

CD4013B Types

CMOS Dual 'D'-Type Flip-Flop

High-Voltage Types (20-Volt Rating)

■ CD4013B consists of two identical, independent data-type flip-flops. Each flip-flop has independent data, set, reset, and clock inputs and Q and \bar{Q} outputs. These devices can be used for shift register applications, and, by connecting \bar{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.

The CD4013B types are supplied in 14-lead hermetic dual-in-line ceramic packages (D and F suffixes), 14-lead dual-in-line plastic packages (E suffix), and in chip form (H suffix).

Features:

- Set-Reset capability
- Static flip-flop operation — retains state indefinitely with clock level either "high" or "low"
- Medium-speed operation — 16 MHz (typ.) clock toggle rate at 10V
- Standardized symmetrical output characteristics
- 100% tested for quiescent current at 20 V
- Maximum input current of 1 μ A at 18 V over full package temperature range; 100 nA at 18 V and 25°C
- Noise margin (over full package temperature range):
1 V at $V_{DD}=5$ V
2 V at $V_{DD}=10$ V
2.5 V at $V_{DD}=15$ V
- 5-V, 10-V, and 15-V parametric ratings
- Meets all requirements of JEDEC Tentative Standard No. 13B, "Standard Specifications for Description of 'B' Series CMOS Devices"

Applications:

- Registers, counters, control circuits

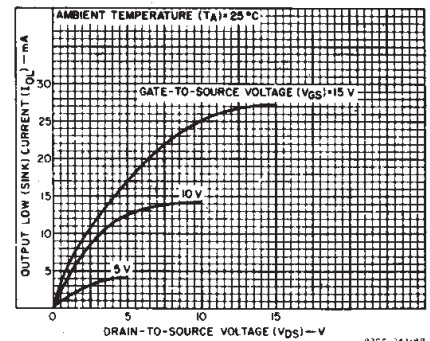
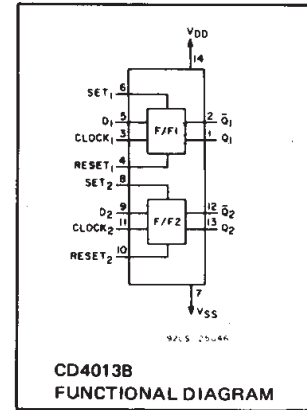


Fig. 1 — Typical output low (sink) current characteristics.

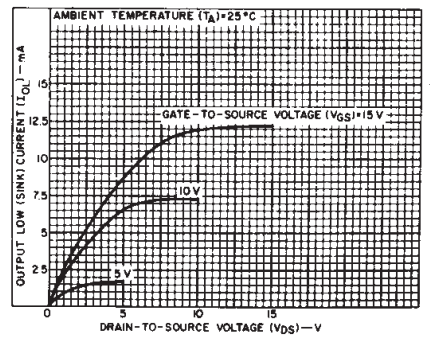


Fig. 2 — Minimum output low (sink) current characteristics.

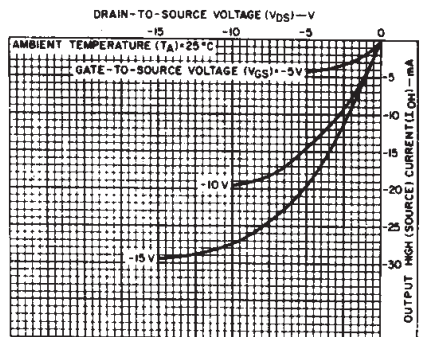


Fig. 3 — Typical output high (source) current characteristics.

RECOMMENDED OPERATING CONDITIONS

At $T_A = 25^\circ\text{C}$, Except as Noted. For maximum reliability, nominal operating conditions should be selected so that operation is always within the following ranges:

CHARACTERISTIC	V_{DD} (V)	LIMITS		UNITS
		MIN.	MAX.	
Supply-Voltage Range (For $T_A =$ Full Package Temperature Range)	—	3	18	V
Data Setup Time t_S	5	40	—	ns
	10	20	—	
Clock Pulse Width t_W	5	140	—	ns
	10	60	—	
Clock Input Frequency f_{CL}	5	—	3.5	MHz
	10	dc	8	
Clock Rise or Fall Time t_{rCL}, t_{fCL}	5	—	500	μ s
	10	—	30	
Set or Reset Pulse Width t_W	5	180	—	ns
	10	80	—	
	15	50	—	

*If more than one unit is cascaded in a parallel clocked operation, t_{rCL} should be made less than or equal to the sum of the fixed propagation delay time at 15 pF and the transition time of the output driving stage for the estimated capacitive load.

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STATIC ELECTRICAL CHARACTERISTICS

CHARACTERISTIC	CONDITIONS			LIMITS AT INDICATED TEMPERATURES (°C)							UNITS
	V _O (V)	V _{IN} (V)	V _{DD} (V)	-55	-40	+85	+125	+25			
								Min.	Typ.	Max.	
Quiescent Device Current I _{DD} Max.	—	0.5	5	1	1	30	30	—	0.02	1	μA
	—	0.10	10	2	2	60	60	—	0.02	2	
	—	0.15	15	4	4	120	120	—	0.02	4	
	—	0.20	20	20	20	600	600	—	0.04	20	
Output Low (Sink) Current, I _{OL} Min.	0.4	0.5	5	0.64	0.61	0.42	0.36	0.51	1	—	mA
	0.5	0.10	10	1.6	1.5	1.1	0.9	1.3	2.6	—	
	1.5	0.15	15	4.2	4	2.8	2.4	3.4	6.8	—	
	4.6	0.5	5	-0.64	-0.61	-0.42	-0.36	-0.51	-1	—	
Output High (Source) Current, I _{OH} Min.	2.5	0.5	5	-2	-1.8	-1.3	-1.15	-1.6	-3.2	—	mA
	9.5	0.10	10	-1.6	-1.5	-1.1	-0.9	-1.3	-2.6	—	
	13.5	0.15	15	-4.2	-4	-2.8	-2.4	-3.4	-6.8	—	
	4.6	0.5	5	-0.64	-0.61	-0.42	-0.36	-0.51	-1	—	
Output Voltage: Low-Level, V _{OL} Max.	—	0.5	5	0.05				—	0	0.05	V
	—	0.10	10	0.05				—	0	0.05	
	—	0.15	15	0.05				—	0	0.05	
Output Voltage: High-Level, V _{OH} Min.	—	0.5	5	4.95				4.95	5	—	V
	—	0.10	10	9.95				9.95	10	—	
	—	0.15	15	14.95				14.95	15	—	
Input Low Voltage, V _{IL} Max.	0.5, 4.5	—	5	1.5				—	—	1.5	V
	1.9	—	10	3				—	—	3	
	1.5, 13.5	—	15	4				—	—	4	
Input High Voltage, V _{IH} Min.	0.5, 4.5	—	5	3.5				3.5	—	—	V
	1.9	—	10	7				7	—	—	
	1.5, 13.5	—	15	11				11	—	—	
Input Current, I _{IN} Max.	—	0.18	18	±0.1	±0.1	±1	±1	—	±10 ⁻⁵	±0.1	μA

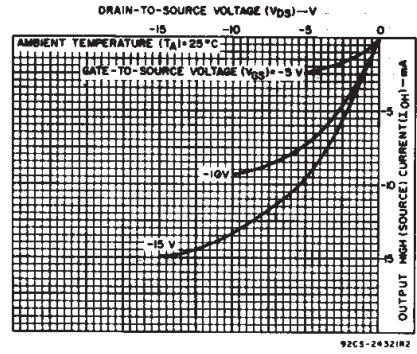


Fig. 4 — Minimum output high (source) current characteristics.

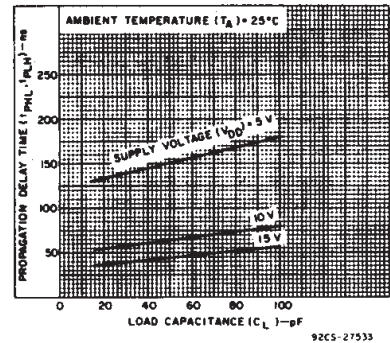


Fig. 5 — Typical propagation delay time vs. load capacitance (CLOCK or SET to Q, CLOCK or RESET to Q).

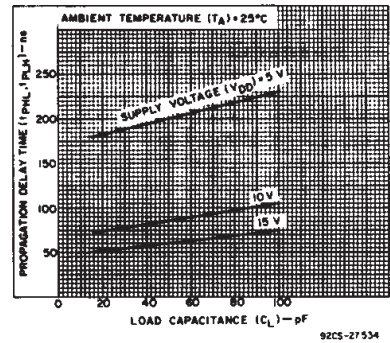


Fig. 6 — Typical propagation delay time vs. load capacitance (SET to Q or RESET to Q).

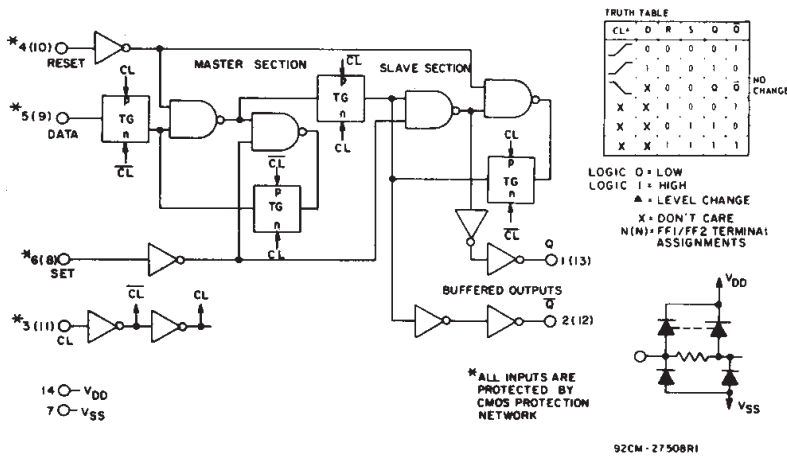


Fig. 7 — Logic diagram and truth table for CD4013B (one of two identical flip-flops).

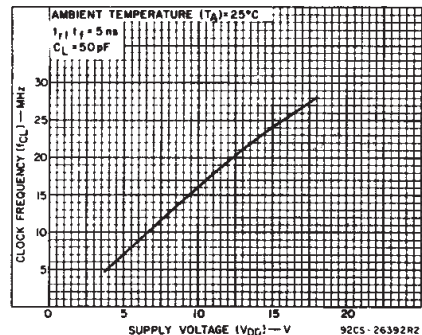


Fig. 8 — Typical maximum clock frequency vs. supply voltage.

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MAXIMUM RATINGS, Absolute-Maximum Values:

DC SUPPLY-VOLTAGE RANGE, (V_{DD})	-0.5V to +20V
Voltages referenced to V_{SS} Terminal	
INPUT VOLTAGE RANGE, ALL INPUTS	-0.5V to V_{DD} +0.5V
DC INPUT CURRENT, ANY ONE INPUT	± 10 mA
POWER DISSIPATION PER PACKAGE (P_D):	
For $T_A = -55^\circ\text{C}$ to $+100^\circ\text{C}$	500mW
For $T_A = +100^\circ\text{C}$ to $+125^\circ\text{C}$	Derate Linearly at 12mW/ $^\circ\text{C}$ to 200mW
DEVICE DISSIPATION PER OUTPUT TRANSISTOR	
FOR $T_A = \text{FULL PACKAGE-TEMPERATURE RANGE (All Package Types)}$	100mW
OPERATING-TEMPERATURE RANGE (T_A)	-55°C to $+125^\circ\text{C}$
STORAGE TEMPERATURE RANGE (T_{stg})	-65°C to $+150^\circ\text{C}$
LEAD TEMPERATURE (DURING SOLDERING):	
At distance $1/16 \pm 1/32$ inch (1.59 ± 0.79 mm) from case for 10s max	$+265^\circ\text{C}$

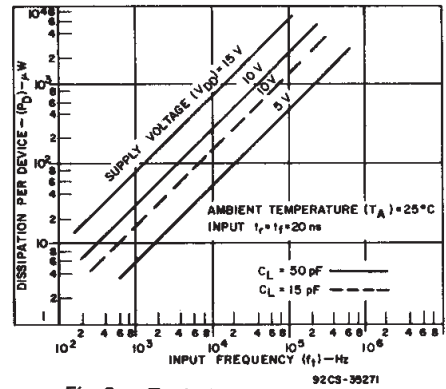


Fig. 9 – Typical power dissipation vs. frequency.

DYNAMIC ELECTRICAL CHARACTERISTICS

At $T_A = 25^\circ\text{C}$; Input $t_r, t_f = 20$ ns, $C_L = 50$ pF, $R_L = 20$ k Ω

CHARACTERISTIC	TEST CONDITIONS V_{DD} (V)	LIMITS			UNITS
		MIN.	TYP.	MAX.	
Propagation Delay Time: Clock to Q or \bar{Q} Outputs t_{PHL}, t_{PLH}	5 10 15	— — —	150 65 45	300 130 90	ns
Set to Q or Reset to \bar{Q} t_{PLH}	5 10 15	— — —	150 65 45	300 130 90	ns
Set to \bar{Q} or Reset to Q t_{PHL}	5 10 15	— — —	200 85 60	400 170 120	ns
Transition Time t_{THL}, t_{TLH}	5 10 15	— — —	100 50 40	200 100 80	ns
Maximum Clock Input Frequency# f_{CL}	5 10 15	3.5 8 12	7 16 24	— — —	MHz
Minimum Clock Pulse Width t_w	5 10 15	— — —	70 30 20	140 60 40	ns
Minimum Set or Reset Pulse Width t_w	5 10 15	— — —	90 40 25	180 80 50	ns
Minimum Data Setup Time t_s	5 10 15	— — —	20 10 7	40 20 15	ns
Minimum Data Hold Time t_H	5 10 15	— — —	2 2 2	5 5 5	ns
Clock Input Rise or Fall Time t_{rCL}, t_{fCL}	5 10 15	— — —	— — —	500 30 6	μs
Input Capacitance C_{IN}	Any Input	—	5	7.5	pF

#Input $t_r, t_f = 5$ ns.

TEST CIRCUITS

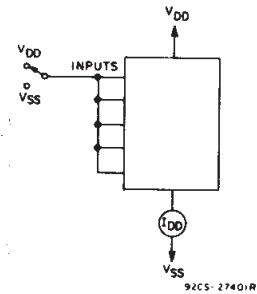


Fig. 10 – Quiescent device current.

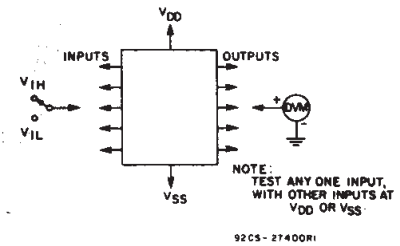


Fig. 11 – Input voltage.

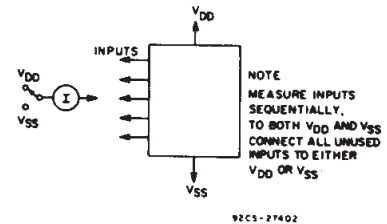


Fig. 12 – Input current.

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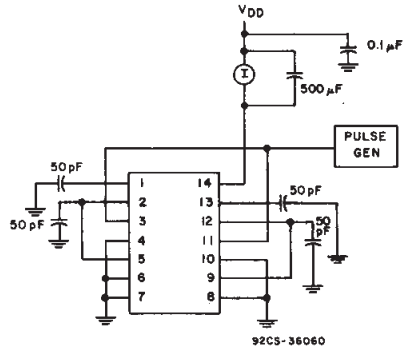
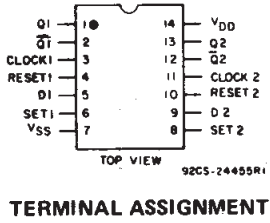
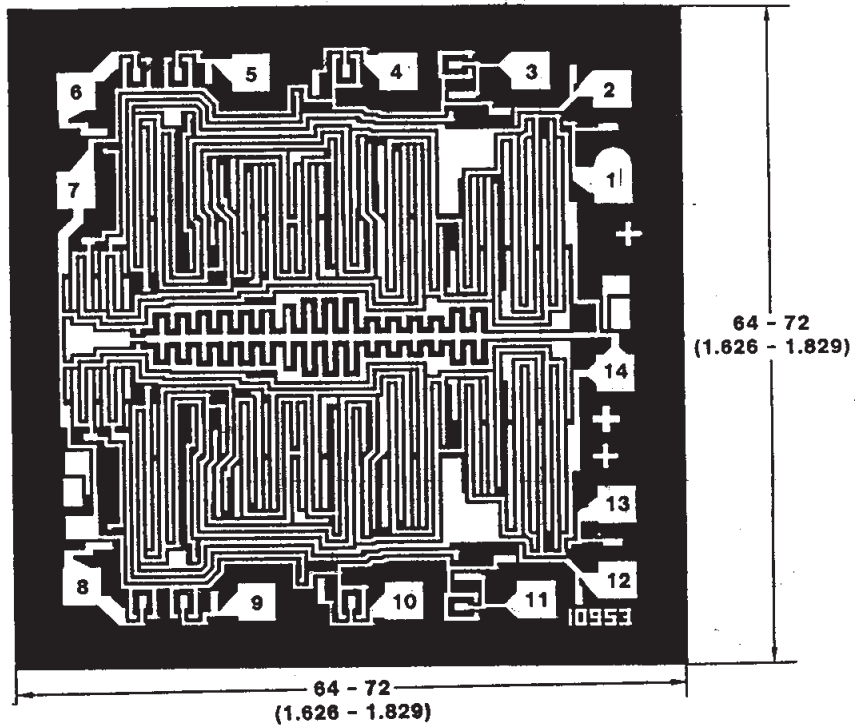


Fig. 13—Dynamic power dissipation test circuit.

DIMENSIONS AND PAD LAYOUT FOR CD4013BH



Dimensions in parentheses are in millimeters and are derived from the basic inch dimensions as indicated. Grid graduations are in mils (10^{-3} inch).

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