

# 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.

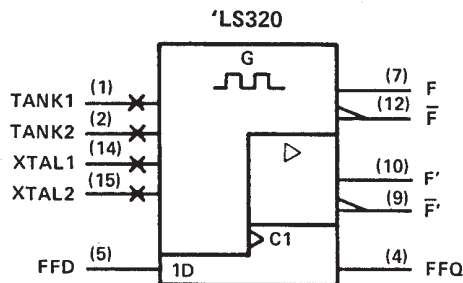
The 'LS321 is identical to the 'LS320 except it additionally features two count-down outputs, F/2 and F/4.

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.

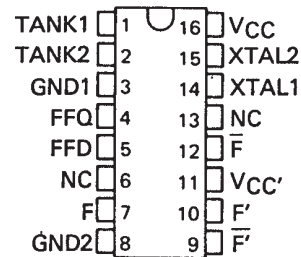
The SN54LS320 and SN54LS321 are characterized for operation over the full military temperature range of -55°C to 125°C. The SN74LS320 and SN74LS321 are characterized for operation from 0°C to 70°C.

### logic symbols†



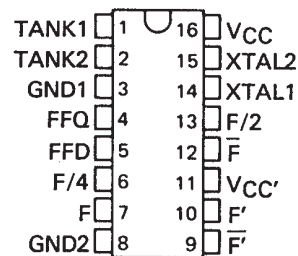
SN54LS320 . . . J OR W PACKAGE  
SN74LS320 . . . N PACKAGE

(TOP VIEW)



SN54LS321 . . . J PACKAGE  
SN74LS321 . . . N PACKAGE

(TOP VIEW)



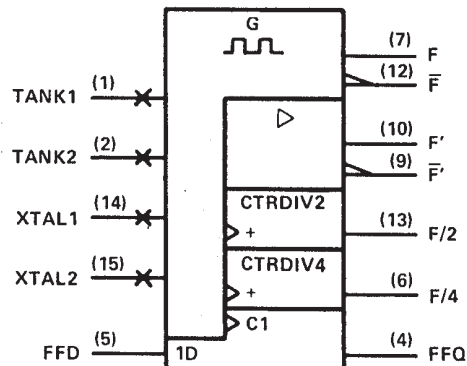
NC – No internal connection.

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



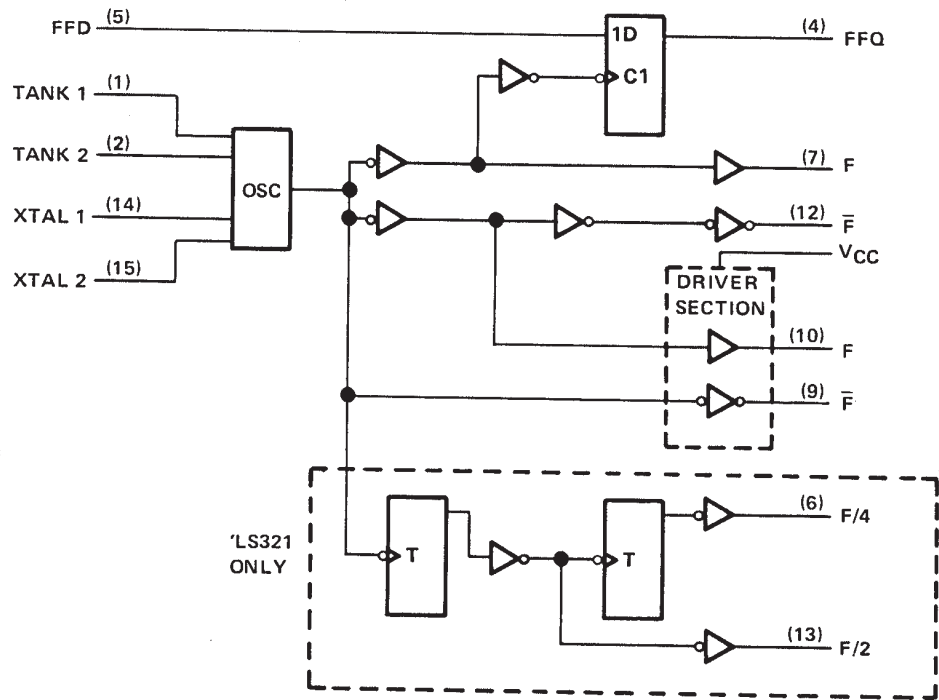
†The value of the inductor is selected from the graph in Figure 2. Use the next higher standard inductor value if the selected value is not available. If a third overtone crystal is used, a tuned tank is necessary. The center frequency of the tuned tank is determined by the equation  $f = \frac{1}{2}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

‡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	0.5		10	MHz
	$F/4$ ('LS321)	0.25		5	0.25		5	
	$F$ or $\bar{F}$	1		20	1		20	
Operating free-air temperature, $T_A$		-55		125	0		70	°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 <sub>IH</sub>	High-level input voltage			2			2	V		
V <sub>IL</sub>	Low-level input voltage					0.7		0.8		
V <sub>IK</sub>	Input clamp voltage	V <sub>CC</sub> = MIN, V <sub>CC</sub> ' = MIN, I <sub>I</sub> = -18 mA				-1.5		-1.5		
V <sub>OH</sub>	High-level output voltage	F', F'	V <sub>CC</sub> = 4.5 V, V <sub>CC</sub> ' = 4.5 V, I <sub>OH</sub> = -12 mA	2.4	3.3			V		
			V <sub>CC</sub> = 4.75 V, V <sub>CC</sub> ' = 4.75 V, I <sub>OH</sub> = -24 mA			2.7	3.3			
		Others	V <sub>CC</sub> = MIN, V <sub>IH</sub> = 2 V, I <sub>OH</sub> = -400 µA	2.4	3.4		2.7		3.4	
V <sub>OL</sub>	Low-level output voltage	F', F'	V <sub>CC</sub> = MIN, V <sub>CC</sub> ' = MIN	I <sub>OL</sub> = 12 mA	0.25	0.4	0.25	0.4	V	
				I <sub>OL</sub> = 24 mA			0.35	0.5		
		Others	V <sub>CC</sub> = MIN, V <sub>IL</sub> = V <sub>IL</sub> max	I <sub>OL</sub> = 4 mA	0.25	0.4	0.25	0.4		
				I <sub>OL</sub> = 8 mA			0.35	0.5		
I <sub>I</sub>	Input current at maximum input voltage	V <sub>CC</sub> = MAX, V <sub>I</sub> = 7 V				0.1		0.1	mA	
I <sub>IH</sub>	High-level input current	V <sub>CC</sub> = MAX, V <sub>I</sub> = 2.7 V				20		20	µA	
I <sub>IL</sub>	Low-level input current	V <sub>CC</sub> = MAX, V <sub>I</sub> = 0.4 V				-0.4		-0.4	mA	
I <sub>OS</sub>	Short-circuit output current§	V <sub>CC</sub> = MAX		-20		-100	-20	-100	mA	
I <sub>CC</sub>	Supply current from V <sub>CC</sub>	V <sub>CC</sub> = MAX, FFD at GND	'LS320	42	70		42	70	mA	
			'LS321	47	75		47	75		
I <sub>CC</sub> '	Supply current from V <sub>CC</sub> '	V <sub>CC</sub> = MAX, V <sub>CC</sub> ' = MAX, FFD at GND				4		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<sub>CC</sub> = 5 V, V<sub>CC'</sub> = 5 V, and T<sub>A</sub> = 25°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 F' do not have short-circuit protection and these limits do not apply.

switching characteristics, V<sub>CC</sub> = 5 V, V<sub>CC'</sub> = 5 V, T<sub>A</sub> = 25°C

PARAMETER	OUTPUTS	TEST CONDITIONS¹		'LS320			'LS321			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	
f <sub>max</sub>	Maximum operating frequency	C <sub>L</sub> = 100 pF	R <sub>L</sub> = 667 Ω				10	15		MHz
			R <sub>L</sub> = 2 kΩ	20	30		20	30		
t <sub>r</sub>	F', F'	C <sub>L</sub> = 50 pF	R <sub>L</sub> = 667 Ω	6	12		6	12		ns
				7	14		7	14		
				7	14		7	14		
	Others	C <sub>L</sub> = 50 pF	R <sub>L</sub> = 2 kΩ	11	22		11	22		
				25	40		25	40		
				45	70		45	70		
t <sub>f</sub>	F', F'	C <sub>L</sub> = 50 pF	R <sub>L</sub> = 667 Ω	5	10		5	10		ns
				5	10		5	10		
				6	12		6	12		
	Others	C <sub>L</sub> = 50 pF	R <sub>L</sub> = 2 kΩ	6	12		6	12		
				10	20		10	20		
				17	30		17	30		

¹Load 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.

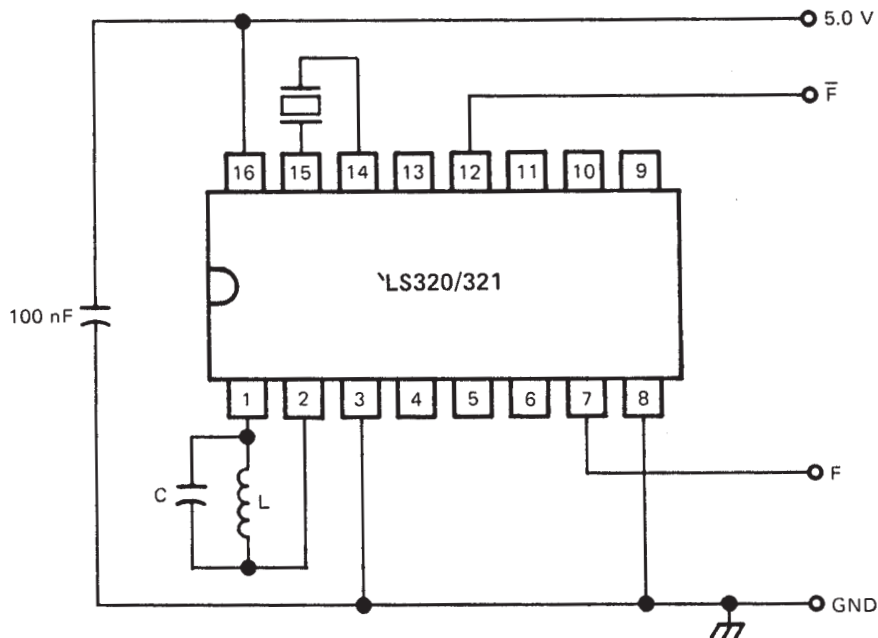


FIGURE 1. CRYSTAL-CONTROLLED OSCILLATOR 'LS320/321

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.

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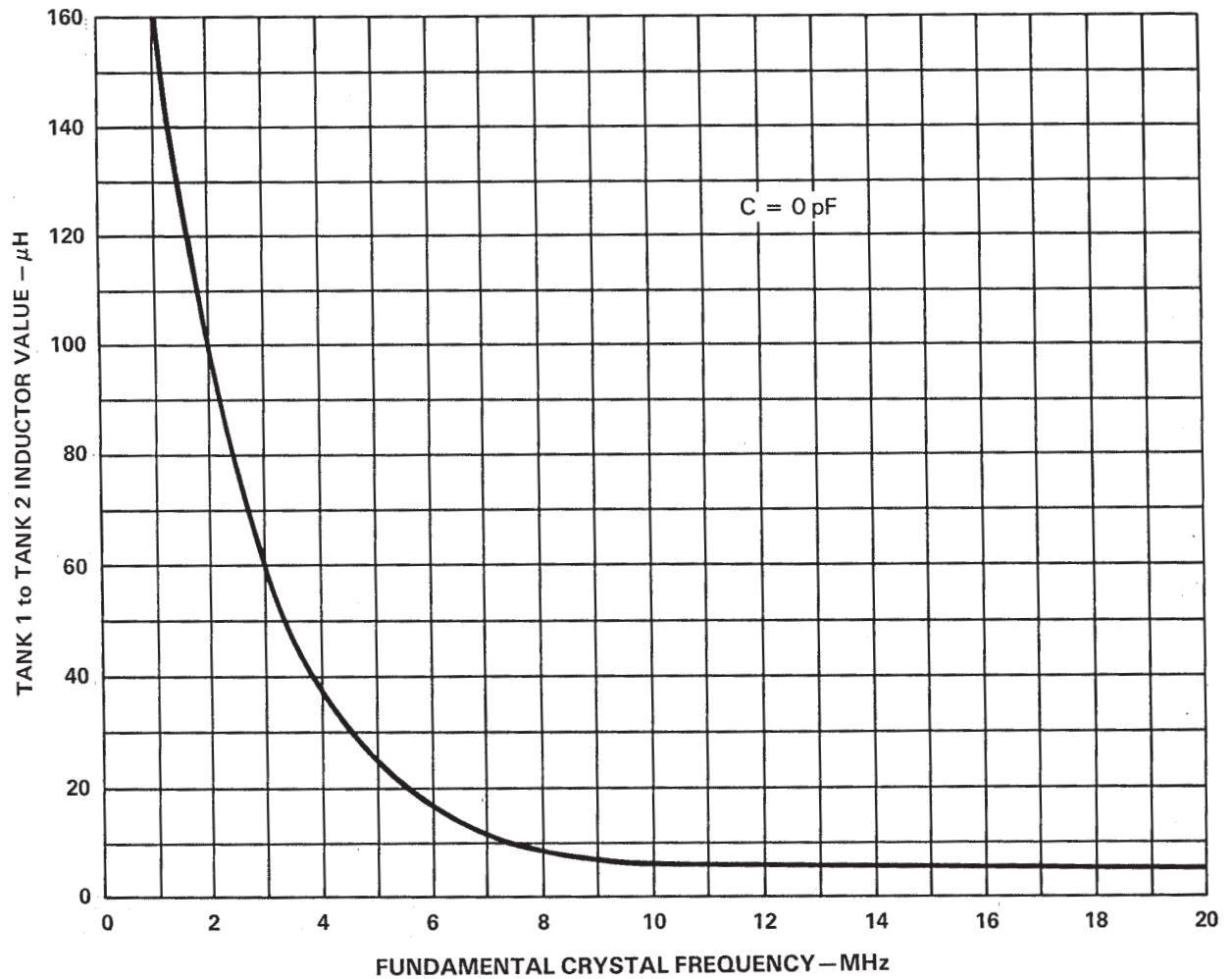


FIGURE 2

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