

December 1992

CMOS Quad 'D' Type Flip-Flop

Features

- High Voltage Type (20V Rating)
- Output Compatible with Two HTL Loads, Two Low Power TTL Loads, or One Low Power Schottky TTL Load
- Functional Equivalent to TTL74175
- 100% Tested for Quiescent Current at 20V
- 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
- Standardized Symmetrical Output Characteristics
- Meets All Requirements of JEDEC Tentative Standard No. 13B, "Standard Specifications for Description of 'B' Series CMOS Devices"

Applications

- Shift Registers
- Buffer/Storage Registers
- Pattern Generators

Description

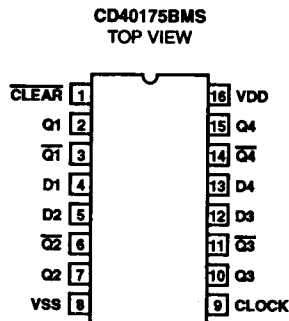
CD40175BMS consists of four identical D-type flip-flops. Each flip-flop has an independent DATA D input and complementary Q and \bar{Q} outputs. The CLOCK and CLEAR inputs are common to all flip-flops. Data are transferred to the Q outputs on the positive going transition of the clock pulse. All four flip-flops are simultaneously reset by a low level on the CLEAR input.

These devices can function as shift register elements or as T-type flip-flops for toggle and counter applications.

The CD40175BMS is supplied in these 16-lead outline packages:

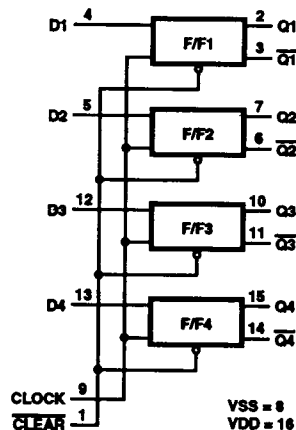
Braze Seal DIP	H4T
Ceramic Flatpack	H6W

Pinout



VDD = PIN 16
VSS = PIN 8

Functional Diagram



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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 T _A = -55°C to +100°C (Package Type D, F, K)	500mW	
For T _A = +100°C to +125°C (Package Type D, F, K)	Derate Linearity at 12mW/°C to 200mW	
Device Dissipation per Output Transistor	100mW	
For T _A = 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	-	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
			VDD = 18V	2	+125°C	-1000	-	nA
				3	-55°C	-100	-	nA
Input Leakage Current	IIH	VIN = VDD or GND	VDD = 20	1	+25°C	-	100	nA
			VDD = 18V	2	+125°C	-	1000	nA
				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. 3. For accuracy, voltage is measured differentially to VDD. Limit is 0.050V max.
 2. Go/No Go test with limits applied to inputs.

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TABLE 2. AC ELECTRICAL PERFORMANCE CHARACTERISTICS

PARAMETER	SYMBOL	CONDITIONS (NOTES 1, 2)	GROUP A SUBGROUPS	TEMPERATURE	LIMITS		UNITS
					MIN	MAX	
Propagation Delay Clock to Q Output	TPHL1 TPLH1	VDD = 5V, VIN = VDD or GND	9	+25°C	-	400	ns
			10, 11	+125°C, -55°C	-	540	ns
Propagation Delay Clear to Q Output	TPHL2	VDD = 5V, VIN = VDD or GND	9	+25°C	-	500	ns
			10, 11	+125°C, -55°C	-	675	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	2	-	MHz
			10, 11	+125°C, -55°C	1.48	-	MHz

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	-	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

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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 Q Output	TPHL1 TPLH1	VDD = 10V	1, 2, 3	+25°C	-	160	ns
		VDD = 15V	1, 2, 3	+25°C	-	120	ns
Propagation Delay Clear to Q Output	TPHL2	VDD = 10V	1, 2, 3	+25°C	-	200	ns
		VDD = 15V	1, 2, 3	+25°C	-	150	ns
Transition Time	TTHL TTLH	VDD = 10V	1, 2, 3	+25°C	-	100	ns
		VDD = 15V	1, 2, 3	+25°C	-	80	ns
Minimum Data Setup Time	TS	VDD = 5V	1, 2, 3	+25°C	-	120	ns
		VDD = 10V	1, 2, 3	+25°C	-	50	ns
		VDD = 15V	1, 2, 3	+25°C	-	40	ns
Minimum Data Hold Time	TH	VDD = 5V	1, 2, 3	+25°C	-	80	ns
		VDD = 10V	1, 2, 3	+25°C	-	40	ns
		VDD = 15V	1, 2, 3	+25°C	-	30	ns
Minimum Clear Pulse Width	TW	VDD = 5V	1, 2, 3	+25°C	-	200	ns
		VDD = 10V	1, 2, 3	+25°C	-	80	ns
		VDD = 15V	1, 2, 3	+25°C	-	60	ns
Maximum Clock Rise or Fall Time	TRCL TFCL	VDD = 5V	1, 2, 3, 4	+25°C	15	-	µs
		VDD = 10V	1, 2, 3, 4	+25°C	15	-	µs
		VDD = 15V	1, 2, 3, 4	+25°C	15	-	µs
Minimum Clear Removal Time (Clear to be High before Positive Transition of Clock)	TREM	VDD = 5V	1, 2, 3	+25°C	-	250	ns
		VDD = 10V	1, 2, 3	+25°C	-	100	ns
		VDD = 15V	1, 2, 3	+25°C	-	80	ns
Minimum Clock Pulse Width	TW	VDD = 5V	1, 2, 3	+25°C	-	250	ns
		VDD = 10V	1, 2, 3	+25°C	-	100	ns
		VDD = 15V	1, 2, 3	+25°C	-	75	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.
4. If more than one unit is cascaded, TRCL should be made less than or equal to the sum of the transition time and the fixed propagation delay of the output of the driving stage for the estimated capacitive load.

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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
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.

3. See Table 2 for +25°C limit.

2. CL = 50pF, RL = 200K, Input TR, TF < 20ns.

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, RONDEL10
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	1, 2, 3, 7, 8A, 8B, 9, 10, 11, Deltas	Subgroups 1, 2, 3, 9, 10, 11
	Subgroup B-6	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

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TABLE 8. BURN-IN AND IRRADIATION TEST CONNECTIONS

FUNCTION	OPEN	GROUND	VDD	9V ± 0.5V	OSCILLATOR	
					50kHz	25kHz
Static Burn-In 1 (Note 1)	2, 3, 6, 7, 10, 11, 14, 15	1, 4, 5, 8, 9, 12, 13	16			
Static Burn-In 2 (Note 1)	2, 3, 6, 7, 10, 11, 14, 15	8	1, 4, 5, 9, 12, 13, 16			
Dynamic Burn-In (Note 1)	-	8	1, 16	2, 3, 6, 7, 10, 11, 14, 15	9	4, 5, 12, 13
Irradiation (Note 2)	2, 3, 6, 7, 10, 11, 14, 15	8	1, 4, 5, 9, 12, 13, 16			

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

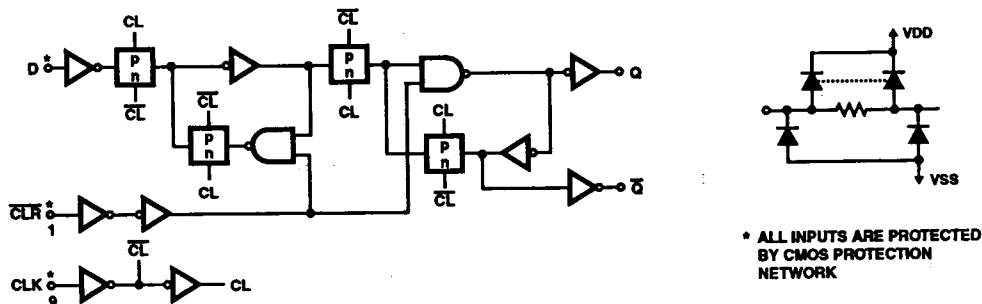


FIGURE 1. 1 OF 4 FLIP-FLOPS

TRUTH TABLE FOR 1 OF 4 FLIP-FLOPS (Positive Logic)

INPUTS			OUTPUTS	
CLOCK	DATA	$\overline{\text{CLEAR}}$	Q	$\overline{\text{Q}}$
⎓	0	1	0	1
⎓	1	1	1	0
⎓	X	1	Q	$\overline{\text{Q}}$
X	X	0	0	1

1 = High level
X = Don't care
0 = Low level

Electrical Performance Characteristics

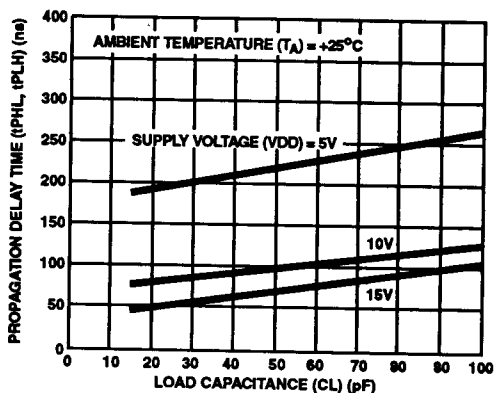


FIGURE 2. TYPICAL PROPAGATION DELAY TIME (CLOCK TO OUTPUT) AS A FUNCTION OF LOAD CAPACITANCE

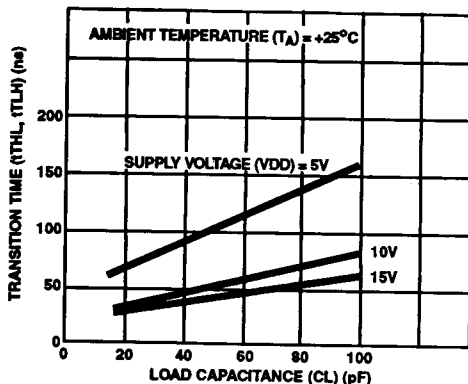


FIGURE 3. TYPICAL TRANSITION TIME AS A FUNCTION OF LOAD CAPACITANCE

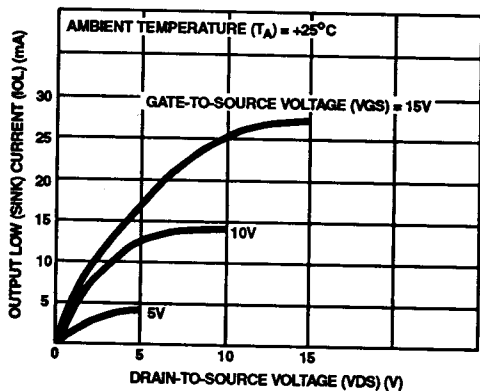


FIGURE 4. TYPICAL OUTPUT LOW (SINK) CURRENT CHARACTERISTICS

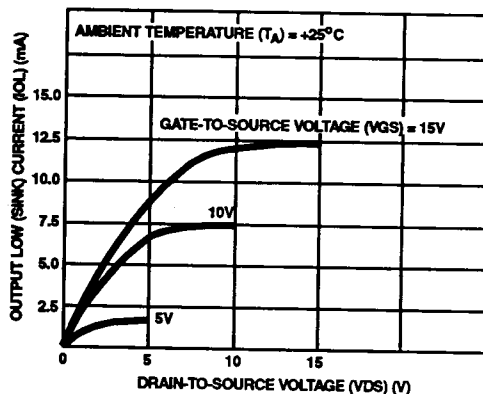


FIGURE 5. MINIMUM OUTPUT LOW (SINK) CURRENT CHARACTERISTICS

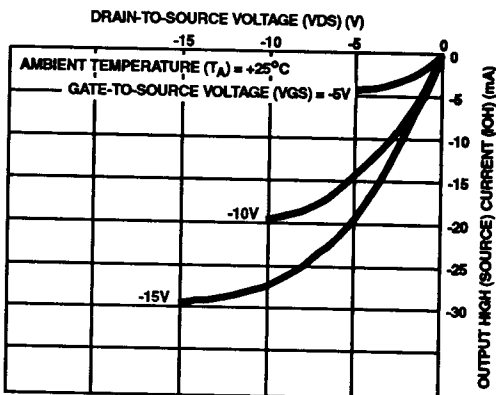


FIGURE 6. TYPICAL OUTPUT HIGH (SOURCE) CURRENT CHARACTERISTICS

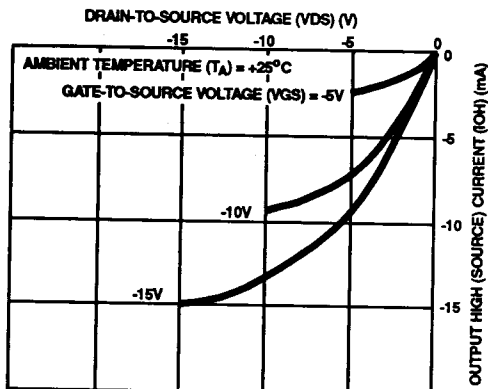


FIGURE 7. MINIMUM OUTPUT HIGH (SOURCE) CURRENT CHARACTERISTICS

Electrical Performance Characteristics (Continued)

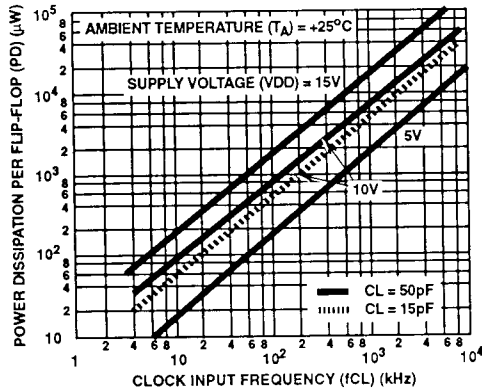
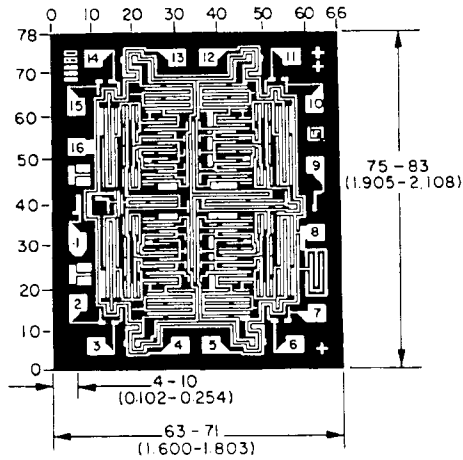


FIGURE 8. TYPICAL DYNAMIC POWER DISSIPATION AS A FUNCTION OF CLOCK FREQUENCY

Chip Dimensions and Pad Layout



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: $11\text{k}\text{\AA} - 14\text{k}\text{\AA}$, 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

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