Am29337

16-Bit Bounds Checker

PRELIMINARY

DISTINCTIVE CHARACTERISTICS

- Double Comparator
  - Compares a 16-bit input number with a lower limit and an upper limit
- Cascadable
  - 16-bit cascadable to longer words

- Out-of-Bounds Flag
  - Flags values that are outside the bounds of a lower and an upper limit
- Compares Signed or Unsigned Numbers
- 28-Pin Packages

GENERAL DESCRIPTION

The Am29337 is the 16-bit bounds checker that compares a 16-bit signed or unsigned number with a lower and an upper limit stored in the registers. The part flags values that are out of bounds, or triggers a counter used to count the number of values that lie within the given range.

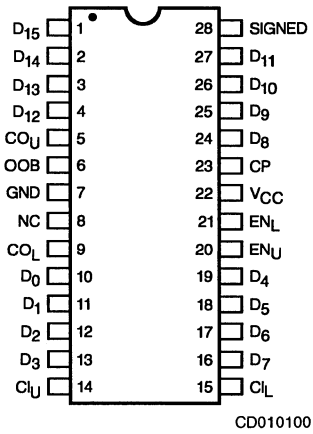The Am29337 is cascadable up to 32 bits or greater.

BLOCK DIAGRAM
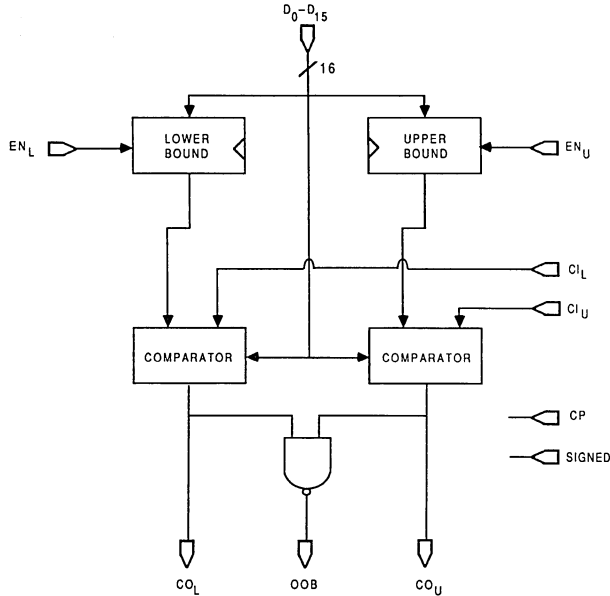
BD006640

RELATED AMD PRODUCTS

Part No.	Description
Am29331	16-Bit Microprogram Sequencer
Am29332	32-Bit ALU
Am29334	Four-Port Dual-Access Register File
Am29323	32 x 32 Parallel Multiplier
Am29325	32-Bit Floating Point Processor

Advanced Micro Devices

CONNECTION DIAGRAMS
Top View

LCC*

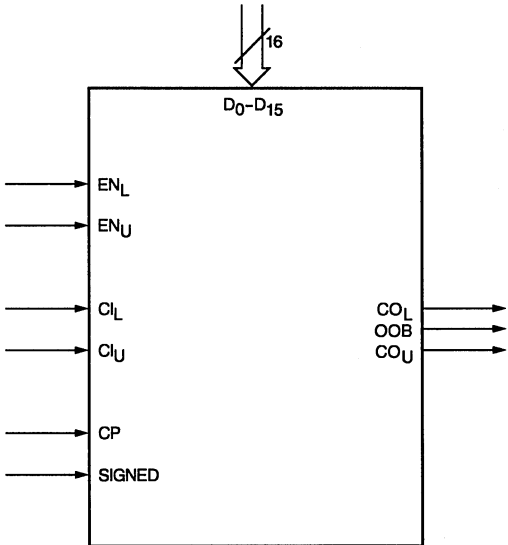|		
D15	1	28 SIGNED
D14	2	27 D11
D13	3	26 D10
D12	4	25 D9
COU	5	24 D8
OOB	6	23 CP
GND	7	22 VCC
NC	8	21 ENL
COL	9	20 ENU
D0	10	19 D4
D1	11	18 D5
D2	12	17 D6
D3	13	16 D7
CIU	14	15 CIL

CD010100

CD010110
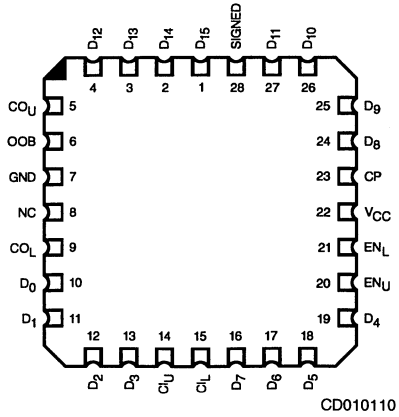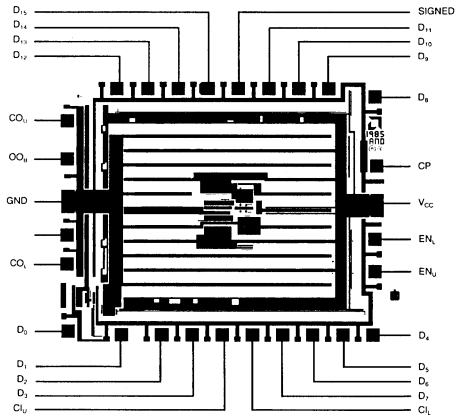
* Also available in PLCC.
Pinouts identical to LCC.

Note: Pin 1 is marked for orientation.

LOGIC SYMBOL

LS002810
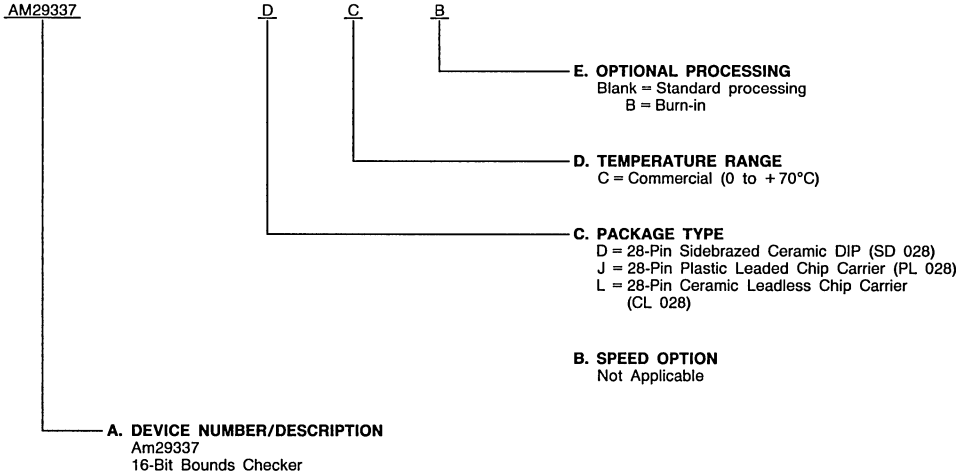
METALLIZATION AND PAD LAYOUT

2

ORDERING INFORMATION

Standard Products

AMD standard products are available in several packages and operating ranges. The order number (Valid Combination) is formed by a combination of: **A. Device Number**

B. Speed Option (if applicable)
C. Package Type
D. Temperature Range
E. Optional Processing

AM29337   D C B

E. OPTIONAL PROCESSING
Blank = Standard processing
B = Burn-in

D. TEMPERATURE RANGE
C = Commercial (0 to +70°C)

C. PACKAGE TYPE
D = 28-Pin Sidebrazed Ceramic DIP (SD 028)
J = 28-Pin Plastic Leaded Chip Carrier (PL 028)
L = 28-Pin Ceramic Leadless Chip Carrier (CL 028)

B. SPEED OPTION
Not Applicable

A. DEVICE NUMBER/DESCRIPTION
Am29337
16-Bit Bounds Checker

Valid Combinations	
AM29337	DC, DCB, JC, LC

Valid Combinations

Valid Combinations list configurations planned to be supported in volume for this device. Consult the local AMD sales office to confirm availability of specific valid combinations, to check on newly released combinations, and to obtain additional data on AMD's standard military grade products.

PIN DESCRIPTION

$D_0 - D_{15}$ Data Input (Input)
Input to the comparators and limit registers.

CI_L, CI_U Carry-In (Inputs)
Carry input for cascading.

CO_L, CO_U Carry Out (Outputs)
Carry outputs for the result of comparison.

OOB   Out-of-Bounds Flag (Output)
Flags values that are out of bounds. Defined as $\overline{CO_L} \cdot \overline{CO_U}$.

SIGNED   Sign Input (Input)
Selects signed comparisons when HIGH and unsigned comparisons when LOW.

EN_L, EN_U Load Enable (Inputs)
Loads enables for the limit registers.

CP   System Clock (Input)
Clocks limit registers at the LOW-to-HIGH transition.

FUNCTIONAL DESCRIPTION

The Am29337 is a high-speed bounds checker that determines if a 16-bit number lies within a lower and an upper limit. It consists of two comparators and two limit registers, as shown in the Block Diagram.

Limit Registers, Double Comparator

The Am29337 has a lower limit register and an upper limit register. The values of these two registers are loaded from the D-bus with the load enable inputs EN_L and EN_U on the clock's rising edge. The values of the data present on the D-bus are compared with the values stored in the limit registers through the two comparators. The comparators operate on signed numbers when SIGNED is HIGH and on unsigned numbers when it is LOW. The results of the comparisons are given by the outputs CO_L, CO_U, and OOB. The definitions of carry inputs CI_L and CI_U are given in Table 1, and the combination of the different regions in Table 2. If the data being compared is out of the region, the out-of-bounds flag, OOB, which is defined as $\overline{CO_L} \cdot \overline{CO_U}$, is set.

Cascading

Comparison of numbers longer than 16 bits requires cascading of two or more bounds-checker slices. Figure 1 shows an example of this for a 32-bit bounds checker. The comparison starts from the least significant slice. CO_L, CO_U, and OOB of the most significant slice act as outputs of the overall bounds checker, while CO_L and CO_U of the least significant slice are connected to CI_L and CI_U of the most significant slice. CI_L and CI_U of the least significant slice act as inputs to the overall bounds checker. The SIGNED input of the most significant slice identifies the value when being compared with either signed or unsigned number when the SIGNED input of the least significant slice is tied LOW.

The comparison can start from the most significant slice. In this case, CO_L, CO_U, OOB of the least significant slice act as outputs of the overall bounds checker, while CO_L and CO_U of the most significant slice are connected to CI_L and CI_U of the least significant slice.

TABLE 1. DEFINITION OF CO_L AND CO_U

Inputs		Outputs	
CI_L	CI_U	CO_L	CO_U
0	0	$L < D$	$D < U$
0	1	$L < D$	$D \leq U$
1	0	$L \leq D$	$D < U$
1	1	$L \leq D$	$D \leq U$

Note:
D = Data Input
L = Lower Unit
U = Upper Unit

TABLE 2. DIFFERENT COMBINATIONS OF REGIONS

Inputs		Outputs			
CI_L	CI_U	CO_L	CO_U	OOB	Description
0	0	0	0	1	Impossible Combination
		0	1	1	$D \leq L$
		1	0	1	$U \leq D$
		1	1	0	$L < D < U$
0	1	0	0	1	Impossible Combination
		0	1	1	$D \leq L$
		1	0	1	$U < D$
		1	1	0	$L < D \leq U$
1	0	0	0	1	Impossible Combination
		0	1	1	$D < L$
		1	0	1	$U \leq D$
		1	1	0	$L \leq D < U$
1	1	0	0	1	Impossible Combination
		0	1	1	$D < L$
		1	0	1	$U < D$
		1	1	0	$L \leq D \leq U$
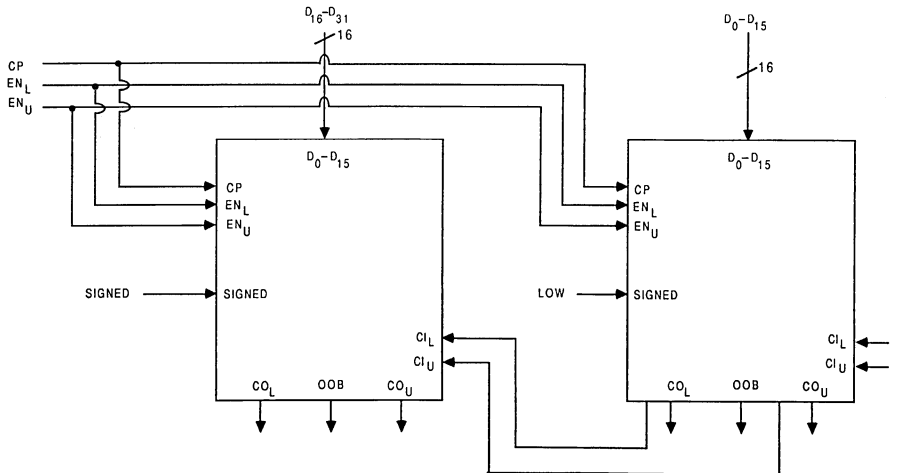
AF004530

Figure 1. 32-Bit Bounds Checker

ABSOLUTE MAXIMUM RATINGS

Storage Temperature .... −65 to +150°C
Temperature Under Bias — T_C .... −55 to +125°C
Supply Voltage to Ground
   Potential Continuous .... −0.5 to +7.0 V
DC Voltage Applied to Outputs
   for HIGH State .... −0.5 V to V_{CC} Max.
DC Input Voltage .... −0.5 to +5.5 V
DC Output Current, into Outputs .... 30 mA
DC Input Current .... −30 to +5.0 mA

Stresses above those listed under ABSOLUTE MAXIMUM RATINGS may cause permanent device failure. Functionality at or above these limits is not implied. Exposure to absolute maximum ratings for extended periods may affect device reliability.

OPERATING RANGES

Commercial (C) Devices
   Temperature (T_A) .... 0 to +70°C
   Supply Voltage (V_{CC}) .... +4.75 to +5.25 V

Operating ranges define those limits between which the functionality of the device is guaranteed.

## DC CHARACTERISTICS over operating range unless otherwise specified

Parameter Symbol	Parameter Description	Test Conditions (Note 1)	Min.	Typ. (Note 2)	Max.	Units
V_{OH}	Output HIGH Voltage	V_{CC} = Min., $V_{IN} = V_{IL}$ or V_{IH} I_{OH} = −1.0 mA	2.4			V
V_{OL}	Output LOW Voltage	V_{CC} = Min., $V_{IN} = V_{IL}$ or V_{IH} I_{OL} = 8.0 mA			0.5	V
V_{IH}	Input HIGH Level	Guaranteed Input Logical HIGH Voltage for All Inputs	2.0			V
V_{IL}	Input LOW Level	Guaranteed Input Logical LOW Voltage for All Inputs			0.8	V
V_I	Input Clamp Voltage	V_{CC} = Min., I_{IN} = −18 mA			−1.2	V
I_{IL}	Input LOW Current	V_{CC} = Max., V_{IN} = 0.5 V			−0.5	mA
I_{IH}	Input HIGH Current	V_{CC} = Max., V_{IN} = 2.4 V			50	μA
I_I	Input HIGH Current	V_{CC} = Max., V_{IN} = 5.5 V			1	mA
I_{OZH} I_{OZL}	$F_0 - F_{31}$ Off State (High Impedance) Output Current	V_{CC} = Max. V_O = 2.4 V			25	μA
		V_O = 0.4 V			−25	
I_{SC}	Output Short-Circuit Current (Note 3)	V_{CC} = Max., V_O = 0 V	−15		−50	mA
I_{CC}	Power Supply Current	V_{CC} = Max. T_A = +25°C			220	mA
		T_A = 0 to +70°C			230	
		T_A = +70°C			180	

Notes: 1. For conditions as Min. or Max., use the appropriate value specified under Operating Ranges for the applicable device type.
     2. Typical values are for V_{CC} 5.0 +25°C ambient and maximum loading.
     3. Not more than one output should be shorted at a time. Duration of the short-circuit test should not exceed one second.

SWITCHING CHARACTERISTICS over operating range unless otherwise specified

No.	Parameter Symbol		Test Conditions	Min.	Max.	Units
1	t_{PD}	$D_0 - D_{15}$ to CO_L, CO_U, OOB			19	ns
2	t_{PC}	CI_L, CI_U to CO_L, CO_U, OOB			14	ns
3	t_{PS}	SIGNED to CO_L, CO_U, OOB			18	ns
4	t_{CPO}	CP to CO_L, CO_U, OOB			22	ns
5	t_{SD}	$D_0 - D_{15}$ Setup Time			11	ns
6	t_{SL}	EN_L, EN_U Setup Time			11	ns
7	t_{HD}	$D_0 - D_{15}$ Hold Time			0	ns
8	t_{HL}	EN_L, EN_U Hold Time			0	ns
9	t_{PWL}	Clock Pulse Width LOW			12	ns
10	t_{PWH}	Clock Pulse Width HIGH			12	ns

SWITCHING TEST CIRCUIT
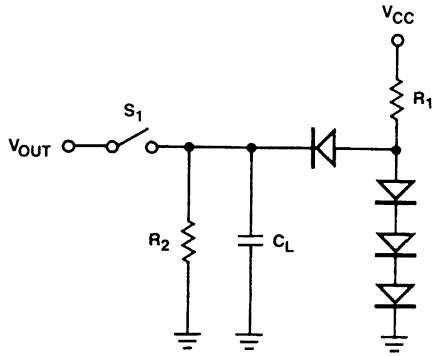
TCR01240

$$R_2 = \frac{2.4\ \text{V}}{I_{OH}} \qquad R_1 = \frac{5.0 - V_{BE} - V_{OL}}{\dfrac{I_{OL} + V_{OL}}{R_2}}$$

Normal Outputs

Notes: 1. $C_L = 50$ pF includes scope probe, wiring, and stray capacitances without device in test fixture.
2. S_1 is closed during function tests and all AC tests except output enable tests.
3. $C_L = 5.0$ pF for output disable tests.

KEY TO SWITCHING WAVEFORMS

WAVEFORM	INPUTS	OUTPUTS
———	MUST BE STEADY	WILL BE STEADY
	MAY CHANGE FROM H TO L	WILL BE CHANGING FROM H TO L
	MAY CHANGE FROM L TO H	WILL BE CHANGING FROM L TO H
	DON'T CARE; ANY CHANGE PERMITTED	CHANGING; STATE UNKNOWN
	DOES NOT APPLY	CENTER LINE IS HIGH IMPEDANCE "OFF" STATE

KS000010

SWITCHING WAVEFORMS

$D_0 - D_{15}$

CI_L, CI_U

SIGNED

CO_L, CO_U, OOB
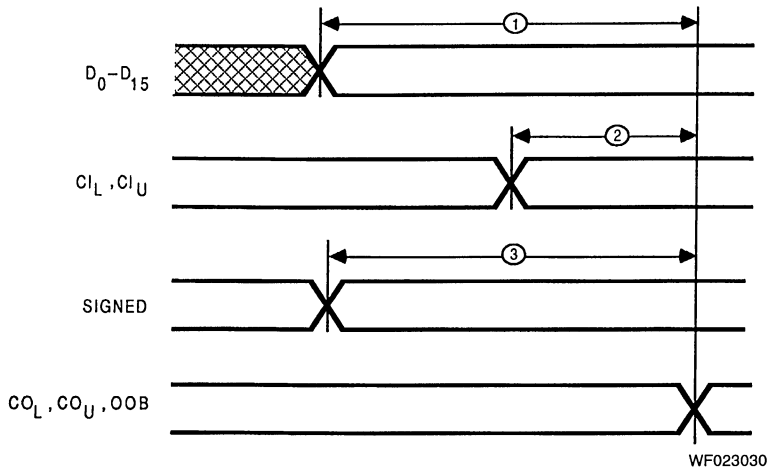
WF023030

Propagation Delays from Data Input to Output

CP

$D_0 - D_{15}$

$EN_L - EN_U$

CO_L, CO_U, OOB
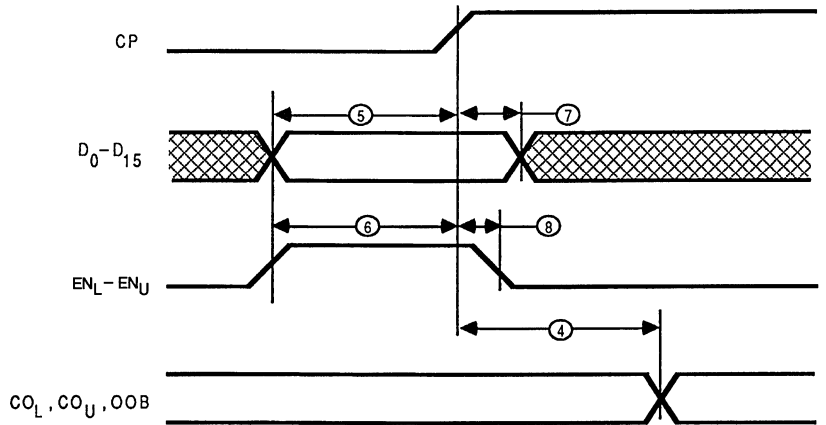
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Loading the Limit Registers

INPUT/OUTPUT CURRENT INTERFACE DIAGRAMS

DRIVING OUTPUT

DRIVEN INPUT

I_{OH}

I_{OL}

I_{IL}

I_{IH}
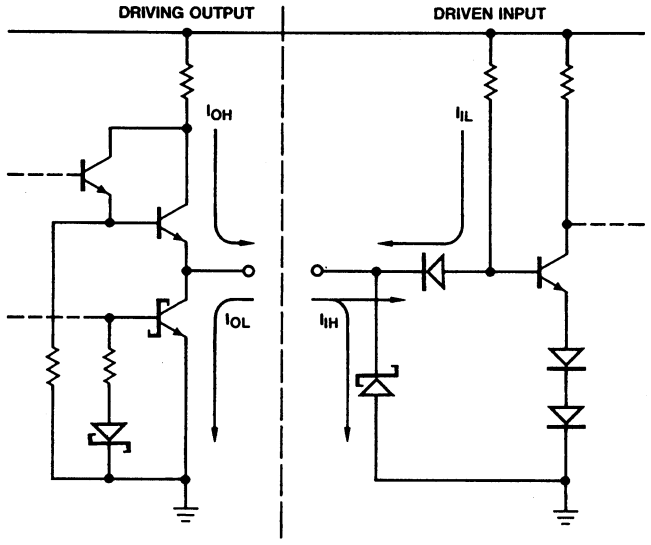
ICR00480

$C_I \approx 5.0$ pF, all inputs

$C_O \approx 5.0$ pF, all outputs

PHYSICAL DIMENSIONS

SD 028

PID # 07430B

PL 028

PID # 06751D

CL 028

PID # 06595D
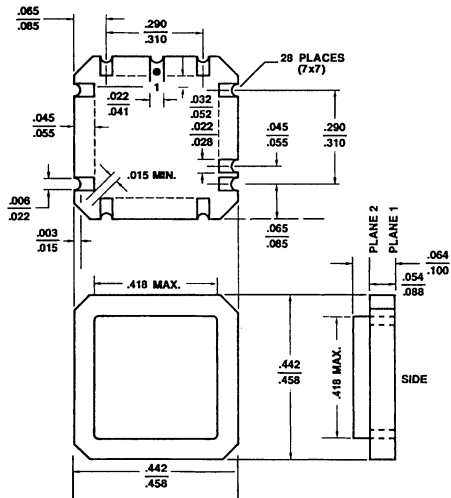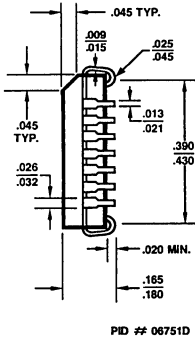
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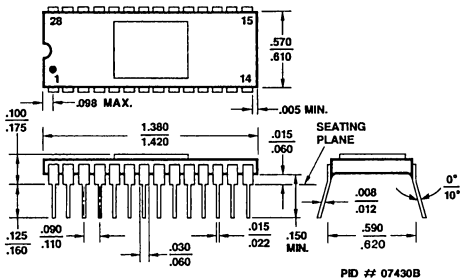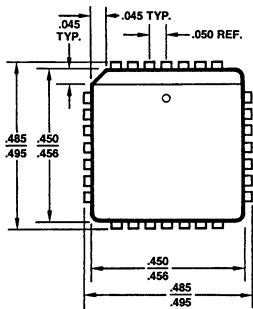CALIFORNIA,
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