

**TYPES SN54LS275, SN54S274, SN54S275,
SN74LS275, SN74S274, SN74S275**
4-BIT-BY-4-BIT BINARY MULTIPLIER WITH 3-STATE OUTPUTS
7-BIT-SLICE WALLACE TREES WITH 3-STATE OUTPUTS
BULLETIN NO. DL-S 7612121, OCTOBER 1976

- 'S274 Provides 8-Bit Product in Typically 45 ns
- 'S274 Can Provide Sub-Multiple Products for n-Bit-by-n-Bit Binary Numbers
- 'LS275 and 'S275 Accept 7 Bit-Slice Inputs and 2 Carry Inputs for Reduction to 4 Lines in Typically 45 ns
- These High-Complexity Functions Can Reduce Package Count by Nearly 50% in Most Parallel Multiplier Designs
- When SN74S274 is Combined With SN74H183 (or SN74LS183) and Schottky Look-Ahead Adders, Multiplication Times are Typically:

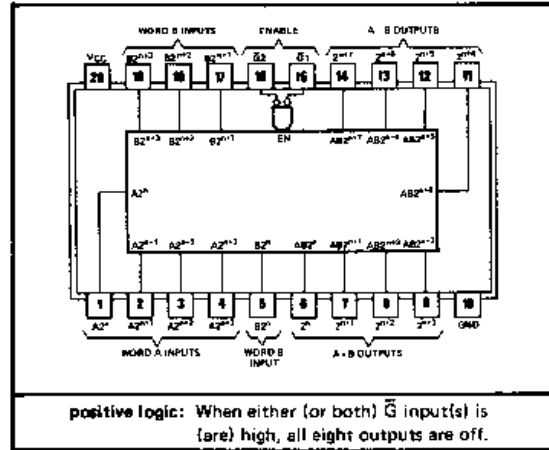
16-Bit Product in 75 ns (79 ns)
32-Bit Product in 116 ns (132 ns)

description

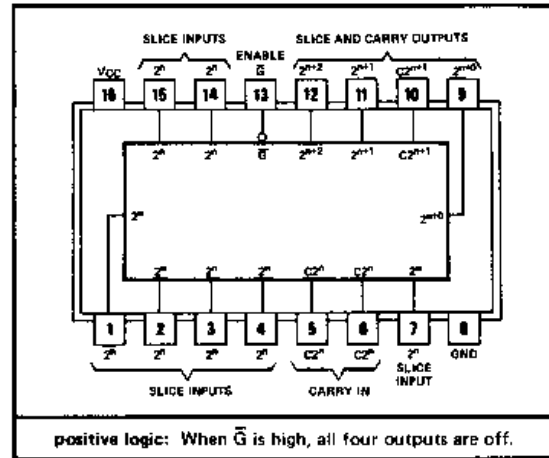
These high-complexity Schottky-clamped TTL circuits are designed specifically to reduce the delay time required to perform high-speed parallel binary multiplication and significantly reduce package count. The 'S274 is a basic 4-bit-by-4-bit parallel multiplier in a single package, and as such, no additional components are required to obtain an 8-bit product. For word lengths longer than 4 bits, a number of 'S274 multipliers can be combined to generate sub-multiple partial products. These partial products can then be combined in Wallace trees to obtain the final product. See Typical Application Data.

The 'LS275 and 'S275 expandable bit-slice Wallace trees have been designed to accept up to seven bit-slice inputs and two carry inputs from previous slices for reduction to four lines.

SN54S274 . . . J PACKAGE
SN74S274 . . . J OR N PACKAGE
(TOP VIEW)

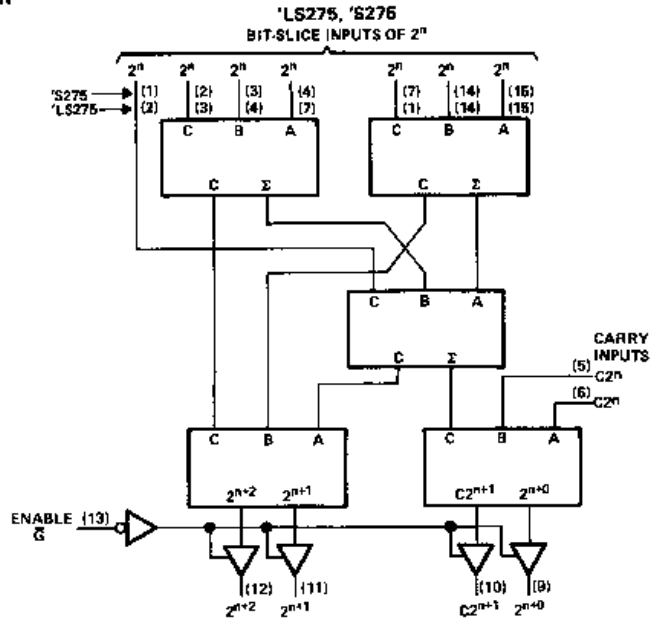


SN54LS275, SN54S275 . . . J PACKAGE
SN74LS275, SN74S275 . . . J OR N PACKAGE
(TOP VIEW)



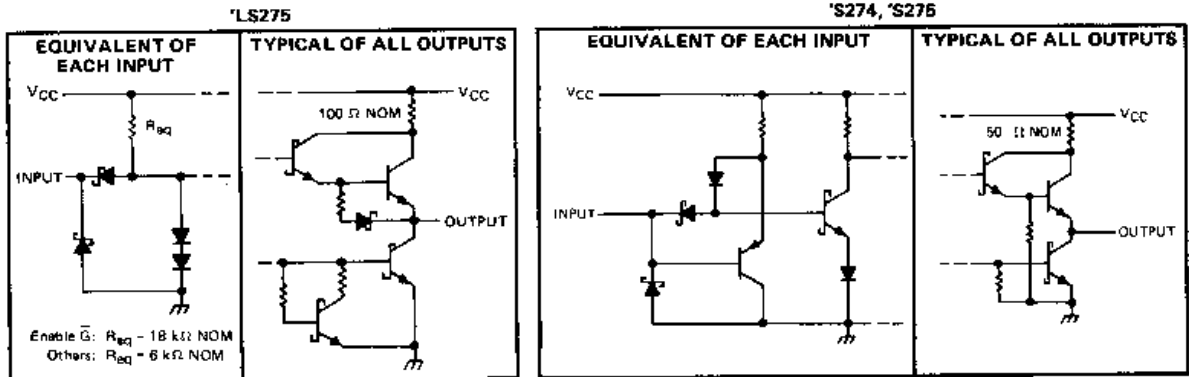
TYPES SN54LS275, SN54S274, SN54S275, SN74LS275, SN74S274, SN74S275 4-BIT-BY-4-BIT BINARY MULTIPLIER WITH 3-STATE OUTPUTS 7-BIT-SLICE WALLACE TREES WITH 3-STATE OUTPUTS

functional block diagram



NOTE: When one of the $C2^n$ carry inputs is not used, it must be grounded. If neither $C2^n$ carry input is used, both $C2^n$ inputs are grounded and the $C2^{n+1}$ output is normally left open.

schematics of inputs and outputs



absolute maximum ratings over operating free-air temperature range (unless otherwise noted)

Supply voltage, V_{CC} (see Note 1)	7 V
Input voltage: 'LS275	7 V
'S274, 'S275	5.5 V
Off-state output voltage: 'LS275	7 V
'S274, 'S275	5.5 V
Operating free-air temperature range: SN54LS, SN54S Circuits	-55°C to 125°C
SN74LS, SN74S Circuits	0°C to 70°C
Storage temperature range	-65°C to 150°C

NOTE 1: Voltage values are with respect to network ground terminal.

TYPES SN54LS275, SN74LS275

7-BIT-SLICE WALLACE TREES WITH 3-STATE OUTPUTS

REVISED AUGUST 1977

recommended operating conditions

	SN54LS275			SN74LS275			UNIT
	MIN	NOM	MAX	MIN	NOM	MAX	
Supply voltage, V_{CC}	4.5	5	5.5	4.75	5	5.25	V
High-level output current, I_{OH}			-1			-2.6	mA
Low-level output current, I_{OL}			12			24	mA
Operating free-air temperature, T_A	-55		125	0		70	$^{\circ}$ C

electrical characteristics over recommended operating free-air temperature range (unless otherwise noted)

PARAMETER		TEST CONDITIONS†	SN54LS275			SN74LS275			UNIT
			MIN	TYP‡	MAX	MIN	TYP‡	MAX	
V_{IH}	High-level input voltage		2			2			V
V_{IL}	Low-level input voltage		0.7			0.8			V
V_{IK}	Input clamp voltage	$V_{CC} = \text{MIN}, I_I = -18 \text{ mA}$	-1.5			-1.5			V
V_{OH}	High-level output voltage	$V_{CC} = \text{MIN}, V_{IH} = 2 \text{ V}, V_{IL} = V_{IL \text{ max}}, I_{OH} = \text{MAX}$	2.4	3.2		2.4	3.1		V
V_{OL}	Low-level output voltage	$V_{CC} = \text{MIN}, V_{IH} = 2 \text{ V}, V_{IL} = V_{IL \text{ max}}$	0.25 0.4			0.25 0.4			V
I_{OZH}	Off-state output current, high-level voltage applied	$V_{CC} = \text{MAX}, V_{IH} = 2 \text{ V}, V_O = 2.7 \text{ V}$	20			20			μ A
I_{OZL}	Off-state output current, low-level voltage applied	$V_{CC} = \text{MAX}, V_{IH} = 2 \text{ V}, V_O = 0.4 \text{ V}$	-20			-20			μ A
I_I	Input current at maximum input voltage	Enable \bar{G}	0.1			0.1			mA
		All others	0.3			0.3			
I_{IH}	High-level input current	Enable \bar{G}	20			20			μ A
		All others	60			60			
I_{IL}	Low-level input current	Enable \bar{G}	-0.4			-0.4			mA
		All others	-1.2			-1.2			
I_{OS}	Short-circuit output current§	$V_{CC} = \text{MAX}$	-30	-130		-30	-130		mA
I_{CC}	Supply current	$V_{CC} = \text{MAX}$	25 40			25 40			mA

† For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.

‡ All typical values are at $V_{CC} = 5 \text{ V}, T_A = 25^{\circ}\text{C}$.

§ Not more than one output should be shorted at a time and duration of the short-circuit should not exceed one second.

switching characteristics, $V_{CC} = 5 \text{ V}, T_A = 25^{\circ}\text{C}$

PARAMETER¶	FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	MIN	TYP	MAX	UNIT	
t_{PLH}	Any Slice or Carry	Any	$C_L = 45 \text{ pF}, R_L = 667 \Omega,$ See Note 2	35	62		ns	
t_{PHL}				42	66			
t_{PZH}	Enable \bar{G}	Any	$C_L = 45 \text{ pF}, R_L = 667 \Omega,$ See Note 2	8	23		ns	
t_{PZL}				13	23			
t_{PHZ}				10	15			ns
t_{PLZ}						10	15	

¶ t_{PLH} \equiv Propagation delay time, low-to-high-level output

t_{PHL} \equiv Propagation delay time, high-to-low-level output

t_{PZH} \equiv Output enable time to high level

t_{PZL} \equiv Output enable time to low level

t_{PHZ} \equiv Output disable time from high level

t_{PLZ} \equiv Output disable time from low level

NOTE 2: Load circuit and voltage waveforms are shown on page 3-11.

TYPES SN54S274, SN54S275, SN74S274, SN74S275

4-BIT-BY-4-BIT BINARY MULTIPLIER WITH 3-STATE OUTPUTS

7-BIT-SLICE WALLACE TREES WITH 3-STATE OUTPUTS

recommended operating conditions

	SN54S274 SN54S275			SN74S274 SN74S275			UNIT
	MIN	NOM	MAX	MIN	NOM	MAX	
Supply voltage, V_{CC}	4.5	5	5.5	4.75	5	5.25	V
High-level output current, I_{OH}			-2			-6.5	mA
Low-level output current, I_{OL}			12			12	mA
Operating free-air temperature, T_A	-65		125	0		70	°C

electrical characteristics over recommended operating free-air temperature range (unless otherwise noted)

PARAMETER	TEST CONDITIONS†	SN54S274 SN54S275			SN74S274 SN74S275			UNIT	
		MIN	TYP‡	MAX	MIN	TYP‡	MAX		
V_{IH} High-level input voltage		2			2			V	
V_{IL} Low-level input voltage				0.8			0.8	V	
V_{IK} Input clamp voltage	$V_{CC} = \text{MIN}$, $I_I = -18 \text{ mA}$			-1.2			-1.2	V	
V_{OH} High-level output voltage	$V_{CC} = \text{MIN}$, $V_{IH} = 2 \text{ V}$, $V_{IL} = 0.8 \text{ V}$, $I_{OH} = \text{MAX}$	2.4	3.4		2.4	3.2		V	
V_{OL} Low-level output voltage	$V_{CC} = \text{MIN}$, $V_{IH} = 2 \text{ V}$, $V_{IL} = 0.8 \text{ V}$, $I_{OL} = 12 \text{ mA}$			0.5			0.5	V	
I_{OZH} Off-state output current, high-level voltage applied	$V_{CC} = \text{MAX}$, $V_{IH} = 2 \text{ V}$, $V_O = 2.4 \text{ V}$			50			50	μA	
I_{OZL} Off-state output current, low-level voltage applied	$V_{CC} = \text{MAX}$, $V_{IH} = 2 \text{ V}$, $V_O = 0.5 \text{ V}$			-50			-50	μA	
I_I Input current at maximum input voltage	$V_{CC} = \text{MAX}$, $V_I = 5.5 \text{ V}$			1			1	mA	
I_{IH} High-level input current	$V_{CC} = \text{MAX}$, $V_I = 2.7 \text{ V}$			25			25	μA	
I_{IL} Low-level input current	$V_{CC} = \text{MAX}$, $V_I = 0.5 \text{ V}$			-0.25			-0.25	mA	
I_{OS} Short-circuit output current§	$V_{CC} = \text{MAX}$	-30		-100	-30		-100	mA	
I_{CC} Supply current	$V_{CC} = \text{MAX}$			105	155		105	155	mA

switching characteristics over recommended ranges of T_A and V_{CC} (unless otherwise noted)

PARAMETER¶	FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	SN54S274 SN54S275		SN74S274 SN74S275		UNIT	
				MIN	TYP‡	MAX	MIN		TYP‡
t_{PHL}	Any A or B ('S274), or Any Slice or Carry ('S275)	Any	$C_L = 30 \text{ pF}$, $R_L = 400 \Omega$, See Note 3	60		95	50	70	ns
t_{PLH}				50		95	50	70	
t_{PZH}	Any Enable	Any	$C_L = 5 \text{ pF}$, $R_L = 400 \Omega$, See Note 3	15		45	15	30	ns
t_{PZL}				15		45	15	30	
t_{PHZ}				10		40	10	25	ns
t_{PLZ}				10		40	10	25	

† For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.

‡ All typical values are at $V_{CC} = 5 \text{ V}$, $T_A = 25^\circ\text{C}$.

§ Not more than one output should be shorted at a time and duration of the short-circuit should not exceed one second.

¶ t_{PLH} ≡ Propagation delay time, low-to-high-level output

t_{PHL} ≡ Propagation delay time, high-to-low-level output

t_{PZH} ≡ Output enable time to high level

t_{PZL} ≡ Output enable time to low level

t_{PHZ} ≡ Output disable time from high level

t_{PLZ} ≡ Output disable time from low level

NOTE 3: Load circuit and voltage waveforms are shown on page 3-10.

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TYPES SN54LS275, SN54S274, SN54S275, SN74LS275, SN74S274, SN74S275

4-BIT-BY-4-BIT BINARY MULTIPLIER WITH 3-STATE OUTPUTS

7-BIT-SLICE WALLACE TREES WITH 3-STATE OUTPUTS

TYPICAL APPLICATION DATA

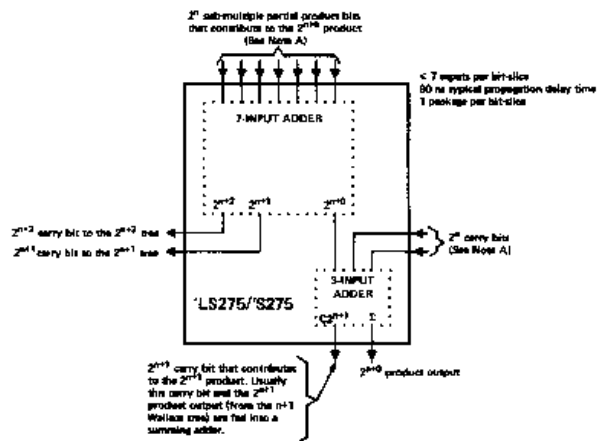


FIGURE 1—BASIC BIT-SLICE WALLACE TREE

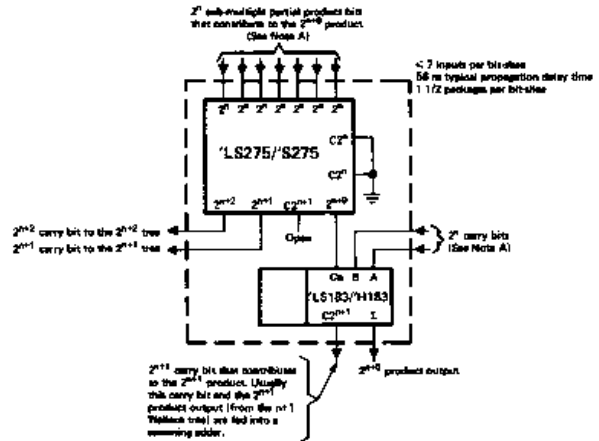


FIGURE 2—HIGH-SPEED BIT-SLICE WALLACE TREE

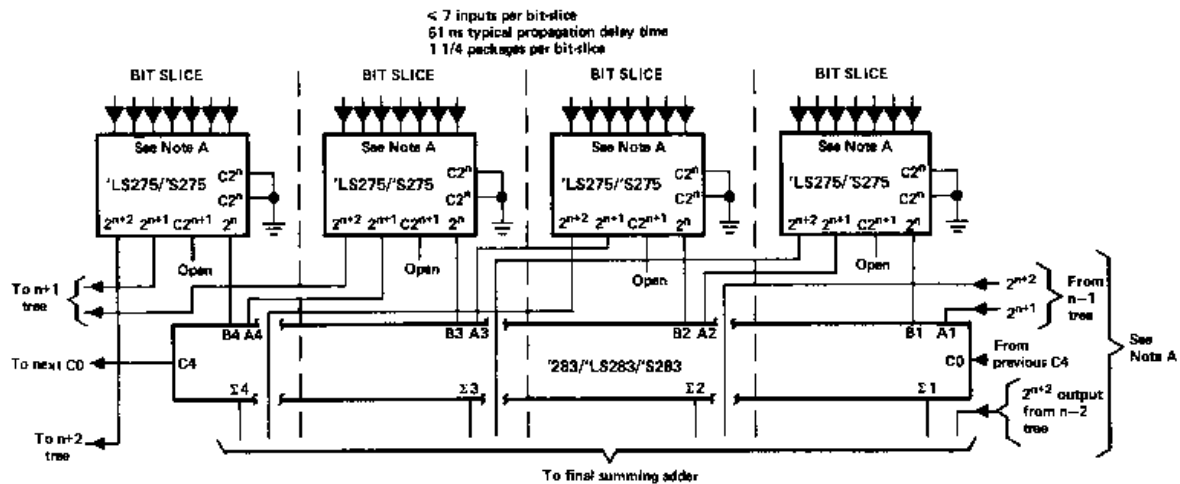


FIGURE 3—MODERATE-SPEED BIT-SLICE WALLACE TREE

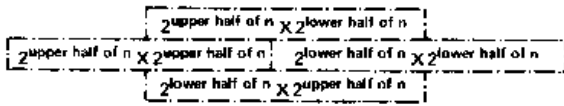
NOTE A: All unused inputs must be grounded.

TYPES SN54LS275, SN54S274, SN54S275, SN74LS275, SN74S274, SN74S275

4-BIT-BY-4-BIT BINARY MULTIPLIER WITH 3-STATE OUTPUTS

7-BIT-SLICE WALLACE TREES WITH 3-STATE OUTPUTS

TYPICAL APPLICATION DATA



NOTE A: The left-hand half of each rectangle is the portion of word one used to obtain the product shown within the rectangle. Similarly, the right-hand half of each rectangle is the portion of word two used.

FIGURE 6—UNIVERSAL METHOD OF ADDING $\frac{n}{2}$ -BIT PRODUCTS TO OBTAIN AN n -BIT PRODUCT

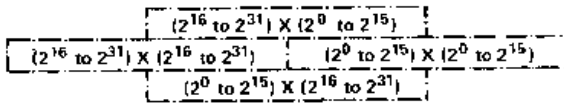


FIGURE 7—METHOD OF ADDING 32-BIT PRODUCTS TO OBTAIN A 64-BIT PRODUCT

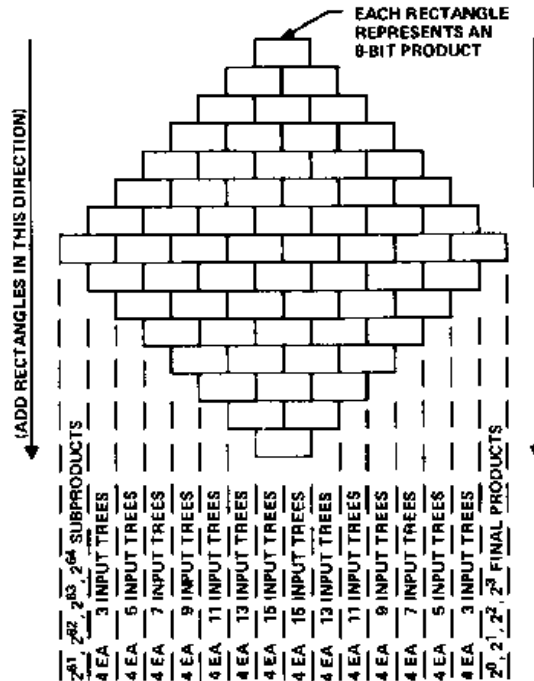
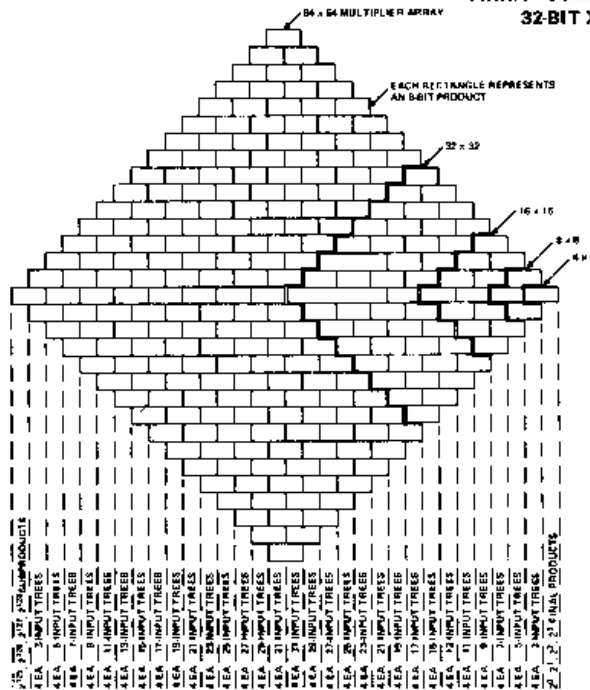


FIGURE 8—FINAL PRODUCTS AND ARRAY SUBPRODUCT ADDITIONS FOR 32-BIT X 32-BIT MULTIPLIER

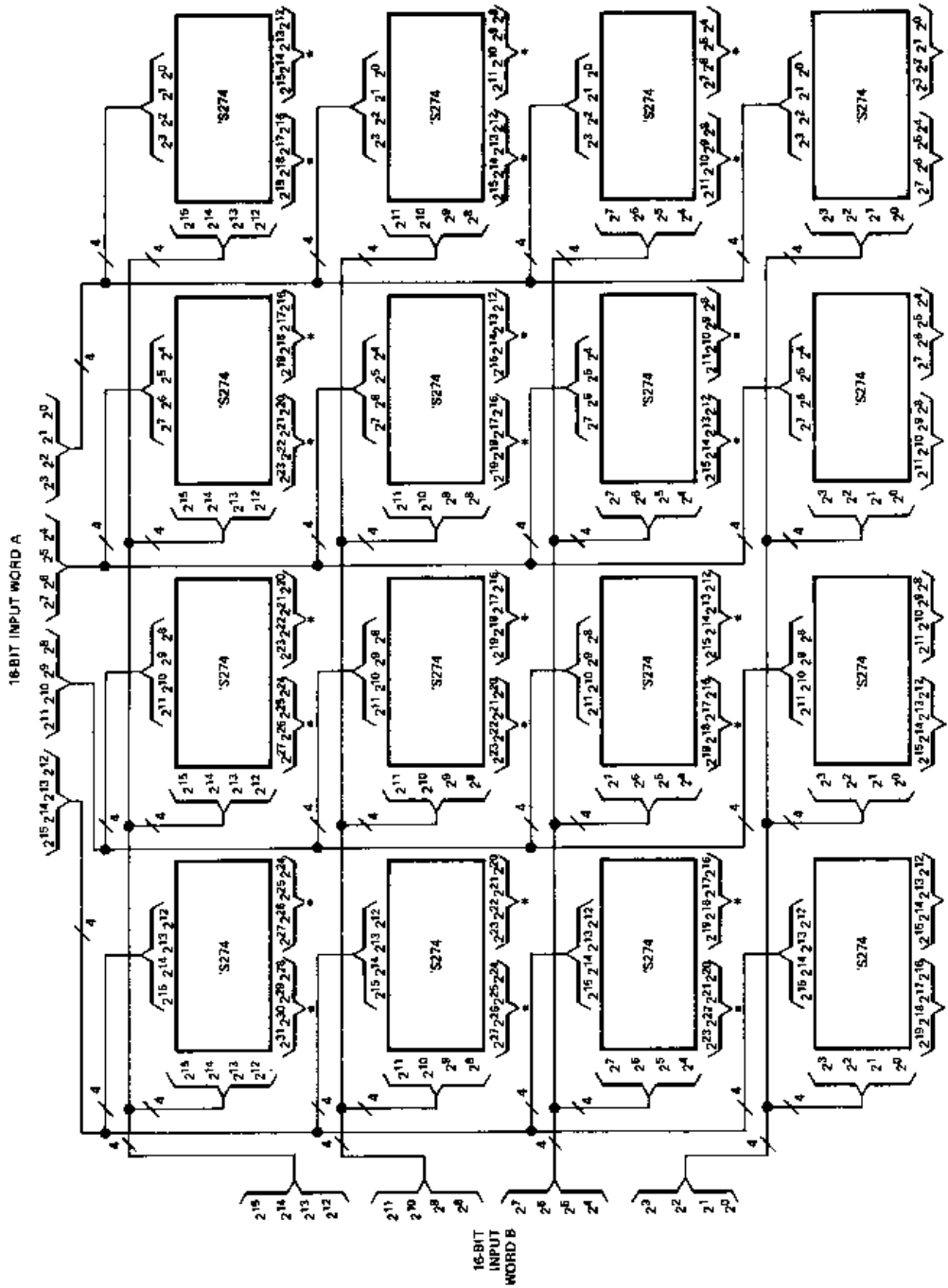


NOTE A: See Note B of Figure 6 for designing trees with any number of inputs up to 31.

FIGURE 9—ARRAY ARRANGEMENT FOR VARIOUS MULTIPLIERS INCLUDING ARRAY SUBPRODUCT ADDITIONS FOR 64-BIT X 64-BIT MULTIPLIER

TYPES SN54LS275, SN54S274, SN54S275, SN74LS275, SN74S274, SN74S275
4-BIT-BY-4-BIT BINARY MULTIPLIER WITH 3-STATE OUTPUTS
7-BIT-SLICE WALLACE TREES WITH 3-STATE OUTPUTS

TYPICAL APPLICATION DATA

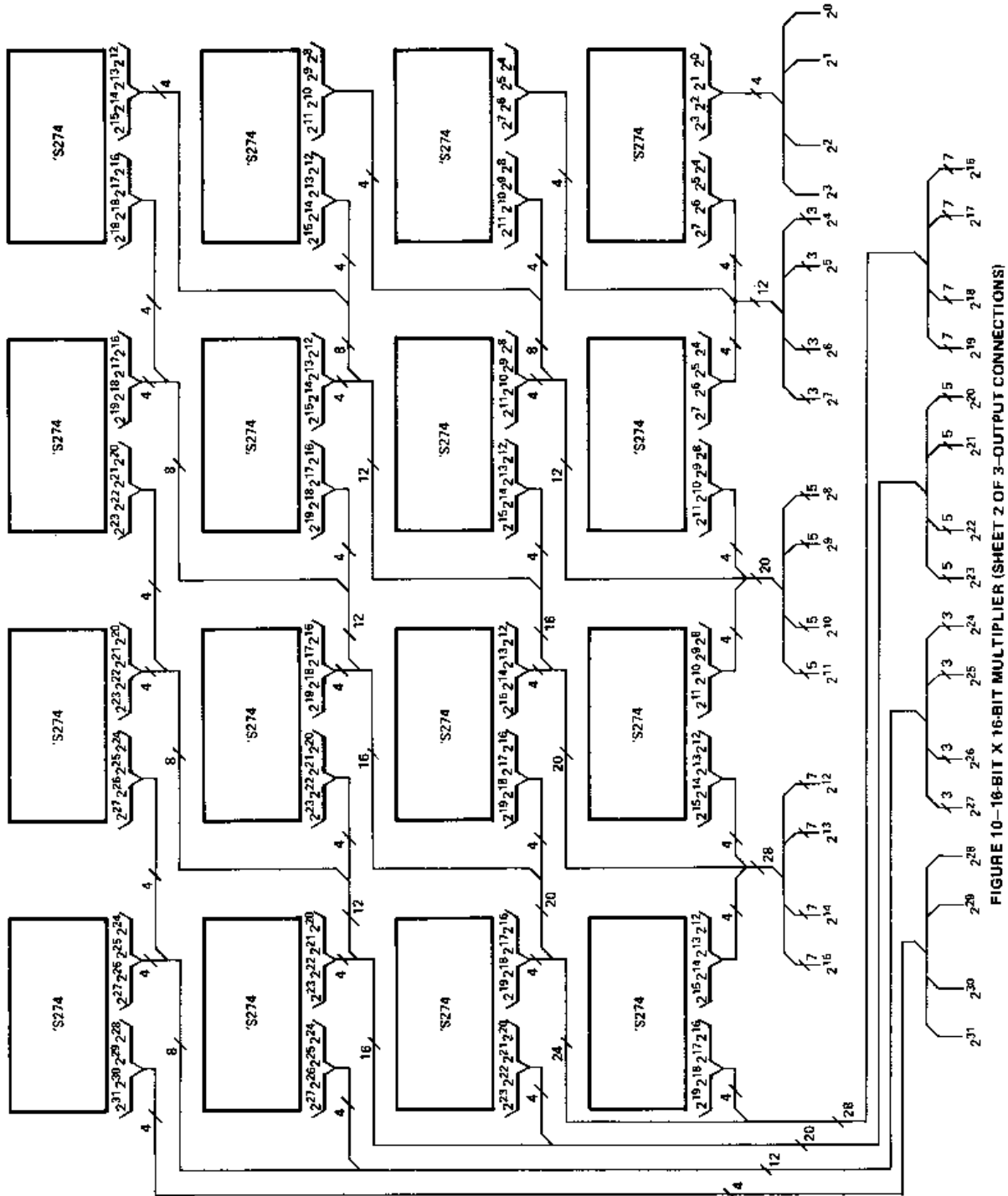


* This 4-bit binary number is a partial product. See Figure 11, Sheets 2 and 3 for diagram of summation process.

FIGURE 10-16-BIT X 16-BIT MULTIPLIER (SHEET 1 OF 3-OUTPUT CONNECTIONS)

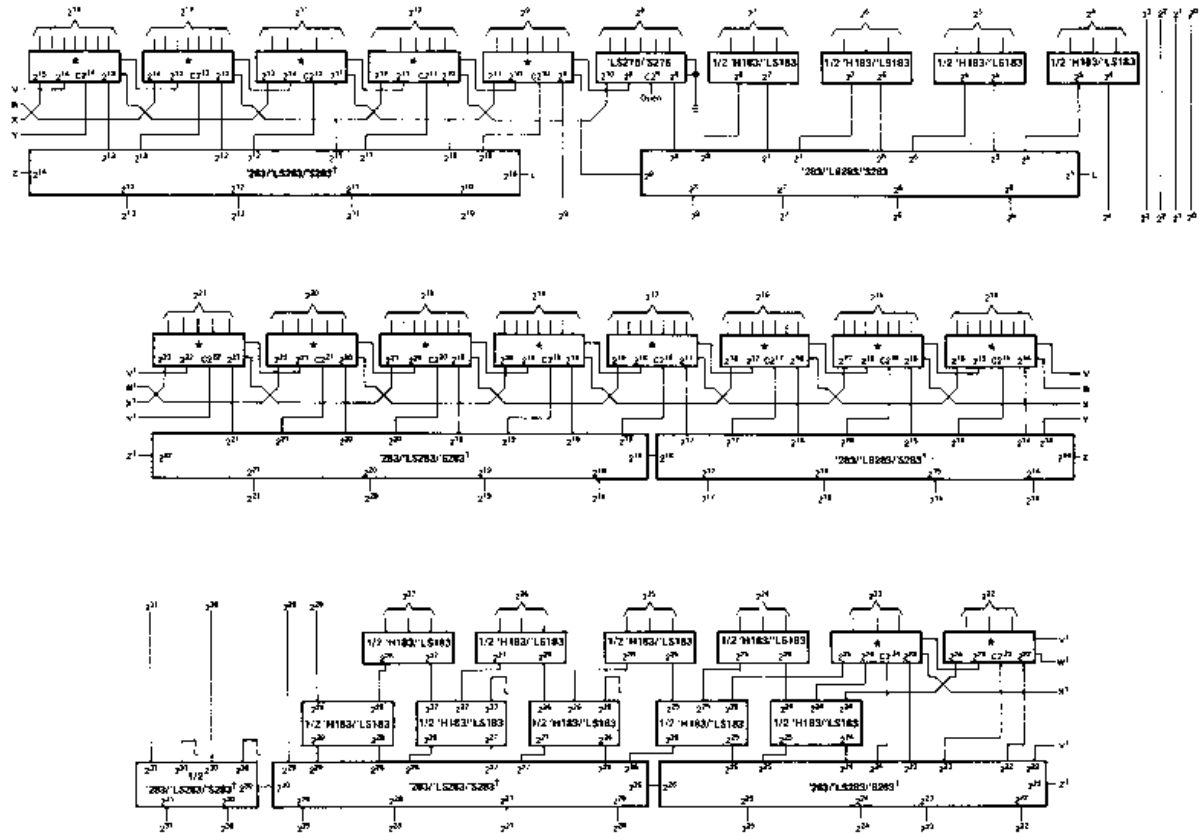
TYPES SN54LS275, SN54S274, SN54S275, SN74LS275, SN74S274, SN74S275
4-BIT-BY-4-BIT BINARY MULTIPLIER WITH 3-STATE OUTPUTS
7-BIT-SLICE WALLACE TREES WITH 3-STATE OUTPUTS

TYPICAL APPLICATION DATA



TYPES SN54LS275, SN54S274, SN54S275, SN74LS275, SN74S274, SN74S275 4-BIT-BY-4-BIT BINARY MULTIPLIER WITH 3-STATE OUTPUTS 7-BIT-SLICE WALLACE TREES WITH 3-STATE OUTPUTS

TYPICAL APPLICATION DATA



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*Each starred block may be either a basic bit-slice Wallace tree ('LS275 or 'S275 only) or a high-speed bit-slice Wallace tree ('LS275 plus 1/2 'LS183 or 'S275 plus 1/2 'H183). In either case the function of the terminal is the same as the similarly located terminal of the basic bit-slice (Figure 1) or high-speed bit-slice Wallace tree (Figure 2). Also for either tree, when only five inputs of the seven-input adder of the 'LS275/'S275 are used, the remaining two inputs must be grounded. When the high-speed adder is used, the C²ⁿ inputs of the 'LS275/'S275 must be grounded.

†For improved performance SN74LS181/SN74S181 ALUs with SN74S182 look-ahead generators can be substituted for the SN74283/SN74LS283/SN74S283 adders. Typically, the multiplication time will be reduced by 18 to 32 nanoseconds.

FIGURE 10—16-BIT X 16-BIT MULTIPLIER
(SHEET 3 OF 3—SUMMING PARTIAL PRODUCTS)