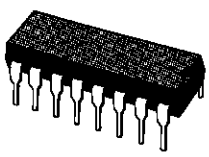
SGS-THOMSON MICROELECTRONICS

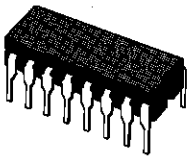
# M54/74HC40102
# M54/74HC40103

## 8 STAGE PRESETTABLE SYNCHRONOUS DOWN COUNTERS

- HIGH SPEED
  $f_{MAX}$ = 40 MHz (TYP.) at $V_{CC}$ = 5 V
- LOW POWER DISSIPATION
  $I_{CC}$ = 4 μA (MAX.) at $T_A$ = 25 °C
- HIGH NOISE IMMUNITY
  $V_{NIH} = V_{NIL}$ = 28 % $V_{CC}$ (MIN.)
- OUTPUT DRIVE CAPABILITY
  10 LSTTL LOADS
- SYMMETRICAL OUTPUT IMPEDANCE
  $|I_{OH}| = I_{OL}$ = 4 mA (MIN.)
- BALANCED PROPAGATION DELAYS
  $t_{PLH} = t_{PHL}$
- WIDE OPERATING VOLTAGE RANGE
  $V_{CC}$ (OPR) = 2 V to 6 V
- PIN AND FUNCTION COMPATIBLE WITH 40102B/40103B



**B1R**
(Plastic Package)



**F1R**
(Ceramic Package)

**M1R**
(Micro Package)

**C1R**
(Chip Carrier)

**ORDER CODES :**

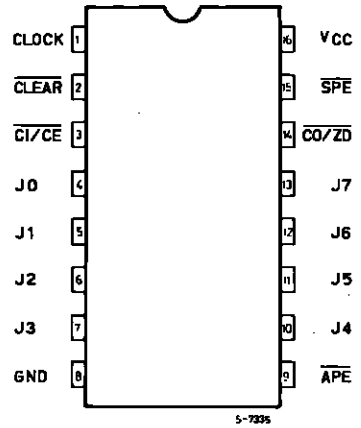
M54HCXXXXXF1R M74HCXXXXXM1R
M74HCXXXXXB1R M74HCXXXXX C1R

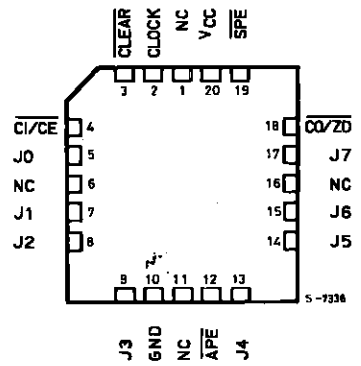
### DESCRIPTION

The M54/74HC40102/40103 are high speed CMOS 8-STAGE PRESETTABLE SYNCHRONOUS DOWN COUNTERS fabricated with silicon gate $C^2MOS$ technology. They achieve the high speed operation similar to equivalent LSTTL while maintaining the CMOS low power dissipation.

The HC40102, and HC40103 consist of an 8-stage synchronous down counter with a single output which is active when the internal count is zero. The HC40102 is configured as two cascaded 4-bit BCD counters, and the HC40103 contains a single 8-bit binary counter. Each type has control inputs for enabling or disabling the clock, for clearing the counter to its maximum count, and for presetting the counter either synchronously or asynchronously. All control inputs and the CARRY-OUT/ZERO-DETECT output are active-low logic. In normal operation, the counter is decremented by one count on each positive transition of the CLOCK. Counting is inhibited when the CARRY-IN/COUNTER ENABLE ($\overline{CI/CE}$) input is high. The CARRY-OUT/ZERO-DETECT ($\overline{CO/ZD}$) output goes low when the count reaches zero if the $\overline{CI/CE}$ input is low, and remains low for one full clock period. When the SYNCHRONOUS PRESET-ENABLE (SPE) input is low, data at the J input is clocked into the counter on the next positive clock transition regardless of the state of the $\overline{CI/CE}$ input.

**PIN CONNECTIONS** (top view)




NC =
No Internal
Connection

**DESCRIPTION** (Continued)

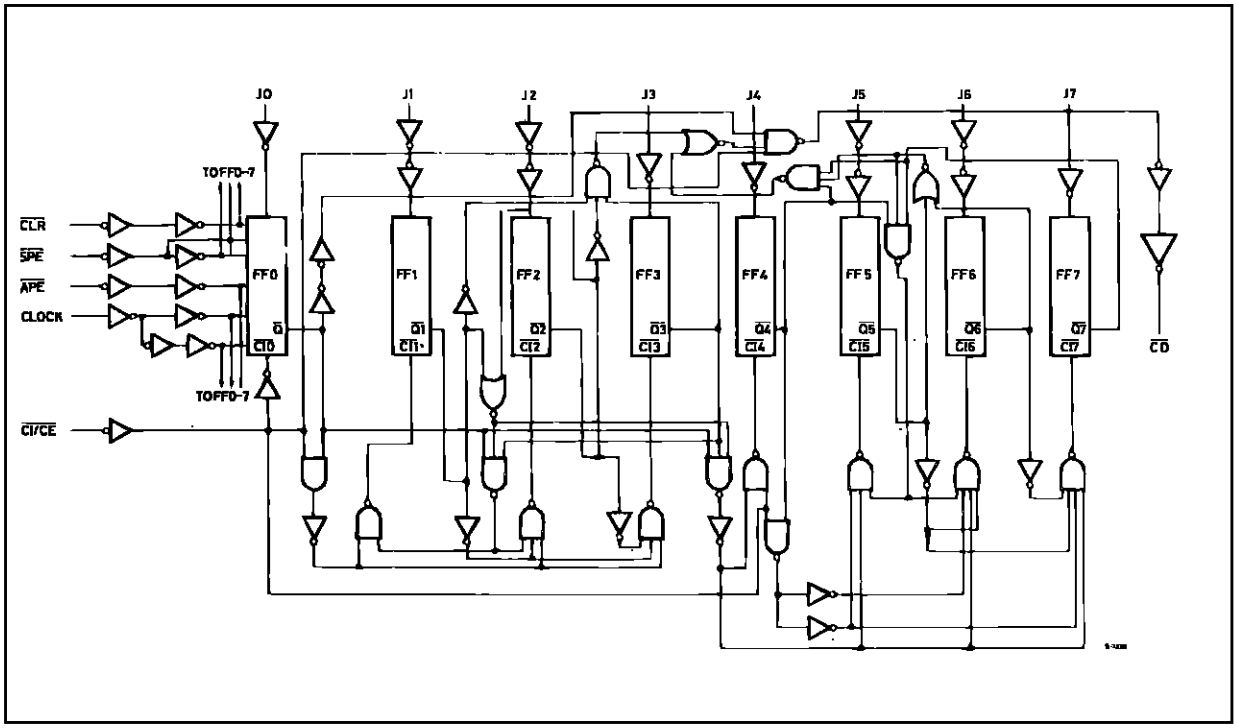
When the ASYNCHRONOUS PRESET-ENABLE ($\overline{APE}$) input is low, data at the J inputs is asynchronously forced into the counter regardless of the state of the $\overline{SPE}$, $\overline{CI/CE}$, or CLOCK inputs. J Inputs J0-J7 represent two 4-bit BCD words for the HC40102 and a single 8-bit binary word for the HC40103. When the CLEAR ($\overline{CLR}$ input is low, the counter is asynchronously cleared to its maximum count ($99_{10}$ for the HC40102 and $255_{10}$ for the HC40103 regardless of the state of any other input. The precedence relationship between control input is indicated in the truth table. If all control inputs are high at the time of zero count, the counters will jump to the maximum count, giving a counting sequence of 100 pr 256 clock pulses long. The HC40102 and HC40103 may be cascaded using the $\overline{CI/CE}$ input and the $\overline{CO/ZD}$ output, in either a synchronous or ripple mode. All inputs are equipped with protection circuits against static discharge and transient excess voltage.

**TRUTH TABLE**

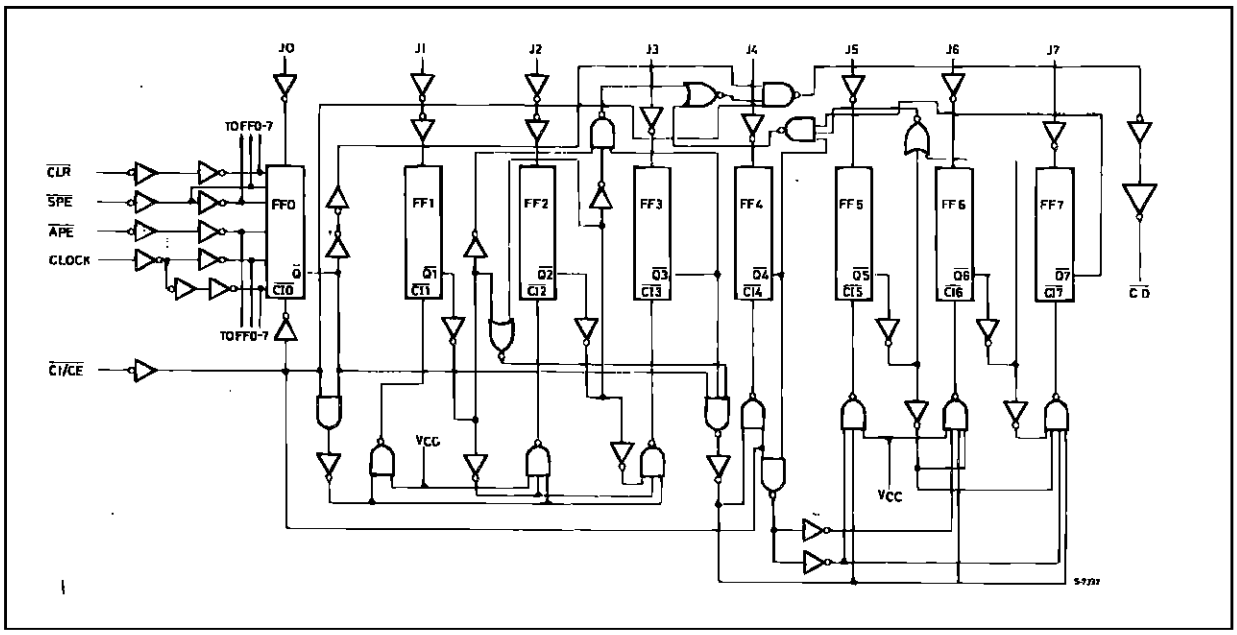
| CONTROL INPUTS | | | | MODE | FUNCTIONAL DESCRIPTION |
|---|---|---|---|---|---|
| $\overline{CLEAR}$ | $\overline{APE}$ | $\overline{SPE}$ | $\overline{CI/CE}$ | | |
| H | H | H | H | COUNT INHIBIT | EVEN IF CLOCK IS GIVEN, NO COUNT IS MADE |
| H | H | H | L | REGULAR COUNT | DOWN COUNT AT RISING EDGE OF CLOCK |
| H | H | L | X | SYNCHRONOUS PRESET | DATA OF PI TERMINAL IS PRESET AT RISING EDGE OF CLOCK |
| H | L | X | X | ASYNCRONOUS PRESET | DATA PF PI TERMINAL IS ASYNCHRONOUSLY PRESET TO CLOCK |
| L | X | X | X | CLEAR | COUNTER IS SET TO MAXIMUM COUNT |

X: DON'T CARE - MAXIMUM COUNT: "99" FOR HC40102 AND "255": FOR HC40103

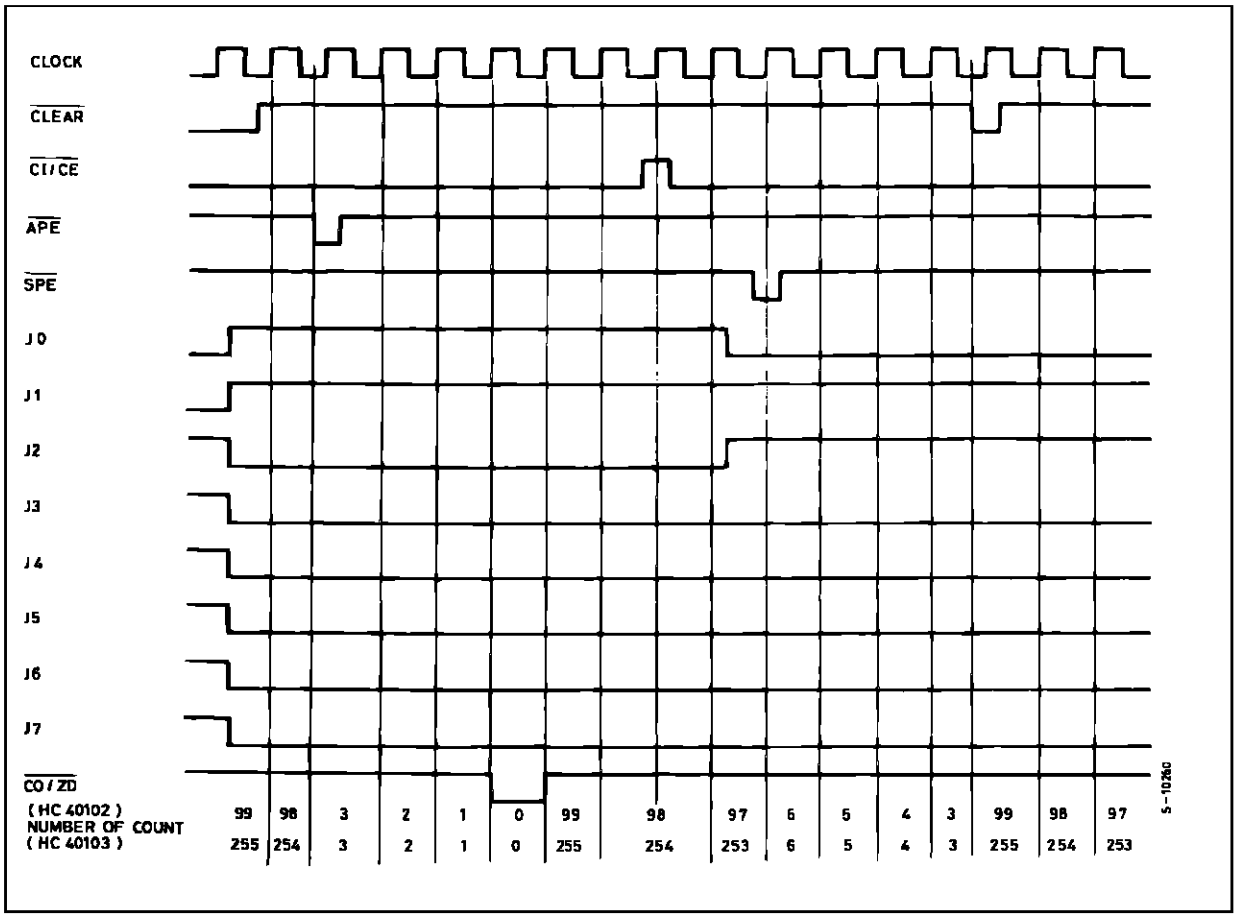
**LOGIC DIAGRAM** (HC40102)



## LOGIC DIAGRAM (HC40103)



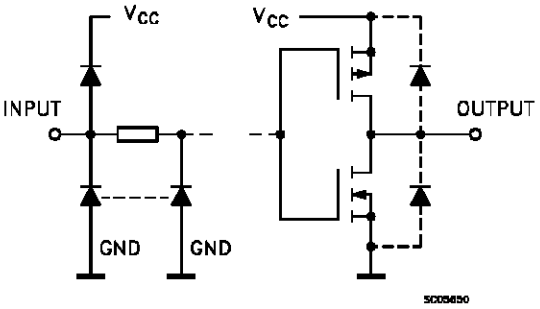

## TIMING CHART



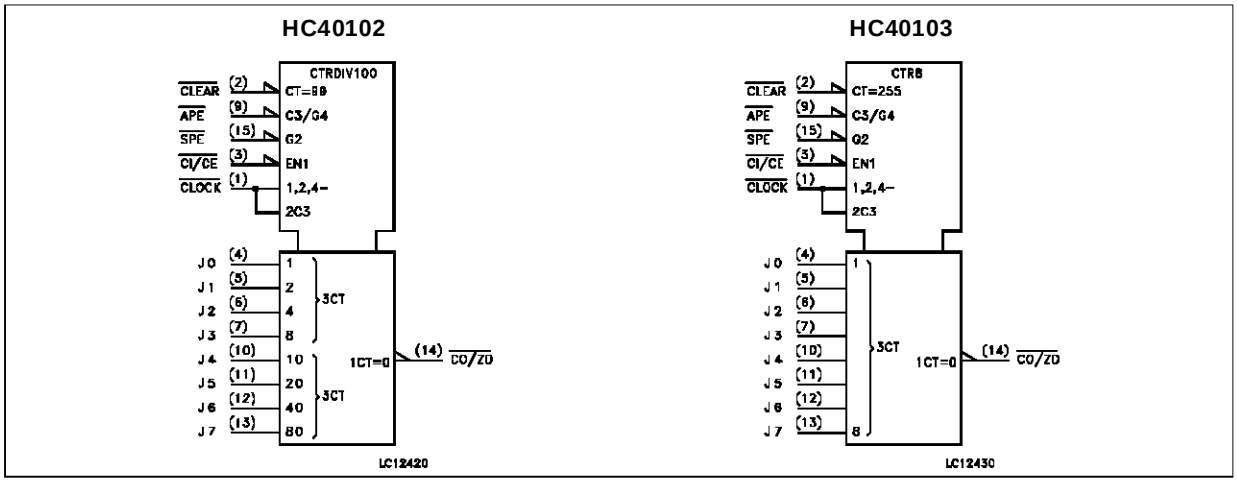
## PIN DESCRIPTION

| PIN No | SYMBOL | NAME AND FUNCTION |
|---|---|---|
| 1 | CLOCK | CLock Input (LOW to HIGH edge triggered) |
| 2 | $\overline{\text{CLEAR}}$ | Asynchronous Master Reset Input (Active LOW) |
| 3 | $\overline{\text{CI/CE}}$ | Terminal Enable Input |
| 4, 5, 6, 7, 10, 11, 12, 13 | J0 to J9 | Jam Inputs |
| 9 | $\overline{\text{APE}}$ | Asynchronous Preset Enable Input (Active LOW) |
| 14 | $\overline{\text{CO/ZD}}$ | Terminal Count Output (Active LOW) |
| 15 | $\overline{\text{SPE}}$ | Synchronous Preset Enable Input (Active LOW) |
| 8 | GND | Ground (0V) |
| 16 | $V_{CC}$ | Positive Supply Voltage |

## INPUT AND OUTPUT EQUIVALENT CIRCUIT




## IEC LOGIC SYMBOLS




## 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 Source Sink Current Per Output Pin | ± 25 | mA |
| $I_{CC}$ or $I_{GND}$ | DC $V_{CC}$ or Ground Current | ± 50 | mA |
| $P_D$ | Power Dissipation | 500 (*) | mW |
| $T_{stg}$ | Storage Temperature | -65 to +150 | °C |
| $T_L$ | Lead Temperature (10 sec) | 300 | °C |

Absolute Maximum Ratings are those values beyond which damage to the device may occur. Functional operation under these condition is not implied.
(*) 500 mW: ≅ 65 °C derate to 300 mW by 10mW/°C: 65 °C to 85 °C

## 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: **M54HC** Series<br>**M74HC** Series | | -55 to +125<br>-40 to +85 | $^oC$<br>$^oC$ |
| $t_r$, $t_f$ | Input Rise and Fall Time | $V_{CC}$ = 2 V | 0 to 1000 | ns |
| | | $V_{CC}$ = 4.5 V | 0 to 500 | |
| | | $V_{CC}$ = 6 V | 0 to 400 | |

## DC SPECIFICATIONS

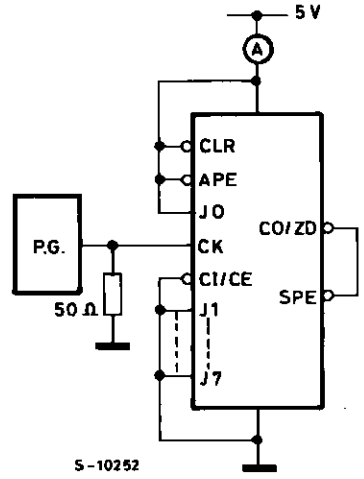
| Symbol | Parameter | Test Conditions | | | Value | | | | | | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $V_{CC}$ (V) | | | $T_A$ = 25 $^oC$ 54HC and 74HC | | | -40 to 85 $^oC$ 74HC | | -55 to 125 $^oC$ 54HC | | |
| | | | | | Min. | Typ. | Max. | Min. | Max. | Min. | Max. | |
| $V_{IH}$ | 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 | 2.0 | $V_I$ = $V_{IH}$ or $V_{IL}$ | $I_O$=-20 µA | 1.9 | 2.0 | | 1.9 | | 1.9 | | V |
| | | 4.5 | | | 4.4 | 4.5 | | 4.4 | | 4.4 | | |
| | | 6.0 | | | 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 | 2.0 | $V_I$ = $V_{IH}$ or $V_{IL}$ | $I_O$= 20 µA | | 0.0 | 0.1 | | 0.1 | | 0.1 | V |
| | | 4.5 | | | | 0.0 | 0.1 | | 0.1 | | 0.1 | |
| | | 6.0 | | | | 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 | |
| $I_I$ | 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 |

## AC ELECTRICAL CHARACTERISTICS ($C_L$ = 50 pF, Input $t_r = t_f$ = 6 ns)

| Symbol | Parameter | Test Conditions | | Value | | | | | | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $V_{CC}$ (V) | | $T_A$ = 25 °C 54HC and 74HC | | | -40 to 85 °C 74HC | | -55 to 125 °C 54HC | | |
| | | | | 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 (CK - CO/ZD) | 2.0 | | | 96 | 185 | | 230 | | 280 | ns |
| | | 4.5 | | | 24 | 37 | | 46 | | 56 | |
| | | 6.0 | | | 20 | 31 | | 39 | | 47 | |
| $t_{PLH}$ $t_{PHL}$ | Propagation Delay Time (APE - CO/ZD) | 2.0 | | | 116 | 225 | | 280 | | 340 | ns |
| | | 4.5 | | | 29 | 45 | | 56 | | 68 | |
| | | 6.0 | | | 25 | 38 | | 48 | | 57 | |
| $t_{PLH}$ $t_{PHL}$ | Propagation Delay Time (CL - CO/ZD) | 2.0 | | | 104 | 200 | | 250 | | 300 | ns |
| | | 4.5 | | | 26 | 40 | | 50 | | 60 | |
| | | 6.0 | | | 22 | 34 | | 43 | | 51 | |
| $t_{PLH}$ $t_{PHL}$ | Propagation Delay Time (CI/CE - CO/ZD) | 2.0 | | | 48 | 95 | | 120 | | 145 | ns |
| | | 4.5 | | | 12 | 19 | | 24 | | 29 | |
| | | 6.0 | | | 10 | 16 | | 20 | | 24 | |
| $f_{MAX}$ | Propagation Delay Time | 2.0 | | 4 | 8 | | 3 | | 2.6 | | pF |
| | | 4.5 | | 20 | 32 | | 16 | | 13 | | |
| | | 6.0 | | 24 | 38 | | 19 | | 15 | | |
| $C_{IN}$ | Input Capacitance | | | | 5 | 10 | | 10 | | 10 | pF |
| $C_{PD}$ (*) | Power Dissipation Capacitance | | | | 60 | | | | | | pF |

(*) $C_{PD}$ 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 operting current can be obtained by the following equation. $I_{CC}(opr) = C_{PD} \bullet V_{CC} \bullet f_{IN} + I_{CC}$

## TEST CIRCUIT $I_{CC}$ (Opr.)




INPUT TRANSITION TIME IS THE SAME AS THAT IN CASE OF SWITCHING CHARACTERISTICS TEST.

## FUNCTIONAL DESCRIPTION

The HC40102 and HC40103 are 8-stage presettable synchronous down counters. Carry Out/Zero Detect ($\overline{CO/ZD}$) is output at the "L" level for the period of 1 bit when the readout becomes "0". The HC40102 adopts binary coded decimal notation, making setting up to 99 counts possible. While the HC40103 adopts 8-bit binary counter and can set up to 255 counts.

### COUNT OPERATION

At the "H" level of control input of $\overline{CLEAR}$, $\overline{SPE}$ and $\overline{APE}$, the counter carriers out down count operation one by one at the rise of pulse given to CLOCK input. Count operation can be inhibited by setting Carry Input/Clock Enable $\overline{CI/CE}$ to the "H" level.

$\overline{CO/ZD}$ is output at the "L" level when the readout becomes "0" but is not output even if the readout becomes "0" when $\overline{CI/CE}$ is at the "H" level, thus maintaining the "H" level.

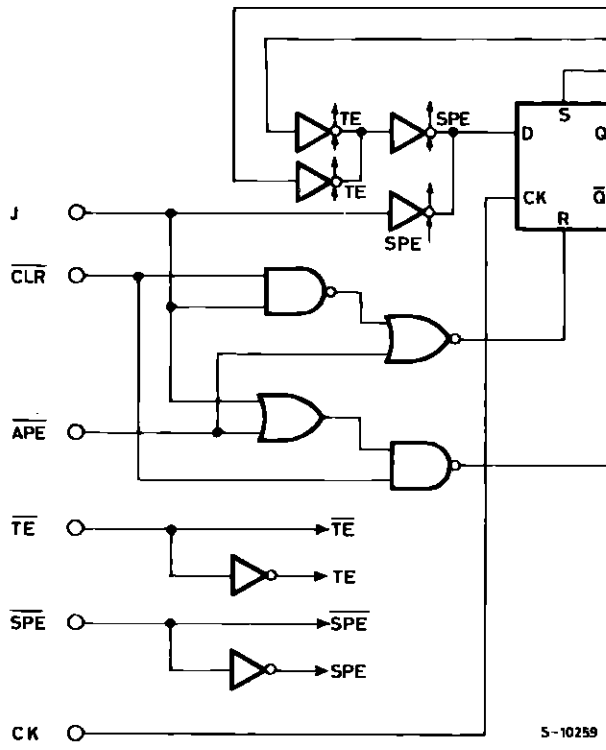
Synchronous cascade operation can be carried out by using $\overline{CI/CE}$ input and $\overline{CO/ZD}$ output.

The contents of count jump to maximum count (99 for the HC40102 and 225 for the HC40103) if clock is given when the readout is "0". Therefore, operation of 100-frequency division and that of 256-frequency division are carried out for the HC40102 and HC40103, respectively, when clock input alone is given without various kinds of preset operation.

### PRESET OPERATION AND RESET OPERATION

When Clear ($\overline{CLEAR}$) input is set to the "L" level, the readout is set to the maximum count independetly of other inputs. When Asynchronous Preset Enable ($\overline{APE}$) input is set to the "L" level, readouts given on J0 to J7 can be preset asynchronously to counter independently of inputs other than $\overline{CLEAR}$ input. When Synchronous Preset Enable ($\overline{SPE}$) is set to the "L" level, the readouts given on J0 to J7 can be preset to counter synchronously with the rise of clock.

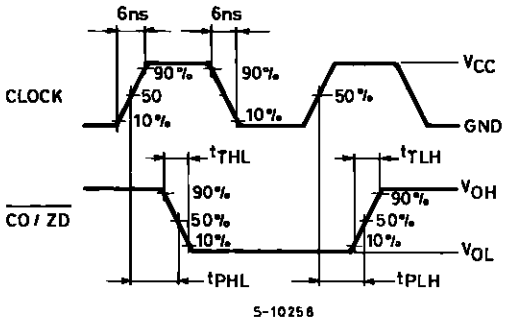
As to these operation modes, refer to the truth table.



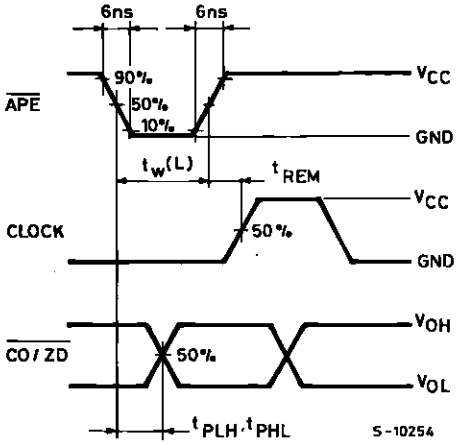

| Input | | | | | | Output |
|---|---|---|---|---|---|---|
| $\overline{CLEAR}$ | $\overline{APE}$ | $\overline{SPE}$ | J | $\overline{TE}$ | CLOCK | $\overline{Q}_n + 1$ |
| L | X | X | X | X | X | L |
| H | L | X | L | X | X | L |
| H | L | X | H | X | X | H |
| H | H | L | L | X | ↓ | L |
| H | H | L | H | X | ↓ | H |
| H | H | L | X | X | ↑ | $\overline{Q}_n$ |
| H | H | H | X | L | ↓ | Qn |
| H | H | H | X | H | X | $\overline{Q}_n$ |

## SWITCHING CHARACTERISTICS TEST WAVEFORM

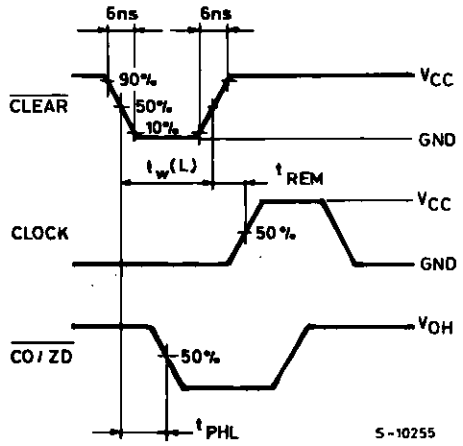
WAVEFORM 1



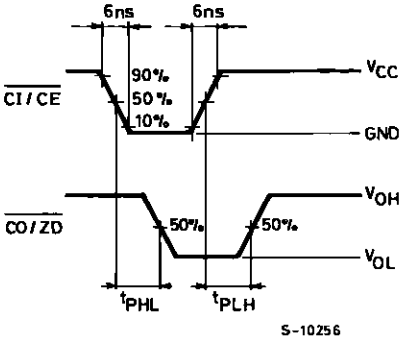

WAVEFORM 2



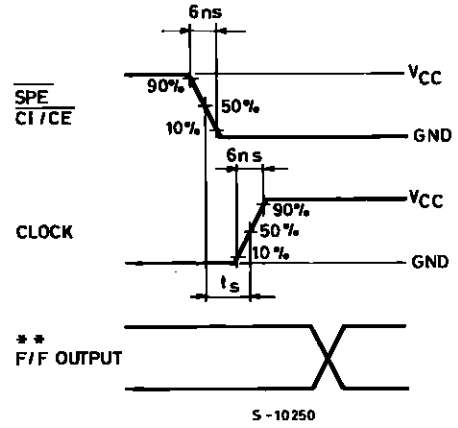

WAVEFORM 3



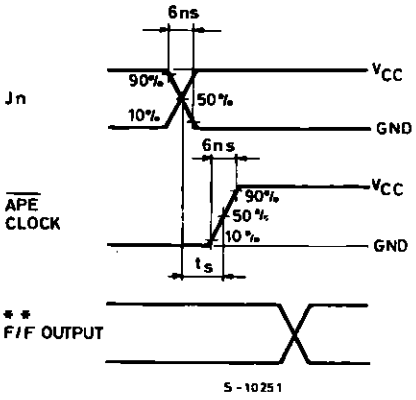

WAVEFORM 4




WAVEFORM 5



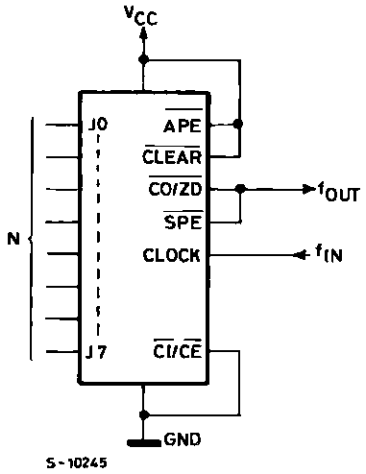

WAVEFORM 6



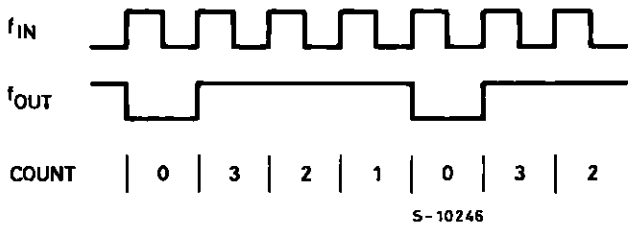

(** F/F output is internal signal of IC)

## EXAMPLE OF TYPICAL APPLICATION

### PROGRAMMABLE DIVIDE-BY-N COUNTER

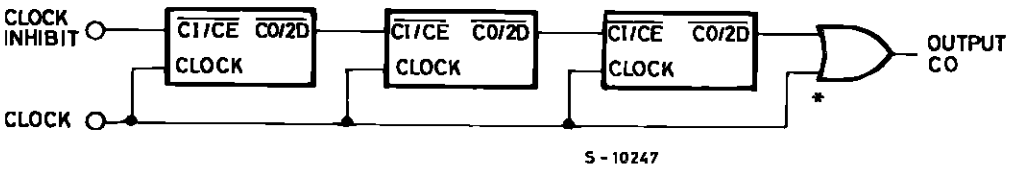



- $f_{OUT} = \frac{f_{IN}}{N+1}$
- Timing chart when N = "3" (J0, J1 = $V_{CC}$, J2 – J7 = GND)



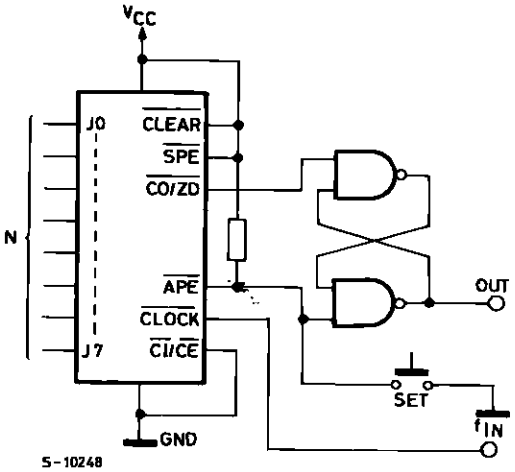

- HC40102... 1/2 to 1/100 are dividable
- HC40103... 1/2 to 1/256 are dividable

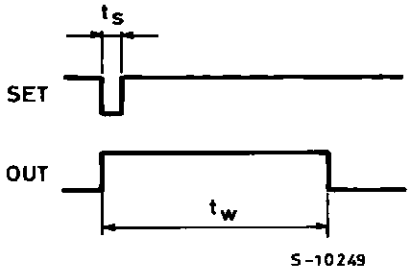
### PARALLEL CARRY CASCADING




* At synchronous cascade connection, huzzerd occurs at C0 output after its second stage when digit place changes, due to delay arrival. Therefore, take gate from HC32 or the like, not from C0 output at the rear stage directly.

### PROGRAMMABLE TIMER



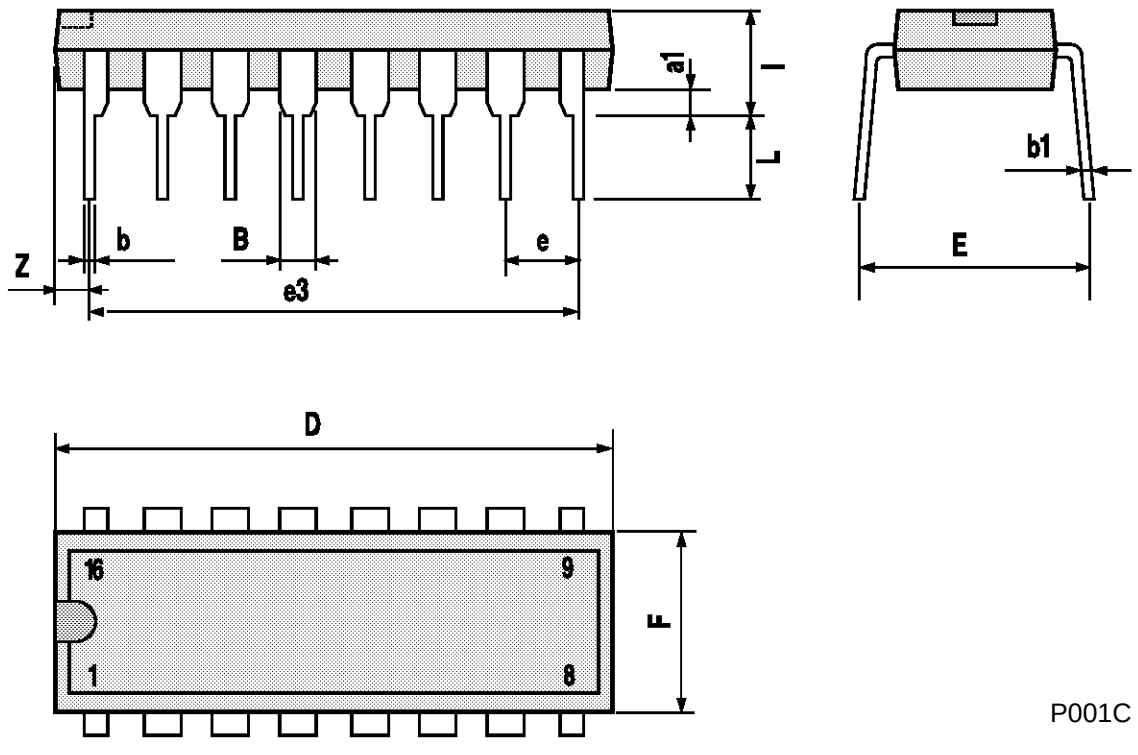




$$t_W = \left(\frac{N}{f_{IN}} + t_S\right)$$

**Note :** The above formula does not take into account the phase of clock input. Therefore, the real pulse width is the distance between the above formula-1/fIN ~ the above formula.

## Plastic DIP16 (0.25) MECHANICAL DATA

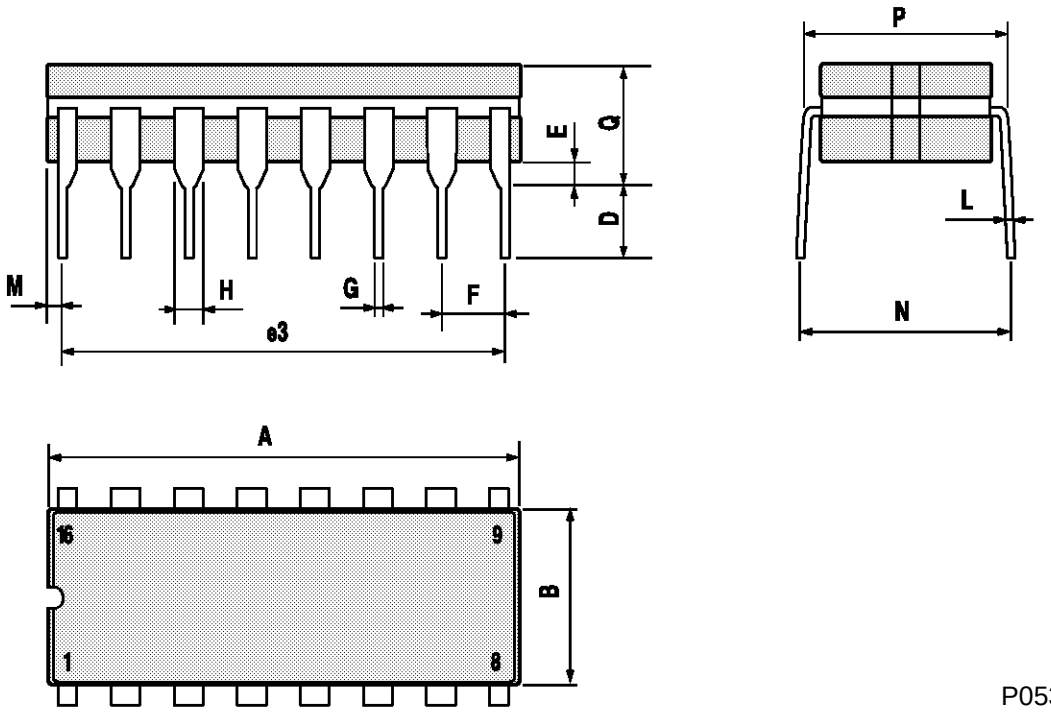
| DIM. | mm | | | inch | | |
|---|---|---|---|---|---|---|
| | MIN. | TYP. | MAX. | MIN. | TYP. | MAX. |
| a1 | 0.51 | | | 0.020 | | |
| B | 0.77 | | 1.65 | 0.030 | | 0.065 |
| b | | 0.5 | | | 0.020 | |
| b1 | | 0.25 | | | 0.010 | |
| D | | | 20 | | | 0.787 |
| E | | 8.5 | | | 0.335 | |
| e | | 2.54 | | | 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

## Ceramic DIP16/1 MECHANICAL DATA

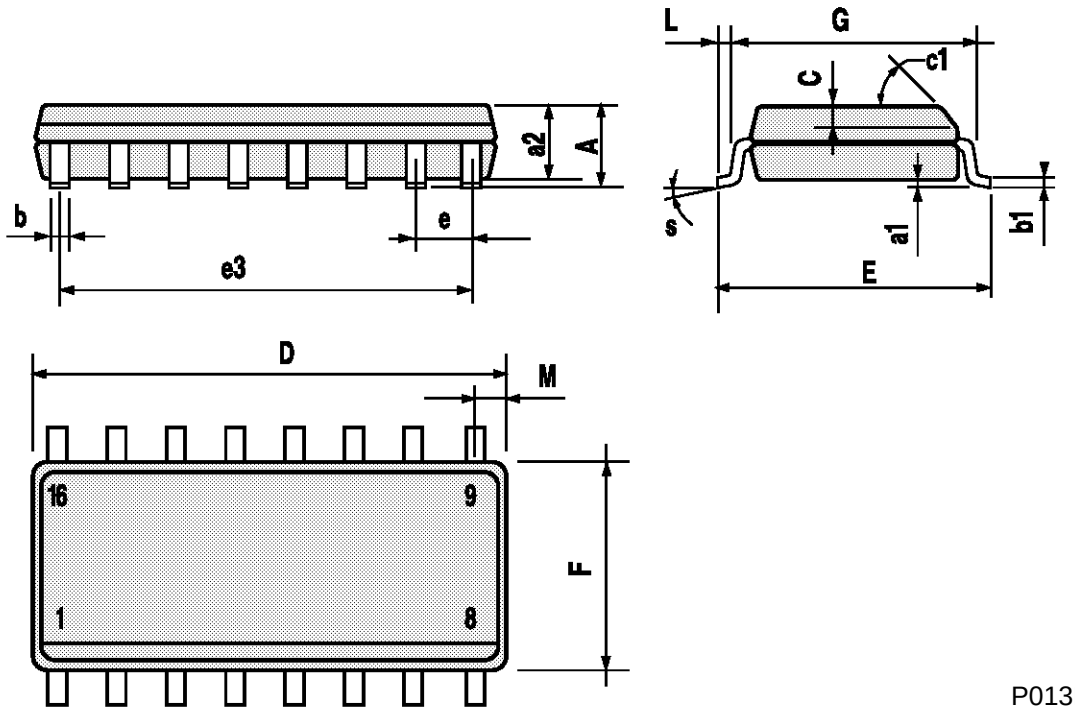
| DIM. | mm | | | inch | | |
|---|---|---|---|---|---|---|
| | MIN. | TYP. | MAX. | MIN. | TYP. | MAX. |
| A | | | 20 | | | 0.787 |
| B | | | 7 | | | 0.276 |
| D | | 3.3 | | | 0.130 | |
| E | 0.38 | | | 0.015 | | |
| e3 | | 17.78 | | | 0.700 | |
| F | 2.29 | | 2.79 | 0.090 | | 0.110 |
| G | 0.4 | | 0.55 | 0.016 | | 0.022 |
| H | 1.17 | | 1.52 | 0.046 | | 0.060 |
| L | 0.22 | | 0.31 | 0.009 | | 0.012 |
| M | 0.51 | | 1.27 | 0.020 | | 0.050 |
| N | | | 10.3 | | | 0.406 |
| P | 7.8 | | 8.05 | 0.307 | | 0.317 |
| Q | | | 5.08 | | | 0.200 |




P053D

## SO16 (Narrow) MECHANICAL DATA

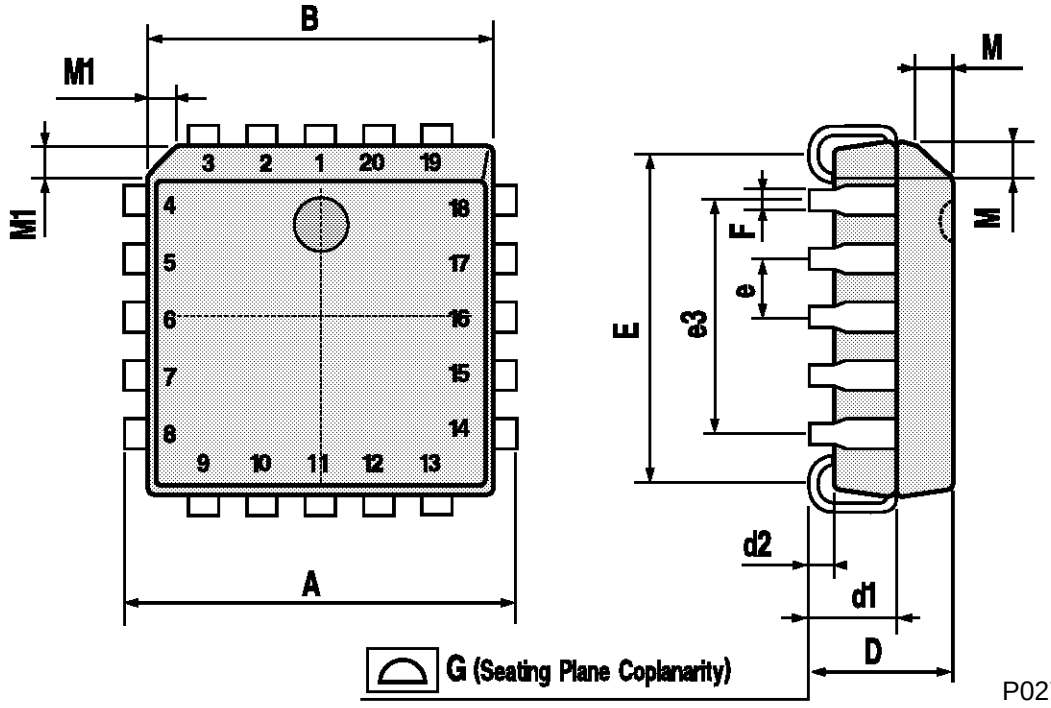
| DIM. | mm | | | inch | | |
|---|---|---|---|---|---|---|
| | MIN. | TYP. | MAX. | MIN. | TYP. | MAX. |
| A | | | 1.75 | | | 0.068 |
| a1 | 0.1 | | 0.2 | 0.004 | | 0.007 |
| a2 | | | 1.65 | | | 0.064 |
| b | 0.35 | | 0.46 | 0.013 | | 0.018 |
| b1 | 0.19 | | 0.25 | 0.007 | | 0.010 |
| C | | 0.5 | | | 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.) | | | | | |




P013H

## PLCC20 MECHANICAL DATA

| DIM. | mm | | | inch | | |
|---|---|---|---|---|---|---|
| | MIN. | TYP. | MAX. | MIN. | TYP. | MAX. |
| A | 9.78 | | 10.03 | 0.385 | | 0.395 |
| B | 8.89 | | 9.04 | 0.350 | | 0.356 |
| D | 4.2 | | 4.57 | 0.165 | | 0.180 |
| d1 | | 2.54 | | | 0.100 | |
| d2 | | 0.56 | | | 0.022 | |
| E | 7.37 | | 8.38 | 0.290 | | 0.330 |
| e | | 1.27 | | | 0.050 | |
| e3 | | 5.08 | | | 0.200 | |
| F | | 0.38 | | | 0.015 | |
| G | | | 0.101 | | | 0.004 |
| M | | 1.27 | | | 0.050 | |
| M1 | | 1.14 | | | 0.045 | |




P027A