

CD4013BM/CD4013BC Dual D Flip-Flop

General Description

The CD4013B dual D flip-flop is a monolithic complementary MOS (CMOS) integrated circuit constructed with N- and P-channel enhancement mode transistors. Each flip-flop has independent data, set, reset, and clock inputs and "Q" and "Q̄" outputs. These devices can be used for shift register applications, and by connecting "Q̄" output to the data input, for counter and toggle applications. The logic level present at the "D" input is transferred to the Q output during the positive-going transition of the clock pulse. Setting or resetting is independent of the clock and is accomplished by a high level on the set or reset line respectively.

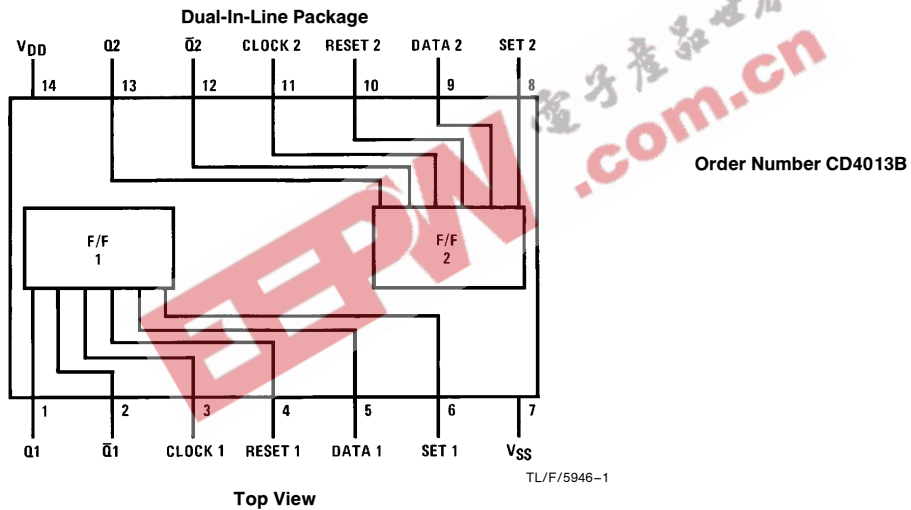
Features

- Wide supply voltage range 3.0V to 15V
- High noise immunity 0.45 V_{DD} (typ.)
- Low power TTL compatibility fan out of 2 driving 74L or 1 driving 74LS




Applications

- Automotive
- Data terminals
- Instrumentation
- Medical electronics
- Alarm system
- Industrial electronics
- Remote metering
- Computers

Connection Diagram



Truth Table

| CL [†] | D | R | S | Q | Q̄ |
|---|---|---|---|---|----|
|  | 0 | 0 | 0 | 0 | 1 |
|  | 1 | 0 | 0 | 1 | 0 |
|  | x | 0 | 0 | Q | Q̄ |
| x | x | 1 | 0 | 0 | 1 |
| x | x | 0 | 1 | 1 | 0 |
| x | x | 1 | 1 | 1 | 1 |

No change
[†] = Level change
 x = Don't care case

Absolute Maximum Ratings (Notes 1 & 2)

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/Distributors for availability and specifications.

| | |
|--------------------------------|--|
| DC Supply Voltage (V_{DD}) | -0.5 V_{DC} to +18 V_{DC} |
| Input Voltage (V_{IN}) | -0.5 V_{DC} to V_{DD} + 0.5 V_{DC} |
| Storage Temp. Range (T_S) | -65°C to +150°C |
| Power Dissipation (P_D) | |
| Dual-In-Line | 700 mW |
| Small Outline | 500 mW |
| Lead Temperature (T_L) | |
| (Soldering, 10 seconds) | 260°C |

Recommended Operating Conditions (Note 2)

| | |
|---------------------------------------|---------------------------------|
| DC Supply Voltage (V_{DD}) | +3 V_{DC} to +15 V_{DC} |
| Input Voltage (V_{IN}) | 0 V_{DC} to V_{DD} V_{DC} |
| Operating Temperature Range (T_A) | |
| CD4013BM | -55°C to +125°C |
| CD4013BC | -40°C to +85°C |

DC Electrical Characteristics CD4013BM (Note 2)

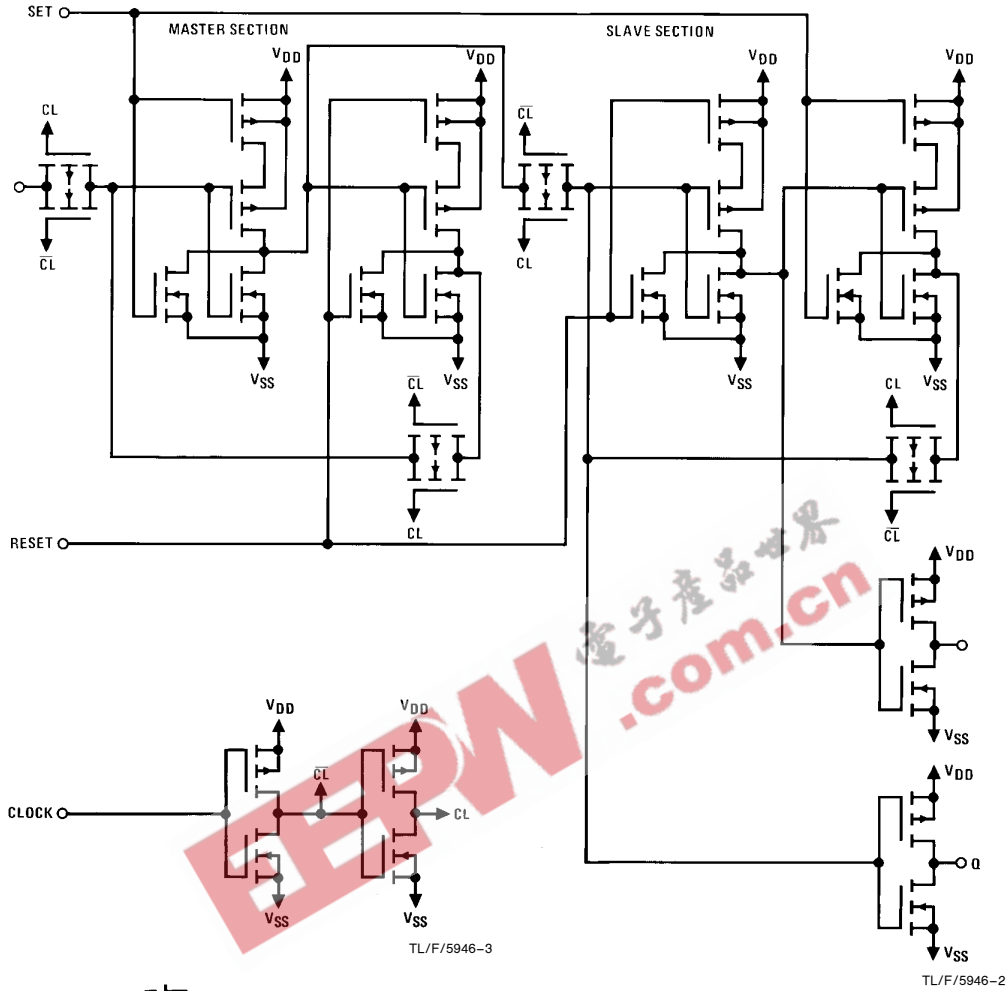
| Symbol | Parameter | Conditions | -55°C | | +25°C | | | +125°C | | Units |
|----------|------------------------------------|--|-------|------|-------|------------|------|--------|------|---------|
| | | | Min | Max | Min | Typ | Max | Min | Max | |
| I_{DD} | Quiescent Device Current | $V_{DD} = 5V, V_{IN} = V_{DD}$ or V_{SS} | | 1.0 | | | 1.0 | | 30 | μA |
| | | $V_{DD} = 10V, V_{IN} = V_{DD}$ or V_{SS} | | 2.0 | | | 2.0 | | 60 | μA |
| | | $V_{DD} = 15V, V_{IN} = V_{DD}$ or V_{SS} | | 4.0 | | | 4.0 | | 120 | μA |
| V_{OL} | Low Level Output Voltage | $ I_O < 1.0 \mu A$ $V_{DD} = 5V$ | | 0.05 | | | 0.05 | | 0.05 | V |
| | | $V_{DD} = 10V$ | | 0.05 | | | 0.05 | | 0.05 | V |
| | | $V_{DD} = 15V$ | | 0.05 | | | 0.05 | | 0.05 | V |
| V_{OH} | High Level Output Voltage | $ I_O < 1.0 \mu A$ $V_{DD} = 5V$ | 4.95 | | 4.95 | | | 4.95 | | V |
| | | $V_{DD} = 10V$ | 9.95 | | 9.95 | | | 9.95 | | V |
| | | $V_{DD} = 15V$ | 14.95 | | 14.95 | | | 14.95 | | V |
| V_{IL} | Low Level Input Voltage | $ I_O < 1.0 \mu A$ $V_{DD} = 5V, V_O = 0.5V$ or $4.5V$ | | 1.5 | | | 1.5 | | 1.5 | V |
| | | $V_{DD} = 10V, V_O = 1.0V$ or $9.0V$ | | 3.0 | | | 3.0 | | 3.0 | V |
| | | $V_{DD} = 15V, V_O = 1.5V$ or $13.5V$ | | 4.0 | | | 4.0 | | 4.0 | V |
| V_{IH} | High Level Input Voltage | $ I_O < 1.0 \mu A$ $V_{DD} = 5V, V_O = 0.5V$ or $4.5V$ | 3.5 | | 3.5 | | | 3.5 | | V |
| | | $V_{DD} = 10V, V_O = 1.0V$ or $9.0V$ | 7.0 | | 7.0 | | | 7.0 | | V |
| | | $V_{DD} = 15V, V_O = 1.5V$ or $13.5V$ | 11.0 | | 11.0 | | | 11.0 | | V |
| I_{OL} | Low Level Output Current (Note 3) | $V_{DD} = 5V, V_O = 0.4V$ | 0.64 | | 0.51 | 0.88 | | 0.36 | | mA |
| | | $V_{DD} = 10V, V_O = 0.5V$ | 1.6 | | 1.3 | 2.25 | | 0.9 | | mA |
| | | $V_{DD} = 15V, V_O = 1.5V$ | 4.2 | | 3.4 | 8.8 | | 2.4 | | mA |
| I_{OH} | High Level Output Current (Note 3) | $V_{DD} = 5V, V_O = 4.6V$ | -0.64 | | -0.51 | -0.88 | | -0.36 | | mA |
| | | $V_{DD} = 10V, V_O = 9.5V$ | -1.6 | | -1.3 | -2.25 | | -0.9 | | mA |
| | | $V_{DD} = 15V, V_O = 13.5V$ | -4.2 | | -3.4 | -8.8 | | -2.4 | | mA |
| I_{IN} | Input Current | $V_{DD} = 15V, V_{IN} = 0V$ | | -0.1 | | -10^{-5} | -0.1 | | -1.0 | μA |
| | | $V_{DD} = 15V, V_{IN} = 15V$ | | 0.1 | | 10^{-5} | 0.1 | | 1.0 | μA |


DC Electrical Characteristics CD4013BC (Note 2)


| Symbol | Parameter | Conditions | -40°C | | +25°C | | | +85°C | | Units |
|----------|---------------------------|--|-------|------|-------|-----|------|-------|------|---------|
| | | | Min | Max | Min | Typ | Max | Min | Max | |
| I_{DD} | Quiescent Device Current | $V_{DD} = 5V, V_{IN} = V_{DD}$ or V_{SS} | | 4.0 | | | 4.0 | | 30 | μA |
| | | $V_{DD} = 10V, V_{IN} = V_{DD}$ or V_{SS} | | 8.0 | | | 8.0 | | 60 | μA |
| | | $V_{DD} = 15V, V_{IN} = V_{DD}$ or V_{SS} | | 16.0 | | | 16.0 | | 120 | μA |
| V_{OL} | Low Level Output Voltage | $ I_O < 1.0 \mu A$ $V_{DD} = 5V$ | | 0.05 | | | 0.05 | | 0.05 | V |
| | | $V_{DD} = 10V$ | | 0.05 | | | 0.05 | | 0.05 | V |
| | | $V_{DD} = 15V$ | | 0.05 | | | 0.05 | | 0.05 | V |
| V_{OH} | High Level Output Voltage | $ I_O < 1.0 \mu A$ $V_{DD} = 5V$ | 4.95 | | 4.95 | | | 4.95 | | V |
| | | $V_{DD} = 10V$ | 9.95 | | 9.95 | | | 9.95 | | V |
| | | $V_{DD} = 15V$ | 14.95 | | 14.95 | | | 14.95 | | V |
| V_{IL} | Low Level Input Voltage | $ I_O < 1.0 \mu A$ $V_{DD} = 5V, V_O = 0.5V$ or $4.5V$ | | 1.5 | | | 1.5 | | 1.5 | V |
| | | $V_{DD} = 10V, V_O = 1.0V$ or $9.0V$ | | 3.0 | | | 3.0 | | 3.0 | V |
| | | $V_{DD} = 15V, V_O = 1.5V$ or $13.5V$ | | 4.0 | | | 4.0 | | 4.0 | V |

| DC Electrical Characteristics CD4013BC (Note 2) (Continued) | | | | | | | | | | |
|---|------------------------------------|---|-------|------|-------|-------------------|------|-------|------|-------|
| Symbol | Parameter | Conditions | -40°C | | +25°C | | | +85°C | | Units |
| | | | Min | Max | Min | Typ | Max | Min | Max | |
| V _{IH} | High Level Input Voltage | I _O < 1.0 μA | | | | | | | | |
| | | V _{DD} = 5V, V _O = 0.5V or 4.5V | 3.5 | | 3.5 | | | 3.5 | | V |
| | | V _{DD} = 10V, V _O = 1.0V or 9.0V | 7.0 | | 7.0 | | | 7.0 | | V |
| | | V _{DD} = 15V, V _O = 1.5V or 13.5V | 11.0 | | 11.0 | | | 11.0 | | V |
| I _{OL} | Low Level Output Current (Note 3) | V _{DD} = 5V, V _O = 0.4V | 0.52 | | 0.44 | 0.88 | | 0.36 | | mA |
| | | V _{DD} = 10V, V _O = 0.5V | 1.3 | | 1.1 | 2.25 | | 0.9 | | mA |
| | | V _{DD} = 15V, V _O = 1.5V | 3.6 | | 3.0 | 8.8 | | 2.4 | | mA |
| I _{OH} | High Level Output Current (Note 3) | V _{DD} = 5V, V _O = 4.6V | -0.52 | | -0.44 | -0.88 | | -0.36 | | mA |
| | | V _{DD} = 10V, V _O = 9.5V | -1.3 | | -1.1 | -2.25 | | -0.9 | | mA |
| | | V _{DD} = 15V, V _O = 13.5V | -3.6 | | -3.0 | -8.8 | | -2.4 | | mA |
| I _{IN} | Input Current | V _{DD} = 15V, V _{IN} = 0V | | -0.3 | | -10 ⁻⁵ | -0.3 | | -1.0 | μA |
| | | V _{DD} = 15V, V _{IN} = 15V | | 0.3 | | 10 ⁻⁵ | 0.3 | | 1.0 | μA |
| <p>Note 1: "Absolute Maximum Ratings" are those values beyond which the safety of the device cannot be guaranteed, they are not meant to imply that the devices should be operated at these limits. The tables of "Recommended Operating Conditions" and "Electrical Characteristics" provide conditions for actual device operation.</p> <p>Note 2: V_{SS} = 0V unless otherwise specified.</p> <p>Note 3: I_{OH} and I_{OL} are measured one output at a time.</p> | | | | | | | | | | |
| AC Electrical Characteristics* T _A = 25°C, C _L = 50 pF, R _L = 200k, unless otherwise noted | | | | | | | | | | |
| Symbol | Parameter | Conditions | Min | Typ | Max | Units | | | | |
| CLOCK OPERATION | | | | | | | | | | |
| t _{PHL} , t _{PLH} | Propagation Delay Time | V _{DD} = 5V | | 200 | | 350 | ns | | | |
| | | V _{DD} = 10V | | 80 | | 160 | ns | | | |
| | | V _{DD} = 15V | | 65 | | 120 | ns | | | |
| t _{THL} , t _{TLH} | Transition Time | V _{DD} = 5V | | 100 | | 200 | ns | | | |
| | | V _{DD} = 10V | | 50 | | 100 | ns | | | |
| | | V _{DD} = 15V | | 40 | | 80 | ns | | | |
| t _{WL} , t _{WH} | Minimum Clock Pulse Width | V _{DD} = 5V | | 100 | | 200 | ns | | | |
| | | V _{DD} = 10V | | 40 | | 80 | ns | | | |
| | | V _{DD} = 15V | | 32 | | 65 | ns | | | |
| t _{RCL} , t _{FCL} | Maximum Clock Rise and Fall Time | V _{DD} = 5V | | | | 15 | μs | | | |
| | | V _{DD} = 10V | | | | 10 | μs | | | |
| | | V _{DD} = 15V | | | | 5 | μs | | | |
| t _{SU} | Minimum Set-Up Time | V _{DD} = 5V | | 20 | | 40 | ns | | | |
| | | V _{DD} = 10V | | 15 | | 30 | ns | | | |
| | | V _{DD} = 15V | | 12 | | 25 | ns | | | |
| f _{CL} | Maximum Clock Frequency | V _{DD} = 5V | 2.5 | 5 | | | MHz | | | |
| | | V _{DD} = 10V | 6.2 | 12.5 | | | MHz | | | |
| | | V _{DD} = 15V | 7.6 | 15.5 | | | MHz | | | |
| SET AND RESET OPERATION | | | | | | | | | | |
| t _{PHL(R)} , t _{PLH(S)} | Propagation Delay Time | V _{DD} = 5V | | 150 | | 300 | ns | | | |
| | | V _{DD} = 10V | | 65 | | 130 | ns | | | |
| | | V _{DD} = 15V | | 45 | | 90 | ns | | | |
| t _{WH(R)} , t _{WH(S)} | Minimum Set and Reset Pulse Width | V _{DD} = 5V | | 90 | | 180 | ns | | | |
| | | V _{DD} = 10V | | 40 | | 80 | ns | | | |
| | | V _{DD} = 15V | | 25 | | 50 | ns | | | |
| C _{IN} | Average Input Capacitance | Any Input | | 5 | | 7.5 | pF | | | |
| *AC Parameters are guaranteed by DC correlated testing. | | | | | | | | | | |

Schematic Diagram

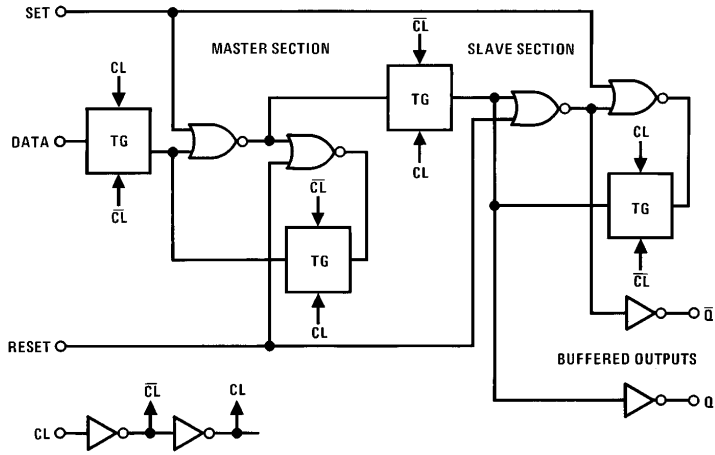


ALL P-SUBSTRATES () CONNECTED TO V_{DD}

ALL N-SUBSTRATES () CONNECTED TO V_{SS}

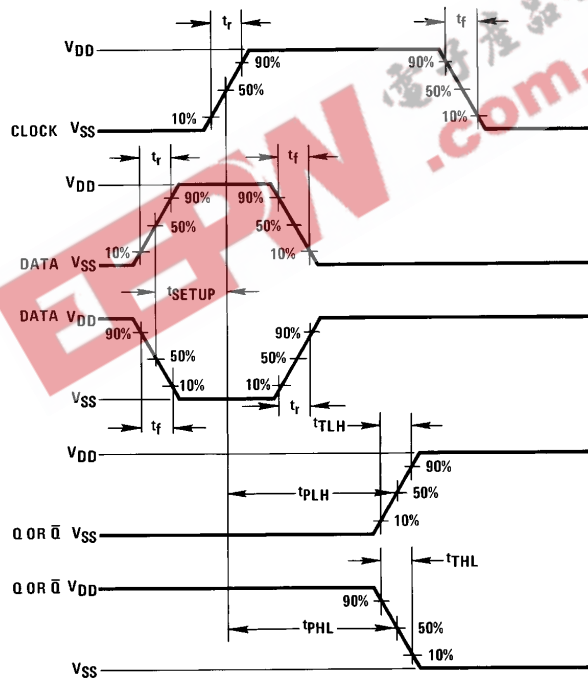
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Logic Diagram



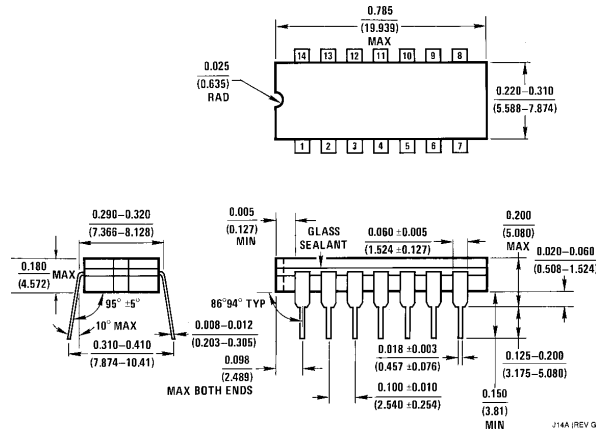
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Switching Time Waveforms

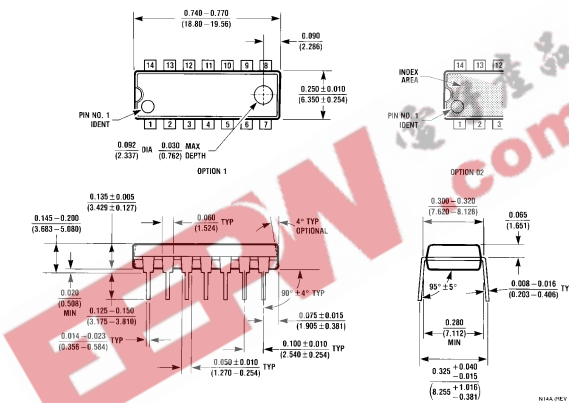


TL/F/5946-6

Physical Dimensions inches (millimeters)



Ceramic Dual-In-Line Package (J)
Order Number CD4013BMJ or CD4013BCJ
NS Package Number J14A



Molded Dual-In-Line Package (N)
Order Number CD4013BMN or CD4013BCN
NS Package Number N14A

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2. A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.



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