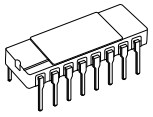
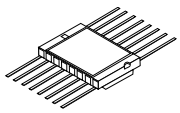
# M54HC4060

## RAD-HARD 14 STAGE BINARY COUNTER/OSCILLATOR

- HIGH SPEED:
  $f_{MAX}$ = 65MHz (TYP.) at $V_{CC}$ = 6V
- LOW POWER DISSIPATION:
  $I_{CC}$ =4µA(MAX.) at $T_A$=25°C
- HIGH NOISE IMMUNITY:
  $V_{NIH} = V_{NIL}$ = 28% $V_{CC}$ (MIN.)
- SYMMETRICAL OUTPUT IMPEDANCE:
  $|I_{OH}| = I_{OL}$ = 4mA (MIN)
- BALANCED PROPAGATION DELAYS:
  $t_{PLH} \cong t_{PHL}$
- WIDE OPERATING VOLTAGE RANGE:
  $V_{CC}$ (OPR) = 2V to 6V
- PIN AND FUNCTION COMPATIBLE WITH 54 SERIES 4060
- SPACE GRADE-1: ESA SCC QUALIFIED
- 50 krad QUALIFIED, 100 krad AVAILABLE ON REQUEST
- NO SEL UNDER HIGH LET HEAVY IONS IRRADIATION
- DEVICE FULLY COMPLIANT WITH SCC-9204-076



**DILC-16**



**FPC-16**

### ORDER CODES

| PACKAGE | FM | EM |
|---|---|---|
| DILC | M54HC4060D | M54HC4060D1 |
| FPC | M54HC4060K | M54HC4060K1 |

### DESCRIPTION

The M54HC4060 is an high speed CMOS 14-STAGE BINARY COUNTER/OSCILLATOR fabricated with silicon gate $C^2$MOS technology.

The oscillator configuration allows design of either RC or crystal oscillator circuits. A high level on the CLEAR accomplishes the reset function, i.e. all counter outputs are made low and the oscillator is disabled.
A negative transition on the clock input increments the counter. Ten kinds of divided output are provided; 4 to 10 and 12 to 14 stage inclusive. The maximum division available at Q12 is 1/16384 f oscillator.
The $\overline{Ø_1}$ input and the CLEAR input are equipped with protection circuits against static discharge and transient excess voltage.

### PIN CONNECTION

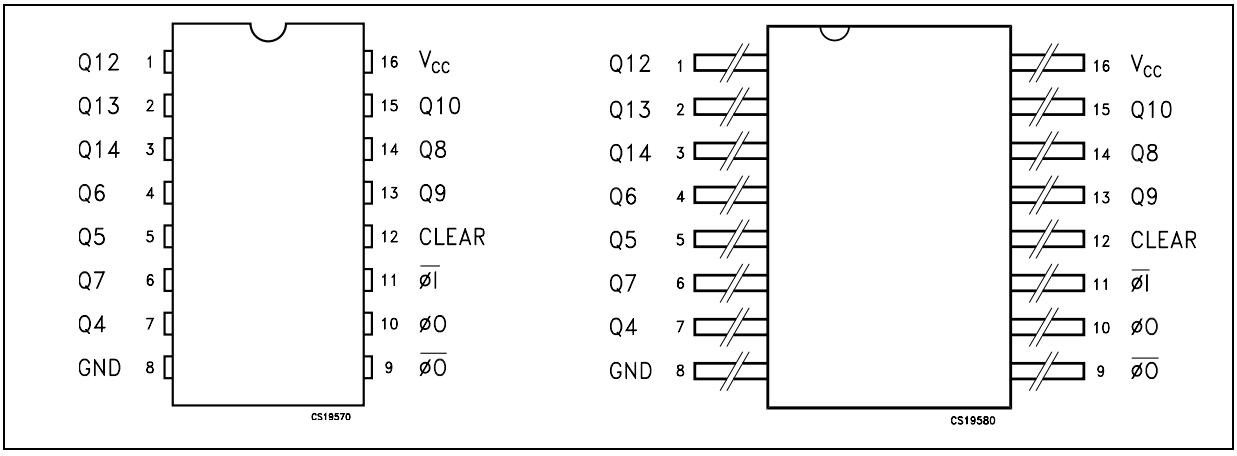


**Figure 1: IEC Logic Symbols**

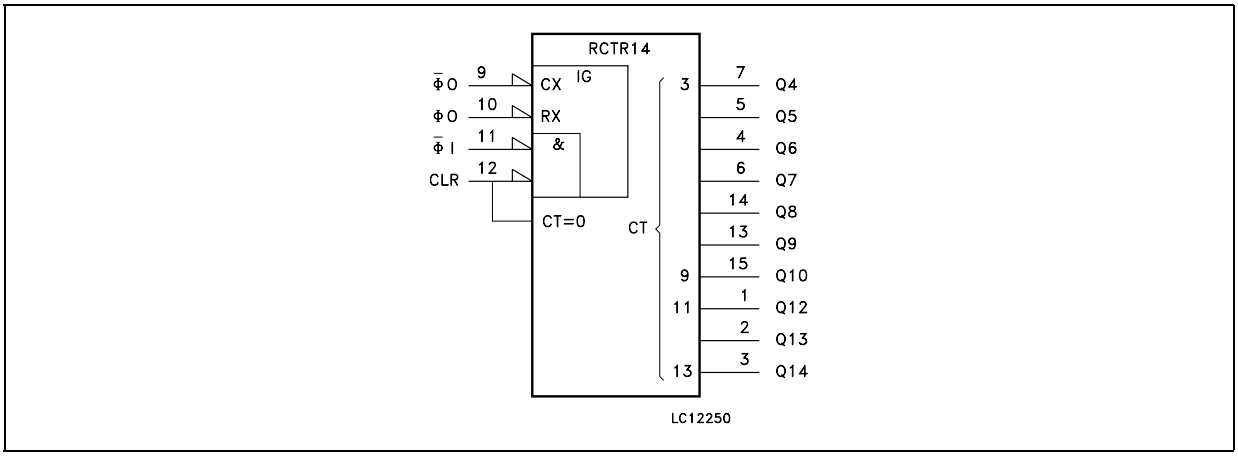



**Figure 2: Input And Output Equivalent Circuit**

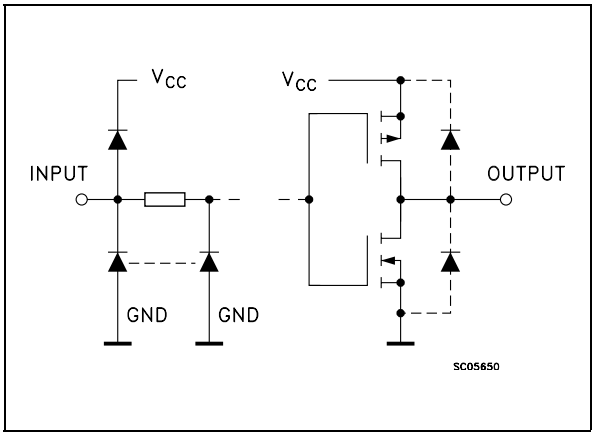



**Table 1: Pin Description**

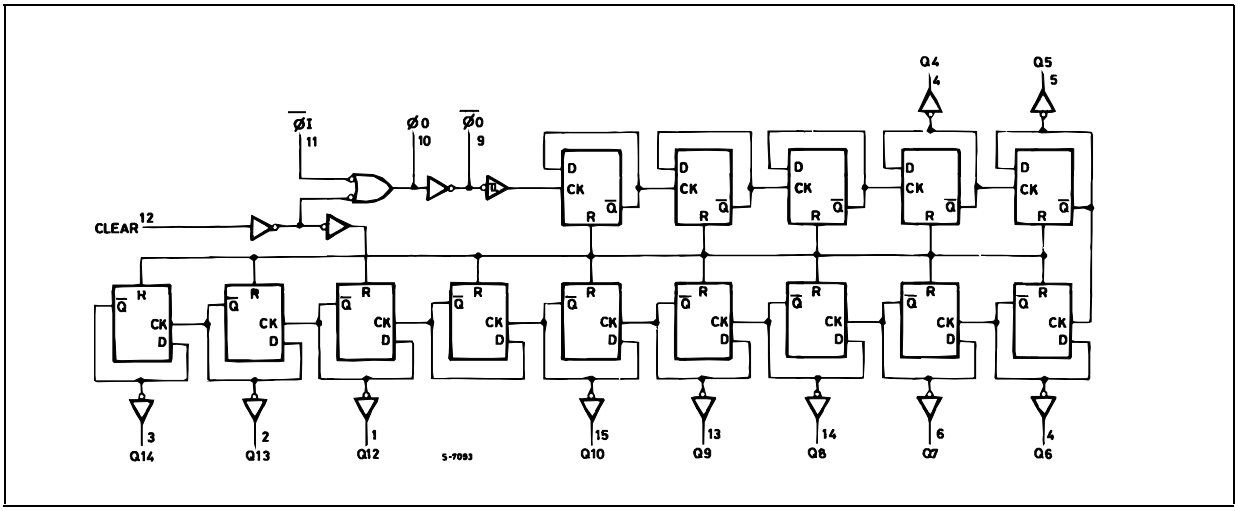
| PIN N° | SYMBOL | NAME AND FUNCTION |
|---|---|---|
| 1, 2, 3 | Q12 to Q14 | Counter Outputs |
| 7, 5, 4, 6, 14, 13, 15 | Q4 to Q10 | Counter Outputs |
| 9 | $\overline{ØO}$ | External Capacitor Connection |
| 10 | ØO | External Resistor Connection |
| 11 | $\overline{ØI}$ | Clock Input / Oscillator Pin |
| 12 | CLEAR | Master Reset |
| 8 | GND | Ground (0V) |
| 16 | $V_{CC}$ | Positive Supply Voltage |

**Table 2: Truth Table**

| $\overline{ØI}$ | CLEAR | FUNCTION |
|---|---|---|
| X | H | COUNTER IS RESET TO ZERO STATE<br>$\overline{ØO}$ OUTPUT GOES TO HIGH LEVEL<br>ØO OUTPUT GOES TO LOW LEVEL |
| ⌐ | L | COUNT UP ONE STEP |
| ⌐ | L | NO CHANGE |

X : Don't Care

### Figure 3: Logic Diagram




This logic diagram has not be used to estimate propagation delays

### Table 3: Absolute Maximum Ratings

| Symbol | Parameter | Value | Unit |
|---|---|---|---|
| $V_{CC}$ | Supply Voltage | -0.5 to +7 | V |
| $V_I$ | DC Input Voltage | -0.5 to $V_{CC}$ + 0.5 | V |
| $V_O$ | DC Output Voltage | -0.5 to $V_{CC}$ + 0.5 | V |
| $I_{IK}$ | DC Input Diode Current | ± 20 | mA |
| $I_{OK}$ | DC Output Diode Current | ± 20 | mA |
| $I_O$ | DC Output Current | ± 25 | mA |
| $I_{CC}$ or $I_{GND}$ | DC $V_{CC}$ or Ground Current | ± 50 | mA |
| $P_D$ | Power Dissipation | 300 | mW |
| $T_{stg}$ | Storage Temperature | -65 to +150 | °C |
| $T_L$ | Lead Temperature (10 sec) | 265 | °C |

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

### Table 4: Recommended Operating Conditions

| Symbol | Parameter | | Value | Unit |
|---|---|---|---|---|
| $V_{CC}$ | Supply Voltage | | 2 to 6 | V |
| $V_I$ | Input Voltage | | 0 to $V_{CC}$ | V |
| $V_O$ | Output Voltage | | 0 to $V_{CC}$ | V |
| $T_{op}$ | Operating Temperature | | -55 to 125 | °C |
| $t_r$, $t_f$ | Input Rise and Fall Time | $V_{CC}$ = 2.0V | 0 to 1000 | ns |
| | | $V_{CC}$ = 4.5V | 0 to 500 | ns |
| | | $V_{CC}$ = 6.0V | 0 to 400 | ns |

### Table 5: DC Specifications

| Symbol | Parameter | Test Condition | | Value | | | | | | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $V_{CC}$ (V) | | $T_A$ = 25°C | | | -40 to 85°C | | -55 to 125°C | | |
| | | | | Min. | Typ. | Max. | Min. | Max. | Min. | Max. | |
| $V_{IH}$ | High Level Input Voltage | 2.0 | | 1.5 | | | 1.5 | | 1.5 | | V |
| | | 4.5 | | 3.15 | | | 3.15 | | 3.15 | | |
| | | 6.0 | | 4.2 | | | 4.2 | | 4.2 | | |
| $V_{IL}$ | Low Level Input Voltage | 2.0 | | | | 0.5 | | 0.5 | | 0.5 | V |
| | | 4.5 | | | | 1.35 | | 1.35 | | 1.35 | |
| | | 6.0 | | | | 1.8 | | 1.8 | | 1.8 | |
| $V_{OH}$ | High Level Output Voltage (Q Output) | 2.0 | $I_O$=-20 µA | 1.9 | 2.0 | | 1.9 | | 1.9 | | V |
| | | 4.5 | $I_O$=-20 µA | 4.4 | 4.5 | | 4.4 | | 4.4 | | |
| | | 6.0 | $I_O$=-20 µA | 5.9 | 6.0 | | 5.9 | | 5.9 | | |
| | | 4.5 | $I_O$=-4.0 mA | 4.18 | 4.31 | | 4.13 | | 4.10 | | |
| | | 6.0 | $I_O$=-5.2 mA | 5.68 | 5.8 | | 5.63 | | 5.60 | | |
| $V_{OL}$ | Low Level Output Voltage (Q Output) | 2.0 | $I_O$=20 µA | | 0.0 | 0.1 | | 0.1 | | 0.1 | V |
| | | 4.5 | $I_O$=20 µA | | 0.0 | 0.1 | | 0.1 | | 0.1 | |
| | | 6.0 | $I_O$=20 µA | | 0.0 | 0.1 | | 0.1 | | 0.1 | |
| | | 4.5 | $I_O$=4.0 mA | | 0.17 | 0.26 | | 0.33 | | 0.40 | |
| | | 6.0 | $I_O$=5.2 mA | | 0.18 | 0.26 | | 0.33 | | 0.40 | |
| $V_{OH}$ | High Level Output Voltage (ØO, $\overline{ØO}$ Output) | 2.0 | $I_O$=-20 µA | 1.8 | 2.0 | | 1.8 | | 1.8 | | V |
| | | 4.5 | $I_O$=-20 µA | 4.4 | 4.5 | | 4.0 | | 4.0 | | |
| | | 6.0 | $I_O$=-20 µA | 5.5 | 5.9 | | 5.5 | | 5.5 | | |
| $V_{OL}$ | Low Level Output Voltage (ØO, $\overline{ØO}$ Output) | 2.0 | $I_O$=-20 µA | | 0.0 | 0.2 | | 0.2 | | 0.2 | V |
| | | 4.5 | $I_O$=-20 µA | | 0.0 | 0.5 | | 0.5 | | 0.5 | |
| | | 6.0 | $I_O$=-20 µA | | 0.1 | 0.5 | | 0.5 | | 0.5 | |
| $I_I$ | Input Leakage Current | 6.0 | $V_I$ = $V_{CC}$ or GND | | | ± 0.1 | | ± 1 | | ± 1 | µA |
| $I_{CC}$ | Quiescent Supply Current | 6.0 | $V_I$ = $V_{CC}$ or GND | | | 4 | | 40 | | 80 | µA |

**Table 6: AC Electrical Characteristics** ($C_L$ = 50 pF, Input $t_r = t_f$ = 6ns)

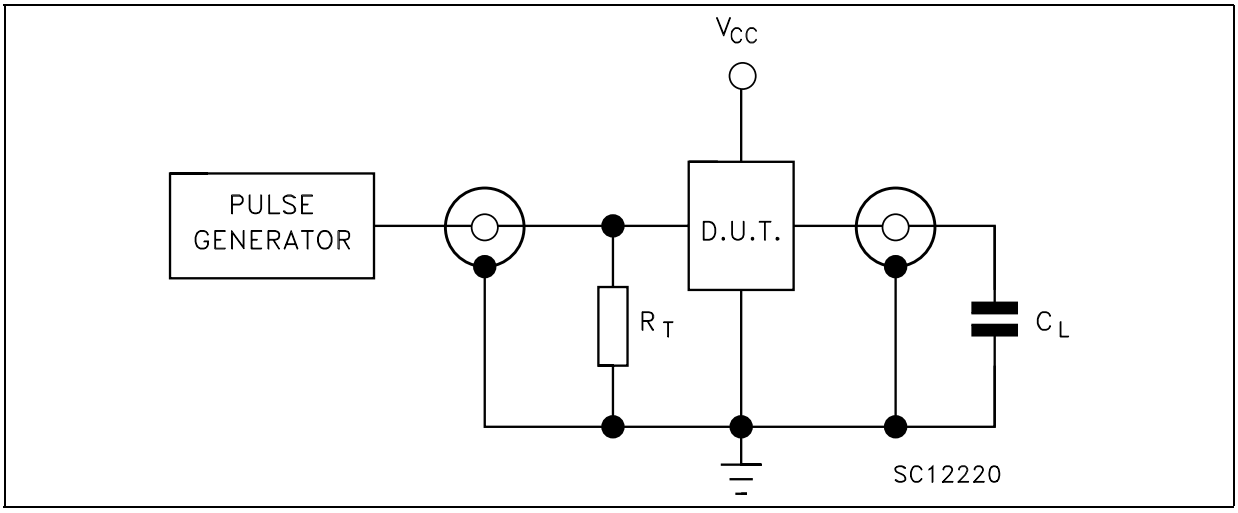
| Symbol | Parameter | Test Condition | | Value | | | | | | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $V_{CC}$ (V) | | $T_A$ = 25°C | | | -40 to 85°C | | -55 to 125°C | | |
| | | | | Min. | Typ. | Max. | Min. | Max. | Min. | Max. | |
| $t_{TLH}$ $t_{THL}$ | Output Transition Time | 2.0 | | | 30 | 75 | | 95 | | 110 | ns |
| | | 4.5 | | | 8 | 15 | | 19 | | 22 | |
| | | 6.0 | | | 7 | 13 | | 16 | | 19 | |
| $t_{PLH}$ $t_{PHL}$ | Propagation Delay Time ($\overline{ØI}$ - Q4) | 2.0 | | | 170 | 300 | | 375 | | 450 | ns |
| | | 4.5 | | | 41 | 60 | | 75 | | 90 | |
| | | 6.0 | | | 30 | 51 | | 64 | | 76 | |
| $t_{PD}$ | Propagation Delay Time Difference (Qn - Qn+1) | 2.0 | | | 32 | 75 | | 95 | | 110 | ns |
| | | 4.5 | | | 7 | 15 | | 19 | | 22 | |
| | | 6.0 | | | 5 | 13 | | 16 | | 19 | |
| $t_{PHL}$ | Propagation Delay Time (CLEAR - Qn) | 2.0 | | | 85 | 195 | | 245 | | 295 | ns |
| | | 4.5 | | | 23 | 39 | | 49 | | 59 | |
| | | 6.0 | | | 17 | 33 | | 42 | | 50 | |
| $f_{MAX}$ | Maximum Clock Frequency | 2.0 | | 6 | 12 | | 5 | | 4 | | MHz |
| | | 4.5 | | 30 | 50 | | 24 | | 20 | | |
| | | 6.0 | | 35 | 65 | | 28 | | 24 | | |
| $t_{W(H)}$ $t_{W(L)}$ | Minimum Pulse Width ($\overline{ØI}$) | 2.0 | | | 30 | 75 | | 95 | | 110 | ns |
| | | 4.5 | | | 8 | 15 | | 19 | | 22 | |
| | | 6.0 | | | 7 | 13 | | 16 | | 19 | |
| $t_{W(H)}$ | Minimum Pulse Width (CLEAR) | 2.0 | | | 30 | 75 | | 95 | | 110 | ns |
| | | 4.5 | | | 8 | 15 | | 19 | | 22 | |
| | | 6.0 | | | 7 | 13 | | 16 | | 19 | |
| $t_{REM}$ | Minimum Removal Time | 2.0 | | | 40 | 100 | | 125 | | 150 | ns |
| | | 4.5 | | | 10 | 20 | | 25 | | 30 | |
| | | 6.0 | | | 9 | 17 | | 21 | | 26 | |

**Table 7: Capacitive Characteristics**

| Symbol | Parameter | Test Condition | | Value | | | | | | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $V_{CC}$ (V) | | $T_A$ = 25°C | | | -40 to 85°C | | -55 to 125°C | | |
| | | | | Min. | Typ. | Max. | Min. | Max. | Min. | Max. | |
| $C_{IN}$ | Input Capacitance | 5.0 | | | 5 | 10 | | 10 | | 10 | pF |
| $C_{PD}$ | Power Dissipation Capacitance (note 1) | 5.0 | | | 27 | | | | | | pF |

1) $C_{PD}$ is defined as the value of the IC's internal equivalent capacitance which is calculated from the operating current consumption without load. (Refer to Test Circuit). Average operating current can be obtained by the following equation. $I_{CC(opr)} = C_{PD} \times V_{CC} \times f_{IN} + I_{CC}$

**Figure 4: Test Circuit**




$C_L$ = 50pF or equivalent (includes jig and probe capacitance)
$R_T = Z_{OUT}$ of pulse generator (typically 50Ω)

**Figure 5: Waveform - Propagation Delay Times, Minimum Pulse Width ($\overline{ØI}$)** (f=1MHz; 50% duty cycle)

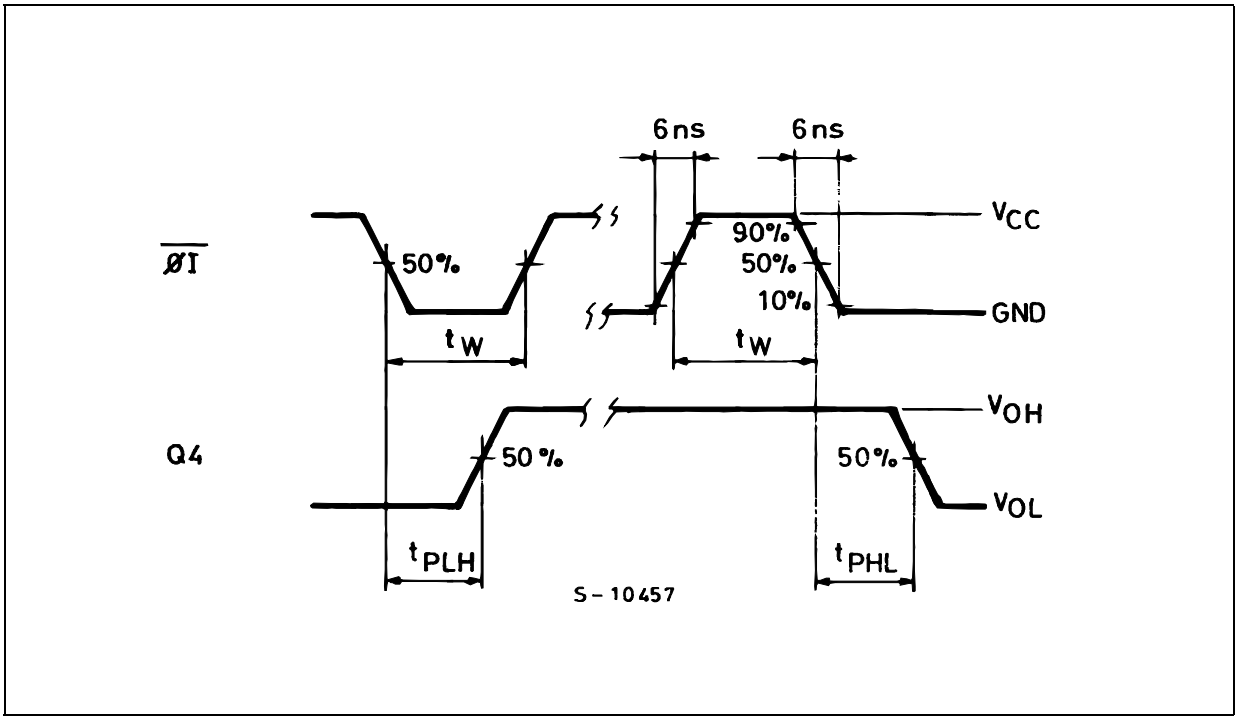


**Figure 6: Waveform - Propagation Delay Times, Minimum Pulse Width (CLEAR)** (f=1MHz; 50% duty cycle)

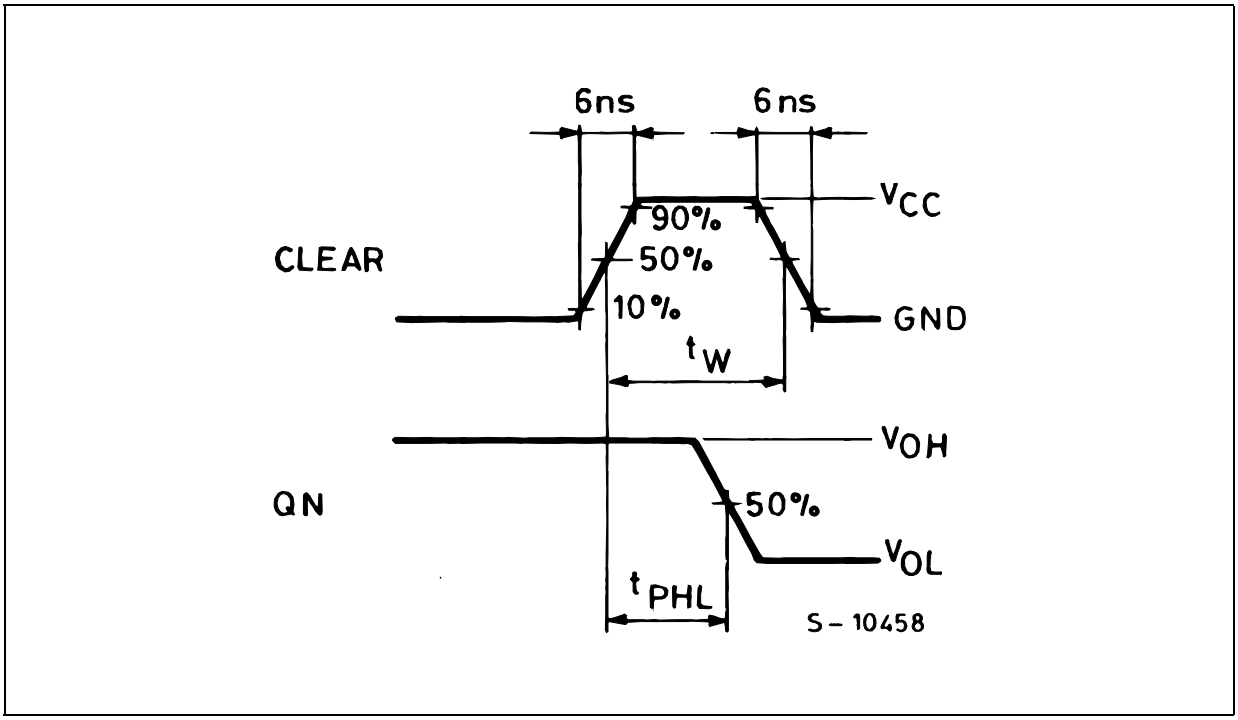



**Figure 7: Waveform - Propagation Delay Times** (f=1MHz; 50% duty cycle)

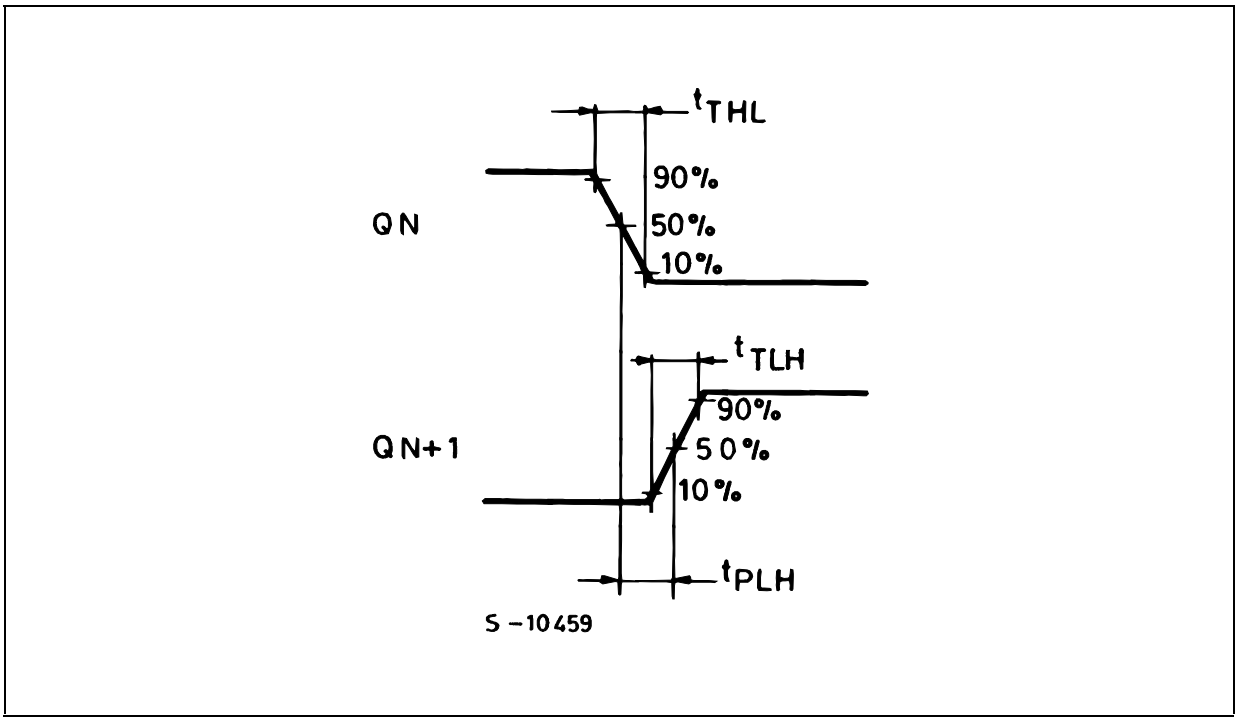


**Figure 8: Waveform - Propagation Delay Times** (f=1MHz; 50% duty cycle)

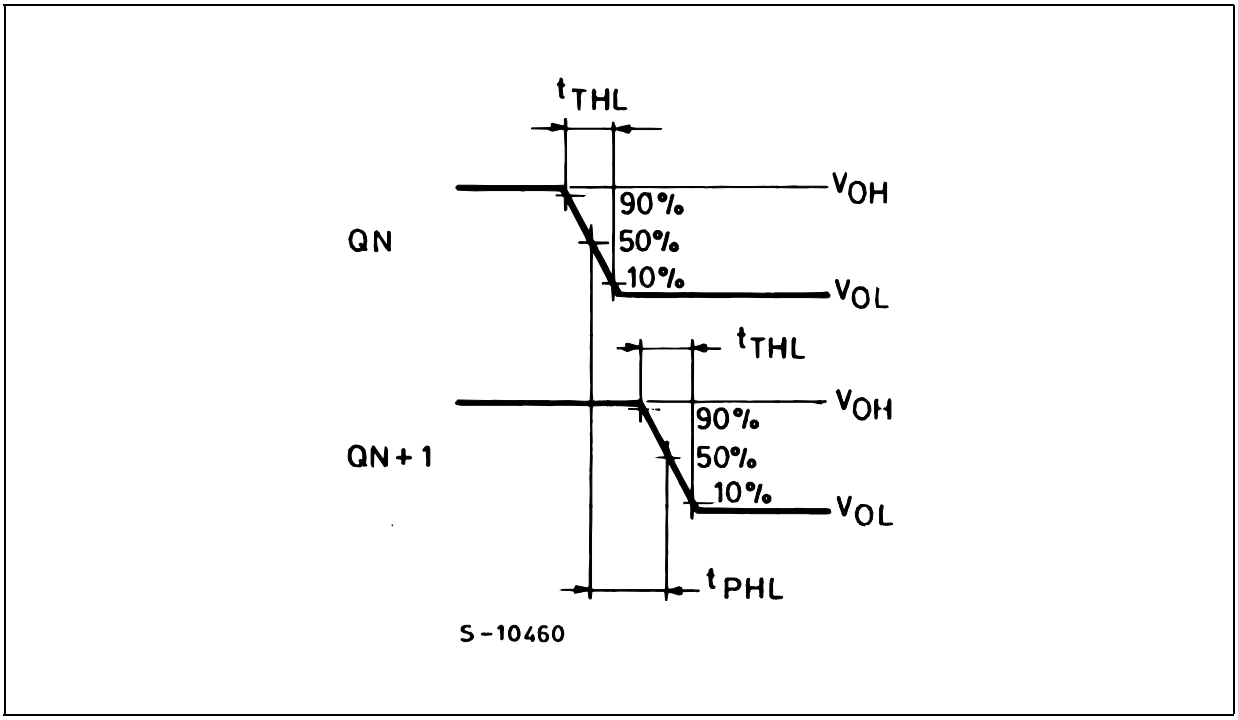
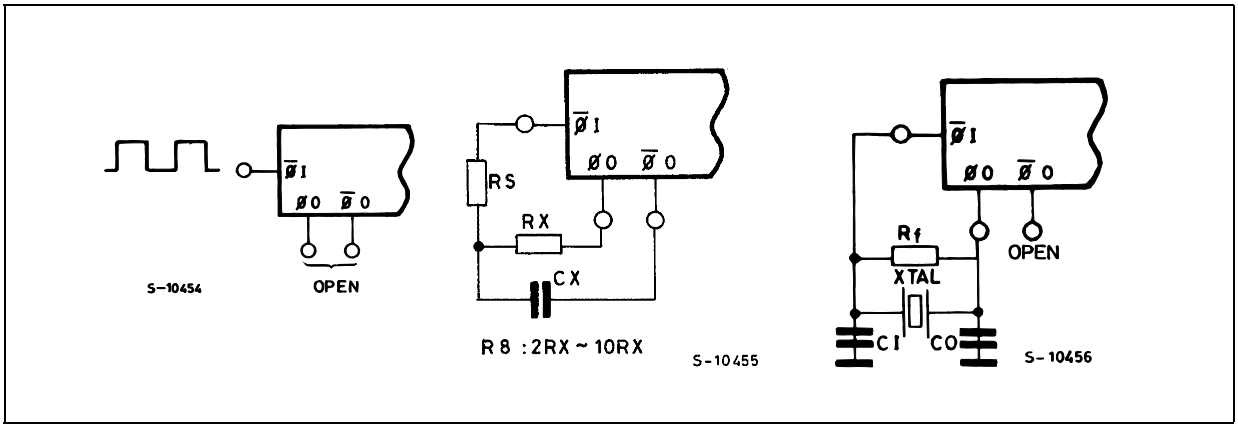
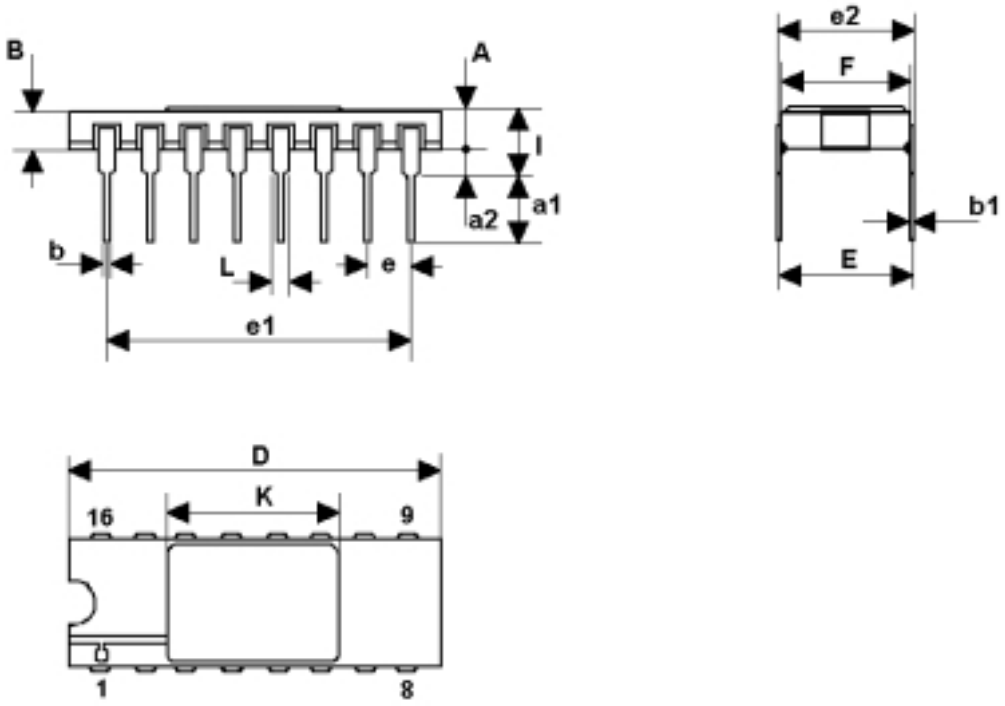



**Figure 9: Typical Clock Drive Circuits**



## DILC-16 MECHANICAL DATA

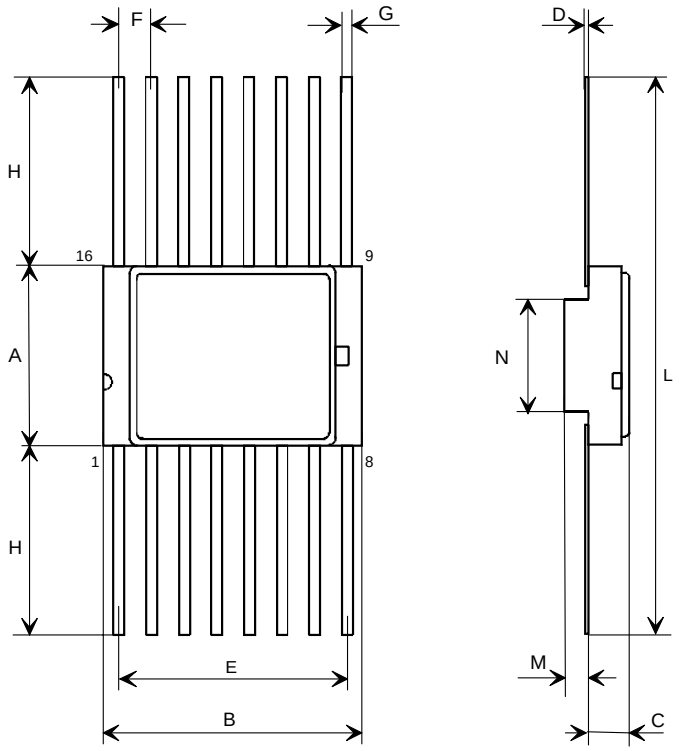
| DIM. | mm. | | | inch | | |
|---|---|---|---|---|---|---|
| | MIN. | TYP | MAX. | MIN. | TYP. | MAX. |
| A | 2.1 | | 2.71 | 0.083 | | 0.107 |
| a1 | 3.00 | | 3.70 | 0.118 | | 0.146 |
| a2 | 0.63 | 0.88 | 1.14 | 0.025 | 0.035 | 0.045 |
| B | 1.82 | | 2.39 | 0.072 | | 0.094 |
| b | 0.40 | 0.45 | 0.50 | 0.016 | 0.018 | 0.020 |
| b1 | 0.20 | 0.254 | 0.30 | 0.008 | 0.010 | 0.012 |
| D | 20.06 | 20.32 | 20.58 | 0.790 | 0.800 | 0.810 |
| E | 7.36 | 7.62 | 7.87 | 0.290 | 0.300 | 0.310 |
| e | | 2.54 | | | 0.100 | |
| e1 | 17.65 | 17.78 | 17.90 | 0.695 | 0.700 | 0.705 |
| e2 | 7.62 | 7.87 | 8.12 | 0.300 | 0.310 | 0.320 |
| F | 7.29 | 7.49 | 7.70 | 0.287 | 0.295 | 0.303 |
| I | | | 3.83 | | | 0.151 |
| K | 10.90 | | 12.1 | 0.429 | | 0.476 |
| L | 1.14 | | 1.5 | 0.045 | | 0.059 |




0056437F

## FPC-16 MECHANICAL DATA

| DIM. | mm. | | | inch | | |
|---|---|---|---|---|---|---|
| | MIN. | TYP | MAX. | MIN. | TYP. | MAX. |
| A | 6.75 | 6.91 | 7.06 | 0.266 | 0.272 | 0.278 |
| B | 9.76 | 9.94 | 10.14 | 0.384 | 0.392 | 0.399 |
| C | 1.49 | | 1.95 | 0.059 | | 0.077 |
| D | 0.102 | 0.127 | 0.152 | 0.004 | 0.005 | 0.006 |
| E | 8.76 | 8.89 | 9.01 | 0.345 | 0.350 | 0.355 |
| F | | 1.27 | | | 0.050 | |
| G | 0.38 | 0.43 | 0.48 | 0.015 | 0.017 | 0.019 |
| H | 6.0 | | | 0.237 | | |
| L | 18.75 | | 22.0 | 0.738 | | 0.867 |
| M | 0.33 | 0.38 | 0.43 | 0.013 | 0.015 | 0.017 |
| N | | 4.31 | | | 0.170 | |




0016030E

**Table 8: Revision History**

| Date | Revision | Description of Changes |
|---|---|---|
| 14-May-2004 | 1 | First Release |