10 MHz, Four-Quadrant Multiplier/Divider

AD734

FEATURES

High accuracy
- **0.1% typical error**

High speed
- **10 MHz full power bandwidth**
- **450 V/µs slew rate**
- **200 ns settling to 0.1% at full power**

Low distortion
- **–80 dBc from any input**
- **Third-order IMD typically –75 dBc at 10 MHz**

Low noise
- **94 dB SNR, 10 Hz to 20 kHz**
- **70 dB SNR, 10 Hz to 10 MHz**

Direct division mode
- **2 MHz BW at gain of 100**

APPLICATIONS

High performance replacement for AD534
Multiply, divide, square, square root
Modulators, demodulators
Wideband gain control, rms-to-dc conversion
Voltage-controlled amplifiers, oscillators, and filters
Demodulator with 40 MHz input bandwidth

FUNCTIONAL BLOCK DIAGRAM

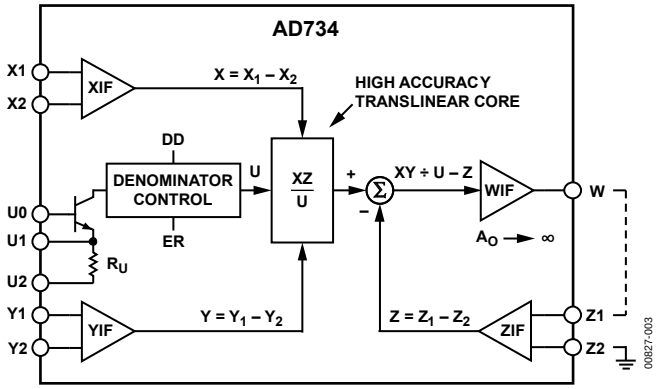

Figure 1.

GENERAL DESCRIPTION

The AD734 is an accurate high speed, four-quadrant analog multiplier that is pin compatible with the industry-standard AD534 and provides the transfer function W = XY/U. The AD734 provides a low impedance voltage output with a full power (20 V p-p) bandwidth of 10 MHz. Total static error (scaling, offsets, and nonlinearities combined) is 0.1% of full scale. Distortion is typically less than –80 dBc and guaranteed. The low capacitance X, Y, and Z inputs are fully differential. In most applications, no external components are required to define the function.

The internal scaling (denominator) voltage, U, is 10 V, derived from a buried-Zener voltage reference. A new feature provides the option of substituting an external denominator voltage, allowing the use of the AD734 as a two-quadrant divider with a 1000:1 denominator range and a signal bandwidth that remains 10 MHz to a gain of 20 dB, 2 MHz at a gain of 40 dB, and 200 kHz at a gain of 60 dB, for a gain-bandwidth product of 200 MHz.

The advanced performance of the AD734 is achieved by a combination of new circuit techniques, the use of a high speed complementary bipolar process, and a novel approach to laser trimming based on ac signals rather than the customary dc methods. The wide bandwidth (>40 MHz) of the AD734's input stages and the 200 MHz gain-bandwidth product of the multiplier core allow the AD734 to be used as a low distortion demodulator with input frequencies as high as 40 MHz as long as the desired output frequency is less than 10 MHz.

The AD734AQ and AD734BQ are specified for the industrial temperature range of –40°C to +85°C and come in a 14-lead CERDIP and a 14-lead PDIP package. The AD734SQ/883B, available processed to MIL-STD-883B for the military range of –55°C to +125°C, is available in a 14-lead CERDIP.

Rev. E

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REVISION HISTORY

2/11—Rev. D to Rev. E

Changes to Figure 4, Figure 5, and Figure 6 ... 7
Changes to Figure 22 and Figure 23 ... 12
Changes to Figure 27 and Figure 28 ... 14
Changes to Figure 36 ... 17

1/11—Rev. C to Rev. D

Updated Format ... Universal
Changes to Figure 1 and General Description Section ... 1
Deleted Product Highlights Section ... 1
Change to Endnote 3 ... 4
Changes to Table 2 and Table 3 ... 5
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Added Figure 3; Renumbered Sequentially ... 6
Added Table 4; Renumbered Sequentially ... 6
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SPECIFICATIONS

T_A = +25°C, $+V_S$ = VP = +15 V, $-V_S$ = VN = −15 V, $R_L \geq 2$ kΩ, unless otherwise noted.

Generalized transfer function: $W = A_O\left\{\frac{(X_1 - X_2)(Y_1 - Y_2)}{U_1 - U_2} - (Z_1 - Z_2)\right\}$

Table 1.

		A			B			S		
Parameter	**Conditions**	**Min**	**Typ**	**Max**	**Min**	**Typ**	**Max**	**Min**	**Typ**	**Max**	**Unit**
MULTIPLIER PERFORMANCE											
Transfer Function			W = XY/10			W = XY/10			W = XY/10		
Total Static Error[1]	−10 V ≤ X, Y ≤ 10 V		0.1	0.4		0.1	0.25		0.1	0.4	%
Over T_{MIN} to T_{MAX}				1			0.6			1.25	%
vs. Temperature	T_{MIN} to T_{MAX}		0.004			0.003			0.004		%/°C
vs. Either Supply	$\pm V_S$ = 14 V to 16 V		0.01	0.05		0.01	0.05		0.01	0.05	%/V
Peak Nonlinearity	−10 V ≤ X ≤ +10 V, Y = +10 V		0.05			0.05			0.05		%
	−10 V ≤ Y ≤ +10 V, X = +10 V		0.025			0.025			0.025		%
THD[2]	X = 7 V rms, Y = +10 V, f ≤ 5 kHz			−58			−66			−58	dBc
	T_{MIN} to T_{MAX}			−55			−63			−55	dBc
	Y = 7 V rms, X = +10 V, f ≤ 5 kHz			−60			−80			−60	dBc
	T_{MIN} to T_{MAX}			−57			−74			−57	dBc
Feedthrough	X = 7 V rms, Y = nulled, f ≤ 5 kHz		−85	−60		−85	−70		−85	−60	dBc
	Y = 7 V rms, X = nulled, f ≤ 5 kHz		−85	−66		−85	−76		−85	−66	dBc
Noise (RTO)	X = Y = 0 V										
Spectral Density	100 Hz to 1 MHz		1.0			1.0			1.0		µV/√Hz
Total Output Noise	10 Hz to 20 kHz		−94	−88		−94	−88		−94	−88	dBc
	T_{MIN} to T_{MAX}			−85			−85			−85	dBc
DIVIDER PERFORMANCE (Y = 10 V)											
Transfer Function			W = XY/U			W = XY/U			W = XY/U		
Gain Error	Y = 10 V, U = 100 mV to 10 V		1		1			1			%
X Input Clipping Level	Y ≤ 10 V		1.25 × U			1.25 × U			1.25 × U		V
U Input Scaling Error[3]				0.3			0.15			0.3	%
	T_{MIN} to T_{MAX}			0.8			0.65			1	%
Output to 1%	U = 1 V to 10 V step, X = 1 V		100			100			100		ns
INPUT INTERFACES (X, Y, AND Z)											
3 dB Bandwidth			40			40			40		MHz
Operating Range	Differential or common mode		±12.5			±12.5			±12.5		V
X Input Offset Voltage				15			5			15	mV
	T_{MIN} to T_{MAX}			25			15			25	mV
Y Input Offset Voltage				10			5			10	mV
	T_{MIN} to T_{MAX}			12			6			12	mV
Z Input Offset Voltage				20			10			20	mV
	T_{MIN} to T_{MAX}			50			50			90	mV
Z Input PSRR (Either Supply)	f ≤ 1 kHz	54	70		66	70		54	70		dB
	T_{MIN} to T_{MAX}	50			56			50			dB

Parameter	Conditions	A			B			S			Unit
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
CMRR	f = 5 kHz	70	85		70	85		70	85		dB
Input Bias Current (X, Y, Z Inputs)			50	300		50	150		50	300	nA
	T_{MIN} to T_{MAX}			400			300			500	nA
Input Resistance	Differential		50			50			50		kΩ
Input Capacitance	Differential		2			2			2		pF
DENOMINATOR INTERFACES (U0, U1, AND U2)											
Operating Range			VN to VP – 3			VN to VP – 3			VN to VP – 3		V
Denominator Range			1000:1			1000:1			1000:1		
Interface Resistor	U1 to U2		28			28			28		kΩ
OUTPUT AMPLIFIER (W)											
Output Voltage Swing	T_{MIN} to T_{MAX}	±12			±12			±12			V
Open-Loop Voltage Gain	X = Y = 0, input to Z		72			72			72		dB
Dynamic Response	From X or Y input, $C_{LOAD} \leq 20$ pF										
3 dB Bandwidth	W ≤ 7 V rms	8	10		8	10		8	10		MHz
Slew Rate			450			450			450		V/µs
Settling Time	+20 V or −20 V output step										
To 1%			125			125			125		ns
To 0.1%			200			200			200		ns
Short-Circuit Current	T_{MIN} to T_{MAX}	20	50	80	20	50	80	20	50	80	mA
POWER SUPPLIES, $\pm V_S$											
Operating Supply Range		±8		±16.5	±8		±16.5	±8		±16.5	V
Quiescent Current	T_{MIN} to T_{MAX}	6	9	12	6	9	12	6	9	12	mA

[1] Figures given are percent of full scale (for example, 0.01% = 1 mV).
[2] dBc refers to decibels relative to the full-scale input (carrier) level of 7 V rms.
[3] See Figure 28 for test circuit.

ABSOLUTE MAXIMUM RATINGS

Table 2.

Parameter	Rating
Supply Voltage	±18 V
Internal Power Dissipation	
for T_J max = 175°C	500 mW
X, Y, and Z Input Voltages	VN to VP
Output Short-Circuit Duration	Indefinite
Storage Temperature Range	
Q-14	−65°C to +150°C
N-14	−65°C to +150°C
Operating Temperature Range	
AD734A, AD734B (Industrial)	−40°C to +85°C
AD734S (Military)	−55°C to +125°C
Lead Temperature Range (Soldering, 60 sec)	+300°C
Transistor Count	81
ESD Rating	500 V

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

THERMAL RESISTANCE

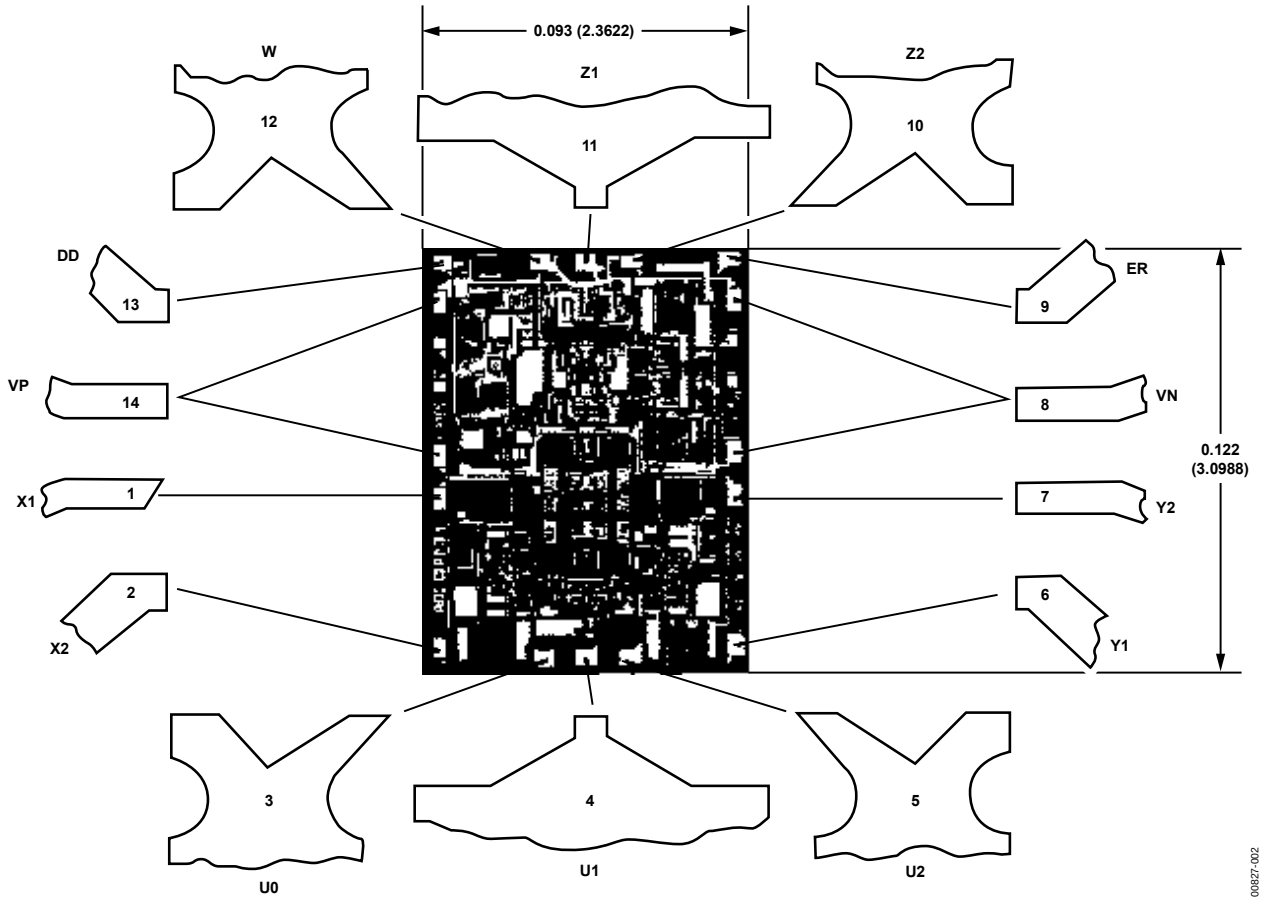
θ_{JA} is specified for the worst-case conditions, that is, a device soldered in a circuit board for surface-mount packages.

Table 3. Thermal Resistance

Package Type	θ_{JA}	Unit
14-Lead PDIP (N-14)	150	°C/W
14-Lead CERDIP (Q-14)	110	°C/W

ESD CAUTION

ESD (electrostatic discharge) sensitive device. Charged devices and circuit boards can discharge without detection. Although this product features patented or proprietary protection circuitry, damage may occur on devices subjected to high energy ESD. Therefore, proper ESD precautions should be taken to avoid performance degradation or loss of functionality.



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