} = –12 V ±10%; GND = 0 V; R_L = 5 kΩ and C_L = 220 pF to GND; T_A = T_{MIN} to T_{MAX}, unless otherwise noted.)

Parameter	AD5530	AD5531	Unit	Test Conditions/Comments
ACCURACY				
Resolution	12	14	Bits	
Relative Accuracy	±1	±2	LSB max	
Differential Nonlinearity	±1	±1	LSB max	Guaranteed Monotonic Over Temperature
Zero-Scale Error	±2	±8	LSB max	Typically within ±1 LSB
Full-Scale Error	±2	±8	LSB max	Typically within ±1 LSB
Gain Error	±1	±4	LSB typ	
Gain Temperature Coefficient[2]	0.5	0.5	ppm FSR/°C typ	
	10	10	ppm FSR/°C max	
REFERENCE INPUTS[2]				
Reference Input Range	0/4.096	0/4.096	V min/V max	Max Output Range ±8.192 V
DC Input Resistance	100	100	MΩ typ	
Input Current	±1	±1	µA max	Per Input. Typically ±20 nA.
DUTGND INPUT[2]				
DC Input Impedance	60	60	kΩ typ	
Max Input Current	±0.3	±0.3	mA typ	
Input Range	–3/+3	–3/+3	V min/V max	Max Output Range ±8.192 V
O/P CHARACTERISTICS[2]				
Output Voltage Swing	±8.192	±8.192	V max	
Short Circuit Current	15	15	mA max	
Resistive Load	5	5	kΩ min	To 0 V
Capacitive Load	1200	1200	pF max	To 0 V
DC Output Impedance	0.5	0.5	Ω max	
DIGITAL I/O				
V_{INH}, Input High Voltage	2.4	2.4	V min	
V_{INL}, Input Low Voltage	0.8	0.8	V max	
I_{INH}, Input Current	±10	±10	µA max	Total for All Pins
C_{IN}, Input Capacitance[2]	10	10	pF max	3 pF Typ
SDO V_{OL} Output Low Voltage	0.4	0.4	V max	I_{SINK} = 1 mA
POWER REQUIREMENTS				
V_{DD}/V_{SS}	+12/–12	+12/–12	V nom	±10% For Specified Performance
Power Supply Sensitivity				
ΔFull Scale/ΔV_{DD}	110	110	dB typ	
ΔFull Scale/ΔV_{SS}	100	100	dB typ	
I_{DD}	2	2	mA max	Outputs Unloaded
I_{SS}	2	2	mA max	Outputs Unloaded
I_{DD} in Power-Down	150	150	µA max	Typically 50 µA

NOTES
[1]Temperature range for B Version: –40°C to +85°C.
[2]Guaranteed by design, not subject to production test.
Specifications subject to change without notice.

AC PERFORMANCE CHARACTERISTICS (V_{DD} = 10.8 V to 16.5 V, V_{SS} = –10.8 V to –16.5 V; GND = 0 V; R_L = 5 kΩ and C_L = 220 pF to GND. All specifications T_{MIN} to T_{MAX}, unless otherwise noted.)

Parameter	A	Unit	Test Conditions/Comments
DYNAMIC PERFORMANCE			
Output Voltage Settling Time	20	µs typ	Full-Scale Change to ±1/2 LSB. DAC Latch Contents alternately loaded with all 0s and all 1s.
Slew Rate	1.3	V/µs typ	
Digital-to-Analog Glitch Impulse	120	nV-s typ	DAC Latch alternately loaded with 0FFF Hex and 1000 Hex. Not dependent on load conditions.
Digital Feedthrough	0.5	nV-s typ	Effect of Input Bus Activity on DAC Output Under Test
Output Noise Spectral Density			
@ 1 kHz	100	nV/(Hz)$^{1/2}$typ	All 1s Loaded to DAC

Specifications subject to change without notice. Guaranteed by design, not subject to production test.

STANDALONE TIMING CHARACTERISTICS[1, 2] (V_{DD} = 10.8 V to 16.5 V, V_{SS} = –10.8 V to –16.5 V; GND = 0 V; R_L = 5 kΩ and C_L = 220 pF to GND. All specifications T_{MIN} to T_{MAX}, unless otherwise noted.)

Parameter	Limit at T_{MIN}, T_{MAX}	Unit	Description
f_{MAX}	7	MHz max	SCLK Frequency
t_1	140	ns min	SCLK Cycle Time
t_2	60	ns min	SCLK Low Time
t_3	60	ns min	SCLK High Time
t_4	50	ns min	$\overline{SYNC}$ to SCLK Falling Edge Setup Time
t_5	40	ns min	SCLK Falling Edge to $\overline{SYNC}$ Rising Edge
t_6	50	ns min	Min $\overline{SYNC}$ High Time
t_7	40	ns min	Data Setup Time
t_8	15	ns min	Data Hold Time
t_9	5	ns min	$\overline{SYNC}$ High to $\overline{LDAC}$ Low
t_{10}	50	ns min	$\overline{LDAC}$ Pulsewidth
t_{11}	5	ns min	$\overline{LDAC}$ High to $\overline{SYNC}$ Low
t_{12}	50	ns min	$\overline{CLR}$ Pulsewidth

[1]Guaranteed by design. Not production tested.
[2]Sample tested during initial release and after any redesign or process change that may affect this parameter. All input signals are measured with tr = tf = 5 ns (10% to 90% of V_{DD}) and timed from a voltage level of $(V_{IL} + V_{IH})/2$.
Specifications subject to change without notice.

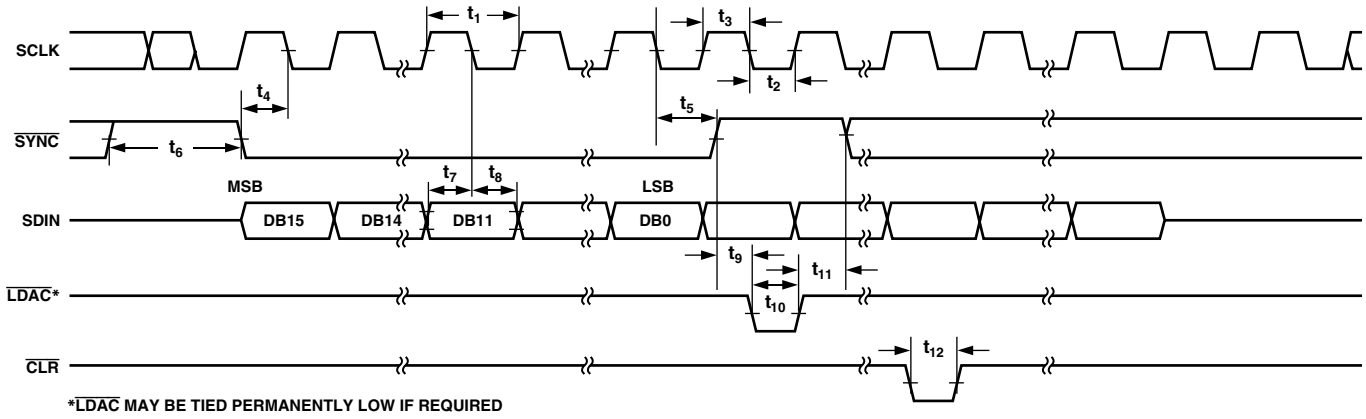


Figure 1. Timing Diagram for Standalone Mode

DAISY-CHAINING AND READBACK TIMING CHARACTERISTICS[1, 2, 3]

(V_{DD} = 10.8 V to 16.5 V, V_{SS} = –10.8 V to –16.5 V; V_{SS} = –15 V ±10%; GND = 0 V; R_L = 5 kΩ and C_L = 220 pF to GND. All specifications T_{MIN} to T_{MAX}, unless otherwise noted.)

Parameter	Limit at T_{MIN}, T_{MAX}	Unit	Description
f_{MAX}	2	MHz max	SCLK Frequency
t_1	500	ns min	SCLK Cycle Time
t_2	200	ns min	SCLK Low Time
t_3	200	ns min	SCLK High Time
t_4	50	ns min	$\overline{SYNC}$ to SCLK Falling Edge Setup Time
t_5	40	ns min	SCLK Falling Edge to $\overline{SYNC}$ Rising Edge
t_6	50	ns min	Min $\overline{SYNC}$ High Time
t_7	40	ns min	Data Setup Time
t_8	15	ns min	Data Hold Time
t_{12}	50	ns min	$\overline{CLR}$ Pulsewidth
t_{13}	130	ns min	SCLK Falling Edge to SDO Valid
t_{14}	50	ns max	SCLK Falling Edge to SDO Invalid
t_{15}	50	ns min	$\overline{RBEN}$ to SCLK Falling Edge Setup Time
t_{16}	50	ns min	$\overline{RBEN}$ Hold Time
t_{17}	100	ns min	$\overline{RBEN}$ Falling Edge to SDO Valid

[1]Guaranteed by design. Not production tested.

[2]Sample tested during initial release and after any redesign or process change that may affect this parameter. All input signals are measured with tr = tf = 5 ns (10% to 90% of V_{DD}) and timed from a voltage level of $(V_{IL} + V_{IH})/2$.

[3]SDO; R_{PULLUP} = 5 kΩ, C_L = 15 pF.

Specifications subject to change without notice.

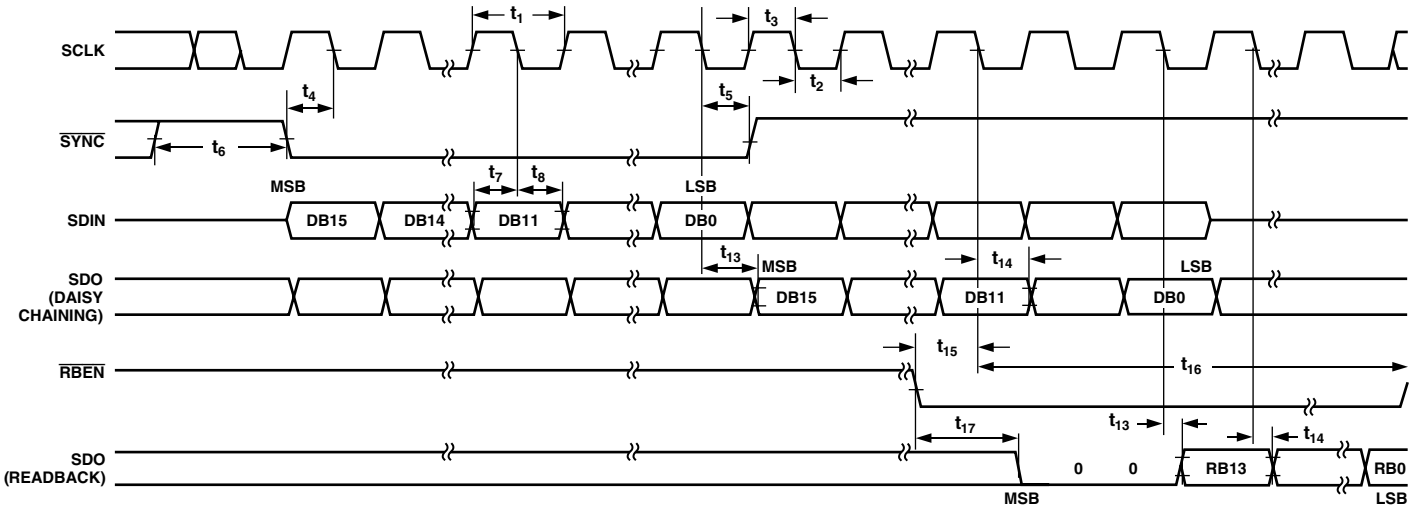


Figure 2. Timing Diagram for Daisy-Chaining and READBACK Mode

ABSOLUTE MAXIMUM RATINGS*

(T_A = 25°C unless otherwise noted)

V_{DD} to GND . . . . . –0.3 V, +17 V
V_{SS} to GND . . . . . +0.3 V, –17 V
Digital Inputs to GND . . . . . –0.3 V to V_{DD} +0.3 V
SDO to GND . . . . . –0.3 V to +6.5 V
REFIN to REFAGND . . . . . –0.3 V, +17 V
REFIN to GND . . . . . V_{SS} – 0.3 V, V_{DD} +0.3 V
REFAGND to GND . . . . . V_{SS} – 0.3 V, V_{DD} +0.3 V
DUTGND to GND . . . . . V_{SS} – 0.3 V, V_{DD} +0.3 V
Operating Temperature Range
Industrial (B Version) . . . . . –40°C to +85°C
Storage Temperature Range . . . . . –65°C to +150°C
Maximum Junction Temperature ($T_{J\ MAX}$) . . . . . 150°C
Package Power Dissipation . . . . . ($T_{J\ MAX} - T_A$)/θ_{JA}
Thermal Impedance θ_{JA}
TSSOP (RU-16) . . . . . 150.4°C/W
Lead Temperature (Soldering 10s) . . . . . 300°C
IR Reflow, Peak Temperature (< 20 sec) . . . . . 235°C

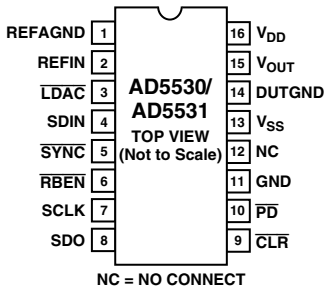
*Stresses above those listed under Absolute Maximum Ratings may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions above those listed in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

ORDERING GUIDE

Model	Temperature Range	Resolution	INL (LSBs)	DNL(LSBs)	Package Option*
AD5530BRU	–40°C to +85 °C	12	±1	±1	RU-16
AD5531BRU	–40°C to +85 °C	14	±2	±1	RU-16

*RU = Thin Shrink Small Outline Package.

PIN CONFIGURATION



CAUTION

ESD (electrostatic discharge) sensitive device. Electrostatic charges as high as 4000 V readily accumulate on the human body and test equipment and can discharge without detection. Although the AD5530/AD5531 features proprietary ESD protection circuitry, permanent damage may occur on devices subjected to high-energy electrostatic discharges. Therefore, proper ESD precautions are recommended to avoid performance degradation or loss of functionality.



PIN FUNCTION DESCRIPTIONS

Pin	Mnemonic	Function
1	REFAGND	For bipolar ±10 V output range, this pin should be tied to 0 V.
2	REFIN	This is the voltage reference input for the DAC. Connect to external +5 V reference for specified bipolar ±10 V output.
3	$\overline{\text{LDAC}}$	Load DAC logic input (active low). When taken low, the contents of the shift register are transferred to the DAC register. $\overline{\text{LDAC}}$ may be tied permanently low enabling the outputs to be updated on the rising edge of $\overline{\text{SYNC}}$.
4	SDIN	Serial data input. This device accepts 16-bit words. Data is clocked into the input register on the falling edge of SCLK.
5	$\overline{\text{SYNC}}$	Active low control input. Data is clocked into the shift requester on the falling edges of SCLK.
6	$\overline{\text{RBEN}}$	Active low readback enable function. This function allows the contents of the DAC register to be read. Data from the DAC register will be shifted out on SDO pin on each rising edge of SCLK.
7	SCLK	Clock input. Data is clocked into the input register on the falling edge of SCLK.
8	SDO	Serial data out. This pin is used to clock out the serial data previously written to the input shift register or may be used in conjunction with $\overline{\text{RBEN}}$ to read back the data from the DAC register. This is an open drain output; it should be pulled high with an external pull-up resistor. In standalone mode, SDO should be tied to GND or left high impedance.
9	$\overline{\text{CLR}}$	Level sensitive, active low input. A falling edge of $\overline{\text{CLR}}$ resets V_{OUT} to DUTGND. The contents of the registers are untouched.
10	$\overline{\text{PD}}$	This allows the DAC to be put into a power-down state.
11	GND	Ground reference
12	NC	Do not connect anything to this pin.
13	V_{SS}	Negative analog supply voltage, –12 V ±10% or –15 V ±10% for specified performance.
14	DUTGND	V_{OUT} is referenced to the voltage applied to this pin.
15	V_{OUT}	DAC output
16	V_{DD}	Positive analog supply voltage, +12 V ±10% or +15 V ±10% for specified performance.

TERMINOLOGY

Relative Accuracy
Relative accuracy or endpoint linearity is a measure of the maximum deviation, in LSBs, from a straight line passing through the endpoints of the DAC transfer function.

Differential Nonlinearity
Differential nonlinearity is the difference between the measured change and the ideal 1 LSB change between any two adjacent codes. A specified differential nonlinearity of ±1 LSB maximum ensures monotonicity.

Zero-Scale Error
Zero-scale error is a measure of the output error when all 0s are loaded to the DAC latch.

Full-Scale Error
This is the error in DAC output voltage when all 1s are loaded into the DAC latch. Ideally the output voltage, with all 1s loaded into the DAC latch, should be 2 V_{REF} – 1 LSB.

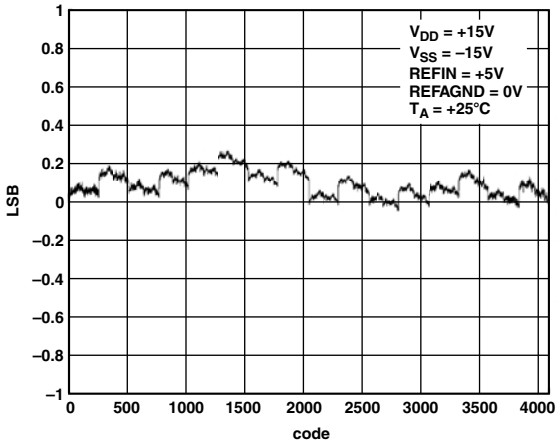
Gain Error
Gain error is the difference between the actual and ideal analog output range, expressed as a percent of the full-scale range. It is the deviation in slope of the DAC transfer characteristic from ideal.

Output Voltage Settling Time
This is the amount of time it takes for the output to settle to a specified level for a full-scale input change.

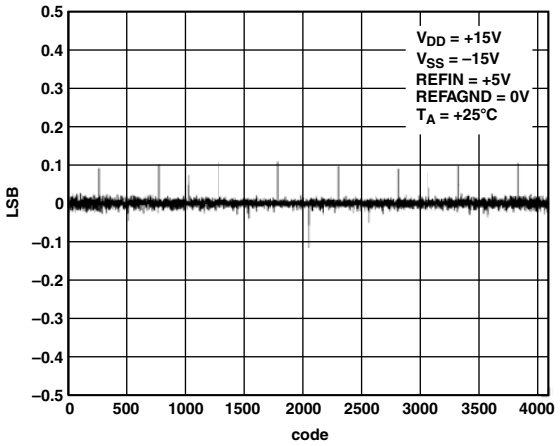
Digital-to-Analog Glitch Impulse
Digital-to-analog glitch impulse is the impulse injected into the analog output when the input code in the DAC register changes state. It is specified as the area of the glitch in nV-s and is measured when the digital input code is changed by 1 LSB at the major carry transition.

Digital Feedthrough
Digital feedthrough is a measure of the impulse injected into the analog output of the DAC from the digital inputs of the DAC, but is measured when the DAC output is not updated. It is specified in nV-s and is measured with a full-scale code change on the data bus, i.e., from all 0s to all 1s and vice versa.

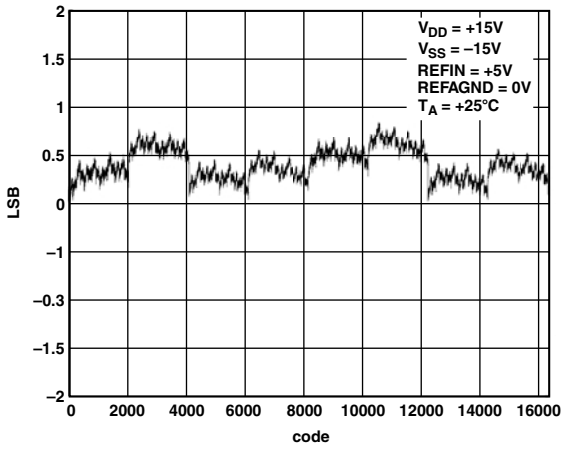
AD5530/AD5531–Typical Performance Characteristics



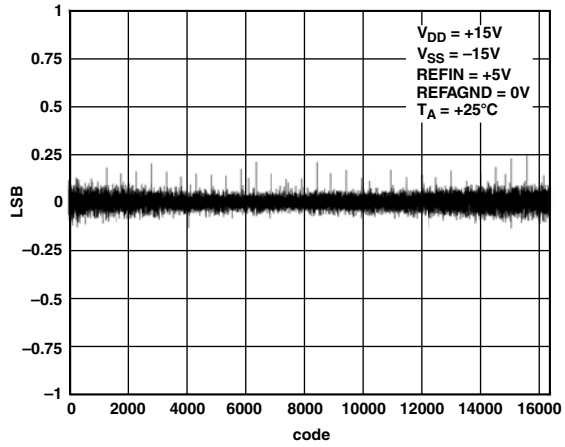
TPC 1. AD5530 Typical INL Plot



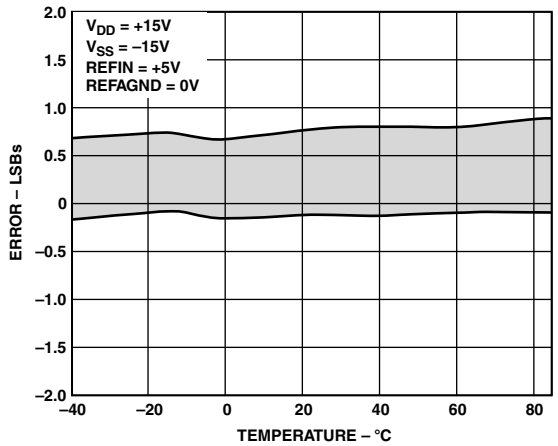
TPC 2. AD5530 Typical DNL Plot



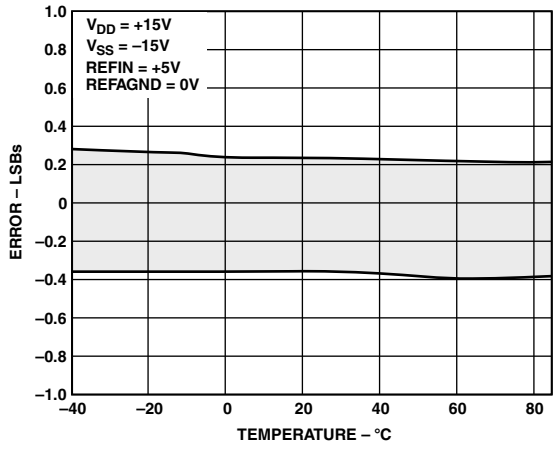
TPC 3. AD5531 Typical INL Plot



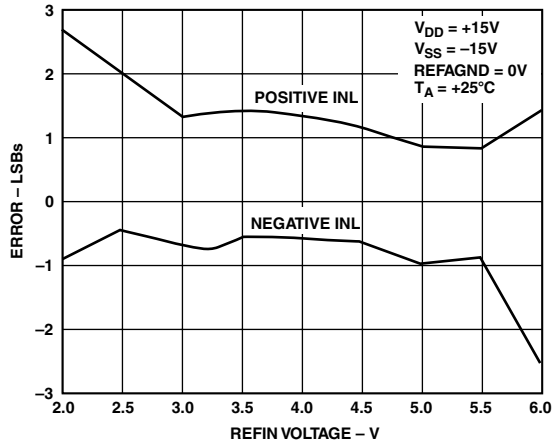
TPC 4. AD5531 Typical DNL Plot



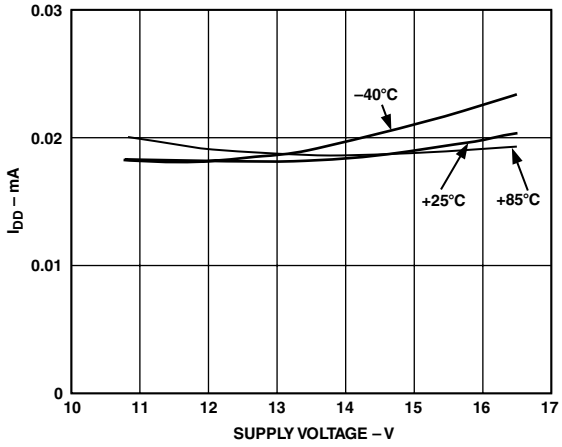
TPC 5. AD5531 Typical INL Error vs. Temperature



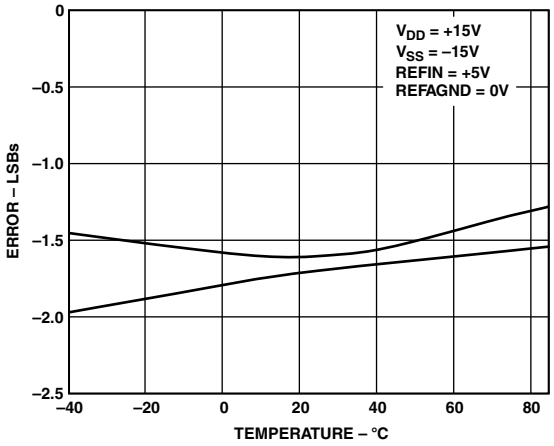
TPC 6. AD5531 Typical DNL Error vs. Temperature



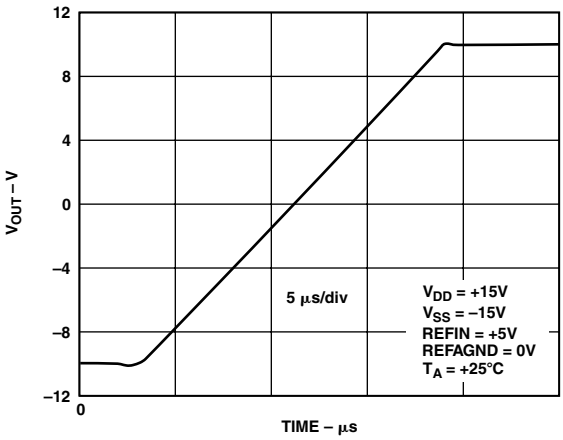
TPC 7. AD5531 Typical INL Error vs. Reference Voltage



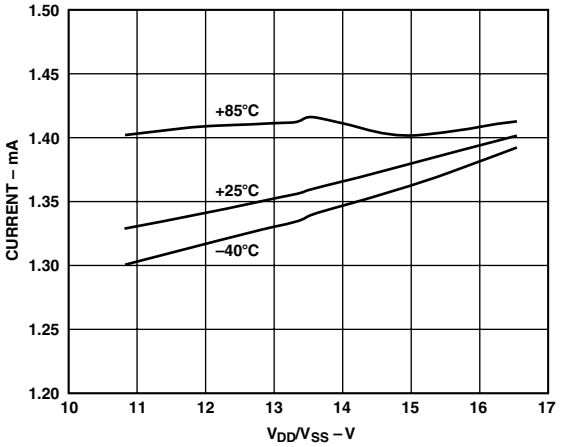
TPC 10. I_{DD} in Power-Down vs. Supply



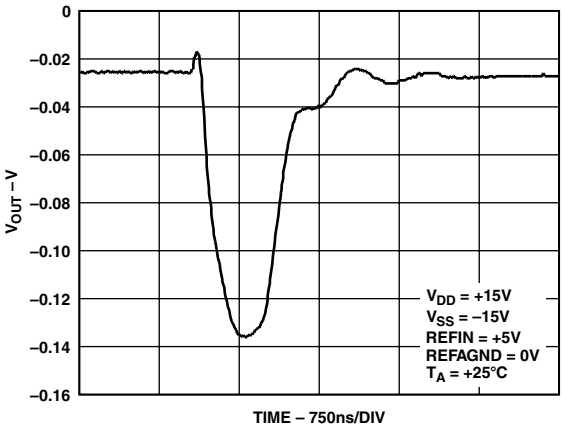
TPC 8. Typical Full-Scale and Offset Error vs. Temperature



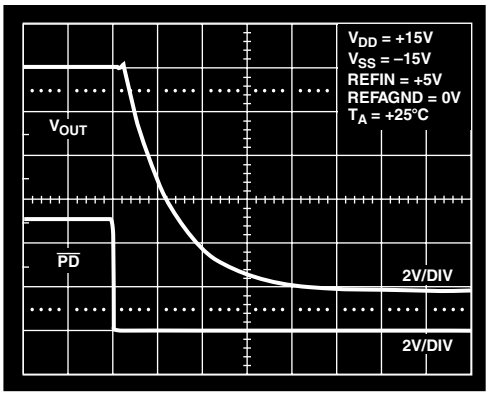
TPC 11. Settling Time



TPC 9. I_{DD} vs. V_{DD}/V_{SS}



TPC 12. Typical Digital-to-Analog Glitch Impulse



TPC 13. Typical Power-Down Time

GENERAL DESCRIPTION

DAC Architecture

The AD5530/AD5531 are pin-compatible 12-/14-bit DACs. The AD5530 consists of a straight 12-bit R-2R voltage mode DAC, while the AD5531 consists of a 14-bit R-2R section. Using a +5 V reference connected to the REFIN pin and REFAGND tied to 0 V, a bipolar ±10 V voltage output results. The DAC coding is straight binary.

Serial Interface

Serial data on the SDIN input is loaded to the input register under the control of SCLK, $\overline{\text{SYNC}}$, and $\overline{\text{LDAC}}$. A write operation transfers a 16-bit word to the AD5530/AD5531. Figures 1 and 2 show the timing diagrams. Figure 3 shows the contents of the input shift register. Twelve or 14 bits of the serial word are data bits; the rest are don't cares.

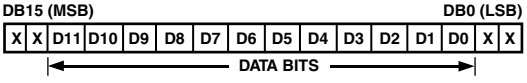


Figure 3a. AD5530 Input Shift Register Contents

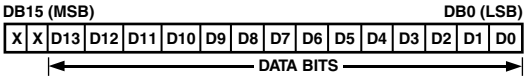


Figure 3b. AD5531 Input Shift Register Contents

The serial word is framed by the signal, $\overline{\text{SYNC}}$. After a high to low transition on $\overline{\text{SYNC}}$, data is latched into the input shift register on the falling edges of SCLK. There are two ways in which the DAC register and output may be updated. The $\overline{\text{LDAC}}$ signal is examined on the falling edge of $\overline{\text{SYNC}}$; depending on its status, either a synchronous or asynchronous update is selected. If $\overline{\text{LDAC}}$ is low, then the DAC register and output are updated on the low to high transition of $\overline{\text{SYNC}}$. Alternatively, if $\overline{\text{LDAC}}$ is high upon sampling, the DAC register is not loaded with the new data on a rising edge of $\overline{\text{SYNC}}$. The contents of the DAC register and the output voltage will be updated by bringing $\overline{\text{LDAC}}$ low any time after the 16-bit data transfer is complete. $\overline{\text{LDAC}}$ may be tied permanently low if required. A simplified diagram of the input loading circuitry is illustrated in Figure 4.

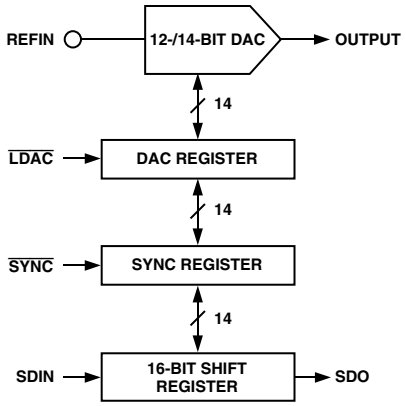


Figure 4. Simplified Serial Interface

Data written to the part via SDIN is available on the SDO pin 16 clocks later if the readback function is not used. SDO data is clocked out on the falling edge of the serial clock with some delay.

$\overline{\text{PD}}$ Function

The $\overline{\text{PD}}$ pin allows the user to place the device into power-down mode. While in this mode, power consumption is at a minimum; the device draws only 50μA of current. The $\overline{\text{PD}}$ function does not affect the contents of the DAC register.

READBACK Function

The AD5530/AD5531 allows the data contained in the DAC register to be read back if required. The pins involved are the $\overline{\text{RBEN}}$ and SDO (serial data out). When $\overline{\text{RBEN}}$ is taken low, on the next falling edge of SCLK, the contents of the DAC register are transferred to the shift register. $\overline{\text{RBEN}}$ may be used to frame the readback data by leaving it low for 16 clock cycles, or it may be asserted high after the required hold time. The shift register contains the DAC register data and this is shifted out on the SDO line on each falling edge of SCLK with some delay. This ensures the data on the serial data output pin is valid for the falling edge of the receiving part. The two MSBs of the 16-bit word will be '0's.

$\overline{\text{CLR}}$ Function

The falling edge of $\overline{\text{CLR}}$ causes V_{OUT} to be reset to the same potential as DUTGND. The contents of the registers remain unchanged, so the user can reload the previous data with $\overline{\text{LDAC}}$ after $\overline{\text{CLR}}$ is asserted high. Alternatively, if $\overline{\text{LDAC}}$ is tied low, the output will be loaded with the contents of the DAC register automatically after $\overline{\text{CLR}}$ is brought high.

Output Voltage

The DAC transfer function is as follows:

$$V_{OUT} = 2\left[2 \times \left(REFIN - REFAGND \times \frac{D}{2^N}\right) + 2 \times REFAGND - REFIN\right] - DUTGND$$

where:
D is the decimal data word loaded to the DAC register,
N is the resolution of the DAC.

Bipolar Configuration

Figure 5 shows the AD5530/AD5531 in a bipolar circuit configuration. REFIN is driven by the AD586, 5 V reference, while the REFAGND and DUTGND pins are tied to GND. This results in a bipolar output voltage ranging from –10 V to +10 V. Resistor R1 is provided (if required) for gain adjust. Figure 6 shows the transfer function of the DAC when REFAGND is tied to 0 V.

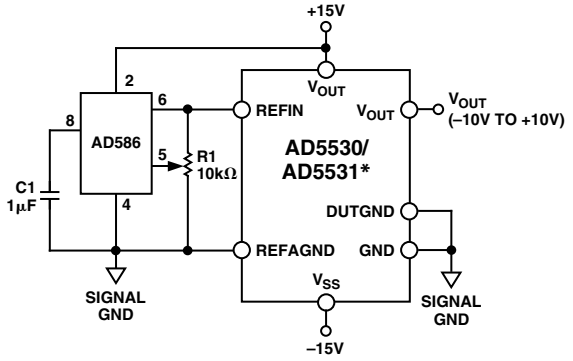


Figure 5. Bipolar ±10 V Operation

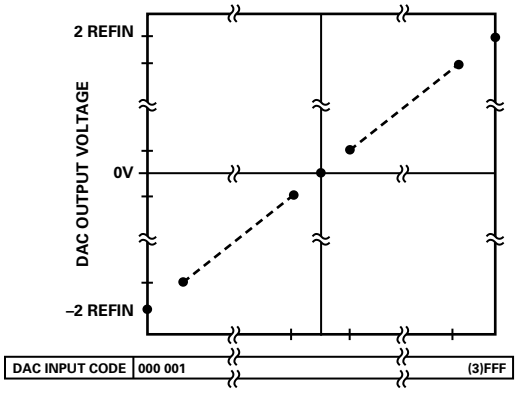


Figure 6. Output Voltage vs. DAC Input Codes (Hex)

MICROPROCESSOR INTERFACING

Microprocessor interfacing to the AD5530/AD5531 is via a serial bus that uses standard protocol compatible with microcontrollers and DSP processors. The communications channel is a 3-wire (minimum) interface consisting of a clock signal, a data signal, and a synchronization signal. The AD5530/AD5531 requires a 16-bit data word with data valid on the falling edge of SCLK.

For all the interfaces, the DAC output update may be done automatically when all the data is clocked in or asynchronously under the control of $\overline{\text{LDAC}}$.

The contents of the DAC register may be read using the readback function. $\overline{\text{RBEN}}$ is used to frame the readback data, which is clocked out on SDO. The following figures illustrate these DACs interfacing with a simple 4-wire interface. The serial interface of the AD5530/AD5531 may be operated from a minimum of three wires.

AD5530/AD5531 to ADSP-21xx

An interface between the AD5530/AD5531 and the ADSP-21xx is shown in Figure 7. In the interface example shown, SPORT0 is used to transfer data to the DAC. The SPORT control register should be configured as follows: internal clock operation, alternate framing mode; active low framing signal.

Transmission is initiated by writing a word to the Tx register after the SPORT has been enabled. As the data is clocked out of the DSP on the rising edge of SCLK, no glue logic is required to interface the DSP to the DAC. In the interface shown, the DAC output is updated using the $\overline{\text{LDAC}}$ pin via the DSP. Alternatively, the $\overline{\text{LDAC}}$ input could be tied permanently low and then the update takes place automatically when TFS is taken high.

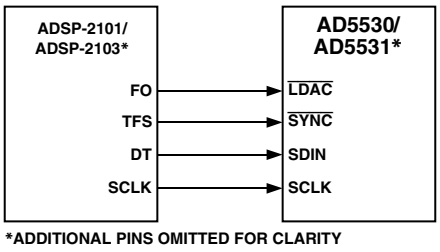


Figure 7. AD5530/AD5531 to ADSP-21xx Interface

AD5530/AD5531 to 8051 Interface

A serial interface between the AD5530/AD5531 and the 8051 is shown in Figure 8. TXD of the 8051 drives SCLK of the AD5530/AD5531, while RXD drives the serial data line, SDIN. P3.3 and P3.4 are bit-programmable pins on the serial port and are used to drive $\overline{\text{SYNC}}$ and $\overline{\text{LDAC}}$ respectively.

The 8051 provides the LSB of its SBUF register as the first bit in the data stream. The user will have to ensure that the data in the SBUF register is arranged correctly as the DAC expects MSB first.

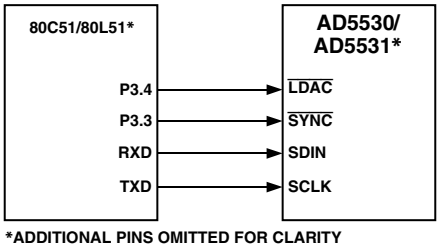


Figure 8. AD5530/AD5531 to 8051 Interface

When data is to be transmitted to the DAC, P3.3 is taken low. Data on RXD is clocked out of the microcontroller on the rising edge of TXD and is valid on the falling edge. As a result no glue logic is required between this DAC and microcontroller interface.

The 8051 transmits data in 8-bit bytes with only eight falling clock edges occurring in the transmit cycle. As the DAC expects a 16-bit word, P3.3 must be left low after the first 8 bits are transferred. After the second byte has been transferred, the P3.3 line is taken high. The DAC may be updated using $\overline{\text{LDAC}}$ via P3.4 of the 8051.

AD5530/AD5531 to MC68HC11 Interface

Figure 9 shows an example of a serial interface between the AD5530/AD5531 and the MC68HC11 microcontroller. SCK of the 68HC11 drives the SCLK of the DAC, while the MOSI output drives the serial data lines, SDIN. $\overline{\text{SYNC}}$ is driven from one of the port lines, in this case PC7.

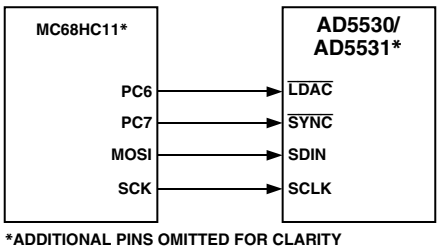


Figure 9. AD5530/AD5531 to MC68HC11 Interface

The 68HC11 is configured for master mode, MSTR= 1, CPOL = 0, and CPHA = 1. When data is transferred to the part, PC7 is taken low and data is transmitted MSB first. Data appearing on the MOSI output is valid on the falling edge of SCK. Eight falling clock edges occur in the transmit cycle, so in order to load the required 16-bit word, PC7 is not brought high until the second 8-bit word has been transferred to the DAC's input shift register.

$\overline{\text{LDAC}}$ is controlled by the PC6 port output. The DAC can be updated after each 2-byte transfer by bringing $\overline{\text{LDAC}}$ low. This example does not show other serial lines for the DAC. If $\overline{\text{CLR}}$ were used, it could be controlled by port output PC5. In order to read data back from the DAC register, the SDO line could be connected to MISO of the MC68HC11, with $\overline{\text{RBEN}}$ tied to another port output controlling and framing the readback data transfer.

APPLICATIONS

Optocoupler Interface

In many process control applications, it is necessary to provide an isolation barrier between the controller and the unit being controlled. Opto-isolators can provide voltage isolation in excess of 3 kV. The serial loading structure of the AD5530/AD5531 makes it ideal for opto-isolated interfaces as the number of interface lines is kept to a minimum. Figure 10 shows a 4- channel isolated interface to the AD5530/AD5531. To reduce the number of opto-isolators, if simultaneous updating is not required, then the $\overline{\text{LDAC}}$ pin may be tied permanently low.

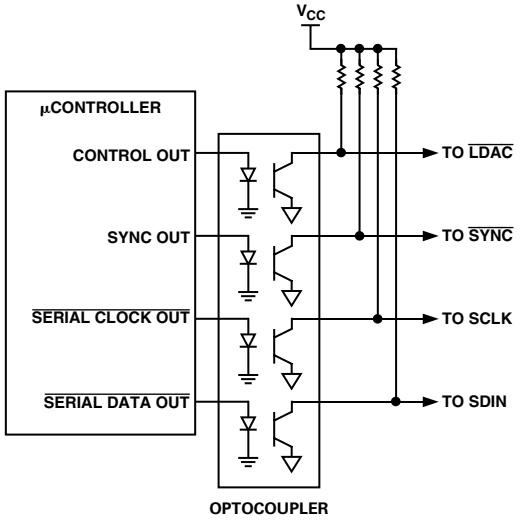


Figure 10. Opto-Isolated Interface

Serial Interface to Multiple AD5530s or AD5531s

Figure 11 shows how the $\overline{\text{SYNC}}$ pin is used to address multiple AD5530/AD5531s. All devices receive the same serial clock and serial data, but only one device will receive the $\overline{\text{SYNC}}$ signal at any one time. The DAC addressed will be determined by the decoder. There will be some feedthrough from the digital input lines, the effects of which can be minimized by using a burst clock.

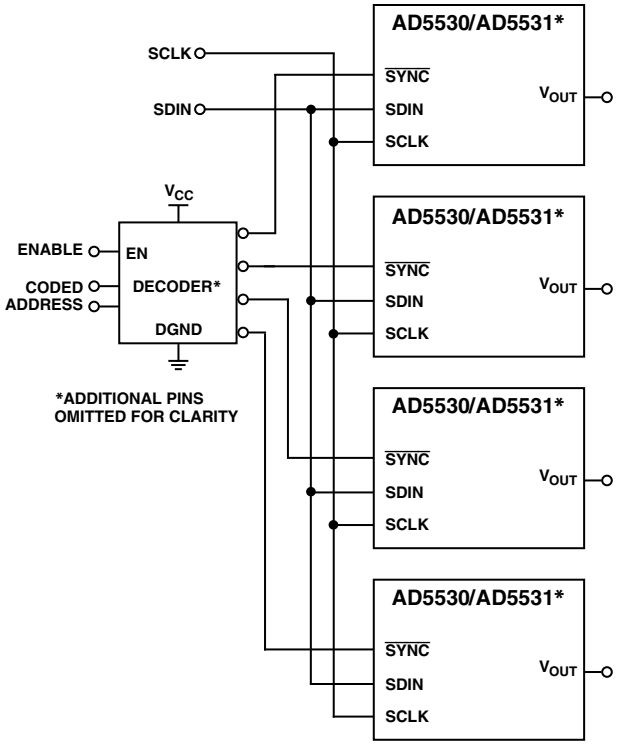


Figure 11. Addressing Multiple AD5530/AD5531s

Daisy-Chaining Interface with Multiple AD5530s or AD5531s

A number of these DAC parts may be daisy-chained together using the SDO pin. Figure 12 illustrates such a configuration.

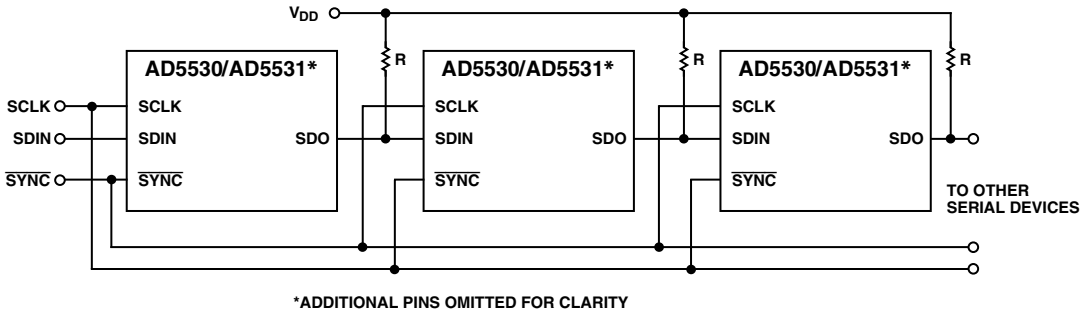
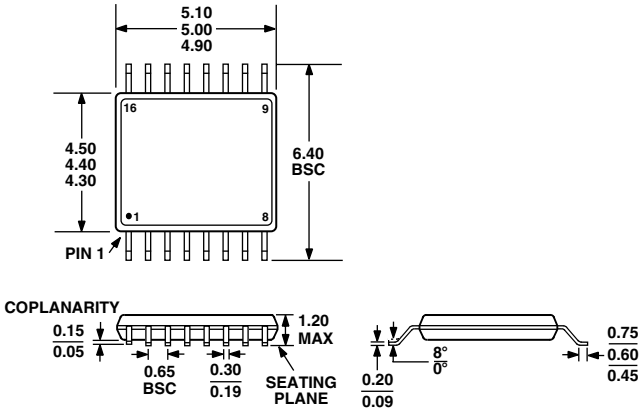


Figure 12. Daisy-Chaining Multiple AD5530/AD5531s

OUTLINE DIMENSIONS

Dimensions shown in millimeters

16-Lead Thin Shrink SO Package (TSSOP)
(RU-16)



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