National Semiconductor

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 "$\overline{Q}$" outputs. These devices can be used for shift register applications, and by connecting "$\overline{Q}$" 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

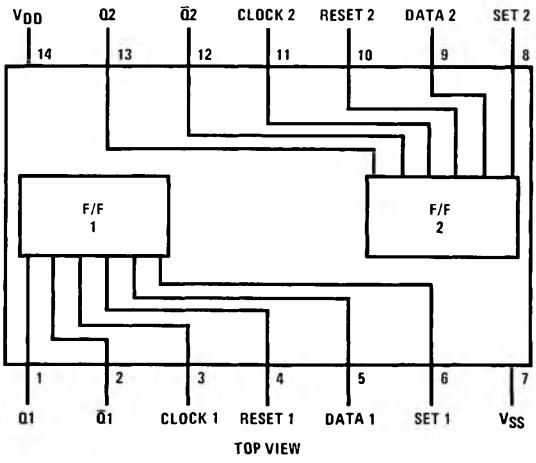
■ Wide supply voltage range	3.0 V to 15 V
■ High noise immunity	0.45 V_{DD} (typ.)
■ Low power TTL compatibility	fan out of 2 driving 74L or 1 driving 74LS

Applications

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

Connection Diagram

Dual-In-Line and Flat Package



TOP VIEW

Truth Table

CL†	D	R	S	Q	$\overline{Q}$
↗	0	0	0	0	1
↗	1	0	0	1	0
↘	x	0	0	Q	$\overline{Q}$
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 and 2)

V_{DD} dc Supply Voltage	−0.5 to +18 V_{DC}
V_{IN} Input Voltage	−0.5 to V_{DD} +0.5 V_{DC}
T_S Storage Temperature Range	−65°C to +150°C
P_D Package Dissipation	500 mW
T_L Lead Temperature (Soldering, 10 seconds)	300°C

Recommended Operating Conditions

(Note 2)

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

DC Electrical Characteristics 4013BM (Note 2)

PARAMETER		CONDITIONS	−55°C		25°C			125°C		UNITS
			MIN	MAX	MIN	TYP	MAX	MIN	MAX	
I_{DD}	Quiescent Device Current	V_{DD} = 5V		1.0			1.0		30	μA
		V_{DD} = 10V		2.0			2.0		60	μA
		V_{DD} = 15V		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	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	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 4013BC (Note 2)

PARAMETER		CONDITIONS	−40°C		25°C			85°C		UNITS
			MIN	MAX	MIN	TYP	MAX	MIN	MAX	
I_{DD}	Quiescent Device Current	V_{DD} = 5V		4.0			4.0		30	μA
		V_{DD} = 10V		8.0			8.0		60	μA
		V_{DD} = 15V		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 (Cont'd.) CD4013BC (Note 2)

PARAMETER		CONDITIONS	−40°C		25°C			85°C		UNITS
			MIN	MAX	MIN	TYP	MAX	MIN	MAX	
V_{IH}	High Level Input Voltage	$\|I_O\| < 1.0\mu A$								
		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	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	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

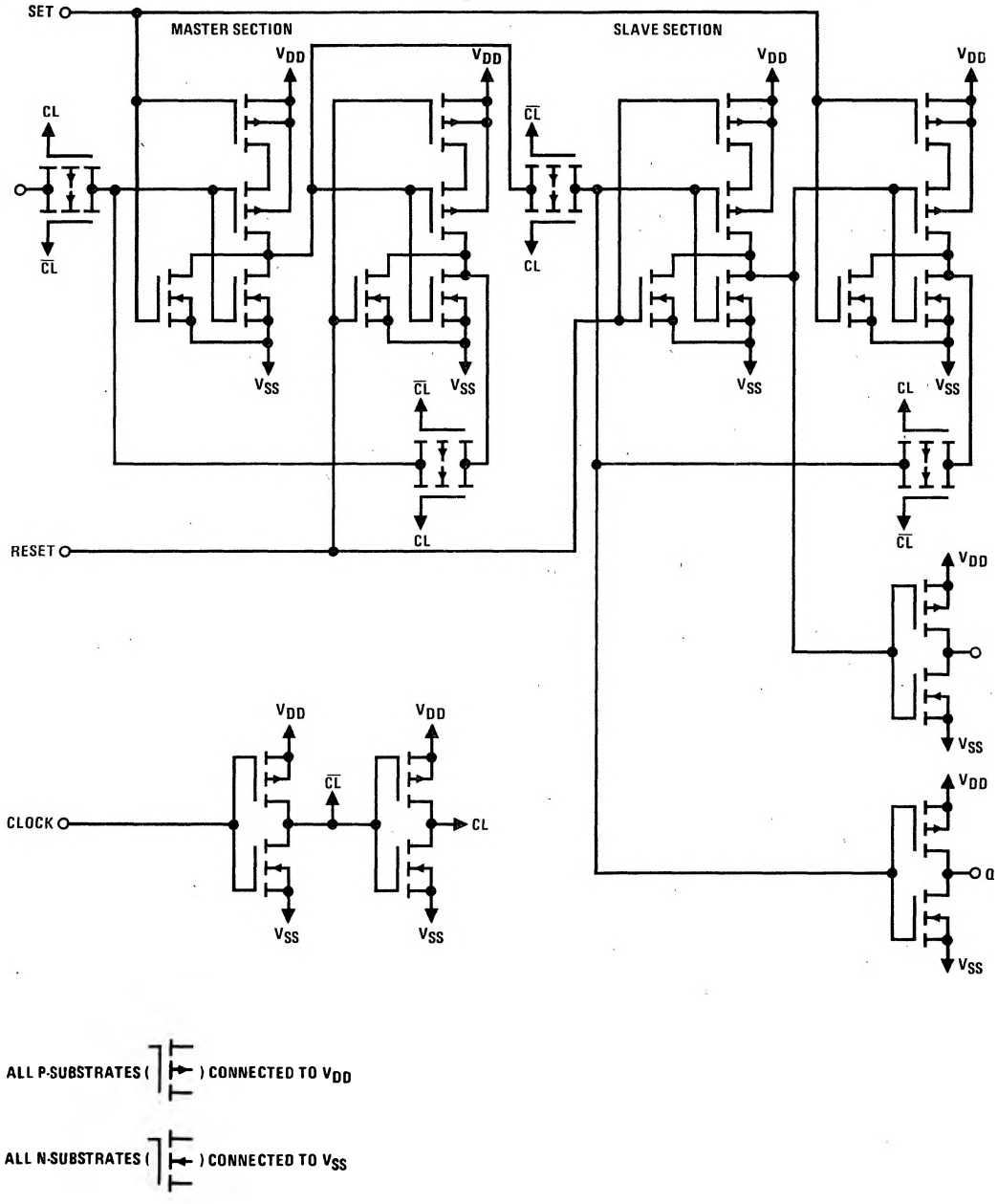
Note 1: "Absolute Maximum Ratings" are those values beyond which the safety of the device cannot be guaranteed, they are not meant to imply that the devices should be operated at these limits. The table of "Recommended Operating Conditions" and "Electrical Characteristics" provides conditions for actual device operation.

Note 2: V_{SS} = 0V unless otherwise specified.

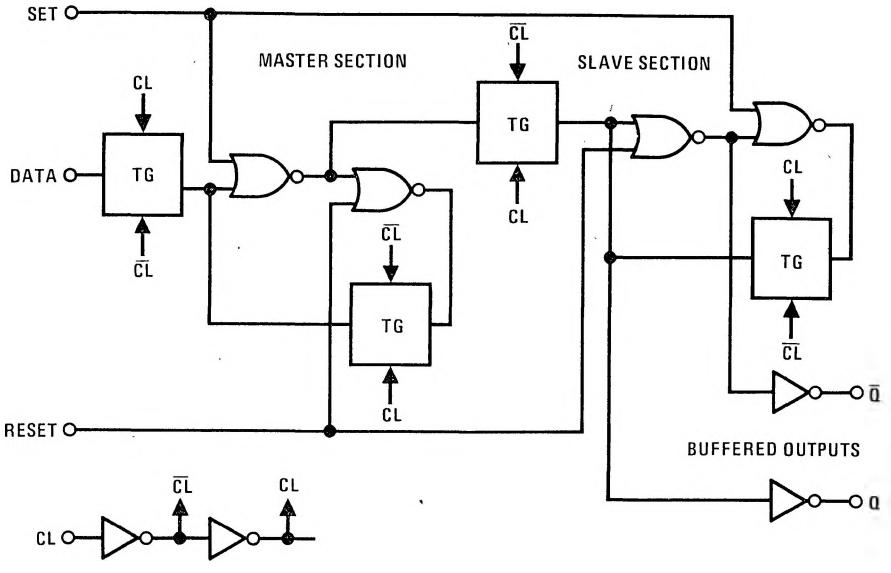
AC Electrical Characteristics T_A = 25°C, C_L = 50 pF, R_L = 200 k, unless otherwise noted

PARAMETER		CONDITIONS	MIN	TYP	MAX	UNITS
CLOCK OPERATION						
t_{PHL}, or 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}, or t_{TLH}	Transition Time	V_{DD} = 5V		100	200	ns
		V_{DD} = 10V		50	100	ns
		V_{DD} = 15V		40	80	ns
t_{WL}, or 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

Schematic Diagram



Logic Diagram



Switching Time Waveforms