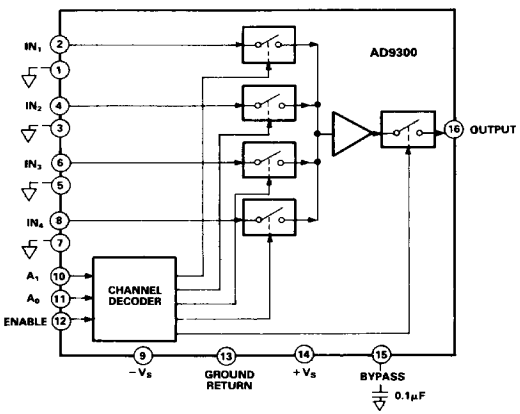
4 × 1 Wideband Video Multiplexer

AD9300

FEATURES
34MHz Full Power Bandwidth
±0.1dB Gain Flatness to 8MHz
72dB Crosstalk Rejection @ 10MHz
0.03°/0.01% Differential Phase/Gain
Cascadable for Switch Matrices
MIL-STD-883 Compliant Versions Available

APPLICATIONS
Video Routing
Medical Imaging
Electro-Optics
ECM Systems
Radar Systems
Data Acquisition

FUNCTIONAL BLOCK DIAGRAM
(Based on Cerdip)



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GENERAL DESCRIPTION

The AD9300 is a monolithic high-speed video signal multiplexer useable in a wide variety of applications.

Its four channels of video input signals can be randomly switched at megahertz rates to the single output. In addition, multiple devices can be configured in either parallel or cascade arrangements to form switch matrices. This flexibility in using the AD9300 is possible because the output of the device is in a high-impedance state when the chip is not enabled; when the chip is enabled, the unit acts as a buffer with a high input impedance and low output impedance.

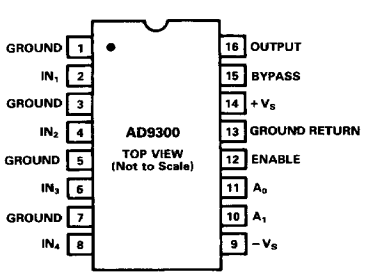
An advanced bipolar process provides fast, wideband switching capabilities while maintaining crosstalk rejection of 72dB at 10MHz. Full power bandwidth is a minimum 27MHz. The device can be operated from ±10V to ±15V power supplies.

The AD9300K is available in a 16-pin ceramic DIP and a 20-pin PLCC and is designed to operate over the commercial temperature range of 0 to +70°C. The AD9300TQ is a hermetic 16-pin ceramic DIP for military temperature range (−55°C to +125°C) applications. This part is also available processed to MIL-STD-883. The AD9300 is available in a 20-pin LCC as the model AD9300TE, which operates over a temperature range of −55°C to +125°C.

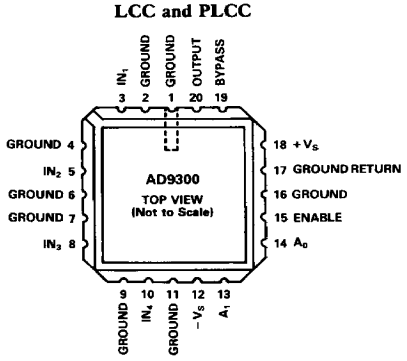
The AD9300 Video Multiplexer is available in versions compliant with MIL-STD-883. Refer to the Analog Devices *Military Products Databook* or current AD9300/883B data sheet for detailed specifications.

PIN DESIGNATIONS

DIP



LCC and PLCC



(PLCC PINOUTS SAME AS LCC)

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AD9300—SPECIFICATIONS

ELECTRICAL CHARACTERISTICS ($\pm V_S = \pm 12V \pm 5\%$; $C_L = 10pF$; $R_L = 2k\Omega$, unless otherwise noted)

Parameter (Conditions)	Temp	Test Level	COMMERCIAL 0°C to +70°C AD9300KQ/KP Min	Typ	Max	Units
INPUT CHARACTERISTICS						
Input Offset Voltage	+25°C	I		3	10	mV
Input Offset Voltage	Full	VI			14	mV
Input Offset Voltage Drift[2]	Full	V		75		µV/°C
Input Bias Current	+25°C	I		15	37	µA
Input Bias Current	Full	VI			55	µA
Input Resistance	+25°C	V		3.0		MΩ
Input Capacitance	+25°C	V		2		pF
Input Noise Voltage (dc to 8MHz)	+25°C	V		16		µV rms
TRANSFER CHARACTERISTICS						
Voltage Gain[3]	+25°C	I	0.990	0.994		V/V
Voltage Gain[3]	Full	VI	0.985			V/V
DC Linearity[4]	+25°C	V		0.01		%
Gain Tolerance ($V_{IN} = \pm 1V$)						
dc to 5MHz	+25°C	I		0.05	0.1	dB
5MHz to 8MHz	+25°C	I		0.1	0.3	dB
Small-Signal Bandwidth (V_{IN} = 100mV p-p)	+25°C	V		350		MHz
Full Power Bandwidth[5] (V_{IN} = 2V p-p)	+25°C	I	27	34		MHz
Output Swing	Full	VI	±2			V
Output Current (Sinking @ = 25°C)	+25°C	V		5		mA
Output Resistance	+25°C	IV, V		9	15	Ω
DYNAMIC CHARACTERISTICS						
Slew Rate[6]	+25°C	I	170	215		V/µs
Settling Time (to 0.1% on ±2V Output)	+25°C	IV		70	100	ns
Overshoot						
To T-Step[7]	+25°C	V		<0.1		%
To Pulse[8]	+25°C	V		<10		%
Differential Phase[9]	+25°C	IV		0.03	0.1	°
Differential Gain[9]	+25°C	IV		0.01	0.1	%
Crosstalk Rejection						
Three Channels[10]	+25°C	IV	68	72		dB
One Channel[11]	+25°C	IV	70	76		dB
SWITCHING CHARACTERISTICS[12]						
A_X Input to Channel HIGH Time[13] (t_{HIGH})	+25°C	I		40	50	ns
A_X Input to Channel LOW Time[14] (t_{LOW})	+25°C	I		35	45	ns
Enable to Channel ON Time[15] (t_{ON})	+25°C	I		35	45	ns
Enable to Channel OFF Time[16] (t_{OFF})	+25°C	I		35	45	ns
Switching Transient[17]	+25°C	V		60		mV

EXPLANATION OF TEST LEVELS

Test Level I – 100% production tested.
Test Level II – 100% production tested at + 25°C, and sample tested at specified temperatures.
Test Level III – Sample tested only.
Test Level IV – Parameter is guaranteed by design and characterization testing.
Test Level V – Parameter is a typical value only.
Test Level VI – All devices are 100% production tested at + 25°C. 100% production tested at temperature extremes for military temperature devices; sample tested at temperature extremes for commercial/industrial devices.

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Parameter (Conditions)	Temp	Test Level	COMMERCIAL 0°C to +70°C AD9300KQ/KP Min	Typ	Max	Units
DIGITAL INPUTS						
Logic "1" Voltage	Full	VI	2			V
Logic "0" Voltage	Full	VI			0.8	V
Logic "1" Current	Full	VI			5	μA
Logic "0" Current	Full	VI			1	μA
POWER SUPPLY						
Positive Supply Current (+12V)	+25°C	I		13	16	mA
Positive Supply Current (+12V)	Full	VI		13	16	mA
Negative Supply Current (−12V)	+25°C	I		12.5	15	mA
Negative Supply Current (−12V)	Full	VI		12.5	16	mA
Power Supply Rejection Ratio ($\pm V_S = \pm 12V \pm 5\%$)	Full	VI	67	75		dB
Power Dissipation (±12V)[18]	+25°C	V		306		mW

NOTES
[1]Permanent damage may occur if any one absolute maximum rating is exceeded. Functional operation is not implied, and device reliability may be impaired by exposure to higher-than-recommended voltages for extended periods of time.
[2]Measured at extremes of temperature range.
[3]Measured as slope of V_{OUT} versus V_{IN} with $V_{IN} = \pm 1V$.
[4]Measured as worst deviation from end-point fit with $V_{IN} = \pm 1V$.
[5]Full Power Bandwith (FPBW) based on Slew Rate (SR). FPBW = $SR/2\pi V_{PEAK}$
[6]Measured between 20% and 80% transition points of ±1V output.
[7]T-Step = Sin^2X Step, when Step between 0V and +700mV points has 10%-to-90% risetime = 125ns.
[8]Measured with a pulse input having slew rate >250V/μs.
[9]Measured at output between 0.28Vdc and 1.0Vdc with V_{IN} = 284mV p–p at 3.58MHz and 4.43MHz.
[10]This specification is critically dependent on circuit layout. Value shown is measured with selected channel grounded and 10MHz 2V p–p signal applied to remaining three channels. If selected channel is grounded through 75Ω, value is approximately 6dB higher.
[11]This specification is critically dependent on circuit layout. Value shown is measured with selected channel grounded and 10MHz 2V p–p signal applied to one other channel. If selected channel is grounded through 75Ω, value is approximately 6dB higher. Minimum specification in ( ) applies to DIPs.
[12]Consult system timing diagram.
[13]Measured from address change to 90% point of −2V to +2V output LOW-to-HIGH transition.
[14]Measured from address change to 90% point of +2V to −2V output HIGH-to-LOW transition.
[15]Measured from 50% transition point of ENABLE input to 90% transition of 0V to −2V and 0V to +2V output.
[16]Measured from 50% transition point of ENABLE input to 10% transition of +2V to 0V and −2V to 0V output.
[17]Measured while switching between two grounded channels.
[18]Maximum power dissipation is a package-dependent parameter related to the following typical thermal impedances:
16-Pin Ceramic θ_{JA} = 87°C/W; θ_{JC} = 25°C/W
20-Pin LCC θ_{JA} = 74°C/W; θ_{JC} = 10°C/W
20-Pin PLCC θ_{JA} = 71°C/W; θ_{JC} = 26°C/W

Specifications subject to change without notice.

ABSOLUTE MAXIMUM RATINGS[1]

Supply Voltages ($\pm V_S$) . . . . . ±16V
Analog Input Voltage Each Input (IN_1 thru IN_4) . . . . . ±3.5V
Differential Voltage Between Any Two Inputs (IN_1 thru IN_4) 5V
Digital Input Voltages (A_0, A_1, ENABLE) . −0.5V to +5.5V
Output Current
Sinking 6.0mA
Sourcing 6.0mA
Operating Temperature Range
AD9300KQ/KP . . . . . 0°C to +70°C
Storage Temperature Range . . . . . −65°C to +150°C
Junction Temperature . . . . . +175°C
Lead Soldering (10sec) . . . . . +300°C

ORDERING GUIDE

Device	Temperature Range	Description	Package Option[1]
AD9300KQ	0 to +70°C	16-Pin Cerdip, Commercial	Q-16
AD9300TE/883B[2]	−55°C to +125°C	20-Pin LCC, Military Temperature	E-20A
AD9300TQ/883B[2]	−55°C to +125°C	16-Pin Cerdip, Military Temperature	Q-16
AD9300KP	0 to +70°C	20-Pin PLCC, Commercial	P-20A

NOTES
[1]E = Ceramic Leadless Chip Carrier; P = Plastic Leaded Chip Carrier; Q = Cerdip. For outline information see Package Information section.
[2]For specifications, refer to Analog Devices *Military Products Databook*.

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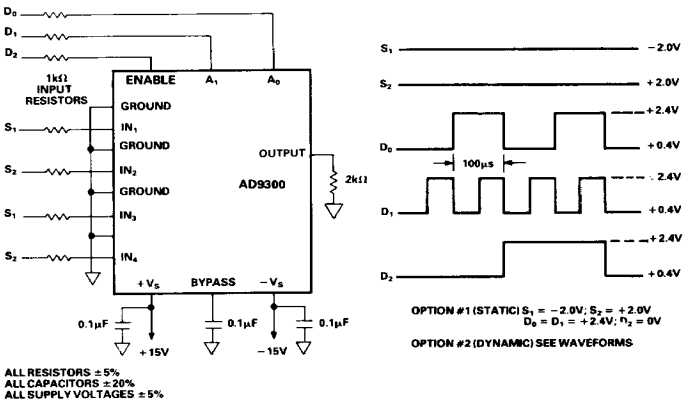
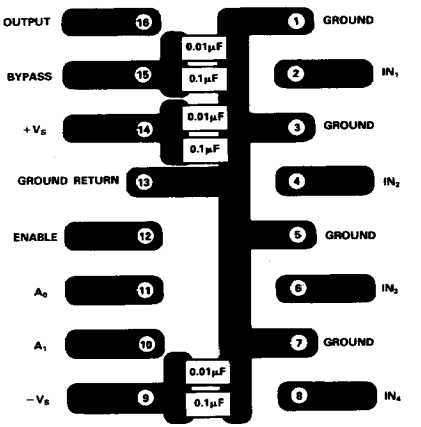
AD9300 BURN-IN DIAGRAM

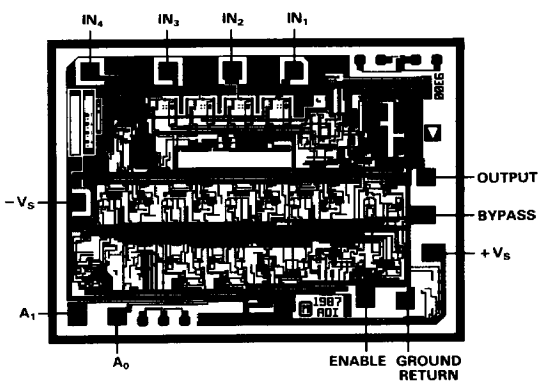


SUGGESTED LAYOUT OF AD9300 PC BOARD



Suggested Layout of AD9300 PC Board
(Bottom View – Not to Scale)
Component Side Should be Ground Plane

METALIZATION PHOTOGRAPH



MECHANICAL INFORMATION

Die Dimensions	84 × 104 × 18 (max) mils
Pad Dimensions	4 × 4 (min) mils
Metalization	Aluminum
Backing	None
Substrate Potential	$-V_S$
Passivation	Oxynitride
Die Attach	Gold Eutectic
Bond Wire	1.25 mil, Aluminum; Ultrasonic Bonding or 1 mil, Gold; Gold Ball Bonding

FUNCTIONAL DESCRIPTION

$IN_1 - IN_4$	Four analog input channels.
GROUND	Analog input shielding grounds, not internally connected. Connect each to external low-impedance ground as close to device as possible.
A_0	One of two TTL decode control lines required for channel selection. See Logic Truth Table.
A_1	One of two TTL decode control lines required for channel selection. See Logic Truth Table.
ENABLE	TTL-compatible chip enable. In enabled mode (logic HIGH), output signal tracks selected input channel; in disabled mode (logic LOW), output is high impedance and no signal appears at output.
$-V_S$	Negative supply voltage; nominally − 10V dc to − 15V dc.
$+V_S$	Positive supply voltage; nominally + 10V dc to + 15V dc.
OUTPUT	Analog output. Tracks selected input channel when enabled.
BYPASS	Bypass terminal for internal bias line; must be decoupled externally to ground through 0.1μF capacitor.
GROUND RETURN	Analog signal and power supply ground return.

LOGIC TRUTH TABLE

ENABLE	A_1	A_0	OUTPUT
0	X	X	High Z
1	0	0	IN_1
1	0	1	IN_2
1	1	0	IN_3
1	1	1	IN_4

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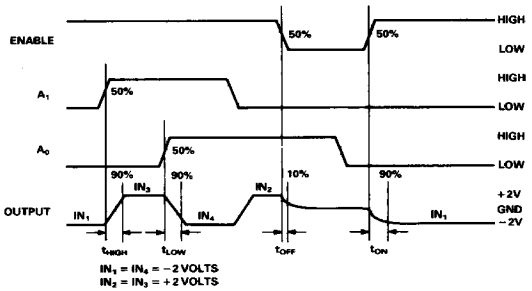

AD9300 Timing

THEORY OF OPERATION

Refer to the functional block diagram of the AD9300.

As shown on the drawing, this diagram is based on the pinouts of the DIP packaging of the models AD9300KQ and AD9300TQ. The AD9300KP and AD9300TE are packaged in 20-pin surface mount packages. The extra pins are used for ground connections; the theory of operation remains the same.

The AD9300 Video Multiplexer allows the user to connect any one of four analog input channels (IN_1 – IN_4) to the output of the device, and to switch between channels at megahertz rates.

The input channel which is connected to the output is determined by a 2-bit TTL digital code applied to A_0 and A_1. The selected input will not appear at the output unless a digital "1" is also applied to the ENABLE input pin; unless the output is enabled, it is a high impedance. Necessary combinations to accomplish channel selection are shown in the Logic Truth Table.

Bipolar construction used in the AD9300 insures that the input impedance of the device remains high, and will not vary with power supply voltages. This characteristic makes the AD9300, in effect, a switchable-input buffer. An on-board bias network makes the performance of the AD9300 independent of applied supply voltages, which can have any nominal value from ± 10V dc to ± 15V dc.

Although the primary application for the AD9300 is the routing of video signals, the harmonic and dynamic attributes of the device make it appropriate for other applications. The AD9300 has exceptional performance when switching video signals, but can also be used for switching other analog signals requiring greater dynamic range and/or precision than those in video.

As shown in Figure 1, Input and Output Equivalent Circuits, each analog input is connected to the base of a bipolar transistor. If Channel 1 is selected, a current switch is closed and routes current through the input transistor for Channel 1.

If Channel 2 is then selected by the digital inputs, the current switch for Channel 1 is opened and the current switch for Channel 2 is closed. This causes current to be routed away from the Channel 1 transistor and into the Channel 2 input transistor. Whenever a channel's input device is carrying current, the analog input applied to that channel is passed to the output stage.

The operation of the output stage is similar to that of the input stages. Whenever the output stage is enabled with a HIGH digital "1" signal at the ENABLE pin, the output transistor will carry current and pass the selected analog input.

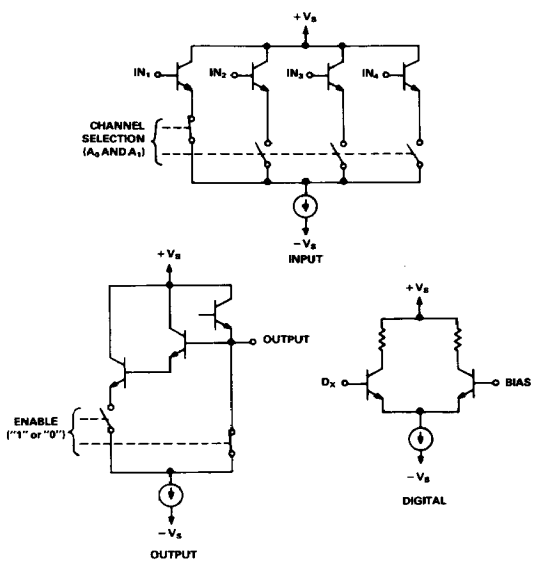

Figure 1. Input and Output Equivalent Circuits

When the output stage is disabled (by virtue of the ENABLE pin being driven LOW with a digital "0"), the output current switch is opened. This routes the current to other circuits within the AD9300 which keep the output transistor biased "off". These circuits require approximately 1μA of bias current from the load connected to the output of the multiplexer. In the absence of a terminating load and the resulting dc bias, the output of the AD9300 "floats" at −2.5V.

In summary, when the AD9300 is enabled by the ENABLE pin being driven HIGH with a digital "1", the selected analog input channel acts as a buffer for the input; and the output of the multiplexer is a low impedance. When the AD9300 is disabled with a digital "0" LOW signal, the selected channel acts as an open switch for the input; and the output of the unit becomes a high impedance. This characteristic allows the user to wire-or several AD9300 Analog Multiplexers together to form switch matrices.

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AD9300 APPLICATIONS

To ensure optimum performance from circuits using the AD9300, it is important to follow a few basic rules which apply to all high-speed devices.

A large, low-impedance ground plane under the AD9300 is critical. Generally, GROUND and GROUND RETURN connections should be connected solidly to this plane. GROUND pin connections are signal isolation grounds which are not connected internally; they can be left unconnected, but there may be some degradation in crosstalk rejection. GROUND RETURN, on the other hand, serves as the internal ground reference for the AD9300 and should be connected to the ground plane *without exception.*

The output stage of the unit is capable of driving a 2kΩ||10pF load. Larger capacative loads may limit full power bandwidth and increase t_{OFF} (the interval between the 50% point of the ENABLE high-to-low transition and the instant the output becomes a high impedance.)

For applications such as driving cables (See Figure 2), output buffers are recommended.

It is recommended that the AD9300 be soldered directly into circuit boards, rather than using socket assemblies. If sockets must be used, individual pin sockets are the preferred choice, rather than a socket assembly. A second requirement for proper high-speed design involves decoupling the power supply and internal bias supply lines from ground to improve noise immunity. Chip capacitors are recommended for connecting 0.1μF and 0.01μF capacitors between ground and the $\pm V_S$ supplies (Pins 9 and 14), and the BYPASS connection (Pin 15).

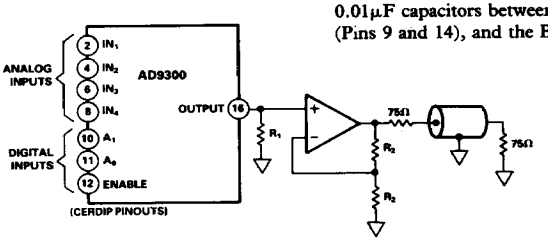

Figure 2. 4×1 AD9300 Multiplexer with Buffered Output Driving 75Ω Coaxial Cable

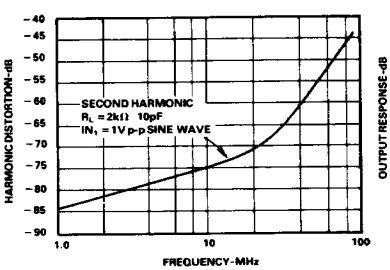

Figure 3. Harmonic Distortion vs. Frequency

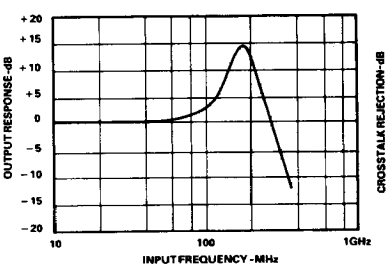

Figure 4. Output vs. Frequency

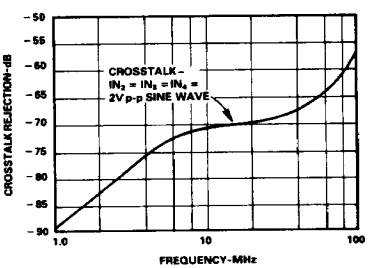

Figure 5. Crosstalk vs. Frequency

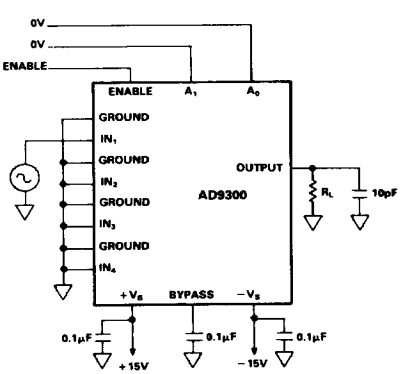

Figure 6. Test Circuit for Harmonic Distortion, Pulse Response, T-Step Response and Disable Characteristics

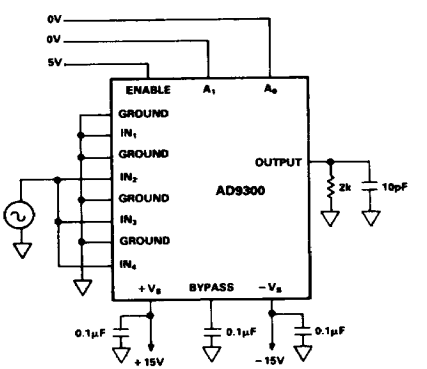

Figure 7. Crosstalk Rejection Test Circuit

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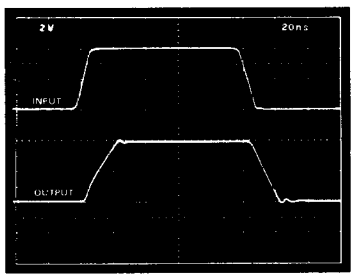

Figure 8. Pulse Response

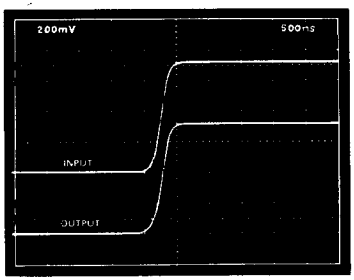

Figure 9. T-Step Response

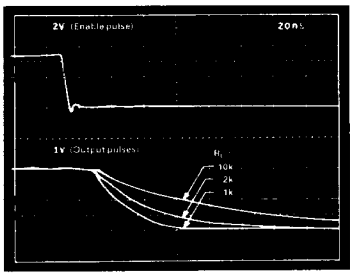

Figure 10. Enable to Channel "Off" Response

CROSSPOINT CIRCUIT APPLICATIONS

Four AD9300 multiplexers can be used to implement an 8 × 2 crosspoint, as shown in Figure 11. The circuit is modular in concept, with each pair of multiplexers (#1 and #2; #3 and #4) forming an 8 × 1 crosspoint. When the inputs to all four units are connected as shown, the result is an 8 × 2 crosspoint circuit.

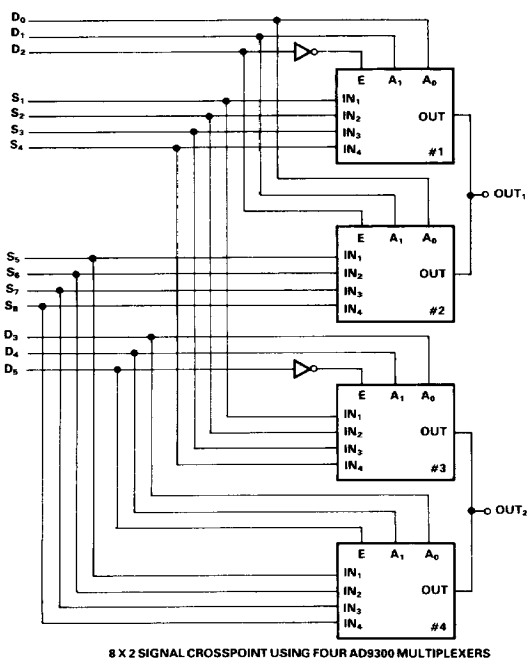

Figure 11. 8 × 2 Signal Crosspoint Using Four AD9300 Multiplexers

The truth table describes the relationships among the digital inputs ($D_0 - D_5$) and the analog inputs ($S_1 - S_8$); and which signal input is selected at the outputs (OUT_1 and OUT_2). The number of crosspoint modules that can be connected in parallel is limited by the drive capabilities of the input signal sources. High input impedance (3MΩ) and low input capacitance (2pF) of the AD9300 help minimize this limitation.

8 × 2 Crosspoint Truth Table

D_2 or D_5	D_1 or D_4	D_0 or D_3	OUT_1 or OUT_2
0	0	0	S_1
0	0	1	S_2
0	1	0	S_3
0	1	1	S_4
1	0	0	S_5
1	0	1	S_6
1	1	0	S_7
1	1	1	S_8

Adding to the number of inputs applied to each crosspoint module is simply a matter of adding AD9300 multiplexers in parallel to the module. Eight devices connected in parallel result in a 32 × 1 crosspoint which can be used with input signals having 30MHz bandwidth and 1V peak-to-peak amplitude. Even more AD9300 units can be added if input signal amplitude and/or bandwidth are reduced; if they are not, distortion of the output signals can result.

When an AD9300 is enabled, its low output impedance causes the "off" isolation of disabled parallel devices to be greater than the crosstalk rejection of a single unit.

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