

# SN54LS320, SN54LS321, SN74LS320, SN74LS321 CRYSTAL-CONTROLLED OSCILLATORS

SDLS158 – DECEMBER 1978 – REVISED MARCH 1988

## 'LS320

- Crystal-Controlled Oscillator Operation from 1 MHz to 20 MHz
- 2-Phase Driver Outputs

## 'LS321

- Similar to 'LS320 But Includes f/2 and f/4 Count-Down Outputs

### description

The 'LS320 is a crystal-controlled oscillator/clock driver. It features complementary standard and high-current driver outputs. A synchronization flip-flop is included.

The driver outputs, F' and  $\bar{F}'$  have very-low impedance and can be used to drive highly capacitive TTL-level lines. If the driver outputs are not used, then the VCC' terminal can be left open.

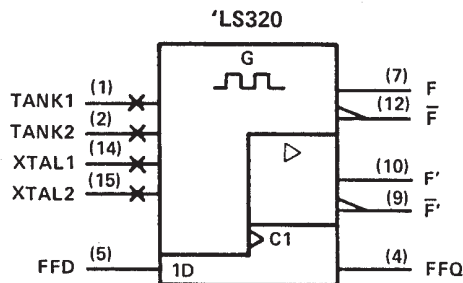
The 'LS321 is identical to the 'LS320 except it additionally features two count-down outputs, F/2 and F/4.

These circuits were designed for crystal control of frequency and capacitive control is not recommended. If a fundamental crystal is used, an inductor of 5 to 160  $\mu$ H is required to be connected between the tank 1 and tank 2 inputs. †

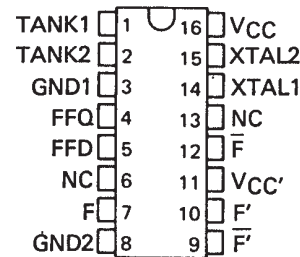
Interaction of the driver outputs with the other outputs limits useful frequencies as shown in the frequency-limits table.

The SN54LS320 and SN54LS321 are characterized for operation over the full military temperature range of -55°C to 125°C. The SN74LS320 and SN74LS321 are characterized for operation from 0°C to 70°C.

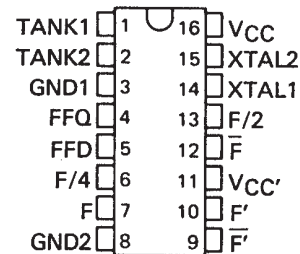
### logic symbols‡



SN54LS320 . . . J OR W PACKAGE  
SN74LS320 . . . N PACKAGE  
(TOP VIEW)



SN54LS321 . . . J PACKAGE  
SN74LS321 . . . N PACKAGE  
(TOP VIEW)



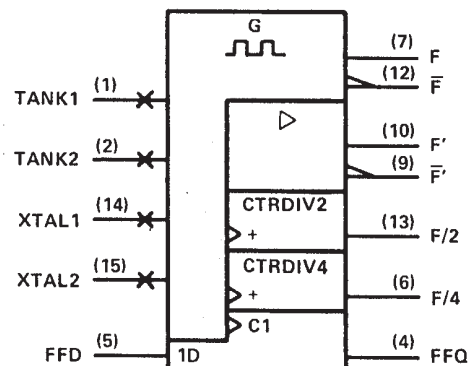
NC – No internal connection.

For chip carrier information,  
contact the factory.

### FREQUENCY LIMITS

OUTPUTS IN USE	VCC	VCC'	f <sub>max</sub>
Driver outputs only	5 V	5 V	20 MHz
Other outputs only	5 V	Open	20 MHz
Driver and any other outputs	5 V	5 V	10 MHz

### 'LS321



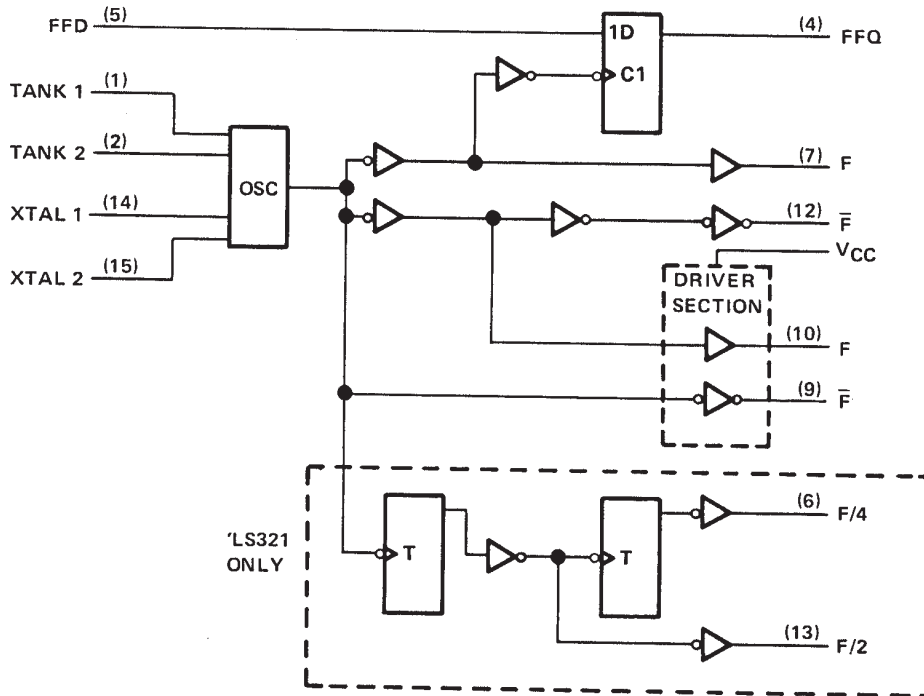
†The value of the inductor is selected from the graph in Figure 2. Use the next higher standard inductor value if the selected value is not available. If a third overtone crystal is used, a tuned tank is necessary. The center frequency of the tuned tank is determined by the equation  $f = \frac{1}{2} \pi \sqrt{LC}$ .

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

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## logic diagram (positive logic)



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

Supply voltage, $V_{CC}$ (see Note 1)	7 V
Supply voltage, $V_{CC}'$	7 V
Input voltage to FFD terminal	-0.5 V to 7 V
Operating free-air temperature range: SN54LS320, SN54LS321	-55°C to 125°C
SN74LS320, SN74LS321	0°C to 70°C
Storage temperature range	-65°C to 150°C

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

### recommended operating conditions

	SN54LS320 SN54LS321			SN74LS320 SN74LS321			UNIT
	MIN	NOM	MAX	MIN	NOM	MAX	
Supply voltage, $V_{CC}$	4.5	5	5.5	4.75	5	5.25	V
Supply voltage, $V_{CC}'$	4.5	5	5.5	4.75	5	5.25	V
High-level output current, $I_{OH}$	F' or $\bar{F}'$		-12			-24	mA
	F, $\bar{F}$ , F/2, F/4		-0.4			-0.4	
Low-level output current, $I_{OL}$	F' or $\bar{F}'$		12			24	mA
	F, $\bar{F}$ , F/2, F/4		4			8	
Output frequency, $f_{out}$	F/2 ('LS321)		0.5			10	MHz
	F/4 ('LS321)		0.25			5	
	F or $\bar{F}$		1			20	
Operating free-air temperature, $T_A$			-55			125	°C

Input and output schematics are similar to those shown for SN74LS326.



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

PARAMETER	TEST CONDITIONS†	SN54LS320 SN54LS321		SN74LS320 SN74LS321		UNIT		
		MIN	TYP‡	MAX	MIN		TYP‡	MAX
		$V_{IH}$ High-level input voltage		2			2	
$V_{IL}$ Low-level input voltage				0.7		0.8	V	
$V_{IK}$ Input clamp voltage	$V_{CC} = \text{MIN}, V_{CC}' = \text{MIN}, I_I = -18 \text{ mA}$			-1.5		-1.5	V	
$V_{OH}$ High-level output voltage	F', $\bar{F}'$	$V_{CC} = 4.5 \text{ V}, V_{CC}' = 4.5 \text{ V}, I_{OH} = -12 \text{ mA}$	2.4	3.3			V	
		$V_{CC} = 4.75 \text{ V}, V_{CC}' = 4.75 \text{ V}, I_{OH} = -24 \text{ mA}$			2.7	3.3		
	Others	$V_{CC} = \text{MIN}, V_{IH} = 2 \text{ V}, I_{OH} = -400 \mu\text{A}$	2.4	3.4	2.7	3.4		
$V_{OL}$ Low-level output voltage	F', $\bar{F}'$	$V_{CC} = \text{MIN}, V_{CC}' = \text{MIN}$	$I_{OL} = 12 \text{ mA}$	0.25	0.4	0.25	0.4	V
			$I_{OL} = 24 \text{ mA}$			0.35	0.5	
	Others	$V_{CC} = \text{MIN}, V_{IL} = V_{IL \text{ max}}$	$I_{OL} = 4 \text{ mA}$	0.25	0.4	0.25	0.4	
			$I_{OL} = 8 \text{ mA}$			0.35	0.5	
$I_I$ Input current at maximum input voltage	$V_{CC} = \text{MAX}, V_I = 7 \text{ V}$			0.1		0.1	mA	
$I_{IH}$ High-level input current	$V_{CC} = \text{MAX}, V_I = 2.7 \text{ V}$			20		20	$\mu\text{A}$	
$I_{IL}$ Low-level input current	$V_{CC} = \text{MAX}, V_I = 0.4 \text{ V}$			-0.4		-0.4	mA	
$I_{OS}$ Short-circuit output current§	$V_{CC} = \text{MAX}$	-20		-100	-20	-100	mA	
$I_{CC}$ Supply current from $V_{CC}$	$V_{CC} = \text{MAX}, \text{FFD at GND}$	'LS320	42	70	42	70	mA	
		'LS321	47	75	47	75		
$I_{CC}'$ Supply current from $V_{CC}'$	$V_{CC} = \text{MAX}, V_{CC}' = \text{MAX}, \text{FFD at GND}$		4	8		4	8	mA

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

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

§ Not more than one output should be shorted at a time, and duration of the short-circuit should not exceed one second. Outputs F' and  $\bar{F}'$  do not have short-circuit protection and these limits do not apply.

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

PARAMETER	OUTPUTS	TEST CONDITIONS†		'LS320			'LS321			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	
$f_{\text{max}}$ Maximum operating frequency	F/2	$C_L = 100 \text{ pF}$	$R_L = 667 \Omega$				10	15	MHz	
	F/4						5	7.5		
	All others			20	30		20	30		
$t_r$ Rise time, 1 V to 3 V	F', F'	$C_L = 50 \text{ pF}$	$R_L = 667 \Omega$		6	12		6	12	ns
		$C_L = 100 \text{ pF}$			7	14		7	14	
		$C_L = 200 \text{ pF}$			7	14		7	14	
	Others	$C_L = 50 \text{ pF}$	$R_L = 2 \text{ k}\Omega$		11	22		11	22	
		$C_L = 100 \text{ pF}$			25	40		25	40	
		$C_L = 200 \text{ pF}$			45	70		45	70	
$t_f$ Fall time, 3 V to 1 V	F', F'	$C_L = 50 \text{ pF}$	$R_L = 667 \Omega$		5	10		5	10	ns
		$C_L = 100 \text{ pF}$			5	10		5	10	
		$C_L = 200 \text{ pF}$			6	12		6	12	
	Others	$C_L = 50 \text{ pF}$	$R_L = 2 \text{ k}\Omega$		6	12		6	12	
		$C_L = 100 \text{ pF}$			10	20		10	20	
		$C_L = 200 \text{ pF}$			17	30		17	30	

† Load circuits and voltage waveforms are shown in Section 1.



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## TYPICAL APPLICATION DATA

The SN54/74LS320 and 'LS321 are crystal-controlled oscillators. Figure 1 shows the device with all required external components.

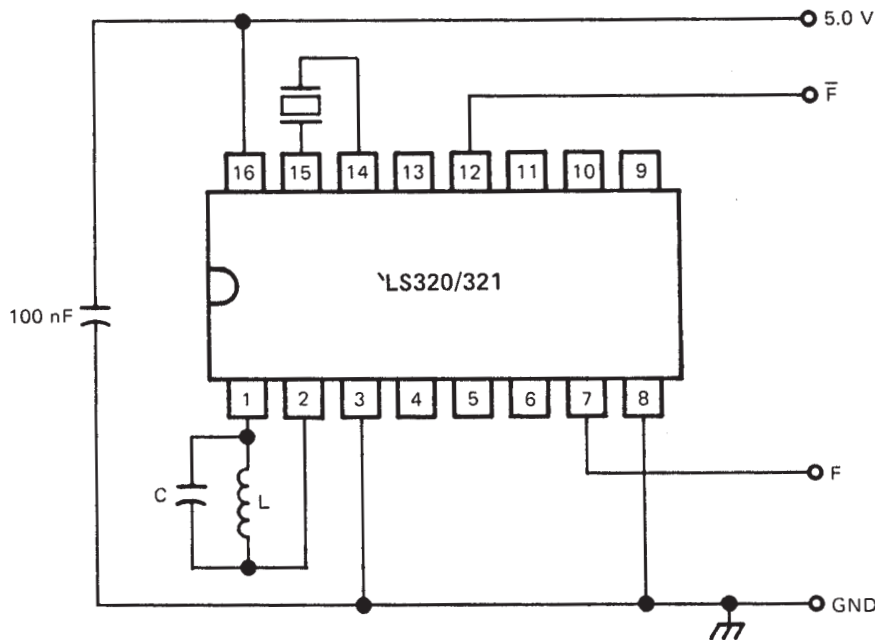


FIGURE 1. CRYSTAL-CONTROLLED OSCILLATOR 'LS320/321

1. Determination of C and L are as follows:
  - a. Inductance L  
Select Inductance L according to Figure 2.
  - b. Capacitor C

$$C = C_S - C_P - C_L$$

- Where:
- $C_P$  = parasitic board capacitance
  - $C_L$  = parasitic capacitance of the inductor
  - L = inductance
  - $C_S$  = required capacitance calculated as follows:

$$C_S = \frac{1}{(2 \cdot \pi \cdot f_q)^2 \cdot L}$$

for  $f_q > 12 \text{ MHz}$ ,  $C = 0 \text{ pf}$

2. Electrical characteristic for the crystal:  
The quartz crystal used as a frequency reference should be designed for series mode operation with a resistance in the  $20 \Omega$  to  $75 \Omega$  range and be capable of a minimum 2 mw power dissipation.  
It is recommended to use a tuned tank also for fundamental crystals.

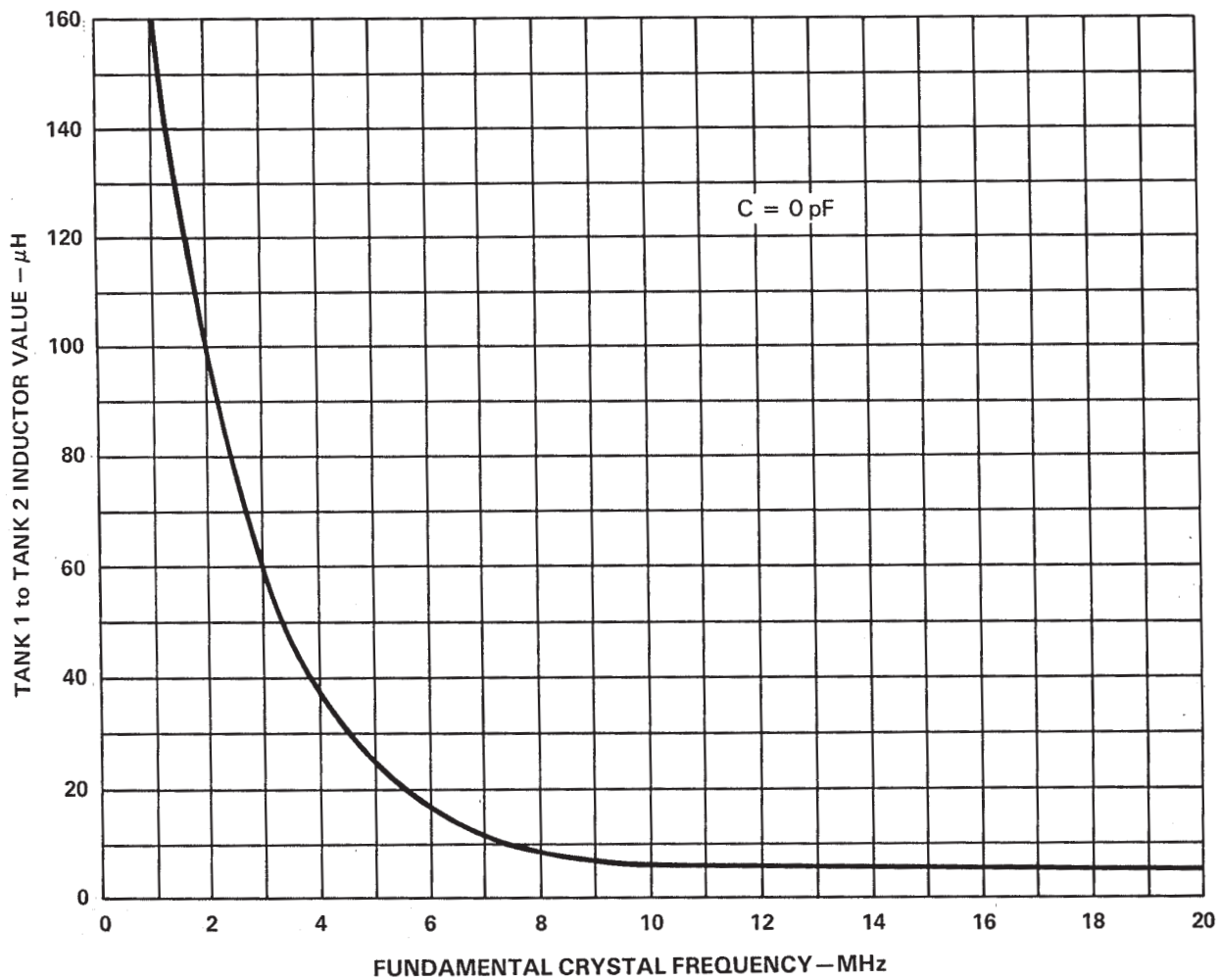


FIGURE 2

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