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 $\overline{Q}$ 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.

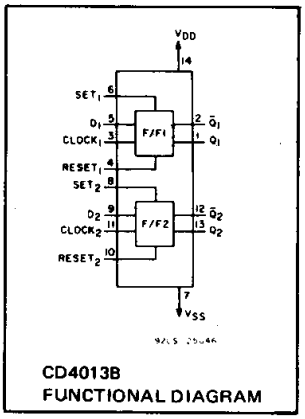
The CD4013B types are supplied in 14-lead hermetic dual-in-line ceramic packages (D and F suffixes), 14-lead dual-in-line plastic packages (E suffix), 14-lead small-outline package (NSR suffix), and in chip form (H suffix).

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 μA 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



CD4013B
FUNCTIONAL DIAGRAM

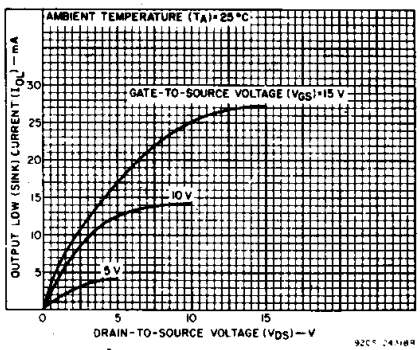


Fig. 1 – Typical output low (sink) current characteristics.

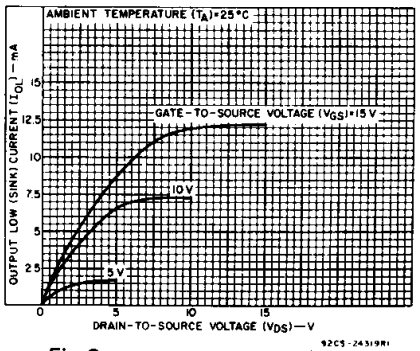


Fig. 2 – Minimum output low (sink) current characteristics.

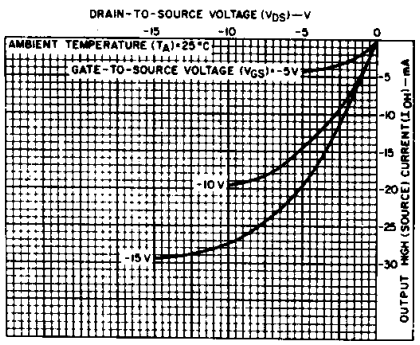


Fig. 3 – Typical output high (source) current characteristics.

RECOMMENDED OPERATING CONDITIONS

At T_A = 25°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	–	
	15	15	–	
Clock Pulse Width t_W	5	140	–	ns
	10	60	–	
	15	40	–	
Clock Input Frequency f_{CL}	5	dc	3.5	MHz
	10		8	
	15		12	
Clock Rise or Fall Time t_rCL,* t_fCL	5	–	500	μs
	10	–	30	
	15	–	6	
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.

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.	+25 Typ.	+25 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	–	
Output High (Source) Current, I_{OH} Min.	4.6	0,5	5	−0.64	−0.61	−0.42	−0.36	−0.51	−1	–	
	2.5	0,5	5	−2	−1.8	−1.3	−1.15	−1.6	−3.2	–	
	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	–	
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	–	
	–	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	–	–	
	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	–	$\pm 10^{-5}$	±0.1	μA

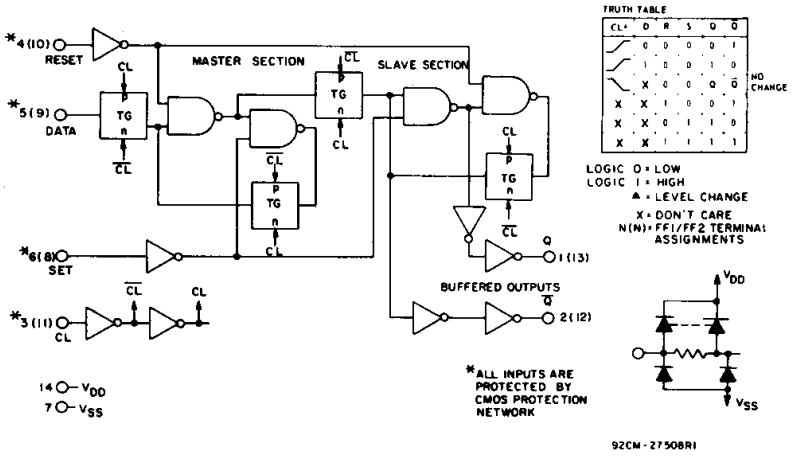


Fig. 7 — Logic diagram and truth table for CD4013B (one of two identical flip-flops).

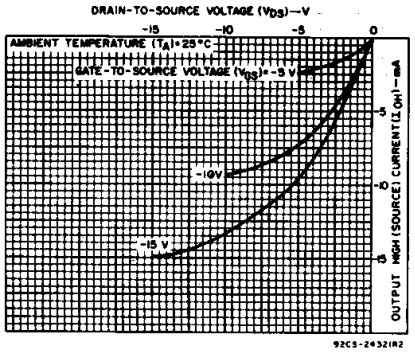


Fig. 4 — Minimum output high (source) current characteristics.

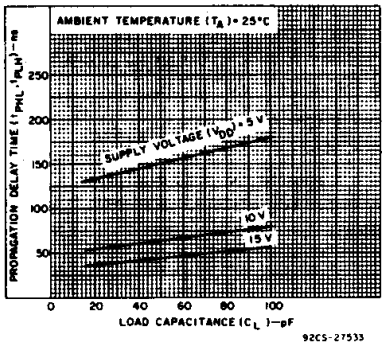


Fig. 5 — Typical propagation delay time vs. load capacitance (CLOCK or SET to Q,CLOCK or RESET to $\overline{Q}$).

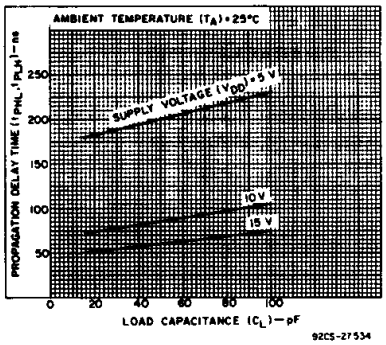


Fig. 6 — Typical propagation delay time vs. load capacitance (SET to $\overline{Q}$ or RESET to Q.

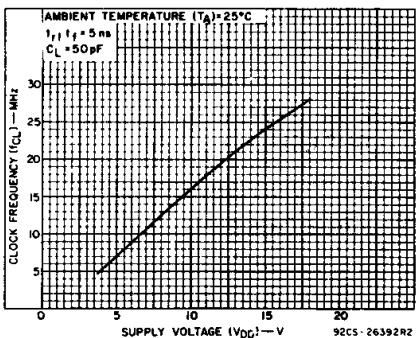


Fig. 8 — Typical maximum clock frequency vs. supply voltage.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

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

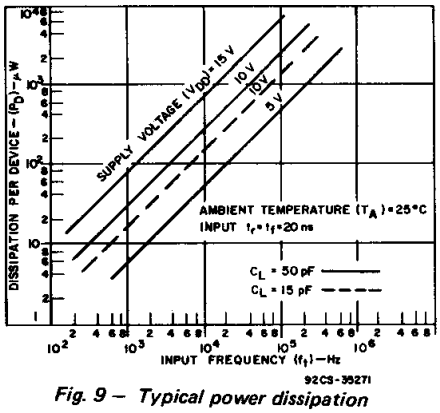


Fig. 9 – Typical power dissipation vs. frequency.

DYNAMIC ELECTRICAL CHARACTERISTICS

At T_A = 25°C; Input t_r,t_f = 20 ns, C_L = 50 pF, R_L = 20 kΩ

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

#Input t_r,t_f = 5 ns.

TEST CIRCUITS

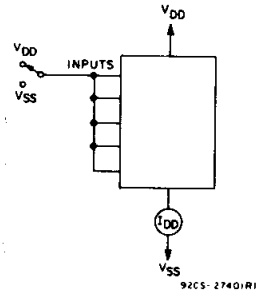


Fig. 10 – Quiescent device current.

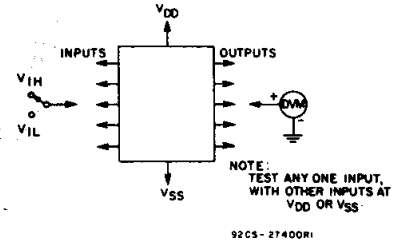


Fig. 11 – Input voltage.

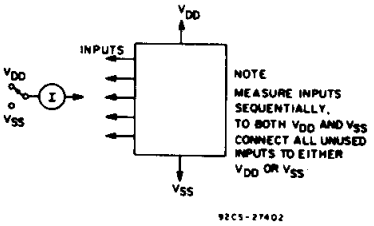
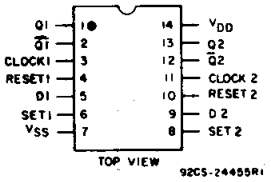


Fig. 12 – Input current.



TERMINAL ASSIGNMENT

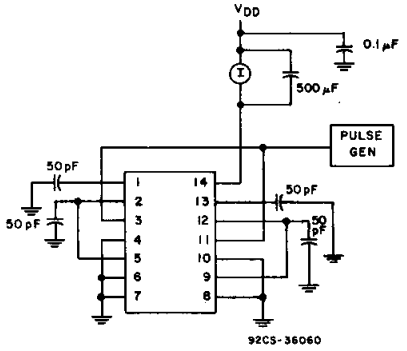
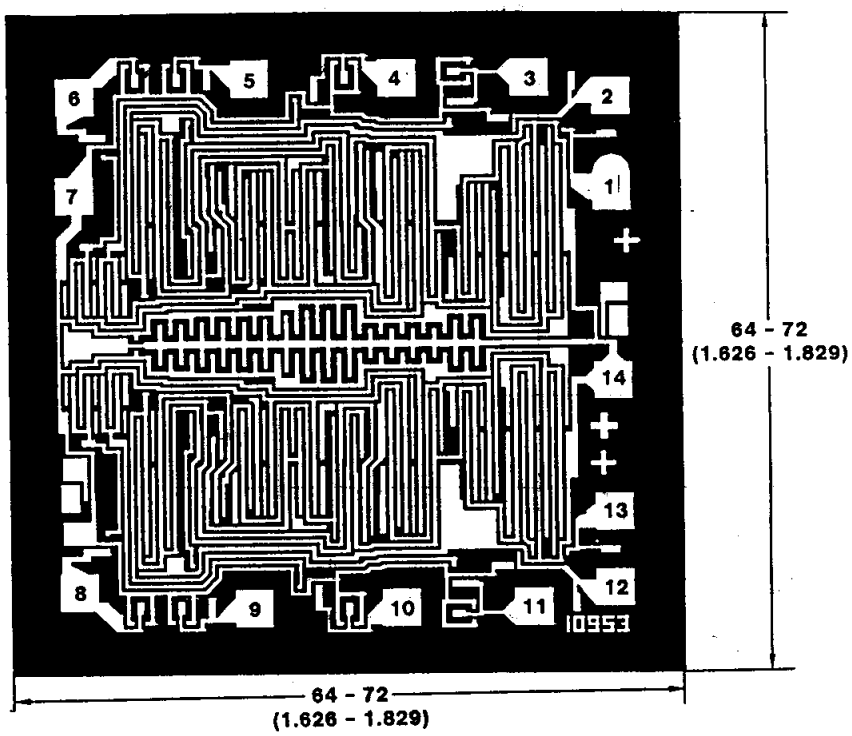


Fig. 13—Dynamic power dissipation test circuit.

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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