

# Am54S/74S160 • Am54S/74S161 • Am54S/74S163

## BCD Decade/Four-Bit Binary Counters

### Distinctive Characteristics

- Fully synchronous counting
- Fully synchronous parallel loading

- Edge-triggered clock action
- Advanced Schottky technology
- 100% MIL-STD-883 reliability assurance testing

### FUNCTIONAL DESCRIPTION

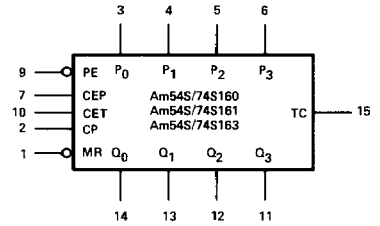
The Am54S/74S160 is a fully synchronous 4-bit decimal counter. The Am54S/74S161 and Am54S/74S163 are fully synchronous 4-bit binary counters. With the parallel enable ( $\overline{PE}$ ) LOW, data on the  $P_0$ - $P_3$  inputs is parallel loaded on the positive clock transition. When  $\overline{PE}$  is HIGH and both count enables CEP and CET are also HIGH, counting will occur on the LOW-to-HIGH clock transition.

The terminal count state (1001 for the Am54S/74S160 and 1111 for both the Am54S/74S161 and Am54S/74S163) is decoded and ANDed with CET in the terminal count (TC) output. If CET is HIGH and the counter is in its terminal count state, then TC is HIGH.

Both the Am54S/74S160 and Am54S/74S161 have an asynchronous master reset ( $\overline{MR}$ ). A LOW on the  $\overline{MR}$  input forces the Q outputs LOW independent of all other inputs.

The Am54S/74S163 has a synchronous master reset ( $\overline{MR}$ ). A LOW on the  $\overline{MR}$  input forces the Q outputs LOW after the next clock pulse independent of all other inputs. The only requirements on the  $\overline{PE}$ , CEP, CET and  $P_0$ - $P_3$  inputs is that they meet the set-up time requirements before the clock LOW-to-HIGH transition.

### LOGIC SYMBOL

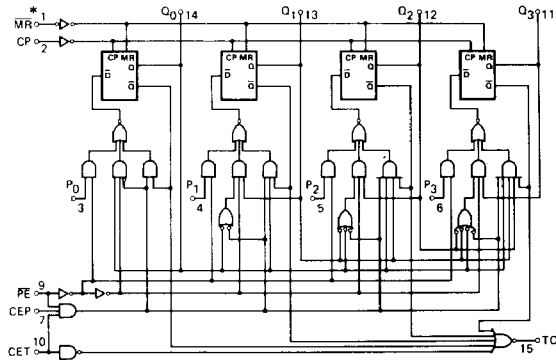
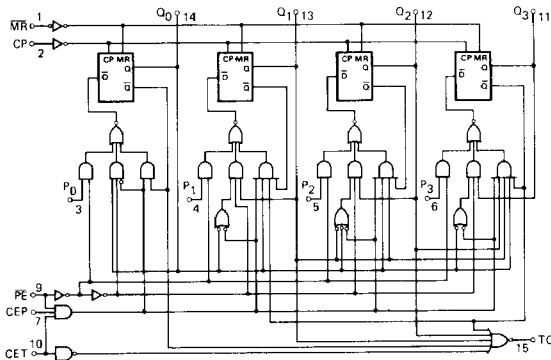


$V_{CC}$  = Pin 16  
GND = Pin 8

### Am54S/74S160

### LOGIC DIAGRAMS

### Am54S/74S161/S163

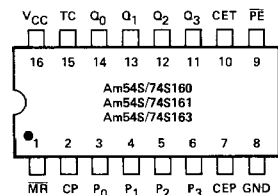


\* $\overline{MR}$  is asynchronous on the Am54S/74S161 and synchronous on the Am54S/74S163

### ORDERING INFORMATION

Package Type	Temperature Range	Am54S/74S160 Order Number	Am54S/74S161 Order Number	Am54S/74S163 Order Number
Molded DIP	0 to +75°C	SN74S160N	SN74S161N	SN74S163N
Hermetic DIP	0 to +75°C	SN74S160J	SN74S161J	SN74S163J
Dice	0 to +75°C	SN74S160X	SN74S161X	SN74S163X
Hermetic DIP	-55 to +125°C	SN54S160J	SN54S161J	SN54S163J
Hermetic Flat Pak	-55 to +125°C	SN54S160W	SN54S161W	SN54S163W
Dice	-55 to +125°C	SN54S160X	SN54S161X	SN54S163X

### CONNECTION DIAGRAM Top View



Note: Pin 1 is marked for orientation.

**AXIMUM RATINGS** (Above which the useful life may be impaired)

Storage Temperature	-65°C to +150°C
Temperature (Ambient) Under Bias	-55°C to +125°C
Supply Voltage to Ground Potential (Pin 16 to Pin 8) Continuous	-0.5V to +7V
Supply Voltage Applied to Outputs for HIGH Output State	-0.5V to +V <sub>CC</sub> max.
Input Voltage	-0.5V to +5.5V
Output Current, Into Outputs	30mA
Input Current	-30mA to +5.0mA

**ELECTRICAL CHARACTERISTICS OVER OPERATING TEMPERATURE RANGE** (Unless Otherwise Noted)

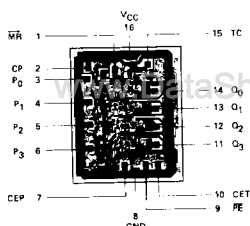
Am74S160X, Am74S161X, Am74S163	T <sub>A</sub> = 0 to +75°C	V <sub>CC</sub> = 5.0V ± 5% (COM'L)	MIN = 4.75V	MAX = 5.25V
Am54S160X, Am54S161X, Am54S163	T <sub>A</sub> = -55 to +125°C	V <sub>CC</sub> = 5.0V ± 10% (MIL)	MIN = 4.5V	MAX = 5.5V

Parameters	Description	Test Conditions (Note 1)	Min	Typ (Note 2)	Max	Units
V <sub>OH</sub>	Output HIGH Voltage	V <sub>CC</sub> = MIN, I <sub>OH</sub> = -1mA V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub>	MIL	2.5	3.4	Volts
			COM'L	2.7	3.4	
V <sub>OL</sub>	Output LOW Voltage	V <sub>CC</sub> = MIN, I <sub>OL</sub> = 20mA V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub>		0.35	0.5	Volts
V <sub>IH</sub>	Input HIGH Level	Guaranteed input logical HIGH voltage for all inputs	2.0			Volts
V <sub>IL</sub>	Input LOW Level	Guaranteed input logical LOW voltage for all inputs			0.8	Volts
V <sub>I</sub>	Input Clamp Voltage	V <sub>CC</sub> = MIN, I <sub>IN</sub> = -18mA			-1.2	Volts
I <sub>IL</sub> (Note 3)	Input LOW Current	V <sub>CC</sub> = MAX, V <sub>IN</sub> = 0.5V	P; MR; CEP		-2.0	mA
			CET		-3.0	
			PE		-4.0	
			CP		-5.0	
I <sub>IH</sub> (Note 3)	Input HIGH Current	V <sub>CC</sub> = MAX, V <sub>IN</sub> = 2.7V	P; MR; CEP		50	μA
			CET		75	
			PE		100	
			CP		125	
I <sub>I</sub>	Input HIGH Current	V <sub>CC</sub> = MAX, V <sub>IN</sub> = 5.5V			1.0	mA
I <sub>SC</sub>	Output Short Circuit Current (Note 4)	V <sub>CC</sub> = MAX	-40	-65	-100	mA
I <sub>CC</sub>	Power Supply Current Am54S/74S160/161 only	V <sub>CC</sub> = MAX (Note 5)		82	127	mA
	Am54S/74S163 only	V <sub>CC</sub> = MAX (Note 6)		96	150	mA

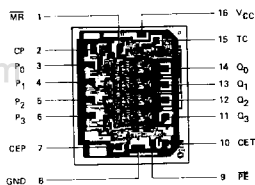
- Notes: 1. For conditions shown as MIN or MAX, use the appropriate value specified under Electrical Characteristics for the applicable device type.  
 2. Typical limits are at V<sub>CC</sub> = 5.0V, 25°C ambient and maximum loading.  
 3. Actual input currents = Unit Load Current x Input Load Factor (See Loading Rules).  
 4. Not more than one output should be shorted at a time. Duration of the short circuit test should not exceed one second.  
 5. Outputs open; MR = 0V; all other inputs HIGH.  
 6. Outputs open; MR, CP, CET = HIGH; all other inputs LOW.

**Metallization and Pad Layouts**  
Am54S/74S161

Am54S/74S160

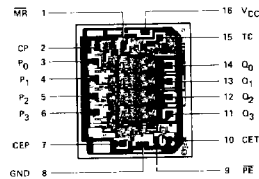


DIE SIZE 0.078" X 0.096"



DIE SIZE 0.092" X 0.076"

Am54S/74S163



DIE SIZE 0.092" X 0.076"

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**DEFINITION OF FUNCTIONAL TERMS**

- PE** Parallel Enable. When  $\overline{PE}$  is LOW, the parallel inputs, P<sub>0</sub> through P<sub>3</sub>, are enabled. When  $\overline{PE}$  is HIGH, the count function is possible.
- CEP** Count Enable Parallel. CEP is one of the count enable inputs that must be HIGH for the counter to count.
- CET** Count Enable Trickle. CET is one of the count enable inputs that must be HIGH for the counter to count. In addition, CET is included in the TC output gate and must be HIGH for TC to be HIGH.
- CP** Clock Pulse. Causes the required output change on the LOW-to-HIGH transition (Edge-triggered).
- $\overline{MR}$**  Master Reset (Am54S/74S160/S161). When the asynchronous master reset is LOW, the Q<sub>0</sub> through Q<sub>3</sub> outputs will be LOW regardless of the other inputs.
- $\overline{MR}$**  Master Reset (Am54S/74S163). When the synchronous master reset is LOW the Q<sub>0</sub> through Q<sub>3</sub> outputs will be LOW following the next clock pulse regardless of the other inputs.
- P<sub>0</sub>, P<sub>1</sub>, P<sub>2</sub>, P<sub>3</sub>** The parallel data inputs for the four internal flip-flops.
- Q<sub>0</sub>, Q<sub>1</sub>, Q<sub>2</sub>, Q<sub>3</sub>** The four parallel outputs from the counter.
- TC** Terminal Count. The terminal count output will be HIGH for CET HIGH and binary nine on the Am54S/74S160 or CET HIGH and binary 15 on the Am54S/74S161.

**LOADING RULES (In Unit Loads)**

Input/Output	Pin No.'s	Input Unit Load	Fan-out Output	
			HIGH	LOW
$\overline{MR}$	1	1	—	—
CP	2	2.5	—	—
P <sub>0</sub>	3	1	—	—
P <sub>1</sub>	4	1	—	—
P <sub>2</sub>	5	1	—	—
P <sub>3</sub>	6	1	—	—
CEP	7	1	—	—
GND	8	—	—	—
$\overline{PE}$	9	2	—	—
CET	10	1.5	—	—
Q <sub>3</sub>	11	—	20	10
Q <sub>2</sub>	12	—	20	10
Q <sub>1</sub>	13	—	20	10
Q <sub>0</sub>	14	—	20	10
TC	15	—	20	10
VCC	16	—	—	—

A Schottky TTL Unit Load is defined as 50μA measured at 2.7V HIGH and -2.0mA measured at 0.5V LOW.

**FUNCTION TABLE**

DEVICE TYPE	INPUTS									OUTPUTS			
	CP	$\overline{MR}$	$\overline{PE}$	CEP	CET	P <sub>0</sub>	P <sub>1</sub>	P <sub>2</sub>	P <sub>3</sub>	Q <sub>0</sub>	Q <sub>1</sub>	Q <sub>2</sub>	Q <sub>3</sub>
Am54S/74S160/S161	X	L	X	X	X	X	X	X	X	L	L	L	L
Am54S/74S163	↑	L	X	X	X	X	X	X	X	L	L	L	L
Am54S/74S160/S161/S163	↑	H	L	X	X	D <sub>0</sub>	D <sub>1</sub>	D <sub>2</sub>	D <sub>3</sub>	D <sub>0</sub>	D <sub>1</sub>	D <sub>2</sub>	D <sub>3</sub>
	↑	H	H	L	L	X	X	X	X	NC	NC	NC	NC
	↑	H	H	L	H	X	X	X	X	NC	NC	NC	NC
	↑	H	H	H	L	X	X	X	X	NC	NC	NC	NC
	↑	H	H	H	H	X	X	X	X	COUNT			

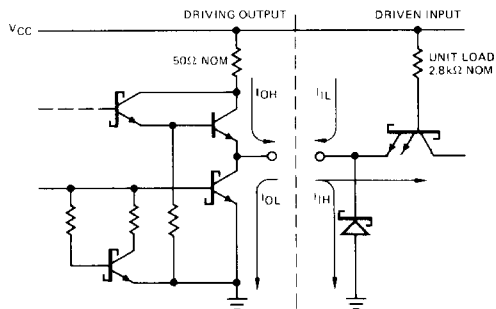
H = HIGH      X = Don't Care      D<sub>i</sub> may be either HIGH or LOW  
 L = LOW      NC = No Change      ↑ LOW-to-HIGH Transition

**TERMINAL COUNT (TC) TRUTH TABLE**

Am54S/74S160					Am54S/74S161/163					TC
CET	Q <sub>0</sub>	Q <sub>1</sub>	Q <sub>2</sub>	Q <sub>3</sub>	CET	Q <sub>0</sub>	Q <sub>1</sub>	Q <sub>2</sub>	Q <sub>3</sub>	
H	H	L	L	H	H	H	H	H	H	H
L	X	X	X	X	L	X	X	X	X	L
X	L	X	X	X	X	L	X	X	X	L
X	X	H	X	X	X	X	L	X	X	L
X	X	X	H	X	X	X	X	L	X	L
X	X	X	X	L	X	X	X	X	L	L

H = HIGH    L = LOW    X = Don't Care

**SCHOTTKY INPUT/OUTPUT CURRENT INTERFACE CONDITIONS**



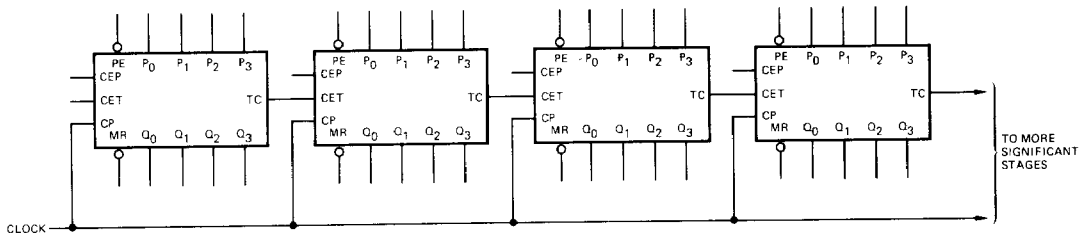
Note: Actual current flow direction shown.

SWITCHING CHARACTERISTICS ( $T_A = +25^\circ$ )

Parameters	Description	Test Conditions	Min	Typ	Max	Units
$f_{MAX}$	Count Frequency	$V_{CC} = 5.0V, C_L = 15pF, R_L = 280\Omega$	70	100		MHz
$t_{PLH}$	Clock to Q			6	9	ns
$t_{PHL}$				8.5	13	
$t_{PLH}$	Clock to TC			12	18	ns
$t_{PHL}$				8	12	
$t_{PLH}$	CET to TC			6.5	10	ns
$t_{PHL}$				6.5	10	
$t_{PHL}$	$\overline{MR}$ to Q (Am54S/74S160/161 only)			14	20	ns
$t_s$	Recovery Time for MR (inactive) Am54S/74S160 and Am54S/74S161 only			6		ns
$t_{pw}$	Master Reset Pulse Width			13		ns
$t_{pw}$	Clock Pulse Width HIGH			6		ns
	Clock Pulse Width LOW			10		ns
$t_s$	Data to Clock			8		ns
$t_h$				0		
$t_s$	$\overline{PE}$ to Clock			16		ns
$t_h$				0		
$t_s$	CEP or CET to Clock			12		ns
$t_h$				0		
$t_s$	$\overline{MR}$ to Clock Am54S/74S163 only			14		ns
$t_h$				0		

## APPLICATIONS

## SYNCHRONOUS MULTISTAGE COUNTING USING CET INPUT ONLY



## FASTER SYNCHRONOUS MULTISTAGE COUNTING USING CET AND CEP INPUTS

