

T-49-11

41

**9341
93L41
93S41**

4-BIT ARITHMETIC LOGIC UNIT

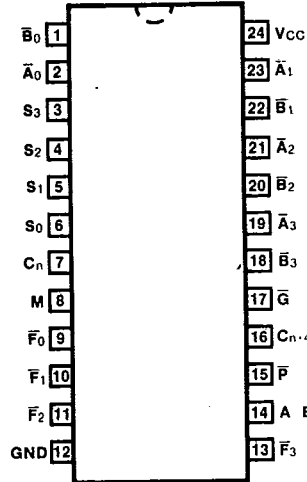
DESCRIPTION—The '41 4-bit arithmetic logic units can perform all the possible 16 logic operations on two variables and a variety of arithmetic operations; the Add and Subtract modes are the most important. The '41 is a pin replacement for the 54/74181.

- **PROVIDE 16 OPERATIONS**
ADD, SUBTRACT, COMPARE, DOUBLE
TWELVE OTHER ARITHMETIC OPERATIONS
- **PROVIDE ALL 16 LOGIC OPERATIONS OF TWO VARIABLES**
EXCLUSIVE-OR, COMPARE, AND NAND, OR, NOR, PLUS
TEN OTHER LOGIC OPERATIONS

ORDERING CODE: See Section 9

PKGS	PIN OUT	COMMERCIAL GRADE	MILITARY GRADE	PKG TYPE
		V _{CC} = +5.0 V ±5%, T _A = 0°C to +70°C	V _{CC} = +5.0 V ±10%, T _A = -55°C to +125°C	
Plastic DIP (P)	A	9341PC, 93L41PC 93S41PC		9N
Ceramic DIP (D)	A	9341DC, 93L41DC 93S41DC	9341DM, 93L41DM 93S41DM	6N
Flatpak (F)	A	9341FC, 93L41FC 93S41FC	9341FM, 93L41FM 93S41FM	4M

**CONNECTION DIAGRAM
PINOUT A**



6

INPUT LOADING/FAN-OUT: See Section 3 for U.L. definitions

PIN NAMES	DESCRIPTION	93XX (U.L.) HIGH/LOW	93L (U.L.) HIGH/LOW	93S (U.L.) HIGH/LOW
A ₀ —A ₃ , B ₀ —B ₃	Operand Inputs (Active LOW)	3.0/3.0	1.5/0.75	3.75/3.75
S ₀ —S ₃	Function Select Inputs	4.0/4.0	2.0/1.0	5.0/5.0
M	Mode Control Input	1.0/1.0	0.5/0.25	1.25/1.25
C _n	Carry Input	5.0/5.0	2.5/1.25	7.5/7.5
F ₀ —F ₃	Function Outputs (Active LOW)	20/10	10/5.0 (3.0)	25/12.5
A = B	Comparator Output	OC*/10	OC*/5.0 (3.0)	OC*/12.5
G	Carry Generator Output (Active LOW)	20/10	10/5.0 (3.0)	25/12.5
P	Carry Propagate Output (Active LOW)	20/10	10/5.0 (3.0)	25/12.5
C _n + 4	Carry Output	20/10	10/5.0 (3.0)	25/12.5

*OC—Open Collector

FUNCTIONAL DESCRIPTION — The '41 is a 4-bit high speed parallel arithmetic logic unit (ALU). Controlled by the four Function Select inputs ($S_0 - S_3$) and the Mode Control input (M), it can perform all the 16 possible operations or 16 different arithmetic operations on active HIGH or active LOW operands. The Function Table below lists these operations.

When the Mode Control input (M) is HIGH, all internal carries are inhibited and the device performs logic operations on the individual bits as listed. When the Mode Control input is LOW, the carries are enabled and the device performs arithmetic operations on the two 4-bit words. The device incorporates full internal carry lookahead and provides for either ripple carry between devices using the C_{n+4} output, or for carry lookahead between packages using the signals \bar{P} (Carry Propagate) and \bar{G} (Carry Generate). \bar{P} and \bar{G} are not affected by carry in. When speed requirements are not stringent, the '41 can be used in a simple ripple carry mode by connecting the Carry output (C_{n+4}) signal to the Carry input (C_n) of the next unit. For super high speed operation the Schottky '41 should be used in conjunction with the '42 carry lookahead circuit.

The $A = B$ output from the '41 goes HIGH when all four \bar{F}_n outputs are HIGH and can be used to indicate logic equivalence over four bits when the unit is in the subtract mode. The $A = B$ output is open-collector and can be wired-AND with the other $A = B$ outputs to give a comparison for more than four bits. The $A = B$ signal can also be used with the C_{n+4} signal to indicate $A > B$ and $A < B$.

The Function Table lists the arithmetic operations that are performed without a carry in. An incoming carry adds a one to each operation. Thus select code LHHL generates A minus B minus 1 (2s complement notation) without a carry in and generates A minus B when a carry is applied. Because subtraction is actually performed by complementary addition (1s complement), a carry out means borrow; thus a carry is generated when there is no underflow and no carry is generated when there is underflow.

As indicated the '41 can be used with either active LOW inputs producing active LOW outputs or with active HIGH inputs producing active HIGH outputs. For either case the table lists the operations that are performed to the operands labeled inside the logic symbol.

FUNCTION TABLE

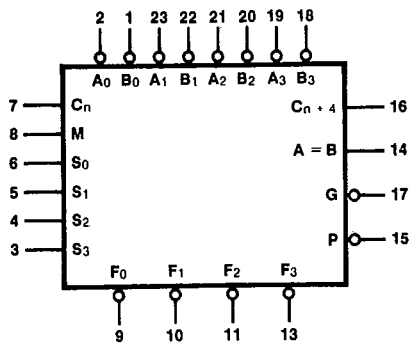
MODE SELECT INPUTS				ACTIVE LOW INPUTS & OUTPUTS		ACTIVE HIGH INPUTS & OUTPUTS	
S_3	S_2	S_1	S_0	LOGIC (M = H)	ARITHMETIC** (M = L) ($C_n = L$)	LOGIC (M = H)	ARITHMETIC** (M = L) ($C_n = H$)
L	L	L	L	\bar{A}	A minus 1	\bar{A}	A
L	L	L	H	$\bar{A}\bar{B}$	AB minus 1	$\bar{A} + \bar{B}$	A + B
L	L	H	L	$\bar{A} + \bar{B}$	AB minus 1	$\bar{A}\bar{B}$	A + B
L	L	H	H	Logic 1	minus 1	Logic 0	minus 1
L	H	L	L	$\bar{A} + \bar{B}$	A plus ($A + \bar{B}$)	$\bar{A}\bar{B}$	A plus $\bar{A}\bar{B}$
L	H	L	H	\bar{B}	AB plus ($A + \bar{B}$)	\bar{B}	(A + B) plus $\bar{A}\bar{B}$
L	H	H	L	$\bar{A} \oplus \bar{B}$	A minus B minus 1	$A \oplus B$	A minus B minus 1
L	H	H	H	$A + \bar{B}$	$A + \bar{B}$	$\bar{A}\bar{B}$	$\bar{A}\bar{B}$ minus 1
H	L	L	L	$\bar{A}\bar{B}$	A plus (A + B)	$\bar{A} + B$	A plus AB
H	L	L	H	$A \oplus B$	A plus B	$A \oplus B$	A plus B
H	L	H	L	B	$\bar{A}\bar{B}$ plus (A + B)	B	(A + \bar{B}) plus AB
H	L	H	H	A + B	A + B	AB	AB minus 1
H	H	L	L	Logic 0	A plus A*	Logic 1	A plus A*
H	H	L	H	$\bar{A}\bar{B}$	AB plus A	$\bar{A} + \bar{B}$	(A + B) plus A
H	H	H	L	AB	$\bar{A}\bar{B}$ minus A	A + B	(A + \bar{B}) plus A
H	H	H	H	A	A	A	A minus 1

*Each bit is shifted to the next more significant position
 **Arithmetic operations expressed in 2s complement notation
 H = HIGH Voltage Level
 L = LOW Voltage Level

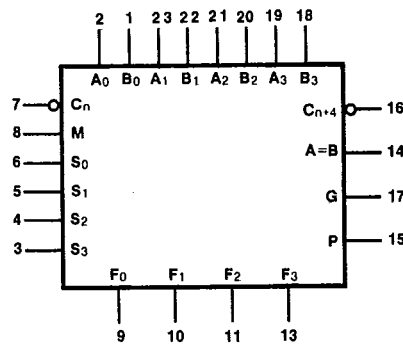
T-49-11

LOGIC SYMBOLS

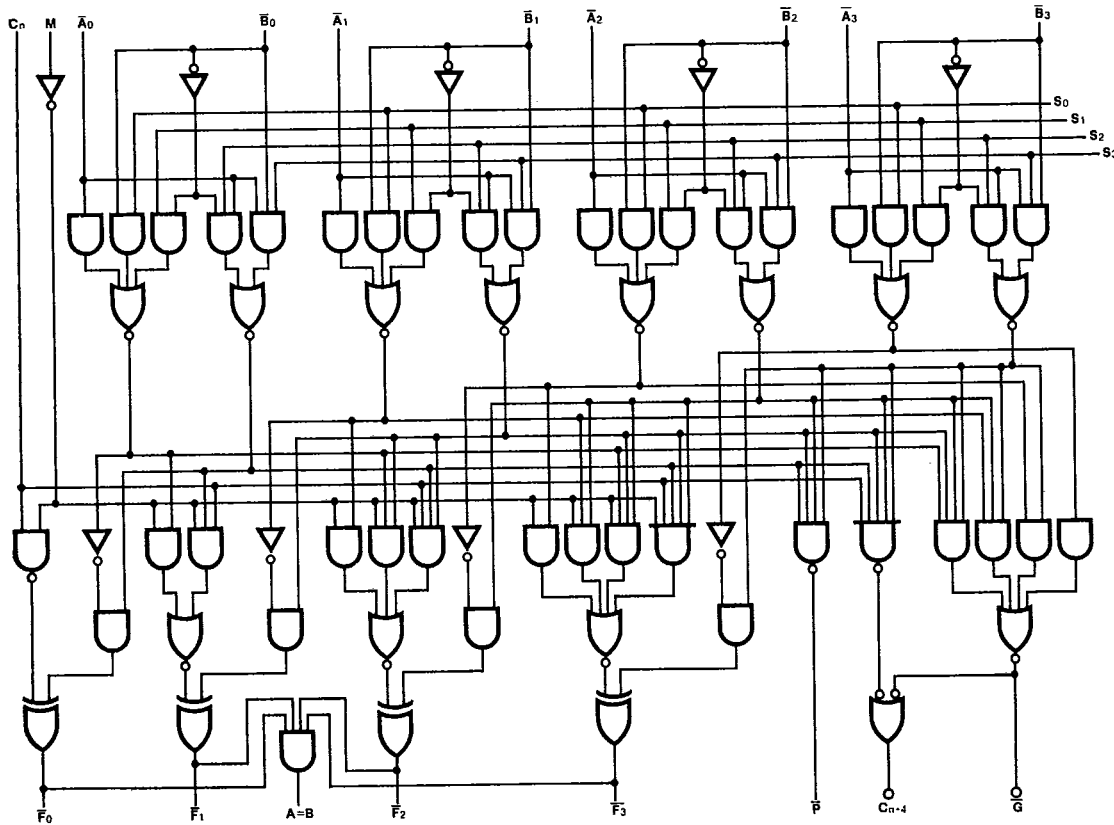
ACTIVE LOW OPERANDS



ACTIVE HIGH OPERANDS



LOGIC DIAGRAM



6

DC CHARACTERISTICS OVER OPERATING TEMPERATURE RANGE (unless otherwise specified)									
SYMBOL	PARAMETER	93XX		93L		93S		UNITS	CONDITIONS
		Min	Max	Min	Max	Min	Max		
I _{CC}	Power Supply Current	XM	127			125		mA	V _{CC} = Max C _n , $\bar{B}_0 - \bar{B}_3$ = Gnd All Other Inputs = 4.5 V
		XC	140			140			
I _{CC}	Power Supply Current	XM	135			135		mA	V _{CC} = Max M, S ₀ - S ₃ = 4.5 V All Other Inputs = Gnd
		XC	150			150			
I _{CC}	Power Supply Current			36				mA	V _{CC} = Max

AC CHARACTERISTICS: V _{CC} = +5.0 V, T _A = +25° C (See Section 3 for waveforms and load configurations)									
SYMBOL	PARAMETER	93XX		93L		93S		UNITS	CONDITIONS
		C _L = 15 pF R _L = 400 Ω		C _L = 15 pF		C _L = 15 pF R _L = 280 Ω			
		Min	Max	Min	Max	Min	Max		
t _{PLH} t _{PHL}	Propagation Delay C _n to C _n + 4	16 17		51 22		12 12		ns	M = Gnd Figs. 3-1, 3-4 Tables I & II
t _{PLH} t _{PHL}	Propagation Delay C _n to \bar{F}	17 17		37 42		12 12		ns	M = Gnd Figs. 3-1, 3-4 Table I
t _{PLH} t _{PHL}	Propagation Delay \bar{A}_n or \bar{B}_n to \bar{G}	19 12		51 26		14 14		ns	M, S ₁ , S ₂ = Gnd S ₀ , S ₃ = 4.5 V Figs. 3-1, 3-5 Table I
t _{PLH} t _{PHL}	Propagation Delay \bar{A}_n or \bar{B}_n to \bar{G}	22 17		50 43		15 15		ns	M, S ₀ , S ₃ = Gnd S ₁ , S ₂ = 4.5 V Figs. 3-1, 3-4, 3-5 Table II
t _{PLH} t _{PHL}	Propagation Delay \bar{A}_n or \bar{B}_n to \bar{P}	19 15		50 46		14 14		ns	M, S ₁ , S ₂ = Gnd S ₀ , S ₃ = 4.5 V Figs. 3-1, 3-5 Table I
t _{PLH} t _{PHL}	Propagation Delay \bar{A}_n or \bar{B}_n to \bar{P}	21 21		38 63		15 15		ns	M, S ₀ , S ₃ = Gnd S ₁ , S ₂ = 4.5 V Figs. 3-1, 3-4, 3-5 Table II
t _{PLH} t _{PHL}	Propagation Delay \bar{A}_i or \bar{B}_i to \bar{F}_i	26 26		36 65		20 20		ns	M, S ₁ , S ₃ = Gnd S ₀ , S ₂ = 4.5 V Figs. 3-1, 3-5 Table I

AC CHARACTERISTICS: $V_{CC} = +5.0\text{ V}$, $T_A = +25^\circ\text{C}$ (Cont'd)

SYMBOL	PARAMETER	93XX		93L		93S		UNITS	CONDITIONS
		$C_L = 15\text{ pF}$ $R_L = 400\ \Omega$		$C_L = 15\text{ pF}$		$C_L = 15\text{ pF}$ $R_L = 280\ \Omega$			
		Min	Max	Min	Max	Min	Max		
tPLH tPHL	Propagation Delay \bar{A}_i or \bar{B}_i to \bar{F}_i	26 32		39 49		21 21		ns	M, S ₀ , S ₃ = Gnd S ₁ , S ₂ = 4.5 V Figs. 3-1, 3-4, 3-5 Table II
tPLH tPHL	Propagation Delay \bar{A}_i or \bar{B}_i to \bar{F}_{i+1}	29 25		56 62		24 24		ns	M, S ₁ , S ₂ = Gnd S ₀ , S ₃ = 4.5 V Figs. 3-1, 3-5 Table I
tPLH tPHL	Propagation Delay \bar{A}_i or \bar{B}_i to \bar{F}_{i+1}	29 30		68 71		25 25		ns	M, S ₀ , S ₃ = Gnd S ₁ , S ₂ = 4.5 V Figs. 3-1, 3-4, 3-5 Table II
tPLH tPHL	Propagation Delay \bar{A}_n or \bar{B}_n to \bar{F}	24 24		51 49		20 20		ns	M = 4.5 V Figs. 3-1, 3-5 Table III
tPLH tPHL	Propagation Delay \bar{A}_n or \bar{B}_n to C_{n+1}	21 30		46 60		18.5 18.5		ns	M, S ₁ , S ₂ = Gnd S ₀ , S ₃ = 4.5 V Figs. 3-1, 3-4 Table I
tPLH tPHL	Propagation Delay \bar{A}_n or \bar{B}_n to C_{n+1}	25 30		60 58		23 23		ns	M, S ₀ , S ₃ = Gnd S ₁ , S ₂ = 4.5 V Figs. 3-1, 3-4, 3-5 Table II
tPLH tPHL	Propagation Delay \bar{A}_n or \bar{B}_n to A = B	40 42		68 72		23 23		ns	M, S ₀ , S ₃ = Gnd S ₁ , S ₂ = 4.5 V $R_L = 400\ \Omega$ to 5.0 V; Figs. 3-1, 3-4, 3-5; Table II

6

41

T-49-11

SUM MODE TEST TABLE I

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

SYMBOL	INPUT UNDER TEST	OTHER INPUT SAME BIT		OTHER DATA INPUTS		OUTPUT UNDER TEST
		APPLY 4.5 V	APPLY GND	APPLY 4.5 V	APPLY GND	
tPLH tPHL	\bar{A}_i	\bar{B}_i	None	Remaining \bar{A} and \bar{B}	C_n	\bar{F}_i
tPLH tPHL	\bar{B}_i	\bar{A}_i	None	Remaining \bar{A} and \bar{B}	C_n	\bar{F}_i
tPLH tPHL	\bar{A}_i	\bar{B}_i	None	C_n	Remaining \bar{A} and \bar{B}	\bar{F}_{i+1}
tPLH tPHL	\bar{B}_i	\bar{A}_i	None	C_n	Remaining \bar{A} and \bar{B}	\bar{F}_{i+1}
tPLH tPHL	\bar{A}	\bar{B}	None	None	Remaining \bar{A} and \bar{B} , C_n	\bar{P}
tPLH tPHL	\bar{B}	\bar{A}	None	None	Remaining \bar{A} and \bar{B} , C_n	\bar{P}
tPLH tPHL	\bar{A}	None	\bar{B}	Remaining \bar{B}	Remaining \bar{A} , C_n	\bar{G}
tPLH tPHL	\bar{B}	None	\bar{A}	Remaining \bar{B}	Remaining \bar{A} , C_n	\bar{G}
tPLH tPHL	\bar{A}	None	\bar{B}	Remaining \bar{B}	Remaining \bar{A} , C_n	$C_n + 4$
tPLH tPHL	\bar{B}	None	\bar{A}	Remaining \bar{B}	Remaining \bar{A} , C_n	$C_n + 4$
tPLH tPHL	C_n	None	None	All \bar{A}	All \bar{B}	Any \bar{F} or $C_n + 4$

DIFF MODE TEST TABLE II

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

SYMBOL	INPUT UNDER TEST	OTHER INPUT SAME BIT		OTHER DATA INPUTS		OUTPUT UNDER TEST
		APPLY 4.5 V	APPLY GND	APPLY 4.5 V	APPLY GND	
t _{PLH} t _{PHL}	\bar{A}	None	\bar{B}	Remaining \bar{A}	Remaining \bar{B} , C_n	\bar{F}_i
t _{PLH} t _{PHL}	\bar{B}	\bar{A}	None	Remaining \bar{A}	Remaining \bar{B} , C_n	\bar{F}_i
t _{PLH} t _{PHL}	\bar{A}_i	None	\bar{B}_i	Remaining \bar{B} , C_n	Remaining \bar{A}	\bar{F}_{i+1}
t _{PLH} t _{PHL}	\bar{B}_i	\bar{A}_i	None	Remaining \bar{B} , C_n	Remaining \bar{A}	\bar{F}_{i+1}
t _{PLH} t _{PHL}	\bar{A}	None	\bar{B}	None	Remaining \bar{A} and \bar{B} , C_n	\bar{P}
t _{PLH} t _{PHL}	\bar{B}	\bar{A}	None	None	Remaining \bar{A} and \bar{B} , C_n	\bar{P}
t _{PLH} t _{PHL}	\bar{A}	\bar{B}	None	None	Remaining \bar{A} and \bar{B} , C_n	\bar{G}
t _{PLH} t _{PHL}	\bar{B}	None	\bar{A}	None	Remaining \bar{A} and \bar{B} , C_n	\bar{G}
t _{PLH} t _{PHL}	\bar{A}	None	\bar{B}	Remaining \bar{A}	Remaining \bar{B} , C_n	$A = B$
t _{PLH} t _{PHL}	\bar{B}	\bar{A}	None	Remaining \bar{A}	Remaining \bar{B} , C_n	$A = B$
t _{PLH} t _{PHL}	\bar{A}	\bar{B}	None	None	Remaining \bar{A} and \bar{B} , C_n	$C_n + 4$
t _{PLH} t _{PHL}	\bar{B}	None	\bar{A}	None	Remaining \bar{A} and \bar{B} , C_n	$C_n + 4$
t _{PLH} t _{PHL}	C_n	None	None	All \bar{A} and \bar{B}	None	$C_n + 4$

6

LOGIC MODE TEST TABLE III

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

SYMBOL	INPUT UNDER TEST	OTHER INPUT SAME BIT		OTHER DATA INPUTS		OUTPUT UNDER TEST
		APPLY 4.5 V	APPLY GND	APPLY 4.5 V	APPLY GND	
t _{PLH} t _{PHL}	\bar{A}	\bar{B}	None	None	Remaining \bar{A} and \bar{B} , C_n	Any \bar{F}
t _{PLH} t _{PHL}	\bar{B}	\bar{A}	None	None	Remaining \bar{A} and \bar{B} , C_n	Any \bar{F}