# 14-STAGE RIPPLE-CARRY BINARY COUNTER/ DIVIDER AND OSCILLATOR

## GENERAL DESCRIPTION

The MMC 4060 is a monolithic i.c. processed in standard Al-gate CMOS technology. This 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. 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 $\varnothing_I$ (and $\varnothing_O$) A high level on the RESET line resets the counter to the all 0's state and disables the oscillator. Schmitt trigger action on the clock line permits unlimited clock rise and fall times. All inputs and outputs are fully buffered.

## FEATURES

- Medium-speed operation
- Fully static operation
- Buffered inputs and outputs
- Common reset

## ABSOLUTE MAXIMUM RATINGS

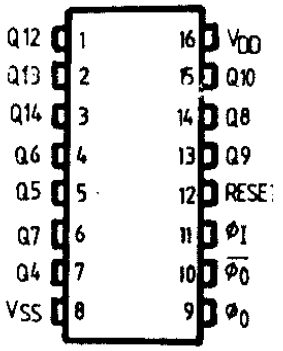
| | | | | |
|---|---|---|---|---|
| $V_{DD}$* | Supply voltage: G and H types | -0.5 to | 20 | V |
| | E and F types | -0.5 to | 18 | V |
| $V_I$ | Input voltage | -0.5 to | $V_{DD}$+0.5 | V |
| $I_I$ | DC input current (any one input) | | ±10 | mA |
| $P_{tot}$ | Total power dissipation (per package)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

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

## RECOMMENDED OPERATING CONDITIONS

| | | | | |
|---|---|---|---|---|
| $V_{DD}$* | Supply voltage: G and H types | 3 to | 18 | V |
| | E and F types | 3 to | 15 | V |
| $V_I$ | Input voltage | 0 to | $V_{DD}$ | V |
| $T_A$ | Operating temperature : G and H types | -55 to | 125 | °C |
| | E and F types | -40 to | 85 | °C |

## CONNECTION DIAGRAM



## STATIC ELECTRICAL CHARACTERISTICS

(Over recommended operating conditions)

| PARAMETER | | | TEST CONDITIONS $V_I$ (V) | $V_O$ (V) | $\|I_{IO}\|$ (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 | G, H 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 | |
| | | E, F 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 | G, H 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 | | |
| | | E, F 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 | G, H 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 | | |
| | | E, F 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 | G, H types | 0/18 | Any input | | 18 | | ±0.1 | | $±10^{-5}$ | ±0.1 | | ±1 | μA |
| | | E, F 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 G, H devices; -40°C for E, F devices
* $T_{HIGH}$ = +125°C for G, H devices; +85°C for E, F devices

The Noise Margin for both "1" and "0" level is:

1 V min. with $V_{DD}$ = 5 V
2 V min. with $V_{DD}$ = 10 V
2.5 V min. with $V_{DD}$ = 15 V

## DYNAMIC ELECTRICAL CHARACTERISTICS

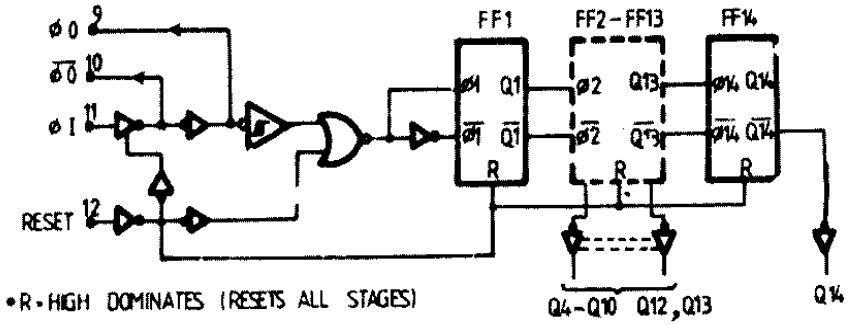
($T_A$ = 25°C, $C_L$ = 50 pF, $R_L$ = 200 kohm, typical temperature coefficient for all $V_{DD}$ = 0.3%/°C values, all input rise and fall time = 20 ns)

| PARAMETER | | TEST CONDITIONS | | VALUES | | | UNIT |
|---|---|---|---|---|---|---|---|
| | | | $V_{DD}$(V) | Min. | Typ. | Max. | |
| **Input-pulse operation** | | | | | | | |
| $t_{PLH}$ $t_{PHL}$ | Propagation delay time (Ø to Q4 Out) | | 5 | | 370 | 740 | ns |
| | | | 10 | | 150 | 300 | |
| | | | 15 | | 100 | 200 | |
| $t_{PLH}$ $t_{PHL}$ | Propagation delay time (Qn to $Q_{n+1}$) | | 5 | | 100 | 200 | ns |
| | | | 10 | | 50 | 100 | |
| | | | 15 | | 40 | 80 | |
| $t_{TLH}$ $t_{THL}$ | Transition time | | 5 | | 100 | 200 | ns |
| | | | 10 | | 50 | 100 | |
| | | | 15 | | 40 | 80 | |
| $t_W$ | Input pulse width | f = 100 kHz | 5 | | 50 | 100 | ns |
| | | | 10 | | 20 | 40 | |
| | | | 15 | | 15 | 30 | |
| $t_r$, $t_f$ | Input rise and fall time | | 5 | Unlimited | | | µs |
| | | | 10 | | | | |
| | | | 15 | | | | |
| $f_{max}$ | Maximum clock input frequency | | 5 | 3.5 | 7 | | MHz |
| | | | 10 | 8 | 16 | | |
| | | | 15 | 12 | 24 | | |
| **Reset operation** | | | | | | | |
| $t_{PLH}$ | Propagation delay time | | 5 | | 180 | 360 | ns |
| | | | 10 | | 80 | 160 | |
| | | | 15 | | 50 | 100 | |
| $t_W$ | Reset pulse width | | 5 | | 60 | 120 | ns |
| | | | 10 | | 30 | 60 | |
| | | | 15 | | 20 | 40 | |
| **RC operation** | | | | | | | |
| Variation of frequency (Unit-to-Unit) | | $C_x$ = 200 pF<br>$R_S$ = 560 kΩ<br>$R_x$ = 50 kΩ | 5 | 18 | 21.5 | 25 | kHz |
| | | | 10 | 20 | 23 | 26 | |
| | | | 15 | 21.1 | 24 | 27 | |
| Variation of frequency with voltage (Same Unit) | | $C_x$ = 200 pF<br>$R_S$ = 560 kΩ<br>$R_x$ = 50 kΩ | 5V to 10 V | – | – | 2 | |
| | | | 10 V to 15 V | – | – | 1 | |
| $R_x$ max | | $C_x$ = 10 µF | 5 | – | – | 20 | MΩ |
| | | = 50 µF | 10 | – | – | 20 | |
| | | = 10 µF | 15 | – | – | 10 | |

| PARAMETER | TEST CONDITIONS | | VALUES | | | UNIT |
|---|---|---|---|---|---|---|
| | | $V_{DD}$(V) | Min. | Typ. | Max. | |
| $C_x$ max | $R_x$ = 500 kΩ | 5 | – | – | 1000 | pF |
| | = 300 kΩ | 10 | – | – | 50 | |
| | = 300 kΩ | 15 | – | – | 50 | |
| Maximum Oscillator Frecquency* | $R_x$ = 5 kΩ | 10 | 530 | 650 | 810 | kHz |
| | $C_x$ = 15 pF | 15 | 690 | 800 | 940 | |

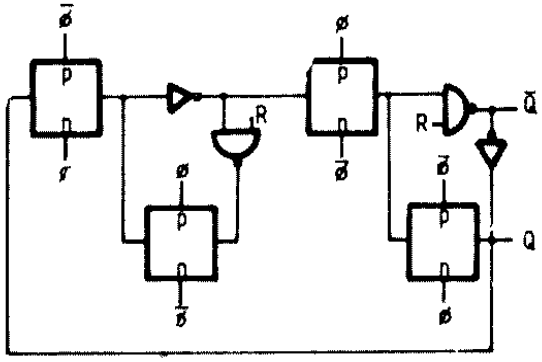
* RC oscillator applications are not recommended at supply voltages below 7 V for $R_x$ = 50 kΩ

## LOGIC DIAGRAM




•R = HIGH DOMINATES (RESETS ALL STAGES)
▲COUNTER ADVANCES ONE BINARY COUNT ON EACH NEGATIVE-GOING TRANSITION OF ø I (AND ø 0)

Detail of tipical flip-flop stage



## APPLICATIONS