

# SN54LS381A, SN54S381, SN74LS381A, SN54LS382A, SN74LS382A, SN74S381 ARITHMETIC LOGIC UNITS/FUNCTION GENERATORS

SDLS168 – JANUARY 1981 – REVISED MARCH 1988

## PIN DESIGNATIONS

DESIGNATION	PIN NOS.	FUNCTION
A3, A2, A1, A0	17, 19, 1, 3	WORD A INPUTS
B3, B2, B1, B0	16, 18, 2, 4	WORD B INPUTS
S2, S1, S0	7, 6, 5	FUNCTION-SELECT INPUTS
$C_n$	15	CARRY INPUT FOR ADDITION, INVERTED CARRY INPUT FOR SUBTRACTION
F3, F2, F1, F0	12, 11, 9, 8	FUNCTION OUTPUTS
$\bar{P}$ ('LS381A 'S381 ONLY)	14	ACTIVE-LOW CARRY PROPAGATE OUTPUT
$\bar{G}$ ('LS381A 'S381 ONLY)	13	ACTIVE-LOW CARRY GENERATE OUTPUT
$C_n + 4$ ('LS382A ONLY)	14	RIPPLE-CARRY OUTPUT
OVR ('LS382A ONLY)	13	OVERFLOW OUTPUT
VCC	20	SUPPLY VOLTAGE
GND	10	GROUND

- Fully Parallel 4-Bit ALUs in 20-Pin Package for 0.300-Inch Row Spacing
- Ideally Suited for High-Density Economical Processors
- 'LS381A and 'S381 Feature  $\bar{G}$  and  $\bar{P}$  Outputs for Look-Ahead Carry Cascading
- 'LS382A Features Ripple Carry ( $C_n + 4$ ) and Overflow (OVR) Outputs
- Arithmetic and Logic Operations Selected Specifically to Simplify System Implementation:
  - A Minus B
  - B Minus A
  - A Plus B
  - and Five Other Functions

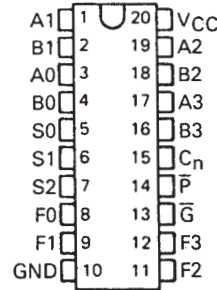
## description

The 'LS381A, 'S381 and 'LS382A are low-power Schottky and Schottky TTL arithmetic logic units (ALUs)/function generators that perform eight binary arithmetic/logic operations on two 4-bit words as shown in the function table. The exclusive-OR, AND, or OR function of the two Boolean variables is provided without the use of external circuitry. Also, the outputs can be cleared (low) or preset (high) as desired. The 'LS381A and 'S381 provide two cascade outputs ( $\bar{P}$  and  $\bar{G}$ ) for expansion utilizing SN54S182/SN74S182 look-ahead carry generators. The 'LS382 provides a  $C_n + 4$  output to ripple the carry to the  $C_n$  input of the next stage. The 'LS382A detects and indicates two's complement overflow condition via the OVR output. The overflow output is logically equivalent to  $C_n + 3 \oplus C_n + 4$ . When the 'LS382A is cascaded to handle word lengths longer than four bits in length, only the most significant overflow (OVR) output is used.

The SN54' family is characterized for operation over the full military temperature range of  $-55^\circ\text{C}$  to  $125^\circ\text{C}$ . The SN74' family is characterized for operation from  $0^\circ\text{C}$  to  $70^\circ\text{C}$ .

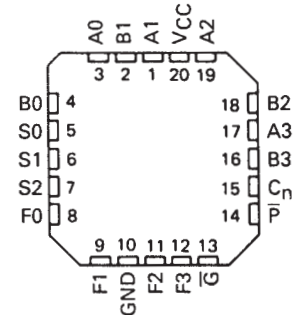
SN54LS381A, SN54S381  
... J OR W PACKAGE  
SN74LS381A, SN74S381  
... DW OR N PACKAGE

(TOP VIEW)



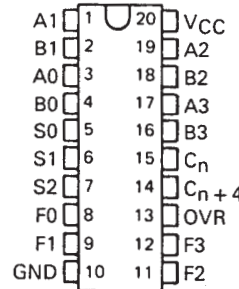
SN54LS381A, SN54S381  
... FK PACKAGE

(TOP VIEW)



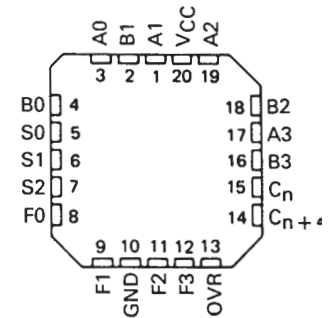
SN54LS382A ...  
J OR W PACKAGE  
SN74LS382A ...  
DW OR N PACKAGE

(TOP VIEW)



SN54LS382A ... FK PACKAGE

(TOP VIEW)



## FUNCTION TABLE

SELECTION	ARITHMETIC/LOGIC		
S2	S1	S0	OPERATION
L	L	L	CLEAR
L	L	H	B MINUS A
L	H	L	A MINUS B
L	H	H	A PLUS B
H	L	L	$A \oplus B$
H	L	H	$A + B$
H	H	L	AB
H	H	H	PRESET

H = high level, L = low level

# SN54LS381A, SN54S381, SN74LS381A, SN54LS382A, SN74LS382A, SN74S381 ARITHMETIC LOGIC UNITS/FUNCTION GENERATORS

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## function table

Certain differences exist in the  $\overline{G}$ ,  $\overline{P}$  ('LS381A, 'S381) and OVR,  $C_{n+4}$  ('LS382A) function table compared with similar parts from other technologies and other vendors. No differences exist in the arithmetic modes (B minus A, A minus B, and A plus B), where these outputs perform valuable cascade functions. There are slight differences in the other modes (CLEAR,  $A + B$ ,  $A \oplus B$ , AB, and PRESET), where these outputs are strictly "don't care".

This function table is a condensed version and assumes for  $A_n$  that A0, A1, A2, and A3 inputs all agree and for  $B_n$  that B0, B1, B2, and B3 inputs all agree. This table is intended to point out the response of these  $\overline{G}$ ,  $\overline{P}$  ('LS381A, 'S381) and OVR,  $C_{n+4}$  ('LS382A) outputs in all modes of operation to facilitate incoming inspection.

FUNCTION TABLE

ARITHMETIC/LOGIC OPERATION	INPUTS						OUTPUTS				('LS381A, 'S381)		('LS382A)			
	S2	S1	S0	$C_n$	$A_n$	$B_n$	F3	F2	F1	F0	$\overline{G}$	$\overline{P}$	OVR	$C_{n+4}$		
CLEAR	L	L	L	X	X	X	L	L	L	L	H	H	L	L		
B MINUS A	L	L	H	L	L	L	H	H	H	H	H	L	L	L		
				L	L	H	H	H	H	L	L	H	H	L	H	
				L	H	L	L	L	L	L	L	L	H	H	L	L
				L	H	H	H	H	H	H	H	H	H	L	L	L
				H	L	L	L	L	L	L	L	L	H	L	L	H
				H	L	H	H	H	H	H	H	H	L	H	L	H
				H	H	L	L	L	L	L	L	H	H	H	L	L
				H	H	H	L	L	L	L	L	L	H	L	L	H
A MINUS B	L	H	L	L	L	L	H	H	H	H	H	L	L	L		
				L	L	H	L	L	L	L	L	H	H	L	L	
				L	H	L	H	H	H	L	L	L	L	H	L	H
				L	H	H	H	H	H	H	H	H	H	L	L	L
				H	L	L	L	L	L	L	L	L	H	L	L	H
				H	L	H	L	L	L	L	L	H	H	H	L	L
				H	H	L	H	H	H	H	H	H	L	H	L	H
				H	H	H	L	L	L	L	L	L	H	L	L	H
A PLUS B	L	H	H	L	L	L	L	L	L	L	H	H	L	L		
				L	L	H	H	H	H	H	H	H	L	L	L	
				L	H	L	H	H	H	H	H	H	L	L	L	
				L	H	H	H	H	H	L	L	L	L	H	L	H
				H	L	L	L	L	L	L	L	H	H	L	L	L
				H	L	H	L	L	L	L	L	L	H	L	L	H
				H	H	L	L	L	L	L	L	L	H	L	L	H
				H	H	H	L	L	L	L	L	L	H	L	L	H
$A \oplus B$	H	L	L	X	L	L	L	L	L	L	H	H	L	L		
				L	L	H	H	H	H	H	H	L	L	L		
				H	L	H	H	H	H	H	H	H	L	H	H	
				L	H	L	H	H	H	H	H	H	L	L	L	
				X	H	H	L	L	L	L	L	H	H	L	L	
A + B	H	L	H	X	L	L	L	L	L	L	H	H	L	L		
				L	L	H	H	H	H	H	H	L	L	L		
				H	L	H	H	H	H	H	H	H	L	H	H	
				L	H	L	H	H	H	H	H	H	L	L	L	
				L	H	H	H	H	H	H	H	H	L	L	L	
AB	H	H	L	X	L	L	L	L	L	L	H	H	L	L		
				X	L	H	L	L	L	L	L	H	H	L	L	
				L	H	H	H	H	H	H	H	H	L	L	L	
				H	H	H	H	H	H	H	H	H	L	H	H	
PRESET	H	H	H	L	X	X	H	H	H	H	H	L	L	L		
				H	X	X	H	H	H	H	H	H	L	H	H	

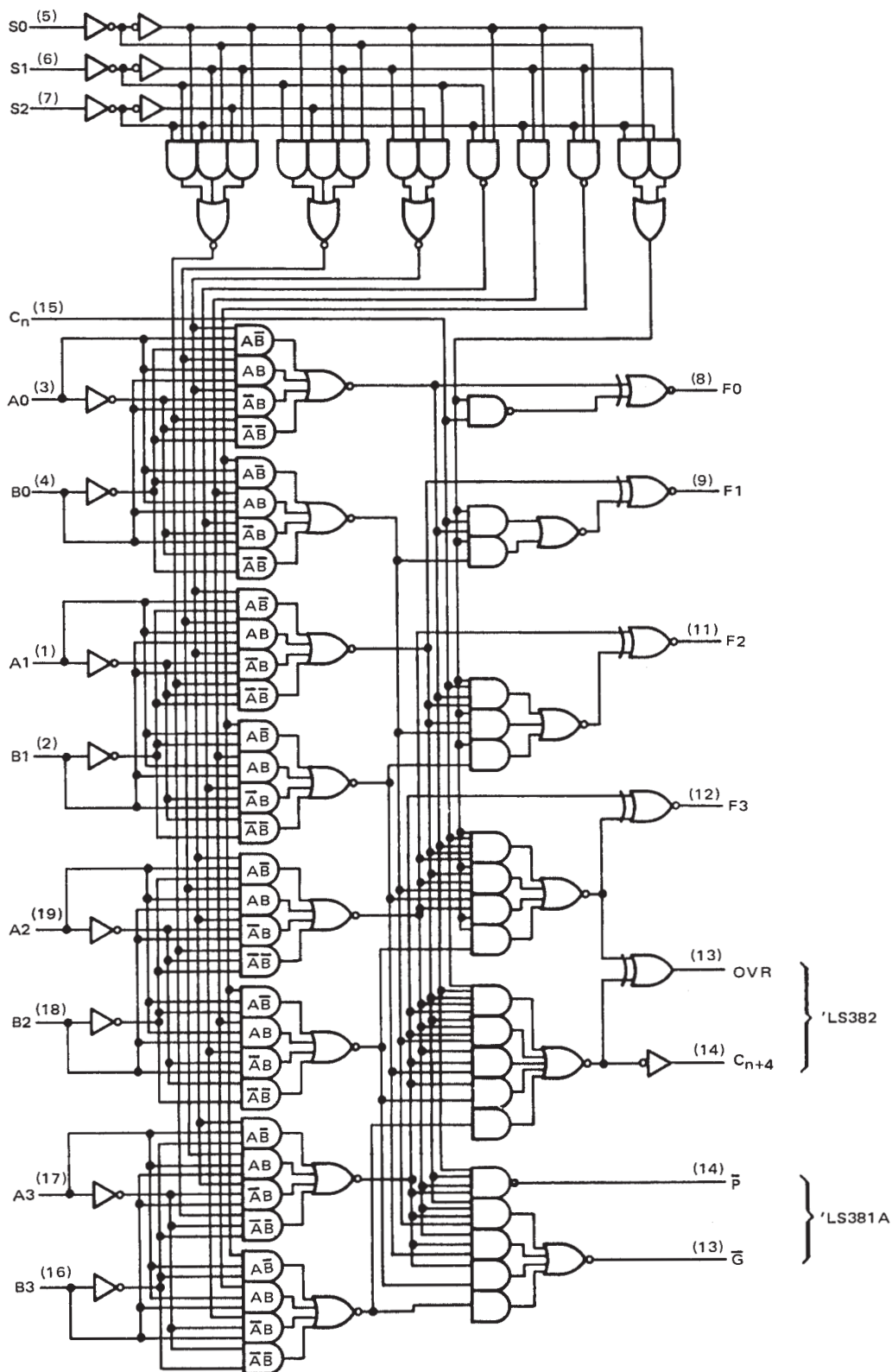


# SN54LS381A, SN54S381, SN74LS381A, SN54LS382A, SN74LS382A, SN74S381 ARITHMETIC LOGIC UNITS/FUNCTION GENERATORS

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logic diagram (positive logic)

'LS381A, 'LS382A



Pin numbers shown are for DW, J, N, and W packages.

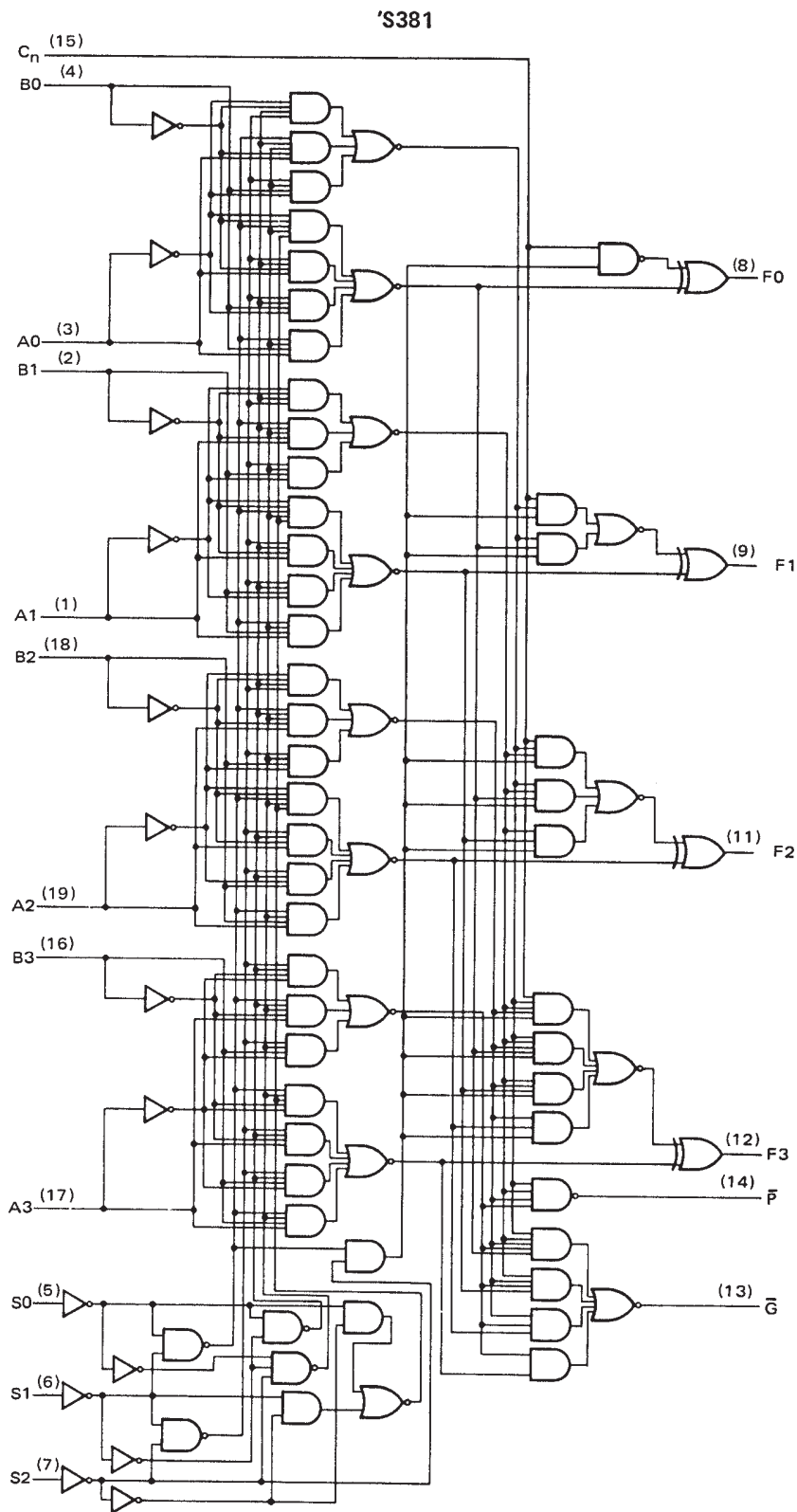


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## logic diagram and schematics of inputs and outputs



Pin numbers shown are for DW, J, N, and W packages.

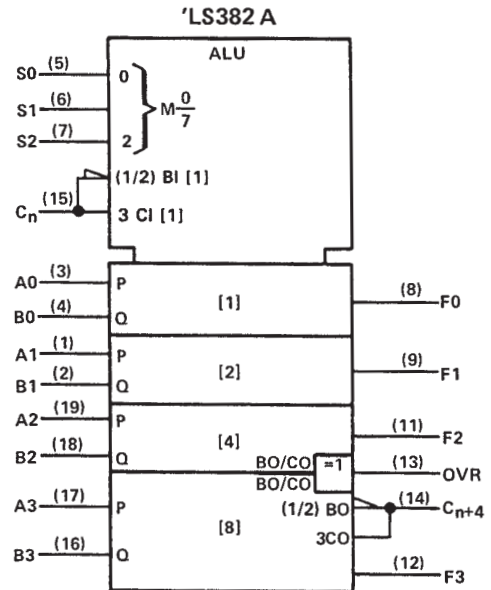
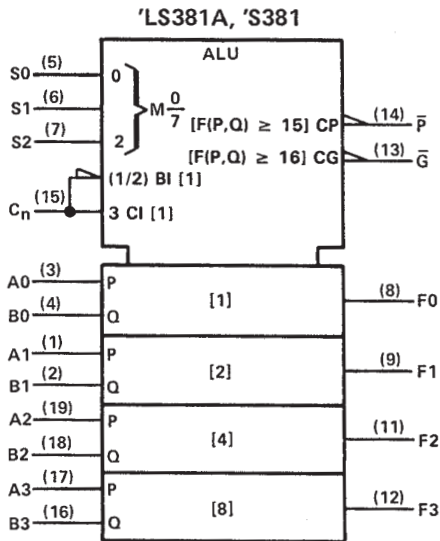


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# SN54LS381A, SN54S381, SN74LS381A, SN54LS382A, SN74LS382A, SN74S381 ARITHMETIC LOGIC UNITS/FUNCTION GENERATORS

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## logic symbols †

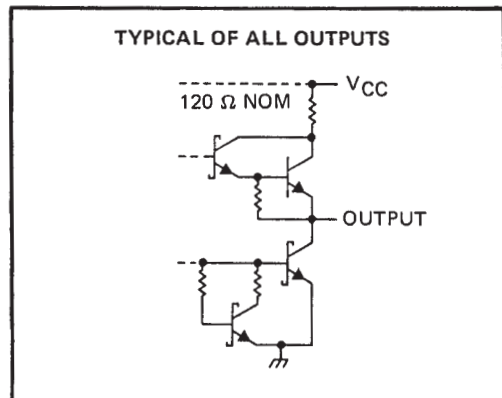
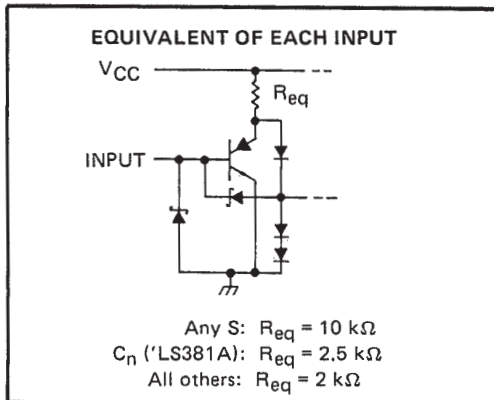


†These symbols are in accordance with ANSI/IEEE Std 91-1984 and IEC Publication 617-12.

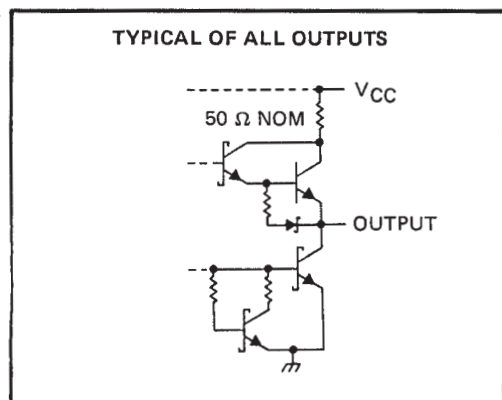
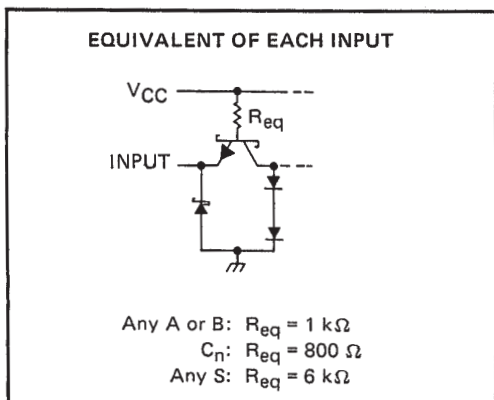
Pin numbers shown are for DW, J, N, and W packages.

## schematics of inputs and outputs

'LS381, 'LS382A



'S381





# SN54LS381A, SN54S381, SN74LS381A, SN54LS382A, SN74LS382A, SN74S381 ARITHMETIC LOGIC UNITS/FUNCTION GENERATORS

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## absolute maximum ratings over operating free-air temperature range (unless otherwise noted)

Supply voltage, $V_{CC}$ (See Note 1) . . . . .	7 V
Input voltage . . . . .	7 V
Operating free-air temperature range: SN54LS381A, SN54LS382A . . . . .	-55°C to 125°C
SN74LS381A, SN74LS382A . . . . .	0°C to 70°C
Storage temperature range . . . . .	-65°C to 150°C

NOTE 1: Voltage values are with respect to the network ground terminal.

## recommended operating conditions

	SN54LS'			SN74LS'			UNIT
	MIN	NOM	MAX	MIN	NOM	MAX	
$V_{CC}$ Supply voltage	4.5	5	5.5	4.75	5	5.25	V
$V_{IH}$ High-level input voltage	2			2			V
$V_{IL}$ Low-level input voltage			0.7			0.8	V
$I_{OH}$ High-level output current			-0.4			-0.4	mA
$I_{OL}$ Low-level output current	$\bar{G}$ output of 'LS381A		16			16	mA
	All other outputs		4			8	
$T_A$ Operating free-air temperature	-55		125	0		70	°C

## electrical characteristics over recommended operating free-air temperature range (unless otherwise noted)

PARAMETER	TEST CONDITIONS†	SN54LS'			SN74LS'			UNIT	
		MIN	TYP‡	MAX	MIN	TYP‡	MAX		
$V_{IK}$	$V_{CC} = \text{MIN}, I_I = -18 \text{ mA}$			-1.5			-1.5	V	
$V_{OH}$	$V_{CC} = \text{MIN}, V_{IH} = 2 \text{ V}, V_{IL} = \text{MAX}, I_{OH} = -0.4 \text{ mA}$	2.5	3.4		2.7	3.4		V	
$V_{OL}$	$\bar{G}$ ('LS381A)	$V_{CC} = \text{MIN}, V_{IH} = 2 \text{ V}, I_{OL} = 16 \text{ mA}$		0.47	0.7	$V_{CC} = \text{MIN}, V_{IH} = 2 \text{ V}, I_{OL} = 16 \text{ mA}$		0.47	0.7
	Other outputs	$V_{CC} = \text{MIN}, V_{IH} = 2 \text{ V}, I_{OL} = 4 \text{ mA}$		0.25	0.4	$V_{CC} = \text{MIN}, V_{IH} = 2 \text{ V}, I_{OL} = 4 \text{ mA}$		0.25	0.4
		$V_{CC} = \text{MIN}, V_{IH} = 2 \text{ V}, I_{OL} = 8 \text{ mA}$				$V_{CC} = \text{MIN}, V_{IH} = 2 \text{ V}, I_{OL} = 8 \text{ mA}$		0.35	0.5
$I_I$	$V_{CC} = \text{MAX}, V_I = 7 \text{ V}$			0.1			0.1	mA	
$I_{IH}$	Any S	$V_{CC} = \text{MAX}, V_I = 2.7 \text{ V}$		20		$V_{CC} = \text{MAX}, V_I = 2.7 \text{ V}$		20	$\mu\text{A}$
	Any A or B			100				100	
	$C_n$ ('LS381A)			80				80	
	$C_n$ ('LS382A)			100				100	
$I_{IL}$	Any S	$V_{CC} = \text{MAX}, V_I = 0.4 \text{ V}$		-0.2		$V_{CC} = \text{MAX}, V_I = 0.4 \text{ V}$		-0.2	mA
	Any A or B			-1				-1	
	$C_n$ ('LS381A)			-0.8				-0.8	
	$C_n$ ('LS382A)			-0.8				-0.8	
$I_{OS}§$	$V_{CC} = \text{MAX}$	-20		-100		-20		-100	mA
$I_{CC}$	$V_{CC} = \text{MAX},$ All inputs grounded, outputs open		35	65		35	65	mA	

† For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.

‡ All typical values are at  $V_{CC} = 5 \text{ V}, T_A = 25^\circ\text{C}$ .

§ Not more than one output should be shorted at a time, and duration of the short circuit should not exceed one second.



# SN54LS381A, SN54S381, SN74LS381A, SN54LS382A, SN74LS382A, SN74S381 ARITHMETIC LOGIC UNITS/FUNCTION GENERATORS

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switching characteristics,  $V_{CC} = 5\text{ V}$ ,  $T_A = 25^\circ\text{C}$  (see note 3)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	'LS381A			'LS382			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	
t <sub>PLH</sub>	C <sub>n</sub>	Any F	$R_L = 2\text{ k}\Omega, \quad C_L = 15\text{ pF}$	18		27	18		27	ns
t <sub>PHL</sub>				14		21	14		21	
t <sub>PLH</sub>	Any A or B	$\bar{G}$		20		30				ns
t <sub>PHL</sub>				21		33				
t <sub>PLH</sub>	Any A or B	$\bar{P}$		21		33				ns
t <sub>PHL</sub>				23		33				
t <sub>PLH</sub>	A <sub>i</sub> or B <sub>i</sub>	F <sub>i</sub>		20		30	20		30	ns
t <sub>PHL</sub>				15		23	15		23	
t <sub>PLH</sub>	S <sub>0</sub> , S <sub>1</sub> , S <sub>2</sub>	F <sub>i</sub>		35		53	35		53	ns
t <sub>PHL</sub>				34		51	34		51	
t <sub>PLH</sub>	S <sub>0</sub> , S <sub>1</sub> , S <sub>2</sub>	$\bar{G}$ or $\bar{P}$		31		47				ns
t <sub>PHL</sub>				32		48				
t <sub>PLH</sub>	Any A or B	C <sub>n+4</sub>					28		42	ns
t <sub>PHL</sub>							26		39	
t <sub>PLH</sub>	Any A or B	OVR					23		35	ns
t <sub>PHL</sub>							27		41	
t <sub>PLH</sub>	S <sub>0</sub> , S <sub>1</sub> , S <sub>2</sub>	C <sub>n+4</sub> or OVR					38		57	ns
t <sub>PHL</sub>							36		54	
t <sub>PLH</sub>	C <sub>n</sub>	OVR					10		15	ns
t <sub>PHL</sub>							13		23	
t <sub>PLH</sub>	C <sub>n</sub>	C <sub>n+4</sub>				13		21	ns	
t <sub>PHL</sub>						11		20		

NOTE 3: Load circuits and voltage waveforms are shown in Section 1.



# SN54LS381A, SN54S381, SN74LS381A, SN54LS382A, SN74LS382A, SN74S381 ARITHMETIC LOGIC UNITS/FUNCTION GENERATORS

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## absolute maximum ratings over operating free-air temperature range (unless otherwise noted)

Supply voltage, $V_{CC}$ (see Note 1)	7 V
Input voltage	5.5 V
Interemitter voltage (see Note 2)	5.5 V
Operating free-air temperature range: SN54S381	-55°C to 125°C
SN74S381	0°C to 70°C
Storage free-air temperature	-65°C to 150°C

NOTES: 1. Voltage values, except interemitter voltage, are with respect to network ground terminal.

2. This is the voltage between two emitters of a multiple-emitter transistor. For this circuit, this rating applies to each A input in conjunction with its respective B input; for example A0 with B0, etc.

## recommended operating conditions

	SN54S381			SN74S381			UNIT
	MIN	NOM	MAX	MIN	NOM	MAX	
Supply voltage, $V_{CC}$	4.5	5	5.5	4.75	5	5.25	V
High-level output current, $I_{OH}$			-1			-1	mA
Low-level output current, $I_{OL}$			20			20	mA
Operating free-air temperature, $T_A$	-55		125	0		70	°C

## electrical characteristics over recommended operating free-air temperature range (unless otherwise noted)

PARAMETER		TEST CONDITIONS†	MIN	TYP‡	MAX	UNIT
$V_{IH}$	High-level input voltage		2			V
$V_{IL}$	Low-level input voltage				0.8	V
$V_{IK}$	Input clamp voltage	$V_{CC} = \text{MIN}, I_I = -18 \text{ mA}$			-1.2	V
$V_{OH}$	High-level output voltage	SN54S381	$V_{CC} = \text{MIN}, V_{IH} = 2 \text{ V},$	2.4	3.4	V
		SN74S381	$V_{IL} = 0.8 \text{ V}, I_{OH} = -1 \text{ mA}$	2.7	3.4	
$V_{OL}$	Low-level output voltage	$V_{CC} = \text{MIN}, V_{IH} = 2 \text{ V},$ $V_{IL} = 0.8 \text{ V}, I_{OL} = 20 \text{ mA}$			0.5	V
$I_I$	Input current at maximum input voltage	$V_{CC} = \text{MAX}, V_I = 5.5 \text{ V}$			1	mA
$I_{IH}$	High-level input current	Any S input			50	$\mu\text{A}$
		$C_n$	$V_{CC} = \text{MAX}, V_I = 2.7 \text{ V}$		250	
		All others			200	
$I_{IL}$	Low-level input current	Any S input			-2	mA
		$C_n$	$V_{CC} = \text{MAX}, V_I = 0.5 \text{ V}$		-8	
		All others			-6	
$I_{OS}$	Short-circuit output current§	$V_{CC} = \text{MAX}$	-40		-100	mA
$I_{CC}$	Supply current	$V_{CC} = \text{MAX}$		105	160	mA

† For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.

‡ All typical values are at  $V_{CC} = 5 \text{ V}, T_A = 25^\circ\text{C}$ .

§ Not more than one output should be shorted at a time.

## switching characteristics, $V_{CC} = 5 \text{ V}, T_A = 25^\circ\text{C}$

PARAMETER	FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	MIN	TYP	MAX	UNIT
$t_{PLH}$	$C_n$	Any F	$C_L = 15 \text{ pF}, R_L = 280 \Omega,$ See Note 3	10	17	ns	
$t_{PHL}$				10	17		
$t_{PLH}$	Any A or B	$\bar{G}$		12	20	ns	
$t_{PHL}$				12	20		
$t_{PLH}$	Any A or B	$\bar{P}$		11	18	ns	
$t_{PHL}$				11	18		
$t_{PLH}$	$A_i$ or $B_i$	$F_i$		18	27	ns	
$t_{PHL}$				16	25		
$t_{PLH}$	Any S	Any		18	30	ns	
$t_{PHL}$				18	30		

NOTE 3: Load circuits and voltage waveforms are shown in Section 1.





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