# SN54LS624 THRU SN54LS629, SN74LS624 THRU SN74LS629 VOLTAGE-CONTROLLED OSCILLATORS

D2501, JANUARY 1980 – REVISED MARCH 1988

- Separate Supply Voltage Pins for Isolation of Frequency Control Inputs and Oscillators from Output Circuitry
- Highly Stable Operation over Specified Temperature and/or Supply Voltage Ranges

| DEVICE TYPE | SIMILAR TO | NUMBER VCO's | COMP'L Z OUT | ENABLE | RANGE INPUT | $R_{ext}$ |
|---|---|---|---|---|---|---|
| 'LS624 | 'LS324 | single | yes | yes | yes | no |
| 'LS625 | 'LS325 | dual | yes | no | no | no |
| 'LS626 | 'LS326 | dual | yes | yes | no | no |
| 'LS627 | 'LS327 | dual | no | no | no | no |
| 'LS628 | 'LS324 | single | yes | yes | yes | yes |
| 'LS629 | 'LS124 | dual | no | yes | yes | no |

## description

These voltage-controlled oscillators (VCOs) are improved versions of the original VCO family: SN54LS124, SN54LS324 thru SN54LS327, SN74LS124, and SN74LS324 thru SN74LS327. These new devices feature improved voltage-to-frequency linearity, range, and compensation. With the exception of the 'LS624 and 'LS628, all of these devices feature two independent VCOs in a single monolithic chip. The 'LS624, 'LS625, 'LS626, and 'LS628 have complementary Z outputs. The output frequency for each VCO is established by a single external component (either a capacitor or crystal) in combination with voltage-sensitive inputs used for frequency control and frequency range. Each device has a voltage-sensitive input for frequency control; however, the 'LS624, 'LS628, and 'LS629 devices also have one for frequency range. (See Figures 1 thru 6).

The 'LS628 offers more precise temperature compensation than its 'LS624 counterpart. The 'LS624 features a 600 ohm internal timing resistor. The 'LS628 requires a timing resistor to be connected externally across $R_{ext}$ pins. Temperature compensation will be improved dur to the temperature coefficient of the external resistor.

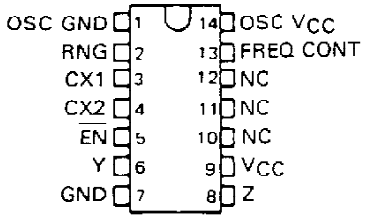
Figure 3 and Figure 6 contain the necessary information to choose the proper capacitor value to obtain the desired operating frequency.

A single 5-volt supply can be used: however, one set of supply voltage and ground pins ($V_{CC}$ and GND) is provided for the enable, synchronization-gating, and output sections, and a separate set (OSC $V_{CC}$ and OSC GND) is provided for the oscillator and associated frequency-control circuits so that effective isolation can be accomplished in the system. For operation of frequencies greater than 10 MHz, it is recommended that two independent supplies be used. Disabling either VCO of the 'LS625 and 'LS625 and 'LS627 can be achieved by removing the appropriate OSC $V_{CC}$. An enable input is provided on the 'LS624, 'LS626, 'LS628, and 'LS629. When the enable input is low, the output is enabled: when the enable input is high, the internal oscillator is disabled, Y is high, and Z is low. Caution! Crosstalk may occur in the dual devices ('LS625, 'LS626, 'LS627 and 'LS629) when both VCOs are operated simultaneously. To minimize crosstalk, either of the following are recommended: (A) If frequencies are widely separated, use a 10-$\mu$h inductor between $V_{CC}$ pins. (B) If frequencies are closely spaced, use two separate $V_{CC}$ supplies or place two series diodes between the $V_{CC}$ pins.

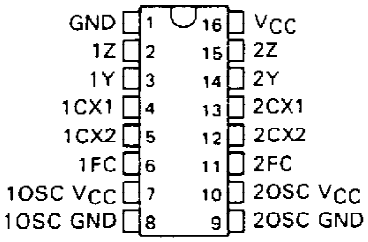
The pulse-synchronization-gating section ensures that the first output pulse is neither clipped nor extended. The duty cycle of the square-wave output is fixed at approximately 50 percent.

The SN54LS624 thru SN54LS629 are characterized for operation over the full military temperature range of −55°C to 125°C. The SN74LS624 thru SN74LS629 are characterized for operation from 0°C to 70°C.

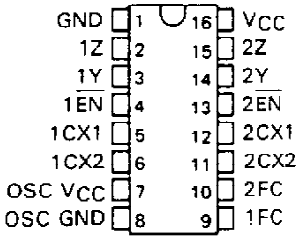
**SN54LS624 . . . J OR W PACKAGE**
**SN74LS624 . . . D OR N PACKAGE**
**(TOP VIEW)**




**SN54LS625 . . . J OR W PACKAGE**
**SN74LS625 . . . D OR N PACKAGE**
**(TOP VIEW)**

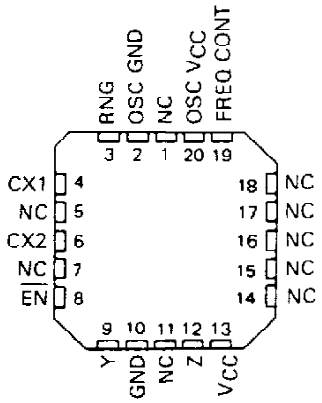



**SN54LS626 . . . J OR W PACKAGE**
**SN74LS626 . . . D OR N PACKAGE**
**(TOP VIEW)**

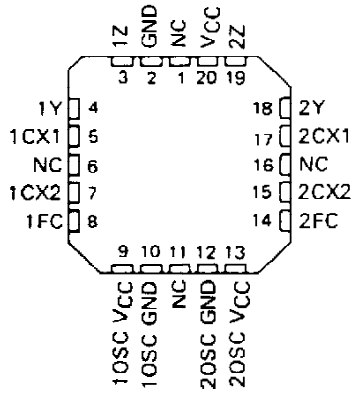



NC – No internal connection

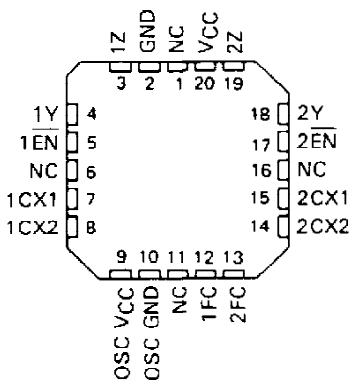
**SN54LS624 . . . FK PACKAGE**
**(TOP VIEW)**



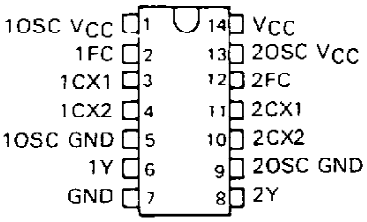

**SN54LS625 . . . FK PACKAGE**
**(TOP VIEW)**



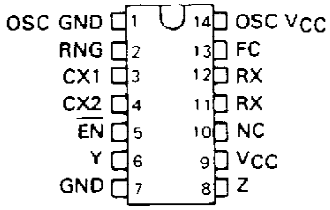

**SN54LS626 . . . FK PACKAGE**
**(TOP VIEW)**



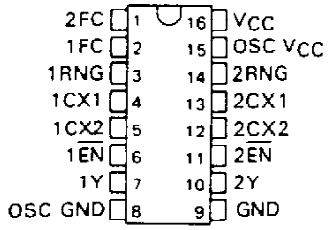
**SN54LS627 . . . J OR W PACKAGE**
**SN74LS627 . . . D OR N PACKAGE**
**(TOP VIEW)**




**SN54LS628 . . . J OR W PACKAGE**
**SN74LS628 . . . D OR N PACKAGE**
**(TOP VIEW)**

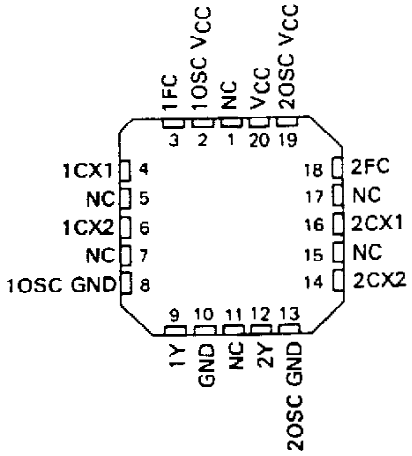



**SN54LS629 . . . J OR W PACKAGE**
**SN74LS629 . . . D OR N PACKAGE**
**(TOP VIEW)**

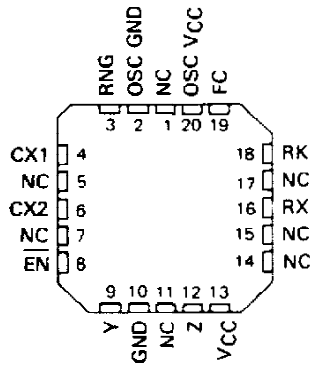



NC-No internal connection

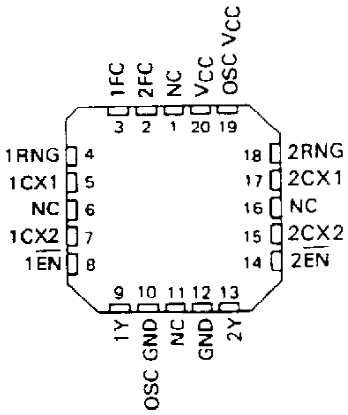
**SN54LS627 . . . FK PACKAGE**
**(TOP VIEW)**



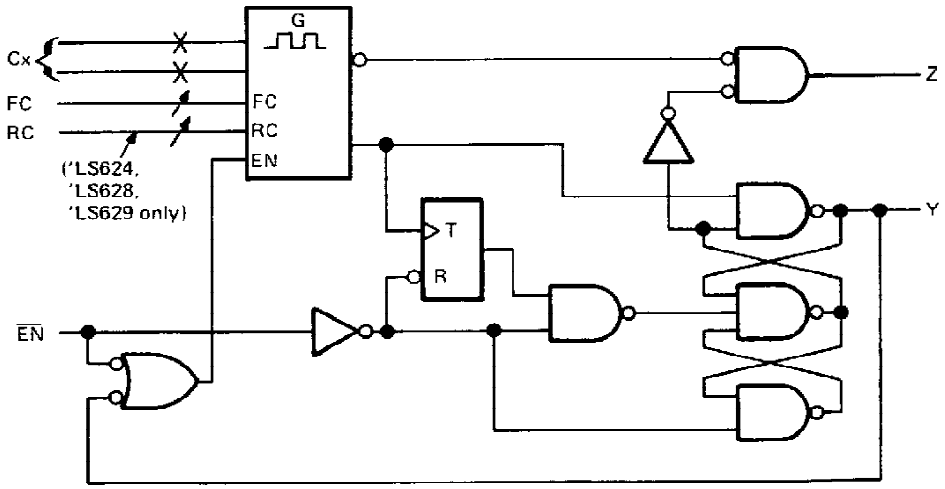

**SN54LS628 . . . FK PACKAGE**
**(TOP VIEW)**



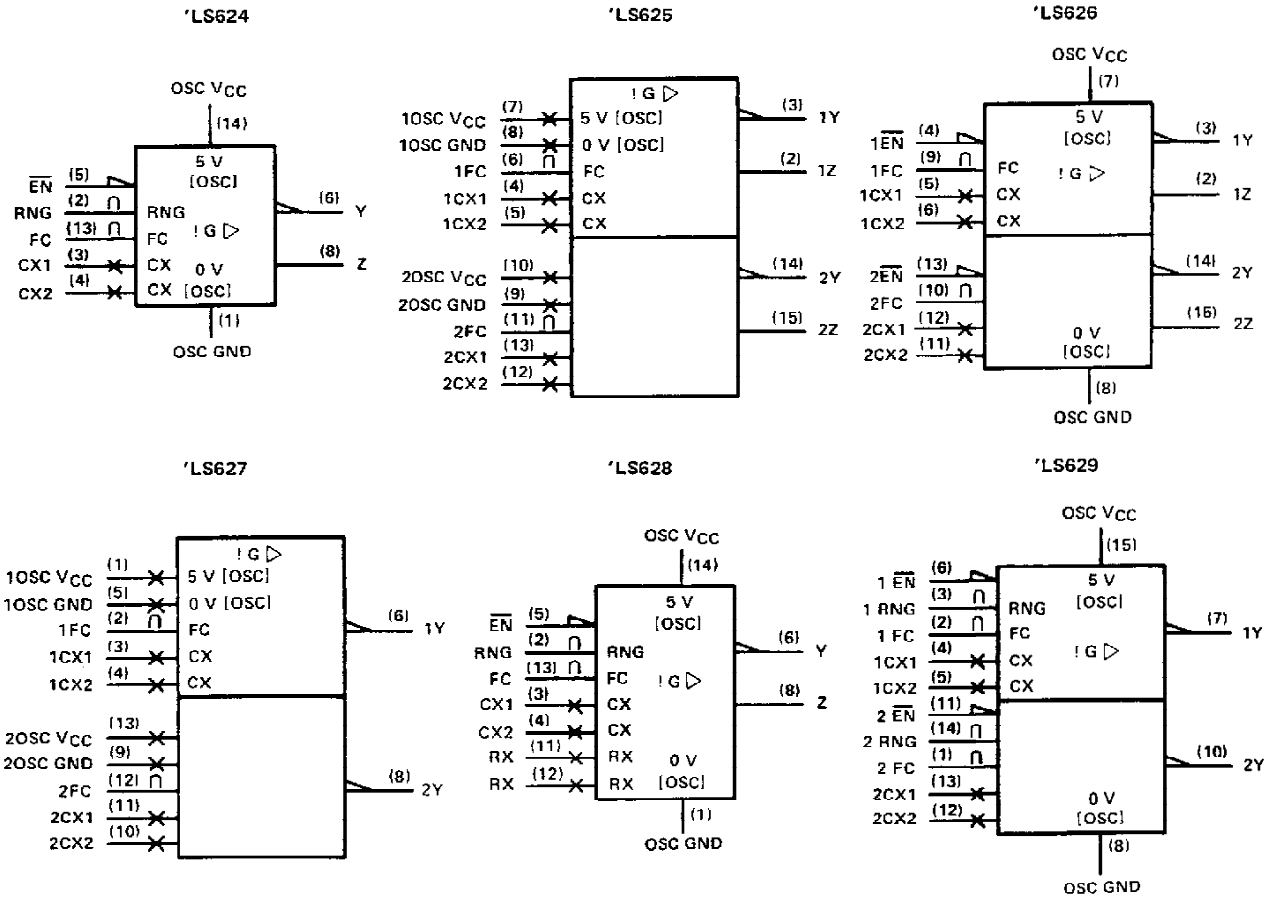

**SN54LS629 . . . FK PACKAGE**
**(TOP VIEW)**



## logic diagram (positive logic)



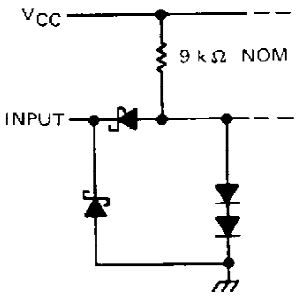

## logic symbols†



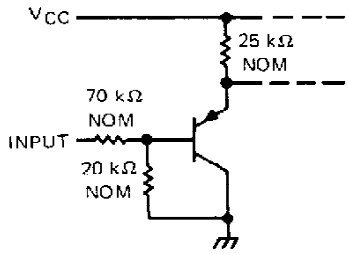

†These symbols are in accordance with ANSI/IEEE Std. 91-1984 and IEC Publication 617-12.
Pin numbers shown are for D, J, N, and W packages.

## schematics of inputs and outputs

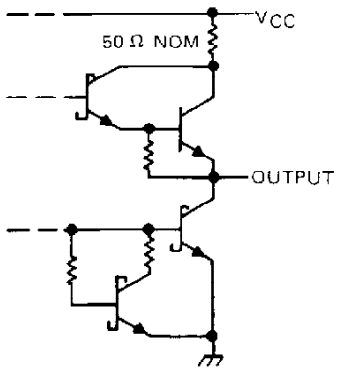
EQUIVALENT OF EACH ENABLE INPUT ('LS624, 'LS626, 'LS628, AND 'LS629)




EQUIVALENT OF EACH FREQUENCY CONTROL OR ('LS624, 'LS628, AND 'LS629) RANGE INPUT




TYPICAL OF ALL OUTPUTS




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

| | | |
|---|---|---|
| Supply voltage, $V_{CC}$ (see Notes 1 and 2) | | 7 V |
| Input voltage: Enable input† | | 7 V |
| Frequency control or range input‡ | | $V_{CC}$ |
| Operating free-air temperature range: | SN54LS' Circuits | −55°C to 125°C |
| | SN74LS' Circuits | 0°C to 70°C |
| Storage temperature range | | −65°C to 150°C |

† The enable input is provided only on the 'LS624, 'LS626, 'LS628, and 'LS629.

‡ The range input is provided only on 'LS624, 'LS628, and 'LS629.

NOTE: 1. Voltage values are with respect to the appropriate ground terminal.

2. Throughout the data sheet, the symbol $V_{CC}$ is used for the voltage applied to both the $V_{CC}$ and OSC $V_{CC}$ terminals, unless otherwise noted.

## recommended operating conditions

| | SN54LS' | | | SN74LS' | | | UNIT |
|---|---|---|---|---|---|---|---|
| | MIN | NOM | MAX | MIN | NOM | MAX | |
| Supply voltage, $V_{CC}$ | 4.5 | 5 | 5.5 | 4.75 | 5 | 5.25 | V |
| Input voltage at frequency control or range input, $V_{I(freq)}$ or $V_{I(rng)}$ ¶ | 0 | | 5 | 0 | | 5 | V |
| High-level output current, $I_{OH}$ | | | −1.2 | | | −1.2 | mA |
| Low-level output current, $I_{OL}$ | | | 12 | | | 24 | mA |
| Output frequency, $f_o$ | 1 | | | 1 | | | Hz |
| | | | 20 | | | 20 | MHz |
| Operating free-air temperature, $T_A$ | −55 | | 125 | 0 | | 70 | °C |

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

| PARAMETER | | | TEST CONDITIONS† | | | SN54LS' | | | SN74LS' | | | UNIT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | MIN | TYP‡ | MAX | MIN | TYP‡ | MAX | |
| $V_{IH}$ | High-level input voltage at enable# | | | | | 2 | | | 2 | | | V |
| $V_{IL}$ | Low-level input voltage at enable# | | | | | | | 0.7 | | | 0.8 | V |
| $V_{IK}$ | Input clamp voltage at enable# | | $V_{CC}$ = MIN, | $I_I$ = −18 mA | | | | −1.5 | | | −1.5 | V |
| $V_{OH}$ | High-level output voltage | | $V_{CC}$ = MIN, $I_{OH}$ = −1.2 mA, | $\overline{EN}$ at $V_{IL}$ max, See Note 3 | | 2.5 | 3.4 | | 2.7 | 3.4 | | V |
| $V_{OL}$ | Low-level output voltage | | $V_{CC}$ = MIN, $\overline{EN}$ at $V_{IL}$ max, | See Note 3 | $I_{OL}$ = 12 mA | | 0.25 | 0.4 | | 0.25 | 0.4 | V |
| | | | | | $I_{OL}$ = 24 mA | | | | | 0.35 | 0.5 | |
| $I_I$ | Input current | Freq control or range¶ | $V_{CC}$ = MAX | | $V_I$ = 5 V | | 50 | 250 | | 50 | 250 | μA |
| | | | | | $V_I$ = 1 V | | 10 | 50 | | 10 | 50 | |
| $I_I$ | Input current at maximum input voltage | Enable# | $V_{CC}$ = MAX, | $V_I$ = 7 V | | | | 0.2 | | | 0.2 | mA |
| $I_{IH}$ | High-level input current | Enable# | $V_{CC}$ = MAX, | $V_I$ = 2.7 V | | | | 40 | | | 40 | μA |
| $I_{IL}$ | Low-level input current | Enable# | $V_{CC}$ = MAX, | $V_I$ = 0.4 V | | | | −0.8 | | | −0.8 | mA |
| $I_{OS}$ | Short-circuit output current§ | | $V_{CC}$ = MAX | | | −40 | | −225 | −40 | | −225 | mA |
| $I_{CC}$ | Supply current, total into $V_{CC}$ and OSC $V_{CC}$ pins | | $V_{CC}$ = MAX, Enable# = 4.5 V See Note 4 | | 'LS624 | | 20 | 35 | | 20 | 35 | mA |
| | | | | | 'LS625 | | 35 | 55 | | 35 | 55 | |
| | | | | | 'LS626 | | 35 | 55 | | 35 | 55 | |
| | | | | | 'LS627 | | 35 | 55 | | 35 | 55 | |
| | | | | | 'LS628 | | 20 | 35 | | 20 | 35 | |
| | | | | | 'LS629 | | 35 | 55 | | 35 | 55 | |

†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, $T_A$ = 25°C.
§Not more than one output should be shorted at a time and duration of the short-circuit should not exceed one second.
¶The range input is provided only on the 'LS624, 'LS628, and 'LS629.
#The enable input is provided only on the 'LS624, 'LS626, 'LS628, and 'LS629.

NOTES: 3. $V_{OH}$ for Y outputs and $V_{OL}$ for Z outputs are measured while enable inputs are at $V_{IL}$ MAX, with individual 1-kΩ resistors connected from CX1 to $V_{CC}$ and from CX2 to ground. The resistor connections are reversed for testing $V_{OH}$ for Z outputs and $V_{OL}$ for Y inputs.

4. For 'LS624, 'LS626, 'LS628, and 'LS629, $I_{CC}$ is measured with the outputs disabled and open. For 'LS625 and 'LS627, $I_{CC}$ is measured with one OSC $V_{CC}$ = MAX, and with the other OSC $V_{CC}$ and outputs open.

switching characteristics, $V_{CC}$ = 5 V (unless otherwise noted), $R_L$ = 667 Ω, $C_L$ = 45 pF, $T_A$ = 25 °C

| PARAMETER | | TEST CONDITIONS | | 'LS624, 'LS628, 'LS629 | | | 'LS625, 'LS626, 'LS627 | | | UNIT |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | MIN | TYP | MAX | MIN | TYP | MAX | |
| $f_O$ | Output frequency | $C_{ext}$ = 50 pF | $V_{I(freq)}$ = 5 V, $V_{I(rng)}$ = 0 V | 15 | 20 | 25 | | | | MHz |
| | | | $V_{I(freq)}$ = 1 V, $V_{I(rng)}$ = 5 V | 1.1 | 1.6 | 2.1 | | | | |
| | | | $V_{I(freq)}$ = 5 V | | | | 7 | 9.5 | 12 | |
| | | | $V_{I(freq)}$ = 0 V | | | | 0.9 | 1.2 | 1.5 | |

## TYPICAL CHARACTERISTICS

**'LS624, 'LS628, 'LS629**

OUTPUT FREQUENCY
vs
FREQUENCY-CONTROL INPUT VOLTAGE†

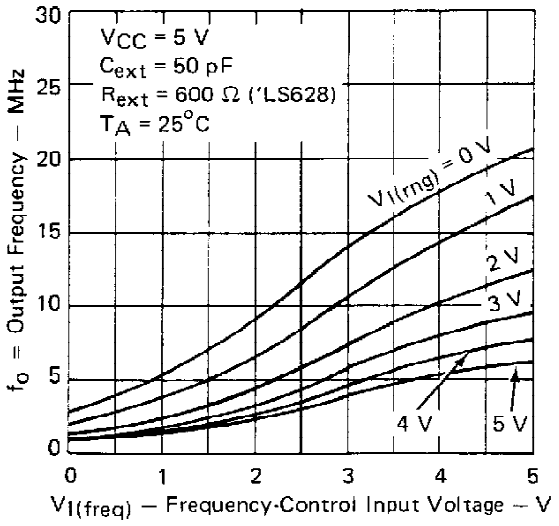



FIGURE 1

**'LS624, 'LS628, 'LS629**

OUTPUT FREQUENCY
vs
FREQUENCY-CONTROL INPUT VOLTAGE†

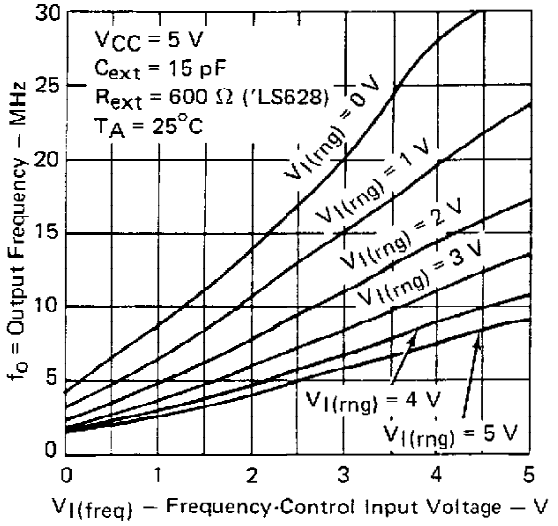



FIGURE 2

† Due to the effects of stray capacitance the output frequency may be unstable when the frequency control voltage is less than 1 volt.

## TYPICAL CHARACTERISTICS

**'LS624, 'LS628, 'LS629**

OUTPUT FREQUENCY
vs
EXTERNAL CAPACITANCE

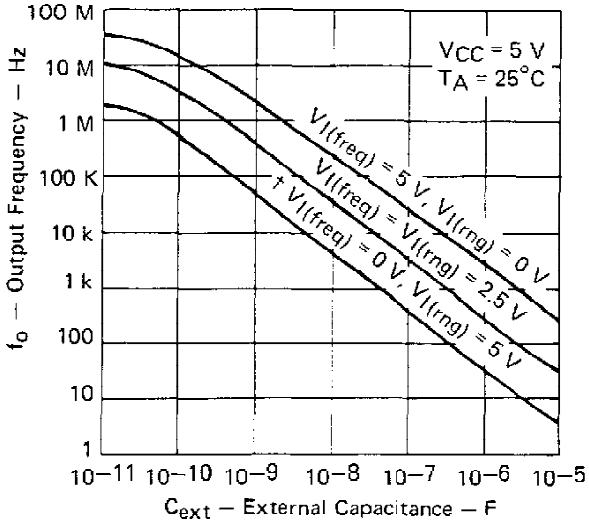



**FIGURE 3**

**'LS625, 'LS626, 'LS627**

OUTPUT FREQUENCY
vs
FREQUENCY-CONTROL INPUT VOLTAGE †

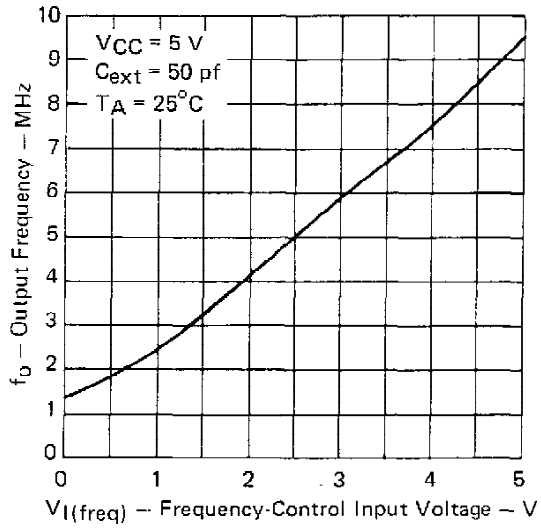



**FIGURE 4**

**'LS625, 'LS626, 'LS627**

OUTPUT FREQUENCY
vs
FREQUENCY-CONTROL INPUT VOLTAGE

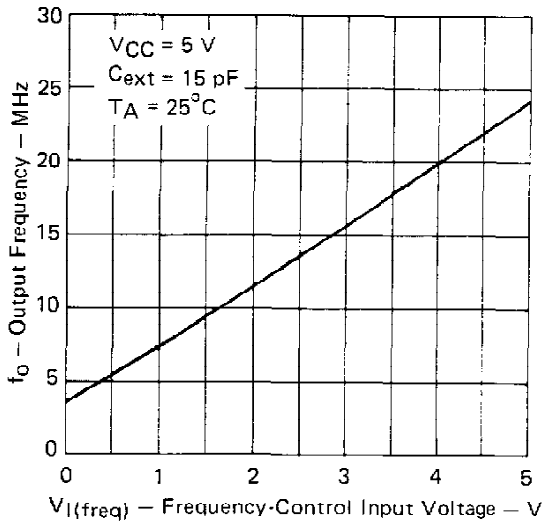



**FIGURE 5**

**'LS625, 'LS626, 'LS627**

OUTPUT FREQUENCY
vs
EXTERNAL CAPACITANCE

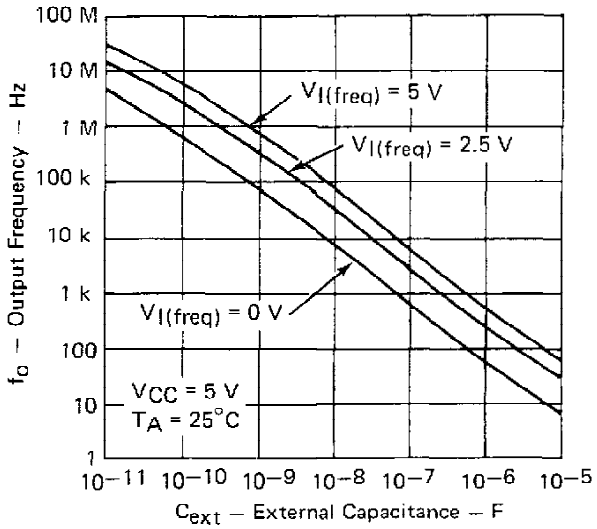



**FIGURE 6**

† Due to the effects of stray capacitance the output frequency may be unstable when the frequency control voltage is less than 1 volt.

## TYPICAL CHARACTERISTICS

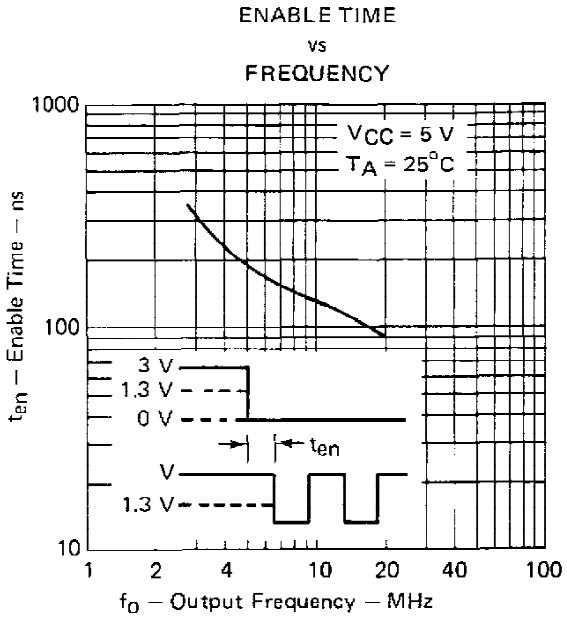
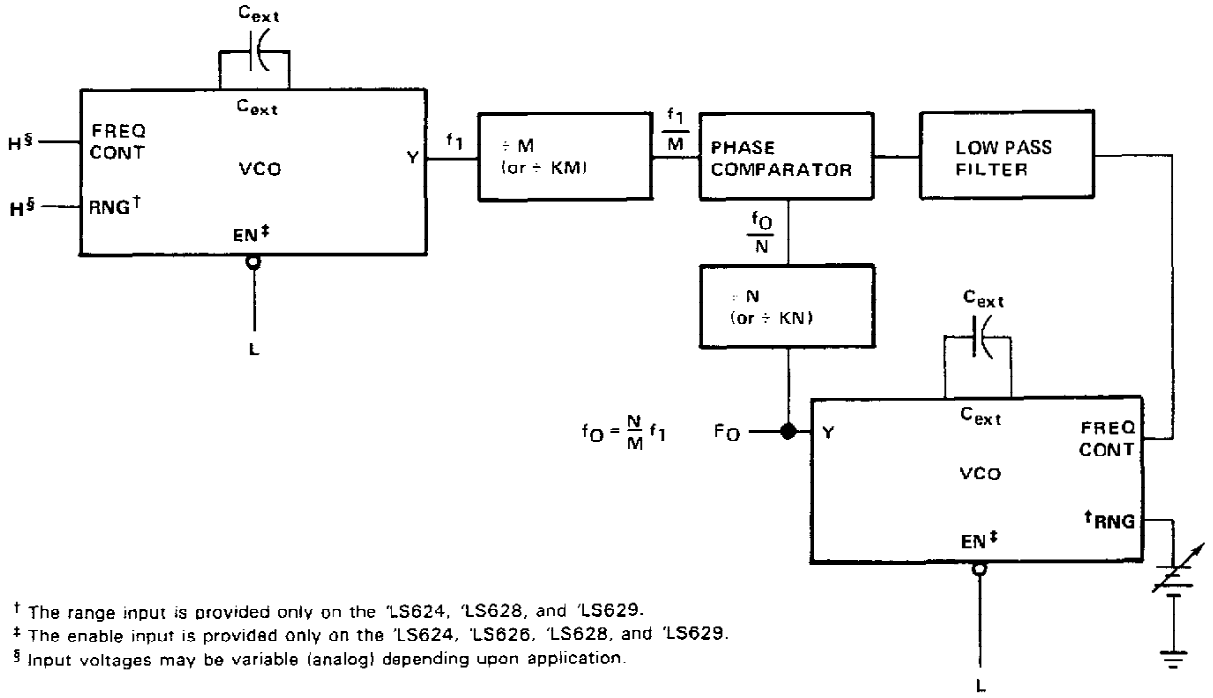



FIGURE 7

## TYPICAL APPLICATIONS DATA




† The range input is provided only on the 'LS624, 'LS628, and 'LS629.
‡ The enable input is provided only on the 'LS624, 'LS626, 'LS628, and 'LS629.
§ Input voltages may be variable (analog) depending upon application.

FIGURE A–PHASE-LOCKED LOOP

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