

TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

TC7MH4040FK

12-Stage Ripple-Carry Binary Counter

The TC7MH4040FK is an advanced high speed CMOS 12-stage ripple-carry binary counter fabricated with silicon gate C²MOS technology.

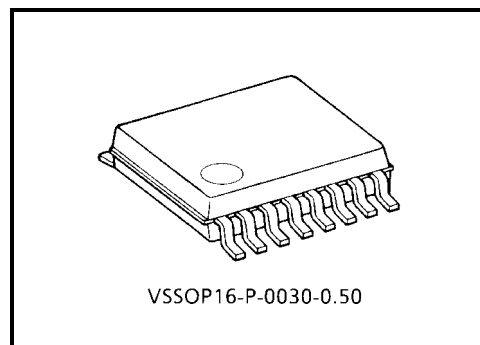
It achieves the high speed operation similar to equivalent bipolar schottky TTL while maintaining the CMOS low power dissipation.

Setting CLR to high resets the counter to low.

A negative transition on the \overline{CK} input brings one increment into the counter.

This counter provides all divided output stages, and at Q12, a 1/4096 divided frequency will be output.

An input protection circuit ensures that 0 to 7 V can be applied to the input pins without regard to the supply voltage. This device can be used to interface 5 V to 3 V systems and two supply systems such as battery back up. This circuit prevents device destruction due to mismatched supply and input voltages.

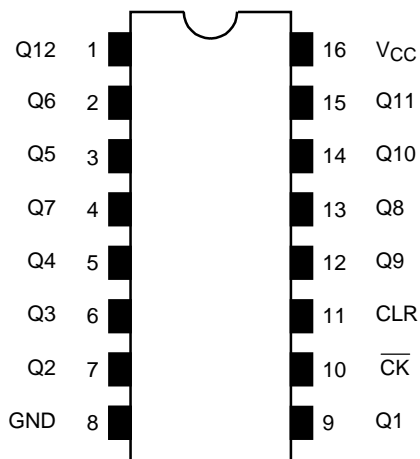


Weight: 0.02 g (typ.)

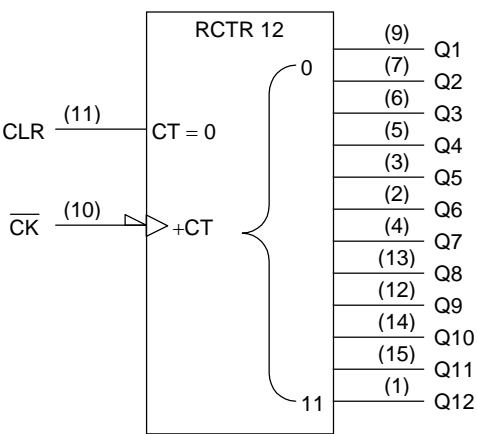
Features

- High speed: $f_{\max} = 210 \text{ MHz}$ (typ.) ($V_{CC} = 5 \text{ V}$)
- Low power dissipation: $I_{CC} = 4 \mu\text{A}$ (max) ($T_a = 25^\circ\text{C}$)
- High noise immunity: $V_{NIH} = V_{NIL} = 28\% V_{CC}$ (min)
- Power down protection is provided on all inputs.
- Balanced propagation delays: $t_{pLH} \approx t_{pHL}$
- Wide operating voltage range: $V_{CC}(\text{opr}) = 2 \sim 5.5 \text{ V}$
- Low noise: $V_{OLP} = 1.5 \text{ V}$ (max)
- Pin and function compatible with 74HC4040



Pin Assignment (top view)



IEC Logic Level

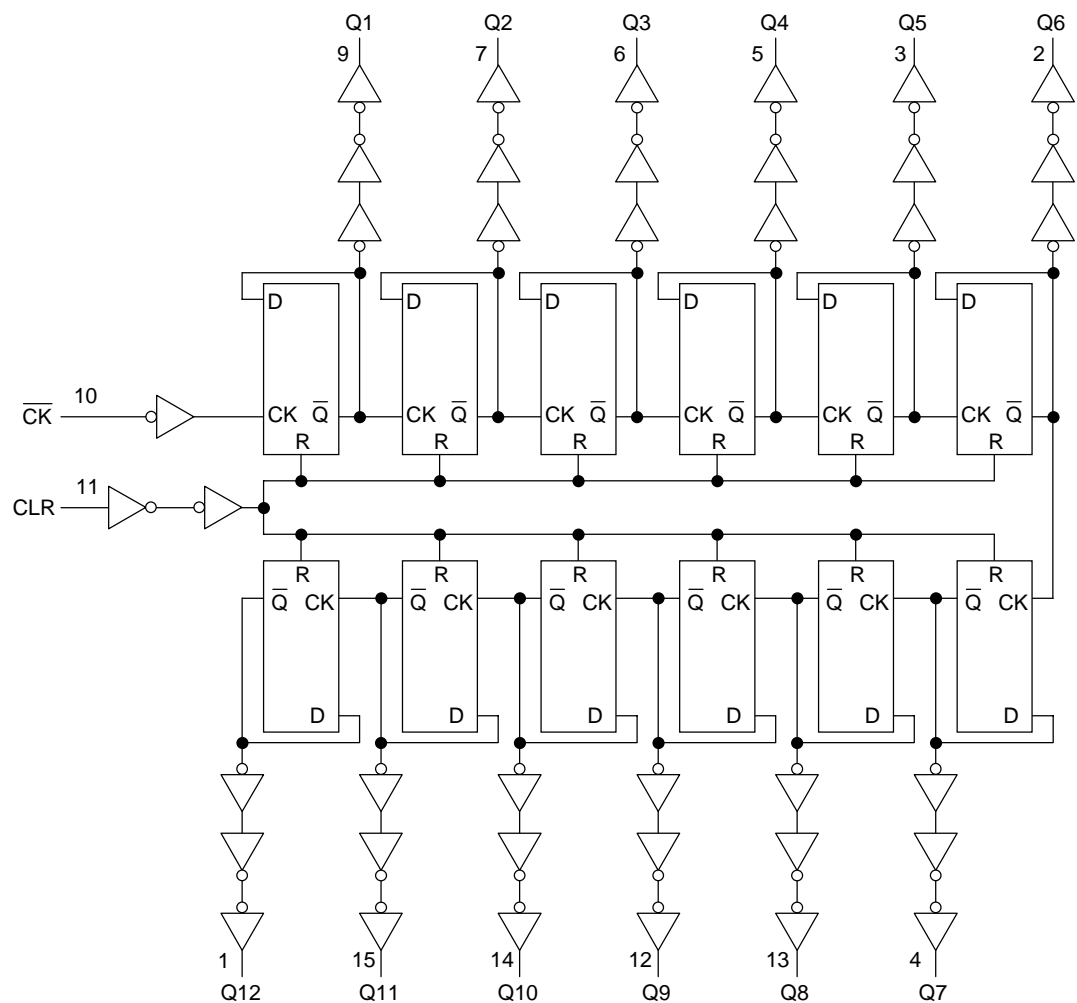


Truth Table

| \overline{CK} | CLR | Outputs |
|---|-----|------------------------|
| X | H | All outputs = "L" |
|  | L | No change |
|  | L | Advance to next statge |

X: Don't care

System Diagram



Maximum Ratings

| Characteristics | Symbol | Rating | Unit |
|-----------------------------|-----------|----------------------|------|
| Supply voltage range | V_{CC} | -0.5~7.0 | V |
| DC input voltage | V_{IN} | -0.5~7.0 | V |
| DC output voltage | V_{OUT} | -0.5~ V_{CC} + 0.5 | V |
| Input diode current | I_{IK} | -20 | mA |
| Output diode current | I_{OK} | ±20 | mA |
| DC output current | I_{OUT} | ±25 | mA |
| DC V_{CC} /ground current | I_{CC} | ±100 | mA |
| Power dissipation | P_D | 180 | mW |
| Storage temperature | T_{stg} | -65~150 | °C |

Recommended Operating Conditions

| Characteristics | Symbol | Rating | Unit |
|--------------------------|-----------|-----------------------------------|------|
| Supply voltage | V_{CC} | 2.0~5.5 | V |
| Input voltage | V_{IN} | 0~5.5 | V |
| Output voltage | V_{OUT} | 0~ V_{CC} | V |
| Operating temperature | T_{opr} | -40~85 | °C |
| Input rise and fall time | dt/dv | 0~100 ($V_{CC} = 3.3 \pm 0.3$ V) | ns/V |
| | | 0~20 ($V_{CC} = 5 \pm 0.5$ V) | |

Electrical Characteristics

DC Characteristics

| Characteristics | | Symbol | Test Condition | | V _{CC} (V) | Ta = 25°C | | | Ta = -40~85°C | | Unit |
|--------------------------|------------|-----------------|---|--------------------------|-------------------------|-----------------------|------|-----------------------|-----------------------|-----------------------|------|
| | | | | | Min | Typ. | Max | Min | Max | | |
| Input voltage | High level | V _{IH} | — | | 2.0 | 1.50 | — | — | 1.50 | — | V |
| | | | | | 3.0~5.5 | V _{CC} × 0.7 | — | — | V _{CC} × 0.7 | — | |
| | Low level | V _{IL} | — | | 2.0 | — | — | 0.50 | — | 0.50 | |
| | | | | | 3.0~5.5 | — | — | V _{CC} × 0.3 | — | V _{CC} × 0.3 | |
| Output voltage | High level | V _{OH} | V _{IN} = V _{IH} or V _{IL} | I _{OH} = -50 μA | 2.0 | 1.9 | 2.0 | — | 1.9 | — | V |
| | | | | | 3.0 | 2.9 | 3.0 | — | 2.9 | — | |
| | | | | | 4.5 | 4.4 | 4.5 | — | 4.4 | — | |
| | | | | I _{OH} = -4 mA | 3.0 | 2.58 | — | — | 2.48 | — | |
| | | | | | I _{OH} = -8 mA | 4.5 | 3.94 | — | — | 3.80 | |
| | Low level | V _{OL} | V _{IN} = V _{IH} or V _{IL} | I _{OL} = 50 μA | 2.0 | — | 0 | 0.1 | — | 0.1 | |
| | | | | | 3.0 | — | 0 | 0.1 | — | 0.1 | |
| | | | | | 4.5 | — | 0 | 0.1 | — | 0.1 | |
| | | | | I _{OL} = 4 mA | 3.0 | — | — | 0.36 | — | 0.44 | |
| | | | | | I _{OL} = 8 mA | 4.5 | — | — | 0.36 | — | |
| Input leakage current | | I _{IN} | V _{IN} = 5.5 V or GND | 0~5.5 | — | — | ±0.1 | — | ±1.0 | μA | |
| Quiescent supply current | | I _{CC} | V _{IN} = V _{CC} or GND | 5.5 | — | — | 4.0 | — | 40.0 | μA | |

Timing Requirements (Input: $t_r = t_f = 3$ ns)

| Characteristics | Symbol | Test Condition | V _{CC} (V) | Ta = 25°C | | Ta = −40~85°C | Unit |
|--|--|----------------|---------------------|-----------|-------|---------------|------|
| | | | Typ. | Limit | Limit | | |
| Minimum pulse width (\overline{CK}) | t _w (L) t _w (H) | — | 3.3 ± 0.3 | — | 5.0 | 5.0 | ns |
| | | | 5.0 ± 0.5 | — | 5.0 | 5.0 | |
| Minimum pulse width (CLR) | t _w (H) | — | 3.3 ± 0.3 | — | 5.0 | 5.0 | ns |
| | | | 5.0 ± 0.5 | — | 5.0 | 5.0 | |
| Minimum removal time | t _{rem} | — | 3.3 ± 0.3 | — | 5.0 | 5.0 | ns |
| | | | 5.0 ± 0.5 | — | 5.0 | 5.0 | |

AC Characteristics (Input: $t_r = t_f = 3\text{ ns}$)

| Characteristics | Symbol | Test Condition | | | Ta = 25°C | | | Ta = −40~85°C | | Unit |
|---|--------------------------------------|----------------|-----------|---------|-----------|------|------|---------------|------|------|
| | | | VCC (V) | CL (pF) | Min | Typ. | Max | Min | Max | |
| Propagation delay time ($\overline{\text{CK}}$ - Q1) | t _{pLH} t _{pHL} | — | 3.3 ± 0.3 | 15 | — | 7.5 | 11.9 | 1.0 | 14.0 | ns |
| | | | | 50 | — | 10.0 | 15.4 | 1.0 | 17.5 | |
| | | | 5.0 ± 0.5 | 15 | — | 4.8 | 7.3 | 1.0 | 8.5 | |
| | | | | 50 | — | 6.3 | 9.3 | 1.0 | 10.5 | |
| Propagation delay time (Q _n - Q _n + 1) | Δt _{pd} | — | 3.3 ± 0.3 | 50 | — | 2.4 | 4.4 | 1.0 | 5.0 | ns |
| | | | 5.0 ± 0.5 | 50 | — | 1.6 | 3.1 | 1.0 | 3.5 | |
| Propagation delay time (CLR - Q) | t _{pHL} | — | 3.3 ± 0.3 | 15 | — | 8.3 | 12.8 | 1.0 | 15.0 | ns |
| | | | | 50 | — | 10.8 | 16.3 | 1.0 | 18.5 | |
| | | | 5.0 ± 0.5 | 15 | — | 5.6 | 8.6 | 1.0 | 10.0 | |
| | | | | 50 | — | 7.1 | 10.6 | 1.0 | 12.0 | |
| Maximum clock frequency | f _{max} | — | 3.3 ± 0.3 | 15 | 75 | 140 | — | 75 | — | MHz |
| | | | | 50 | 55 | 80 | — | 50 | — | |
| | | | 5.0 ± 0.5 | 15 | 150 | 210 | — | 125 | — | |
| | | | | 50 | 95 | 125 | — | 80 | — | |
| Input capacitance | C _{IN} | — | | | — | 4 | 10 | — | 10 | pF |
| Power dissipation capacitance | C _{PD} | (Note) | | | — | 21 | — | — | — | pF |

Note: C_{PD} is defined as the value of the internal equivalent capacitance which is calculated from the operating current consumption without load.

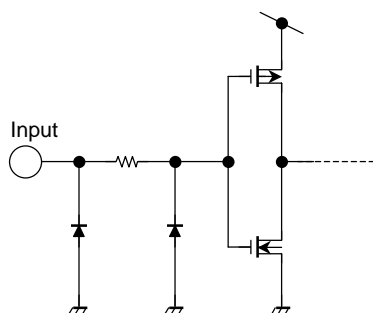
Average operating current can be obtained by the equation:

$$I_{\text{CC (opr)}} = C_{\text{PD}} \cdot V_{\text{CC}} \cdot f_{\text{IN}} + I_{\text{CC}}$$

Noise Characteristics (Input: $t_r = t_f = 3\text{ ns}$)

| Characteristics | Symbol | Test Condition | Ta = 25°C | | Unit |
|--|------------------|------------------------|---------------------|------------|------|
| | | | V _{CC} (V) | Typ. Limit | |
| Quiet output maximum dynamic V _{OL} | V _{OLP} | C _L = 50 pF | 5.0 | 1.2 1.5 | V |
| Quiet output minimum dynamic V _{OL} | V _{OLV} | C _L = 50 pF | 5.0 | -1.2 -1.5 | V |
| Minimum high level dynamic input voltage V _{IH} | V _{IHD} | C _L = 50 pF | 5.0 | — 3.5 | V |
| Minimum low level dynamic input voltage V _{IL} | V _{ILD} | C _L = 50 pF | 5.0 | — 1.5 | V |

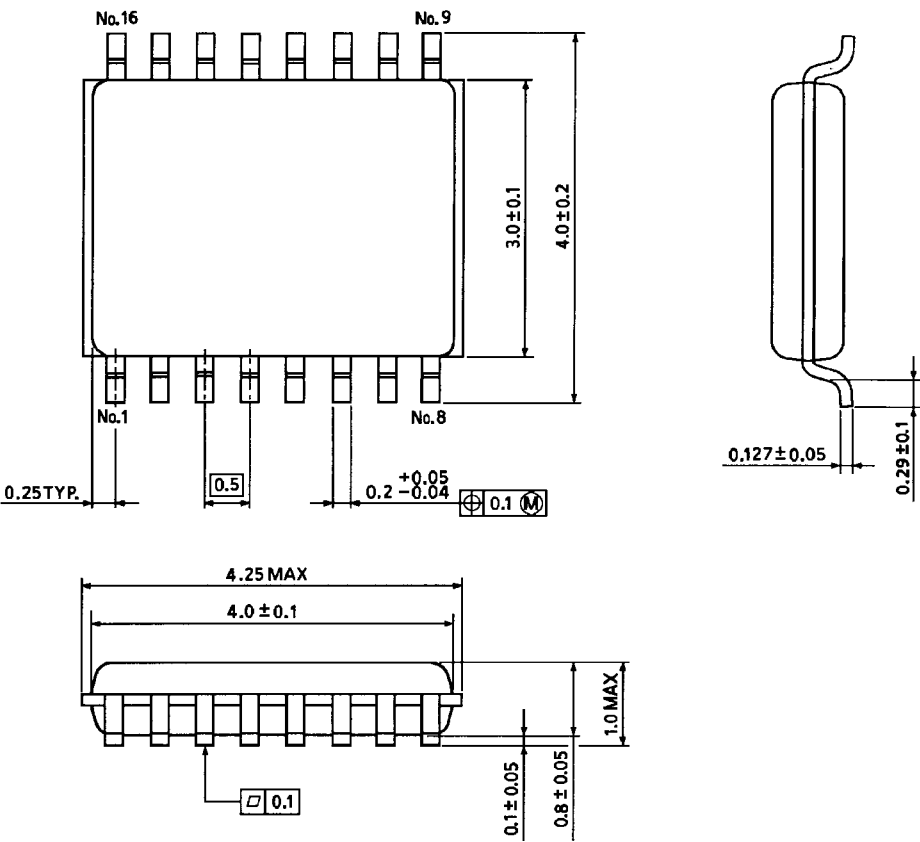
Input Equivalent Circuit



Package Dimensions

VSSOP16-P-0030-0.50

Unit : mm



Weight: 0.02 g (typ.)

RESTRICTIONS ON PRODUCT USE

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