



# 54F/74F385 Quad Serial Adder/Subtractor

## General Description

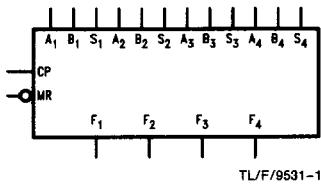
The 'F385 contains four serial adder/subtractors with common clock and clear inputs, but independent operand and mode select inputs. Each adder/subtractor contains a sum flip-flop and a carry-save flip-flop for synchronous operations. Each circuit performs either A plus B or A minus B in two's complement notation, but can also be used for magnitude-only or ones complement operation. The 'F385 is designed for use with the 'F384 and 'F784 serial multipliers in implementing digital filters or butterfly networks in fast Fourier transforms.

## Features

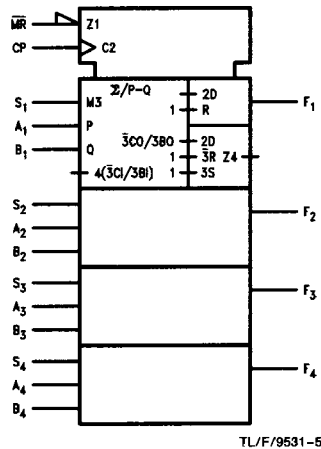
- Four independent adder/subtractors
- Two's complement arithmetic
- Synchronous operation
- Common clear and clock
- Ones complement or magnitude-only capability

**Ordering Code:** See Section 5

## Logic Symbols

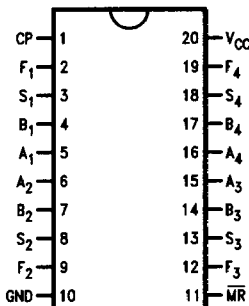


### IEEE/IEC

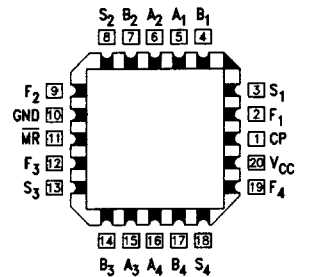


## Connection Diagrams

Pin Assignment for DIP, SOIC and Flatpak



Pin Assignment for LCC



**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 <sub>1</sub> -A <sub>4</sub>	A Operand Inputs	1.0/1.0	20 $\mu$ A/ -0.6 mA
B <sub>1</sub> -B <sub>4</sub>	B Operand Inputs	1.0/1.0	20 $\mu$ A/ -0.6 mA
S <sub>1</sub> -S <sub>4</sub>	Function Select Inputs	1.0/1.0	20 $\mu$ A/ -0.6 mA
CP	Clock Pulse Input (Active Rising Edge)	1.0/1.0	20 $\mu$ A/ -0.6 mA
$\overline{MR}$	Asynchronous Master Reset Input (Active LOW)	1.0/1.0	20 $\mu$ A/ -0.6 mA
F <sub>1</sub> -F <sub>4</sub>	Sum or Difference Outputs	50/33.3	-1 mA/20 mA

**Functional Description**

Each adder contains two edge-triggered flip-flops to store the sum and carry, as shown in the Logic Diagram. Flip-flop state changes occur on the rising edge of the Clock Pulse (CP) input signal. The Select (S) input should be LOW for the Add (A plus B) mode and HIGH for the Subtract (A minus B) mode. A LOW signal on the asynchronous Master Reset ( $\overline{MR}$ ) input clears the sum flip-flop and resets the carry flip-flop to zero in the Add mode or presets it to one in the Subtract mode.

In the Subtract mode, the B operand is internally complemented. Presetting the carry flip-flop to one completes the twos complement transformation by adding one to "A plus  $\overline{B}$ " during the first (LSB) operation after  $\overline{MR}$  is released. For ones complement subtraction, the carry flip-flop can be set to zero by making S LOW during the reset, then making S HIGH after the reset but before the next clock.

**Truth Table**

Inputs*				Internal Carry		Output*	Function
$\overline{MR}$	S	A	B	C	C <sub>1</sub>	F	
L	L	X	X	L	L	L	Clear
L	H	X	X	H	H	L	
H	L	L	L	L	L	L	Add
H	L	L	L	H	L	H	
H	L	L	H	L	L	H	
H	L	L	H	H	H	L	
H	L	H	L	L	L	H	
H	L	H	L	H	H	L	
H	L	H	H	L	H	L	
H	H	L	L	L	L	H	Subtract
H	H	L	L	H	H	L	
H	H	L	H	L	L	L	
H	H	L	H	H	L	H	
H	H	H	L	L	H	L	
H	H	H	L	H	H	H	
H	H	H	H	L	L	H	
H	H	H	H	H	H	L	

H = HIGH Voltage Level

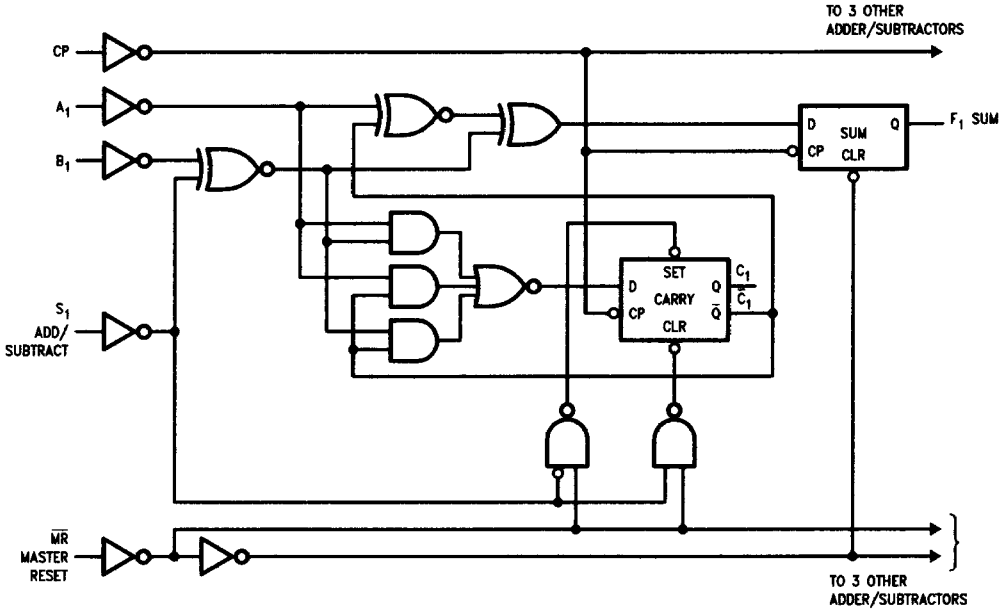
L = LOW Voltage Level

X = Immaterial

\* = Inputs before CP transition, output after C

C<sub>1</sub> = Carry flip-flop state before (C) and after (C<sub>1</sub>) clock transition

# Logic Diagram



TL/F/8531-4

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, please 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 <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>
TRI-STATE® Output	-0.5V to +5.5V

Current Applied to Output in LOW State (Max) twice the rated I<sub>OL</sub> (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 <sub>CC</sub>	Conditions
			Min	Typ	Max			
V <sub>IH</sub>	Input HIGH Voltage		2.0			V		Recognized as a HIGH Signal
V <sub>IL</sub>	Input LOW Voltage					V		Recognized as a LOW Signal
V <sub>CD</sub>	Input Clamp Diode Voltage					V	Min	I <sub>IN</sub> = -18 mA
V <sub>OH</sub>	Output HIGH Voltage	54F 10% V <sub>CC</sub>	2.5		V	Min		I <sub>OH</sub> = -1 mA
		74F 10% V <sub>CC</sub>	2.5					
		74F 5% V <sub>CC</sub>	2.7					
V <sub>OL</sub>	Output LOW Voltage	54F 10% V <sub>CC</sub>	0.5		V	Min		I <sub>OL</sub> = 20 mA
		74F 10% V <sub>CC</sub>	0.5					
I <sub>IH</sub>	Input HIGH Current	54F	20.0		μA	Max		V <sub>IN</sub> = 2.7V
		74F	5.0					
I <sub>BVI</sub>	Input HIGH Current Breakdown Test	54F	100		μA	Max		V <sub>IN</sub> = 7.0V
		74F	7.0					
I <sub>CEX</sub>	Output HIGH Leakage Current	54F	250		μA	Max		V <sub>OUT</sub> = V <sub>CC</sub>
		74F	50					
V <sub>ID</sub>	Input Leakage Test	74F	4.75		V	0.0		I <sub>ID</sub> = 1.9 μA All Other Pins Grounded
I <sub>OD</sub>	Output Leakage Circuit Current	74F	3.75		μA	0.0		V <sub>IOD</sub> = 150 mV All Other Pins Grounded
I <sub>IL</sub>	Input LOW Current		-0.6		mA	Max		V <sub>IN</sub> = 0.5V
I <sub>OS</sub>	Output Short-Circuit Current		-60		mA	Max		V <sub>OUT</sub> = 0V
I <sub>CCH</sub>	Power Supply Current		68		mA	Max		V <sub>O</sub> = HIGH
I <sub>CCL</sub>	Power Supply Current		68		mA	Max		V <sub>O</sub> = LOW

\*95 mA for 54F

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

Symbol	Parameter	74F			54F		74F		Units	Fig. No.
		T <sub>A</sub> = +25°C V <sub>CC</sub> = +5.0V C <sub>L</sub> = 50 pF			T <sub>A</sub> , V <sub>CC</sub> = MII C <sub>L</sub> = 50 pF		T <sub>A</sub> , V <sub>CC</sub> = Com C <sub>L</sub> = 50 pF			
		Min	Typ	Max	Min	Max	Min	Max		
f <sub>max</sub>	Maximum Clock Frequency	70	100		65		70		MHz	2-1
t <sub>PLH</sub>	Propagation Delay CP to F <sub>n</sub>	3.5	6.0	8.0	3.0	10.0	3.5	9.0	ns	2-3
t <sub>PHL</sub>	Propagation Delay CP to F <sub>n</sub>	4.0	7.0	9.0	3.5	11.0	4.0	10.0		
t <sub>PHL</sub>	Propagation Delay MR to F <sub>n</sub>	5.5	9.0	12.0	5.0	14.0	5.5	13.0	ns	2-3

**AC Operating Requirements:** See Section 2 for Waveforms

Symbol	Parameter	74F		54F		74F		Units	Fig. No.
		T <sub>A</sub> = +25°C V <sub>CC</sub> = +5.0V		T <sub>A</sub> , V <sub>CC</sub> = MII		T <sub>A</sub> , V <sub>CC</sub> = Com			
		Min	Max	Min	Max	Min	Max		
t <sub>s</sub> (H)	Setup Time, HIGH or LOW A <sub>n</sub> to CP	15.0		17.5		15.0		ns	2-6
t <sub>s</sub> (L)	Setup Time, HIGH or LOW A <sub>n</sub> to CP	15.0		17.5		15.0			
t <sub>h</sub> (H)	Hold Time, HIGH or LOW A <sub>n</sub> to CP	0		0		0		ns	2-6
t <sub>h</sub> (L)	Hold Time, HIGH or LOW A <sub>n</sub> to CP	0		0		0			
t <sub>s</sub> (H)	Setup Time, HIGH or LOW B <sub>n</sub> or S <sub>n</sub> to CP	15.0		17.5		15.0		ns	2-6
t <sub>s</sub> (L)	Setup Time, HIGH or LOW B <sub>n</sub> or S <sub>n</sub> to CP	15.0		17.5		15.0			
t <sub>h</sub> (H)	Hold Time, HIGH or LOW B <sub>n</sub> or S <sub>n</sub> to CP	0		0		0		ns	2-4
t <sub>h</sub> (L)	Hold Time, HIGH or LOW B <sub>n</sub> or S <sub>n</sub> to CP	0		0		0			
t <sub>w</sub> (H)	CP Pulse Width HIGH or LOW	6.0		7.0		6.0		ns	2-4
t <sub>w</sub> (L)	CP Pulse Width HIGH or LOW	6.0		7.0		6.0			
t <sub>w</sub> (L)	MR Width, LOW	6.0		6.5		6.0		ns	2-4
t <sub>rec</sub>	Recovery Time, MR to CP	8.5		10.0		9.5		ns	2-6