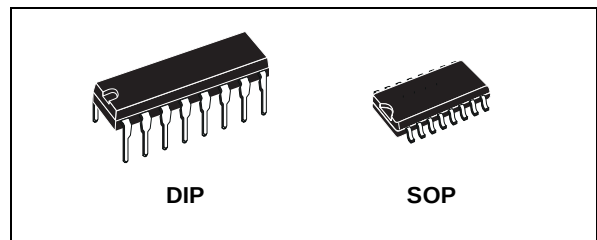


## 24-STAGE FREQUENCY DIVIDER

- HIGH NOISE IMMUNITY
- VOLTAGE SUPPLY RANGE 3V TO 18V
- ALL STAGE ARE PRESETTABLE
- RESET DISABLES THE RC OSCILLATOR FOR LOW STANDBY POWER DRAIN
- RC AND CRYSTAL OSCILLATOR OUTPUT ARE CAPABLE OF DRIVING EXTERNAL LOADS
- QUIESCENT CURRENT SPECIF. UP TO 20V
- 5V, 10V AND 15V PARAMETRIC RATINGS
- INPUT LEAKAGE CURRENT  
 $I_l = 100\text{nA (MAX) AT } V_{DD} = 18\text{V } T_A = 25^\circ\text{C}$
- 100% TESTED FOR QUIESCENT CURRENT
- MEETS ALL REQUIREMENTS OF JEDEC JESD13B "STANDARD SPECIFICATIONS FOR DESCRIPTION OF B SERIES CMOS DEVICES"

### DESCRIPTION

HCF4521B is a monolithic integrated circuit fabricated in Metal Oxide Semiconductor technology available in DIP and SOP packages. HCF4521B has a chain of 24 flip-flops with an input circuit that allows three modes of operation.

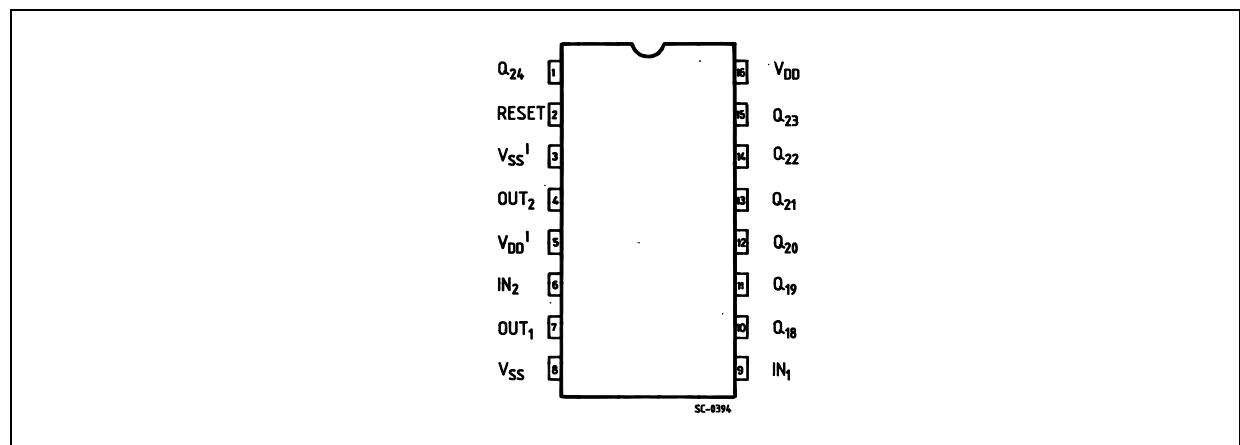


### ORDER CODES

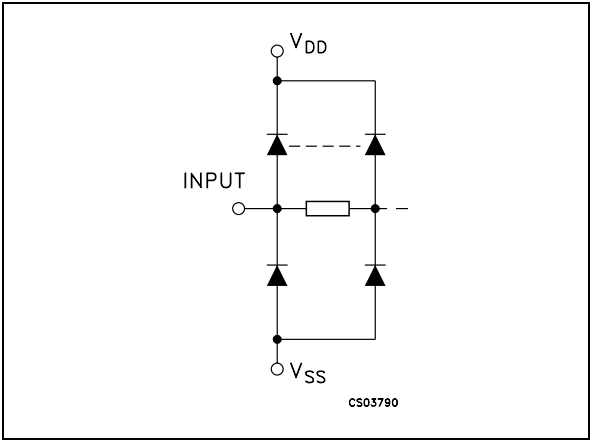
| PACKAGE | TUBE       | T & R         |
|---------|------------|---------------|
| DIP     | HCF4521BEY |               |
| SOP     | HCF4521BM1 | HCF4521M013TR |

The input circuit functions as a crystal or RC oscillator or as an input buffer for an external oscillator. Each flip-flop performs a divide-by-two function giving a total count of  $2^{24} = 16,777,216$ . The count advances on the negative going edge of the clock. Access is available to the final seven stages giving the device added flexibility.

### PIN CONNECTION



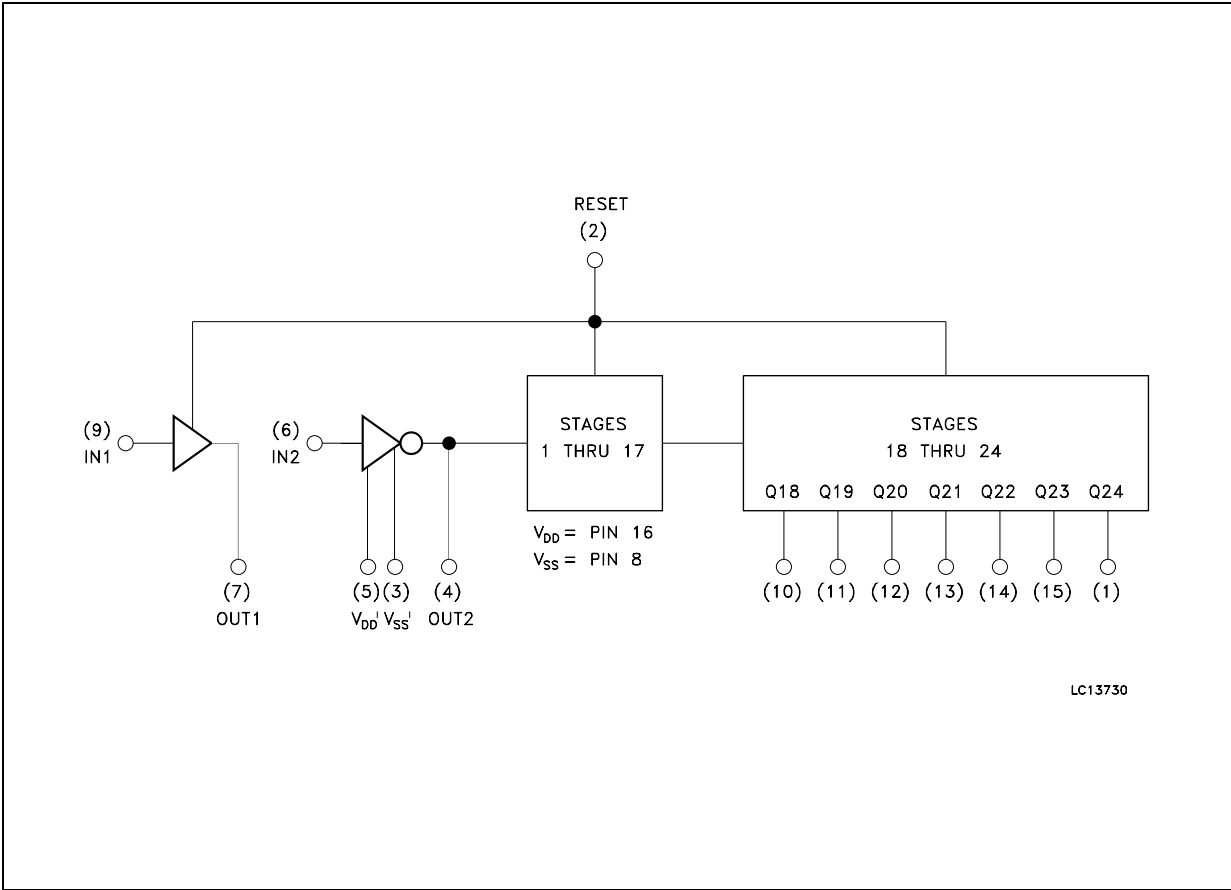
INPUT EQUIVALENT CIRCUIT



PIN DESCRIPTION

| PIN No                    | SYMBOL           | NAME AND FUNCTION         |
|---------------------------|------------------|---------------------------|
| 10, 11, 12, 13, 14, 15, 1 | Q18 to Q24       | Outputs Counter           |
| 2                         | RESET            | Reset Input               |
| 4                         | OUT2             | Output Crystal Oscillator |
| 7                         | OUT1             | Output RC Oscillator      |
| 9                         | IN1              | Clock Input               |
| 6                         | IN2              | Clock Input               |
| 3                         | VSS <sup>1</sup> | Ext. Neg. Supply Voltage  |
| 5                         | VDD <sup>1</sup> | Ext. Pos. Supply Voltage  |
| 8                         | VSS              | Negative Supply Voltage   |
| 16                        | VDD              | Positive Supply Voltage   |

BLOCK DIAGRAM

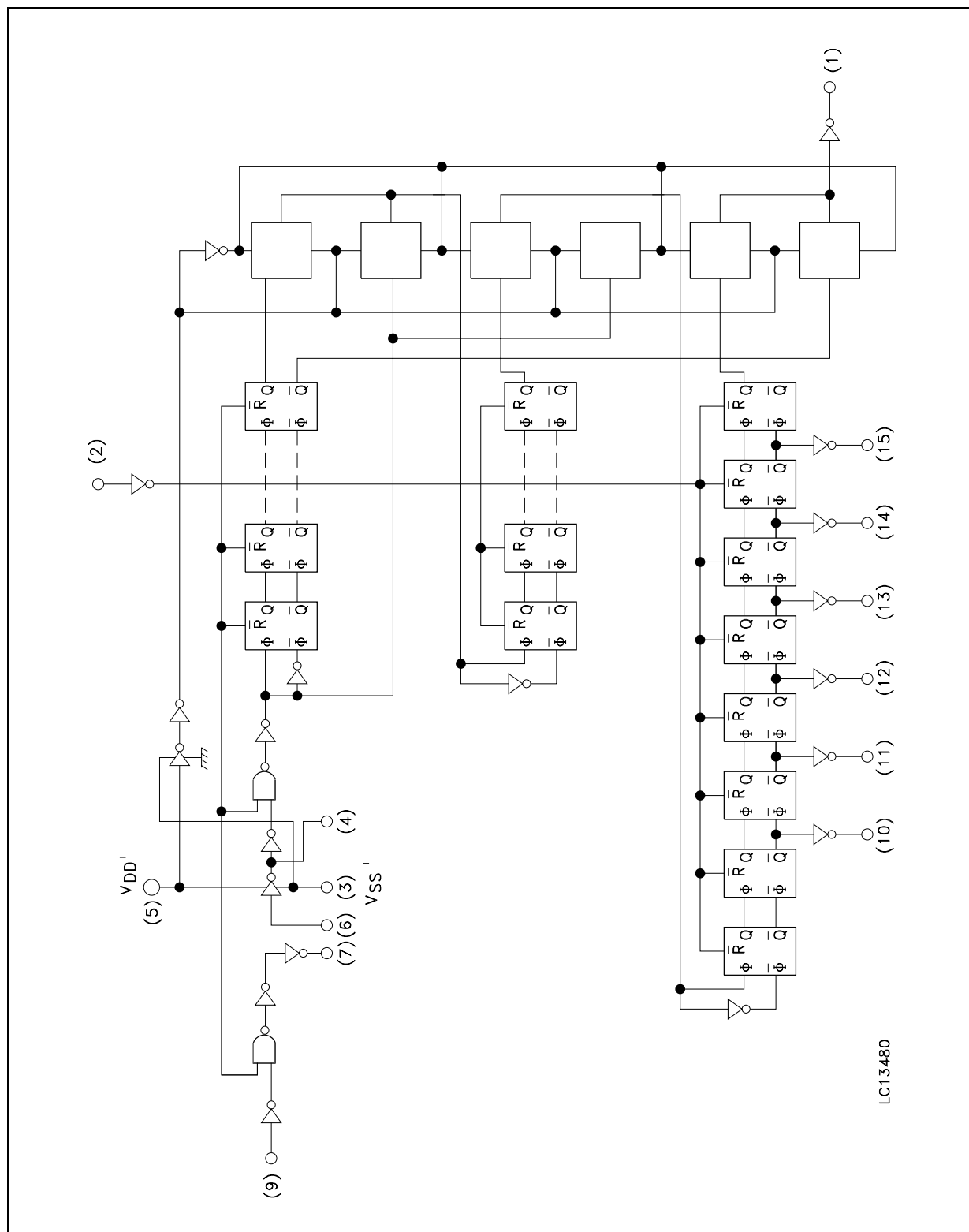


## FUNCTIONAL TEST SEQUENCE

| INPUTS |      | OUTPUTS |            |            |           | COMMENTS                                                                                                    |
|--------|------|---------|------------|------------|-----------|-------------------------------------------------------------------------------------------------------------|
| RESET  | IN 2 | OUT     | $V_{SS}^1$ | $V_{DD}^1$ | Q18 - Q24 |                                                                                                             |
| H      | L    | L       | $V_{DD}$   | $V_{SS}$   | L         | Counter is in three 8-stage sections in parallel mode<br>Counter in reset. IN 2 and OUT 2 are tied together |
| L      | H    | H       | $V_{DD}$   | $V_{SS}$   | L         | First LOW-to-HIGH transition at IN 2                                                                        |
| L      | L    | L       | $V_{DD}$   | $V_{SS}$   | L         | 255 LOW-to-HIGH transition are clocked in at IN 2                                                           |
| L      | H    | H       | $V_{DD}$   | $V_{SS}$   | L         |                                                                                                             |
| L      | H    | H       | $V_{DD}$   | $V_{SS}$   | H         | The 255th LOW-to-HIGH transition                                                                            |
| L      | L    | L       | $V_{DD}$   | $V_{SS}$   | H         |                                                                                                             |
| L      | L    | L       | $V_{SS}$   | $V_{SS}$   | H         |                                                                                                             |
| L      | H    | L       | $V_{SS}$   | $V_{DD}$   | H         | Counter Converted Back to 24-Stage in Series Mode                                                           |
| L      | H    | L       | $V_{SS}$   | $V_{DD}$   | H         | OUT 2 reverts to output operation                                                                           |
| L      | L    | H       | $V_{SS}$   | $V_{DD}$   | L         | Counter ripples from an all-HIGH state to an all-LOW state                                                  |

A test function (see Functional Test Circuit) has been included for the reduction of test time required to exercise all 24 counter stages. This test function divides the counter into three 8-stage sections and 255 counts are loaded in each of the 8-stage sections in parallel. All flip-flop are now at a logic "1". The counter is now returned to the normal 24-stages in series configuration. One more pulse is entered into Input 2 (In2) which will cause the counter to ripple from an all "1" state to an all "0" state.

## FUNCTIONAL DIAGRAM



**ABSOLUTE MAXIMUM RATINGS**

| Symbol    | Parameter                               | Value                  | Unit |
|-----------|-----------------------------------------|------------------------|------|
| $V_{DD}$  | Supply Voltage                          | -0.5 to +22            | V    |
| $V_I$     | DC Input Voltage                        | -0.5 to $V_{DD} + 0.5$ | V    |
| $I_I$     | DC Input Current                        | $\pm 10$               | mA   |
| $P_D$     | Power Dissipation per Package           | 200                    | mW   |
|           | Power Dissipation per Output Transistor | 100                    | mW   |
| $T_{op}$  | Operating Temperature                   | -55 to +125            | °C   |
| $T_{stg}$ | Storage Temperature                     | -65 to +150            | °C   |

Absolute Maximum Ratings are those values beyond which damage to the device may occur. Functional operation under these conditions is not implied.

All voltage values are referred to  $V_{SS}$  pin voltage.

**RECOMMENDED OPERATING CONDITIONS**

| Symbol   | Parameter             | Value         | Unit |
|----------|-----------------------|---------------|------|
| $V_{DD}$ | Supply Voltage        | 3 to 20       | V    |
| $V_I$    | Input Voltage         | 0 to $V_{DD}$ | V    |
| $T_{op}$ | Operating Temperature | -55 to 125    | °C   |

## DC SPECIFICATIONS

| Symbol          | Parameter                 | Test Condition        |                       |                           |                        | Value                 |                   |      |             |      |              |      |    | Unit |
|-----------------|---------------------------|-----------------------|-----------------------|---------------------------|------------------------|-----------------------|-------------------|------|-------------|------|--------------|------|----|------|
|                 |                           | V <sub>I</sub><br>(V) | V <sub>O</sub><br>(V) | I <sub>OL</sub>  <br>(μA) | V <sub>DD</sub><br>(V) | T <sub>A</sub> = 25°C |                   |      | -40 to 85°C |      | -55 to 125°C |      |    |      |
|                 |                           |                       |                       |                           |                        | Min.                  | Typ.              | Max. | Min.        | Max. | Min.         | Max. |    |      |
| I <sub>L</sub>  | Quiescent Current         | 0/5                   |                       |                           | 5                      |                       | 0.04              | 5    |             | 150  |              | 150  | μA |      |
|                 |                           | 0/10                  |                       |                           | 10                     |                       | 0.04              | 10   |             | 300  |              | 300  |    |      |
|                 |                           | 0/15                  |                       |                           | 15                     |                       | 0.04              | 20   |             | 600  |              | 600  |    |      |
|                 |                           | 0/20                  |                       |                           | 20                     |                       | 0.08              | 100  |             | 3000 |              | 3000 |    |      |
| V <sub>OH</sub> | High Level Output Voltage | 0/5                   |                       | <1                        | 5                      | 4.95                  |                   |      | 4.95        |      | 4.95         |      | V  |      |
|                 |                           | 0/10                  |                       | <1                        | 10                     | 9.95                  |                   |      | 9.95        |      | 9.95         |      |    |      |
|                 |                           | 0/15                  |                       | <1                        | 15                     | 14.95                 |                   |      | 14.95       |      | 14.95        |      |    |      |
| V <sub>OL</sub> | Low Level Output Voltage  | 5/0                   |                       | <1                        | 5                      |                       | 0.05              |      |             | 0.05 |              | 0.05 | V  |      |
|                 |                           | 10/0                  |                       | <1                        | 10                     |                       | 0.05              |      |             | 0.05 |              | 0.05 |    |      |
|                 |                           | 15/0                  |                       | <1                        | 15                     |                       | 0.05              |      |             | 0.05 |              | 0.05 |    |      |
| V <sub>IH</sub> | High Level Input Voltage  |                       | 0.5/4.5               | <1                        | 5                      | 3.5                   |                   |      | 3.5         |      | 3.5          |      | V  |      |
|                 |                           |                       | 1/9                   | <1                        | 10                     | 7                     |                   |      | 7           |      | 7            |      |    |      |
|                 |                           |                       | 1.5/13.5              | <1                        | 15                     | 11                    |                   |      | 11          |      | 11           |      |    |      |
| V <sub>IL</sub> | Low Level Input Voltage   |                       | 4.5/0.5               | <1                        | 5                      |                       |                   | 1.5  |             | 1.5  |              | 1.5  | V  |      |
|                 |                           |                       | 9/1                   | <1                        | 10                     |                       |                   | 3    |             | 3    |              | 3    |    |      |
|                 |                           |                       | 13.5/1.5              | <1                        | 15                     |                       |                   | 4    |             | 4    |              | 4    |    |      |
| I <sub>OH</sub> | Output Drive Current      | 0/5                   | 2.5                   | <1                        | 5                      | -1.36                 | -3.2              |      | -1.1        |      | -1.1         |      | mA |      |
|                 |                           | 0/5                   | 4.6                   | <1                        | 5                      | -0.44                 | -1                |      | -0.36       |      | -0.36        |      |    |      |
|                 |                           | 0/10                  | 9.5                   | <1                        | 10                     | -1.1                  | -2.6              |      | -0.9        |      | -0.9         |      |    |      |
|                 |                           | 0/15                  | 13.5                  | <1                        | 15                     | -3.0                  | -6.8              |      | -2.4        |      | -2.4         |      |    |      |
| I <sub>OL</sub> | Output Sink Current       | 0/5                   | 0.4                   | <1                        | 5                      | 0.44                  | 1                 |      | 0.36        |      | 0.36         |      | mA |      |
|                 |                           | 0/10                  | 0.5                   | <1                        | 10                     | 1.1                   | 2.6               |      | 0.9         |      | 0.9          |      |    |      |
|                 |                           | 0/15                  | 1.5                   | <1                        | 15                     | 3.0                   | 6.8               |      | 2.4         |      | 2.4          |      |    |      |
| I <sub>I</sub>  | Input Leakage Current     | 0/18                  | Any Input             |                           | 18                     |                       | ±10 <sup>-5</sup> | ±0.1 |             | ±1   |              | ±1   | μA |      |
| C <sub>I</sub>  | Input Capacitance         |                       | Any Input             |                           |                        |                       | 5                 | 7.5  |             |      |              |      | pF |      |

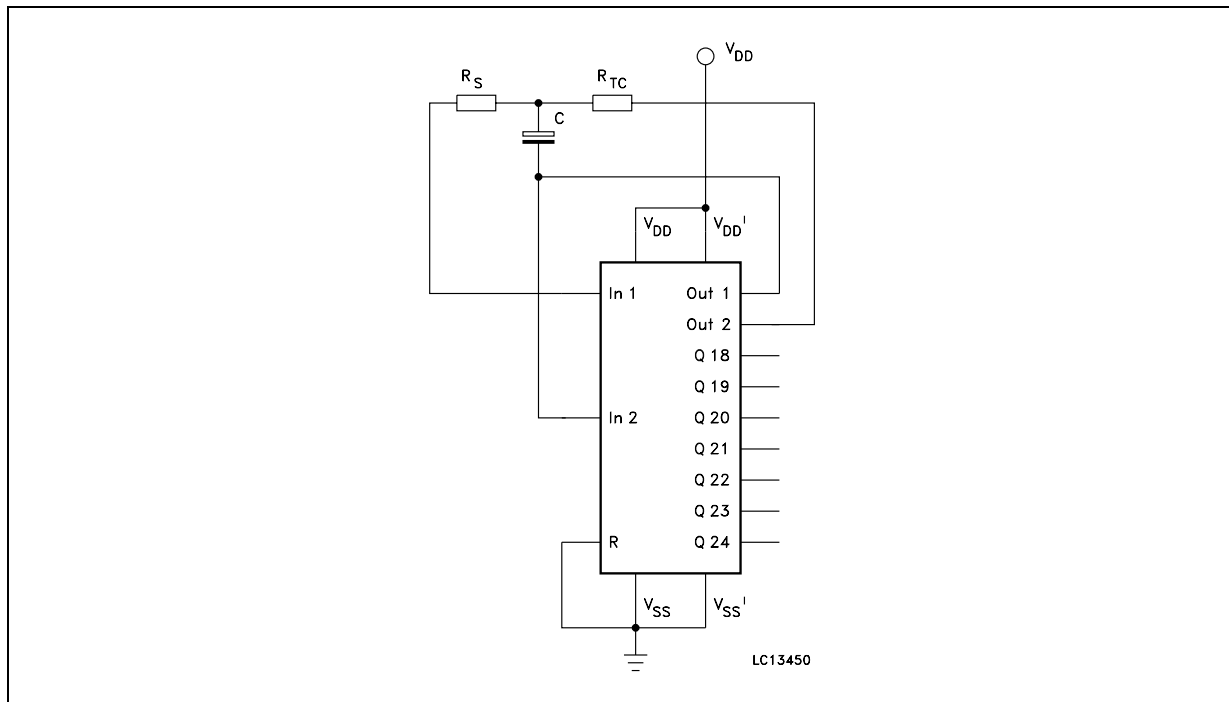
The Noise Margin for both "1" and "0" level is: 1V min. with V<sub>DD</sub>=5V, 2V min. with V<sub>DD</sub>=10V, 2.5V min. with V<sub>DD</sub>=15V

**DYNAMIC ELECTRICAL CHARACTERISTICS** ( $T_{amb} = 25^{\circ}\text{C}$ ,  $C_L = 50\text{pF}$ ,  $R_L = 200\text{K}\Omega$ ,  $t_r = t_f = 20\text{ ns}$ )

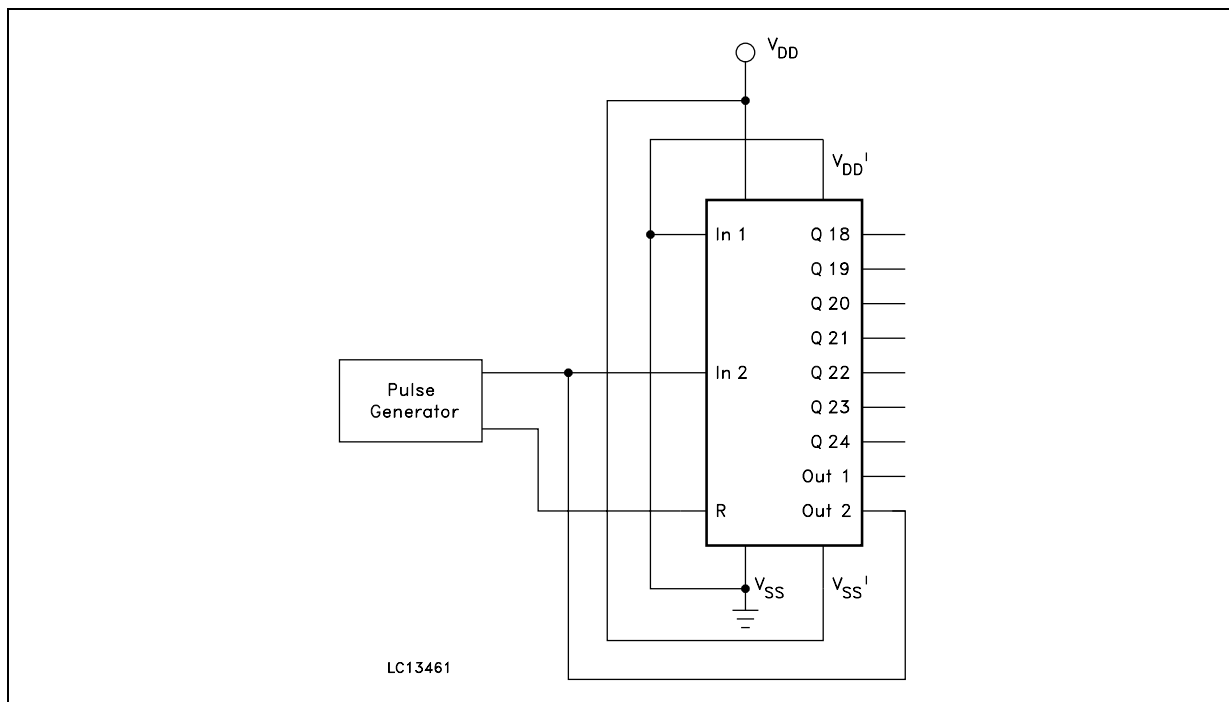
| Symbol                   | Parameter                              | Test Condition |  | Value (*) |      |      | Unit          |
|--------------------------|----------------------------------------|----------------|--|-----------|------|------|---------------|
|                          |                                        | $V_{DD}$ (V)   |  | Min.      | Typ. | Max. |               |
| $t_{PLH}$                | Output Rise Time                       | 5              |  |           | 100  | 200  | ns            |
|                          |                                        | 10             |  |           | 50   | 100  |               |
|                          |                                        | 15             |  |           | 40   | 80   |               |
| $t_{PHL}$                | Output Fall Time                       | 5              |  |           | 100  | 200  | ns            |
|                          |                                        | 10             |  |           | 50   | 100  |               |
|                          |                                        | 15             |  |           | 40   | 80   |               |
| $t_{PHL}$ ,<br>$t_{PLH}$ | Propagation Delay Time<br>Clock to Q18 | 5              |  |           | 4.5  | 9.0  | $\mu\text{s}$ |
|                          |                                        | 10             |  |           | 1.7  | 3.5  |               |
|                          |                                        | 15             |  |           | 1.3  | 2.7  |               |
| $t_{PHL}$ ,<br>$t_{PLH}$ | Propagation Delay Time<br>Clock to Q24 | 5              |  |           | 6.0  | 12   | $\mu\text{s}$ |
|                          |                                        | 10             |  |           | 2.2  | 4.5  |               |
|                          |                                        | 15             |  |           | 1.7  | 3.5  |               |
| $t_{PHL}$                | Propagation Delay Time<br>RESET to Qn  | 5              |  |           | 1300 | 2600 | ns            |
|                          |                                        | 10             |  |           | 500  | 1000 |               |
|                          |                                        | 15             |  |           | 375  | 750  |               |
| $t_{WH(d)}$              | Clock Pulse Width                      | 5              |  | 385       | 140  |      | ns            |
|                          |                                        | 10             |  | 150       | 55   |      |               |
|                          |                                        | 15             |  | 120       | 40   |      |               |
| $f_{cl}$                 | Clock Pulse Frequency                  | 5              |  |           | 3.5  | 2    | MHz           |
|                          |                                        | 10             |  |           | 9    | 5    |               |
|                          |                                        | 15             |  |           | 12   | 6.5  |               |
| $t_{THL}$ ,<br>$t_{TLH}$ | Clock Rise and Fall Time               | 5              |  |           |      | 15   | $\mu\text{s}$ |
|                          |                                        | 10             |  |           |      | 15   |               |
|                          |                                        | 15             |  |           |      | 15   |               |
| $t_{W(R)}$               | Reset Pulse Width                      | 5              |  | 1400      | 700  |      | ns            |
|                          |                                        | 10             |  | 600       | 300  |      |               |
|                          |                                        | 15             |  | 450       | 225  |      |               |

(\*) Typical temperature coefficient for all  $V_{DD}$  value is 0.3 %/°C.

## RC OSCILLATOR CIRCUIT



## FUNCTIONAL TEST CIRCUIT

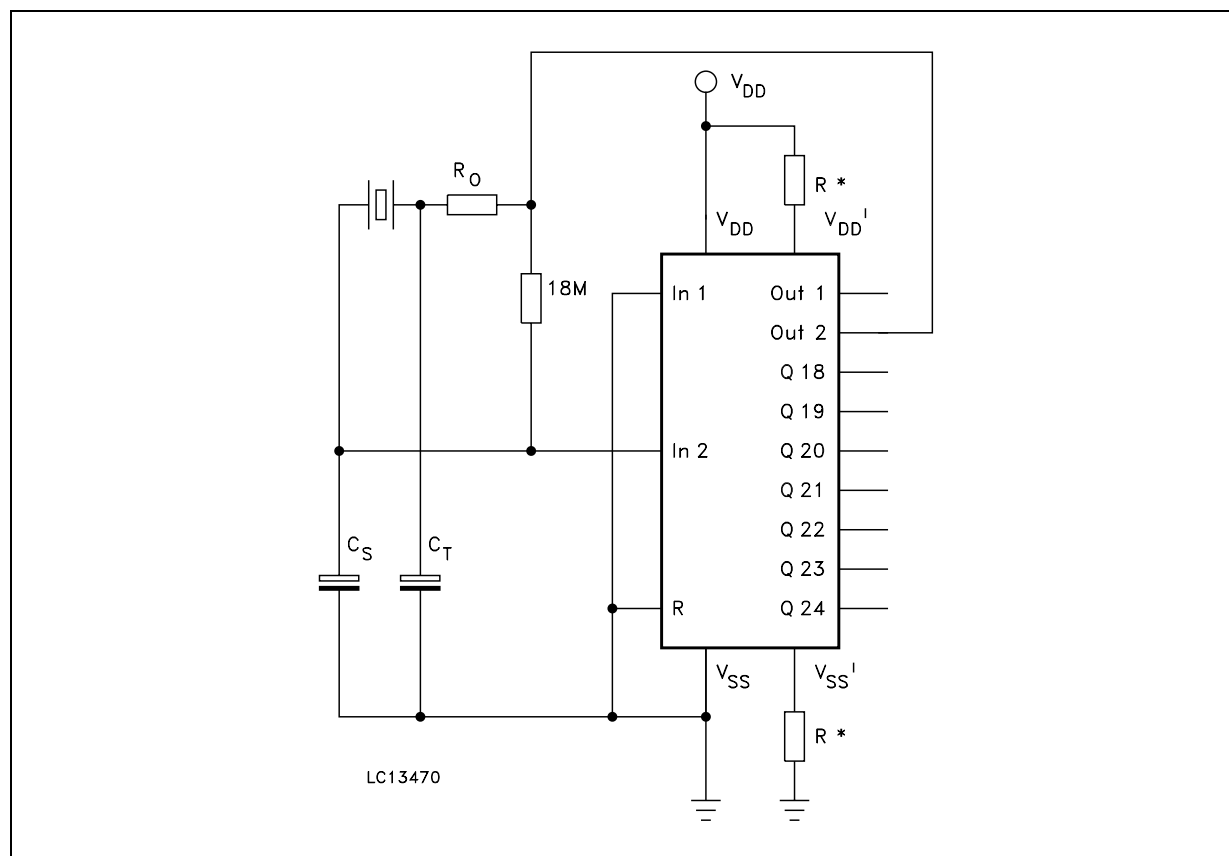


## TYPICAL DATA FOR CRYSTAL OSCILLATOR CIRCUIT

| CHARACTERISTIC                                                                                                                        |                                 | 500 kHz<br>CIRCUIT | 50 kHz<br>CIRCUIT | UNIT      |
|---------------------------------------------------------------------------------------------------------------------------------------|---------------------------------|--------------------|-------------------|-----------|
| Crystal Characteristics                                                                                                               | Resonant Frequency              | 500                | 50                | kHz       |
|                                                                                                                                       | Equivalent Resistance, $R_s$    | 1                  | 6.2               | $k\Omega$ |
| External Resistor/Capacitor Values                                                                                                    | $R_O$                           | 47                 | 750               | $k\Omega$ |
|                                                                                                                                       | $C_T$                           | 82                 | 82                | pF        |
|                                                                                                                                       | $C_S$                           | 20                 | 20                | pF        |
| Frequency Stability<br>Frequency Change as a Function<br>of $V_{DD}$ ( $T_A = 25^\circ\text{C}$ )                                     | $V_{DD}$ Change from 5V to 10V  | 6                  | 2                 | ppm       |
|                                                                                                                                       | $V_{DD}$ Change from 10V to 15V | 2                  | 2                 | ppm       |
| Frequency Change as a Function<br>of temperature $V_{DD} = 10\text{V}$<br>$T_A$ Change from $-55^\circ\text{C}$ to $25^\circ\text{C}$ | HCF4521B only                   | -4                 | -2                | ppm       |
|                                                                                                                                       | Complete Oscillator *           | 100                | 120               | ppm       |
| $T_A$ Change from $25^\circ\text{C}$ to $125^\circ\text{C}$                                                                           | HCF4521B only                   | -2                 | -2                | ppm       |
|                                                                                                                                       | Complete Oscillator *           | 160                | -560              | ppm       |

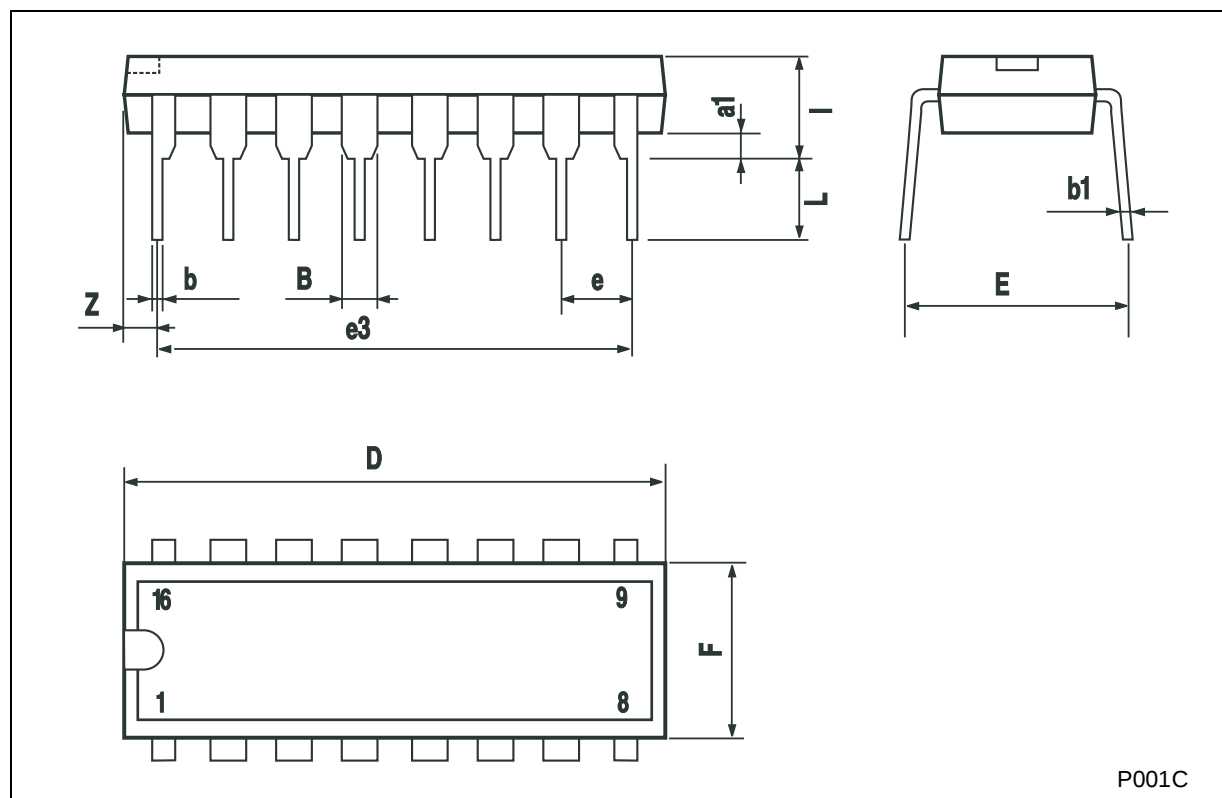
\* Complete oscillator includes crystal, capacitors and resistors.

## CRYSTAL OSCILLATOR CIRCUIT



### Plastic DIP-16 (0.25) MECHANICAL DATA

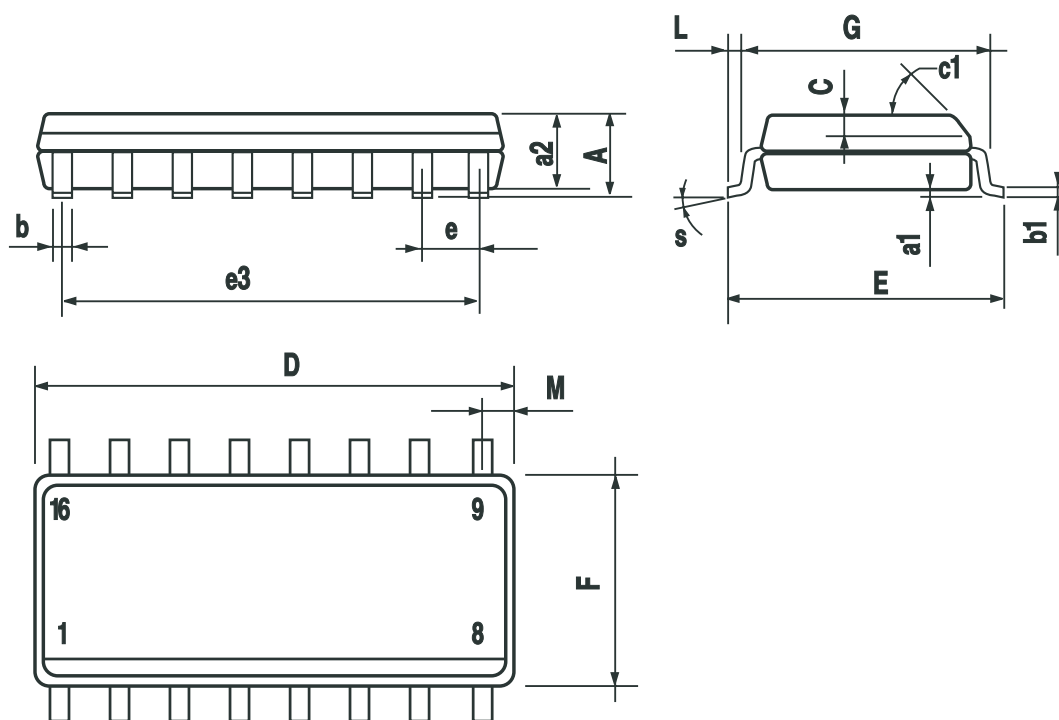
| DIM. | mm.  |       |      | inch  |       |       |
|------|------|-------|------|-------|-------|-------|
|      | MIN. | TYP   | MAX. | MIN.  | TYP.  | MAX.  |
| a1   | 0.51 |       |      | 0.020 |       |       |
| B    | 0.77 |       | 1.65 | 0.030 |       | 0.065 |
| b    |      | 0.5   |      |       | 0.020 |       |
| b1   |      | 0.25  |      |       | 0.010 |       |
| D    |      |       | 20   |       |       | 0.787 |
| E    |      | 8.5   |      |       | 0.335 |       |
| e    |      | 2.54  |      |       | 0.100 |       |
| e3   |      | 17.78 |      |       | 0.700 |       |
| F    |      |       | 7.1  |       |       | 0.280 |
| I    |      |       | 5.1  |       |       | 0.201 |
| L    |      | 3.3   |      |       | 0.130 |       |
| Z    |      |       | 1.27 |       |       | 0.050 |



P001C

## SO-16 MECHANICAL DATA

| DIM. | mm.        |      |      | inch  |       |       |
|------|------------|------|------|-------|-------|-------|
|      | MIN.       | TYP  | MAX. | MIN.  | TYP.  | MAX.  |
| A    |            |      | 1.75 |       |       | 0.068 |
| a1   | 0.1        |      | 0.2  | 0.003 |       | 0.007 |
| a2   |            |      | 1.65 |       |       | 0.064 |
| b    | 0.35       |      | 0.46 | 0.013 |       | 0.018 |
| b1   | 0.19       |      | 0.25 | 0.007 |       | 0.010 |
| C    |            | 0.5  |      |       | 0.019 |       |
| c1   | 45° (typ.) |      |      |       |       |       |
| D    | 9.8        |      | 10   | 0.385 |       | 0.393 |
| E    | 5.8        |      | 6.2  | 0.228 |       | 0.244 |
| e    |            | 1.27 |      |       | 0.050 |       |
| e3   |            | 8.89 |      |       | 0.350 |       |
| F    | 3.8        |      | 4.0  | 0.149 |       | 0.157 |
| G    | 4.6        |      | 5.3  | 0.181 |       | 0.208 |
| L    | 0.5        |      | 1.27 | 0.019 |       | 0.050 |
| M    |            |      | 0.62 |       |       | 0.024 |
| S    | 8° (max.)  |      |      |       |       |       |



PO13H

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