CD4095BMS
CD4096BMS

CMOS Gated J-K Master-Slave Flip-Flops

December 1992

Features

- **Set-Reset Capability**
- **High Voltage Types (20V Rating)**
- **CD4095BMS Non-Inverting J and K Inputs**
- **CD4096BMS Inverting and Non-Inverting J and K Inputs**
- **16MHz Toggle Rate (Typ.) at VDD - VSS = 10V**
- **Gated Inputs**
- **100% Tested for Quiescent Current at 20V**
- **5V, 10V and 15V Parametric Ratings**
- **Standardized Symmetrical Output Characteristics**
- **Maximum Input Current of 1μA at 18V Over Full Package Temperature Range; 100nA at 18V and +25°C**
- **Noise Margin (Over Full Package/Temperature Range)**
  - **1V at VDD = 5V**
  - **2V at VDD = 10V**
  - **2.5V at VDD = 15V**
- **Meets all requirements of JEDEC Tentative Standard No. 13B, "Standard Specifications for Description of 'B' Series CMOS Devices"**

Applications

- **Registers**
- **Counters**
- **Control Circuits**

Description

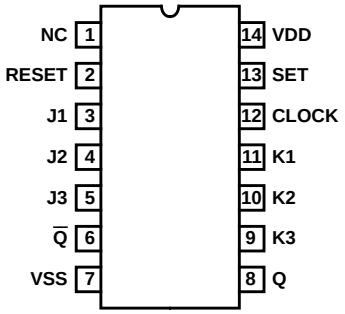
CD4095BMS and CD4096BMS are J-K Master-Slave Flip-Flops featuring separate AND gating of multiple J and K inputs. The gated J-K inputs control transfer of information into the master section during clocked operation. Information on the J-K inputs is transferred to the Q and $\overline{Q}$ outputs on the positive edge of the clock pulse. SET and RESET inputs (active high) are provided for asynchronous operation.

The CD4095BMS and CD4096BMS are supplied in these 14 lead outline packages:

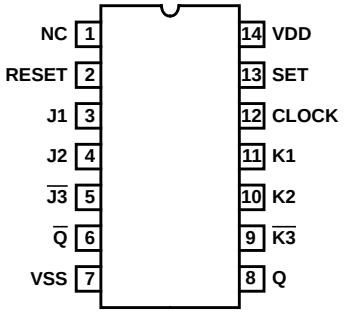
Braze Seal DIP	H4Q
Frit Seal DIP	H1A

Pinouts

CD4095BMS
TOP VIEW



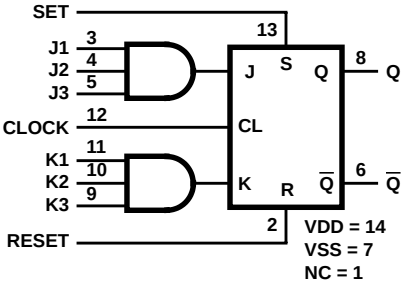
CD4096BMS
TOP VIEW



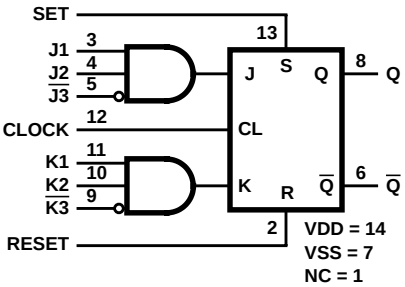
NC = NO CONNECTION

Functional Diagrams

CD4095BMS



CD4096BMS



Absolute Maximum Ratings

DC Supply Voltage Range, (VDD) . . . . . -0.5V to +20V
(Voltage Referenced to VSS Terminals)
Input Voltage Range, All Inputs . . . . . -0.5V to VDD +0.5V
DC Input Current, Any One Input . . . . . ±10mA
Operating Temperature Range . . . . . -55°C to +125°C
Package Types D, F, K, H
Storage Temperature Range (TSTG) . . . . . -65°C to +150°C
Lead Temperature (During Soldering) . . . . . +265°C
At Distance 1/16 ± 1/32 Inch (1.59mm ± 0.79mm) from case for 10s Maximum

Reliability Information

Thermal Resistance	θ_{ja}	θ_{jc}
Ceramic DIP and FRIT Package	80°C/W	20°C/W
Flatpack Package	70°C/W	20°C/W

Maximum Package Power Dissipation (PD) at +125°C
For TA = -55°C to +100°C (Package Type D, F, K) 500mW
For TA = +100°C to +125°C (Package Type D, F, K) . . . . . Derate Linearity at 12mW/°C to 200mW
Device Dissipation per Output Transistor 100mW
For TA = Full Package Temperature Range (All Package Types)
Junction Temperature . . . . . +175°C

TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS

PARAMETER	SYMBOL	CONDITIONS (NOTE 1)		GROUP A SUBGROUPS	TEMPERATURE	LIMITS MIN	LIMITS MAX	UNITS
Supply Current	IDD	VDD = 20V, VIN = VDD or GND		1	+25°C	-	2	µA
				2	+125°C	-	200	µA
		VDD = 18V, VIN = VDD or GND		3	-55°C	-	2	µA
Input Leakage Current	IIL	VIN = VDD or GND	VDD = 20	1	+25°C	-100	-	nA
				2	+125°C	-1000	-	nA
			VDD = 18V	3	-55°C	-100	-	nA
Input Leakage Current	IIH	VIN = VDD or GND	VDD = 20	1	+25°C	-	100	nA
				2	+125°C	-	1000	nA
			VDD = 18V	3	-55°C	-	100	nA
Output Voltage	VOL15	VDD = 15V, No Load		1, 2, 3	+25°C, +125°C, -55°C	-	50	mV
Output Voltage	VOH15	VDD = 15V, No Load (Note 3)		1, 2, 3	+25°C, +125°C, -55°C	14.95	-	V
Output Current (Sink)	IOL5	VDD = 5V, VOUT = 0.4V		1	+25°C	0.53	-	mA
Output Current (Sink)	IOL10	VDD = 10V, VOUT = 0.5V		1	+25°C	1.4	-	mA
Output Current (Sink)	IOL15	VDD = 15V, VOUT = 1.5V		1	+25°C	3.5	-	mA
Output Current (Source)	IOH5A	VDD = 5V, VOUT = 4.6V		1	+25°C	-	-0.53	mA
Output Current (Source)	IOH5B	VDD = 5V, VOUT = 2.5V		1	+25°C	-	-1.8	mA
Output Current (Source)	IOH10	VDD = 10V, VOUT = 9.5V		1	+25°C	-	-1.4	mA
Output Current (Source)	IOH15	VDD = 15V, VOUT = 13.5V		1	+25°C	-	-3.5	mA
N Threshold Voltage	VNTH	VDD = 10V, ISS = -10µA		1	+25°C	-2.8	-0.7	V
P Threshold Voltage	VPTH	VSS = 0V, IDD = 10µA		1	+25°C	0.7	2.8	V
Functional	F	VDD = 2.8V, VIN = VDD or GND		7	+25°C	VOH > VDD/2	VOL < VDD/2	V
		VDD = 20V, VIN = VDD or GND		7	+25°C			
		VDD = 18V, VIN = VDD or GND		8A	+125°C			
		VDD = 3V, VIN = VDD or GND		8B	-55°C			
Input Voltage Low (Note 2)	VIL	VDD = 5V, VOH > 4.5V, VOL < 0.5V		1, 2, 3	+25°C, +125°C, -55°C	-	1.5	V
Input Voltage High (Note 2)	VIH	VDD = 5V, VOH > 4.5V, VOL < 0.5V		1, 2, 3	+25°C, +125°C, -55°C	3.5	-	V
Input Voltage Low (Note 2)	VIL	VDD = 15V, VOH > 13.5V, VOL < 1.5V		1, 2, 3	+25°C, +125°C, -55°C	-	4	V
Input Voltage High (Note 2)	VIH	VDD = 15V, VOH > 13.5V, VOL < 1.5V		1, 2, 3	+25°C, +125°C, -55°C	11	-	V

NOTES:
1. All voltages referenced to device GND, 100% testing being implemented.
2. Go/No Go test with limits applied to inputs.
3. For accuracy, voltage is measured differentially to VDD. Limit is 0.050V max.

TABLE 2. AC ELECTRICAL PERFORMANCE CHARACTERISTICS

PARAMETER	SYMBOL	CONDITIONS (NOTE 1, 2)	GROUP A SUBGROUPS	TEMPERATURE	LIMITS MIN	LIMITS MAX	UNITS
Propagation Delay Clock to Output	TPHL1 TPLH1	VDD = 5V, VIN = VDD or GND	9	+25°C	-	500	ns
			10, 11	+125°C, -55°C	-	675	ns
Propagation Delay Set or Reset to Output	TPHL2 TPLH2	VDD = 5V, VIN = VDD or GND	9	+25°C	-	300	ns
			10, 11	+125°C, -55°C	-	405	ns
Transition Time	TTHL TTLH	VDD = 5V, VIN = VDD or GND	9	+25°C	-	200	ns
			10, 11	+125°C, -55°C	-	270	ns
Maximum Clock Input Frequency	FCL	VDD = 5V, VIN = VDD or GND	9	+25°C	3.5	-	MHz
			10, 11	+125°C, -55°C	2.59	-	MHz

NOTES:

1. VDD = 5V, CL = 50pF, RL = 200K
2. -55°C and +125°C limits guaranteed, 100% testing being implemented.

TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS

PARAMETER	SYMBOL	CONDITIONS	NOTES	TEMPERATURE	LIMITS MIN	LIMITS MAX	UNITS
Supply Current	IDD	VDD = 5V, VIN = VDD or GND	1, 2	-55°C, +25°C	-	1	µA
				+125°C	-	30	µA
		VDD = 10V, VIN = VDD or GND	1, 2	-55°C, +25°C	-	2	µA
				+125°C	-	60	µA
		VDD = 15V, VIN = VDD or GND	1, 2	-55°C, +25°C	-	2	µA
				+125°C	-	120	µA
Output Voltage	VOL	VDD = 5V, No Load	1, 2	+25°C, +125°C, -55°C	-	50	mV
Output Voltage	VOL	VDD = 10V, No Load	1, 2	+25°C, +125°C, -55°C	-	50	mV
Output Voltage	VOH	VDD = 5V, No Load	1, 2	+25°C, +125°C, -55°C	4.95	-	V
Output Voltage	VOH	VDD = 10V, No Load	1, 2	+25°C, +125°C, -55°C	9.95	-	V
Output Current (Sink)	IOL5	VDD = 5V, VOUT = 0.4V	1, 2	+125°C	0.36	-	mA
				-55°C	0.64	-	mA
Output Current (Sink)	IOL10	VDD = 10V, VOUT = 0.5V	1, 2	+125°C	0.9	-	mA
				-55°C	1.6	-	mA
Output Current (Sink)	IOL15	VDD = 15V, VOUT = 1.5V	1, 2	+125°C	2.4	-	mA
				-55°C	4.2	-	mA
Output Current (Source)	IOH5A	VDD = 5V, VOUT = 4.6V	1, 2	+125°C	-	-0.36	mA
				-55°C	-	-0.64	mA
Output Current (Source)	IOH5B	VDD = 5V, VOUT = 2.5V	1, 2	+125°C	-	-1.15	mA
				-55°C	-	-2.0	mA
Output Current (Source)	IOH10	VDD = 10V, VOUT = 9.5V	1, 2	+125°C	-	-0.9	mA
				-55°C	-	-1.6	mA

TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS (Continued)

PARAMETER	SYMBOL	CONDITIONS	NOTES	TEMPERATURE	LIMITS		UNITS
					MIN	MAX	
Output Current (Source)	IOH15	VDD =15V, VOUT = 13.5V	1, 2	+125°C	-	-2.4	mA
				-55°C	-	-4.2	mA
Input Voltage Low	VIL	VDD = 10V, VOH > 9V, VOL < 1V	1, 2	+25°C, +125°C, -55°C	-	3	V
Input Voltage High	VIH	VDD = 10V, VOH > 9V, VOL < 1V	1, 2	+25°C, +125°C, -55°C	+7	-	V
Propagation Delay Clock to Output	TPHL TPLH	VDD = 10V	1, 2, 3	+25°C	-	200	ns
		VDD = 15V	1, 2, 3	+25°C	-	150	ns
Propagation Delay Set or Reset to Output	TPHL TPLH	VDD = 10V	1, 2, 3	+25°C	-	150	ns
		VDD = 15V	1, 2, 3	+25°C	-	100	ns
Transition Time	TTHL TTLH	VDD = 10V	1, 2, 3	+25°C	-	100	ns
		VDD = 15V	1, 2, 3	+25°C	-	80	ns
Maximum Clock Input Frequency	FCL	VDD = 10V	1, 2, 3	+25°C	8	-	MHz
		VDD = 15V	1, 2, 3	+25°C	12	-	MHz
Minimum Set or Reset Pulse Width	TW	VDD = 5V	1, 2, 3	+25°C	-	200	ns
		VDD = 10V	1, 2, 3	+25°C	-	100	ns
		VDD = 15V	1, 2, 3	+25°C	-	50	ns
Minimum Data Setup Time	TS	VDD = 5V	1, 2, 3	+25°C	-	400	ns
		VDD = 10V	1, 2, 3	+25°C	-	160	ns
		VDD = 15V	1, 2, 3	+25°C	-	100	ns
Minimum Clock Pulse Width	TW	VDD = 5V	1, 2, 3	+25°C	-	140	ns
		VDD = 10V	1, 2, 3	+25°C	-	60	ns
		VDD = 15V	1, 2, 3	+25°C	-	40	ns
Maximum Clock Input Rise or Fall Time	TRCL TFCL	VDD = 5V	1, 2, 3	+25°C	-	15	µs
		VDD = 10V	1, 2, 3	+25°C	-	5	µs
		VDD = 15V	1, 2, 3	+25°C	-	5	µs
Input Capacitance	CIN	Any Input	1, 2	+25°C	-	7.5	pF

NOTES:

1. All voltages referenced to device GND.
2. The parameters listed on Table 3 are controlled via design or process and are not directly tested. These parameters are characterized on initial design release and upon design changes which would affect these characteristics.
3. CL = 50pF, RL = 200K, Input TR, TF < 20ns.

TABLE 4. POST IRRADIATION ELECTRICAL PERFORMANCE CHARACTERISTICS

PARAMETER	SYMBOL	CONDITIONS	NOTES	TEMPERATURE	LIMITS		UNITS
					MIN	MAX	
Supply Current	IDD	VDD = 20V, VIN = VDD or GND	1, 4	+25°C	-	7.5	µA
N Threshold Voltage	VNTH	VDD = 10V, ISS = -10µA	1, 4	+25°C	-2.8	-0.2	V

TABLE 4. POST IRRADIATION ELECTRICAL PERFORMANCE CHARACTERISTICS

PARAMETER	SYMBOL	CONDITIONS	NOTES	TEMPERATURE	LIMITS		UNITS
					MIN	MAX	
N Threshold Voltage Delta	ΔVTN	VDD = 10V, ISS = -10μA	1, 4	+25°C	-	±1	V
P Threshold Voltage	VTP	VSS = 0V, IDD = 10μA	1, 4	+25°C	0.2	2.8	V
P Threshold Voltage Delta	ΔVTP	VSS = 0V, IDD = 10μA	1, 4	+25°C	-	±1	V
Functional	F	VDD = 18V, VIN = VDD or GND	1	+25°C	VOH > VDD/2	VOL < VDD/2	V
		VDD = 3V, VIN = VDD or GND					
Propagation Delay Time	TPHL TPLH	VDD = 5V	1, 2, 3, 4	+25°C	-	1.35 x +25°C Limit	ns

NOTES: 1. All voltages referenced to device GND.
2. CL = 50pF, RL = 200K, Input TR, TF < 20ns.
3. See Table 2 for +25°C limit.
4. Read and Record

TABLE 5. BURN-IN AND LIFE TEST DELTA PARAMETERS +25°C

PARAMETER	SYMBOL	DELTA LIMIT
Supply Current - MSI-1	IDD	± 0.2μA
Output Current (Sink)	IOL5	± 20% x Pre-Test Reading
Output Current (Source)	IOH5A	± 20% x Pre-Test Reading

TABLE 6. APPLICABLE SUBGROUPS

CONFORMANCE GROUP		MIL-STD-883 METHOD	GROUP A SUBGROUPS	READ AND RECORD
Initial Test (Pre Burn-In)		100% 5004	1, 7, 9	IDD, IOL5, IOH5A
Interim Test 1 (Post Burn-In)		100% 5004	1, 7, 9	IDD, IOL5, IOH5A
Interim Test 2 (Post Burn-In)		100% 5004	1, 7, 9	IDD, IOL5, IOH5A
PDA (Note 1)		100% 5004	1, 7, 9, Deltas	
Interim Test 3 (Post Burn-In)		100% 5004	1, 7, 9	IDD, IOL5, IOH5A
PDA (Note 1)		100% 5004	1, 7, 9, Deltas	
Final Test		100% 5004	2, 3, 8A, 8B, 10, 11	
Group A		Sample 5005	1, 2, 3, 7, 8A, 8B, 9, 10, 11	
Group B	Subgroup B-5	Sample 5005	1, 2, 3, 7, 8A, 8B, 9, 10, 11, Deltas	Subgroups 1, 2, 3, 9, 10, 11
	Subgroup B-6	Sample 5005	1, 7, 9	
Group D		Sample 5005	1, 2, 3, 8A, 8B, 9	Subgroups 1, 2 3

NOTE: 1. 5% Parameteric, 3% Functional; Cumulative for Static 1 and 2.

TABLE 7. TOTAL DOSE IRRADIATION

CONFORMANCE GROUPS	MIL-STD-883 METHOD	TEST		READ AND RECORD	
		PRE-IRRAD	POST-IRRAD	PRE-IRRAD	POST-IRRAD
Group E Subgroup 2	5005	1, 7, 9	Table 4	1, 9	Table 4

TABLE 8. BURN-IN AND IRRADIATION TEST CONNECTIONS

FUNCTION	OPEN	GROUND	VDD	9V ± -0.5V	OSCILLATOR	
					50kHz	25kHz
CD4095BMS						
Static Burn-In 1 Note 1	1, 6, 8	2-5, 7, 9-13	14			
Static Burn-In 2 Note 1	1, 6, 8	7	2-5, 9-14			
Dynamic Burn-In Note 1	1	2, 7, 13	3-5, 9-11, 14	6, 8	-	12
Irradiation Note 2	1, 6, 8	7	2-5, 9-14			
CD4096BMS						
Static Burn-In 1 Note 1	1, 6, 8	2-5, 7, 9-13	14			
Static Burn-In 2 Note 1	1, 6, 8	7	2-5, 9-14			
Dynamic Burn-In Note 1	1	2, 5, 7, 9, 13	3, 4, 10, 11, 14	6, 8	12	
Irradiation Note 2	1, 6, 8	7	2-5, 9-14			

NOTES:

1. Each pin except VDD and GND will have a series resistor of 10K ± 5%, VDD = 18V ± 0.5V
2. Each pin except VDD and GND will have a series resistor of 47K ± 5%; Group E, Subgroup 2, sample size is 4 dice/wafer, 0 failures, VDD = 10V ± 0.5V

Logic Diagram

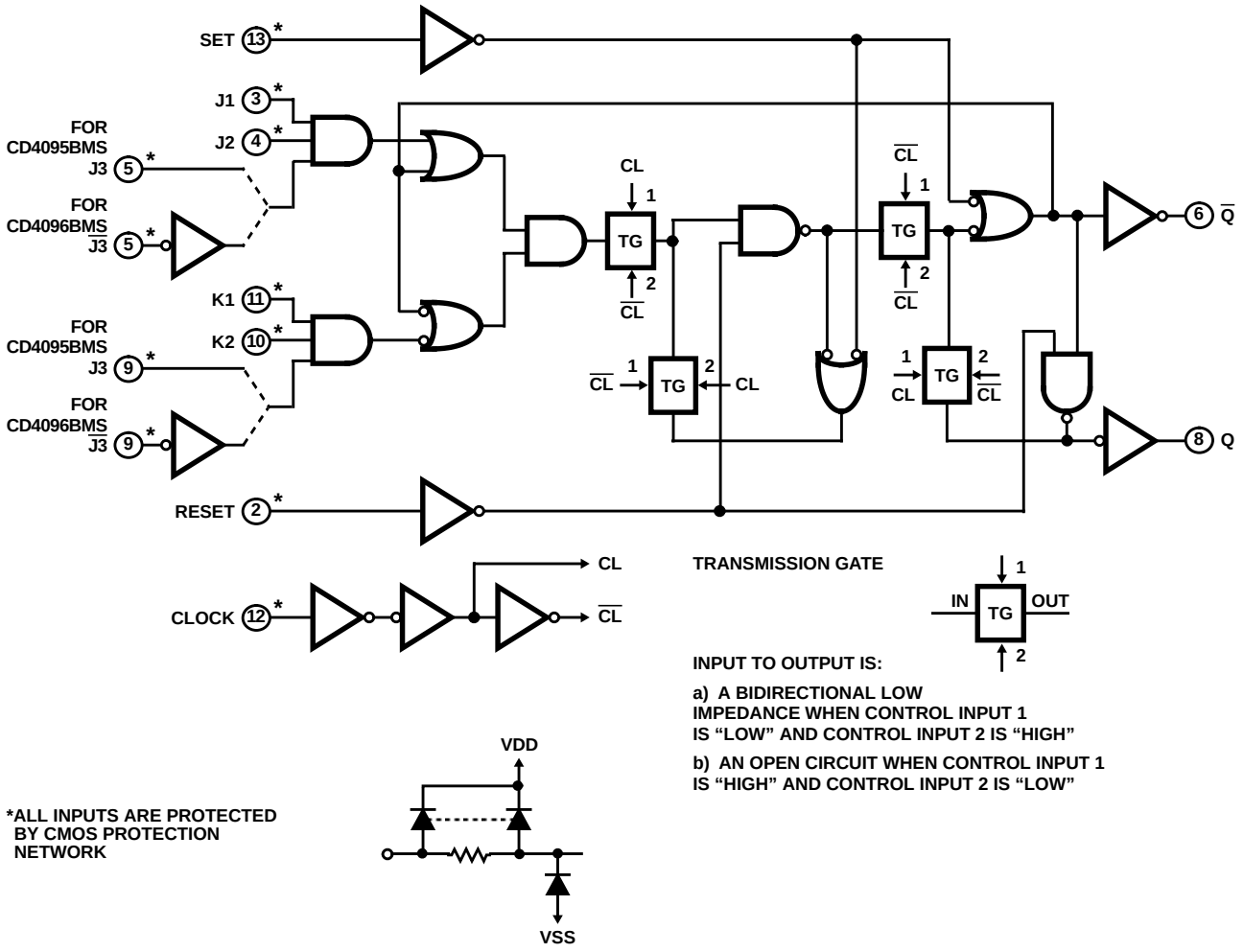


FIGURE 1. CD4095BMS AND CD4096BMS LOGIC DIAGRAM

TRUTH TABLES

SYNCHRONOUS OPERATION (S = 0, R = 0)				ASYNCHRONOUS OPERATION (J AND K = Don't Care)			
INPUTS BEFORE POSITIVE CLOCK TRANSITION		OUTPUTS AFTER POSITIVE CLOCK TRANSITION		INPUTS BEFORE POSITIVE CLOCK TRANSITION		OUTPUTS AFTER POSITIVE CLOCK TRANSITION	
J*	K*	Q	$\overline{Q}$	S	R	Q	$\overline{Q}$
0	0	No Change	No Change	0	0	No Change	No Change
0	1	0	1	0	1	0	1
1	0	1	0	1	0	1	0
1	1	Toggles	Toggles	1	1	0	0

* For CD4095BMS
J = J1 • J2 • J3
K = K1 • K2 • K3

For CD4096BMS
J = J1 • J2 • $\overline{J3}$
K = K1 • K2 • $\overline{K3}$

0 = VSS, 1 = VDD

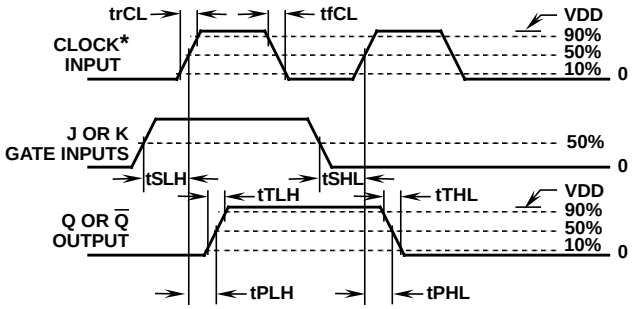


FIGURE 2. PROPAGATION DELAY, TRANSITION, AND SETUP TIME WAVEFORMS

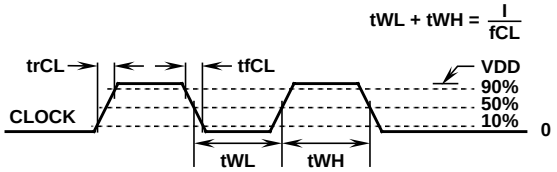


FIGURE 3. CLOCK PULSE RISE AND FALL TIME WAVEFORMS

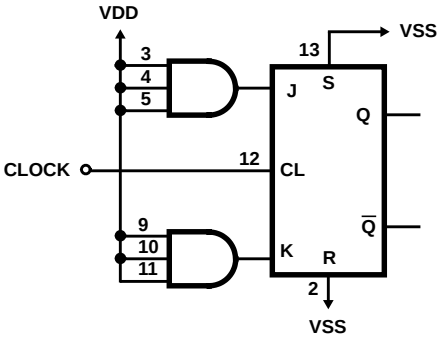


FIGURE 4. CD4095BMS CONNECTED IN TOGGLE MODE

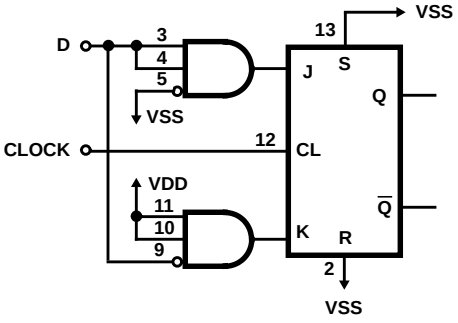
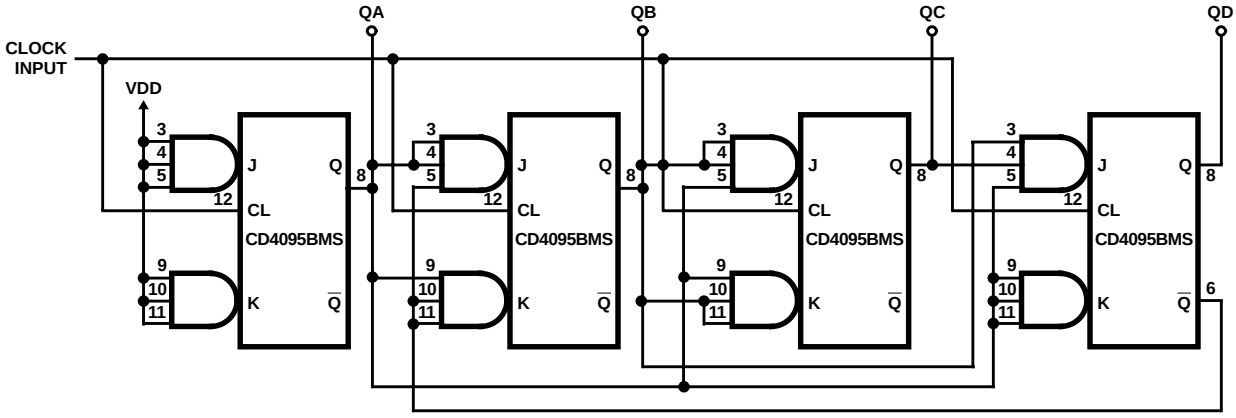
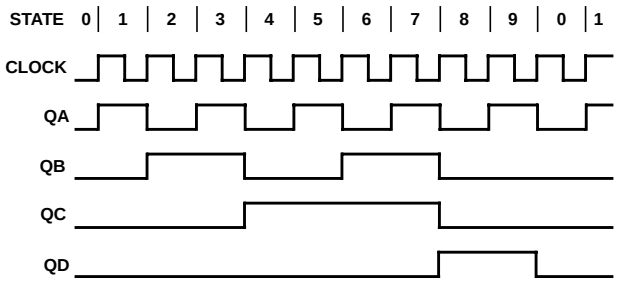


FIGURE 5. CD4096BMS CONNECTED AS A "D" TYPE FLIP-FLOP





STATE	QA	QB	QC	QD
0	0	0	0	0
1	1	0	0	0
2	0	1	0	0
3	1	1	0	0
4	0	0	1	0
5	1	0	1	0
6	0	1	1	0
7	1	1	1	0
8	0	0	0	1
9	1	0	0	1

NOTE:
PINS 2 & 13 RESET & SET, GO TO VSS ON ALL UNITS

FIGURE 6. SYNCHRONOUS BINARY DIVIDE-BY-TEN COUNTER

Typical Performance Characteristics

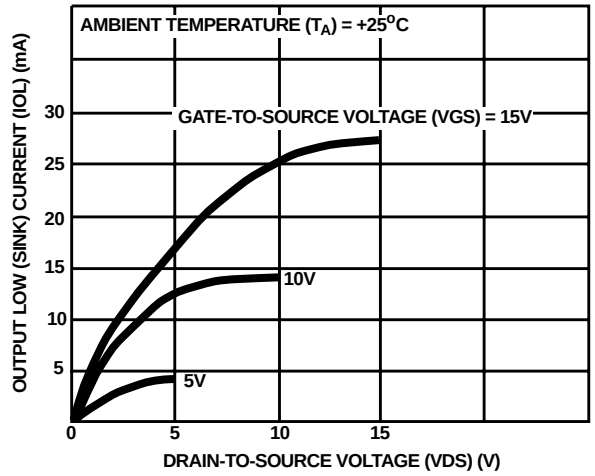


FIGURE 7. TYPICAL OUTPUT LOW (SINK) CURRENT CHARACTERISTICS

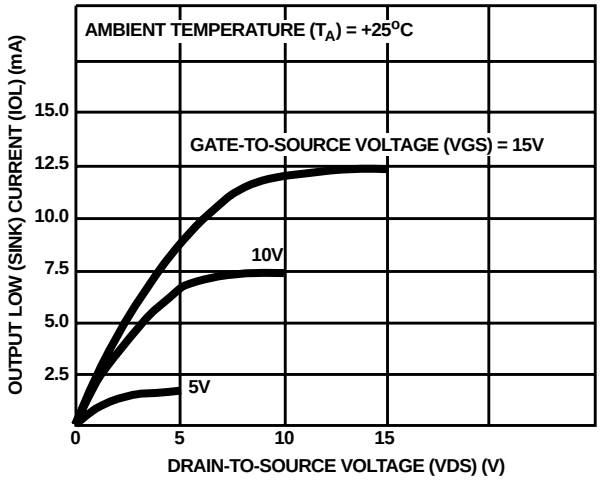


FIGURE 8. MINIMUM OUTPUT LOW (SINK) CURRENT CHARACTERISTICS

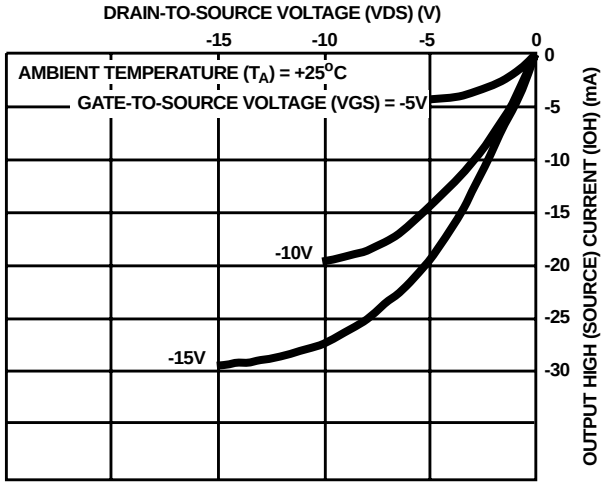


FIGURE 9. TYPICAL OUTPUT HIGH (SOURCE) CURRENT CHARACTERISTICS

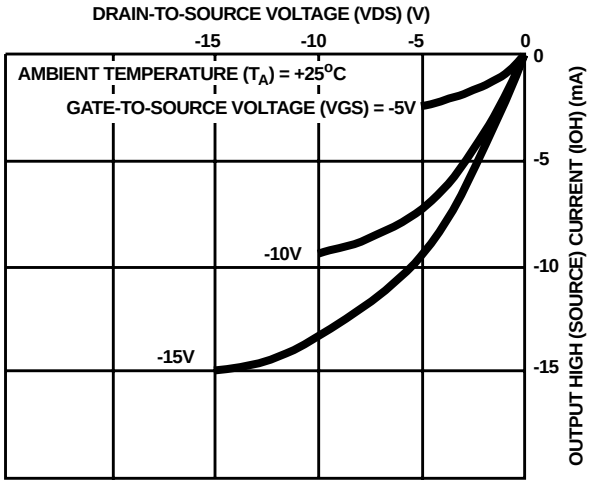


FIGURE 10. MINIMUM OUTPUT HIGH (SOURCE) CURRENT CHARACTERISTICS

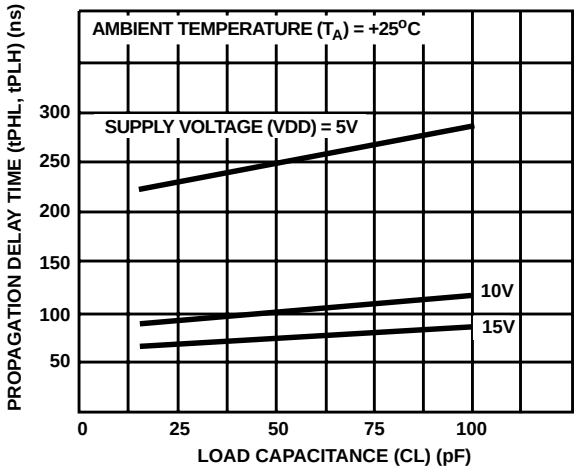


FIGURE 11. TYPICAL PROPAGATION DELAY TIME vs LOAD CAPACITANCE

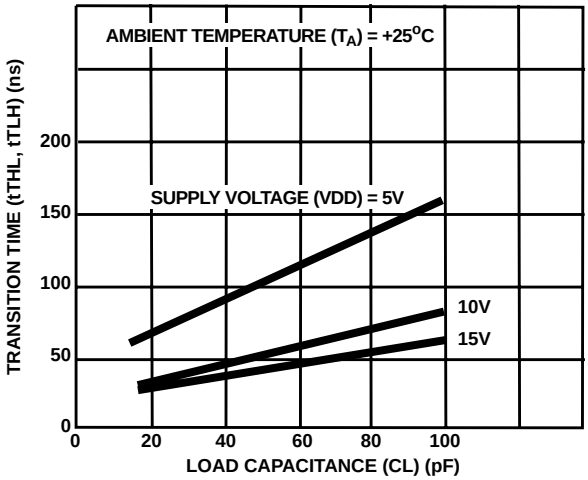


FIGURE 12. TYPICAL TRANSITION TIME vs LOAD CAPACITANCE

Typical Performance Characteristics (Continued)

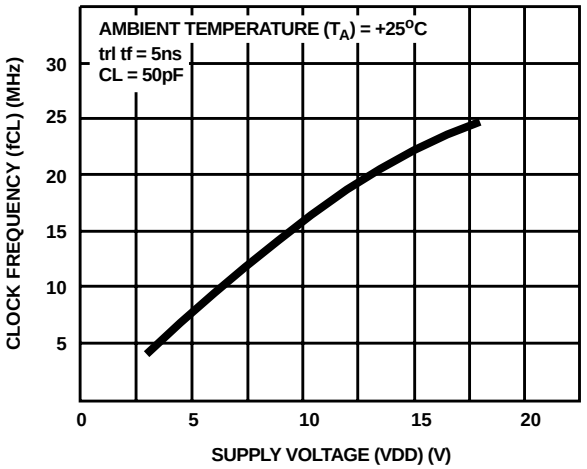


FIGURE 13. TYPICAL CLOCK FREQUENCY vs SUPPLY VOLTAGE (TOGGLE MODE - SEE FIGURE 4)

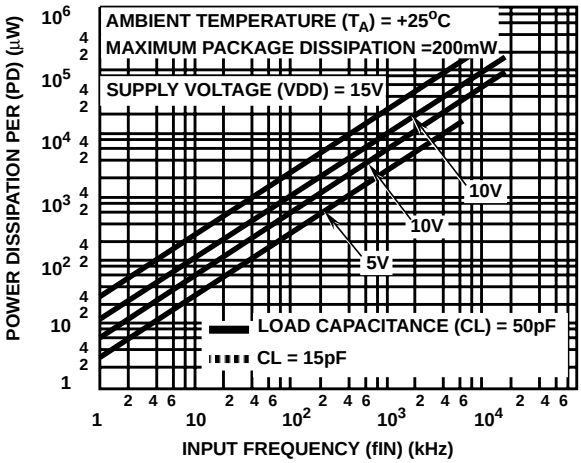
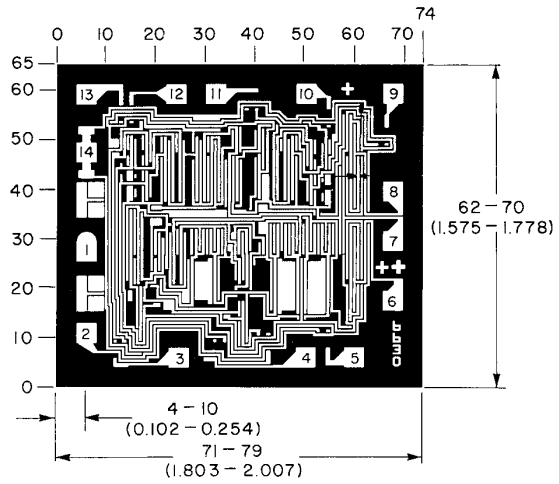
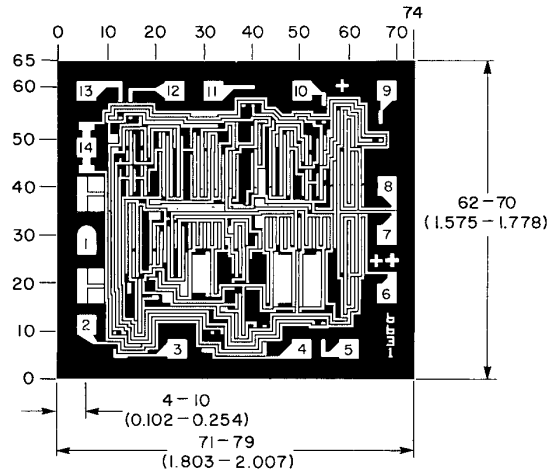


FIGURE 14. TYPICAL POWER DISSIPATION vs INPUT CLOCK FREQUENCY

Chip Dimensions and Pad Layouts



CD4095BHMS



CD4096BHMS

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

METALLIZATION: Thickness: 11kÅ – 14kÅ, AL.

PASSIVATION: 10.4kÅ - 15.6kÅ, Silane

BOND PADS: 0.004 inches X 0.004 inches MIN

DIE THICKNESS: 0.0198 inches - 0.0218 inches

All Intersil semiconductor products are manufactured, assembled and tested under **ISO9000** quality systems certification.