# COS/MOS INTEGRATED CIRCUIT

## HCC/HCF 4527B



### BCD RATE MULTIPLIER

- CASCADABLE IN MULTIPLES OF 4-BITS
- SET TO 9 INPUT AND 9 DETECT OUTPUT
- QUIESCENT CURRENT SPECIFIED TO 20V FOR HCC DEVICE
- STANDARDIZED SYMMETRICAL OUTPUT CHARACTERISTICS
- 5V, 10V, AND 15V PARAMETRIC RATINGS
- INPUT CURRENT OF 100 nA AT 18V AND 25°C FOR HCC DEVICE
- 100% TESTED FOR QUIESCENT CURRENT
- MEETS ALL REQUIREMENTS OF JEDEC TENTATIVE STANDARD No. 13A, "STANDARD SPECIFICATIONS FOR DESCRIPTION OF "B" SERIES CMOS DEVICES"

The **HCC 4527B** (extended temperature range) and **HCF 4527B** (intermediate temperature range) are monolithic integrated circuit, available in 16-lead dual in-line plastic or ceramic package, and ceramic flat package.

The **HCC/HCF 4527** is a low-power 4-bit digital rate multiplier that provides an output-pulse rate which is the clock-input-pulse rate multiplied by 1/10 times the BCD input. For example, when the BCD input is 8, there will be 8 output pulses foe every 10 input pulses. This device may be used to perform arithmetic operations (add, subtract, divide, raise to a power), solve algebraic and differential equations, generate natural logarithms and trigonometric functions, A/D and D/A conversion, and frequency division.

### ABSOLUTE MAXIMUM RATINGS

| | | | |
|---|---|---|---|
| $V_{DD}$* | Supply voltage: **HCC** types | -0.5 to 20 | V |
| | **HCF** types | -0.5 to 18 | V |
| $V_I$ | Input voltage | -0.5 to $V_{DD}$ +0.5 | V |
| $I_I$ | DC input current (any one input) | ± 10 | mA |
| $P_{tot}$ | Total power dissipation (per package) | 200 | mW |
| | Dissipation per output transistor for $T_{op}$= full package-temperature range | 100 | mW |
| $T_{op}$ | Operating temperature: **HCC** types | -55 to 125 | °C |
| | **HCF** types | -40 to 85 | °C |
| $T_{stg}$ | Storage temperature | -65 to 150 | °C |

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

### ORDERING NUMBERS:

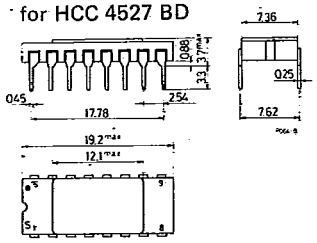
HCC 4527 BD for dual in-line ceramic package
HCC 4527 BF for dual in-line ceramic package, frit seal
HCC 4527 BK for ceramic flat package
HCF 4527 BE for dual in-line plastic package
HCF 4527 BF for dual in-line ceramic package, frit seal

# HCC/HCF 4527B

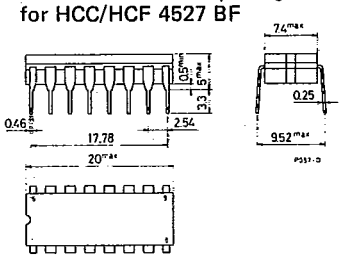


## MECHANICAL DATA(dimensions in mm)

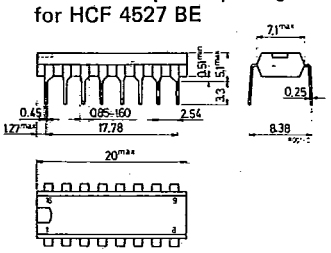
Dual in-line ceramic package for HCC 4527 BD



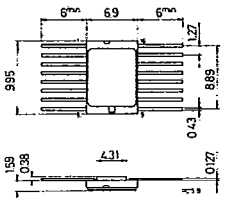

Dual in-line ceramic package for HCC/HCF 4527 BF



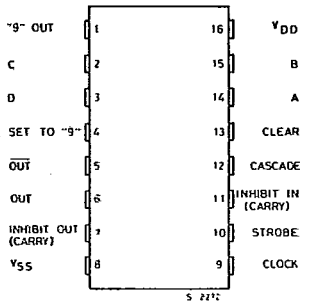

Dual in-line plastic package for HCF 4527 BE



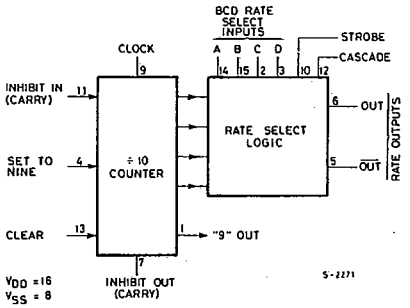

Ceramic flat package for HCC 4527 BK




## CONNECTION DIAGRAM




## FUNCTIONAL DIAGRAM



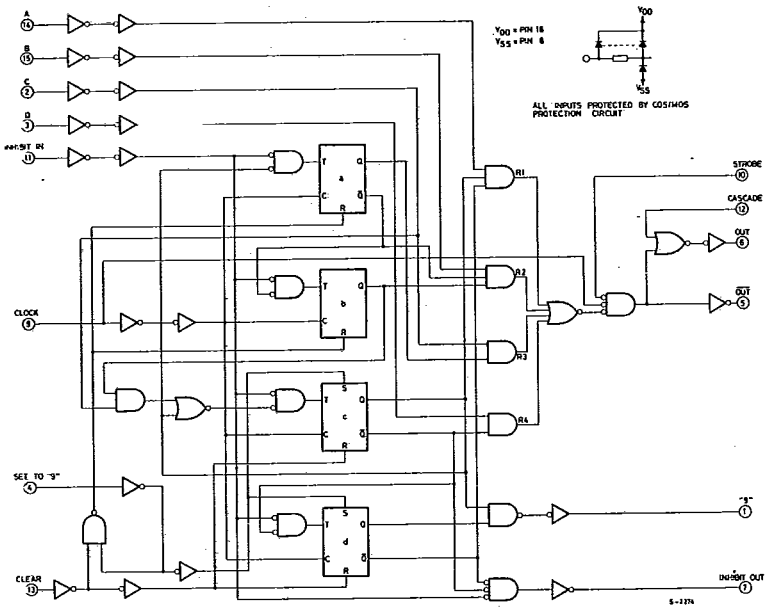

## RECOMMENDED OPERATING CONDITIONS

| | | | |
|---|---|---|---|
| $V_{DD}$ | Supply voltage: **HCC** types | 3 to 18 | V |
| | **HCF** types | 3 to 15 | V |
| $V_I$ | Input voltage | 0 to $V_{DD}$ | V |
| $T_{op}$ | Operating temperature: **HCC** types | -55 to 125 | °C |
| | **HCF** types | -40 to 85 | °C |

# HCC/HCF 4527B



## LOGIC DIAGRAM




## TRUTH TABLE

| INPUTS | | | | | | | | | | OUTPUTS | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number of Pulses or Input Logic Level (0 = Low; 1 = High; X = Don't Care) | | | | | | | | | | Number of Pulses or Output Logic Level (L = Low; H = High) | | | |
| D | C | B | A | CLK | INH IN | STR | CAS | CLR | SET | OUT | $\overline{OUT}$ | INH OUT | "9" OUT |
| 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | L | H | 1 | 1 |
| 0 | 0 | 0 | 1 | 10 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 |
| 0 | 0 | 1 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 1 | 1 |
| 0 | 0 | 1 | 1 | 10 | 0 | 0 | 0 | 0 | 0 | 3 | 3 | 1 | 1 |
| 0 | 1 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 4 | 4 | 1 | 1 |
| 0 | 1 | 0 | 1 | 10 | 0 | 0 | 0 | 0 | 0 | 5 | 5 | 1 | 1 |
| 0 | 1 | 1 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 6 | 6 | 1 | 1 |
| 0 | 1 | 1 | 1 | 10 | 0 | 0 | 0 | 0 | 0 | 7 | 7 | 1 | 1 |
| 1 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 8 | 8 | 1 | 1 |
| 1 | 0 | 0 | 1 | 10 | 0 | 0 | 0 | 0 | 0 | 9 | 9 | 1 | 1 |
| 1 | 0 | 1 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 8 | 8 | 1 | 1 |
| 1 | 0 | 1 | 1 | 10 | 0 | 0 | 0 | 0 | 0 | 9 | 9 | 1 | 1 |
| 1 | 1 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 8 | 8 | 1 | 1 |
| 1 | 1 | 0 | 1 | 10 | 0 | 0 | 0 | 0 | 0 | 9 | 9 | 1 | 1 |
| 1 | 1 | 1 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 8 | 8 | 1 | 1 |
| 1 | 1 | 1 | 1 | 10 | 0 | 0 | 0 | 0 | 0 | 9 | 9 | 1 | 1 |
| X | X | X | X | 10 | 1 | 0 | 0 | 0 | 0 | ▲ | ▲ | H | ▲ |
| X | X | X | X | 10 | 0 | 1 | 0 | 0 | 0 | L | H | 1 | 1 |
| X | X | X | X | 10 | 0 | 0 | 1 | 0 | 0 | H | ● | 1 | 1 |
| 1 | X | X | X | 10 | 0 | 0 | 0 | 1 | 0 | 10 | 10 | H | L |
| 0 | X | X | X | 10 | 0 | 0 | 0 | 1 | 0 | L | H | H | L |
| X | X | X | X | 10 | 0 | 0 | 0 | 0 | 1 | L | H | L | H |

● Output same as the first 16 lines of this truth table (depending on values of A, B, C, D).
▲ Depends on internal state of counter.

# HCC/HCF 4527B



## STATIC ELECTRICAL CHARACTERISTICS (over recommended operating conditions)

| Parameter | | | Test conditions $V_I$ (V) | $V_O$ (V) | $\|I_O\|$ (μA) | $V_{DD}$ (V) | Values $T_{Low}$* Min. | $T_{Low}$* Max. | 25°C Min. | 25°C Typ. | 25°C Max. | $T_{High}$* Min. | $T_{High}$* Max. | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $I_L$ | Quiescent current | HCC types | 0/ 5 | | | 5 | | 5 | | 0.04 | 5 | | 150 | μA |
| | | | 0/10 | | | 10 | | 10 | | 0.04 | 10 | | 300 | |
| | | | 0/15 | | | 15 | | 20 | | 0.04 | 20 | | 600 | |
| | | | 0/20 | | | 20 | | 100 | | 0.08 | 100 | | 3000 | |
| | | HCF types | 0/ 5 | | | 5 | | 20 | | 0.04 | 20 | | 150 | |
| | | | 0/10 | | | 10 | | 40 | | 0.04 | 40 | | 300 | |
| | | | 0/15 | | | 15 | | 80 | | 0.04 | 80 | | 600 | |
| $V_{OH}$ | Output high 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 | | |
| $V_{OL}$ | Output low 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 | |
| $V_{IH}$ | Input high 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 | | |
| $V_{IL}$ | Input low 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 | |
| $I_{OH}$ | Output drive current | HCC types | 0/ 5 | 2.5 | | 5 | -2 | | -1.6 | -3.2 | | -1.15 | | mA |
| | | | 0/ 5 | 4.6 | | 5 | -0.64 | | -0.51 | -1 | | -0.36 | | |
| | | | 0/10 | 9.5 | | 10 | -1.6 | | -1.3 | -2.6 | | -0.9 | | |
| | | | 0/15 | 13.5 | | 15 | -4.2 | | -3.4 | -6.8 | | -2.4 | | |
| | | HCF types | 0/ 5 | 2.5 | | 5 | -1.53 | | -1.36 | -3.2 | | -1.1 | | |
| | | | 0/ 5 | 4.6 | | 5 | -0.52 | | -0.44 | -1 | | -0.36 | | |
| | | | 0/10 | 9.5 | | 10 | -1.3 | | -1.1 | -2.6 | | -0.9 | | |
| | | | 0/15 | 13.5 | | 15 | -3.6 | | -3.0 | -6.8 | | -2.4 | | |
| $I_{OL}$ | Output sink current | HCC types | 0/ 5 | 0.4 | | 5 | 0.64 | | 0.51 | 1 | | 0.36 | | mA |
| | | | 0/10 | 0.5 | | 10 | 1.6 | | 1.3 | 2.6 | | 0.9 | | |
| | | | 0/15 | 1.5 | | 15 | 4.2 | | 3.4 | 6.8 | | 2.4 | | |
| | | HCF types | 0/ 5 | 0.4 | | 5 | 0.52 | | 0.44 | 1 | | 0.36 | | |
| | | | 0/10 | 0.5 | | 10 | 1.3 | | 1.1 | 2.6 | | 0.9 | | |
| | | | 0/15 | 1.5 | | 15 | 3.6 | | 3.0 | 6.8 | | 2.4 | | |
| $I_{IH}$, $I_{IL}$ | Input leakage current | HCC types | 0/18 | Any input | | 18 | | ±0.1 | | $±10^{-5}$ | ±0.1 | | ± 1 | μA |
| | | HCF types | 0/15 | | | 15 | | ±0.3 | | $±10^{-5}$ | ±0.3 | | ± 1 | |
| $C_I$ | Input capacitance | | | Any input | | | | | | 5 | 7.5 | | | pF |

* $T_{Low}$ = − 55°C for **HCC** device: −40°C for **HCF** device.
* $T_{High}$ = +125°C for **HCC** device: +85°C for **HCF** device.
The Noise Margin for both "1" and "0" level is: 1V min. with $V_{DD}$= 5V
2V min. with $V_{DD}$= 10V
2.5V min. with $V_{DD}$= 15V

## DYNAMIC ELECTRICAL CHARACTERISTICS ($T_{amb}$= 25°C, $C_L$= 50 pF, $R_L$= 200 kΩ, typical temperature coefficient for all $V_{DD}$ values is 0.3%/°C, all input rise and fall times = 20 ns)

| Parameter | | Test conditions | Values | | | Unit |
|---|---|---|---|---|---|---|
| | | $V_{DD}$ (V) | Min. | Typ. | Max. | |
| $t_{PHL}$, $t_{PLH}$ Propagation delay time | Clock to out | 5 | | 110 | 220 | ns |
| | | 10 | | 55 | 110 | |
| | | 15 | | 45 | 90 | |
| | Clock or strobe to out | 5 | | 150 | 300 | ns |
| | | 10 | | 75 | 150 | |
| | | 15 | | 60 | 120 | |
| | Clock to inhibit out high level to low level | 5 | | 320 | 640 | ns |
| | | 10 | | 145 | 290 | |
| | | 15 | | 100 | 200 | |
| | Low level to high level | 5 | | 250 | 500 | ns |
| | | 10 | | 100 | 200 | |
| | | 15 | | 75 | 150 | |
| | Clear to out | 5 | | 380 | 760 | ns |
| | | 10 | | 175 | 350 | |
| | | 15 | | 130 | 260 | |
| | Clock to "9" or "1" out | 5 | | 300 | 600 | ns |
| | | 10 | | 125 | 250 | |
| | | 15 | | 90 | 180 | |
| | Cascade to out | 5 | | 90 | 180 | ns |
| | | 10 | | 45 | 90 | |
| | | 15 | | 35 | 70 | |
| | Inhibit input to inhibit out | 5 | | 130 | 260 | ns |
| | | 10 | | 60 | 120 | |
| | | 15 | | 45 | 90 | |
| | Set to out | 5 | | 330 | 660 | ns |
| | | 10 | | 150 | 300 | |
| | | 15 | | 110 | 220 | |
| $t_{THL}$, $t_{TLH}$ Transition time | | 5 | | 100 | 200 | ns |
| | | 10 | | 50 | 100 | |
| | | 15 | | 40 | 80 | |
| $f_{CL}$ Maximum clock frequency | | 5 | 1.2 | 2.4 | | MHz |
| | | 10 | 2.5 | 5 | | |
| | | 15 | 3.5 | 7 | | |
| $t_W$ Clock pulse width | | 5 | 330 | 165 | | ns |
| | | 10 | 170 | 85 | | |
| | | 15 | 100 | 50 | | |
| $t_r$, $t_f$ Clock rise or fall time | | 5 | | | 15 | μs |
| | | 10 | | | 15 | |
| | | 15 | | | 15 | |
| $t_W$ Set or clear pulse width | | 5 | 160 | 80 | | ns |
| | | 10 | 90 | 45 | | |
| | | 15 | 60 | 30 | | |

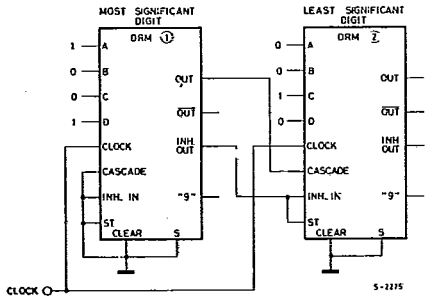
## DYNAMIC ELECTRICAL CHARACTERISTICS (continued)

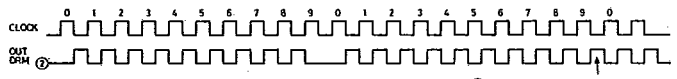
| Parameter | | Test conditions | Values | | | Unit |
|---|---|---|---|---|---|---|
| | | $V_{DD}$ (V) | Min. | Typ. | Max. | |
| $t_{setup}$ | Inhibit input setup time | 5 | 100 | 50 | | ns |
| | | 10 | 40 | 20 | | |
| | | 15 | 20 | 10 | | |
| $t_R$ | Inhibit input removal time | 5 | 240 | 120 | | ns |
| | | 10 | 130 | 65 | | |
| | | 15 | 110 | 55 | | |
| $t_R$ | Set removal time | 5 | 150 | 75 | | ns |
| | | 10 | 80 | 40 | | |
| | | 15 | 50 | 25 | | |
| $t_R$ | Clear removal time | 5 | 60 | 30 | | ns |
| | | 10 | 40 | 20 | | |
| | | 15 | 30 | 15 | | |

## APPLICATIONS NOTE

For fractional multipliers with more than one digit, **HCC/HCF 4527** devices may be cascaded in two different modes: the Add mode and the Multiply mode. See figs. 1 and 3.

Fig. 1 - Two **HCC/HCF 4527B** cascaded in the "Add" mode with a preset number




TIMING DIAGRAM SHOWING ONE OF FOUR OUTPUT PULSES CONTRIBUTED BY ORM ② TO OUTPUT FOR EVERY 100 CLOCK PULSES IN FOR PRESET N° 94

5-2278/1

When two units are cascaded in Add mode and programmed to 9 and 4 respectively, the more significant unit will have 9 output pulses for every 10 input pulses and the other unit will have 4 output pulses for every 100 input pulses for a total of $\frac{9}{10} + \frac{4}{100} = \frac{94}{100}$ .



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## APPLICATIONS NOTE (continued)

The Addition of two variables, A and B is instead obtained with this application:

Fig. 2 - Addition of two variables, A and B

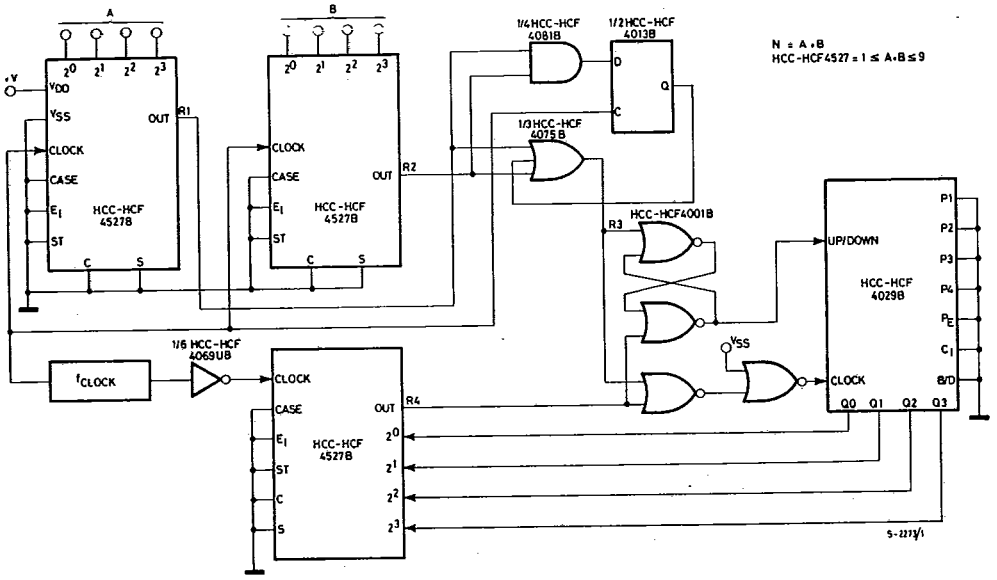
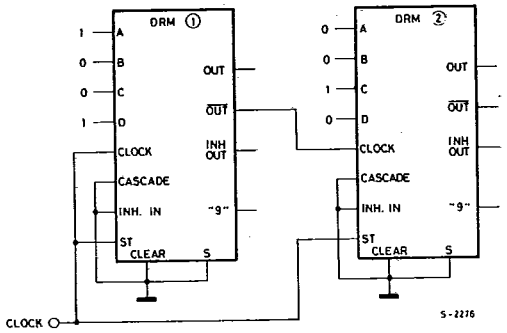



Fig. 3 - Two **HCC/HCF 4527B** cascaded in the "Multiply" mode with a preset number



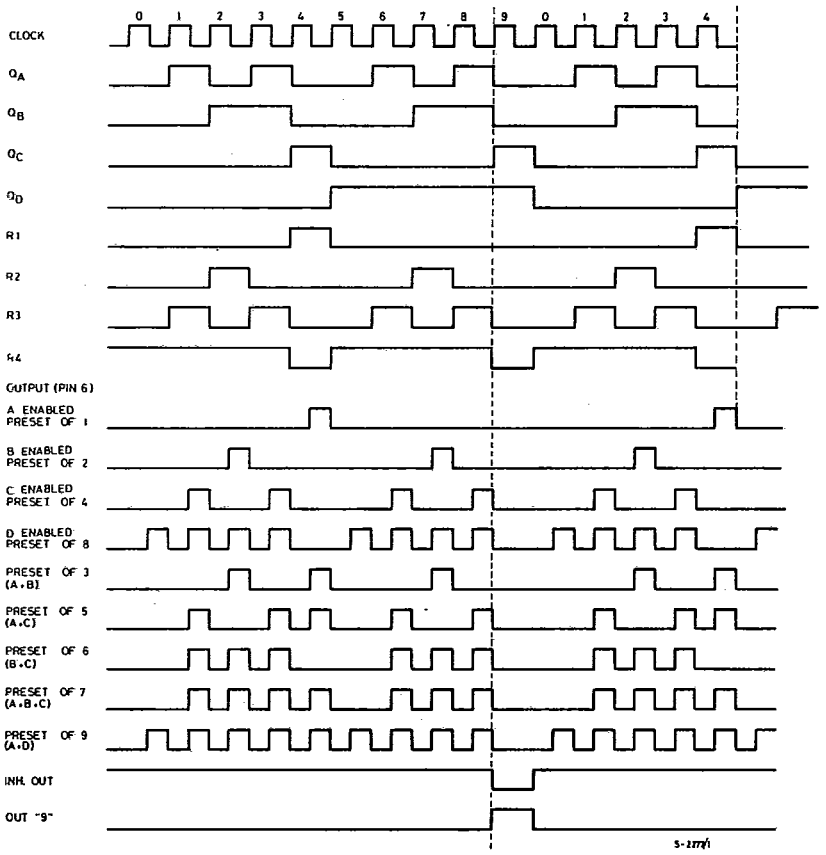

In the Multiply mode, the fraction programmed into the first rate multiplier is multiplied by the fraction programmed into the second one: $f_f$ $N_1 = 9$ and $N_2 = 4$

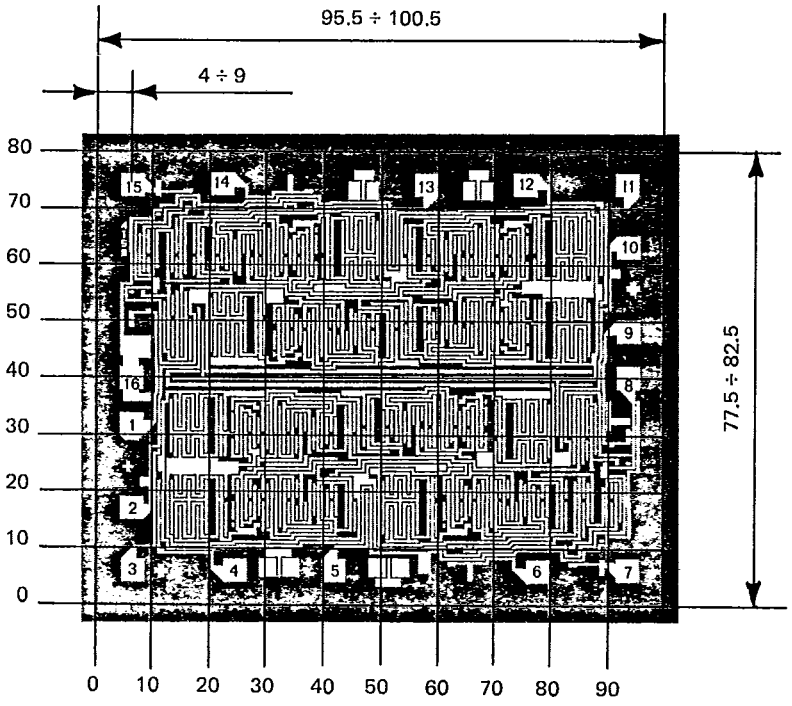
$f_{out2} = (\frac{4}{10}) \cdot f_{out1}$ $\quad f_{out1} = \frac{9}{10} f_{clock}$ $\quad f_{out2} = \frac{4}{10} \times (\frac{9}{10} f_{clock}) = \frac{36}{100} f_{clock}$

There fore 36 output pulses for every 100 clock input pulses.

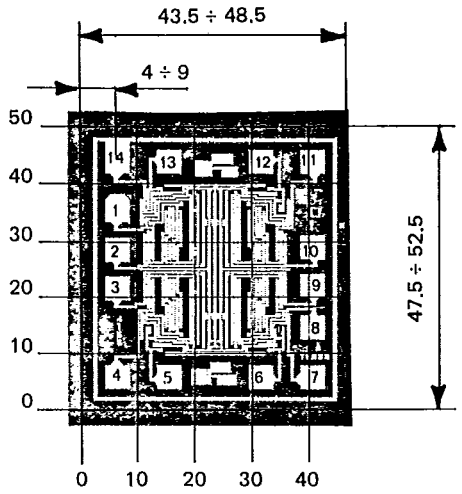
## APPLICATIONS NOTE (continued)

Fig. 4 - Timing diagram (see Logic Diagram)




95.5 ÷ 100.5
4 ÷ 9
77.5 ÷ 82.5
80
70
60
50
40
30
20
10
0
0 10 20 30 40 50 60 70 80 90
15 14 13 12 11 10 9 8 16 1 2 3 4 5 6 7

**4015B**


43.5 ÷ 48.5
4 ÷ 9
47.5 ÷ 52.5
50
40
30
20
10
0
0 10 20 30 40
14 13 12 11 1 2 3 10 9 8 4 5 6 7

**4016B**