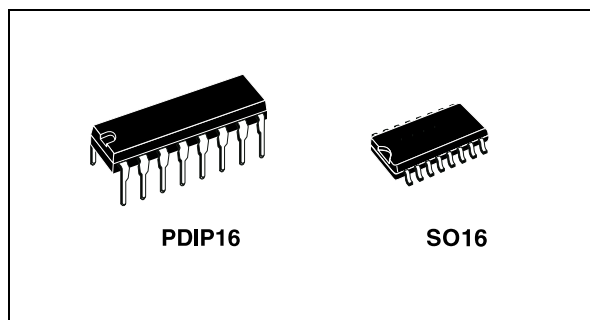


## 14-stage ripple carry binary counter/divider and oscillator

Datasheet - production data



### Features

- Medium speed operation
- Common reset
- Fully static operation
- Buffered inputs and outputs
- Quiescent current specified up to 20 V
- 5 V, 10 V and 15 V parametric ratings
- Input leakage current:  $I_I = 100 \text{ nA}$  (max.) at  $V_{DD} = 18 \text{ V}$ ,  $T_A = 25^\circ\text{C}$
- 100% tested for quiescent current
- ESD performance
  - HBM: 1 kV
  - MM: 200 V
  - CDM: 1 kV

### Applications

- Automotive
- Industrial
- Computer
- Consumer

### Description

The HCF4060 device is a monolithic integrated circuit fabricated in MOS (metal oxide semiconductor) technology available in SO16 and PDIP16 packages.

The HCF4060 device consists of an oscillator section and 14 ripple carry binary counter stages.

The oscillator configuration allows design of either RC or crystal oscillator circuits. A RESET input is provided which resets the counter to the all 0's state and disables the oscillator. A high level on the RESET line accomplishes the reset function. All counter stages are master slave flip-flops. The state of the counter is advanced one step in binary order on the negative transition of  $\phi_1$  (and  $\phi_0$ ). All inputs and outputs are fully buffered. Schmitt trigger action on the clock pin permits unlimited clock rise and fall time.

Table 1. Device summary

| Order code                    | Temperature range | Package                   | Packaging     | Marking   |
|-------------------------------|-------------------|---------------------------|---------------|-----------|
| HCF4060M013TR                 | -55/+125 °C       | SO16                      | Tape and reel | HCF4060   |
| HCF4060YM013TR <sup>(1)</sup> | -40/+125 °C       | SO16 (automotive version) | Tape and reel | HCF4060Y  |
| HCF4060BEY                    | -55/+125 °C       | PDIP16                    | Tube          | HCF4066BE |

1. Qualification and characterization according to AEC Q100 and Q003 or equivalent, advanced screening according to AEC Q001 and Q002 or equivalent.

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1 Pin information

Figure 1. Pin connection

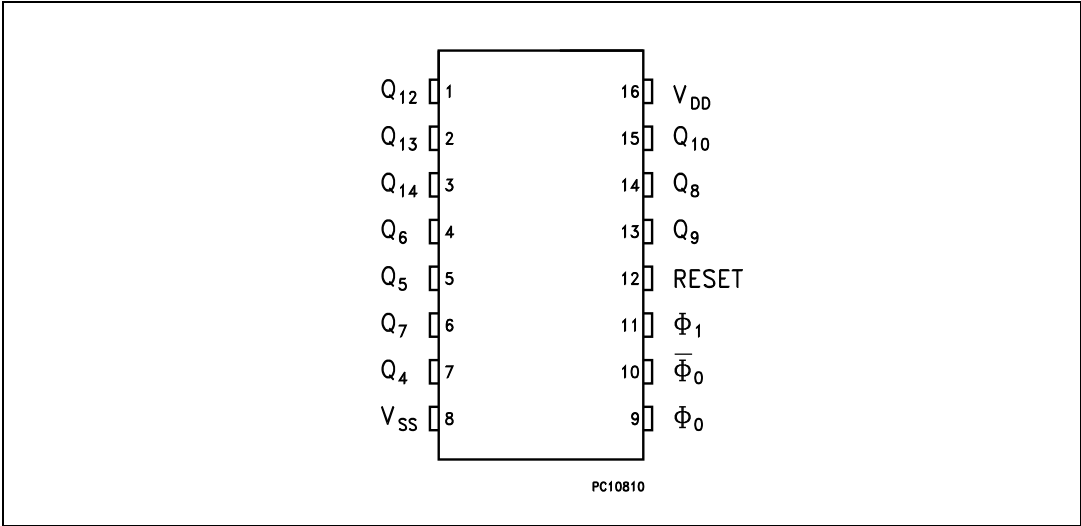


Table 2. Pin description

| Pin no.                         | Symbol                                                         | Name and function       |
|---------------------------------|----------------------------------------------------------------|-------------------------|
| 1, 2, 3, 4, 5, 6, 7, 13, 14, 15 | $Q_{12}, Q_{13}, Q_{14}, Q_6, Q_5, Q_7, Q_4, Q_9, Q_8, Q_{10}$ | Outputs                 |
| 9, 10, 11                       | $\Phi_0, \overline{\Phi_0}, \Phi_1$                            | Oscillator input        |
| 12                              | RESET                                                          | Reset                   |
| 8                               | $V_{SS}$                                                       | Negative supply voltage |
| 16                              | $V_{DD}$                                                       | Positive supply voltage |

## 2 Functional description

Figure 2. Logic diagram

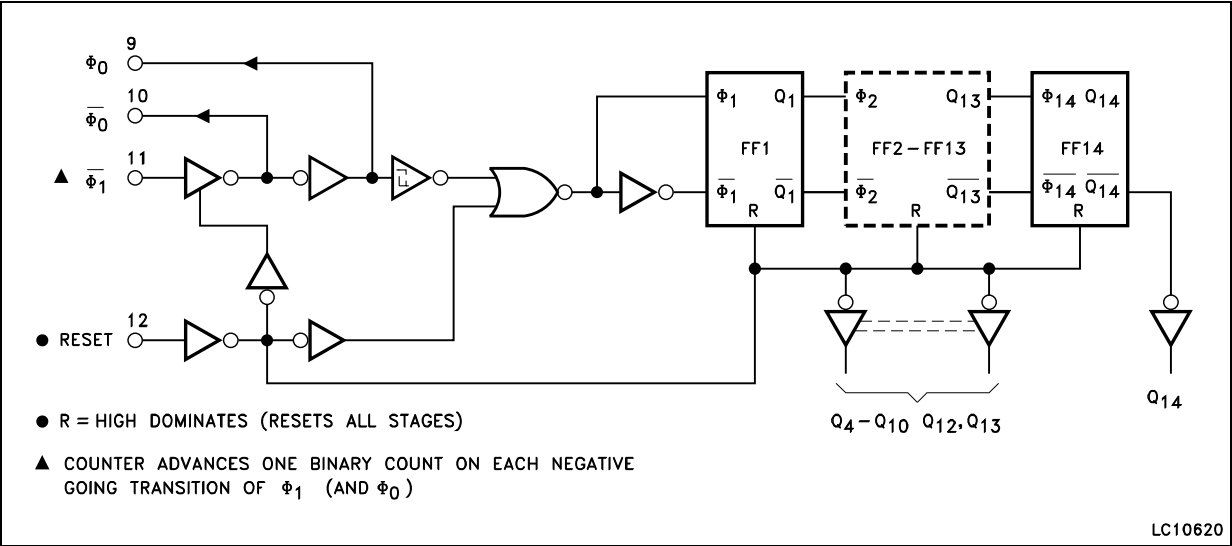


Figure 3. Functional diagram

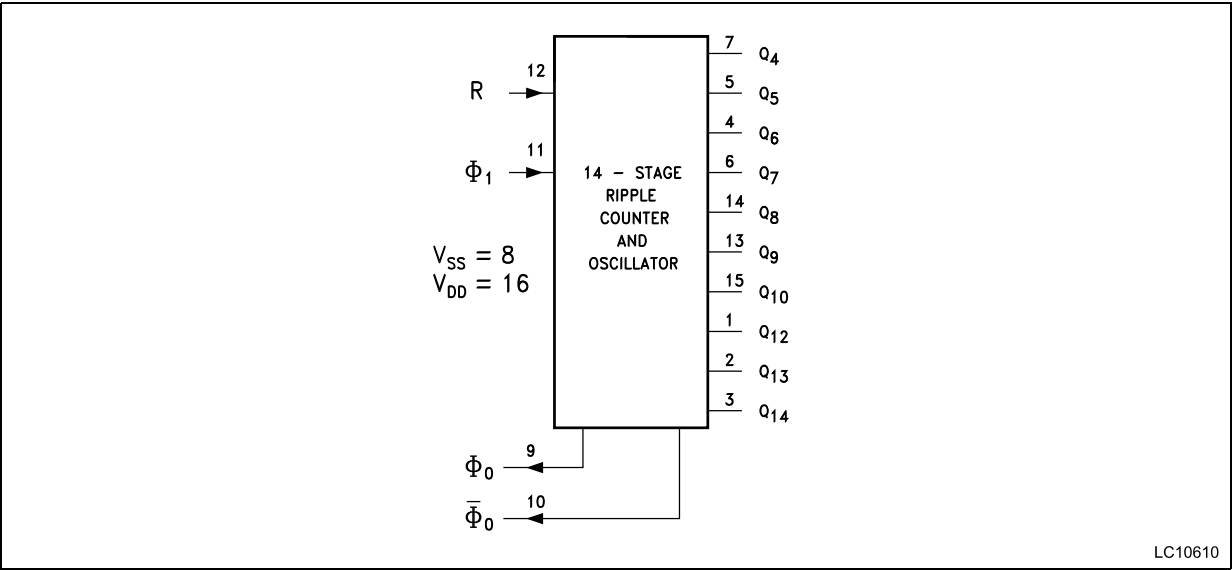
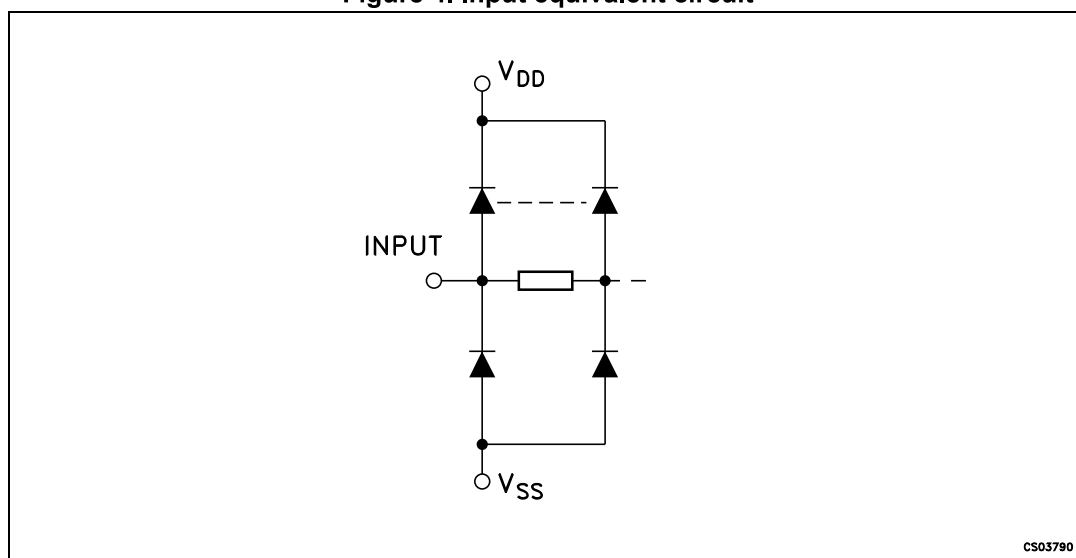


Figure 4. Input equivalent circuit



### 3 Electrical characteristics

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.

**Table 3. Absolute maximum ratings**

| Symbol    | Parameter                               | Value                  | Unit |
|-----------|-----------------------------------------|------------------------|------|
| $V_{DD}$  | Supply voltage                          | -0.5 to +22            | V    |
| $V_I$     | DC input voltage                        | -0.5 to $V_{DD} + 0.5$ |      |
| $I_I$     | DC input current                        | $\pm 10$               | mA   |
| $P_D$     | Power dissipation per package           | 200                    | mW   |
|           | Power dissipation per output transistor | 100                    |      |
| $T_{op}$  | Operating temperature                   | -55 to +125            | °C   |
| $T_{stg}$ | Storage temperature                     | -65 to +150            |      |

**Table 4. Recommended operating conditions**

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

Table 5. DC specifications<sup>(1)</sup>

| Symbol          | Parameter                 | Test condition        |                       |                          |                        | Value                  |                   |      |              |      |               |      | Unit |
|-----------------|---------------------------|-----------------------|-----------------------|--------------------------|------------------------|------------------------|-------------------|------|--------------|------|---------------|------|------|
|                 |                           | V <sub>I</sub><br>(V) | V <sub>O</sub><br>(V) | I <sub>O</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    |              | 5    |               | 150  | μA   |
|                 |                           | 0/10                  |                       |                          | 10                     |                        | 0.04              | 10   |              | 10   |               | 300  |      |
|                 |                           | 0/15                  |                       |                          | 15                     |                        | 0.04              | 20   |              | 20   |               | 600  |      |
|                 |                           | 0/20                  |                       |                          | 20                     |                        | 0.08              | 100  |              | 100  |               | 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                     | 14.9<br>5              |                   |      | 14.9<br>5    |      | 14.9<br>5     |      |      |
| V <sub>OL</sub> | Low level output voltage  | 5/0                   |                       | <1                       | 5                      |                        | 0.05              |      |              | 0.05 |               | 0.05 |      |
|                 |                           | 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           |      |      |
|                 |                           |                       | 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  |      |
|                 |                           |                       | 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              |      | -1.15        |      | -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          |      |      |
|                 |                           | 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> | ±0.3 |              | ±0.3 |               | ±1   | μA   |
| C <sub>I</sub>  | Input capacitance         |                       | Any input             |                          |                        |                        | 5                 | 7.5  |              |      |               |      | pF   |

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

**Table 6. Dynamic electrical characteristics**  
**( $T_{amb} = 25\text{ }^{\circ}\text{C}$ ,  $C_L = 50\text{ pF}$ ,  $R_L = 200\text{ K}\Omega$ ,  $t_r = t_f = 20\text{ ns}$ )**

| Symbol                              | Parameter                                                    | Test condition      |                                                                          | Value <sup>(1)</sup> |      |      | Unit |
|-------------------------------------|--------------------------------------------------------------|---------------------|--------------------------------------------------------------------------|----------------------|------|------|------|
|                                     |                                                              | V <sub>DD</sub> (V) |                                                                          | Min.                 | Typ. | Max. |      |
| t <sub>TLH</sub> , t <sub>THL</sub> | Output transition time                                       | 5                   |                                                                          |                      | 100  | 200  | ns   |
|                                     |                                                              | 10                  |                                                                          |                      | 50   | 100  |      |
|                                     |                                                              | 15                  |                                                                          |                      | 40   | 80   |      |
| t <sub>PLH</sub> , t <sub>PHL</sub> | Propagation delay time (ϕ to Q <sub>4</sub> out)             | 5                   |                                                                          |                      | 370  | 740  |      |
|                                     |                                                              | 10                  |                                                                          |                      | 150  | 300  |      |
|                                     |                                                              | 15                  |                                                                          |                      | 100  | 200  |      |
| t <sub>PLH</sub> , t <sub>PHL</sub> | Propagation delay time (Q <sub>n</sub> to Q <sub>n+1</sub> ) | 5                   |                                                                          |                      | 100  | 200  |      |
|                                     |                                                              | 10                  |                                                                          |                      | 50   | 100  |      |
|                                     |                                                              | 15                  |                                                                          |                      | 40   | 80   |      |
| t <sub>W</sub>                      | Input pulse width                                            | 5                   | f = 100 KHz                                                              |                      | 50   | 100  |      |
|                                     |                                                              | 10                  |                                                                          |                      | 20   | 40   |      |
|                                     |                                                              | 15                  |                                                                          |                      | 15   | 30   |      |
| t <sub>r</sub> , t <sub>f</sub>     | Input pulse rise and fall time                               | 5                   |                                                                          | Unlimited            |      |      | μs   |
|                                     |                                                              | 10                  |                                                                          |                      |      |      |      |
|                                     |                                                              | 15                  |                                                                          |                      |      |      |      |
| f <sub>max</sub>                    | Maximum clock input frequency                                | 5                   |                                                                          | 3.5                  | 7    |      | MHz  |
|                                     |                                                              | 10                  |                                                                          | 8                    | 16   |      |      |
|                                     |                                                              | 15                  |                                                                          | 12                   | 24   |      |      |
| Reset operation                     |                                                              |                     |                                                                          |                      |      |      |      |
| t <sub>PHL</sub>                    | Propagation delay time                                       | 5                   |                                                                          |                      | 180  | 360  | ns   |
|                                     |                                                              | 10                  |                                                                          |                      | 80   | 160  |      |
|                                     |                                                              | 15                  |                                                                          |                      | 50   | 100  |      |
| t <sub>W</sub>                      | Input pulse width                                            | 5                   |                                                                          |                      | 60   | 120  |      |
|                                     |                                                              | 10                  |                                                                          |                      | 30   | 60   |      |
|                                     |                                                              | 15                  |                                                                          |                      | 20   | 40   |      |
| RC operation                        |                                                              |                     |                                                                          |                      |      |      |      |
|                                     | Variation of frequency (unit-to-unit)                        | 5                   | C <sub>x</sub> = 200 pF, R <sub>s</sub> = 560 KΩ, R <sub>x</sub> = 50 KΩ | 18                   | 21.5 | 25   | KHz  |
|                                     |                                                              | 10                  |                                                                          | 20                   | 23   | 26   |      |
|                                     |                                                              | 15                  |                                                                          | 21.1                 | 24   | 27   |      |
|                                     | Variation of frequency with voltage change (the same unit)   | 5 to 10             | C <sub>x</sub> = 200 pF, R <sub>s</sub> = 560 KΩ, R <sub>x</sub> = 50 KΩ |                      |      | 2    |      |
|                                     |                                                              | 10 to 15            |                                                                          |                      |      | 1    |      |

**Table 6. Dynamic electrical characteristics**  
**( $T_{amb} = 25\text{ }^{\circ}\text{C}$ ,  $C_L = 50\text{ pF}$ ,  $R_L = 200\text{ K}\Omega$ ,  $t_r = t_f = 20\text{ ns}$ ) (continued)**

| Symbol | Parameter                                   | Test condition |                                               | Value <sup>(1)</sup> |      |      | Unit             |
|--------|---------------------------------------------|----------------|-----------------------------------------------|----------------------|------|------|------------------|
|        |                                             | $V_{DD}$ (V)   |                                               | Min.                 | Typ. | Max. |                  |
| $R_X$  |                                             | 5              | $C_X = 10\text{ }\mu\text{F}$                 |                      |      | 20   | $\text{M}\Omega$ |
|        |                                             | 10             | $C_X = 50\text{ }\mu\text{F}$                 |                      |      | 20   |                  |
|        |                                             | 15             | $C_X = 10\text{ }\mu\text{F}$                 |                      |      | 10   |                  |
| $C_X$  |                                             | 5              | $R_X = 500\text{ K}\Omega$                    |                      |      | 1000 | $\mu\text{F}$    |
|        |                                             | 10             | $R_X = 300\text{ K}\Omega$                    |                      |      | 50   |                  |
|        |                                             | 15             | $R_X = 300\text{ K}\Omega$                    |                      |      | 50   |                  |
|        | Maximum oscillator frequency <sup>(2)</sup> | 10             | $R_X = 5\text{ K}\Omega$ $C_X = 15\text{ pF}$ | 530                  | 650  | 810  | $\text{pF}$      |
|        |                                             | 15             |                                               | 690                  | 800  | 940  |                  |

1. Typical temperature coefficient for all  $V_{DD}$  values is 0.3 %/ $^{\circ}\text{C}$ , all input rise and fall times = 20 ns.

2. RC oscillator applications are not recommended at supply voltages below 7 V for  $R_X = 50\text{ K}\Omega$ .

Figure 5. Detail of typical flip-flop stage

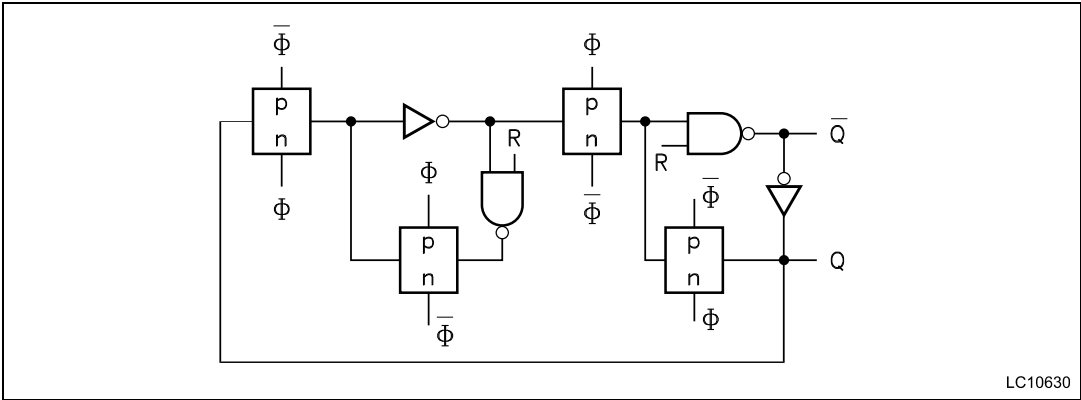


Figure 6. Typical RC oscillator circuit

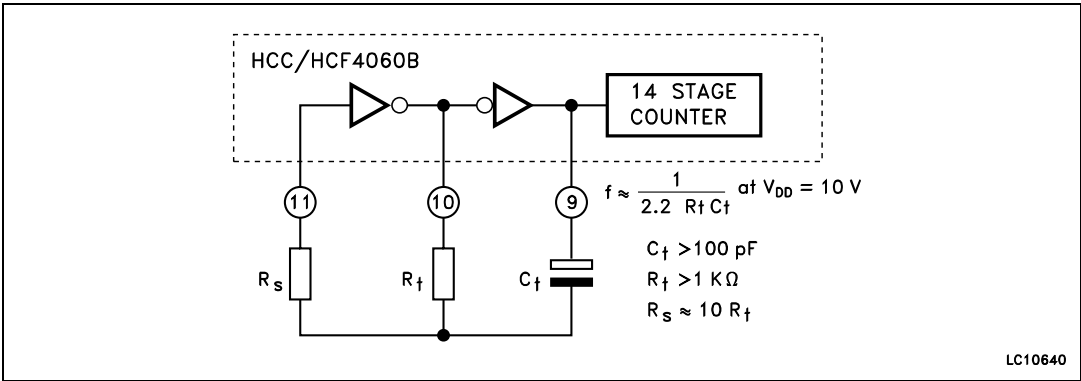
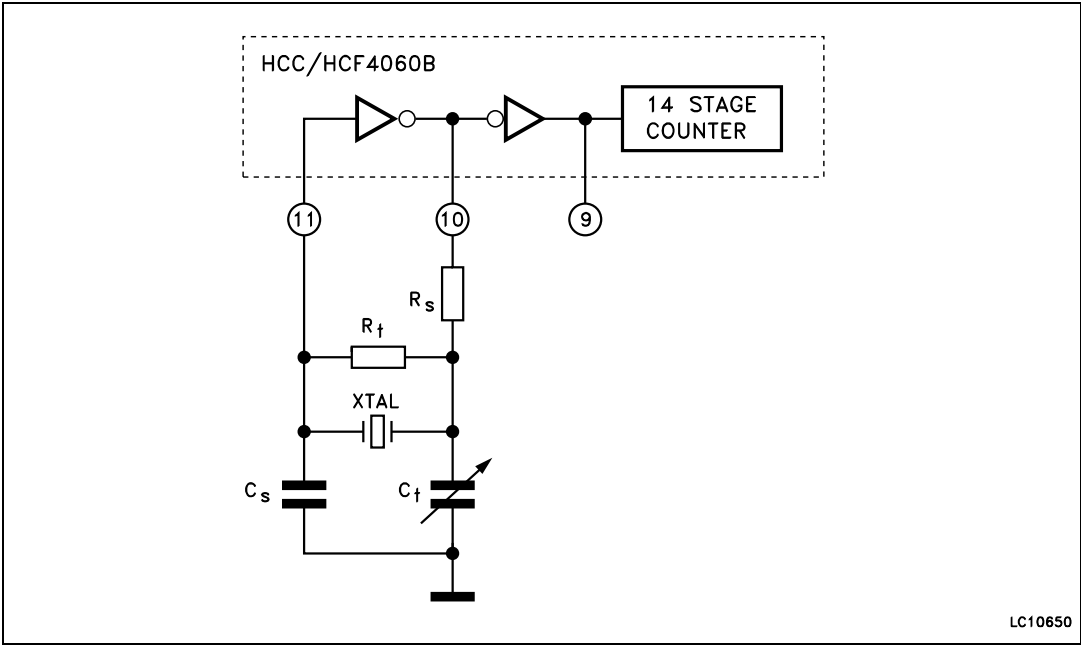


Figure 7. Typical crystal oscillator circuit



## 4 Package information

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK® packages, depending on their level of environmental compliance. ECOPACK specifications, grade definitions and product status are available at: [www.st.com](http://www.st.com). ECOPACK is an ST trademark.

## 4.1 PDIP16 (0.25) package information

Figure 8. PDIP16 (0.25) package mechanical drawing

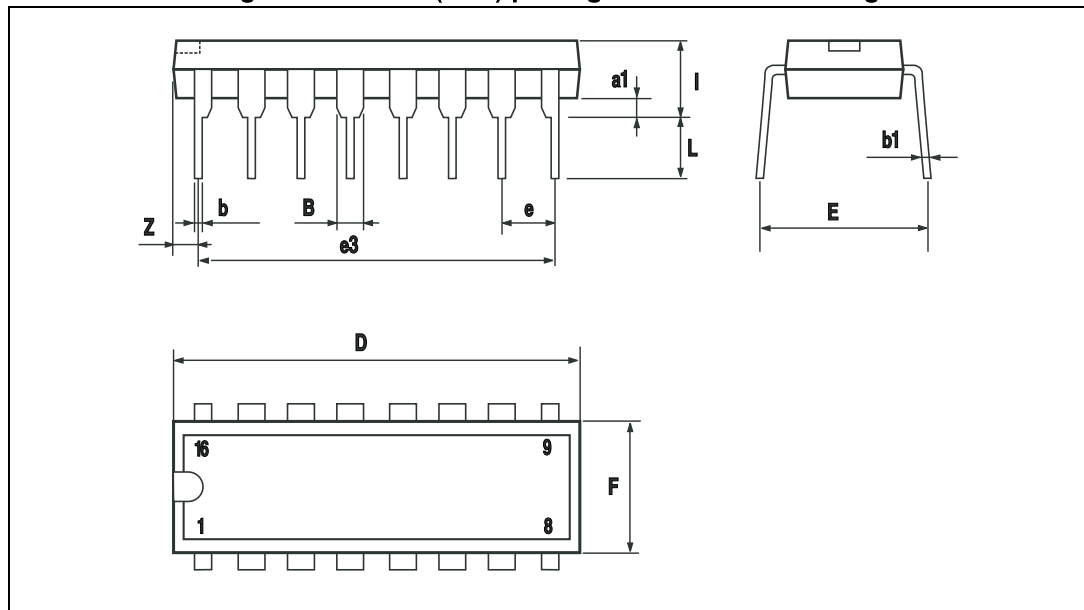


Table 7. PDIP16 (0.25) package mechanical data

| Symbol | Dimensions |       |      |       |       |       |
|--------|------------|-------|------|-------|-------|-------|
|        | 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 |

## 4.2 SO16 package information

Figure 9. SO16 package mechanical drawing

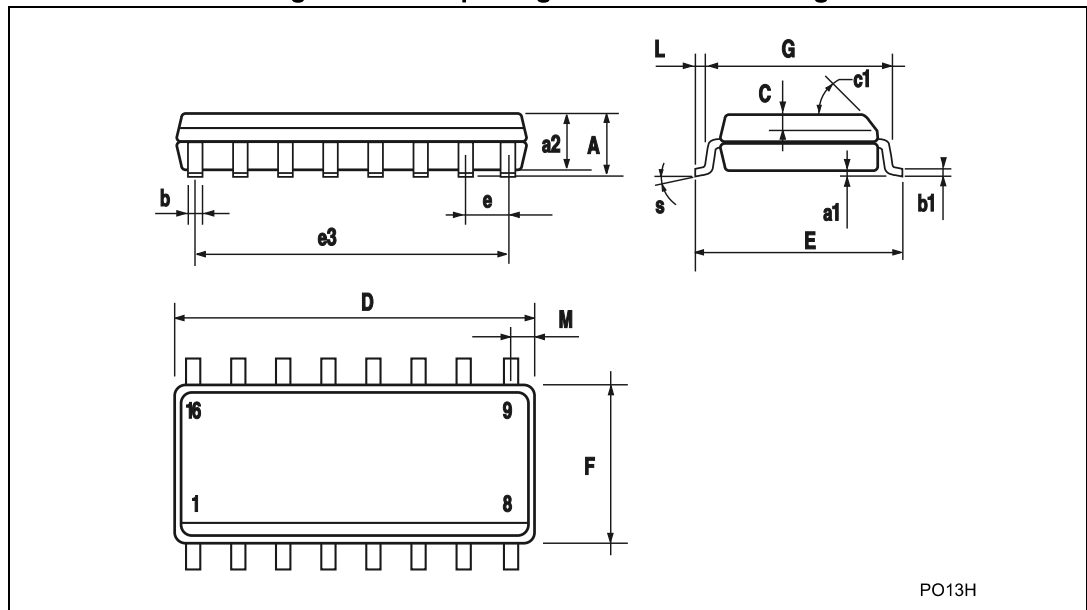


Table 8. SO16 package mechanical data

| Symbol | Dimensions |      |      |       |       |       |
|--------|------------|------|------|-------|-------|-------|
|        | mm         |      |      | inch  |       |       |
|        | Min.       | Typ. | Max. | Min.  | Typ.  | Max.  |
| A      |            |      | 1.75 |       |       | 0.068 |
| a1     | 0.1        |      | 0.2  | 0.004 |       | 0.008 |
| 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.)  |      |      |       |       |       |