

February 1988

CD4013BM/CD4013BC Dual D Flip-Flop

# 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

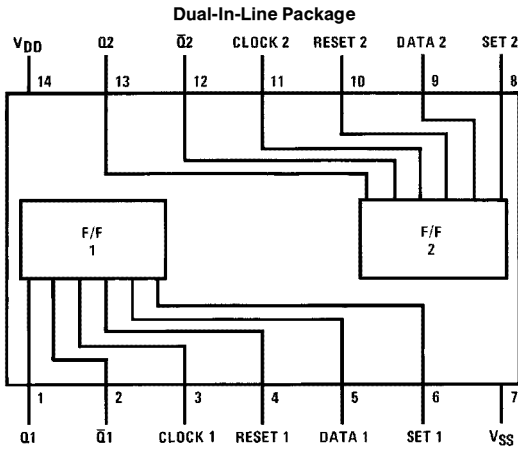
- Wide supply voltage range
- High noise immunity
- Low power TTL compatibility

3.0V to 15V  
 0.45 V<sub>DD</sub> (typ.)  
 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



Order Number CD4013B

TL/F/5946-1

Top View

## Truth Table

CL <sup>†</sup>	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	$\mu A$
		$V_{DD} = 10V, V_{IN} = V_{DD}$ or $V_{SS}$		2.0			2.0		60	$\mu A$
		$V_{DD} = 15V, V_{IN} = V_{DD}$ or $V_{SS}$		4.0			4.0		120	$\mu A$
$V_{OL}$	Low Level Output Voltage	$ I_O  < 1.0 \mu A$								
		$V_{DD} = 5V$		0.05			0.05		0.05	V
		$V_{DD} = 10V$ $V_{DD} = 15V$		0.05 0.05			0.05 0.05		0.05 0.05	V V
$V_{OH}$	High Level Output Voltage	$ I_O  < 1.0 \mu A$								
		$V_{DD} = 5V$	4.95		4.95			4.95		V
		$V_{DD} = 10V$ $V_{DD} = 15V$	9.95 14.95		9.95 14.95			9.95 14.95		V 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 $V_{DD} = 15V, V_O = 1.5V$ or 13.5V		3.0 4.0			3.0 4.0		3.0 4.0	V 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 $V_{DD} = 15V, V_O = 1.5V$ or 13.5V	7.0 11.0		7.0 11.0			7.0 11.0		V 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	$\mu A$
		$V_{DD} = 15V, V_{IN} = 15V$		0.1		$10^{-5}$	0.1		1.0	$\mu A$

**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	$\mu A$
		$V_{DD} = 10V, V_{IN} = V_{DD}$ or $V_{SS}$		8.0			8.0		60	$\mu A$
		$V_{DD} = 15V, V_{IN} = V_{DD}$ or $V_{SS}$		16.0			16.0		120	$\mu A$
$V_{OL}$	Low Level Output Voltage	$ I_O  < 1.0 \mu A$								
		$V_{DD} = 5V$		0.05			0.05		0.05	V
		$V_{DD} = 10V$ $V_{DD} = 15V$		0.05 0.05			0.05 0.05		0.05 0.05	V V
$V_{OH}$	High Level Output Voltage	$ I_O  < 1.0 \mu A$								
		$V_{DD} = 5V$	4.95		4.95			4.95		V
		$V_{DD} = 10V$ $V_{DD} = 15V$	9.95 14.95		9.95 14.95			9.95 14.95		V 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 $V_{DD} = 15V, V_O = 1.5V$ or 13.5V		3.0 4.0			3.0 4.0		3.0 4.0	V 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 <sub>IH</sub>	High Level Input Voltage	I <sub>O</sub>   < 1.0 μA								
		V <sub>DD</sub> = 5V, V <sub>O</sub> = 0.5V or 4.5V	3.5		3.5			3.5		V
		V <sub>DD</sub> = 10V, V <sub>O</sub> = 1.0V or 9.0V	7.0		7.0			7.0		V
		V <sub>DD</sub> = 15V, V <sub>O</sub> = 1.5V or 13.5V	11.0		11.0			11.0		V
I <sub>OL</sub>	Low Level Output Current (Note 3)	V <sub>DD</sub> = 5V, V <sub>O</sub> = 0.4V	0.52		0.44	0.88		0.36		mA
		V <sub>DD</sub> = 10V, V <sub>O</sub> = 0.5V	1.3		1.1	2.25		0.9		mA
		V <sub>DD</sub> = 15V, V <sub>O</sub> = 1.5V	3.6		3.0	8.8		2.4		mA
I <sub>OH</sub>	High Level Output Current (Note 3)	V <sub>DD</sub> = 5V, V <sub>O</sub> = 4.6V	-0.52		-0.44	-0.88		-0.36		mA
		V <sub>DD</sub> = 10V, V <sub>O</sub> = 9.5V	-1.3		-1.1	-2.25		-0.9		mA
		V <sub>DD</sub> = 15V, V <sub>O</sub> = 13.5V	-3.6		-3.0	-8.8		-2.4		mA
I <sub>IN</sub>	Input Current	V <sub>DD</sub> = 15V, V <sub>IN</sub> = 0V		-0.3		-10 <sup>-5</sup>	-0.3		-1.0	μA
		V <sub>DD</sub> = 15V, V <sub>IN</sub> = 15V		0.3		10 <sup>-5</sup>	0.3		1.0	μA

**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.

**Note 2:** V<sub>SS</sub> = 0V unless otherwise specified.

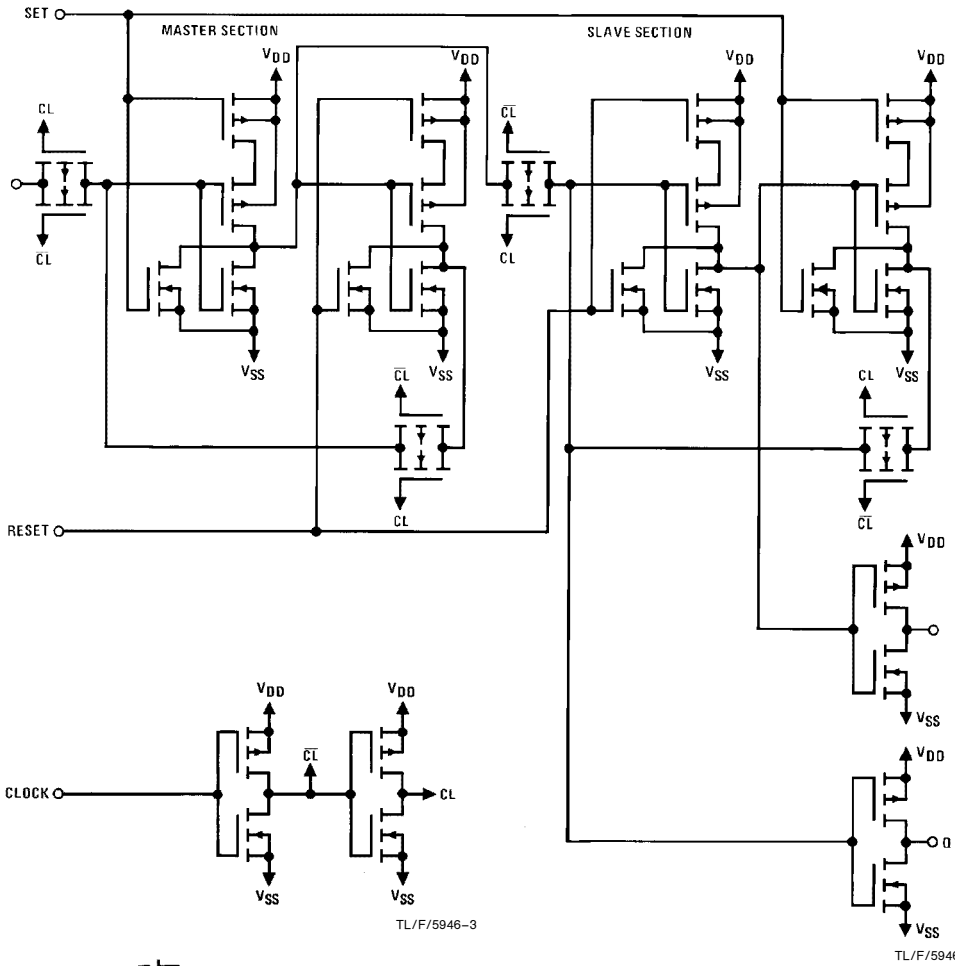
**Note 3:** I<sub>OH</sub> and I<sub>OL</sub> are measured one output at a time.

**AC Electrical Characteristics**\* T<sub>A</sub> = 25°C, C<sub>L</sub> = 50 pF, R<sub>L</sub> = 200k, unless otherwise noted

Symbol	Parameter	Conditions	Min	Typ	Max	Units
<b>CLOCK OPERATION</b>						
t <sub>PHL</sub> , t <sub>PLH</sub>	Propagation Delay Time	V <sub>DD</sub> = 5V		200	350	ns
		V <sub>DD</sub> = 10V		80	160	ns
		V <sub>DD</sub> = 15V		65	120	ns
t <sub>THL</sub> , t <sub>TLH</sub>	Transition Time	V <sub>DD</sub> = 5V		100	200	ns
		V <sub>DD</sub> = 10V		50	100	ns
		V <sub>DD</sub> = 15V		40	80	ns
t <sub>WL</sub> , t <sub>WH</sub>	Minimum Clock Pulse Width	V <sub>DD</sub> = 5V		100	200	ns
		V <sub>DD</sub> = 10V		40	80	ns
		V <sub>DD</sub> = 15V		32	65	ns
t <sub>RCL</sub> , t <sub>FCL</sub>	Maximum Clock Rise and Fall Time	V <sub>DD</sub> = 5V			15	μs
		V <sub>DD</sub> = 10V			10	μs
		V <sub>DD</sub> = 15V			5	μs
t <sub>SU</sub>	Minimum Set-Up Time	V <sub>DD</sub> = 5V		20	40	ns
		V <sub>DD</sub> = 10V		15	30	ns
		V <sub>DD</sub> = 15V		12	25	ns
f <sub>CL</sub>	Maximum Clock Frequency	V <sub>DD</sub> = 5V	2.5	5		MHz
		V <sub>DD</sub> = 10V	6.2	12.5		MHz
		V <sub>DD</sub> = 15V	7.6	15.5		MHz
<b>SET AND RESET OPERATION</b>						
t <sub>PHL(R)</sub> , t <sub>PLH(S)</sub>	Propagation Delay Time	V <sub>DD</sub> = 5V		150	300	ns
		V <sub>DD</sub> = 10V		65	130	ns
		V <sub>DD</sub> = 15V		45	90	ns
t <sub>WH(R)</sub> , t <sub>WH(S)</sub>	Minimum Set and Reset Pulse Width	V <sub>DD</sub> = 5V		90	180	ns
		V <sub>DD</sub> = 10V		40	80	ns
		V <sub>DD</sub> = 15V		25	50	ns
C <sub>IN</sub>	Average Input Capacitance	Any Input		5	7.5	pF


\*AC Parameters are guaranteed by DC correlated testing.


### Schematic Diagram



TL/F/5946-3

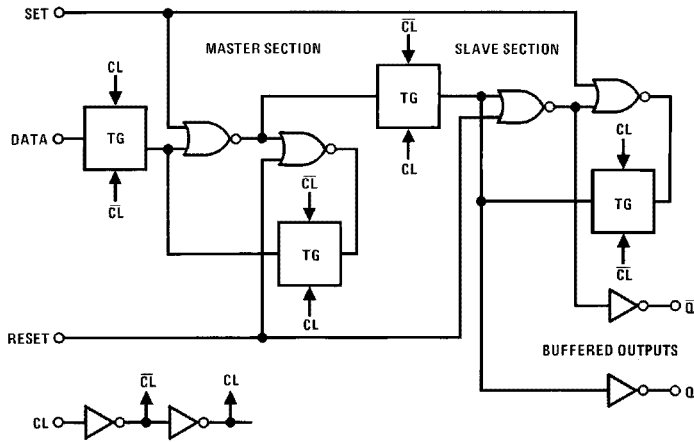
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ALL P-SUBSTRATES (  ) CONNECTED TO V<sub>DD</sub>

ALL N-SUBSTRATES (  ) CONNECTED TO V<sub>SS</sub>

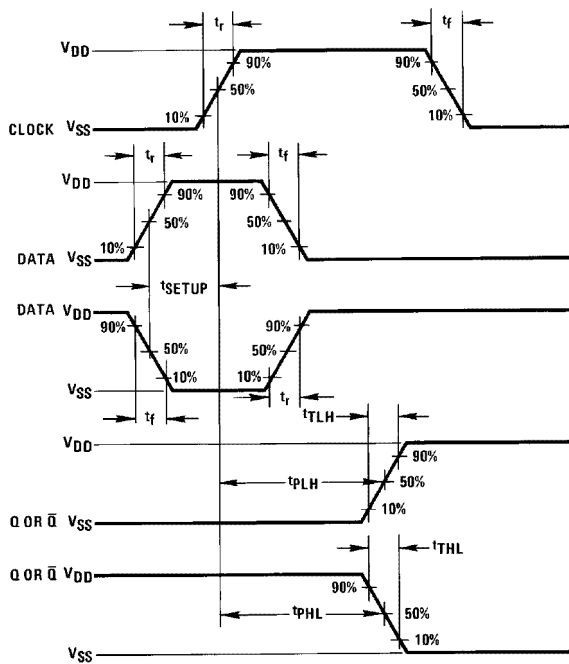
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### Logic Diagram

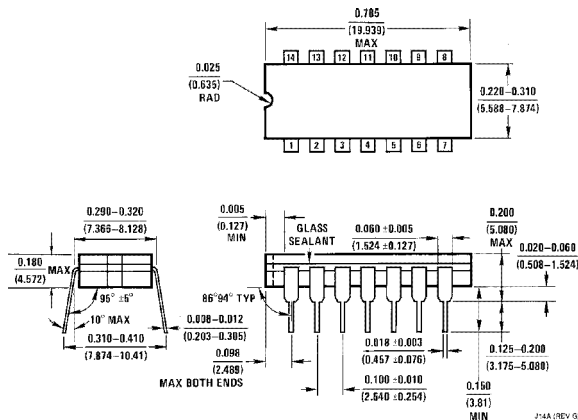


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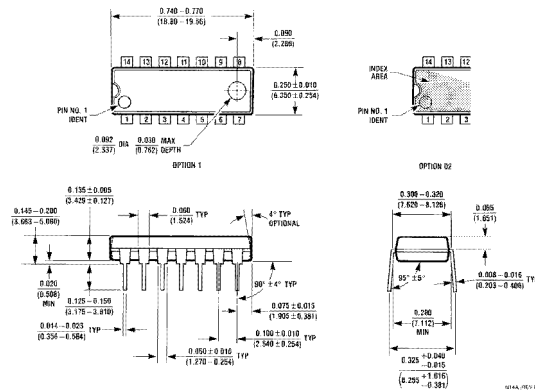
### Switching Time Waveforms



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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**National Semiconductor Corporation**  
 1111 West Bardin Road  
 Arlington, TX 76017  
 Tel: 1(800) 272-9959  
 Fax: 1(800) 737-7018

**National Semiconductor Europe**  
 Fax: (+49) 0-180-530 85 86  
 Email: cnjwge@tevm2.nsc.com  
 Deutsch Tel: (+49) 0-180-530 85 85  
 English Tel: (+49) 0-180-532 78 32  
 Français Tel: (+49) 0-180-532 93 58  
 Italiano Tel: (+49) 0-180-534 16 80

**National Semiconductor Hong Kong Ltd.**  
 13th Floor, Straight Block,  
 Ocean Centre, 5 Canton Rd.  
 Tsimshatsui, Kowloon  
 Hong Kong  
 Tel: (852) 2737-1600  
 Fax: (852) 2736-9960

**National Semiconductor Japan Ltd.**  
 Tel: 81-043-299-2309  
 Fax: 81-043-299-2408