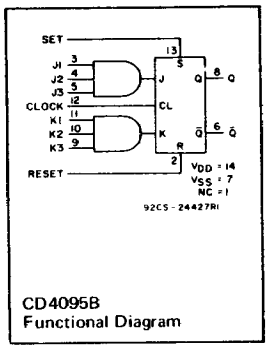
CD4095B, CD4096B Types

CMOS Gated J-K Master-Slave Flip-Flops

With Set-Reset Capability
High-Voltage Types (20-Volt Rating)

CD4095B Non-Inverting J and K Inputs
CD4096B Inverting and Non-Inverting J and K Inputs



CD4095B
Functional Diagram

The RCA-CD4095B and CD4096B are J-K Master-Slave Flip-Flops featuring separate AND gating of multiple J and K inputs. The gated J-K inputs control transfer of information into the master section during clocked operation. Information on the J-K inputs is transferred to the Q and $\bar{Q}$ outputs on the positive edge of the clock pulse. SET and RESET inputs (active high) are provided for asynchronous operation.

The CD4095B and CD4096B types are supplied in 14-lead hermetic dual-in-line ceramic packages (D and F suffixes), 14-lead dual-in-line plastic package (E suffix), 14-lead ceramic flat package (K suffix), and in chip form (H suffix).

Features:

- **16 MHz toggle rate (typ.) at $V_{DD} - V_{SS} = 10$ V**
- **Gated inputs**
- **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**
- **Standardized, symmetrical output characteristics**
- **Meets all requirements of JEDEC Tentative Standard No. 13A, "Standard Specifications for Description of 'B' Series CMOS Devices"**

Applications:

- **Registers** ■ **Counters** ■ **Control circuits**

MAXIMUM RATINGS, *Absolute-Maximum Values:*

DC SUPPLY-VOLTAGE RANGE, (V_{DD})
(Voltages referenced to V_{SS} Terminal) ..... -0.5 to +20 V
INPUT VOLTAGE RANGE, ALL INPUTS ..... -0.5 to V_{DD} +0.5 V
DC INPUT CURRENT, ANY ONE INPUT ..... ±10 mA
POWER DISSIPATION PER PACKAGE (P_D):
For T_A = -40 to +60°C (PACKAGE TYPE E) ..... 500 mW
For T_A = +60 to +85°C (PACKAGE TYPE E) ..... Derate Linearly at 12 mW/°C to 200 mW
For T_A = -55 to +100°C (PACKAGE TYPES D, F, K) ..... 500 mW
For T_A = +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_A = FULL PACKAGE-TEMPERATURE RANGE (All Package Types) ..... 100 mW
OPERATING-TEMPERATURE RANGE (T_A):
PACKAGE TYPES D, F, K, H ..... -55 to +125°C
PACKAGE TYPE E ..... -40 to +85°C
STORAGE TEMPERATURE RANGE (T_{stg}) ..... -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

TRUTH TABLES
SYNCHRONOUS OPERATION (S=0 R=0)

Inputs Before Positive Clock Transition		Outputs After Positive Clock Transition	
J*	K*	Q	$\bar{Q}$
0	0	No Change	
0	1	0	1
1	0	1	0
1	1	Toggles	

* For CD4095B: J = J1 · J2 · J3; K = K1 · K2 · K3
For CD4096B: J = J1 · J2 · $\overline{J3}$; K = K1 · K2 · $\overline{K3}$

ASYNCHRONOUS OPERATION
(J and K - DON'T CARE)

S	R	Q	$\bar{Q}$
0	0	No Change	
0	1	0	1
1	0	1	0
1	1	0	0

0 = V_{SS}, 1 = V_{DD}

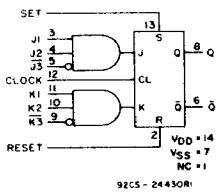


Fig. 1 – CD4096B Functional Diagram.

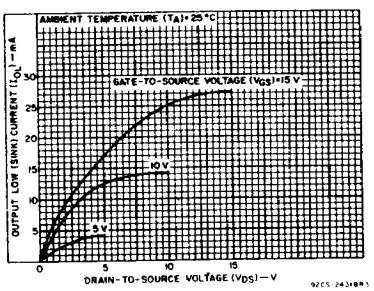


Fig.2 – Typical output low (sink) current characteristics.

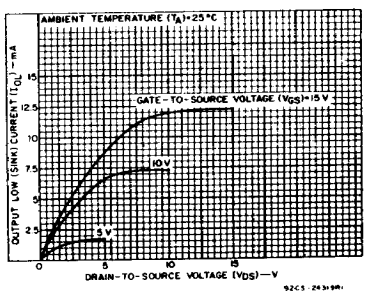


Fig.3 – Minimum output low (sink) current characteristics.

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 MIN.	LIMITS MAX.	UNITS
Supply-Voltage Range (For T_A = Full Package-Temperature Range)		3	18	V
Data Setup Time, t_S	5	400	–	ns
	10	160	–	
	15	100	–	
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 and Fall Time, t_rCL, t_fCL:	5	–	15	μs
	10	–	5	
	15	–	5	
Set or Reset Pulse Width, t_W	5	200	–	ns
	10	100	–	
	15	50	–	

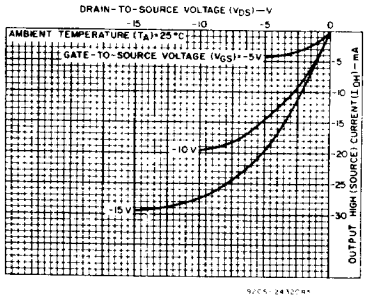


Fig.4 – Typical output high (source) current characteristics.

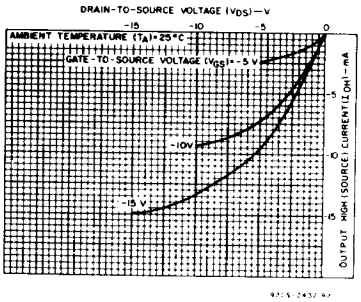


Fig.5 – Minimum output high (source) current characteristics.

STATIC ELECTRICAL CHARACTERISTICS

CHARACTERISTIC	CONDITIONS V_O (V)	CONDITIONS V_{IN} (V)	CONDITIONS V_{DD} (V)	LIMITS AT INDICATED TEMPERATURES (°C) Values at -55, +25, +125 Apply to D, F, K, H Packages; Values at -40, +25, +85 Apply to E Package: -55	-40	+85	+125	+25 Min.	+25 Typ.	+25 Max.	UNITS
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	
	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	–	$±10^{-5}$	±0.1	μA

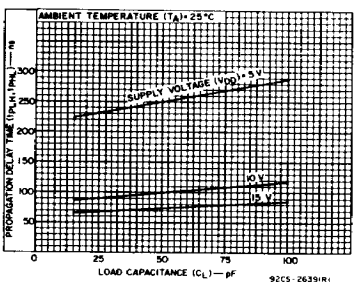


Fig.6 – Typical propagation delay time vs. load capacitance.

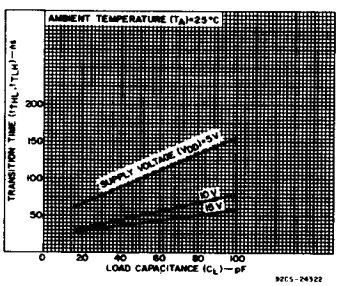


Fig.7 – Typical transition time vs. load capacitance.

DYNAMIC ELECTRICAL CHARACTERISTICS at T_A = 25°C; Input t_r, t_f = 20 ns, C_L = 50 pF, R_L = 200 KΩ

CHARACTERISTIC	TEST CONDITIONS	LIMITS			UNITS
	V_{DD} (V)	MIN.	TYP.	MAX.	
Propagation Delay Time: t_{PHL}, t_{PLH} Clock	5	–	250	500	ns
	10	–	100	200	
	15	–	75	150	
Set or Reset	5	–	150	300	
	10	–	75	150	
	15	–	50	100	
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	
Clock Input Rise or Fall Time, t_{rCl}, t_{rcf}	5	–	–	15	μs
	10	–	–	5	
	15	–	–	5	
Minimum Set or Reset Pulse Width, t_W	5	–	100	200	ns
	10	–	50	100	
	15	–	25	50	
Minimum Data Setup Time, t_S	5	–	200	400	ns
	10	–	80	160	
	15	–	50	100	
Input Capacitance, C_{IN}	Any Input	–	–	5	7.5	pF

* t_r, t_f = 5 ns

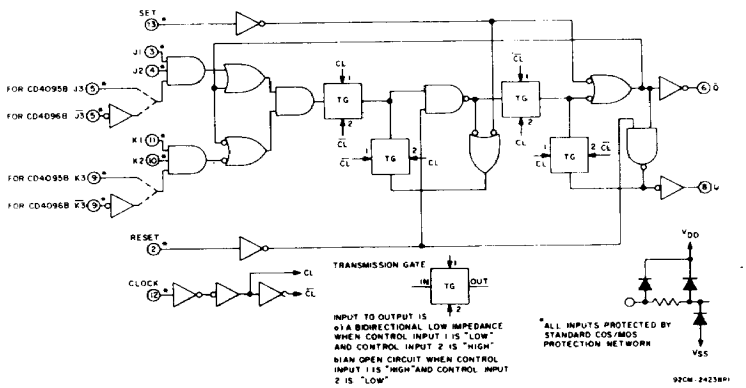


Fig.11 – CD4095B and CD4096B logic diagram.

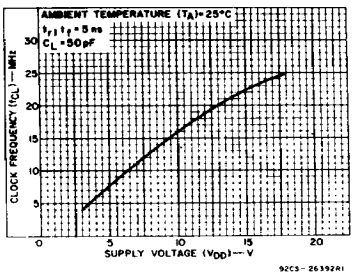


Fig.8 – Typical clock frequency vs. supply voltage (toggle mode–see Fig. 16).

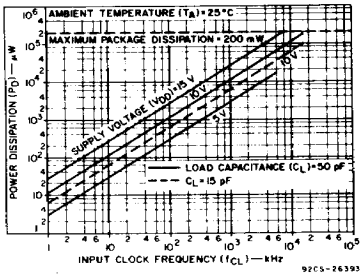


Fig. 9 – Typical power dissipation vs. input clock frequency.

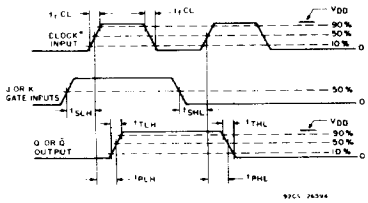


Fig.10 – Propagation delay, transition, and setup-time waveforms.

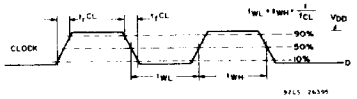


Fig.12 – Clock pulse rise and fall time waveforms.

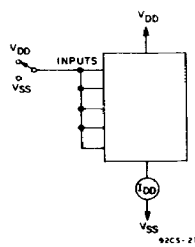


Fig.13 – Quiescent device current test circuit.

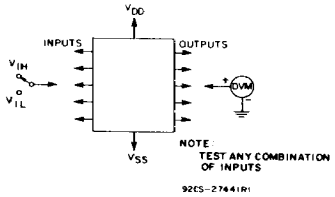


Fig. 14 – Input voltage test circuit.

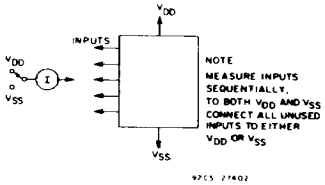


Fig. 15 – Input leakage current test circuit.

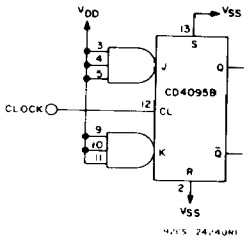


Fig. 16 – CD4095B connected in toggle mode.

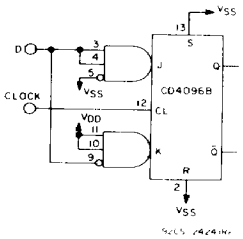


Fig. 17 – CD4096B connected as a "D" type flip-flop.

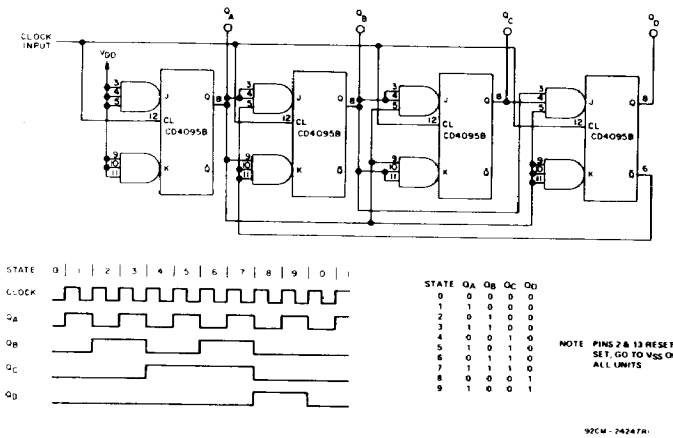
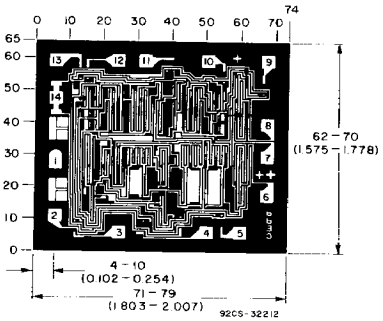


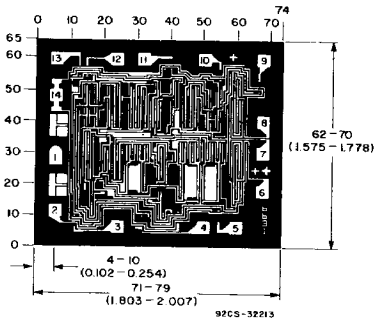
Fig. 18 – Synchronous binary divide-by-ten counter.

DIMENSIONS AND PAD LAYOUT FOR CD4095B AND CD4096B



CD4095BH

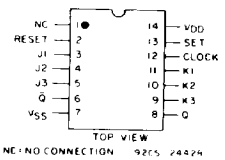
The photographs and dimensions of each CMOS chip represent a chip when it is part of the wafer. When the wafer is separated into individual chips, the angle of cleavage may vary with respect to the chip face for different chips. The actual dimensions of the isolated chip, therefore, may differ slightly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



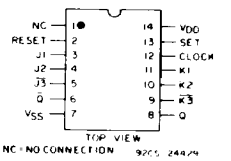
CD4096BH

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

TERMINAL ASSIGNMENTS



CD4095B



CD4096B