

SN54LS320, SN54LS321, SN74LS320, SN74LS321 CRYSTAL-CONTROLLED OSCILLATORS

SDLS158

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 \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.

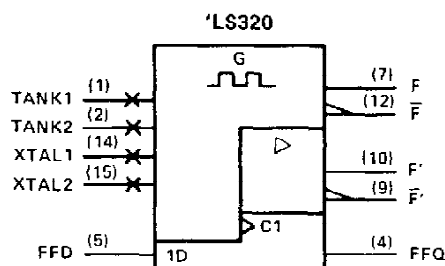
The 'LS321 is identical to the 'LS320 except it additionally features two count-down outputs, $F/2$ and $F/4$.

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 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 .

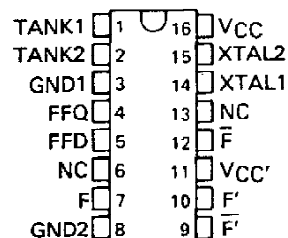
logic symbols†



SN54LS320 . . . J OR W PACKAGE

SN74LS320 . . . N PACKAGE

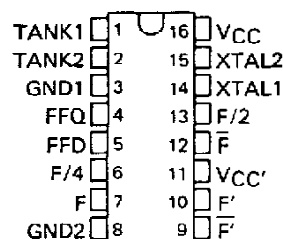
(TOP VIEW)



SN54LS321 . . . J PACKAGE

SN74LS321 . . . N PACKAGE

(TOP VIEW)

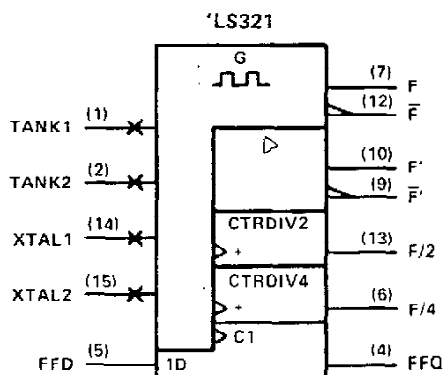


NC — No internal connection.

For chip carrier information,
contact the factory.

FREQUENCY LIMITS

| OUTPUTS IN USE | 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 |



†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.

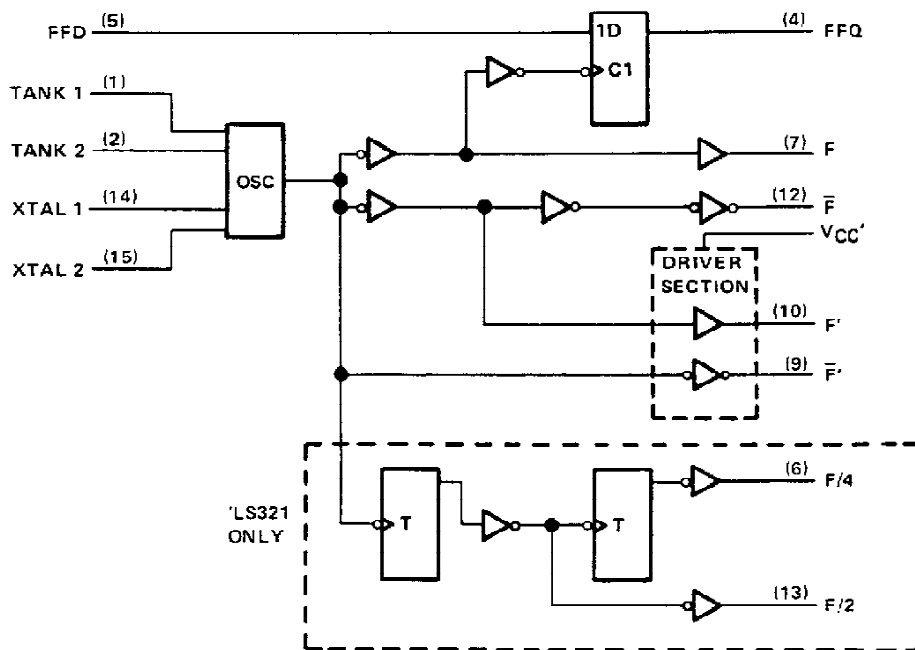
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SN54LS320, SN54LS321, SN74LS320, SN74LS321 CRYSTAL-CONTROLLED OSCILLATORS

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 F-bar' | | -12 | F' or F-bar' | | -24 | mA |
| | F, F-bar, F/2, F/4 | | -0.4 | F, F-bar, F/2, F/4 | | -0.4 | |
| Low-level output current, I_{OL} | F' or F-bar' | | 12 | F' or F-bar' | | 24 | mA |
| | F, F-bar, F/2, F/4 | | 4 | F, F-bar, F/2, F/4 | | 8 | |
| Output frequency, f_{out} | F/2 ('LS321) | | 0.5 | F/2 ('LS321) | | 10 | MHz |
| | F/4 ('LS321) | | 0.25 | F/4 ('LS321) | | 5 | |
| | F or F-bar | | 1 | F or F-bar | | 20 | |
| Operating free-air temperature, T_A | -55 | | 125 | 0 | | 70 | °C |

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

SN54LS320, SN54LS321, SN74LS320, SN74LS321 CRYSTAL-CONTROLLED OSCILLATORS

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', F̄' | V _{CC} = 4.5 V, V _{CC'} = 4.5 V, I _{OH} = -12 mA | 2.4 | 3.3 | | | | | |
| | | | 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', F̄' | 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 | | | 'LS321 | | | mA |
| | | | | 42 | 70 | 42 | 70 | | | |
| 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 F̄' 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 | | | 20 30 | | | 20 30 | | | |
| t _r | Rise time, 1 V to 3 V | F', F̄' | 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', F̄' | 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.

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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.

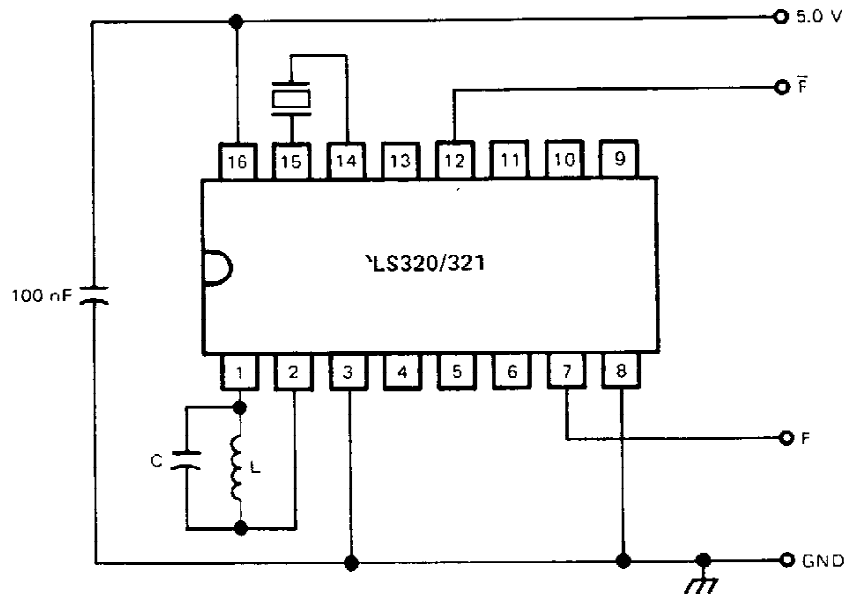


FIGURE 1. CRYSTAL-CONTROLLED OSCILLATOR 'LS320/321

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 20Ω to 75Ω 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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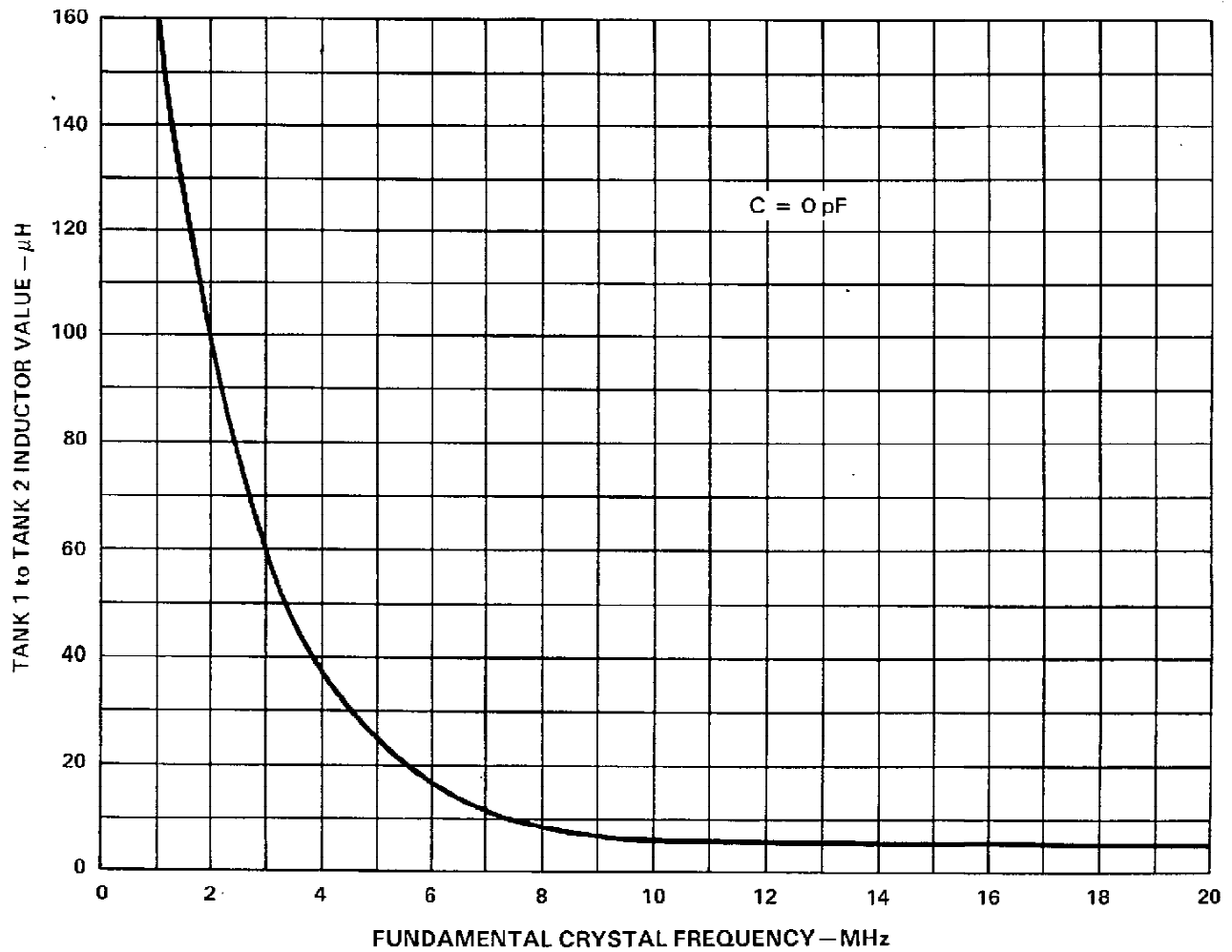


FIGURE 2

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