

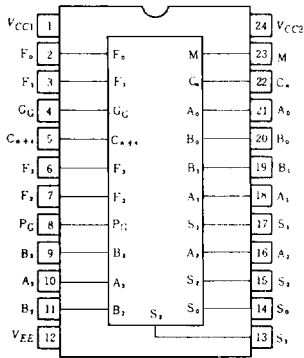
HD10181

4-bit Arithmetic Logic Unit/Function Generator

The HD10181 is a high-speed arithmetic logic unit capable of performing 16 logic operations and 16 arithmetic operations on two four-bit words. Full internal carry is incorporated for ripple through operation. Arithmetic logic operations are selected by applying the appropriate binary word to the select inputs (S0 through S3) as indicated in the

table of arithmetic/logic functions. Group carry propagate (PG) and carry generate (GG) are provided to allow fast operations on very long words using a second order look-ahead. The internal carry is enabled by applying a low level voltage to the mode control input (M).

PIN ARRANGEMENT



(Top View)

FUNCTIONS OF PIN NUMBER

Pin No.	Function
A ₃ , A ₂ , A ₁ , A ₀	Word A Inputs
B ₃ , B ₂ , B ₁ , B ₀	Word B Inputs
S ₃ , S ₂ , S ₁ , S ₀	Function-Select Inputs
C _n	Ripple-Carry Input
M	Mode Control Input
F ₃ , F ₂ , F ₁ , F ₀	Function Outputs
P ₀	Carry Propagate Output
C _{n+1}	Ripple-Carry Output
G ₀	Carry-Generate Output

FUNCTION TABLE

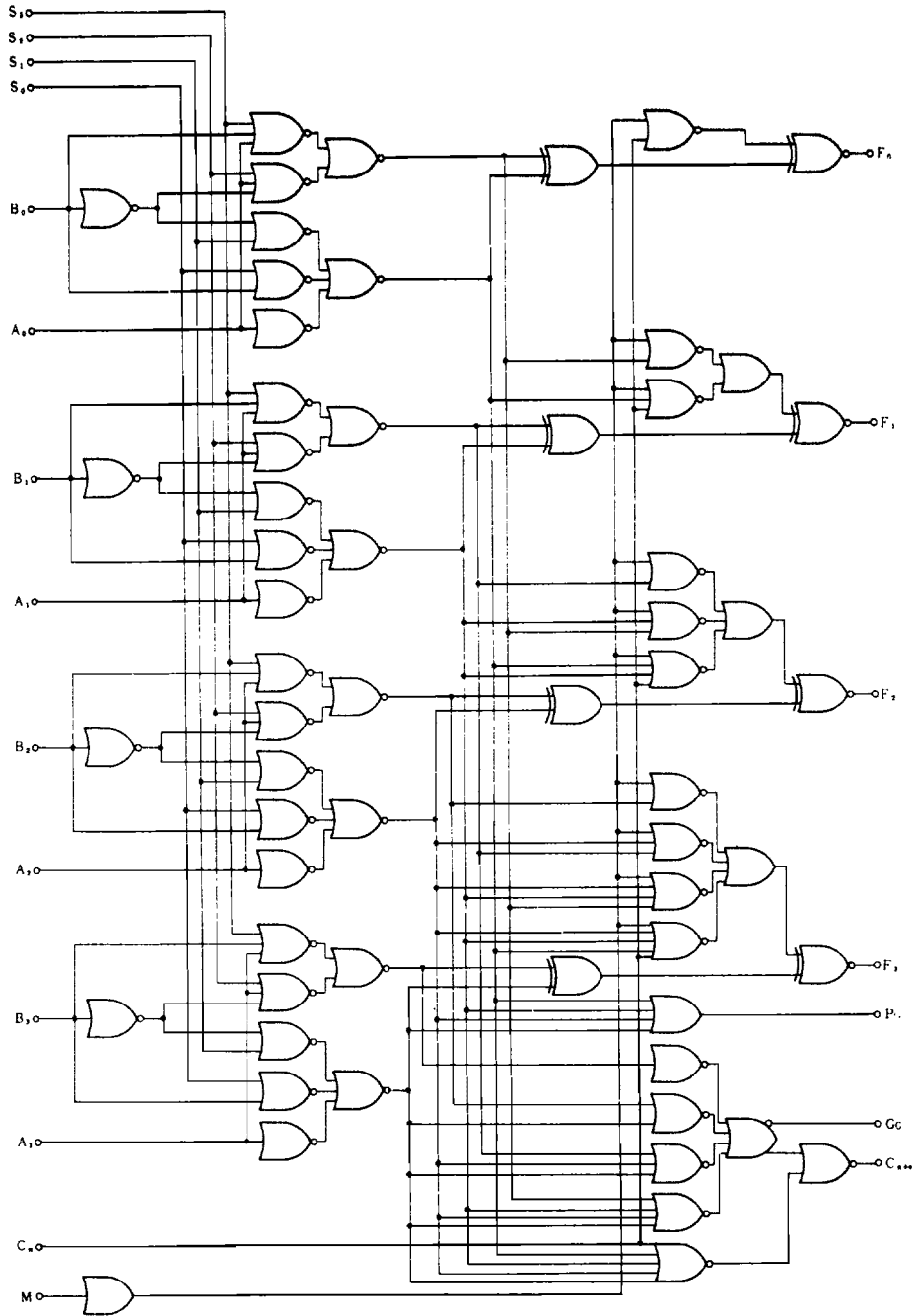
1. Positive Logic

Function Select				Logic Function (M="H")	Arithmetic Operation (M="L", Cn="L")
S ₃	S ₂	S ₁	S ₀	F	F
L	L	L	L	$F = \bar{A}$	$F = A + 0$
L	L	L	H	$F = \bar{A} + \bar{B}$	$F = A + (A \cdot \bar{B})$
L	L	H	L	$F = \bar{A} + B$	$F = A + (A \cdot B)$
L	L	H	H	$F = "H"$	$F = A \times 2$
L	H	L	L	$F = \bar{A} \cdot \bar{B}$	$F = (A + B) - 0$
L	H	L	H	$F = \bar{B}$	$F = (A + B) + (A \cdot \bar{B})$
L	H	H	L	$F = \bar{A} \oplus \bar{B}$	$F = A + B$
L	H	H	H	$F = A + \bar{B}$	$F = A + (A + B)$
H	L	L	L	$F = \bar{A} \cdot B$	$F = (A \cdot \bar{B}) + 0$
H	L	L	H	$F = A + B$	$F = A - B - 1$
H	L	H	L	$F = \bar{B}$	$F = (A + \bar{B}) - (A \cdot B)$
H	L	H	H	$F = A + B$	$F = (A + \bar{B}) + A$
H	H	L	L	$F = "L"$	$F = -1$ (two's complement)
H	H	L	H	$F = A \cdot \bar{B}$	$F = (A \cdot \bar{B}) - 1$
H	H	H	L	$F = A \cdot B$	$F = (A \cdot B) - 1$
H	H	H	H	$F = A$	$F = A - 1$

2. Negative Logic

Function Select				Logic Function (M="H")	Arithmetic Operation (M="L", Cn="H")
S ₃	S ₂	S ₁	S ₀	F	F
L	L	L	L	$F = \bar{A}$	$F = A - 1$
L	L	L	H	$F = \bar{A} + \bar{B}$	$F = A + (A + \bar{B})$
L	L	H	L	$F = \bar{A} \cdot B$	$F = A + (A + B)$
L	L	H	H	$F = "L"$	$F = A \times 2$
L	H	L	L	$F = \bar{A} \cdot \bar{B}$	$F = (A \cdot B) - 1$
L	H	L	H	$F = \bar{B}$	$F = (A \cdot B) + (A + \bar{B})$
L	H	H	L	$F = A + B$	$F = A + B$
L	H	H	H	$F = A \cdot \bar{B}$	$F = A + (A \cdot B)$
H	L	L	L	$F = \bar{A} + B$	$F = (A \cdot \bar{B}) - 0$
H	L	L	H	$F = \bar{A} \oplus \bar{B}$	$F = A - B - 1$
H	L	H	L	$F = \bar{B}$	$F = (A \cdot \bar{B}) + (A + B)$
H	L	H	H	$F = A \cdot B$	$F = (A \cdot \bar{B}) + A$
H	H	L	L	$F = "H"$	$F = -1$ (two's complement)
H	H	L	H	$F = A + \bar{B}$	$F = (A + \bar{B}) + 0$
H	H	H	L	$F = A + B$	$F = (A + B) + 0$
H	H	H	H	$F = A$	$F = A + 0$

■ BLOCK DIAGRAM



■ DC CHARACTERISTICS ($V_{EE} = -5.2V$, $T_a = -30 \sim +85^\circ C$)

Item	Symbol	Test Condition		min	typ	max	Unit	
Supply Current	I_{EE}			25°C	—	—	145 mA	
Input Current	I_{IH}	$V_{IH} = -0.810V$	B_0, B_1, B_2, B_3	25°C	—	—	245	μA
			A_0, A_1, A_2, A_3		—	—	220	
			S_3, M		—	—	200	
			S_0, S_1, S_2		—	—	265	
	C_n	—	—	290				
	I_{IL}	$V_{IL} = -1.850V$		25°C	0.5	—	—	μA
Output Voltage	V_{OH}	$V_{IH} = -0.890V, V_{IL} = -1.890V$	-30°C	-1.060	—	-0.890	V	
		$V_{IH} = -0.810V, V_{IL} = -1.850V$	25°C	-0.960	—	-0.810		
		$V_{IH} = -0.700V, V_{IL} = -1.825V$	85°C	-0.890	—	-0.700		
	V_{OL}	$V_{IH} = -0.890V, V_{IL} = -1.890V$	-30°C	-2.000	—	-1.675	V	
		$V_{IH} = -0.810V, V_{IL} = -1.850V$	25°C	-1.990	—	-1.650		
		$V_{IH} = -0.700V, V_{IL} = -1.825V$	85°C	-1.920	—	-1.615		
Output Threshold Voltage	V_{OHA}	$V_{IHA} = -1.205V, V_{ILA} = -1.500V$	-30°C	-1.080	—	—	V	
		$V_{IHA} = -1.105V, V_{ILA} = -1.475V$	25°C	-0.980	—	—		
		$V_{IHA} = -1.035V, V_{ILA} = -1.440V$	85°C	-0.910	—	—		
	V_{OLA}	$V_{IHA} = -1.205V, V_{ILA} = -1.500V$	-30°C	—	—	-1.655	V	
		$V_{IHA} = -1.105V, V_{ILA} = -1.475V$	25°C	—	—	-1.630		
		$V_{IHA} = -1.035V, V_{ILA} = -1.440V$	85°C	—	—	-1.595		

■ AC CHARACTERISTICS ($V_{EE} = -3.2V$, $V_{CC} = +2.0V$, $T_a = -30 \sim +85^\circ C$, $R_L = 50\Omega$)

Item	Symbol	Input	Output	High level input*	T_a	min	typ	max	Unit			
Propagation Delay Time	t_{PLH}	C_n	C_{n+1}	A_0, A_1, A_2, A_3	-30°C	1.0	—	5.1	ns			
					25°C	1.1	3.1	5.0				
					85°C	1.1	—	5.4				
	t_{PHL}				-30°C	1.0	—	5.1				
					25°C	1.1	3.1	5.0				
					85°C	1.1	—	5.4				
Rise Time	t_{TLH}	C_n	F_1	A_0	-30°C	1.0	—	3.2				
					25°C	1.0	2.0	3.0				
					85°C	1.0	—	3.2				
Fall Time	t_{THL}				C_n	F_1	A_0	-30°C		1.0	—	3.2
								25°C		1.0	2.0	3.0
								85°C		1.0	—	3.2
Propagation Delay Time	t_{PLH}	C_n	F_1	A_0				-30°C	1.7	—	7.2	
								25°C	2.0	4.5	7.0	
								85°C	2.0	—	7.5	
	t_{PHL}				-30°C	1.7	—	7.2				
					25°C	2.0	4.5	7.0				
					85°C	2.0	—	7.5				
Rise Time	t_{TLH}	C_n	F_1	A_0	-30°C	1.3	—	5.3				
					25°C	1.5	3.0	5.0				
					85°C	1.5	—	5.3				
Fall Time	t_{THL}				C_n	F_1	A_0	-30°C	1.3	—	5.3	
								25°C	1.5	3.0	5.0	
								85°C	1.5	—	5.3	

(to be continued)

■ AC CHARACTERISTICS ($V_{EE} = -3.2V$, $V_{CC} = +2.0V$, $T_a = -30 \sim +85^\circ C$, $R_L = 50 \Omega$)

Item	Symbol	Input	Output	High level input *	T_a	min	typ	max	Unit		
Propagation Delay Time	t_{PLH}	A_1	F_1	—	-30°C	2.6	—	10.4	ns		
					25°C	3.0	6.5	10.0			
					85°C	3.0	—	10.8			
	t_{PHL}				-30°C	2.6	—	10.4			
					25°C	3.0	6.5	10.0			
					85°C	3.0	—	10.8			
Rise Time	t_{TLH}	A_1	F_1	—	-30°C	1.3	—	5.4			
					25°C	1.5	3.0	5.0			
					85°C	1.5	—	5.3			
Fall Time	t_{THL}				A_1	F_1	—	-30°C	1.3	—	5.4
								25°C	1.5	3.0	5.0
								85°C	1.5	—	5.3
Propagation Delay Time	t_{PLH}	A_1	P_0	S_0, S_1				-30°C	1.6	—	7.0
								25°C	2.0	5.0	6.5
								85°C	2.0	—	7.0
	t_{PHL}				-30°C	1.6	—	7.0			
					25°C	2.0	5.0	6.5			
					85°C	2.0	—	7.0			
Rise Time	t_{TLH}	A_1	P_0	S_0, S_1	-30°C	0.8	—	3.7			
					25°C	1.1	2.0	3.5			
					85°C	1.1	—	3.8			
Fall Time	t_{THL}				A_1	P_0	S_0, S_1	-30°C	0.8	—	3.7
								25°C	1.1	2.0	3.5
								85°C	1.1	—	3.8
Propagation Delay Time	t_{PLH}	A_1	G_0	A_0, A_2, A_3, C_1				-30°C	1.1	—	7.4
								25°C	2.0	4.5	7.0
								85°C	1.3	—	7.7
	t_{PHL}				-30°C	1.1	—	7.4			
					25°C	2.0	4.5	7.0			
					85°C	1.3	—	7.7			
Rise Time	t_{TLH}	A_1	G_0	A_0, A_2, A_3, C_1	-30°C	1.2	—	5.1			
					25°C	1.5	4.0	5.0			
					85°C	1.2	—	5.3			
Fall Time	t_{THL}				A_1	G_0	A_0, A_2, A_3, C_1	-30°C	1.2	—	5.1
								25°C	1.5	4.0	5.0
								85°C	1.2	—	5.3
Propagation Delay Time	t_{PLH}	A_1	$C_{1..4}$	A_0, A_2, A_3, C_1				-30°C	1.7	—	7.3
								25°C	2.0	5.0	7.0
								85°C	2.0	—	7.8
	t_{PHL}				-30°C	1.7	—	7.3			
					25°C	2.0	5.0	7.0			
					85°C	2.0	—	7.8			
Rise Time	t_{TLH}	A_1	$C_{1..4}$	A_0, A_2, A_3, C_1	-30°C	1.0	—	3.1			
					25°C	1.0	2.0	3.0			
					85°C	1.0	—	3.2			
Fall Time	t_{THL}				A_1	$C_{1..4}$	A_0, A_2, A_3, C_1	-30°C	1.0	—	3.1
								25°C	1.0	2.0	3.0
								85°C	1.0	—	3.2

(to be continued)

AC CHARACTERISTICS ($V_{EE} = -3.2V$, $V_{CC} = +2.0V$, $T_a = -30 \sim +85^\circ C$, $R_L = 50 \Omega$)

Item	Symbol	Input	Output	High level input *	T_a	min	typ	max	Unit		
Propagation Delay Time	t_{PLH}	B_1	F_1	S_1, C_1	$-30^\circ C$	2.7	—	11.3	ns		
					$25^\circ C$	3.0	8.0	11.0			
					$85^\circ C$	3.0	—	11.9			
Rise Time	t_{TLH}				$-30^\circ C$	1.2	—	5.3			
					$25^\circ C$	1.5	3.5	5.0			
					$85^\circ C$	1.5	—	5.3			
Fall Time	t_{THL}				$-30^\circ C$	1.2	—	5.3			
					$25^\circ C$	1.5	3.5	5.0			
					$85^\circ C$	1.5	—	5.3			
Propagation Delay Time	t_{PLH}	B_1	P_C	S_0, S_3	$-30^\circ C$	1.6	—	7.7			
					$25^\circ C$	2.0	6.0	7.5			
					$85^\circ C$	2.0	—	8.0			
Rise Time	t_{TLH}				$-30^\circ C$	1.0	—	3.6			
					$25^\circ C$	1.1	2.0	3.5			
					$85^\circ C$	1.1	—	3.9			
Fall Time	t_{THL}				$-30^\circ C$	1.0	—	3.6			
					$25^\circ C$	1.1	2.0	3.5			
					$85^\circ C$	1.1	—	3.9			
Propagation Delay Time	t_{PLH}				B_1	G_L	S_1, C_1	$-30^\circ C$	1.7	—	8.2
								$25^\circ C$	2.0	6.0	8.0
								$85^\circ C$	2.0	—	8.6
Rise Time	t_{TLH}							$-30^\circ C$	1.4	—	5.2
								$25^\circ C$	1.5	3.0	5.0
								$85^\circ C$	1.2	—	5.4
Fall Time	t_{THL}							$-30^\circ C$	1.4	—	5.2
								$25^\circ C$	1.5	3.0	5.0
								$85^\circ C$	1.2	—	5.4
Propagation Delay Time	t_{PLH}	B_1	C_{1-4}	S_1, C_1				$-30^\circ C$	1.8	—	8.2
								$25^\circ C$	2.0	6.0	8.0
								$85^\circ C$	2.0	—	8.7
Rise Time	t_{TLH}							$-30^\circ C$	0.9	—	3.1
								$25^\circ C$	1.0	2.0	3.0
								$85^\circ C$	1.0	—	3.2
Fall Time	t_{THL}							$-30^\circ C$	0.9	—	3.1
								$25^\circ C$	1.0	2.0	3.0
								$85^\circ C$	1.0	—	3.2

(to be continued)

■ AC CHARACTERISTICS ($V_{EE} = -3.2V$, $V_{CC} = +2.0V$, $T_a = -30 \sim +85^\circ C$, $R_L = 50 \Omega$)

Item	Symbol	Input	Output	High level input*	T_a	min	typ	max	Unit
Propagation Delay Time	t_{PLH}	M	F_1	—	-30°C	2.4	—	10.3	ns
					25°C	3.0	6.5	10.0	
					85°C	3.0	—	10.8	
	t_{PHL}				-30°C	2.4	—	10.3	
					25°C	3.0	6.5	10.0	
					85°C	3.0	—	10.8	
Rise Time	t_{TLN}	-30°C	1.1	—	5.1				
		25°C	1.5	4.0	5.0				
		85°C	1.5	—	5.3				
Fall Time	t_{THL}	-30°C	1.1	—	5.1				
		25°C	1.5	4.0	5.0				
		85°C	1.5	—	5.3				
Propagation Delay Time	t_{PLH}	S_1	F_1	A_1, B_1	-30°C	2.5	—	10.7	
					25°C	3.0	6.5	10.0	
					85°C	3.0	—	10.8	
	t_{PHL}				-30°C	2.5	—	10.7	
					25°C	3.0	6.5	10.0	
					85°C	3.0	—	10.8	
Rise Time	t_{TLN}	-30°C	1.0	—	5.4				
		25°C	1.5	3.0	5.0				
		85°C	1.5	—	5.4				
Fall Time	t_{THL}	-30°C	1.0	—	5.4				
		25°C	1.5	3.0	5.0				
		85°C	1.5	—	5.4				
Propagation Delay Time	t_{PLH}	S_1	P_0	A_3, B_3	-30°C	1.7	—	8.3	
					25°C	2.0	6.0	8.0	
					85°C	2.0	—	8.4	
	t_{PHL}				-30°C	1.7	—	8.3	
					25°C	2.0	6.0	8.0	
					85°C	2.0	—	8.4	
Rise Time	t_{TLN}	-30°C	0.8	—	5.1				
		25°C	1.1	3.0	5.0				
		85°C	1.1	—	5.2				
Fall Time	t_{THL}	-30°C	0.8	—	5.1				
		25°C	1.1	3.0	5.0				
		85°C	1.1	—	5.2				
Propagation Delay Time	t_{PLH}	S_1	$C_{1,4}$	A_3, B_3	-30°C	1.6	—	9.3	
					25°C	2.0	6.0	9.0	
					85°C	2.0	—	9.9	
	t_{PHL}				-30°C	1.6	—	9.3	
					25°C	2.0	6.0	9.0	
					85°C	2.0	—	9.9	
Rise Time	t_{TLN}	-30°C	0.9	—	5.3				
		25°C	1.1	3.0	5.0				
		85°C	1.0	—	5.2				
Fall Time	t_{THL}	-30°C	0.9	—	5.3				
		25°C	1.1	3.0	5.0				
		85°C	1.0	—	5.2				

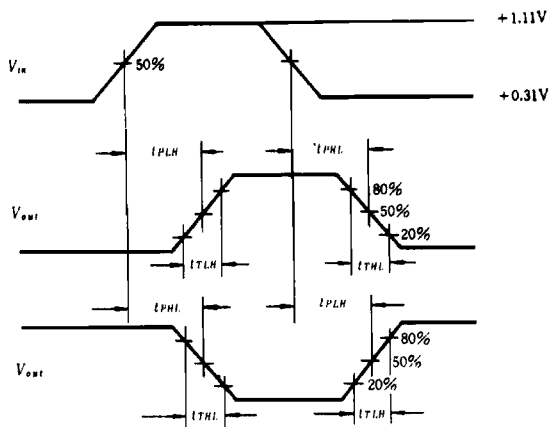
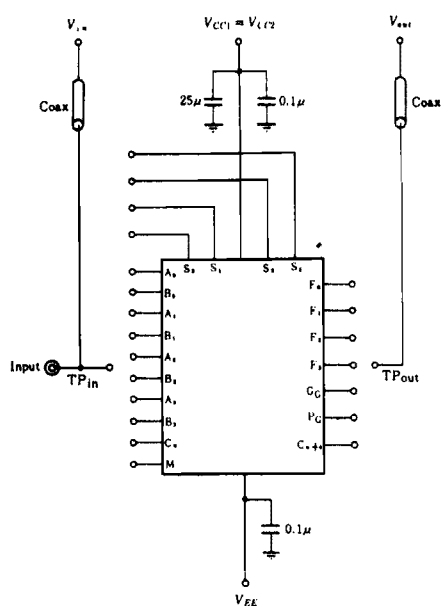
(to be continued)

■ AC CHARACTERISTICS ($V_{EE} = -3.2V$, $V_{CC} = +2.0V$, $T_a = -30 \sim +85^\circ C$, $R_L = 50\Omega$)

Item	Symbol	Input	Output	High level input*	T_a	min	typ	max	Unit				
Propagation Delay Time	t_{PLH}	S_1	G_C	A_1, B_1	$-30^\circ C$	1.5	—	9.6	ns				
					$25^\circ C$	2.0	6.0	9.0					
					$85^\circ C$	1.9	—	9.7					
	$-30^\circ C$				1.5	—	9.6						
	$25^\circ C$				2.0	6.0	9.0						
	$85^\circ C$				1.9	—	9.7						
Rise Time	t_{TLH}	S_1	G_C	A_1, B_1	$-30^\circ C$	0.8	—	6.2	ns				
					$25^\circ C$	0.8	3.0	6.0					
					$85^\circ C$	0.8	—	6.5					
Fall Time	t_{THL}				S_1	G_C	A_1, B_1	$-30^\circ C$		0.8	—	6.2	ns
								$25^\circ C$		0.8	3.0	6.0	
								$85^\circ C$		0.8	—	6.5	

Note) *: Other inputs are open, or connected to +0.31V.

■ SWITCHING TIME TEST CIRCUIT



- Notes)
1. 50Ω termination to ground located in each scope channel input. All input and output cables to the scope are equal lengths of 50Ω coaxial cable.
 2. Wire length should be $< 6.35\text{mm}$ (1/4 inch) from TPIN to input pin and TPOUT to output pin.
 3. Unused outputs connected to a 50Ω resistor to ground.