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## 74F381 4-Bit Arithmetic Logic Unit

### General Description

The 74F381 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 74F182 carry lookahead generator for high-speed expansion to longer word lengths. For ripple expansion, refer to the 74F382 ALU data sheet.

### Features

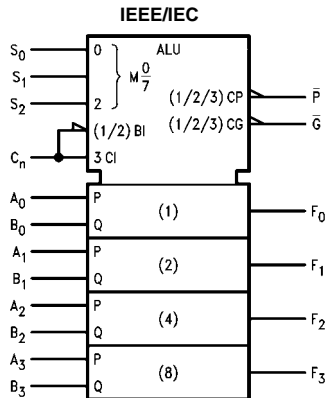
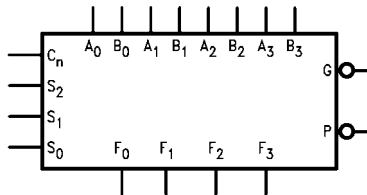
- Low input loading minimizes drive requirements
- Performs six arithmetic and logic functions
- Selectable LOW (clear) and HIGH (preset) functions
- Carry generate and propagate outputs for use with carry lookahead generator

### Ordering Code:

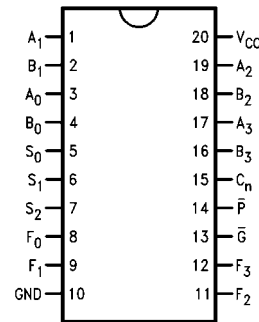
Order Number	Package Number	Package Description
74F381SC	M20B	20-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-013, 0.300 Wide
74F381SJ	M20D	20-Lead Small Outline Package (SOP), EIAJ TYPE II, 5.3mm Wide
74F381PC	N20A	20-Lead Plastic Dual-In-Line Package (PDIP), JEDEC MS-001, 0.300 Wide

Devices also available in Tape and Reel. Specify by appending the suffix letter "X" to the ordering code.

### Logic Symbols



### Connection Diagram



### Unit Loading/Fan Out

Pin Names	Description	U.L. HIGH/LOW	Input $I_{IH}/I_{IL}$ Output $I_{OH}/I_{OL}$
A <sub>0</sub> -A <sub>3</sub>	A Operand Inputs	1.0/3.0	20 $\mu$ A/-1.8 mA
B <sub>0</sub> -B <sub>3</sub>	B Operand Inputs	1.0/3.0	20 $\mu$ A/-1.8 mA
S <sub>0</sub> -S <sub>2</sub>	Function Select Inputs	1.0/1.0	20 $\mu$ A/-0.6 mA
C <sub>n</sub>	Carry Input	1.0/4.0	20 $\mu$ A/-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 <sub>0</sub> -F <sub>3</sub>	Function Outputs	50/33.3	-1 mA/20 mA

### Functional Description

Signals applied to the Select inputs S<sub>0</sub>-S<sub>2</sub> 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<sub>n</sub> input of the least significant package.

The Carry Generate ( $\bar{G}$ ) and Carry Propagate ( $\bar{P}$ ) outputs supply input signals to the 74F182 carry lookahead generator for expansion to longer word length, as shown in Figure 2. Note that a 74F382 ALU is used for the most significant package. Typical delays for Figure 2 are given in Figure 1.

### Function Select Table

Select			Operation
S <sub>0</sub>	S <sub>1</sub>	S <sub>2</sub>	
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 $\oplus$ B
H	L	H	A + B
L	H	H	AB
H	H	H	Preset

H = HIGH Voltage Level  
L = LOW Voltage Level

Path Segment	Toward F	Output C <sub>n</sub> + 4, OVR
A <sub>i</sub> or B <sub>i</sub> to $\bar{P}$	7.2 ns	7.2 ns
$\bar{P}$ <sub>i</sub> to C <sub>n</sub> + ('F182)	6.2 ns	6.2 ns
C <sub>n</sub> to F	8.1 ns	—
C <sub>n</sub> or C <sub>n</sub> + 4, OVR	—	8.0 ns
Total Delay	21.5 ns	21.4 ns

FIGURE 1. 16-Bit Delay Tabulation

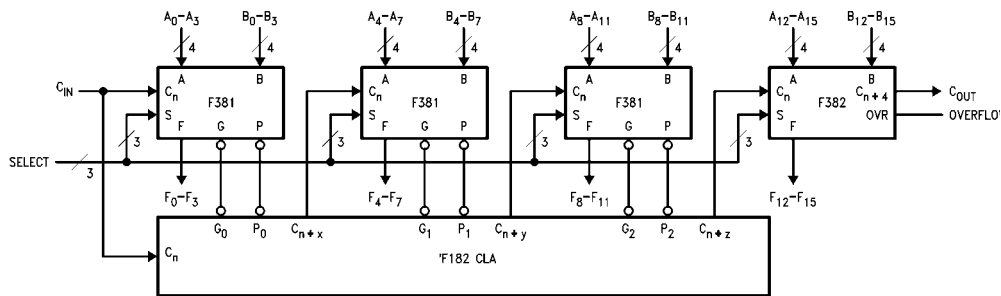


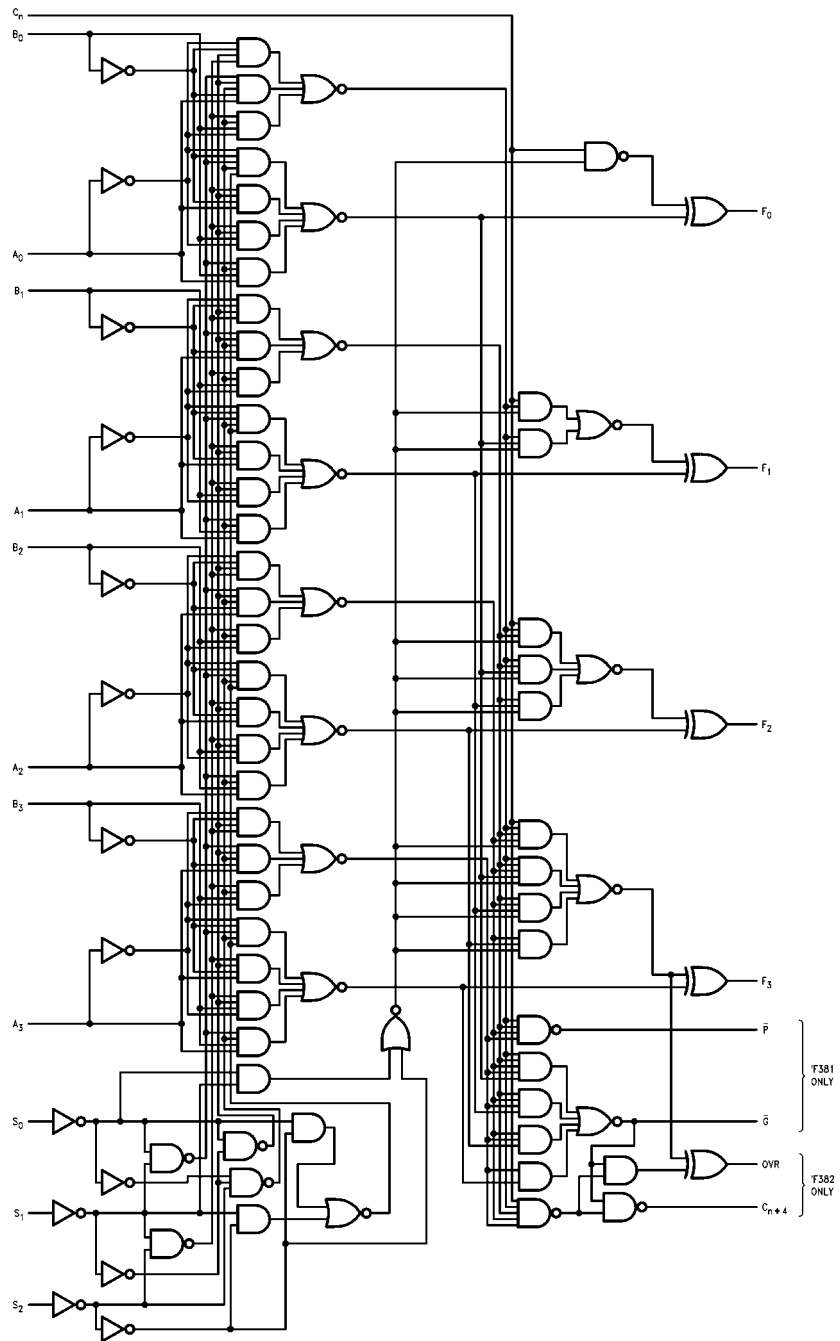
FIGURE 2. 16-Bit Lookahead Carry ALU Expansion

Truth Table

Function	Inputs						Outputs					
	S <sub>0</sub>	S <sub>1</sub>	S <sub>2</sub>	C <sub>n</sub>	A <sub>n</sub>	B <sub>n</sub>	F <sub>0</sub>	F <sub>1</sub>	F <sub>2</sub>	F <sub>3</sub>	$\overline{G}$	$\overline{P}$
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	H	L	L	L	L	L	H	H
				L	H	H	H	H	H	H	H	L
				H	L	L	L	L	L	L	L	H
				H	L	H	H	H	H	H	H	L
				H	H	L	L	L	L	L	L	H
A Minus B	L	H	L	L	L	L	H	H	H	H	H	L
				L	L	H	L	L	L	L	L	H
				L	H	L	L	H	H	H	H	L
				L	H	H	H	H	H	H	H	H
				H	L	L	L	L	L	L	L	H
				H	L	H	H	H	H	H	H	L
				H	H	L	L	L	L	L	L	H
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	H	L	L	H	H	H	H	L
				H	L	L	L	L	L	L	L	H
				H	L	H	L	L	L	L	L	H
				H	H	L	L	L	L	L	L	H
				H	H	H	H	H	H	H	H	L
A ⊕ B	L	L	H	X	L	L	L	L	L	L	H	H
				X	L	H	H	H	H	H	H	
				X	H	L	H	H	H	H	H	
				X	H	H	H	L	L	L	L	
A + B	H	L	H	X	L	L	L	L	L	L	H	H
				X	L	H	H	H	H	H	H	
				X	H	L	H	H	H	H	H	
				X	H	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	
				X	H	L	L	L	L	L	L	
				X	H	H	H	H	H	H	H	
PRESET	H	H	H	X	L	L	H	H	H	H	H	H
				X	L	H	H	H	H	H	H	
				X	H	L	H	H	H	H	H	
				X	H	H	H	H	H	H	H	

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

### Logic Diagram



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

**Absolute Maximum Ratings**(Note 1)

Storage Temperature	-65°C to +150°C
Ambient Temperature under Bias	-55°C to +125°C
Junction Temperature under Bias	-55°C to +150°C
V <sub>CC</sub> 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 <sub>CC</sub> = 0V)	
Standard Output	-0.5V to V <sub>CC</sub>
3-STATE Output	-0.5V to +5.5V
Current Applied to Output in LOW State (Max)	twice the rated I <sub>OL</sub> (mA)

**Recommended Operating Conditions**

Free Air Ambient Temperature	0°C to +70°C
Supply Voltage	+4.5V to +5.5V

**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.

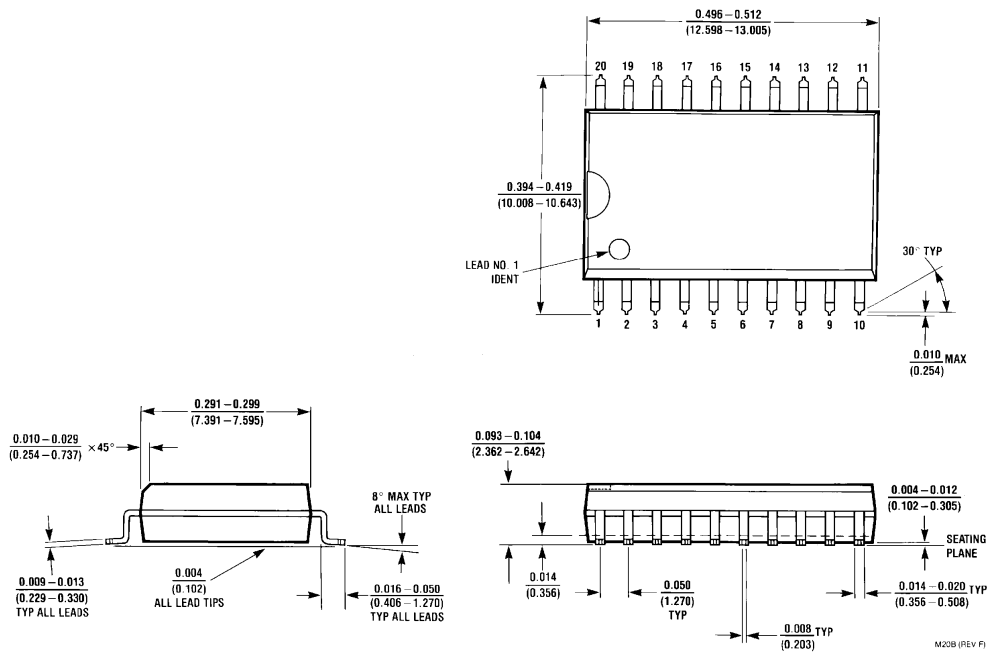
**Note 2:** Either voltage limit or current limit is sufficient to protect inputs.

**DC Electrical Characteristics**

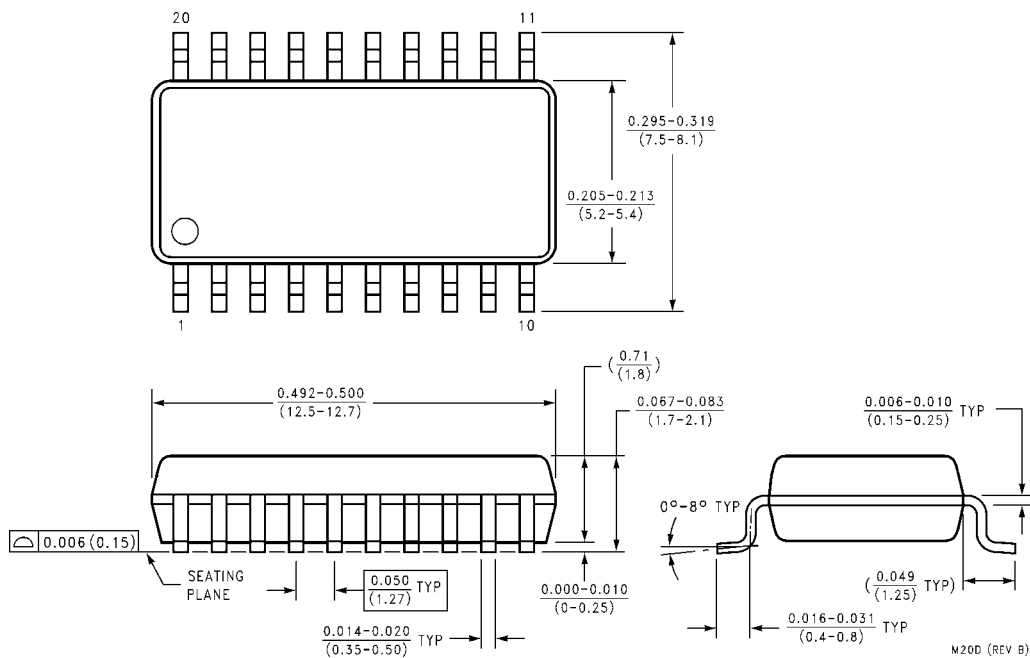
Symbol	Parameter	Min	Typ	Max	Units	V <sub>CC</sub>	Conditions
V <sub>IH</sub>	Input HIGH Voltage	2.0			V		Recognized as a HIGH Signal
V <sub>IL</sub>	Input LOW Voltage			0.8	V		Recognized as a LOW Signal
V <sub>CD</sub>	Input Clamp Diode Voltage			-1.2	V	Min	I <sub>IN</sub> = -18 mA
V <sub>OH</sub>	Output HIGH Voltage	10% V <sub>CC</sub> 5% V <sub>CC</sub>	2.5 2.7		V	Min	I <sub>OH</sub> = -1 mA I <sub>OH</sub> = -1 mA
V <sub>OL</sub>	Output LOW Voltage	10% V <sub>CC</sub>		0.5	V	Min	I <sub>OL</sub> = 20 mA
I <sub>IH</sub>	Input HIGH Current			5.0	μA		V <sub>IN</sub> = 2.7V
I <sub>BVI</sub>	Input HIGH Current Breakdown Test			7.0	μA	Max	V <sub>IN</sub> = 7.0V
I <sub>CEX</sub>	Output HIGH Leakage Current			50	μA	Max	V <sub>OUT</sub> = V <sub>CC</sub>
V <sub>ID</sub>	Input Leakage Test	4.75			V	0.0	I <sub>ID</sub> = 1.9 μA All Other Pins Grounded
I <sub>OD</sub>	Output Leakage Circuit Current			3.75	μA	0.0	V <sub>IOD</sub> = 150 mV All Other Pins Grounded
I <sub>IL</sub>	Input LOW Current			-0.6 -1.8 -2.4	mA	Max	V <sub>IN</sub> = 0.5V (S <sub>n</sub> ) Max V <sub>IN</sub> = 0.5V (A <sub>n</sub> , B <sub>n</sub> ) Max V <sub>IN</sub> = 0.5V (C <sub>n</sub> )
I <sub>OS</sub>	Output Short-Circuit Current	-60		-150	mA	Max	V <sub>OUT</sub> = 0V
I <sub>CC</sub>	Power Supply Current		59	89	mA	Max	

AC Electrical Characteristics							
Symbol	Parameter	$T_A = +25^\circ\text{C}$ $V_{CC} = +5.0\text{V}$ $C_L = 50\text{ pF}$			$T_A = 0^\circ\text{C to } +70^\circ\text{C}$ $V_{CC} = +5.0\text{V}$ $C_L = 50\text{ pF}$		Units
		Min	Typ	Max	Min	Max	
$t_{PLH}$	Propagation Delay	2.5	8.1	12.0	2.5	13.0	ns
$t_{PHL}$	$C_n$ to $F_i$	2.5	5.7	8.0	2.5	9.0	
$t_{PLH}$	Propagation Delay	4.0	10.4	15.0	4.0	16.0	ns
$t_{PHL}$	Any A or B to Any F	3.5	8.2	11.0	3.5	12.0	
$t_{PLH}$	Propagation Delay	4.5	8.3	20.5	4.5	21.5	ns
$t_{PHL}$	$S_i$ to $F_i$	4.0	8.2	15.0	4.0	16.0	
$t_{PLH}$	Propagation Delay	3.5	6.4	10.0	3.5	11.0	ns
$t_{PHL}$	$A_i$ or $B_i$ to $\bar{G}$	3.5	6.8	10.0	3.0	11.0	
$t_{PLH}$	Propagation Delay	2.5	7.2	10.5	2.5	11.5	ns
$t_{PHL}$	$A_i$ or $B_i$ to $\bar{P}$	3.5	6.5	9.5	3.5	10.5	
$t_{PLH}$	Propagation Delay	4.0	7.8	12.0	4.0	13.0	ns
$t_{PHL}$	$S_i$ to $\bar{G}$ or $\bar{P}$	4.5	10.2	13.5	4.5	14.5	

**Physical Dimensions** inches (millimeters) unless otherwise noted



**20-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-013, 0.300 Wide Package Number M20B**



**20-Lead Small Outline Package (SOP), EIAJ TYPE II, 5.3mm Wide Package Number M20D**



