Am29526 • Am29527
Am29528 • Am29529

High Speed Sine, Cosine Generators

DISTINCTIVE CHARACTERISTICS

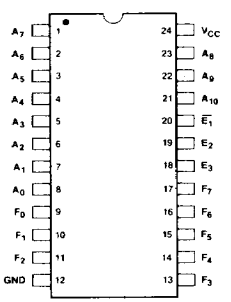
- Provides values for sine/cosine functions in $\pi/2048$ increments
- Outputs are 16-bit two's complement fractions
- Fast generation time of 50ns max Com'l
- S/LS compatible
- Three-state outputs
- IMOX™ processing

RELATED PRODUCTS

Part No.	Description
Am29516/17	16 x 16-Bit High Speed Multipliers
Am29510	16 x 16-Bit Multiply Accumulator
Am29540	FFT Address Sequencer
Am29825	High Performance 8-Bit Register

CONNECTION DIAGRAMS – Top Views

DIP



Chip-Pak™

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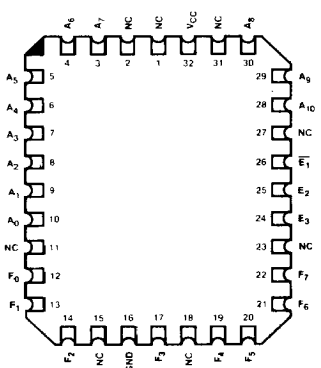

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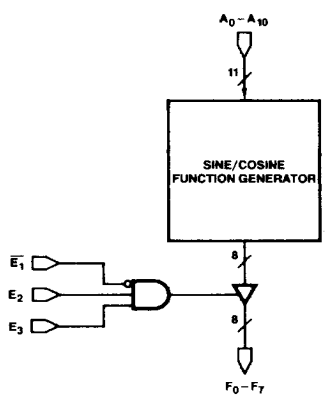
FUNCTIONAL DESCRIPTION

The Am29526/27 and Am29528/29 provide high speed generation of sine and cosine functions over the range $0 \leq \theta < \pi$ in increments of $\pi/2048$. θ is determined by an 11-bit input word. Each device provides an 8-bit output and two are used to give the full 16-bit value. The Am29526 and Am29527 generate the MS and LS bytes respectively for the sine function. Similarly, the Am29528 and Am29529 generate the cosine functions.

The outputs are fractional two's complement numbers with the radix point located immediately to the right of the sign bit (in between the bits weighted -2^{0} and 2^{-1}). As this format does not allow for the representation of $+1$ the functions generated are $-\sin\theta$ and $-\cos\theta$. In this way the output values are restricted to the range $-1 \leq f(\theta) < +1$ which is representable. The outputs are three-state with one active Low enable and two active High enable.

While providing general purpose sine and cosine function capability, the Am29526/27/28/29 satisfy the requirements of the Am29540 FFT Address Sequencer.

BLOCK DIAGRAM



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Am29526/27/28/29
ELECTRICAL CHARACTERISTICS

The following conditions apply unless otherwise specified:

COM'L T_A = 0 to +70°C V_{CC} = 5.0V ±5% (MIN = 4.75V MAX = 5.25V)
MIL T_C = −55 to +125°C V_{CC} = 5.0V ±10% (MIN = 4.50V MAX = 5.50V)

DC CHARACTERISTICS OVER OPERATING RANGE

Parameters	Description	Test Conditions		Min	Typ (Note 1)	Max	Units
V_{OH}	Output HIGH Voltage	V_{CC} = MIN, I_{OH} = −2.0mA V_{IN} = V_{IH} or V_{IL}		2.4			Volts
V_{OL}	Output LOW Voltage	V_{CC} = MIN, I_{OL} = 16mA V_{IN} = V_{IH} or V_{IL}				0.50	Volts
V_{IH}	Input HIGH Level	Guaranteed input logical HIGH voltage for all inputs		2.0			Volts
V_{IL}	Input LOW Level	Guaranteed input logical LOW voltage for all inputs				0.8	Volts
I_{IL}	Input LOW Current	V_{CC} = MAX, V_{IN} = 0.45V			−0.010	−0.250	mA
I_{IH}	Input HIGH Current	V_{CC} = MAX, V_{IN} = 2.7V				25	μA
I_I	Input HIGH Current	V_{CC} = MAX, V_{IN} = 5.5V				1.0	mA
I_{SC}	Output Short Circuit Current	V_{CC} = MAX, V_{OUT} = 0.0V (Note 2)	MIL	−15	−40	−90	mA
			COM'L	−20	−40	−90	
I_{CC}	Power Supply Current	All inputs = GND, V_{CC} = MAX			115	185	mA
V_I	Input Clamp Voltage	V_{CC} = MIN, I_{IN} = −18mA				−1.2	Volts
I_{CEX}	Output Leakage Current	V_{CC} = MAX V_{CS} = 2.4V	V_O = V_{CC}			40	μA
			V_O = 0.4V			−40	
C_{IN}	Input Capacitance	V_{IN} = 2.0V @ f = 1MHz (Note 3)			4.0		pF
C_{OUT}	Output Capacitance	V_{OUT} = 2.0V @ f = 1MHz (Note 3)			8.0		

Notes: 1. Typical limits are at V_{CC} = 5.0V and T_A = +25°C.
2. Not more than one output should be shorted at a time. Duration of the short circuit should not be more than one second.
3. These parameters are not 100% tested, but are periodically sampled.

MAXIMUM RATINGS (Above which the useful life may be impaired)

Storage Temperature	−65 to +150°C
Temperature (Ambient) under Bias	−55 to +125°C
Supply Voltage to Ground Potential Continuous	−0.5 to +7.0V
DC Voltage Applied to Outputs	−0.5V to +V_{CC} max
DC Input Voltage	−0.5 to +5.5V
DC Input Current	−30 to +5mA

DEFINITION OF FUNCTIONAL TERMS

$A_{10}-A_0$ **Data Input Values**
Input, θ, corresponding to θ = 0 (000) to $2047\pi/2048$ (3FF). A_{10} is MSB.

$\overline{E}_1$, E_2, E_3 **Output Enables**
When $\overline{E}_1$ is Low and E_2 and E_3 are High, the outputs F_0-F_7 are enabled. Otherwise the outputs are in the high impedance state or off.

F_7-F_0 **Data Output Values**
The outputs corresponding to $-\sin\theta$ or $-\cos\theta$. F_7 is MSB.

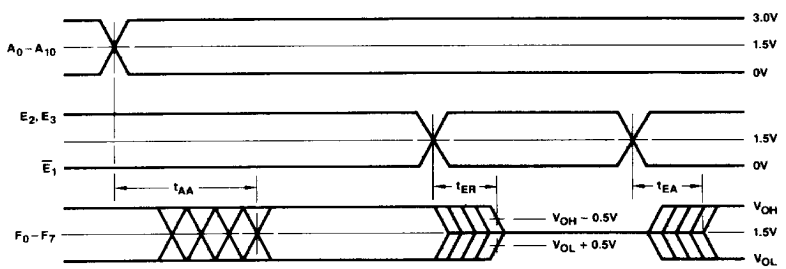
Refer to Page 13-1 for Essential Information on Military Devices

Am29526/27/28/29
SWITCHING CHARACTERISTICS OVER OPERATING RANGE

Parameters	Description		$T_A = +25°C$, $V_{CC} = 5V$ Typ	COM'L: $T_A = 0$ to $+70°C$, $V_{CC} = 5V \pm 5\%$ Max	MIL: $T_C = -55$ to $+125°C$, $V_{CC} = 5V \pm 10\%$ Max	Units	Test Conditions
t_{PLH}	Sin/Cos Generation Time A_i to F_i		30	50	65	ns	$R_L = 600\Omega$, $C_L = 30pF$ (Notes 1 and 2)
t_{PHL}			30	50	65	ns	
t_{PHZ}	$\overline{E}_1, E_2, E_3$ Disable Time	High to Z	10	25	30	ns	
t_{PLZ}		Low to Z	10	25	30	ns	
t_{PZH}	$\overline{E}_1, E_2, E_3$ Enable Time	Z to High	10	25	30	ns	
t_{PZL}		Z to Low	10	25	30	ns	

Notes: 1. t_{PLH} and t_{PHL} are tested with switch S_1 closed and $C_L = 30pF$.
2. For three-state outputs, the disables time is tested with $C_L = 30pF$ to the 1.5V level; S_1 is open for Z to High test and closed for Z to Low test. The enable time is tested with $C_L = 5pF$. High to Z tests are made to an output voltage to $V_{OH} - 0.5V$ with S_1 open; Low to Z tests are made to the $V_{OL} - 0.5V$ level with S_1 closed.

SWITCHING WAVEFORMS



Note: Level on output while chip is disabled is determined externally.

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AC TEST LOAD

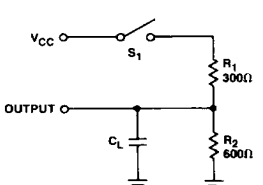

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TABLE 1. $-\text{COS}(\theta)$ TABLE

Decimal Input	Actual Hexadecimal Input	Angle in Radians	Decimal Value of $-\text{Cos}(\theta)$	Hex Value of $-\text{Cos}(\theta)$	Am29526 MS Device	Am29527 LS Device
0	0	0	−1.000000	1000	10	00
512	200	$\pi/4$	−0.707107	A57E	A5	7E
1024	400	$\pi/2$	0.000000	0000	00	00
1536	600	$3\pi/4$	+0.707107	5A82	5A	82
2047	7FF	$2047\pi/2048$	+0.999999	7FFF	7F	FF

TABLE 2. $-\text{SIN}(\theta)$ TABLE

Decimal Input	Actual Hexadecimal Input	Angle in Radians	Decimal Value of $-\text{Sin}(\theta)$	Hex Value of $-\text{Sin}(\theta)$	Am29528 MS Device	Am29529 LS Device
0	000	0	0	0000	00	00
512	200	$\pi/4$	−0.707107	A57E	A5	7E
1024	400	$\pi/2$	−1.00000	8000	80	00
1536	600	$3\pi/4$	−0.707107	A57E	A5	7E
2047	7FF	$2047\pi/2048$	−0.001534	FFCE	FF	CE

Figure 1. The Minus Sine Function

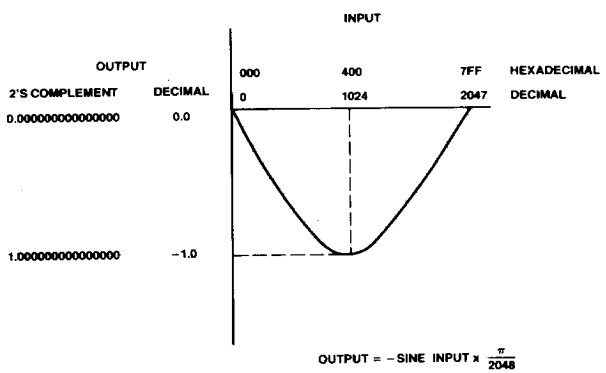

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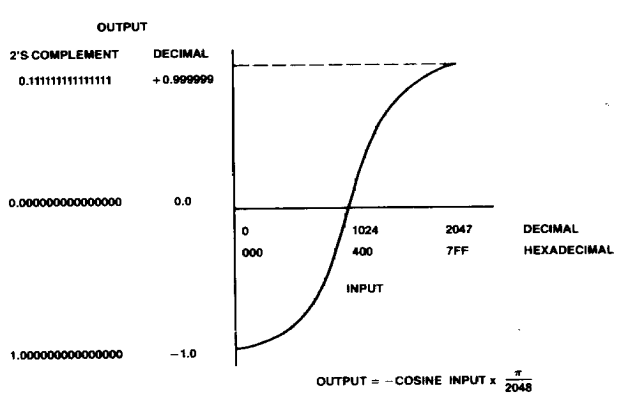
Figure 2. The Minus Cosine Function



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Refer to Page 13-1 for Essential Information on Military Devices

ORDERING INFORMATION

Order the part number according to the table below to obtain the desired package, temperature range and screening level.

Order Number	Package Type (Note 1)	Operating Range (Note 3)	Screening Level (Note 2)
AM29526PC	P-24-1AA	C	C-1
AM29527PC	P-24-1AA	C	C-1
AM29528PC	P-24-1AA	C	C-1
AM29529PC	P-24-1AA	C	C-1
AM29526PC-B	P-24-1AA	C	B-1
AM29527PC-B	P-24-1AA	C	B-1
AM29528PC-B	P-24-1AA	C	B-1
AM29529PC-B	P-24-1AA	C	B-1
AM29526DC	D-24-1AA	C	C-1
AM29527DC	D-24-1AA	C	C-1
AM29528DC	D-24-1AA	C	C-1
AM29529DC	D-24-1AA	C	C-1
AM29526DC-B	D-24-1AA	C	B-1
AM29527DC-B	D-24-1AA	C	B-1
AM29528DC-B	D-24-1AA	C	B-1
AM29529DC-B	D-24-1AA	C	B-1
AM29526DM	D-24-1AA	M	C-3
AM29527DM	D-24-1AA	M	C-3
AM29528DM	D-24-1AA	M	C-3
AM29529DM	D-24-1AA	M	C-3
AM29526DM-B	D-24-1AA	M	B-3
AM29527DM-B	D-24-1AA	M	B-3
AM29528DM-B	D-24-1AA	M	B-3
AM29529DM-B	D-24-1AA	M	B-3
AM29526LC	L-32-2	C	C-1
AM29527LC	L-32-2	C	C-1
AM29528LC	L-32-2	C	C-1
AM29529LC	L-32-2	C	C-1
AM29526LM	L-32-2	M	C-3
AM29527LM	L-32-2	M	C-3
AM29528LM	L-32-2	M	C-3
AM29529LM	L-32-2	M	C-3
AM29526LM-B	L-32-2	M	B-3
AM29527LM-B	L-32-2	M	B-3
AM29528LM-B	L-32-2	M	B-3
AM29529LM-B	L-32-2	M	B-3

Notes: 1. P = Molded DIP, D = Hermetic DIP, L = Chip-Pak. Number following letter is number of leads. See Appendix B for detailed outline. Where Appendix B contains several dash numbers, any of the variations of the package may be used unless otherwise specified.
2. Levels C-1 and C-3 conform to MIL-STD-883, Class C. Level B-3 conforms to MIL-STD-883, Class B.
3. C = 0 to +70°C, V_{CC} = 4.75 to 5.25V, M = −55 to +125°C, V_{CC} = 4.50 to 5.50V.