SN54LS320, SN54LS321, SN74LS320, SN74LS321
CRYSTAL-CONTROLLED OSCILLATORS

D2418, 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 $\overline{F}$' have very-low impedance and can be used to drive highly capacitive TTL-level lines. If the driver outputs are not used, then the V_{CC}' terminal can be left open.

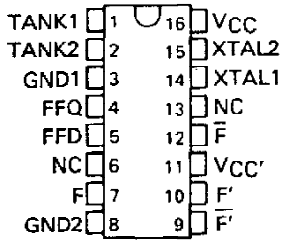
The 'LS321 is identical to the 'LS320 except it additionally features two count-down outputs, F/2 and F/4.

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 µH is required to be connected between the tank 1 and tank 2 inputs. †

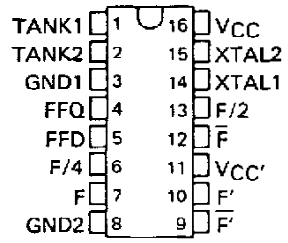
Interaction of the driver outputs with the other outputs limits useful frequencies as shown in the frequency-limits table.

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.

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



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



NC – No internal connection

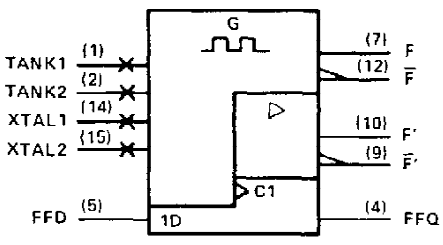
For chip carrier information, contact the factory.

FREQUENCY LIMITS

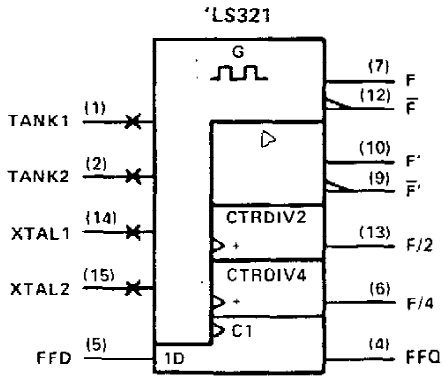
OUTPUTS IN USE	V_{CC}	V_{CC}'	f_{max}
Driver outputs only	5 V	5 V	20 MHz
Other outputs only	5 V	Open	20 MHz
Driver and any other outputs	5 V	5 V	10 MHz

logic symbols‡

'LS320



'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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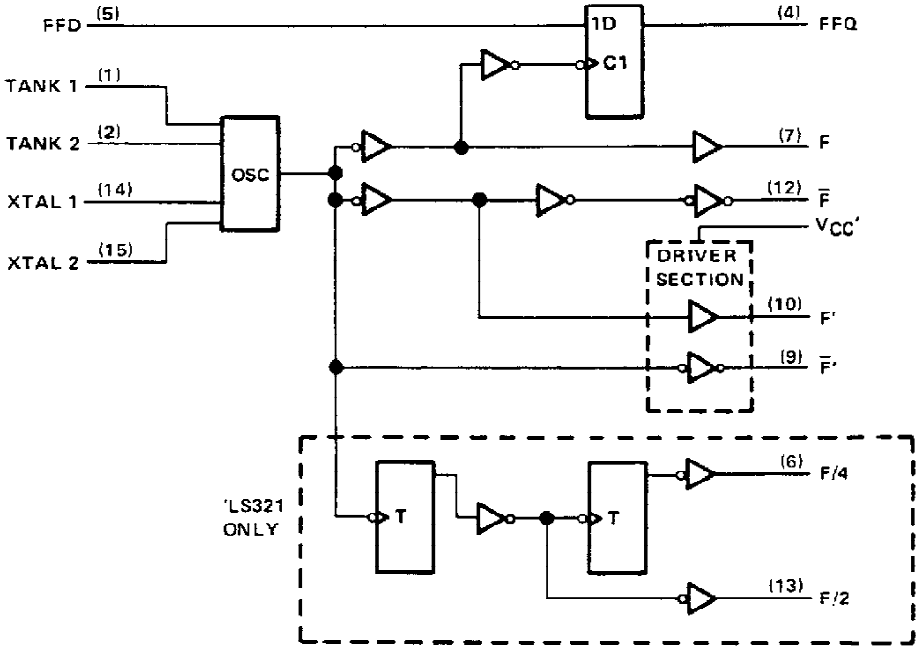
logic diagram (positive logic)



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 F̄'			−12			−24	mA
	F, F̄, F/2, F/4			−0.4			−0.4	
Low-level output current, I_{OL}	F' or F̄'			12			24	mA
	F, F̄, 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 F̄	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.

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
V_{IL}	Low-level input voltage							0.7			0.8	V
V_{IK}	Input clamp voltage		V_{CC} = MIN,	V_{CC}' = MIN,	I_I = −18 mA			−1.5			−1.5	V
V_{OH}	High-level output voltage	F', $\overline{F}$'	V_{CC} = 4.5 V,	V_{CC}' = 4.5 V,	I_{OH} = −12 mA	2.4	3.3					V
			V_{CC} = 4.75 V,	V_{CC}' = 4.75 V,	I_{OH} = −24 mA				2.7	3.3		
		Others	V_{CC} = MIN,	V_{IH} = 2 V,	I_{OH} = −400 µA	2.4	3.4		2.7	3.4		
V_{OL}	Low-level output voltage	F', $\overline{F}$'	V_{CC} = MIN,	V_{CC}' = MIN	I_{OL} = 12 mA		0.25	0.4		0.25	0.4	V
					I_{OL} = 24 mA					0.35	0.5	
		Others	V_{CC} = MIN,	V_{IL} = V_{IL} max	I_{OL} = 4 mA		0.25	0.4		0.25	0.4	
					I_{OL} = 8 mA					0.35	0.5	
I_I	Input current at maximum input voltage		V_{CC} = MAX,	V_I = 7 V				0.1			0.1	mA
I_{IH}	High-level input current		V_{CC} = MAX,	V_I = 2.7 V				20			20	µA
I_{IL}	Low-level input current		V_{CC} = MAX,	V_I = 0.4 V				−0.4			−0.4	mA
I_{OS}	Short-circuit output current§		V_{CC} = MAX			−20		−100	−20		−100	mA
I_{CC}	Supply current from V_{CC}		V_{CC} = MAX,	FFD at GND	'LS320		42	70		42	70	mA
					'LS321		47	75		47	75	
I_{CC}'	Supply current from V_{CC}'		V_{CC} = MAX,	V_{CC}' = MAX,	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 V, V_{CC}' = 5 V, and T_A = 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 $\overline{F}$' do not have short-circuit protection and these limits do not apply.

switching characteristics, V_{CC} = 5 V, V_{CC}' = 5 V, T_A = 25°C

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

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

TYPICAL APPLICATION DATA

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

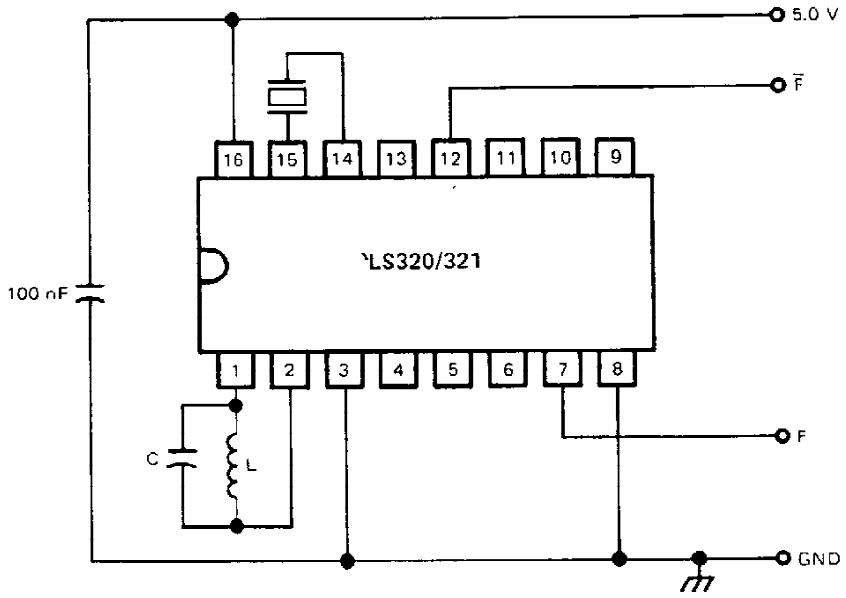


FIGURE 1. CRYSTAL–CONTROLLED OSCILLATOR 'LS320/321

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 $f_Q > 12$ MHz, C = 0 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 Ω to 75 Ω range and be capable of a minimum 2 mw power dissipation.

   It is recommended to use a tuned tank also for fundamental crystals.

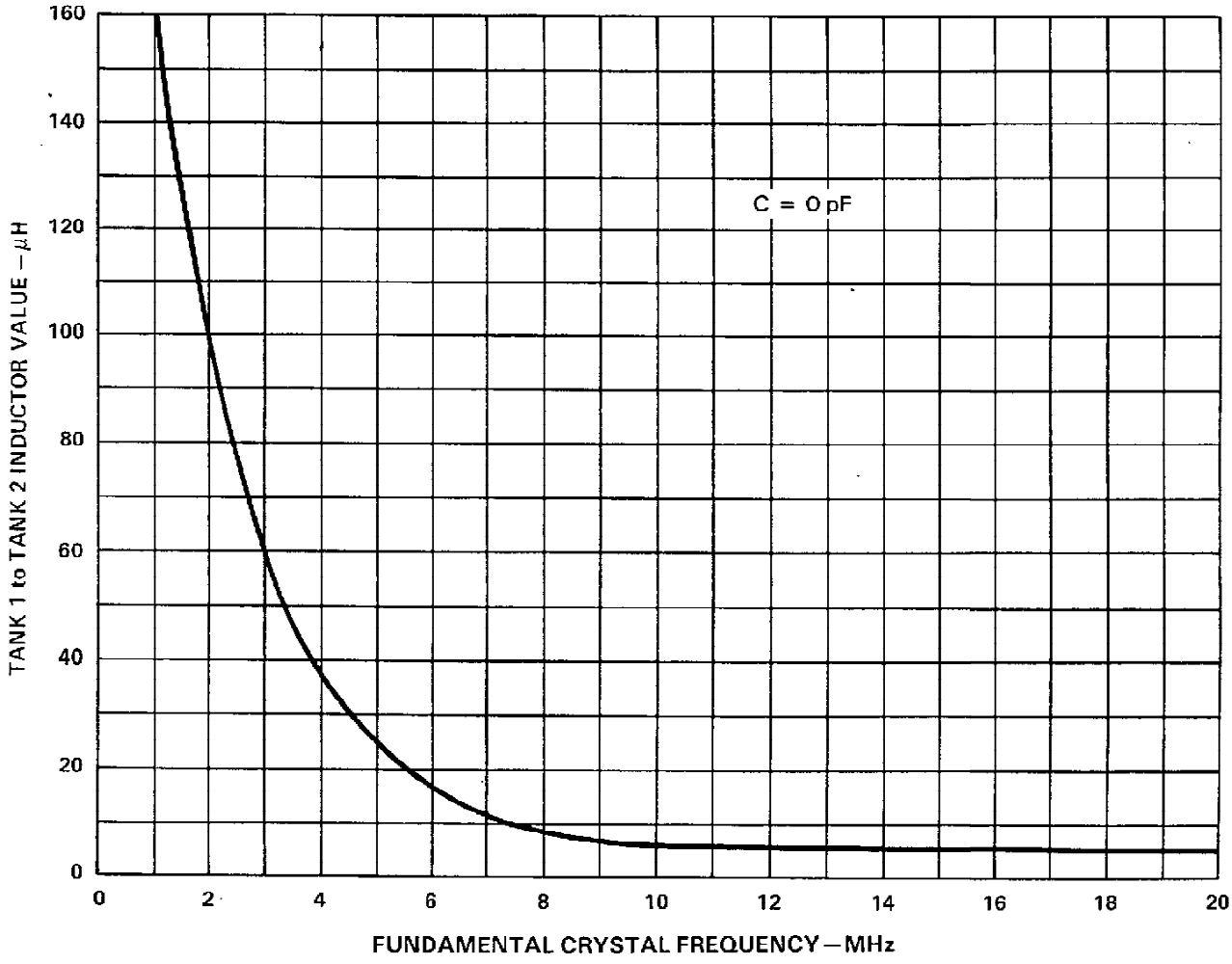

160
140
120
100
80
60
40
20
0
TANK 1 to TANK 2 INDUCTOR VALUE — μH
C = 0 pF
0
2
4
6
8
10
12
14
16
18
20
FUNDAMENTAL CRYSTAL FREQUENCY — MHz

FIGURE 2

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