

## CMOS 64-Stage Static Shift Register

High-Voltage Types (20-Volt Rating)

The RCA-CD4031B is a static shift register that contains 64 D-type, master-slave flip-flop stages and one stage which is a D-type master flip-flop only (referred to as a 1/2 stage).

The logic level present at the DATA input is transferred into the first stage and shifted one stage at each positive-going clock transition. Maximum clock frequencies up to 12 Megahertz (typical) can be obtained. Because fully static operation is allowed, information can be permanently stored with the clock line in either the low or high state. The CD4031B has a MODE CONTROL input that, when in the high state, allows operation in the recirculating mode. The MODE CONTROL input can also be used to select between two separate data sources. Register packages can be cascaded and the clock lines driven directly for high-speed operation. Alternatively, a delayed clock output (CL<sub>D</sub>) is provided that enables cascading register packages while allowing reduced clock drive fan-out and transition-time requirements. A third cascading option makes use of the Q' output from the 1/2 stage, which is available on the next negative-going transition of the clock after the Q output occurs. This delayed output, like the delayed clock CL<sub>D</sub>, is used with clocks having slow rise and fall times.

The CD4031B types are supplied in 16-lead hermetic dual-in-line ceramic packages (D and F suffixes), 16-lead plastic dual-in-line packages (E suffix), 16-lead ceramic flat packages (K suffix), and in chip form (H suffix).

### Features:

- Fully static operation: DC to 12 MHz typ. @ V<sub>DD</sub>-V<sub>SS</sub> = 15 V
- Standard TTL drive capability on Q output
- Recirculation capability
- Three cascading modes:
  - Direct clocking for high-speed operation
  - Delayed clocking for reduced clock drive requirements
  - Additional 1/2 stage for slow clocks
- 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<sub>DD</sub> = 5 V
  - 2 V at V<sub>DD</sub> = 10 V
  - 2.5 V at V<sub>DD</sub> = 15 V

- 5-V, 10-V, and 15-V parametric ratings
- Meets all requirements of JEDEC Tentative Standard No. 13A, "Standard Specifications for Description of 'B' Series CMOS Devices"

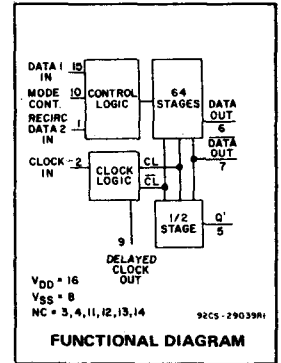
### Applications:

- Serial shift registers
- Time delay circuits

### RECOMMENDED OPERATING CONDITIONS

For maximum reliability, nominal operating conditions should be selected so that operation is always within the following ranges:

CHARACTERISTIC	LIMITS		UNITS
	Min.	Max.	
Supply-Voltage Range (For T <sub>A</sub> =Full Package-Temperature Range)	3	18	V



### INPUT CONTROL CIRCUIT TRUTH TABLE

DATA	RECIRC.	MODE	BIT INTO STAGE 1
1	X	0	1
0	X	0	0
X	1	1	1
X	0	1	0

### TYPICAL STAGE TRUTH TABLE

Data	CL	Data + 1
0		0
1		1
X		NC

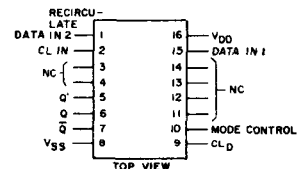
### TRUTH TABLE FOR OUTPUT FROM Q' (TERMINAL 5)

Data + 64	CL	Data + 64½
0		0
1		1
X		NC

1 = HIGH LEVEL      0 = LOW LEVEL  
X = DON'T CARE      NC = NO CHANGE

### MAXIMUM RATINGS, Absolute-Maximum Values:

DC SUPPLY-VOLTAGE RANGE, (V <sub>DD</sub> ) (Voltages referenced to V <sub>SS</sub> Terminal)	-0.5 to +20 V
INPUT VOLTAGE RANGE, ALL INPUTS	-0.5 to V <sub>DD</sub> +0.5 V
DC INPUT CURRENT, ANY ONE INPUT	±10 mA
POWER DISSIPATION PER PACKAGE (P <sub>D</sub> ):	
For T <sub>A</sub> = -40 to +60°C (PACKAGE TYPE E)	500 mW
For T <sub>A</sub> = +60 to +85°C (PACKAGE TYPE E)	Derate Linearly at 12 mW/°C to 200 mW
For T <sub>A</sub> = -55 to +100°C (PACKAGE TYPES D, F, K)	500 mW
For T <sub>A</sub> = +100 to +125°C (PACKAGE TYPES D, F, K)	Derate Linearly at 12 mW/°C to 200 mW
DEVICE DISSIPATION PER OUTPUT TRANSISTOR	
For T <sub>A</sub> = FULL PACKAGE-TEMPERATURE RANGE (All Package Types)	100 mW
OPERATING-TEMPERATURE RANGE (T <sub>A</sub> ):	
PACKAGE TYPES D, F, K, H	-55 to +125°C
PACKAGE TYPE E	-40 to +85°C
STORAGE TEMPERATURE RANGE (T <sub>stg</sub> )	-65 to +150°C
LEAD TEMPERATURE (DURING SOLDERING):	
At distance 1/16 ± 1/32 inch (1.59 ± 0.79 mm) from case for 10 s max.	+265°C



### TERMINAL ASSIGNMENT

# CD4031B Types

## STATIC ELECTRICAL CHARACTERISTICS

CHARACTERISTIC	CONDITIONS			LIMITS AT INDICATED TEMPERATURES (°C)							UNITS
	V <sub>D</sub> (V)	V <sub>IN</sub> (V)	V <sub>DD</sub> (V)	Values at -55, +25, +85, +125 Apply to D, F, K, H Packages				Values at -40, +25, +85, Apply to E Package			
				-55	-40	+85	+125	+25			
				Min.	Typ.	Max.					
Quiescent Device Current, I <sub>DD</sub> Max.	-	0,5	5	5	5	150	150	-	0.04	5	μA
	-	0,10	10	10	10	300	300	-	0.04	10	
	-	0,15	15	20	20	600	600	-	0.04	20	
	-	0,20	20	100	100	3000	3000	-	0.08	100	
Output Low (Sink) Current I <sub>OL</sub> Min.	0,4	0,5	5	2.56	2.44	1.68	1.44	2.04	4	-	mA
	0,5	0,10	10	6.4	6	4.4	3.6	5.2	10.4	-	
	1,5	0,15	15	16.8	16	11.2	9.6	13.6	27.2	-	
	0,4	0,5	5	0.64	0.61	0.42	0.36	0.51	1	-	
	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 <sub>OH</sub> Min.	4,6	0,5	5	0.64	0.61	-0.42	-0.36	-0.51	-1	-	mA
	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 <sub>OL</sub> 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 <sub>OH</sub> 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 <sub>IL</sub> 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 <sub>IH</sub> 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 <sub>IN</sub> Max.		0,18	18	±0.1	±0.1	±1	±1	-	±10 <sup>-5</sup>	±0.1	μA

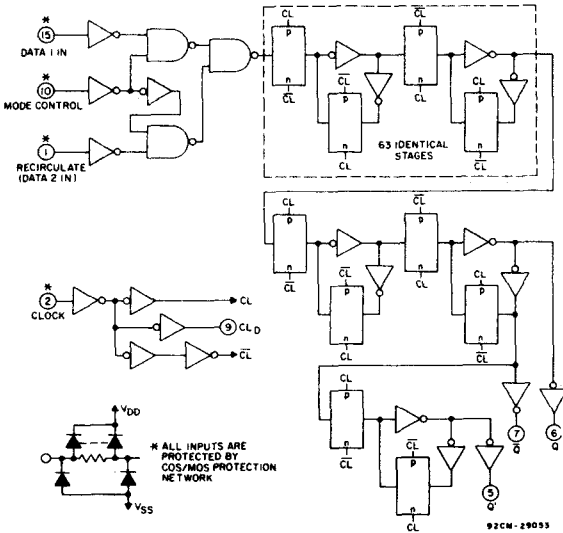


Fig. 1 - Logic diagram.

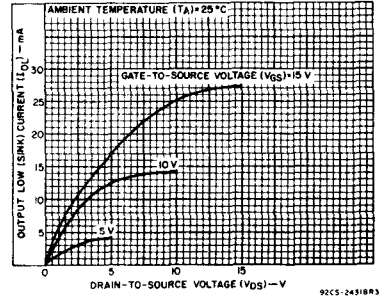


Fig. 2 - Typical output low (sink) current characteristics (Q sink current = 4X ordinate).

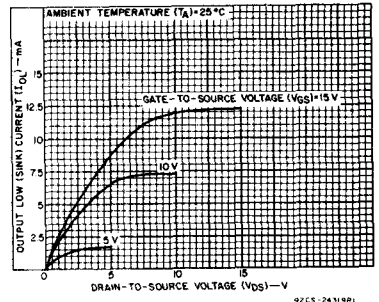


Fig. 3 - Minimum output low (sink) current characteristics (Q sink current = 4X ordinate).

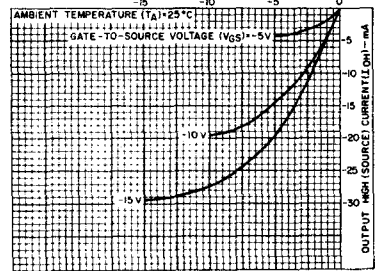


Fig. 4 - Typical output high (source) current characteristics.

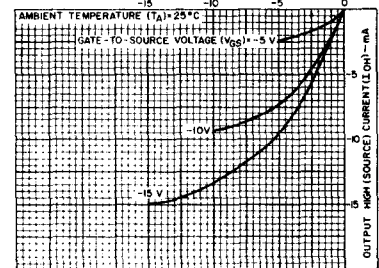


Fig. 5 - Minimum output high (source) current characteristics.

# CD4031B Types

**DYNAMIC ELECTRICAL CHARACTERISTICS** at  $T_A = 25^\circ\text{C}$ ; Input  $t_r, t_f = 20\text{ ns}$ ,  
 $C_L = 50\text{ pF}$ ,  $R_L = 200\text{ k}\Omega$

CHARACTERISTIC	TEST CONDITIONS	LIMITS			UNITS
	$V_{DD}$ (V)	Min.	Typ.	Max.	
Propagation Delay Time: Clock to $\bar{Q}$ , $t_{PHL}$ , $t_{PLH}$ ; Clock to Q, $t_{PLH}$	5	—	250	500	ns
	10	—	110	220	
	15	—	90	180	
Clock to $Q'$ , $t_{PHL}$ , $t_{PLH}$ ; Clock to Q, $t_{PHL}$	5	—	190	380	ns
	10	—	80	160	
	15	—	65	130	
Clock to $CL_D$	5	—	100	200	ns
	10	—	50	100	
	15	—	40	80	
Transition Time, $t_{THL}$ , $t_{TLH}$ (Any Output, except Q, $t_{THL}$ )	5	—	100	200	ns
	10	—	50	100	
	15	—	40	80	
Q, $t_{THL}$	5	—	50	100	ns
	10	—	25	50	
	15	—	20	40	
Minimum Data Setup Time, $t_S$	5	—	30	60	ns
	10	—	15	30	
	15	—	10	20	
Minimum Data Hold Time, $t_H$	5	—	30	60	ns
	10	—	15	30	
	15	—	10	20	
Minimum Clock Pulse Width, $t_W$	5	—	120	240	ns
	10	—	50	100	
	15	—	40	80	
Maximum Clock Input Frequency, $f_{CL}^{**}$	5	2	4	—	MHz
	10	5	10	—	
	15	6	12	—	
Clock Input Rise or Fall Time, $t_{rCL}$ , $t_{fCL}^*$	5	—	—	1000	$\mu\text{s}$
	10	—	—	1000	
	15	—	—	200	
Input Capacitance, $C_{IN}$ (Any Input)	—	—	5	7.5	pF

\*If more than one unit is cascaded in the parallel clocked application,  $t_{rCL}$  should be made less than or equal to the sum of the propagation delay at 50 pF and the transition time of the output driving stage.

\*\*Maximum Clock Frequency for Cascaded Units;

a) Using Delayed Clock Feature in Recirculation Mode:

$$f_{max} = \frac{1}{(n-1) CL_D \text{ prop. delay} + Q \text{ prop. delay} + \text{set-up time}}$$

where n = number of packages

b) Not Using Delayed Clock:

$$f_{max} = \frac{1}{\text{propagation delay} + \text{set-up time}}$$

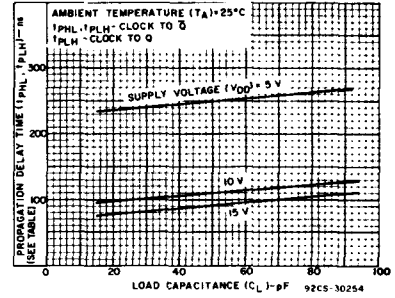


Fig. 6 - Typical propagation delay time as a function of load capacitance (see table).

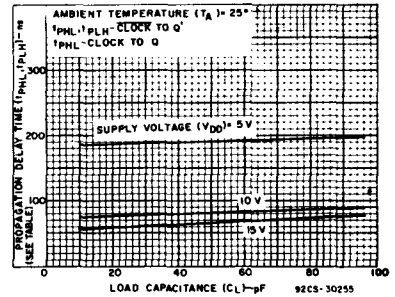


Fig. 7 - Typical propagation delay time as a function of load capacitance (see table).

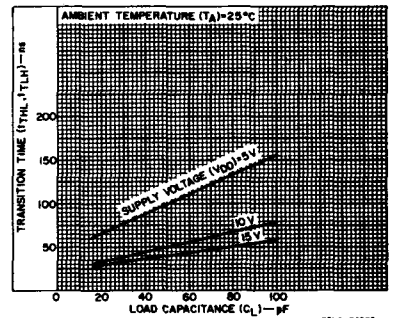


Fig. 8 - Typical transition time as a function of load capacitance (except Q,  $t_{THL}$ ).

# CD4031B Types

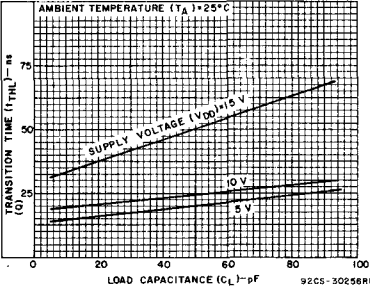


Fig. 9 - Typical transition time as a function of load capacitance (Q, t<sub>THL</sub>).

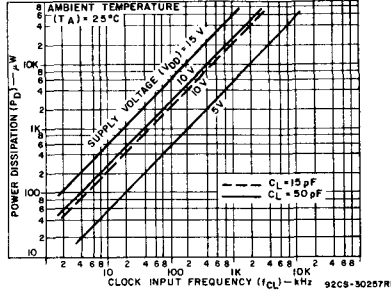


Fig. 10 - Typical dynamic power dissipation as a function of clock input frequency.

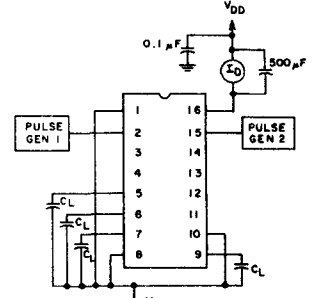


Fig. 11 - Dynamic power dissipation test circuit.

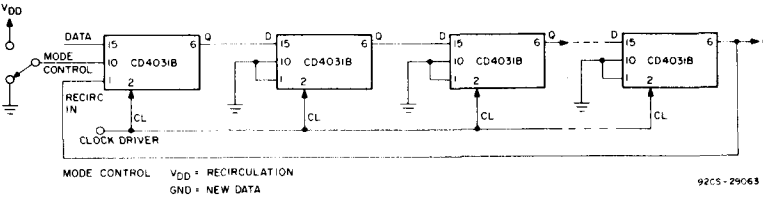


Fig. 12 - Cascading using direct clocking for high-speed operation (see clock rise and fall time requirement).

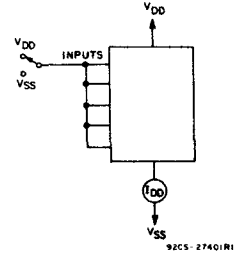


Fig. 13 - Quiescent device current test circuit.

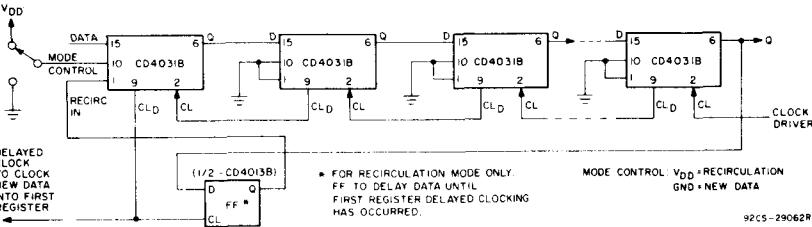


Fig. 14 - Cascading using delayed clocking for reduced clock drive requirements.

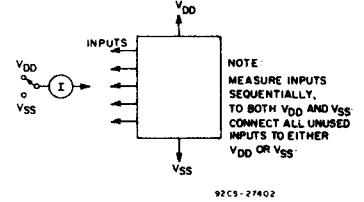


Fig. 15 - Input leakage current.

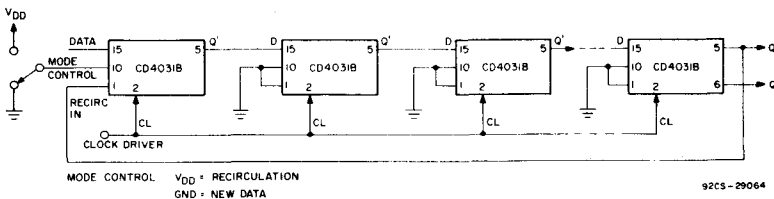


Fig. 16 - Cascading using half-clock-pulse delayed data output (Q') to permit use of slow rise and fall time clock inputs.

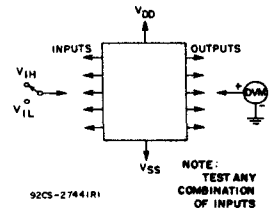
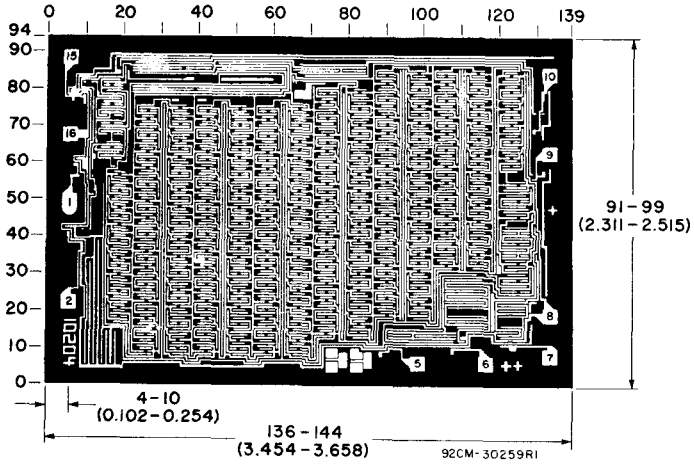


Fig. 17 - Input-voltage test circuit.

## CD4031B Types



### Dimensions and pad layout for CD4031B.

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

The photographs and dimensions of each CMOS chip represent a chip when it is part of the wafer. When the wafer is separated into individual chips, the angle of cleavage may vary with respect to the chip face for different chips. The actual dimensions of the isolated chip, therefore, may differ slightly from the nominal dimensions shown. The user should consider a tolerance of  $-3$  mils to  $+16$  mils applicable to the nominal dimensions shown.