

54F/74F381 4-Bit Arithmetic Logic Unit

General Description

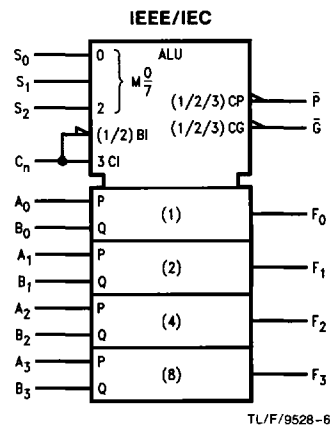
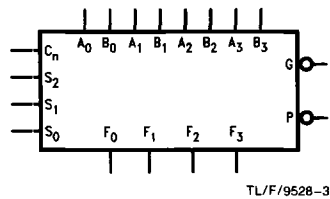
The 'F381 performs three arithmetic and three logic operations on two 4-bit words, A and B. Two additional select input codes force the function outputs LOW or HIGH. Carry propagate and generate outputs are provided for use with the 'F182 carry lookahead generator for high-speed expansion to longer word lengths. For ripple expansion, refer to the 'F382 ALU data sheet.

Features

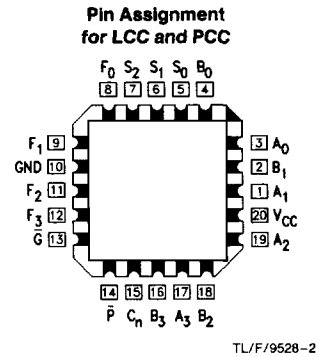
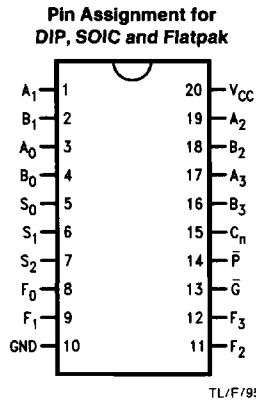
- Low input loading minimizes drive requirements
- Performs six arithmetic and logic functions
- Selectable LOW (clear) and HIGH (preset) functions
- Carry generate and propagate outputs for use with carry lookahead generator

Ordering Code: See Section 5

Logic Symbols



Connection Diagrams



Unit Loading/Fan Out: See Section 2 for U.L. definitions

Pin Names	Description	54F/74F	
		U.L. HIGH/LOW	Input I _{IH} /I _{IL} Output I _{OH} /I _{OL}
A ₀ -A ₃	A Operand Inputs	1.0/3.0	20 μA/ -1.8 mA
B ₀ -B ₃	B Operand Inputs	1.0/3.0	20 μA/ -1.8 mA
S ₀ -S ₂	Function Select Inputs	1.0/1.0	20 μA/ -0.6 mA
C _n	Carry Input	1.0/4.0	20 μA/ -2.4 mA
\bar{G}	Carry Generate Output (Active LOW)	50/33.3	-1 mA/20 mA
\bar{P}	Carry Propagate Output (Active LOW)	50/33.3	-1 mA/20 mA
F ₀ -F ₃	Function Outputs	50/33.3	-1 mA/20 mA

Functional Description

Signals applied to the Select inputs S₀-S₂ determine the mode of operation, as indicated in the Function Select Table. An extensive listing of input and output levels is shown in the Truth Table. The circuit performs the arithmetic functions for either active HIGH or active LOW operands, with output levels in the same convention. In the Subtract operating modes, it is necessary to force a carry (HIGH for active

HIGH operands, LOW for active LOW operands) into the C_n input of the least significant package.

The Carry Generate (\bar{G}) and Carry Propagate (\bar{P}) outputs supply input signals to the 'F182 carry lookahead generator for expansion to longer word length, as shown in Figure 1. Note that an 'F382 ALU is used for the most significant package. Typical delays for Figure 1 are given in Figure 2.

Function Select Table

Select			Operation
S ₀	S ₁	S ₂	
L	L	L	Clear
H	L	L	B Minus A
L	H	L	A Minus B
H	H	L	A Plus B
L	L	H	A ⊕ B
H	L	H	A + B
L	H	H	AB
H	H	H	Preset

H = HIGH Voltage Level
L = LOW Voltage Level

FIGURE 2. 16-Bit Delay Tabulation

Path Segment	Toward F	Output C _n + 4, OVR
A _i or B _i to \bar{P}	7.2 ns	7.2 ns
\bar{P}_i to C _n + j ('F182)	6.2 ns	6.2 ns
C _n to F	8.1 ns	—
C _n or C _n + 4, OVR	—	8.0 ns
Total Delay	21.5 ns	21.4 ns

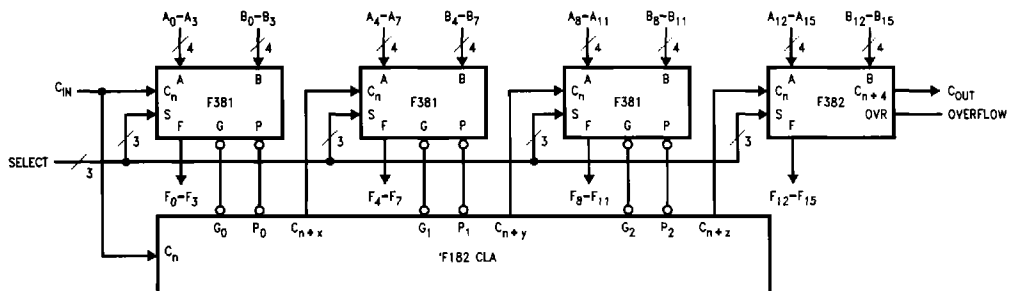
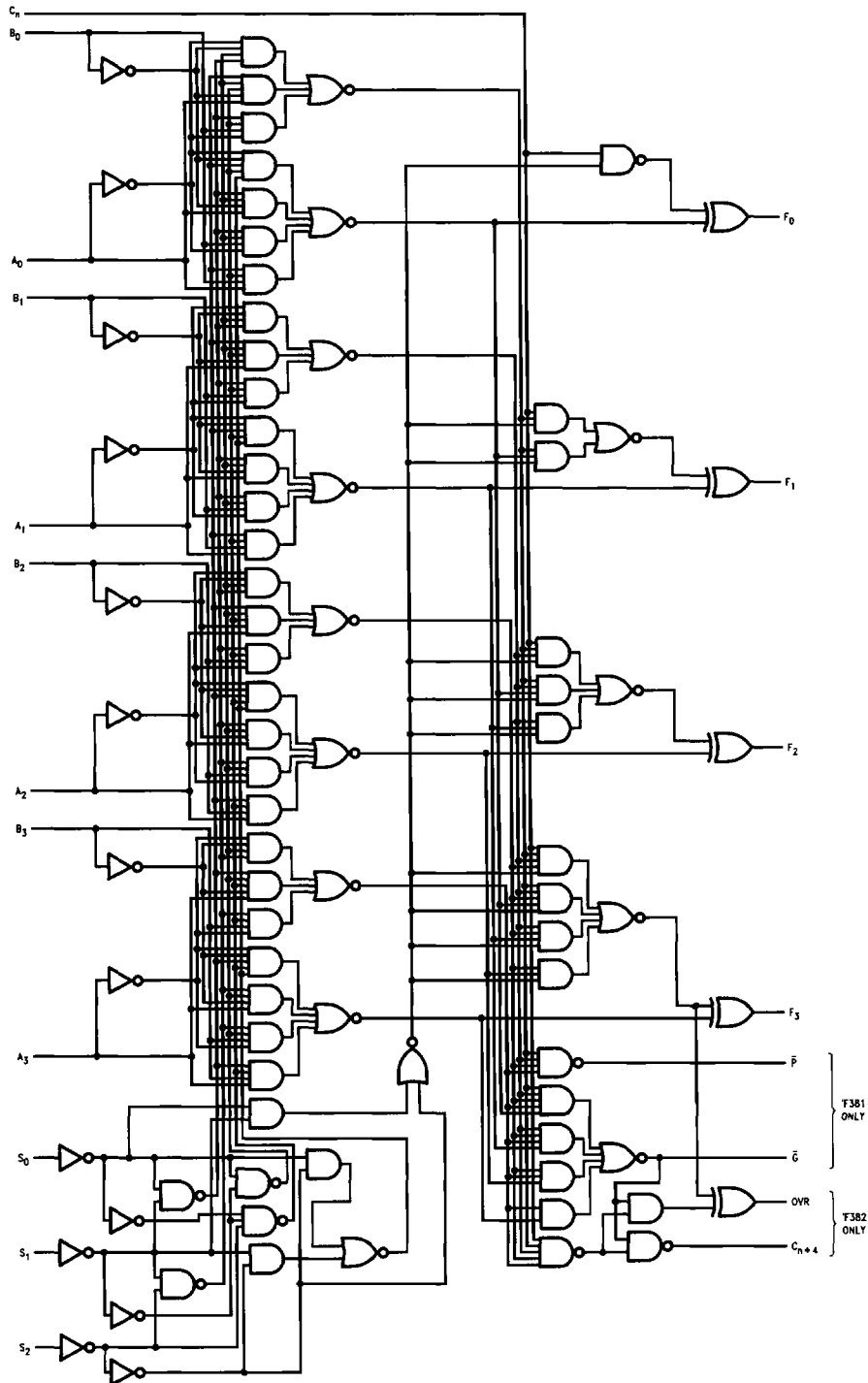


FIGURE 1. 16-Bit Lookahead Carry ALU Expansion

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Logic Diagram



F381 ONLY

F382 ONLY

Please note that this diagram is provided only for the understanding of logic operations and should not be used to estimate propagation delays.

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Truth Table

Function	Inputs						Outputs							
	S ₀	S ₁	S ₂	C _n	A _n	B _n	F ₀	F ₁	F ₂	F ₃	\bar{G}	\bar{P}		
CLEAR	L	L	L	X	X	X	L	L	L	L	L	L		
B Minus A	H	L	L	L	L	L	H	H	H	H	H	L		
				L	L	H	L	H	H	H	L	L	L	
				L	H	L	L	L	L	L	L	L	L	L
				L	H	H	L	L	L	L	L	L	L	L
				H	L	L	L	L	L	L	L	L	L	L
				H	L	H	L	L	L	L	L	L	L	L
				H	H	L	L	L	L	L	L	L	L	L
				H	H	H	L	L	L	L	L	L	L	L
A Minus B	L	H	L	L	L	L	H	H	H	H	H	L		
				L	L	H	L	L	L	L	L	L	L	
				L	H	L	L	L	L	L	L	L	L	L
				L	H	H	L	L	L	L	L	L	L	L
				H	L	L	L	L	L	L	L	L	L	L
				H	L	H	L	L	L	L	L	L	L	L
				H	H	L	L	L	L	L	L	L	L	L
				H	H	H	L	L	L	L	L	L	L	L
A Plus B	H	H	L	L	L	L	L	L	L	L	H	H		
				L	L	H	L	H	H	H	H	H	L	
				L	H	L	L	L	L	L	L	L	L	L
				L	H	H	L	L	L	L	L	L	L	L
				H	L	L	L	L	L	L	L	L	L	L
				H	L	H	L	L	L	L	L	L	L	L
				H	H	L	L	L	L	L	L	L	L	L
				H	H	H	L	L	L	L	L	L	L	L
A ⊕ B	L	L	H	X	L	L	L	L	L	L	H	H		
				X	L	H	L	H	H	H	H	H	H	
				X	H	L	L	L	H	H	H	H	H	L
				X	H	H	L	L	L	L	L	L	L	L
A + B	H	L	H	X	L	L	L	L	L	L	H	H		
				X	L	H	L	H	H	H	H	H	H	
				X	H	L	L	H	H	H	H	H	H	
				X	H	H	L	H	H	H	H	H	H	
AB	L	H	H	X	L	L	L	L	L	L	L	L		
				X	L	H	L	L	L	L	L	L	L	
				X	H	L	L	L	L	L	L	L	L	
				X	H	H	L	L	L	L	L	L	L	
PRESET	H	H	H	X	L	L	L	H	H	H	H	H		
				X	L	H	L	H	H	H	H	H	H	
				X	H	L	L	H	H	H	H	H	H	
				X	H	H	L	H	H	H	H	H	H	

H = HIGH Voltage Level
 L = LOW Voltage Level
 X = Immaterial

Absolute Maximum Ratings (Note 1)

If Military/Aerospace specified devices are required, contact the National Semiconductor Sales Office/Distributors for availability and specifications.

Storage Temperature	-65°C to +150°C
Ambient Temperature under Bias	-55°C to +125°C
Junction Temperature under Bias	-55°C to +175°C
V _{CC} Pin Potential to Ground Pin	-0.5V to +7.0V
Input Voltage (Note 2)	-0.5V to +7.0V
Input Current (Note 2)	-30 mA to +5.0 mA
Voltage Applied to Output in HIGH State (with V _{CC} = 0V)	
Standard Output	-0.5V to V _{CC}
TRI-STATE® Output	-0.5V to +5.5V
Current Applied to Output in LOW State (Max)	twice the rated I _{OL} (mA)

Note 1: Absolute maximum ratings are values beyond which the device may be damaged or have its useful life impaired. Functional operation under these conditions is not implied.

Note 2: Either voltage limit or current limit is sufficient to protect inputs.

Recommended Operating Conditions

Free Air Ambient Temperature	
Military	-55°C to +125°C
Commercial	0°C to +70°C
Supply Voltage	
Military	+4.5V to +5.5V
Commercial	+4.5V to +5.5V

DC Electrical Characteristics

Symbol	Parameter	54F/74F			Units	V _{CC}	Conditions
		Min	Typ	Max			
V _{IH}	Input HIGH Voltage	2.0			V		Recognized as a HIGH Signal
V _{IL}	Input LOW Voltage			0.8	V		Recognized as a LOW Signal
V _{CD}	Input Clamp Diode Voltage			-1.2	V	Min	I _{IN} = -18 mA
V _{OH}	Output HIGH Voltage	54F 10% V _{CC} 74F 10% V _{CC} 74F 5% V _{CC}	2.5 2.5 2.7		V	Min	I _{OH} = -1 mA I _{OH} = -1 mA I _{OH} = -1 mA
V _{OL}	Output LOW Voltage	54F 10% V _{CC} 74F 10% V _{CC}		0.5 0.5	V	Min	I _{OL} = 20 mA I _{OL} = 20 mA
I _{IH}	Input HIGH Current			20	μA	Max	V _{IN} = 2.7V
I _{BVI}	Input HIGH Current Breakdown Test			100	μA	Max	V _{IN} = 7.0V
I _{IL}	Input LOW Current			-0.6 -2.4	mA mA	Max Max	V _{IN} = 0.5V (S _n) V _{IN} = 0.5V (A _n , B _n , C _n)
I _{OS}	Output Short-Circuit Current	-60		-150	mA	Max	V _{OUT} = 0V
I _{CEx}	Output HIGH Leakage Current			250	μA	Max	V _{OUT} = V _{CC}
I _{CC}	Power Supply Current		59	89	mA	Max	

AC Electrical Characteristics: See Section 2 for Waveforms and Load Configurations

Symbol	Parameter	74F			54F		74F		Units	Fig No
		T _A = +25°C V _{CC} = +5.0V C _L = 50 pF			T _A , V _{CC} = MII C _L = 50 pF		T _A , V _{CC} = Com C _L = 50 pF			
		Min	Typ	Max	Min	Max	Min	Max		
t _{PLH} t _{PHL}	Propagation Delay C _n to F _i	2.5 2.5	8.1 5.7	12.0 8.0			2.5 2.5	13.0 9.0	ns	2-3
t _{PLH} t _{PHL}	Propagation Delay Any A or B to Any F	4.0 3.5	10.4 8.2	15.0 11.0			4.0 3.5	16.0 12.0	ns	2-3
t _{PLH} t _{PHL}	Propagation Delay S _i to F _i	4.5 4.0	8.3 8.2	20.5 15.0			4.5 4.0	21.5 16.0	ns	2-3
t _{PLH} t _{PHL}	Propagation Delay A _i or B _i to \bar{G}	3.5 3.5	6.4 6.8	10.0 10.0			3.5 3.0	11.0 11.0	ns	2-3
t _{PLH} t _{PHL}	Propagation Delay A _i or B _i to \bar{P}	2.5 3.5	7.2 6.5	10.5 9.5			2.5 3.5	11.5 10.5	ns	2-3
t _{PLH} t _{PHL}	Propagation Delay S _i to \bar{G} or \bar{P}	4.0 4.5	7.8 10.2	12.0 13.5			4.0 4.5	13.0 14.5	ns	2-3