- **Full Look-Ahead for High-Speed Operations on Long Words**

- **Input Clamping Diodes Minimize Transmission-Line Effects**

- **Darlington Outputs Reduce Turn-Off Time**

- **Arithmetic Operating Modes:**
  Addition
  Subtraction
  Shift Operand A One Position
  Magnitude Comparison
  Plus Twelve Other Arithmetic Operations

- **Logic Function Modes:**
  Exclusive-OR
  Comparator
  AND, NAND, OR, NOR
  Plus Ten Other Logic Operations

SN54181, SN54LS181, SN54S181 . . . J OR W PACKAGE
SN74181 . . . J OR N PACKAGE
SN74LS181, SN74S181 . . . DW, J OR N PACKAGE
(TOP VIEW)

B0	1		24	V_{CC}
A0	2		23	$\overline{A1}$
S3	3		22	$\overline{B1}$
S2	4		21	$\overline{A2}$
S1	5		20	$\overline{B2}$
S0	6		19	$\overline{A3}$
C_n	7		18	$\overline{B3}$
M	8		17	G
$\overline{F0}$	9		16	C_{n+4}
F1	10		15	P
$\overline{F2}$	11		14	A − B
GND	12		13	F3
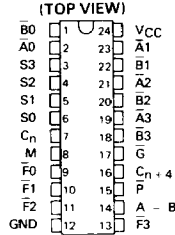
SN54LS181, SN54S181 . . . FK PACKAGE
SN74LS181, SN74S181 . . . FN PACKAGE
(TOP VIEW)

S2 [5		25] $\overline{A2}$
S1 [6		24] $\overline{B2}$
S0 [7		23] $\overline{A3}$
NC [8		22] NC
C_n [9		21] $\overline{B3}$
M [10		20] G
$\overline{F0}$ [11		19] C_{n+4}

Top pins: S3, A0, B0, NC, V_{CC}, $\overline{A1}$, $\overline{B1}$ (4 3 2 1 28 27 26)
Bottom pins: F1, F2, GND, NC, F3, A−B, P (12 13 14 15 16 17 18)

NC - No internal connection

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TTL DEVICES
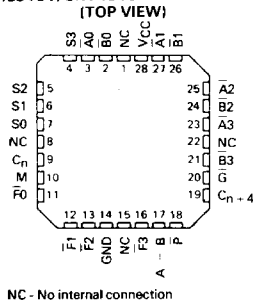
TYPICAL ADDITION TIMES

NUMBER OF BITS	ADDITION TIMES			PACKAGE COUNT		CARRY METHOD BETWEEN ALU's
	USING '181 AND '182	USING 'LS181 AND '182	USING 'S181 AND 'S182	ARITHMETIC/ LOGIC UNITS	LOOK-AHEAD CARRY GENERATORS	
1 to 4	24 ns	24 ns	11 ns	1		NONE
5 to 8	36 ns	40 ns	18 ns	2		RIPPLE
9 to 16	36 ns	44 ns	19 ns	3 or 4	1	FULL LOOK-AHEAD
17 to 64	60 ns	68 ns	28 ns	5 to 16	2 to 5	FULL LOOK-AHEAD

description

The '181, 'LS181, and 'S181 are arithmetic logic units (ALU)/function generators that have a complexity of 75 equivalent gates on a monolithic chip. These circuits perform 16 binary arithmetic operations on two 4-bit words as shown in Tables 1 and 2. These operations are selected by the four function-select lines (S0, S1, S2, S3) and include addition, subtraction, decrement, and straight transfer. When performing arithmetic manipulations, the internal carries must be enabled by applying a low-level voltage to the mode control input (M). A full carry look-ahead scheme is made available in these devices for fast, simultaneous carry generation by means of two cascade-outputs (pins 15 and 17) for the four bits in the package. When used in conjunction with the SN54182, SN54S182, SN74182, or SN74S182, full carry look-ahead circuits, high-speed arithmetic operations can be performed. The typical addition times shown above illustrate the little additional time required for addition of longer words when full carry look-ahead is employed. The method of cascading '182 or 'S182 circuits with these ALU's to provide multi-level full carry look-ahead is illustrated under typical applications data for the '182 and 'S182.

If high speed is not of importance, a ripple-carry input (C_n) and a ripple-carry output (C_{n+4}) are available. However, the ripple-carry delay has also been minimized so that arithmetic manipulations for small word lengths can be performed without external circuitry.

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description (continued)

The '181, 'LS181, and 'S181 will accommodate active-high or active-low data if the pin designations are interpreted as follows:

PIN NUMBER	2	1	23	22	21	20	19	18	9	10	11	13	7	16	15	17
Active-low data (Table 1)	$\overline{A}_0$	$\overline{B}_0$	$\overline{A}_1$	$\overline{B}_1$	$\overline{A}_2$	$\overline{B}_2$	$\overline{A}_3$	$\overline{B}_3$	$\overline{F}_0$	$\overline{F}_1$	$\overline{F}_2$	$\overline{F}_3$	C_n	C_{n+4}	$\overline{P}$	$\overline{G}$
Active-high data (Table 2)	A_0	B_0	A_1	B_1	A_2	B_2	A_3	B_3	F_0	F_1	F_2	F_3	$\overline{C}_n$	$\overline{C}_{n+4}$	X	Y

Subtraction is accomplished by 1's complement addition where the 1's complement of the subtrahend is generated internally. The resultant output is A−B−1, which requires an end-around or forced carry to provide A−B.

The '181, 'LS181, or 'S181 can also be utilized as a comparator. The A = B output is internally decoded from the function outputs (F0, F1, F2, F3) so that when two words of equal magnitude are applied at the A and B inputs, it will assume a high level to indicate equality (A = B). The ALU must be in the subtract mode with C_n = H when performing this comparison. The A = B output is open-collector so that it can be wire-AND connected to give a comparison for more than four bits. The carry output (C_{n+4}) can also be used to supply relative magnitude information. Again, the ALU must be placed in the subtract mode by placing the function select inputs S3, S2, S1, S0 at L, H, H, L, respectively.

INPUT C_n	OUTPUT C_{n+4}	ACTIVE-LOW DATA (FIGURE 1)	ACTIVE-HIGH DATA (FIGURE 2)
H	H	A ⩾ B	A ⩽ B
H	L	A < B	A > B
L	H	A > B	A < B
L	L	A ⩽ B	A ⩾ B

These circuits have been designed to not only incorporate all of the designer's requirements for arithmetic operations, but also to provide 16 possible functions of two Boolean variables without the use of external circuitry. These logic functions are selected by use of the four function-select inputs (S0, S1, S2, S3) with the mode-control input (M) at a high level to disable the internal carry. The 16 logic functions are detailed in Tables 1 and 2 and include exclusive-OR, NAND, AND, NOR, and OR functions.

Series 54, 54LS, and 54S devices are characterized for operation over the full military temperature range of −55°C to 125°C; Series 74, 74LS, and 74S devices are characterized for operation from 0°C to 70°C.

signal designations

The '181, 'LS181, and 'S181 together with the '182 and 'S182 can be used with the signal designations of either Figure 1 or Figure 2. The inversion indicators (O) and the bars over the terminal letter symbols (e.g., $\overline{C}$) each indicate that the associated input or output is active with respect to the selected function of the device when that input or output is low. That is, a low at $\overline{C}$ means "do carry" while a high means "do not carry".

The logic functions and arithmetic operations obtained with signal designations of Figure 1 are given in Table 1; those obtained with signal designations of Figure 2 are given in Table 2.

signal designations (continued)
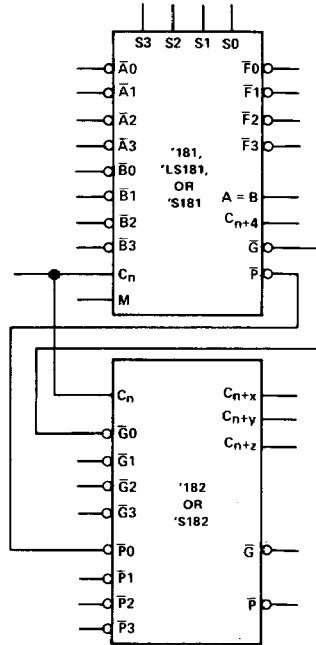
FIGURE 1

TABLE 1

SELECTION				ACTIVE-LOW DATA		
				M = H	M = L; ARITHMETIC OPERATIONS	
S3	S2	S1	S0	LOGIC FUNCTIONS	C_n = L (no carry)	C_n = H (with carry)
L	L	L	L	F = $\overline{A}$	F = A MINUS 1	F = A
L	L	L	H	F = $\overline{AB}$	F = AB MINUS 1	F = AB
L	L	H	L	F = $\overline{A}$ + B	F = $A\overline{B}$ MINUS 1	F = $A\overline{B}$
L	L	H	H	F = 1	F = MINUS 1 (2's COMP)	F = ZERO
L	H	L	L	F = $\overline{A + B}$	F = A PLUS (A + $\overline{B}$)	F = A PLUS (A + $\overline{B}$) PLUS 1
L	H	L	H	F = $\overline{B}$	F = AB PLUS (A + $\overline{B}$)	F = AB PLUS (A + $\overline{B}$) PLUS 1
L	H	H	L	F = $\overline{A \oplus B}$	F = A MINUS B MINUS 1	F = A MINUS B
L	H	H	H	F = A + $\overline{B}$	F = A + $\overline{B}$	F = (A + $\overline{B}$) PLUS 1
H	L	L	L	F = $\overline{A}$B	F = A PLUS (A + B)	F = A PLUS (A + B) PLUS 1
H	L	L	H	F = A $\oplus$ B	F = A PLUS B	F = A PLUS B PLUS 1
H	L	H	L	F = B	F = $A\overline{B}$ PLUS (A + B)	F = $A\overline{B}$ PLUS (A + B) PLUS 1
H	L	H	H	F = A + B	F = (A + B)	F = (A + B) PLUS 1
H	H	L	L	F = 0	F = A	F = A PLUS A PLUS 1
H	H	L	H	F = $A\overline{B}$	F = AB PLUS A	F = AB PLUS A PLUS 1
H	H	H	L	F = AB	F = $A\overline{B}$ PLUS A	F = $A\overline{B}$ PLUS A PLUS 1
H	H	H	H	F = A	F = A	F = A PLUS 1

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signal designations (continued)
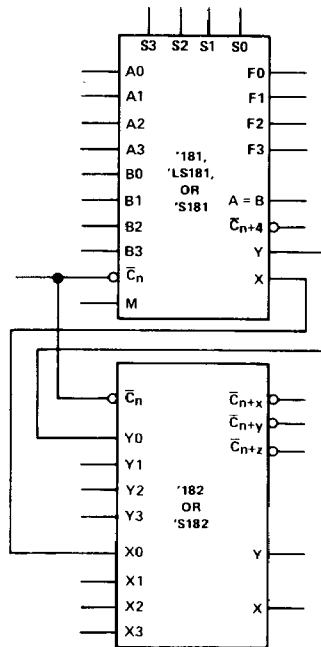
FIGURE 2

TABLE 2

SELECTION				ACTIVE-HIGH DATA		
				M = H	M = L; ARITHMETIC OPERATIONS	
S3	S2	S1	S0	LOGIC FUNCTIONS	$\overline{C}_n$ = H (no carry)	$\overline{C}_n$ = L (with carry)
L	L	L	L	$F = \overline{A}$	F = A	F = A PLUS 1
L	L	L	H	$F = \overline{A + B}$	F = A + B	F = (A + B) PLUS 1
L	L	H	L	$F = \overline{A}B$	$F = A + \overline{B}$	$F = (A + \overline{B})$ PLUS 1
L	L	H	H	F = 0	F = MINUS 1 (2's COMPL)	F = ZERO
L	H	L	L	$F = \overline{AB}$	$F = A$ PLUS $A\overline{B}$	$F = A$ PLUS $A\overline{B}$ PLUS 1
L	H	L	H	$F = \overline{B}$	$F = (A + B)$ PLUS $A\overline{B}$	$F = (A + B)$ PLUS $A\overline{B}$ PLUS 1
L	H	H	L	$F = A \oplus B$	F = A MINUS B MINUS 1	F = A MINUS B
L	H	H	H	$F = A\overline{B}$	$F = A\overline{B}$ MINUS 1	$F = A\overline{B}$
H	L	L	L	$F = \overline{A} + B$	F = A PLUS AB	F = A PLUS AB PLUS 1
H	L	L	H	$F = \overline{A \oplus B}$	F = A PLUS B	F = A PLUS B PLUS 1
H	L	H	L	F = B	$F = (A + \overline{B})$ PLUS AB	$F = (A + \overline{B})$ PLUS AB PLUS 1
H	L	H	H	F = AB	F = AB MINUS 1	F = AB
H	H	L	L	F = 1	F = A	F = A PLUS A PLUS 1
H	H	L	H	$F = A + \overline{B}$	F = (A + B) PLUS A	F = (A + B) PLUS A PLUS 1
H	H	H	L	F = A + B	$F = (A + \overline{B})$ PLUS A	$F = (A + \overline{B})$ PLUS A PLUS 1
H	H	H	H	F = A	F = A MINUS 1	F = A

logic diagram

Pin numbers shown on logic notation are for DW, J or N packages.

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TTL DEVICES

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

Supply voltage, V_{CC} (see Note 1)	7 V
Input voltage	5.5 V
Interemitter voltage (see Note 2)	5.5 V
Operating free-air temperature range: SN54181	$-55°C$ to $125°C$
SN74181	$0°C$ to $70°C$
Storage temperature range	$-65°C$ to $150°C$

NOTES: 1. Voltage values, except interemitter voltage, are with respect to network ground terminal.
2. This is the voltage between two emitters of a multiple-emitter transistor. For this circuit, this rating applies to each $\overline{A}$ input in conjunction with inputs S2 or S3, and to each $\overline{B}$ input in conjunction with inputs S0 or S3.

recommended operating conditions

	SN54181			SN74181			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} (All outputs except A = B)			−800			−800	µA
Low-level output current, I_{OL}			16			16	mA
Operating free-air temperature, T_A	−55		125	0		70	°C

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

PARAMETER		TEST CONDITIONS†		SN54181			SN74181			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} = MIN, I_I = −12 mA				−1.5			−1.5	V
V_{OH}	High-level output voltage, any output except A = B	V_{CC} = MIN, V_{IH} = 2 V, V_{IL} = 0.8 V, I_{OH} = −800 µA		2.4	3.4		2.4	3.4		V
I_{OH}	High-level output current, A = B output only	V_{CC} = MIN, V_{IH} = 2 V, V_{IL} = 0.8 V, V_{OH} = 5.5 V				250			250	µA
V_{OL}	Low-level output voltage	V_{CC} = MIN, V_{IH} = 2 V, V_{IL} = 0.8 V, I_{OL} = 16 mA			0.2	0.4		0.2	0.4	V
I_I	Input current at maximum input voltage	V_{CC} = MAX, V_I = 5.5 V				1			1	mA
I_{IH}	High-level input current	Mode input	V_{CC} = MAX, V_I = 2.4 V			40			40	µA
		Any $\overline{A}$ or $\overline{B}$ input				120			120	
		Any S input				160			160	
		Carry input				200			200	
I_{IL}	Low-level input current	Mode input	V_{CC} = MAX, V_I = 0.4 V			−1.6			−1.6	mA
		Any $\overline{A}$ or $\overline{B}$ input				−4.8			−4.8	
		Any S input				−6.4			−6.4	
		Carry input				−8			−8	
I_{OS}	Short-circuit output current, any output except A = B§	V_{CC} = MAX		−20		−55	−18		−57	mA
I_{CC}	Supply current	V_{CC} = MAX, See Note 3	Condition A		88	127		88	140	mA
			Condition B		94	135		94	150	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 V, T_A = 25°C.
§Not more than one output should be shorted at a time.

NOTE 3: With outputs open, I_{CC} is measured for the following conditions:
A. S0 through S3, M, and $\overline{A}$ inputs are at 4.5 V, all other inputs are grounded.
B. S0 through S3 and M are at 4.5 V, all other inputs are grounded.

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TTL DEVICES

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switching characteristics, $V_{CC} = 5$ V, $T_A = 25°C$ ($C_L = 15$ pF, $R_L = 400$ Ω, see note 4)

PARAMETER¶	FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	MIN	TYP	MAX	UNIT
t_{PLH}	C_n	C_{n+4}			12	18	ns
t_{PHL}					13	19	
t_{PLH}	Any $\overline{A}$ or $\overline{B}$	C_{n+4}	M = 0 V, S0 = S3 = 4.5 V,		28	43	ns
t_{PHL}			S1 = S2 = 0 V ($\overline{SUM}$ mode)		27	41	
t_{PLH}	Any $\overline{A}$ or $\overline{B}$	C_{n+4}	M = 0 V, S0 = S3 = 0 V,		35	50	ns
t_{PHL}			S1 = S2 = 4.5 V ($\overline{DIFF}$ mode)		33	50	
t_{PLH}	C_n	Any $\overline{F}$	M = 0 V		13	19	ns
t_{PHL}			($\overline{SUM}$ or $\overline{DIFF}$ mode)		12	18	
t_{PLH}	Any $\overline{A}$ or $\overline{B}$	$\overline{G}$	M = 0 V, S0 = S3 = 4.5 V,		13	19	ns
t_{PHL}			S1 = S2 = 0 V ($\overline{SUM}$ mode)		13	19	
t_{PLH}	Any $\overline{A}$ or $\overline{B}$	$\overline{G}$	M = 0 V, S0 = S3 = 0 V,		17	25	ns
t_{PHL}			S1 = S2 = 4.5 V ($\overline{DIFF}$ mode)		17	25	
t_{PLH}	Any $\overline{A}$ or $\overline{B}$	$\overline{P}$	M = 0 V, S0 = S3 = 4.5 V,		13	19	ns
t_{PHL}			S1 = S2 = 0 V ($\overline{SUM}$ mode)		17	25	
t_{PLH}	Any $\overline{A}$ or $\overline{B}$	$\overline{P}$	M = 0 V, S0 = S3 = 0 V,		17	25	ns
t_{PHL}			S1 = S2 = 4.5 V ($\overline{DIFF}$ mode)		17	25	
t_{PLH}	$\overline{A}_i$ or $\overline{B}_i$	$\overline{F}_i$	M = 0 V, S0 = S3 = 4.5 V,		28	42	ns
t_{PHL}			S1 = S2 = 0 V ($\overline{SUM}$ mode)		21	32	
t_{PLH}	$\overline{A}_i$ or $\overline{B}_i$	$\overline{F}_i$	M = 0 V, S0 = S3 = 0 V,		32	48	ns
t_{PHL}			S1 = S2 = 4.5 V ($\overline{DIFF}$ mode)		23	34	
t_{PLH}	$\overline{A}_i$ or $\overline{B}_i$	$\overline{F}_i$	M = 4.5 V (logic mode)		32	48	ns
t_{PHL}					23	34	
t_{PLH}	Any $\overline{A}$ or $\overline{B}$	A = B	M = 0 V, S0 = S3 = 0 V,		35	50	ns
t_{PHL}			S1 = S2 = 4.5 V ($\overline{DIFF}$ mode)		32	48	

¶ t_{PLH} ≡ propagation delay time, low-to-high-level output
  t_{PHL} ≡ propagation delay time, high-to-low-level output
NOTE 4: See General Information Section for load circuits and voltage waveforms.

schematics of inputs and outputs

EQUIVALENT OF EACH INPUT

V_{CC}

R_{eq}

INPUT

Mode control: R_{eq} = 4 kΩ NOM
Any $\overline{A}$ or $\overline{B}$: R_{eq} = 2 kΩ NOM
Any S: R_{eq} = 1.3 kΩ NOM
C_n: R_{eq} = 1 kΩ NOM

TYPICAL OF ALL OUTPUTS
EXCEPT A = B

V_{CC}

100 Ω NOM

OUTPUT

A = B OUTPUT

OUTPUT

3
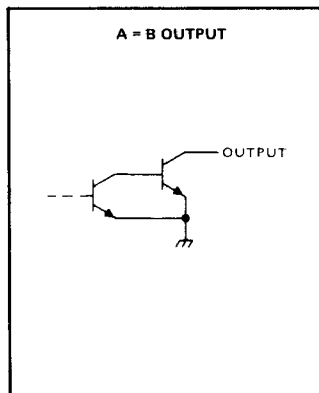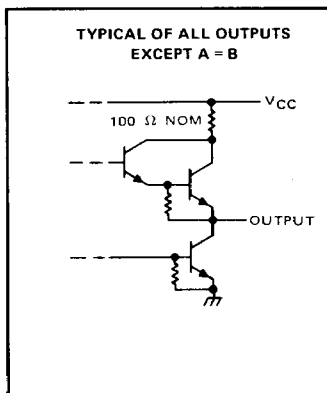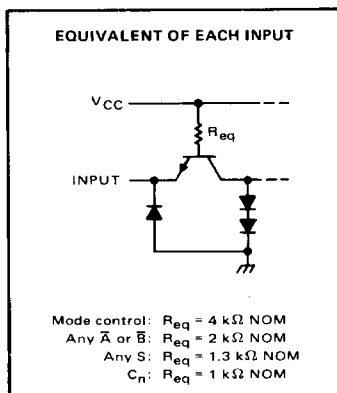
TTL DEVICES

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

Supply voltage, V_{CC} (see Note 1) . . . . 7 V

Input voltage . . . . 5.5 V

Interemitter voltage (see Note 2) . . . . 5.5 V

Operating free-air temperature range: SN54LS181 . . . . $-55°C$ to $125°C$

SN74LS181 . . . . $0°C$ to $70°C$

Storage temperature range . . . . $-65°C$ to $150°C$

NOTES: 1. Voltage values, except interemitter voltage, are with respect to network ground terminal.
2. This is the voltage between two emitters of a multiple-emitter transistor. For this circuit, this rating applies to each $\bar{A}$ input in conjunction with inputs S2 or S3, and to each $\bar{B}$ input in conjunction with inputs S0 or S3.

recommended operating conditions

	SN54LS181			SN74LS181			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} (All outputs except A = B)			−400			−400	μA
Low-level output current, I_{OL}			4			8	mA
Operating free-air temperature, T_A	−55		125	0		70	°C

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

PARAMETER		TEST CONDITIONS†			SN54LS181			SN74LS181			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} = MIN,	I_I = −18 mA				−1.5			−1.5	V
V_{OH}	High-level output voltage, any output except A = B	V_{CC} = MIN, $V_{IL} = V_{IL}$ max,	V_{IH} = 2 V, $I_{OH} = -400 \mu A$		2.5	3.4		2.7	3.4		V
I_{OH}	High-level output current, A = B output only	V_{CC} = MIN, $V_{IL} = V_{IL}$ max,	V_{IH} = 2 V, V_{OH} = 5.5 V				100			100	μA
V_{OL}	Low-level output voltage	All outputs	V_{CC} = MIN, $V_{IL} = V_{IL}$ max	V_{IH} = 2 V, I_{OL} = 4 mA		0.25	0.4		0.25	0.4	V
				I_{OL} = 8 mA					0.35	0.5	
		Output $\bar{G}$		I_{OL} = 16 mA		0.47	0.7		0.47	0.7	
		Output $\bar{P}$		I_{OL} = 8 mA		0.35	0.6		0.35	0.5	
I_I	Input current at max. input voltage	Mode input	V_{CC} = MAX, V_I = 5.5 V				0.1			0.1	mA
		Any $\bar{A}$ or $\bar{B}$ input					0.3			0.3	
		Any S input					0.4			0.4	
		Carry input					0.5			0.5	
I_{IH}	High-level input current	Mode input	V_{CC} = MAX, V_I = 2.7 V				20			20	μA
		Any $\bar{A}$ or $\bar{B}$ input					60			60	
		Any S input					80			80	
		Carry input					100			100	
I_{IL}	Low-level input current	Mode input	V_{CC} = MAX, V_I = 0.4 V				−0.4			−0.4	mA
		Any $\bar{A}$ or $\bar{B}$ input					−1.2			−1.2	
		Any S input					−1.6			−1.6	
		Carry input					−2			−2	
I_{OS}	Short-circuit output current, any output except A = B §	V_{CC} = MAX			−6		−40	−5		−42	mA
I_{CC}	Supply current	V_{CC} = MAX, See Note 3	Condition A		20		32	20		34	mA
			Condition B		21		35	21		37	

†For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.
‡All typical values are at V_{CC} = 5 V, T_A = 25°C.
§Not more than one output should be shorted at a time.
NOTE 3: With outputs open, I_{CC} is measured for the following conditions:
A. S0 through S3, M, and $\bar{A}$ inputs are at 4.5 V, all other inputs are grounded.
B. S0 through S3 and M are at 4.5 V, all other inputs are grounded.

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switching characteristics, $V_{CC} = 5$ V, $T_A = 25°C$, ($C_L = 15$ pF, $R_L = 2$ kΩ, see note 4)

PARAMETER¶	FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	MIN	TYP	MAX	UNIT
t_{PLH}	C_n	C_{n+4}			18	27	ns
t_{PHL}					13	20	
t_{PLH}	Any $\overline{A}$ or $\overline{B}$	C_{n+4}	M = 0 V, S0 = S3 = 4.5 V,		25	38	ns
t_{PHL}			S1 = S2 = 0 V (SUM mode)		25	38	
t_{PLH}	Any $\overline{A}$ or $\overline{B}$	C_{n+4}	M = 0 V, S0 = S3 = 0 V		27	41	ns
t_{PHL}			S1 = S2 = 4.5 V ($\overline{DIFF}$ mode)		27	41	
t_{PLH}	C_n	Any $\overline{F}$	M = 0 V		17	26	ns
t_{PHL}			($\overline{SUM}$ or $\overline{DIFF}$ mode)		13	20	
t_{PLH}	Any $\overline{A}$ or $\overline{B}$	$\overline{G}$	M = 0 V, S0 = S3 = 4.5 V,		19	29	ns
t_{PHL}			S1 = S2 = 0 V ($\overline{SUM}$ mode)		15	23	
t_{PLH}	Any $\overline{A}$ or $\overline{B}$	$\overline{G}$	M = 0 V, S0 = S3 = 0 V,		21	32	ns
t_{PHL}			S1 = S2 = 4.5 V ($\overline{DIFF}$ mode)		21	32	
t_{PLH}	Any $\overline{A}$ or $\overline{B}$	$\overline{P}$	M = 0 V, S0 = S3 = 4.5 V,		20	30	ns
t_{PHL}			S1 = S2 = 0 V ($\overline{SUM}$ mode)		20	30	
t_{PLH}	Any $\overline{A}$ or $\overline{B}$	$\overline{P}$	M = 0 V, S0 = S3 = 0 V,		20	30	ns
t_{PHL}			S1 = S2 = 4.5 V ($\overline{DIFF}$ mode)		22	33	
t_{PLH}	$\overline{A}_i$ or $\overline{B}_i$	$\overline{F}_i$	M = 0 V, S0 = S3 = 4.5 V,		21	32	ns
t_{PHL}			S1 = S2 = 0 V (SUM mode)		13	20	
t_{PLH}	$\overline{A}_i$ or $\overline{B}_i$	$\overline{F}_i$	M = 0 V, S0 = S3 = 0 V,		21	32	ns
t_{PHL}			S1 = S2 = 4.5 V ($\overline{DIFF}$ mode)		21	32	
t_{PLH}	$\overline{A}_i$ or $\overline{B}_i$	$\overline{F}_i$	M = 4.5 V (logic mode)		22	33	ns
t_{PHL}					26	38	
t_{PLH}	Any $\overline{A}$ or $\overline{B}$	A = B	M = 0 V, S0 = S3 = 0 V,		33	50	ns
t_{PHL}			S1 = S2 = 4.5 V ($\overline{DIFF}$ mode)		41	62	

¶ t_{PLH} ≡ propagation delay time, low-to-high-level output
  t_{PHL} ≡ propagation delay time, high-to-low-level output
NOTE 4: See General Information Section for load circuits and voltage waveforms.

schematics of inputs and outputs

EQUIVALENT OF EACH INPUT	TYPICAL OF ALL OUTPUTS EXCEPT A = B	A = B OUTPUT

EQUIVALENT OF EACH INPUT

V_{CC}

R_{eq}

INPUT

Mode control: R_{eq} = 17 kΩ NOM
Any $\overline{A}$ or $\overline{B}$: R_{eq} = 5.67 kΩ NOM
Any S: R_{eq} = 4.25 kΩ NOM
C_n: R_{eq} = 2.86 kΩ NOM

TYPICAL OF ALL OUTPUTS EXCEPT A = B

250 Ω NOM

V_{CC}

OUTPUT

A = B OUTPUT

V_{CC}

OUTPUT

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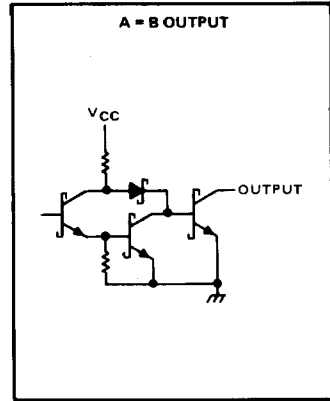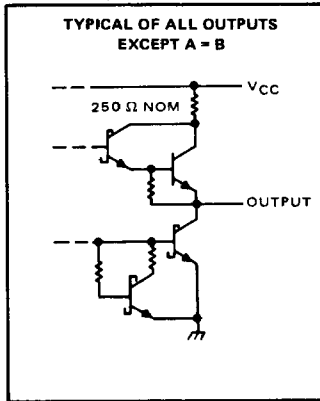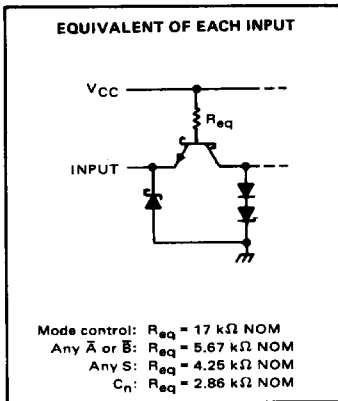
TTL DEVICES

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

Supply voltage, V_{CC} (see Note 1)	7 V
Input voltage	5.5 V
Interemitter voltage (see Note 2)	5.5 V
Operating free-air temperature: SN54S181	$-55°C$ to $125°C$
SN74S181	$0°C$ to $70°C$
Storage temperature range	$-65°C$ to $150°C$

NOTES: 1. Voltage values, except interemitter voltage, are with respect to network ground terminal.
2. This is the voltage between two emitters of a multiple-emitter transistor. For this circuit, this rating applies to each $\overline{A}$ input in conjunction with inputs S2 or S3, and to each $\overline{B}$ input in conjunction with inputs S0 or S3.

recommended operating conditions

	SN54S181 MIN	NOM	MAX	SN74S181 MIN	NOM	MAX	UNIT
Supply voltage, V_{CC}	4.5	5	5.5	4.75	5	5.25	V
High-level output current, I_{OH} (All outputs except A = B)			-1			-1	mA
Low-level output current, I_{OL}			20			20	mA
Operating free-air temperature, T_A	-55		125	0		70	°C

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

PARAMETER		TEST CONDITIONS†		SN54S181 MIN	TYP‡	MAX	SN74S181 MIN	TYP‡	MAX	UNIT
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} = MIN,	$I_I = -18$ mA			-1.2			-1.2	V
V_{OH}	High-level output voltage, any output except A = B	V_{CC} = MIN, V_{IL} = 0.8 V,	V_{IH} = 2 V, $I_{OH} = -1$ mA	2.5	3.4		2.7	3.4		V
I_{OH}	High-level output current, A = B output only	V_{CC} = MIN, V_{IL} = 0.8 V,	V_{IH} = 2 V, V_{OH} = 5.5 V			250			250	µA
V_{OL}	Low-level output voltage	V_{CC} = MIN, V_{IL} = 0.8 V,	V_{IH} = 2 V, I_{OL} = 20 mA			0.5			0.5	V
I_I	Input current at maximum input voltage	V_{CC} = MAX,	V_I = 5.5 V			1			1	mA
I_{IH}	High-level input current	Mode input	V_{CC} = MAX, V_I = 2.5 V			50			50	µA
		Any $\overline{A}$ or $\overline{B}$ input				150			150	
		Any S input				200			200	
		Carry input				250			250	
I_{IL}	Low-level input current	Mode input	V_{CC} = MAX, V_I = 0.5 V			-2			-2	mA
		Any $\overline{A}$ or $\overline{B}$ input				-6			-6	
		Any S input				-8			-8	
		Carry input				-10			-10	
I_{OS}	Short-circuit output current, any output except A = B§	V_{CC} = MAX		-40		-100	-40		-100	mA
I_{CC}	Supply current	V_{CC} = MAX, T_A = 125°C, See Note 3	W package only		195					mA
		V_{CC} = MAX, See Note 3	All packages		120	220		120	220	

†For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.
‡All typical values are at V_{CC} = 5 V, T_A = 25°C.
§Not more than one output should be shorted at a time.
NOTE 3: I_{CC} is measured for the following conditions (the typical and maximum values apply to both):
    A. S0 through S3, M, and $\overline{A}$ inputs are at 4.5 V, all other inputs are grounded, and all outputs are open.
    B. S0 through S3 and M are at 4.5 V, all other inputs grounded, and all outputs are open.

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TTL DEVICES

switching characteristics, V_{CC} = 5 V, T_A = 25°C (C_L = 15 pF, R_L = 280 Ω, see note 4)

PARAMETER¶	FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	MIN	TYP	MAX	UNIT
t_{PLH}	C_n	C_{n+4}			7	10.5	ns
t_{PHL}					7	10.5	
t_{PLH}	Any $\overline{A}$ or $\overline{B}$	C_{n+4}	M = 0 V, $S0$ = $S3$ = 4.5 V, $S1$ = $S2$ = 0 V ($\overline{SUM}$ mode)		12.5	18.5	ns
t_{PHL}					12.5	18.5	
t_{PLH}	Any $\overline{A}$ or $\overline{B}$	C_{n+4}	M = 0 V, $S0$ = $S3$ = 0 V, $S1$ = $S2$ = 4.5 V ($\overline{DIFF}$ mode)		15.5	23	ns
t_{PHL}					15.5	23	
t_{PLH}	C_n	Any $\overline{F}$	M = 0 V ($\overline{SUM}$ or $\overline{DIFF}$ mode)		7	12	ns
t_{PHL}					7	12	
t_{PLH}	Any $\overline{A}$ or $\overline{B}$	$\overline{G}$	M = 0 V, $S0$ = $S3$ = 4.5 V, $S1$ = $S2$ = 0 V ($\overline{SUM}$ mode)		8	12	ns
t_{PHL}					7.5	12	
t_{PLH}	Any $\overline{A}$ or $\overline{B}$	$\overline{G}$	M = 0 V, $S0$ = $S3$ = 0 V, $S1$ = $S2$ = 4.5 V ($\overline{DIFF}$ mode)		10.5	15	ns
t_{PHL}					10.5	15	
t_{PLH}	Any $\overline{A}$ or $\overline{B}$	$\overline{P}$	M = 0 V, $S0$ = $S3$ = 4.5 V, $S1$ = $S2$ = 0 V ($\overline{SUM}$ mode)		7.5	12	ns
t_{PHL}					7.5	12	
t_{PLH}	Any $\overline{A}$ or $\overline{B}$	$\overline{P}$	M = 0 V, $S0$ = $S3$ = 0 V, $S1$ = $S2$ = 4.5 V ($\overline{DIFF}$ mode)		10.5	15	ns
t_{PHL}					10.5	15	
t_{PLH}	$\overline{A}_i$ or $\overline{B}_i$	$\overline{F}_i$	M = 0 V, $S0$ = $S3$ = 4.5 V, $S1$ = $S2$ = 0 V ($\overline{SUM}$ mode)		11	16.5	ns
t_{PHL}					11	16.5	
t_{PLH}	$\overline{A}_i$ or $\overline{B}_i$	$\overline{F}_i$	M = 0 V, $S0$ = $S3$ = 0 V, $S1$ = $S2$ = 4.5 V ($\overline{DIFF}$ mode)		14	20	ns
t_{PHL}					14	22	
t_{PLH}	$\overline{A}_i$ or $\overline{B}_i$	$\overline{F}_i$	M = 4.5 V (logic mode)		14	20	ns
t_{PHL}					14	22	
t_{PLH}	Any $\overline{A}$ or $\overline{B}$	A = B	M = 0 V, $S0$ = $S3$ = 0 V, $S1$ = $S2$ = 4.5 V ($\overline{DIFF}$ mode)		15	23	ns
t_{PHL}					20	30	

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

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

NOTE 4: See General Information Section for load circuits and voltage waveforms.

schematics of inputs and outputs

EQUIVALENT OF EACH INPUT

V_{CC}

R_{eq}

INPUT

Mode control: R_{eq} = 2.8 kΩ NOM
Any $\overline{A}$ or $\overline{B}$: R_{eq} = 940 Ω NOM
Any S: R_{eq} = 700 Ω NOM
C_n: R_{eq} = 560 Ω NOM

TYPICAL OF ALL OUTPUTS
EXCEPT A = B

50 Ω NOM

V_{CC}

OUTPUT

A = B OUTPUT

V_{CC}

OUTPUT

TTL DEVICES

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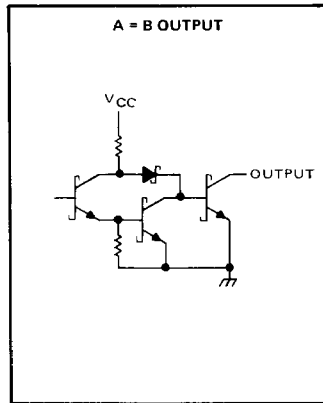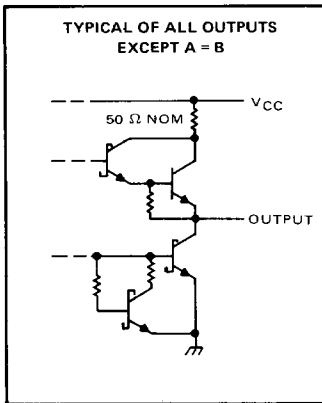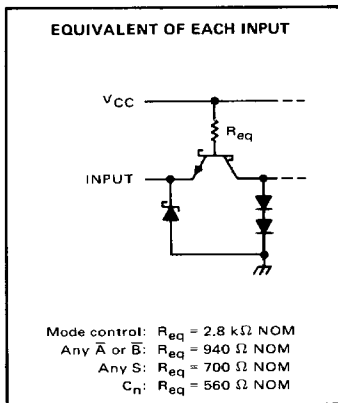
PARAMETER MEASUREMENT INFORMATION

SUM MODE TEST TABLE
FUNCTION INPUTS: S0 = S3 = 4.5 V, S1 = S2 = M = 0 V

PARAMETER	INPUT UNDER TEST	OTHER INPUT SAME BIT		OTHER DATA INPUTS		OUTPUT UNDER TEST	OUTPUT WAVEFORM (See Note 4)
		APPLY 4.5 V	APPLY GND	APPLY 4.5 V	APPLY GND		
t_{PLH} t_{PHL}	$\overline{A}_i$	$\overline{B}_i$	None	Remaining $\overline{A}$ and $\overline{B}$	C_n	$\overline{F}_i$	In-Phase
t_{PLH} t_{PHL}	$\overline{B}_i$	$\overline{A}_i$	None	Remaining $\overline{A}$ and $\overline{B}$	C_n	$\overline{F}_i$	In-Phase
t_{PLH} t_{PHL}	$\overline{A}_i$	$\overline{B}_i$	None	None	Remaining $\overline{A}$ and $\overline{B}$, C_n	$\overline{P}$	In-Phase
t_{PLH} t_{PHL}	$\overline{B}_i$	$\overline{A}_i$	None	None	Remaining $\overline{A}$ and $\overline{B}$, C_n	$\overline{P}$	In-Phase
t_{PLH} t_{PHL}	$\overline{A}_i$	None	$\overline{B}_i$	Remaining $\overline{B}$	Remaining $\overline{A}$, C_n	$\overline{G}$	In-Phase
t_{PLH} t_{PHL}	$\overline{B}_i$	None	$\overline{A}_i$	Remaining $\overline{B}$	Remaining $\overline{A}$, C_n	$\overline{G}$	In-Phase
t_{PLH} t_{PHL}	C_n	None	None	All $\overline{A}$	All $\overline{B}$	Any $\overline{F}$ or C_{n+4}	In-Phase
t_{PLH} t_{PHL}	$\overline{A}_i$	None	$\overline{B}_i$	Remaining $\overline{B}$	Remaining $\overline{A}$, C_n	C_{n+4}	Out-of-Phase
t_{PLH} t_{PHL}	$\overline{B}_i$	None	$\overline{A}_i$	Remaining $\overline{B}$	Remaining $\overline{A}$, C_n	C_{n+4}	Out-of-Phase

DIFF MODE TEST TABLE
FUNCTION INPUTS: S1 = S2 = 4.5 V, S0 = S3 = M = 0 V

PARAMETER	INPUT UNDER TEST	OTHER INPUT SAME BIT		OTHER DATA INPUTS		OUTPUT UNDER TEST	OUTPUT WAVEFORM (See Note 4)
		APPLY 4.5 V	APPLY GND	APPLY 4.5 V	APPLY GND		
t_{PLH} t_{PHL}	$\overline{A}_i$	None	$\overline{B}_i$	Remaining $\overline{A}$	Remaining $\overline{B}$, C_n	$\overline{F}_i$	In-Phase
t_{PLH} t_{PHL}	$\overline{B}_i$	$\overline{A}_i$	None	Remaining $\overline{A}$	Remaining $\overline{B}$, C_n	$\overline{F}_i$	Out-of-Phase
t_{PLH} t_{PHL}	$\overline{A}_i$	None	$\overline{B}_i$	None	Remaining $\overline{A}$ and $\overline{B}$, C_n	$\overline{P}$	In-Phase
t_{PLH} t_{PHL}	$\overline{B}_i$	$\overline{A}_i$	None	None	Remaining $\overline{A}$ and $\overline{B}$, C_n	$\overline{P}$	Out-of-Phase
t_{PLH} t_{PHL}	$\overline{A}_i$	$\overline{B}_i$	None	None	Remaining $\overline{A}$ and $\overline{B}$, C_n	$\overline{G}$	In-Phase
t_{PLH} t_{PHL}	$\overline{B}_i$	None	$\overline{A}_i$	None	Remaining $\overline{A}$ and $\overline{B}$, C_n	$\overline{G}$	Out-of-Phase
t_{PLH} t_{PHL}	$\overline{A}_i$	None	$\overline{B}_i$	Remaining $\overline{A}$	Remaining $\overline{B}$, C_n	A = B	In-Phase
t_{PLH} t_{PHL}	$\overline{B}_i$	$\overline{A}_i$	None	Remaining $\overline{A}$	Remaining $\overline{B}$, C_n	A = B	Out-of-Phase
t_{PLH} t_{PHL}	C_n	None	None	All $\overline{A}$ and $\overline{B}$	None	C_{n+4} or any $\overline{F}$	In-Phase
t_{PLH} t_{PHL}	$\overline{A}_i$	$\overline{B}_i$	None	None	Remaining $\overline{A}$, $\overline{B}$, C_n	C_{n+4}	Out-of-Phase
t_{PLH} t_{PHL}	$\overline{B}_i$	None	$\overline{A}_i$	None	Remaining $\overline{A}$, $\overline{B}$, C_n	C_{n+4}	In-Phase

LOGIC MODE TEST TABLE
FUNCTION INPUTS: S1 = S2 = M = 4.5 V, S0 = S3 = 0 V

PARAMETER	INPUT UNDER TEST	OTHER INPUT SAME BIT		OTHER DATA INPUTS		OUTPUT UNDER TEST	OUTPUT WAVEFORM (See Note 4)
		APPLY 4.5 V	APPLY GND	APPLY 4.5 V	APPLY GND		
t_{PLH} t_{PHL}	$\overline{A}_i$	$\overline{B}_i$	None	None	Remaining $\overline{A}$ and $\overline{B}$, C_n	$\overline{F}_i$	Out-of-Phase
t_{PLH} t_{PHL}	$\overline{B}_i$	$\overline{A}_i$	None	None	Remaining $\overline{A}$ and $\overline{B}$, C_n	$\overline{F}_i$	Out-of-Phase

NOTE 4: See General Information Section for load circuits and voltage waveforms

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