

CMOS Presettable Divide-By- "N" Counter

December 1992

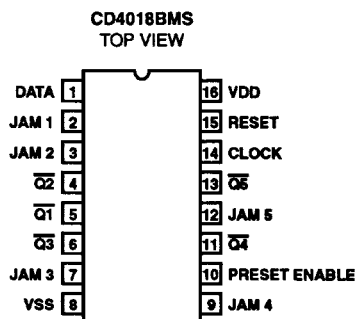
Features

- High Voltage Type (20V Rating)
- Medium Speed Operation 10MHz (typ.) at VDD - VSS = 10V
- Fully Static Operation
- 100% Tested for Quiescent Current at 20V
- Standardized Symmetrical Output Characteristics
- 5V, 10V and 15V Parametric Ratings
- Maximum Input Current of 1 μ A 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

- Fixed and Programmable Divided- By-10, 9, 8, 7, 6, 5, 4, 3, 2 Counters
- Fixed and Programmable Counters Greater Than 10
- Programmable Decade Counters
- Divide-By- "N" Counters/Frequency Synthesizers
- Frequency Division
- Counter Control/Timers

Pinout



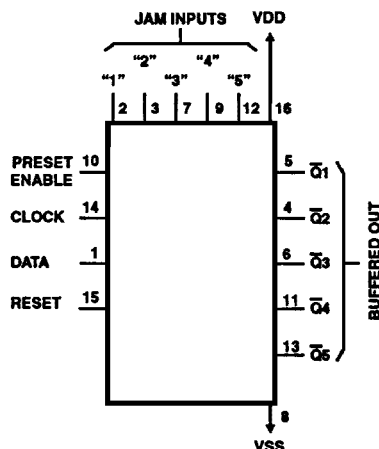
Description

CD4018BMS types consist of 5 Johnson-Counter stages, buffered Q outputs from each stage, and counter preset control gating. CLOCK, RESET, DATA, PRESET ENABLE, and 5 individual JAM inputs are provided. Divide by 10, 8, 6, 4, or 2 counter configurations can be implemented by feeding the Q5, Q4, Q3, Q2, Q1 signals, respectively, back to the DATA input. Divide-by-9, 7, 5, or 3 counter configurations can be implemented by the use of a CD4011B to gate the feedback connection to the DATA input. Divide-by functions greater than 10 can be achieved by use of multiple CD4018BMS units. The counter is advanced one count at the positive clock-signal transition. Schmitt Trigger action on the clock line permits unlimited clock rise and fall times. A high RESET signal clears the counter to an all-zero condition. A high PRESET-ENABLE signal allows information on the JAM inputs to preset the counter. Anti-lock gating is provided to assure the proper counting sequence.

The CD4018BMS is supplied in these 16-lead outline packages:

Braze Seal DIP	H4T
Frit Seal DIP	H1F
Ceramic Flatpack	H6W

Functional Diagram



Specifications CD4018BMS

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 $\pm 10\text{mA}$
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 $\pm$ 1/32 Inch (1.59mm $\pm$ 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		UNITS
					MIN	MAX	
Supply Current	IDD	VDD = 20V, VIN = VDD or GND	1	+25°C	-	10	μA
			2	+125°C	-	1000	μA
		VDD = 18V, VIN = VDD or GND	3	-55°C	-	10	μA
Input Leakage Current	IIL	VIN = VDD or GND	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	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 = -10 μA	1	+25°C	-2.8	-0.7	V
P Threshold Voltage	VPTH	VSS = 0V, IDD = 10 μA	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.

Specifications CD4018BMS

TABLE 2. AC ELECTRICAL PERFORMANCE CHARACTERISTICS

PARAMETER	SYMBOL	CONDITIONS (NOTE 1)	GROUP A SUBGROUPS	TEMPERATURE	LIMITS		UNITS
					MIN	MAX	
Propagation Delay Clock To $\bar{Q}$	TPHL1 TPLH1	VDD = 5V, VIN = VDD or GND	9	+25°C	-	400	ns
			10, 11	+125°C, -55°C	-	540	ns
Propagation Delay Preset To $\bar{Q}$	TPHL2 TPLH2	VDD = 5V, VIN = VDD or GND	9	+25°C	-	550	ns
			10, 11	+125°C, -55°C	-	743	ns
Propagation Delay Reset To $\bar{Q}$	TPLH3	VDD = 5V, VIN = VDD or GND	9	+25°C	-	550	ns
			10, 11	+125°C, -55°C	-	743	ns

NOTES:

1. CL = 50pF, RL = 200K, Input TR, TF < 20ns.
2. -55°C and +125°C limits guaranteed, 100% testing being implemented.

TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS

PARAMETER	SYMBOL	CONDITIONS	NOTES	TEMPERATURE	LIMITS		UNITS
					MIN	MAX	
Supply Current	IDD	VDD = 5V, VIN = VDD or GND	1, 2	-55°C, +25°C	-	5	μA
				+125°C	-	150	μA
		VDD = 10V, VIN = VDD or GND	1, 2	-55°C, +25°C	-	10	μA
				+125°C	-	300	μA
		VDD = 15V, VIN = VDD or GND	1, 2	-55°C, +25°C	-	10	μA
				+125°C	-	600	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
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 $\bar{Q}$	TPHL1 TPLH1	VDD = 10V	1, 2, 3	+25°C	-	180	ns
		VDD = 15V	1, 2, 3	+25°C	-	130	ns
Propagation Delay Preset To $\bar{Q}$	TPHL2 TPLH2	VDD = 10V	1, 2, 3	+25°C	-	250	ns
		VDD = 15V	1, 2, 3	+25°C	-	180	ns

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TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS (Continued)

PARAMETER	SYMBOL	CONDITIONS	NOTES	TEMPERATURE	LIMITS		UNITS
					MIN	MAX	
Propagation Delay Reset to Q	TPLH3	VDD = 10V	1, 2, 3	+25°C	-	250	ns
		VDD = 15V	1, 2, 3	+25°C	-	180	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 = 5V	1, 2, 3	+25°C	3	-	MHz
		VDD = 10V	1, 2, 3	+25°C	7	-	MHz
		VDD = 15V	1, 2, 3	+25°C	8.5	-	MHz
Minimum Data Setup Time	TS	VDD = 5V	1, 2, 3	+25°C	-	40	ns
		VDD = 10V	1, 2, 3	+25°C	-	12	ns
		VDD = 15V	1, 2, 3	+25°C	-	6	ns
Minimum Data Hold Time	TH	VDD = 5V	1, 2, 3	+25°C	-	140	ns
		VDD = 10V	1, 2, 3	+25°C	-	80	ns
		VDD = 15V	1, 2, 3	+25°C	-	60	ns
Minimum Clock Pulse Width	TW	VDD = 5V	1, 2, 3	+25°C	-	160	ns
		VDD = 10V	1, 2, 3	+25°C	-	70	ns
		VDD = 15V	1, 2, 3	+25°C	-	50	ns
Minimum Preset/Reset Removal Time	TREM	VDD = 5V	1, 2, 3	+25°C	-	80	ns
		VDD = 10V	1, 2, 3	+25°C	-	30	ns
		VDD = 15V	1, 2, 3	+25°C	-	20	ns
Minimum Preset/Reset Pulse Width	TW	VDD = 5V	1, 2, 3	+25°C	-	160	ns
		VDD = 10V	1, 2, 3	+25°C	-	70	ns
		VDD = 15V	1, 2, 3	+25°C	-	50	ns
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	-	25	μA
N Threshold Voltage	VNTH	VDD = 10V, ISS = -10μA	1, 4	+25°C	-2.8	-0.2	V
N Threshold Voltage Delta	ΔVTND	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	ΔVTPD	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

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

PARAMETER	SYMBOL	DELTA LIMIT
Supply Current - MSI-2	IDD	± 1.0µA
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
	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% Parametric, 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
Static Burn-In 1 Note 1	4 - 6, 11, 13	1 - 3, 7 - 9, 10, 12, 14, 15	16			
Static Burn-In 2 Note 1	4 - 6, 11, 13	8	1 - 3, 7, 9, 10, 12, 14 - 16			
Dynamic Burn-In Note 1	-	2, 8, 9, 15	1, 3, 12, 16	4 - 6, 11, 13	7, 14	10
Irradiation Note 2	4 - 6, 11, 13	8	1 - 3, 7, 9, 10, 12, 14 - 16			

NOTE:

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

Logic Diagram

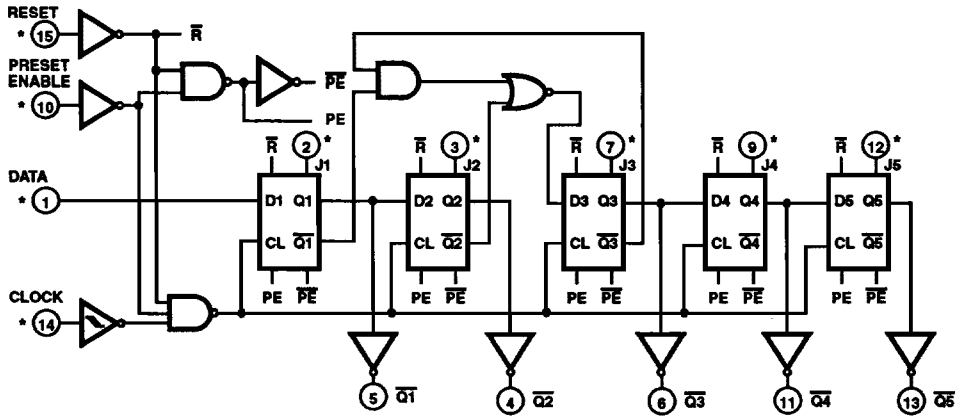


FIGURE 1. LOGIC DIAGRAM

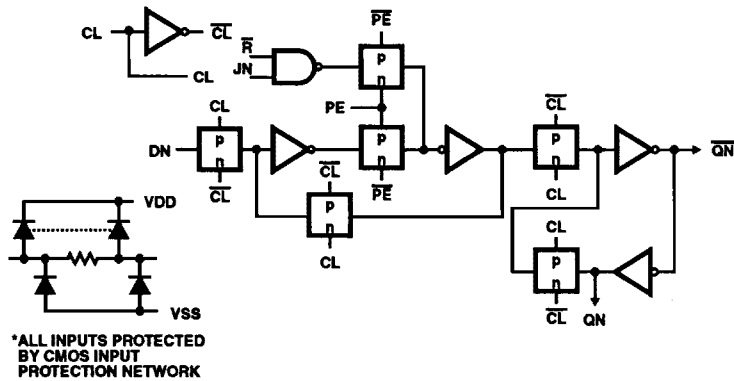


FIGURE 2. DETAIL OF A TYPICAL STAGE

Typical Performance Characteristics

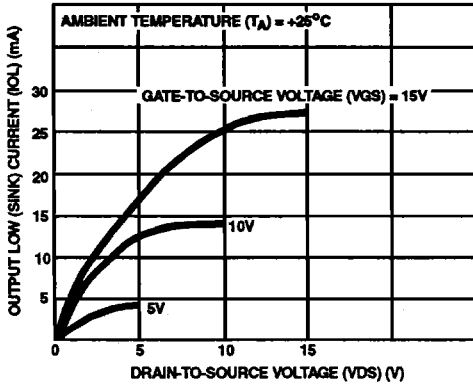


FIGURE 3. TYPICAL OUTPUT LOW (SINK) CURRENT CHARACTERISTICS

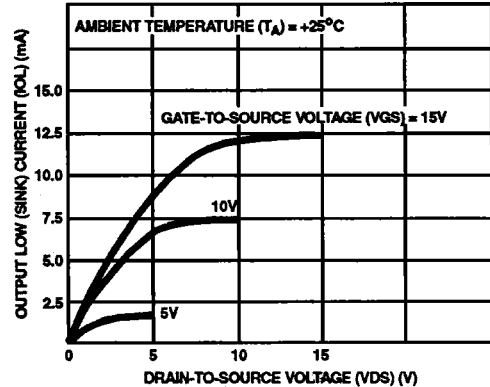


FIGURE 4. MINIMUM OUTPUT LOW (SINK) CURRENT CHARACTERISTICS

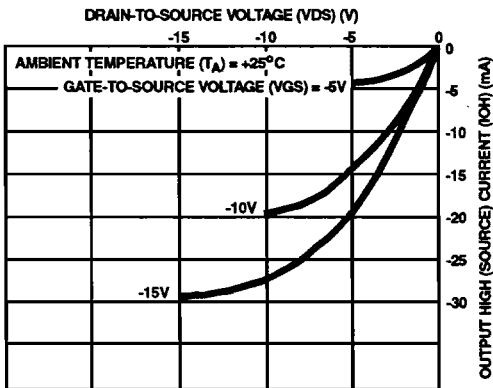


FIGURE 5. TYPICAL OUTPUT HIGH (SOURCE) CURRENT CHARACTERISTICS

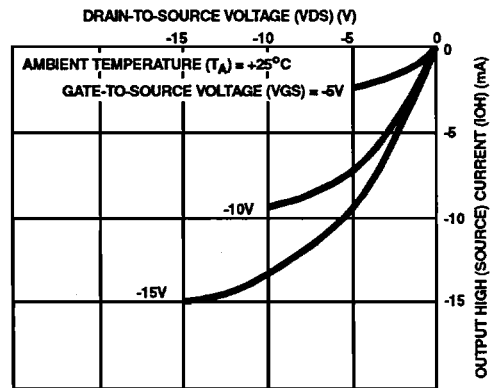


FIGURE 6. MINIMUM OUTPUT HIGH (SOURCE) CURRENT CHARACTERISTICS

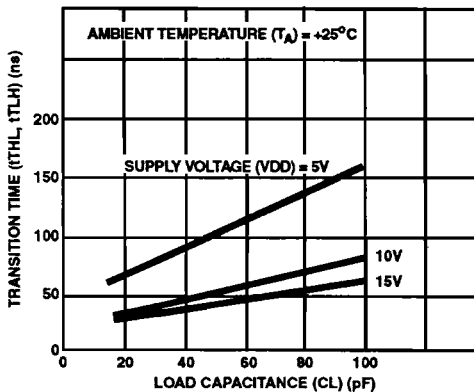


FIGURE 7. TYPICAL TRANSITION TIME AS A FUNCTION OF LOAD CAPACITANCE

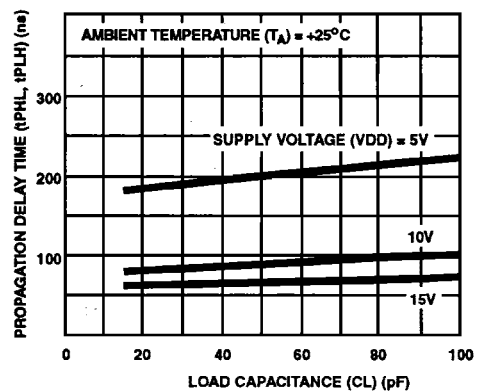


FIGURE 8. TYPICAL PROPAGATION DELAY TIME AS A FUNCTION OF LOAD CAPACITANCE (CLOCK TO Q)

Typical Performance Characteristics (Continued)

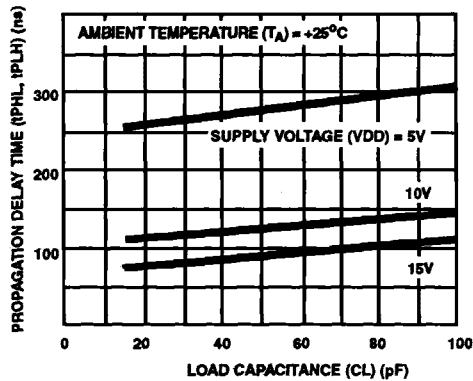


FIGURE 9. TYPICAL PROPAGATION DELAY TIME AS A FUNCTION OF LOAD CAPACITANCE (RESET TO Q)

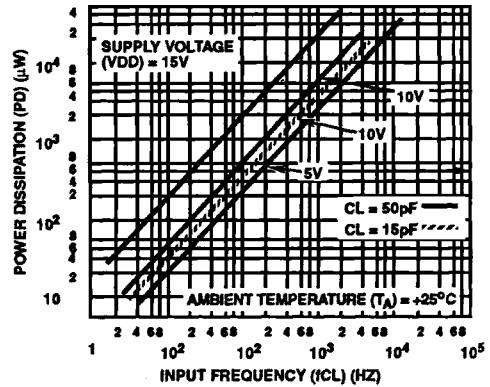


FIGURE 10. TYPICAL DYNAMIC POWER DISSIPATION AS A FUNCTION OF CLOCK INPUT FREQUENCY

Timing Diagram

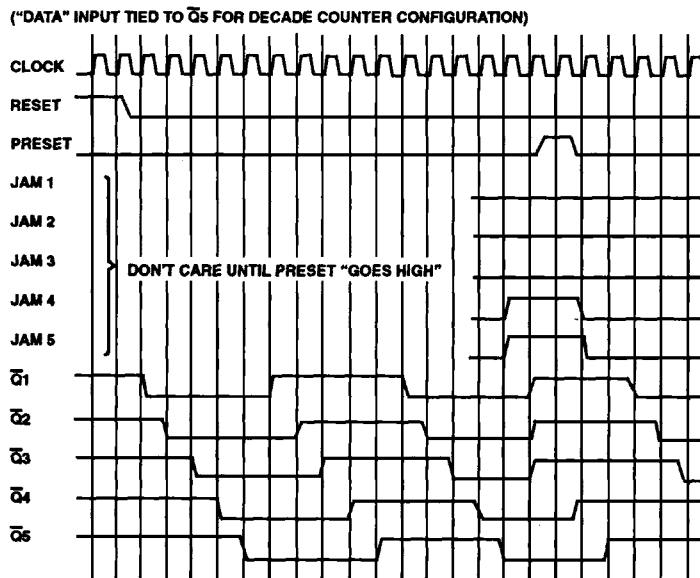


FIGURE 11. TIMING DIAGRAM

EXTERNAL CONNECTIONS FOR DIVIDE BY 10, 9, 8, 7, 6, 5, 4, 3, OPERATION

DIVIDE BY 10	$\overline{Q}5$	Connected Back To "Data"	No External Components Required
DIVIDE BY 8	$\overline{Q}4$	Connected Back To "Data"	No External Components Required
DIVIDE BY 6	$\overline{Q}3$	Connected Back To "Data"	No External Components Required
DIVIDE BY 4	$\overline{Q}2$	Connected Back To "Data"	No External Components Required
DIVIDE BY 2	$\overline{Q}1$		

DIVIDE BY 9

1/2 CD4011B



CONNECTED BACK TO "DATA"
(SKIPS "ALL-1's" STATE)

DIVIDE BY 7

1/2 CD4011B



CONNECTED BACK TO "DATA"
(SKIPS "ALL-1's" STATE)

DIVIDE BY 5

1/2 CD4011B



CONNECTED BACK TO "DATA"
(SKIPS "ALL-1's" STATE)

DIVIDE BY 3

1/2 CD4011B



CONNECTED BACK TO "DATA"
(SKIPS "ALL-1's" STATE)

FIGURE 12. EXTERNAL CONNECTIONS FOR DIVIDE BY 10, 9, 8, 7, 6, 5, 4, 3, 2 OPERATION

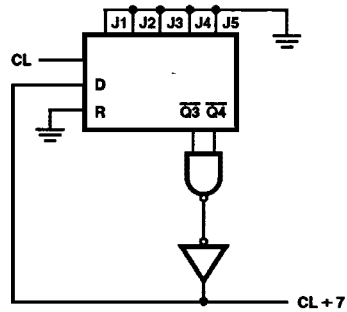
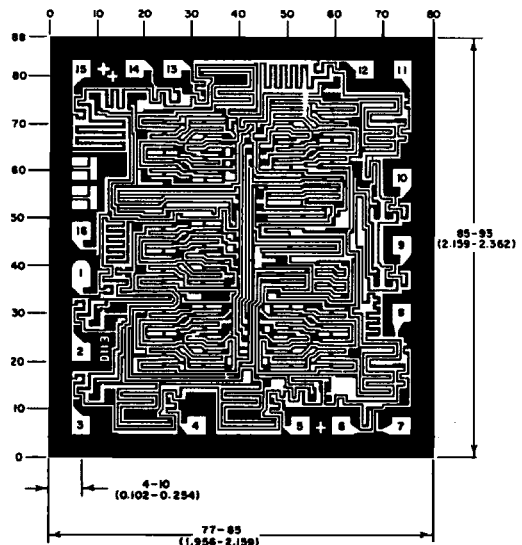


FIGURE 13. EXAMPLE OF DIVIDE BY 7

Chip Dimensions and Pad Layout



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

METALLIZATION: Thickness: $11\text{k}\text{\AA} - 14\text{k}\text{\AA}$, AL.

PASSIVATION: $10.4\text{k}\text{\AA} - 15.6\text{k}\text{\AA}$, Silane

BOND PADS: 0.004 inches X 0.004 inches MIN

DIE THICKNESS: 0.0198 inches - 0.0218 inches