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National Semiconductor

54F/74F382
4-Bit Arithmetic Logic Unit

General Description

The 'F382 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. An Overflow output is provided for convenience in twos complement arithmetic. A Carry output is provided for ripple expansion. For high-speed expansion using a Carry Lookahead Generator, refer to the 'F381 data sheet.

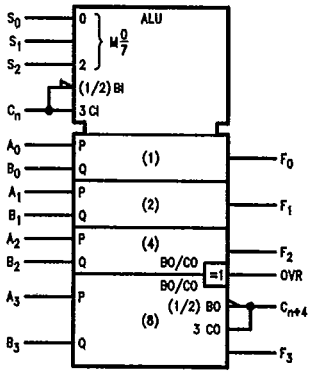
Features

- Performs six arithmetic and logic functions
- Selectable LOW (clear) and HIGH (preset) functions
- LOW input loading minimizes drive requirements
- Carry output for ripple expansion
- Overflow output for twos complement arithmetic

Ordering Code: See Section 5

Logic Symbols

IEEE/IEC



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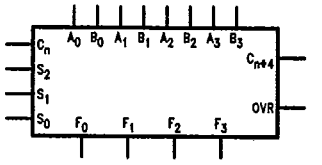

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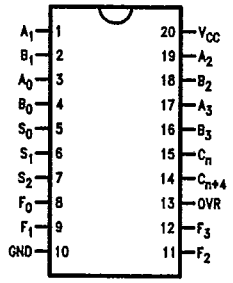
Connection Diagrams

Pin Assignment for DIP, SOIC and Flatpak



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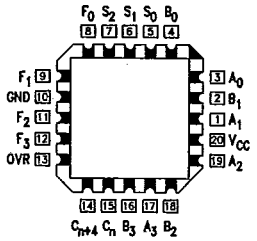
Pin Assignment for LCC and PCC



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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
C_{n+4}	Carry Output	50/33.3	−1 mA/20 mA
OVR	Overflow Output	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 S_0–S_2 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. Ripple expansion is illustrated in *Figure 1*. The overflow output OVR is the Exclusive-OR of C_{n+3} and C_{n+4}; a HIGH signal on OVR indicates overflow in twos complement operation. 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

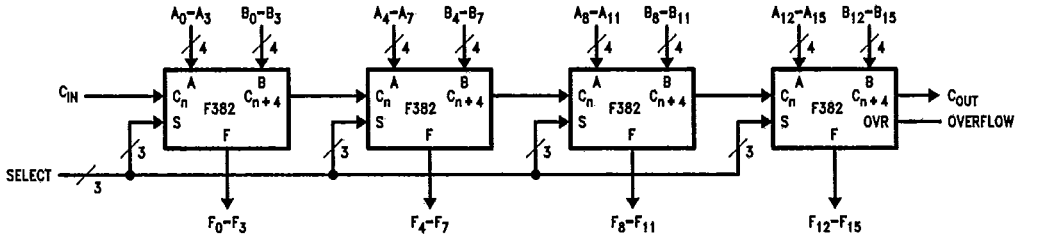

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FIGURE 1. 16-Bit Ripply Carry ALU Expansion

Path Segment	Toward F	Output C_{n+4}, OVR
A_i or B_i to C_{n+4}	6.5 ns	6.5 ns
C_n to C_{n+4}	6.3 ns	6.3 ns
C_n to C_{n+4}	6.3 ns	6.3 ns
C_n to F	8.1 ns	—
C_n to C_{n+4}, OVR	—	8.0 ns
Total Delay	27.2 ns	27.1 ns

FIGURE 2. 16-Bit Delay Tabulation

Truth Table

	Inputs						Outputs					
Function	S_0	S_1	S_2	C_n	A_n	B_n	F_0	F_1	F_2	F_3	OVR	C_{n+4}
CLEAR	L	L	L	L	X	X	L	L	L	L	H	H
				H	X	X	L	L	L	L	H	H
B MINUS A	H	L	L	L	L	L	H	H	H	H	L	L
				L	L	H	L	H	H	H	L	H
				L	H	L	L	L	L	L	L	L
				L	H	H	H	H	H	H	L	L
				H	L	L	L	L	L	L	L	H
				H	L	H	H	H	H	H	L	H
				H	H	L	H	L	L	L	L	L
				H	H	H	L	L	L	L	L	H
A MINUS B	L	H	L	L	L	L	H	H	H	H	L	L
				L	L	H	L	L	L	L	L	L
				L	H	L	L	H	H	H	L	H
				L	H	H	H	H	H	H	L	L
				H	L	L	L	L	L	L	L	H
				H	L	H	H	L	L	L	L	L
				H	H	L	H	H	H	H	L	H
				H	H	H	L	L	L	L	L	H
A PLUS B	H	H	L	L	L	L	L	L	L	L	L	L
				L	L	H	H	H	H	H	L	L
				L	H	L	H	H	H	H	L	L
				L	H	H	L	H	H	H	L	H
				H	L	L	H	L	L	L	L	L
				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	L	H
A ⊕ B	L	L	H	X	L	L	L	L	L	L	L	L
				X	L	H	H	H	H	H	L	L
				L	H	L	H	H	H	H	L	L
				X	H	H	L	L	L	L	H	H
				H	H	L	H	H	H	H	H	H
A + B	H	L	H	X	L	L	L	L	L	L	L	L
				X	L	H	H	H	H	H	L	L
				X	H	L	H	H	H	H	L	L
				L	H	H	H	H	H	H	L	L
				H	H	H	H	H	H	H	H	H
AB	L	H	H	X	L	L	L	L	L	L	H	H
				X	L	H	L	L	L	L	L	L
				X	H	L	L	L	L	L	H	H
				L	H	H	H	H	H	H	L	L
				H	H	H	H	H	H	H	H	H
PRESET	H	H	H	X	L	L	H	H	H	H	L	L
				X	L	H	H	H	H	H	L	L
				X	H	L	H	H	H	H	L	L
				L	H	H	H	H	H	H	L	L
				H	H	H	H	H	H	H	H	H

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

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Logic Diagram

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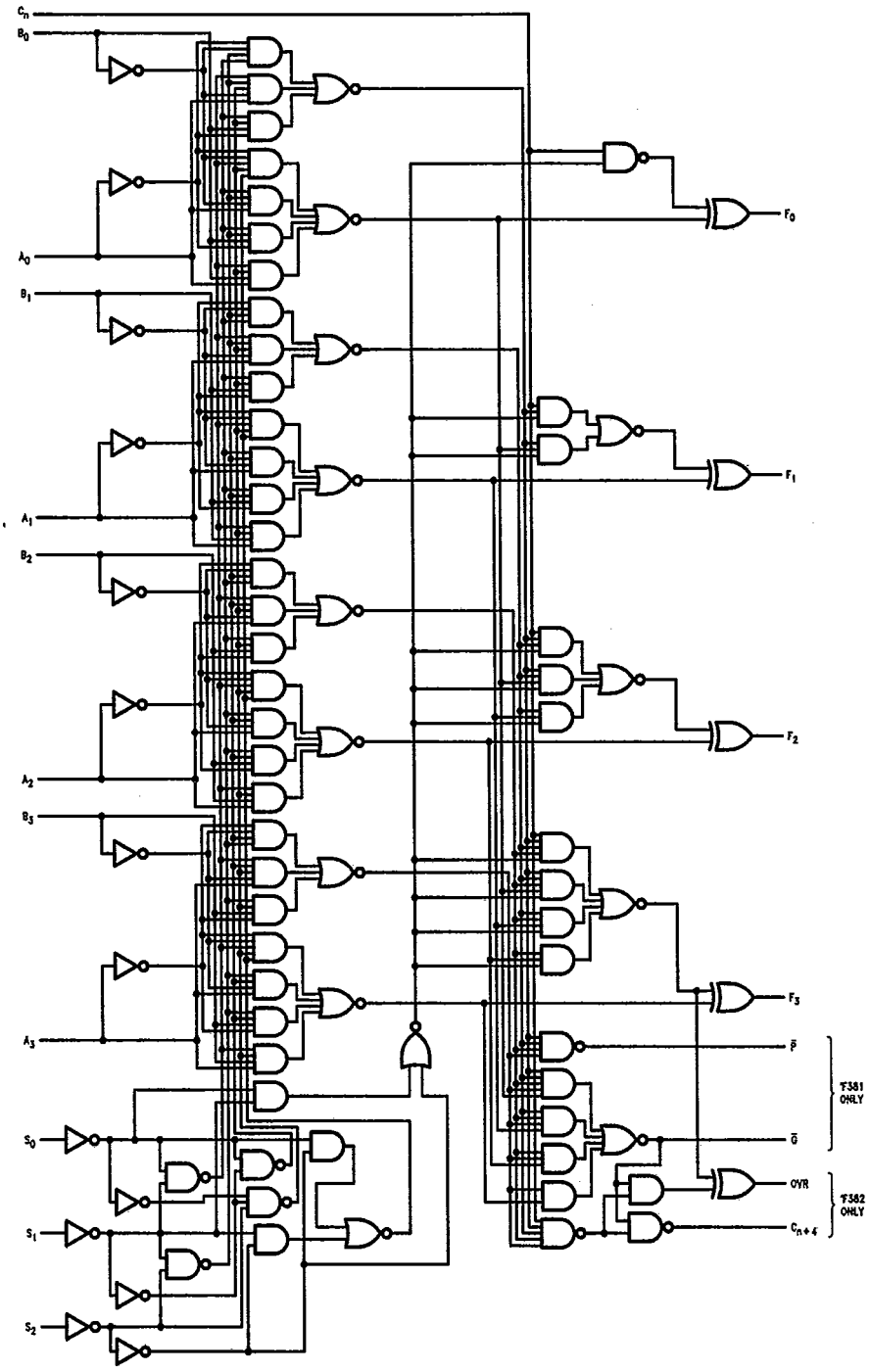

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Please note that this diagram is provided only for the understanding of logic operations and should not be used to estimate propagation delays.

Absolute Maximum Ratings (Note 1)

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 over Operating Temperature Range unless otherwise specified

Symbol	Parameter	54F/74F Min	54F/74F Typ	54F/74F Max	Units	V_{CC}	Conditions
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}	2.5			V	Min	I_{OH} = −1 mA
	Output HIGH Voltage 74F 10% V_{CC}	2.5			V	Min	I_{OH} = −1 mA
	Output HIGH Voltage 74F 5% V_{CC}	2.7			V	Min	I_{OH} = −1 mA
V_{OL}	Output LOW Voltage 54F 10% V_{CC}			0.5	V	Min	I_{OL} = 20 mA
	Output LOW Voltage 74F 10% V_{CC}			0.5	V	Min	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	mA	Max	V_{IN} = 0.5V (S_0–S_2)
				−1.8	mA	Max	V_{IN} = 0.5V (A_0–A_3, B_0–B_3)
				−2.4	mA	Max	V_{IN} = 0.5V (C_n, C_{n+4})
I_{OZH}	Output Leakage Current			50	μA	Max	V_{OUT} = 2.7V
I_{OZL}	Output Leakage Current			−50	μA	Max	V_{OUT} = 0.5V
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		54	81	mA	Max	

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AC Electrical Characteristics: See Section 2 for U.L. definitions

Symbol	Parameter	74F $T_A = +25°C$, $V_{CC} = +5.0V$, $C_L = 50$ pF			54F T_A, V_{CC} = Mil, $C_L = 50$ pF		74F T_A, V_{CC} = Com, $C_L = 50$ pF		Units	Fig No
		Min	Typ	Max	Min	Max	Min	Max		
t_{PLH} t_{PHL}	Propagation Delay C_n to F_i	3.0 2.5	8.1 5.7	12.0 8.0			3.0 2.5	13.0 9.0	ns	2–4
t_{PLH} t_{PHL}	Propagation Delay Any A or B to Any F	4.0 3.0	10.4 8.2	15.0 11.0			3.5 2.5	17.0 12.0	ns	2–4
t_{PLH} t_{PHL}	Propagation Delay S_i to F_i	6.5 4.0	11.0 8.2	20.5 15.0			5.5 4.0	21.5 17.5	ns	2–4
t_{PLH} t_{PHL}	Propagation Delay A_i or B_i to C_{n+4}	3.5 3.5	6.0 6.5	8.5 9.0			3.5 3.5	11.0 10.5	ns	2–4
t_{PLH} t_{PHL}	Propagation Delay S_i to OVR or C_{n+4}	7.0 5.0	12.5 9.0	16.5 12.0			7.0 5.0	17.5 14.5	ns	2–4
t_{PLH} t_{PHL}	Propagation Delay C_n to C_{n+4}	2.5 3.5	5.6 6.3	8.0 9.0			2.0 2.0	9.0 10.0	ns	2–4
t_{PLH} t_{PHL}	Propagation Delay C_n to OVR	3.5 2.5	8.0 7.1	11.0 10.0			3.5 2.5	13.0 11.0	ns	2–4
t_{PLH} t_{PHL}	Propagation Delay A_i or B_i to OVR	7.0 3.0	11.5 8.0	15.5 10.5			7.0 3.0	16.5 11.5	ns	2–4