

TYPES SN54181, SN54LS181, SN54S181, SN74181, SN74LS181, SN74S181 ARITHMETIC LOGIC UNITS/FUNCTION GENERATORS

DECEMBER 1972 — REVISED DECEMBER 1983

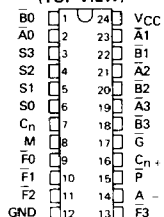
- Full Look-Ahead for High-Speed Operations on Long Words
- Input Clamping Diodes Minimize Transmission-Line Effects
- Darlington Outputs Reduce Turn-Off Time
- Arithmetic Operating Modes:
 - Addition
 - Subtraction
 - Shift Operand A One Position
 - Magnitude Comparison
 - Plus Twelve Other Arithmetic 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

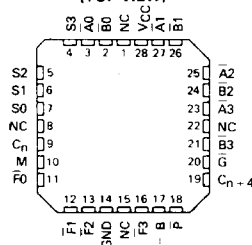
(TOP VIEW)



SN54LS181, SN54S181 . . . FK PACKAGE

SN74LS181, SN74S181 . . . FN PACKAGE

(TOP VIEW)



NC - No internal connection

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.

PRODUCTION DATA

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TYPES SN54181, SN54LS181, SN54S181, SN74181, SN74LS181, SN74S181 ARITHMETIC LOGIC UNITS/FUNCTION GENERATORS

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)	$\bar{A}_0$	$\bar{B}_0$	$\bar{A}_1$	$\bar{B}_1$	$\bar{A}_2$	$\bar{B}_2$	$\bar{A}_3$	$\bar{B}_3$	$\bar{F}_0$	$\bar{F}_1$	$\bar{F}_2$	$\bar{F}_3$	$\bar{C}_n$	$\bar{C}_{n+4}$	$\bar{P}$	$\bar{G}$
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	C_n	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 (F_0, F_1, F_2, F_3) 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 S_3, S_2, S_1, S_0 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	$A > B$	$A \leq B$
H	L	$A < B$	$A > B$
L	H	$A > B$	$A < B$
L	L	$A \leq B$	$A \geq B$

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 (S_0, S_1, S_2, S_3) 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., $\bar{C}$) 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 $\bar{C}$ 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.

TYPES SN54181, SN54LS181, SN54S181,
SN74181, SN74LS181, SN74S181
ARITHMETIC LOGIC UNITS/FUNCTION GENERATORS

signal designations (continued)

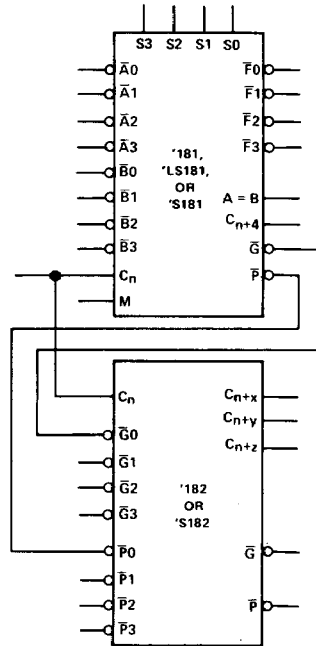


FIGURE 1

TABLE 1

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

**TYPES SN54181, SN54LS181, SN54S181,
SN74181, SN74LS181, SN74S181
ARITHMETIC LOGIC UNITS/FUNCTION GENERATORS**

signal designations (continued)

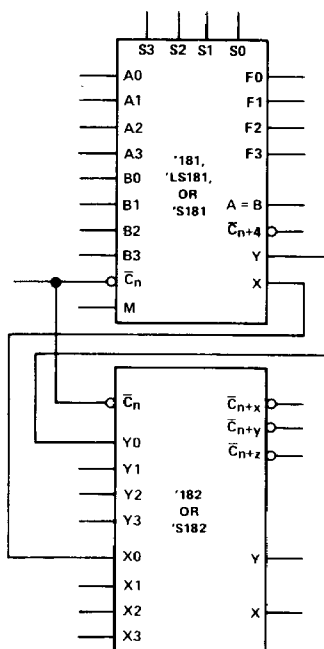


FIGURE 2

TABLE 2

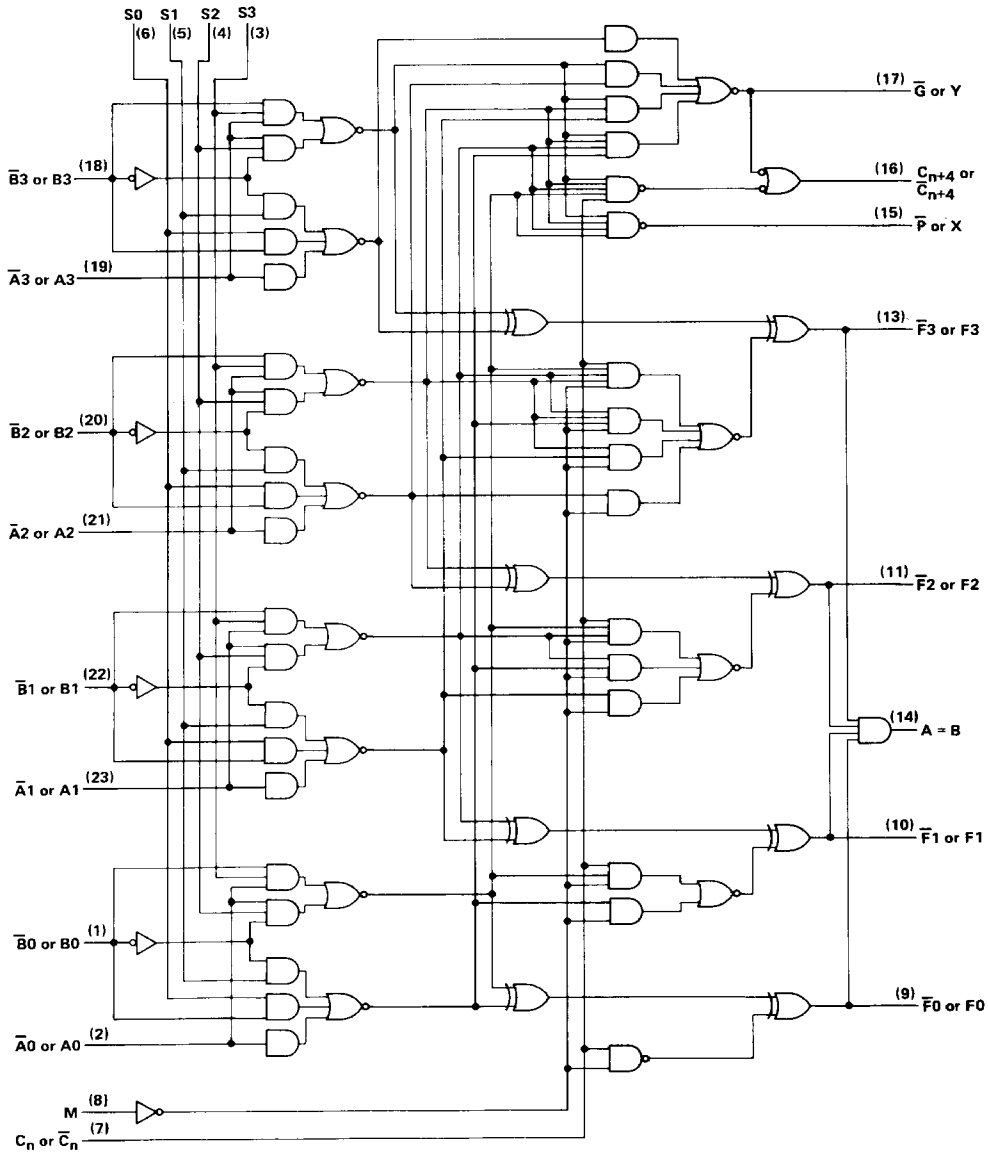
SELECTION					ACTIVE-HIGH DATA		
					M = H LOGIC FUNCTIONS	M = L; ARITHMETIC OPERATIONS	
S3	S2	S1	S0			$\overline{C}_n = H$ (no carry)	$\overline{C}_n = L$ (with carry)
L	L	L	L		$F = \overline{A}$	$F = A$	$F = A \text{ PLUS } 1$
L	L	L	H		$F = \overline{A} + B$	$F = A + B$	$F = (A + B) \text{ PLUS }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

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TTL DEVICES

TYPES SN54181, SN54LS181, SN54S181, SN74181, SN74LS181, SN74S181
ARITHMETIC LOGIC UNITS/FUNCTION GENERATORS

logic diagram



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

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TTL DEVICES

TYPES SN54181, SN74181

ARITHMETIC LOGIC UNITS/FUNCTION GENERATORS

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 $\bar{A}$ input in conjunction with inputs S2 or S3, and to each $\bar{B}$ input in conjunction with inputs S0 or S3.

recommended operating conditions

	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	μ A
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	$V_{CC} = \text{MIN}, I_I = -12 \text{ mA}$			-1.5			-1.5	V
V_{OH}	High-level output voltage, any output except A = B	$V_{CC} = \text{MIN}, V_{IH} = 2 \text{ V}, V_{IL} = 0.8 \text{ V}, I_{OH} = -800 \mu\text{A}$	2.4	3.4		2.4	3.4		V
I_{OH}	High-level output current, A = B output only	$V_{CC} = \text{MIN}, V_{IH} = 2 \text{ V}, V_{IL} = 0.8 \text{ V}, V_{OH} = 5.5 \text{ V}$			250			250	μ A
V_{OL}	Low-level output voltage	$V_{CC} = \text{MIN}, V_{IH} = 2 \text{ V}, V_{IL} = 0.8 \text{ V}, I_{OL} = 16 \text{ mA}$		0.2	0.4		0.2	0.4	V
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	Mode input			40			40	μ A
		Any $\bar{A}$ or $\bar{B}$ input			120			120	
		Any S input			160			160	
		Carry input			200			200	
I_{IL}	Low-level input current	Mode input			-1.6			-1.6	mA
		Any $\bar{A}$ or $\bar{B}$ 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 §	$V_{CC} = \text{MAX}$	-20		-55	-18		-57	mA
I_{CC}	Supply current	$V_{CC} = \text{MAX}, \text{Condition A}$	88	127		88	140		mA
		See Note 3, 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 $V_{CC} = 5 \text{ V}, T_A = 25^\circ \text{C}$.

§ 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.

TYPES SN54181, SN74181

ARITHMETIC LOGIC UNITS/FUNCTION GENERATORS

switching characteristics, $V_{CC} = 5\text{ V}$, $T_A = 25^\circ\text{C}$ ($C_L = 15\text{ pF}$, $R_L = 400\ \Omega$, see note 4)

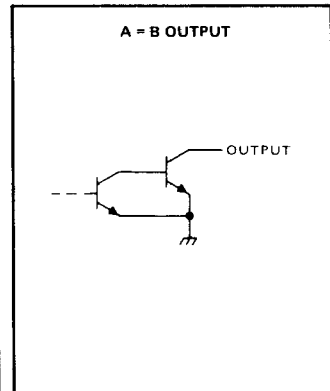
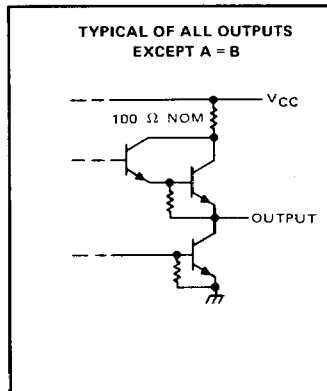
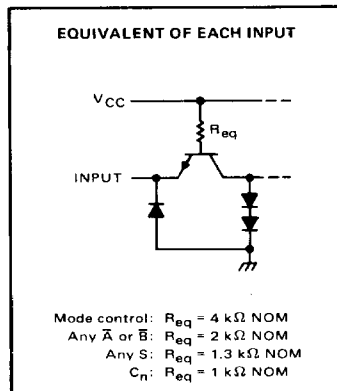
PARAMETER [†]	FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	MIN	TYP	MAX	UNIT
t_{PLH}	C_n	C_{n+4}			12	18	ns
t_{PHL}					13	19	
t_{PLH}	Any $\bar{A}$ or $\bar{B}$	C_{n+4}	$M = 0\text{ V}$, $S_0 = S_3 = 4.5\text{ V}$, $S_1 = S_2 = 0\text{ V}$ (SUM mode)		28	43	ns
t_{PHL}					27	41	
t_{PLH}	Any $\bar{A}$ or $\bar{B}$	C_{n+4}	$M = 0\text{ V}$, $S_0 = S_3 = 0\text{ V}$, $S_1 = S_2 = 4.5\text{ V}$ (DIFF mode)		35	50	ns
t_{PHL}					33	50	
t_{PLH}	C_n	Any $\bar{F}$	$M = 0\text{ V}$ (SUM or DIFF mode)		13	19	ns
t_{PHL}					12	18	
t_{PLH}	Any $\bar{A}$ or $\bar{B}$	$\bar{G}$	$M = 0\text{ V}$, $S_0 = S_3 = 4.5\text{ V}$, $S_1 = S_2 = 0\text{ V}$ (SUM mode)		13	19	ns
t_{PHL}					13	19	
t_{PLH}	Any $\bar{A}$ or $\bar{B}$	$\bar{G}$	$M = 0\text{ V}$, $S_0 = S_3 = 0\text{ V}$, $S_1 = S_2 = 4.5\text{ V}$ (DIFF mode)		17	25	ns
t_{PHL}					17	25	
t_{PLH}	Any $\bar{A}$ or $\bar{B}$	$\bar{P}$	$M = 0\text{ V}$, $S_0 = S_3 = 4.5\text{ V}$, $S_1 = S_2 = 0\text{ V}$ (SUM mode)		13	19	ns
t_{PHL}					17	25	
t_{PLH}	Any $\bar{A}$ or $\bar{B}$	$\bar{P}$	$M = 0\text{ V}$, $S_0 = S_3 = 0\text{ V}$, $S_1 = S_2 = 4.5\text{ V}$ (DIFF mode)		17	25	ns
t_{PHL}					17	25	
t_{PLH}	$\bar{A}_i$ or $\bar{B}_i$	$\bar{F}_i$	$M = 0\text{ V}$, $S_0 = S_3 = 4.5\text{ V}$, $S_1 = S_2 = 0\text{ V}$ (SUM mode)		28	42	ns
t_{PHL}					21	32	
t_{PLH}	$\bar{A}_i$ or $\bar{B}_i$	$\bar{F}_i$	$M = 0\text{ V}$, $S_0 = S_3 = 0\text{ V}$, $S_1 = S_2 = 4.5\text{ V}$ (DIFF mode)		32	48	ns
t_{PHL}					23	34	
t_{PLH}	$\bar{A}_i$ or $\bar{B}_i$	$\bar{F}_i$	$M = 4.5\text{ V}$ (logic mode)		32	48	ns
t_{PHL}					23	34	
t_{PLH}	Any $\bar{A}$ or $\bar{B}$	$A = B$	$M = 0\text{ V}$, $S_0 = S_3 = 0\text{ V}$, $S_1 = S_2 = 4.5\text{ V}$ (DIFF mode)		35	50	ns
t_{PHL}					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



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TTL DEVICES

TYPES SN54LS181, SN74LS181

ARITHMETIC LOGIC UNITS/FUNCTION GENERATORS

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	μ A
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			V		
V _{OH}	High-level output voltage, any output except A = B		V _{CC} = MIN, V _{IH} = 2 V, V _{IL} = V _{IL max} , I _{OH} = -400 µA			2.5 3.4			V		
I _{OH}	High-level output current, A = B output only		V _{CC} = MIN, V _{IH} = 2 V, V _{IL} = V _{IL max} , V _{OH} = 5.5 V			100			µA		
V _{OL}	Low-level output voltage	All outputs Output $\bar{G}$ Output P	V _{CC} = MIN, V _{IH} = 2 V, V _{IL} = V _{IL max}	I _{OL} = 4 mA	0.25 0.4		0.25 0.4		V		
				I _{OL} = 8 mA			0.35 0.5				
				I _{OL} = 16 mA	0.47 0.7		0.47 0.7				
				I _{OL} = 8 mA	0.35 0.6		0.35 0.5				
I _I	Input current at max. input voltage	Mode input Any $\bar{A}$ or $\bar{B}$ input Any S input Carry input	V _{CC} = MAX, V _I = 5.5 V			0.1		0.1		mA	
						0.3		0.3			
						0.4		0.4			
						0.5		0.5			
I _{IH}	High-level input current	Mode input Any $\bar{A}$ or $\bar{B}$ input Any S input Carry input	V _{CC} = MAX, V _I = 2.7 V			20		20		µA	
						60		60			
						80		80			
						100		100			
I _{IL}	Low-level input current	Mode input Any $\bar{A}$ or $\bar{B}$ input Any S input Carry input	V _{CC} = MAX, V _I = 0.4 V			-0.4		-0.4		mA	
						-1.2		-1.2			
						-1.6		-1.6			
						-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 $V_{CC} = 5 \text{ V}, T_A = 25^\circ \text{C}$.

§ 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.

TYPES SN54LS181, SN74LS181 ARITHMETIC LOGIC UNITS/FUNCTION GENERATORS

switching characteristics, $V_{CC} = 5\text{ V}$, $T_A = 25^\circ\text{C}$, ($C_L = 15\text{ pF}$, $R_L = 2\text{ k}\Omega$, see note 4)

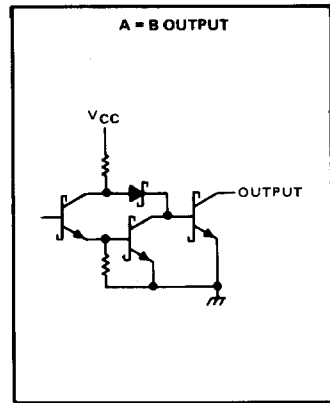
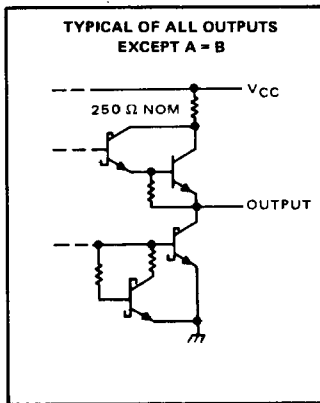
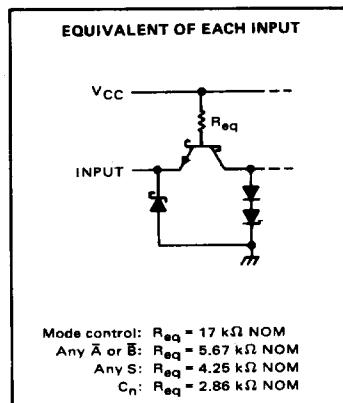
PARAMETER [†]	FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	MIN	TYP	MAX	UNIT
t_{PLH}	C_n	C_{n+4}		18	27	ns	
t_{PHL}				13	20		
t_{PLH}	Any $\bar{A}$ or $\bar{B}$	C_{n+4}	$M = 0\text{ V}$, $S_0 = S_3 = 4.5\text{ V}$, $S_1 = S_2 = 0\text{ V}$ (SUM mode)	25	38	ns	
t_{PHL}				25	38		
t_{PLH}	Any $\bar{A}$ or $\bar{B}$	C_{n+4}	$M = 0\text{ V}$, $S_0 = S_3 = 0\text{ V}$, $S_1 = S_2 = 4.5\text{ V}$ (DIFF mode)	27	41	ns	
t_{PHL}				27	41		
t_{PLH}	C_n	Any F	$M = 0\text{ V}$ (SUM or DIFF mode)	17	26	ns	
t_{PHL}				13	20		
t_{PLH}	Any $\bar{A}$ or $\bar{B}$	$\bar{G}$	$M = 0\text{ V}$, $S_0 = S_3 = 4.5\text{ V}$, $S_1 = S_2 = 0\text{ V}$ (SUM mode)	19	29	ns	
t_{PHL}				15	23		
t_{PLH}	Any $\bar{A}$ or $\bar{B}$	$\bar{G}$	$M = 0\text{ V}$, $S_0 = S_3 = 0\text{ V}$, $S_1 = S_2 = 4.5\text{ V}$ (DIFF mode)	21	32	ns	
t_{PHL}				21	32		
t_{PLH}	Any $\bar{A}$ or $\bar{B}$	$\bar{F}$	$M = 0\text{ V}$, $S_0 = S_3 = 4.5\text{ V}$, $S_1 = S_2 = 0\text{ V}$, (SUM mode)	20	30	ns	
t_{PHL}				20	30		
t_{PLH}	Any $\bar{A}$ or $\bar{B}$	$\bar{F}$	$M = 0\text{ V}$, $S_0 = S_3 = 0\text{ V}$, $S_1 = S_2 = 4.5\text{ V}$ (DIFF mode)	20	30	ns	
t_{PHL}				22	33		
t_{PLH}	$\bar{A}_i$ or $\bar{B}_i$	$\bar{F}_i$	$M = 0\text{ V}$, $S_0 = S_3 = 4.5\text{ V}$, $S_1 = S_2 = 0\text{ V}$ (SUM mode)	21	32	ns	
t_{PHL}				13	20		
t_{PLH}	$\bar{A}_i$ or $\bar{B}_i$	$\bar{F}_i$	$M = 0\text{ V}$, $S_0 = S_3 = 0\text{ V}$, $S_1 = S_2 = 4.5\text{ V}$ (DIFF mode)	21	32	ns	
t_{PHL}				21	32		
t_{PLH}	$\bar{A}_i$ or $\bar{B}_i$	$\bar{F}_i$	$M = 4.5\text{ V}$ (logic mode)	22	33	ns	
t_{PHL}				26	38		
t_{PLH}	Any $\bar{A}$ or $\bar{B}$	$A = B$	$M = 0\text{ V}$, $S_0 = S_3 = 0\text{ V}$, $S_1 = S_2 = 4.5\text{ V}$ (DIFF mode)	33	50	ns	
t_{PHL}				41	62		

[†] t_{PLH} $\equiv$ propagation delay time, low-to-high-level output

t_{PHL} $\equiv$ 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



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TTL DEVICES

TYPES SN54S181, SN74S181

ARITHMETIC LOGIC UNITS/FUNCTION GENERATORS

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 $\bar{A}$ input in conjunction with inputs S2 or S3, and to each $\bar{B}$ input in conjunction with inputs S0 or S3.

recommended operating conditions

	SN54S181			SN74S181			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)			-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			SN74S181			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, any output except A = B	$V_{CC} = \text{MIN}, V_{IH} = 2 \text{ V}, V_{IL} = 0.8 \text{ V}, I_{OH} = -1 \text{ mA}$	2.5	3.4		2.7	3.4		V
I_{OH}	High-level output current, A = B output only	$V_{CC} = \text{MIN}, V_{IH} = 2 \text{ V}, V_{IL} = 0.8 \text{ V}, V_{OH} = 5.5 \text{ V}$			250			250	µA
V_{OL}	Low-level output voltage	$V_{CC} = \text{MIN}, V_{IH} = 2 \text{ V}, V_{IL} = 0.8 \text{ V}, I_{OL} = 20 \text{ mA}$			0.5			0.5	V
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	$V_{CC} = \text{MAX}, V_I = 2.5 \text{ V}$			50			50	µA
	Mode input				150			150	
	Any $\bar{A}$ or $\bar{B}$ input				200			200	
	Any S input				250			250	
I_{IL}	Low-level input current	$V_{CC} = \text{MAX}, V_I = 0.5 \text{ V}$			-2			-2	mA
	Mode input				-6			-6	
	Any $\bar{A}$ or $\bar{B}$ input				-8			-8	
	Any S input				-10			-10	
I_{OS}	Short-circuit output current, any output except A = B §	$V_{CC} = \text{MAX}$	-40		-100	-40		-100	mA
I_{CC}	Supply current	$V_{CC} = \text{MAX}, T_A = 125^\circ\text{C},$ W package only See Note 3			195				mA
		$V_{CC} = \text{MAX},$ 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 $V_{CC} = 5 \text{ V}, T_A = 25^\circ\text{C}$.

§ 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 $\bar{A}$ 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

TYPES SN54S181, SN74S181 ARITHMETIC LOGIC UNITS/FUNCTION GENERATORS

switching characteristics, $V_{CC} = 5\text{ V}$, $T_A = 25^\circ\text{C}$ ($C_L = 15\text{ pF}$, $R_L = 280\ \Omega$, see note 4)

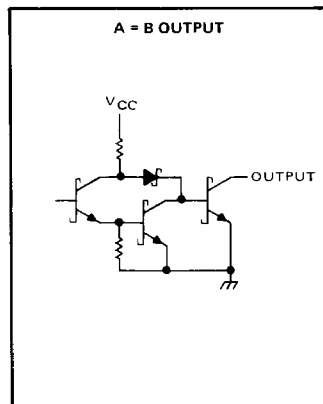
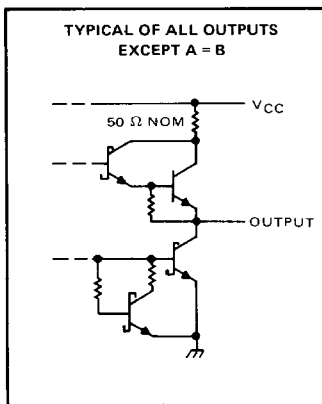
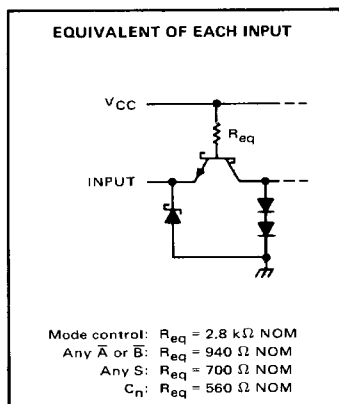
PARAMETER [†]	FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	MIN	TYP	MAX	UNIT
t_{PLH}	C_n	C_{n+4}		7	10.5	ns	
t_{PHL}				7	10.5		
t_{PLH}	Any $\bar{A}$ or $\bar{B}$	C_{n+4}	$M = 0\text{ V}$, $S_0 = S_3 = 4.5\text{ V}$, $S_1 = S_2 = 0\text{ V}$ (SUM mode)	12.5	18.5	ns	
t_{PHL}				12.5	18.5		
t_{PLH}	Any $\bar{A}$ or $\bar{B}$	C_{n+4}	$M = 0\text{ V}$, $S_0 = S_3 = 0\text{ V}$, $S_1 = S_2 = 4.5\text{ V}$ (DIFF mode)	15.5	23	ns	
t_{PHL}				15.5	23		
t_{PLH}	C_n	Any $\bar{F}$	$M = 0\text{ V}$ (SUM or DIFF mode)	7	12	ns	
t_{PHL}				7	12		
t_{PLH}	Any $\bar{A}$ or $\bar{B}$	$\bar{G}$	$M = 0\text{ V}$, $S_0 = S_3 = 4.5\text{ V}$, $S_1 = S_2 = 0\text{ V}$ (SUM mode)	8	12	ns	
t_{PHL}				7.5	12		
t_{PLH}	Any $\bar{A}$ or $\bar{B}$	$\bar{G}$	$M = 0\text{ V}$, $S_0 = S_3 = 0\text{ V}$, $S_1 = S_2 = 4.5\text{ V}$ (DIFF mode)	10.5	15	ns	
t_{PHL}				10.5	15		
t_{PLH}	Any $\bar{A}$ or $\bar{B}$	$\bar{P}$	$M = 0\text{ V}$, $S_0 = S_3 = 4.5\text{ V}$, $S_1 = S_2 = 0\text{ V}$ (SUM mode)	7.5	12	ns	
t_{PHL}				7.5	12		
t_{PLH}	Any $\bar{A}$ or $\bar{B}$	$\bar{P}$	$M = 0\text{ V}$, $S_0 = S_3 = 0\text{ V}$, $S_1 = S_2 = 4.5\text{ V}$ (DIFF mode)	10.5	15	ns	
t_{PHL}				10.5	15		
t_{PLH}	$\bar{A}_i$ or $\bar{B}_i$	$\bar{F}_i$	$M = 0\text{ V}$, $S_0 = S_3 = 4.5\text{ V}$, $S_1 = S_2 = 0\text{ V}$ (SUM mode)	11	16.5	ns	
t_{PHL}				11	16.5		
t_{PLH}	$\bar{A}_i$ or $\bar{B}_i$	$\bar{F}_i$	$M = 0\text{ V}$, $S_0 = S_3 = 0\text{ V}$, $S_1 = S_2 = 4.5\text{ V}$ (DIFF mode)	14	20	ns	
t_{PHL}				14	22		
t_{PLH}	$\bar{A}_i$ or $\bar{B}_i$	$\bar{F}_i$	$M = 4.5\text{ V}$ (logic mode)	14	20	ns	
t_{PHL}				14	22		
t_{PLH}	Any $\bar{A}$ or $\bar{B}$	$A = B$	$M = 0\text{ V}$, $S_0 = S_3 = 0\text{ V}$, $S_1 = S_2 = 4.5\text{ V}$ (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



TTL DEVICES

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TYPES SN54181, SN54LS181, SN54S181, SN74181, SN74LS181, SN74S181 ARITHMETIC LOGIC UNITS/FUNCTION GENERATORS

PARAMETER MEASUREMENT INFORMATION

SUM MODE TEST TABLE

FUNCTION INPUTS: $S_0 = S_3 = 4.5 \text{ V}$, $S_1 = S_2 = M = 0 \text{ V}$

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}	$\bar{A}_1$	$\bar{B}_1$	None	Remaining $\bar{A}$ and $\bar{B}$	C_n	$\bar{F}_1$	In-Phase
t_{PHL}	$\bar{B}_1$	$\bar{A}_1$	None	Remaining $\bar{A}$ and $\bar{B}$	C_n	$\bar{F}_1$	In-Phase
t_{PLH}	A_1	$\bar{B}_1$	None	None	Remaining $\bar{A}$ and B , C_n	$\bar{P}$	In-Phase
t_{PHL}	$\bar{B}_1$	$\bar{A}_1$	None	None	Remaining $\bar{A}$ and B , C_n	$\bar{P}$	In-Phase
t_{PLH}	$\bar{A}_1$	None	$\bar{B}_1$	Remaining $\bar{B}$	Remaining $\bar{A}$, C_n	$\bar{G}$	In-Phase
t_{PHL}	$\bar{B}_1$	None	$\bar{A}_1$	Remaining $\bar{B}$	Remaining $\bar{A}$, C_n	$\bar{G}$	In-Phase
t_{PLH}	C_n	None	None	All $\bar{A}$	All $\bar{B}$	Any F or C_{n+4}	In-Phase
t_{PHL}	$\bar{A}_1$	None	$\bar{B}_1$	Remaining $\bar{B}$	Remaining $\bar{A}$, C_n	C_{n+4}	Out-of-Phase
t_{PHL}	$\bar{B}_1$	None	$\bar{A}_1$	Remaining $\bar{B}$	Remaining $\bar{A}$, C_n	C_{n+4}	Out-of-Phase

DIFF MODE TEST TABLE

FUNCTION INPUTS: $S_1 = S_2 = 4.5 \text{ V}$, $S_0 = S_3 = M = 0 \text{ V}$

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}	$\bar{A}_1$	None	$\bar{B}_1$	Remaining $\bar{A}$	Remaining $\bar{B}$, C_n	$\bar{F}_1$	In-Phase
t_{PHL}	$\bar{B}_1$	A_1	None	Remaining $\bar{A}$	Remaining $\bar{B}$, C_n	$\bar{F}_1$	Out-of-Phase
t_{PLH}	$\bar{A}_1$	None	$\bar{B}_1$	None	Remaining $\bar{A}$ and $\bar{B}$, C_n	$\bar{P}$	In-Phase
t_{PHL}	$\bar{B}_1$	$\bar{A}_1$	None	None	Remaining $\bar{A}$ and $\bar{B}$, C_n	$\bar{P}$	Out-of-Phase
t_{PLH}	$\bar{A}_1$	$\bar{B}_1$	None	None	Remaining $\bar{A}$ and $\bar{B}$, C_n	$\bar{G}$	In-Phase
t_{PHL}	$\bar{B}_1$	None	$\bar{A}_1$	None	Remaining $\bar{A}$ and $\bar{B}$, C_n	$\bar{G}$	Out-of-Phase
t_{PLH}	A_1	None	$\bar{B}_1$	Remaining $\bar{A}$	Remaining $\bar{B}$, C_n	$A = B$	In-Phase
t_{PHL}	$\bar{B}_1$	$\bar{A}_1$	None	Remaining $\bar{A}$	Remaining $\bar{B}$, C_n	$A = B$	Out-of-Phase
t_{PLH}	C_n	None	None	All $\bar{A}$ and $\bar{B}$	None	C_{n+4} or any F	In-Phase
t_{PHL}	$\bar{A}_1$	$\bar{B}_1$	None	None	Remaining $\bar{A}$, $\bar{B}$, C_n	C_{n+4}	Out-of-Phase
t_{PHL}	$\bar{B}_1$	None	$\bar{A}_1$	None	Remaining $\bar{A}$, $\bar{B}$, C_n	C_{n+4}	In-Phase

LOGIC MODE TEST TABLE

FUNCTION INPUTS: $S_1 = S_2 = M = 4.5 \text{ V}$, $S_0 = S_3 = 0 \text{ V}$

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}	$\bar{A}_1$	$\bar{B}_1$	None	None	Remaining $\bar{A}$ and $\bar{B}$, C_n	$\bar{F}_1$	Out-of-Phase
t_{PHL}	$\bar{B}_1$	$\bar{A}_1$	None	None	Remaining $\bar{A}$ and $\bar{B}$, C_n	$\bar{F}_1$	Out-of-Phase

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

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TTL DEVICES