

December 1992

## CMOS 4-Bit Magnitude Comparator

### Features

- High Voltage Type (20V Rating)
- Expansion to 8, 12, 16 . . . 4N Bits by Cascading Units
- Medium Speed Operation
  - Compares Two 4-Bit Words in 250ns (Typ.) at 10V
- 100% Tested for Quiescent Current at 20V
- Standardized Symmetrical Output Characteristics
- 5V, 10V and 15V Parametric Ratings
- Maximum Input Current of 1 $\mu$ A at 18V Over Full Package Temperature Range; 100nA at 18V and +25°C
- Noise Margin (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

- Servo Motor Controls
- Process Controllers

### Description

CD4063BMS is a 4-bit magnitude comparator designed for use in computer and logic applications that require the comparison of two 4-bit words. This logic circuit determines whether one 4-bit word (Binary or BCD) is "less than", "equal to", or "greater than" a second 4-bit word.

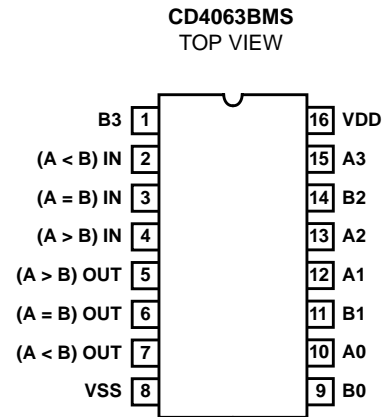
The CD4063BMS has eight comparing inputs (A3, B3, through A0, B0), three outputs (A < B, A = B, A > B) and three cascading inputs (A < B, A = B, A > B) that permit systems designers to expand the comparator function to 8, 12, 16 . . . 4N bits. When a single CD4063BMS is used, the cascading inputs are connected as follows: (A < B) = low, (A = B) = high, (A > B) = low.

For words longer than 4 bits, CD4063BMS devices may be cascaded by connecting the outputs of the less significant comparator to the corresponding cascading inputs of the more significant comparator. Cascading inputs (A < B, A = B, and A > B) on the least significant comparator are connected to a low, a high, and a low level, respectively.

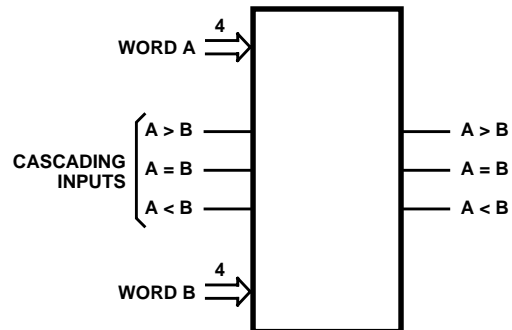
The CD4063BMS is supplied in these 16 lead outline packages:

Braze Seal DIP	H4T
Frit Seal DIP	H1E
Ceramic Flatpack	H6W

### Pinout



### Functional Diagram



# Specifications CD4063BMS

## 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 .....  $\theta_{ja}$   $\theta_{jc}$   
 Ceramic DIP Package ..... 80°C/W 20°C/W  
 Flatpack Package ..... 20°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	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
2. Go/No Go test with limit applied to inputs

3. For accuracy, voltage is measured differentially to VDD. Limit is 0.050V max.

## Specifications CD4063BMS

**TABLE 2. AC ELECTRICAL PERFORMANCE CHARACTERISTICS**

PARAMETER	SYMBOL	(NOTE 1, 2) CONDITIONS	GROUP A SUBGROUPS	TEMPERATURE	LIMITS		UNITS
					MIN	MAX	
Propagation Delay Com- parator Input to Output	T <sub>PHL</sub> T <sub>PLH</sub>	VDD = 5V, VIN = VDD or GND	9	+25°C	-	1250	ns
			10, 11	+125°C, -55°C	-	1688	ns
Propagation Delay Cascade Input to Output	T <sub>PHL</sub> T <sub>PLH</sub>	VDD = 5V, VIN = VDD or GND	9	+25°C	-	1000	ns
			10, 11	+125°C, -55°C	-	1350	ns
Transition Time	T <sub>TTL</sub>	VDD = 5V, VIN = VDD or GND	9	+25°C	-	200	ns
			10, 11	+125°C, -55°C	-	270	ns

**NOTES:**

1. VDD = 5V, 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	-	-2.6	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

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**TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS (Continued)**

PARAMETER	SYMBOL	CONDITIONS	NOTES	TEMPERATURE	LIMITS		UNITS
					MIN	MAX	
Input Voltage High	VIH	VDD = 10V, VOH > 9V, VOL < 1V	1, 2	+25°C, +125°C, -55°C	+7	-	V
Propagation Delay Comparator Input to Output	TPHL1 TPLH1	VDD = 10V	1, 2, 3	+25°C	-	500	ns
		VDD = 15V	1, 2, 3	+25°C	-	350	ns
Propagation Delay Cascade Input to Output	TPHL2 TPLH2	VDD = 10V	1, 2, 3	+25°C	-	400	ns
		VDD = 15V	1, 2, 3	+25°C	-	280	ns
Transition Time	TTHL TTLH	VDD = 10V	1, 2, 3	+25°C	-	100	ns
		VDD = 15V	1, 2, 3	+25°C	-	80	ns
Input Capacitance	CIN		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	ΔVNTH	VDD = 10V, ISS = -10μA	1, 4	+25°C	-	±1	V
P Threshold Voltage	VPTH	VSS = 0V, IDD = 10μA	1, 4	+25°C	0.2	2.8	V
P Threshold Voltage Delta	ΔVPTH	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 (Worst Case)	1, 2, 3, 4	+25°C	-	1.35 x +25°C Limit	ns

**NOTES:**

1. All voltages referenced to device GND.
2. VDD = 5V, 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-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	METHOD	GROUP A SUBGROUPS	READ AND RECORD
Initial Test (Pre Burn-In)	100% 5004	1, 7, 9	IDD, IOL5, IOH5A

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**TABLE 6. APPLICABLE SUBGROUPS**

CONFORMANCE GROUP		METHOD	GROUP A SUBGROUPS	READ AND RECORD
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: 5% parametric, 3% functional; cumulative for static 1 and 2.

**TABLE 7. TOTAL DOSE IRRADIATION**

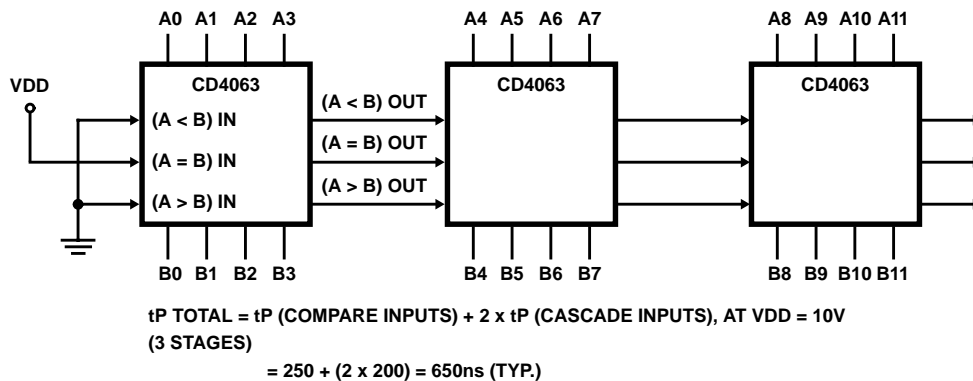
CONFORMANCE GROUPS	METHOD	TEST		READ AND RECORD	
		PRE-IRRAD	POST-IRRAD	PRE-IRRAD	POST-IRRAD
Group E Subgroup 2	5005	1, 7, 9	Table 4	1, 9, Deltas	Table 4

**TABLE 8. BURN-IN AND IRRADIATION TEST CONNECTIONS**

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

NOTE:

- Each pin except VDD and GND will have a series resistor of 10K ± 5%, VDD = 18V ± 0.5V
- 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



**FIGURE 1. TYPICAL SPEED CHARACTERISTICS OF A 12-BIT COMPARATOR**

Logic Diagram

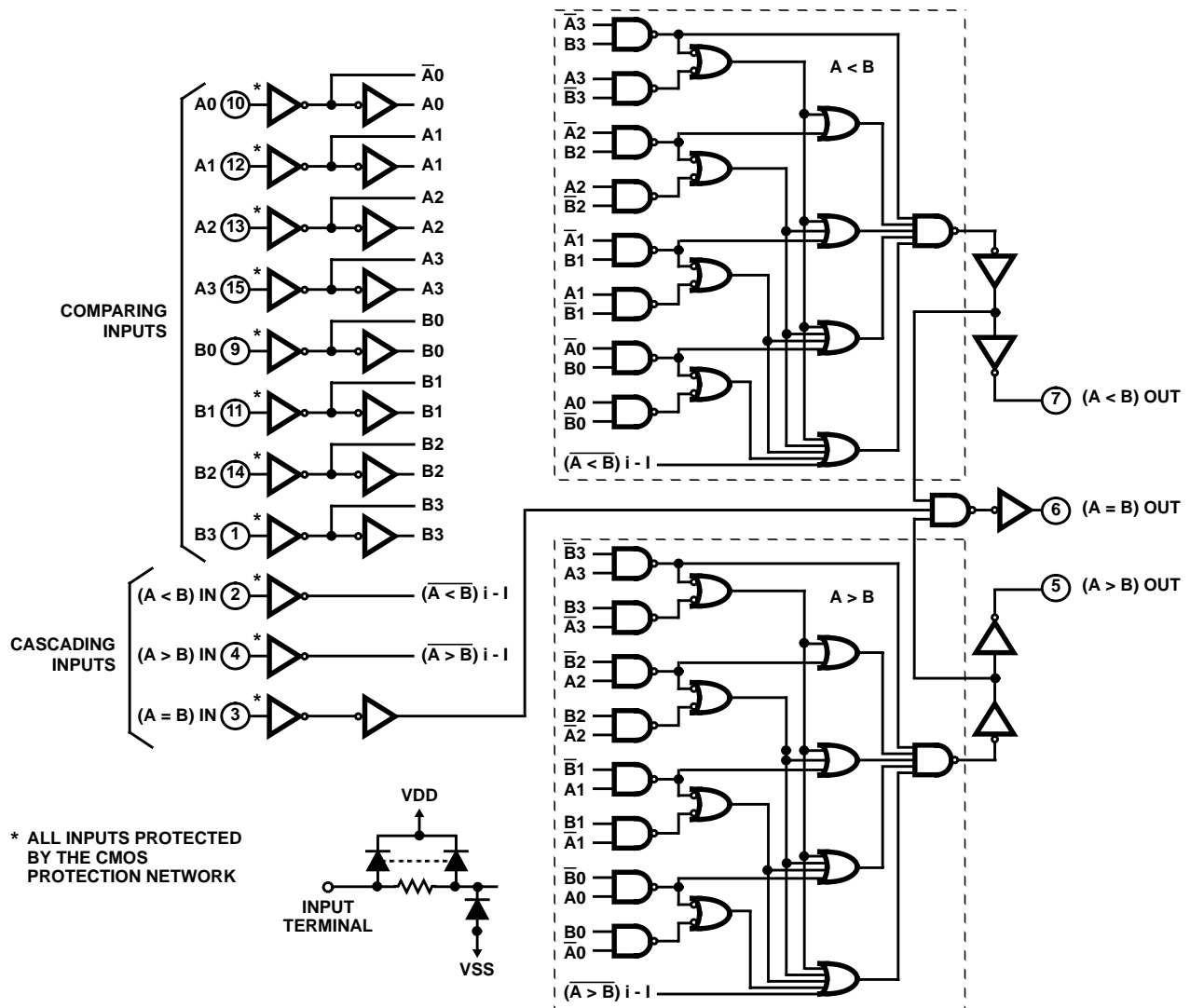


FIGURE 2. LOGIC DIAGRAM

TRUTH TABLE

INPUTS							OUTPUTS		
COMPARING				CASCADING					
A3, B3	A2, B2	A1, B1	A0, B0	A < B	A = B	A > B	A < B	A = B	A > B
A3 > B3	X	X	X	X	X	X	0	0	1
A3 = B3	A2 > B2	X	X	X	X	X	0	0	1
A3 = B3	A2 = B2	A1 > B1	X	X	X	X	0	0	1
A3 = B3	A2 = B2	A1 = B1	A0 > B0	X	X	X	0	0	1
A3 = B3	A2 = B2	A1 = B1	A0 = B0	0	0	1	0	0	1
A3 = B3	A2 = B2	A1 = B1	A0 = B0	0	1	0	0	1	0
A3 = B3	A2 = B2	A1 = B1	A0 = B0	1	0	0	1	0	0
A3 = B3	A2 = B2	A1 = B1	A0 < B0	X	X	X	1	0	0
A3 = B3	A2 = B2	A1 < B1	X	X	X	X	1	0	0
A3 = B3	A2 < B2	X	X	X	X	X	1	0	0
A3 < B3	X	X	X	X	X	X	1	0	0

X = Don't Care    Logic 1 = High Level    Logic 0 = Low Level

Typical Performance Characteristics

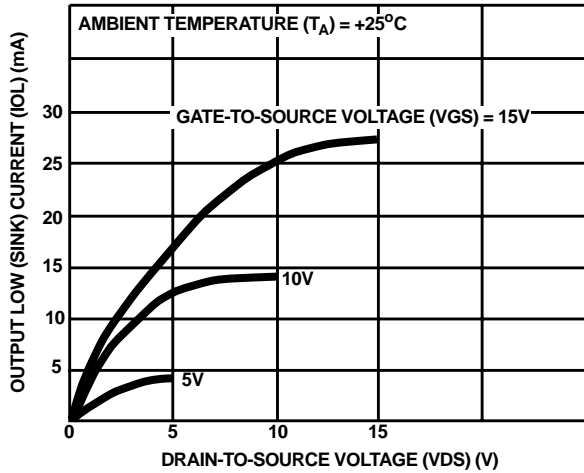


FIGURE 3. TYPICAL OUTPUT LOW (SINK) CURRENT CHARACTERISTICS

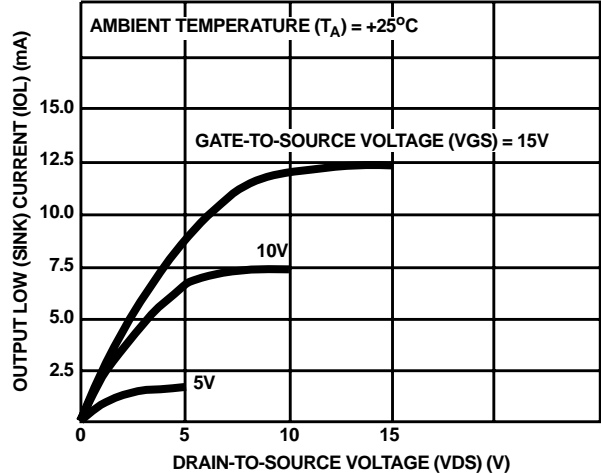


FIGURE 4. MINIMUM OUTPUT LOW (SINK) CURRENT DRAIN CHARACTERISTICS

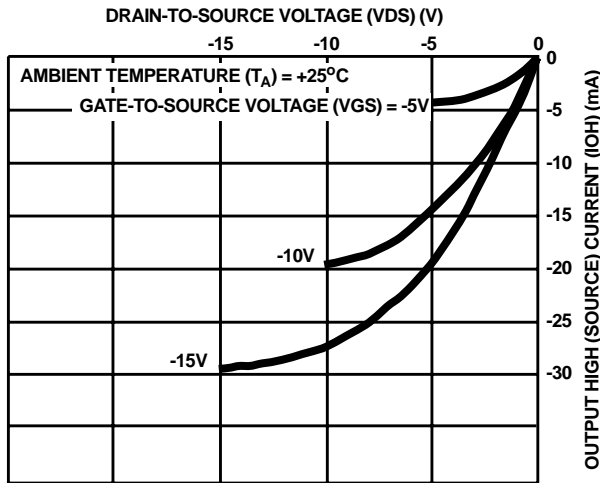


FIGURE 5. TYPICAL OUTPUT HIGH (SOURCE) CURRENT CHARACTERISTICS

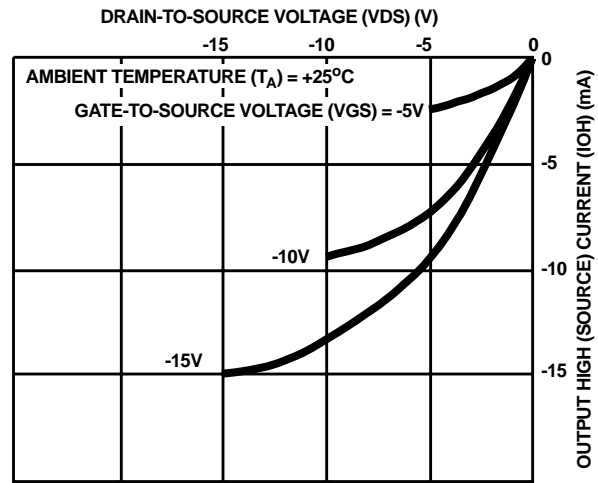


FIGURE 6. MINIMUM OUTPUT HIGH (SOURCE) CURRENT CHARACTERISTICS

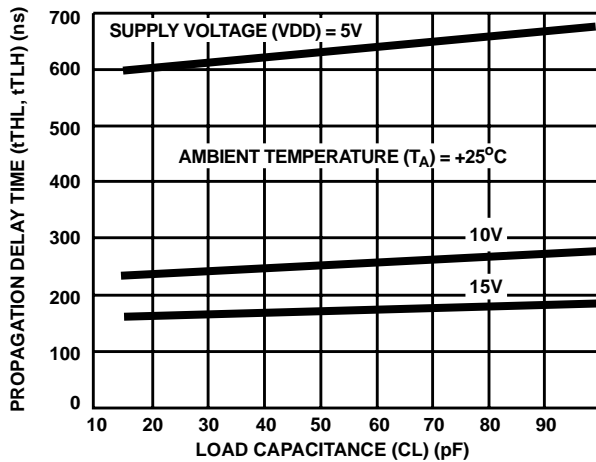


FIGURE 7. TYPICAL PROPAGATION DELAY TIME vs LOAD CAPACITANCE ("COMPARING INPUTS" TO OUTPUTS)

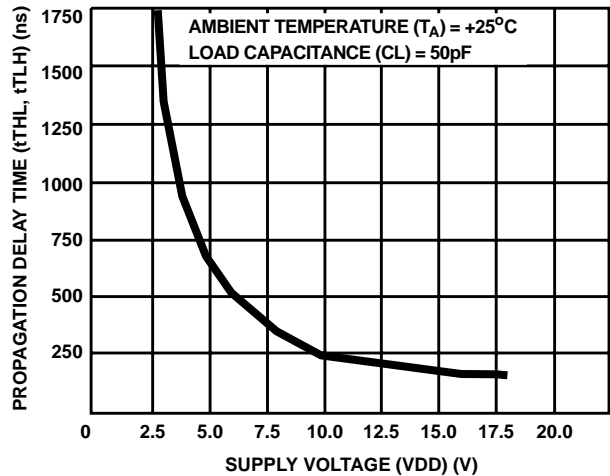


FIGURE 8. TYPICAL PROPAGATION DELAY TIME vs SUPPLY VOLTAGE ("COMPARING INPUTS" TO OUTPUTS)

Typical Performance Characteristics (Continued)

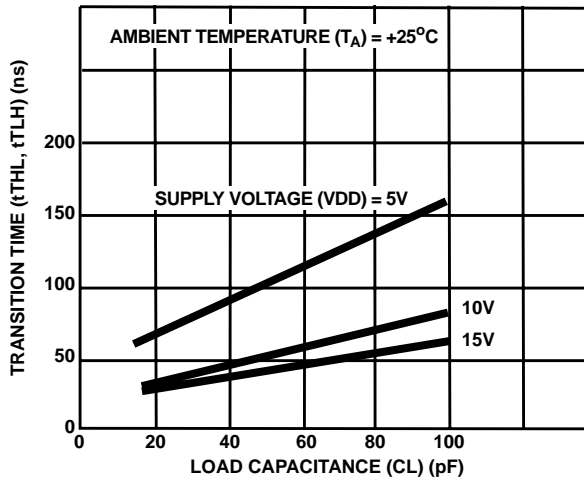


FIGURE 9. TYPICAL TRANSITION TIME vs LOAD CAPACITANCE

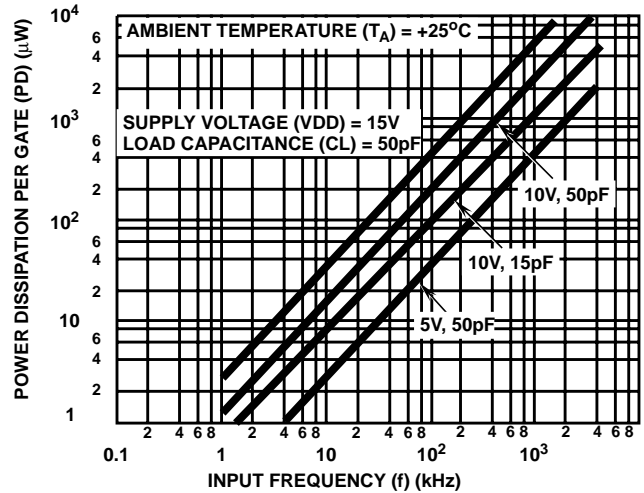
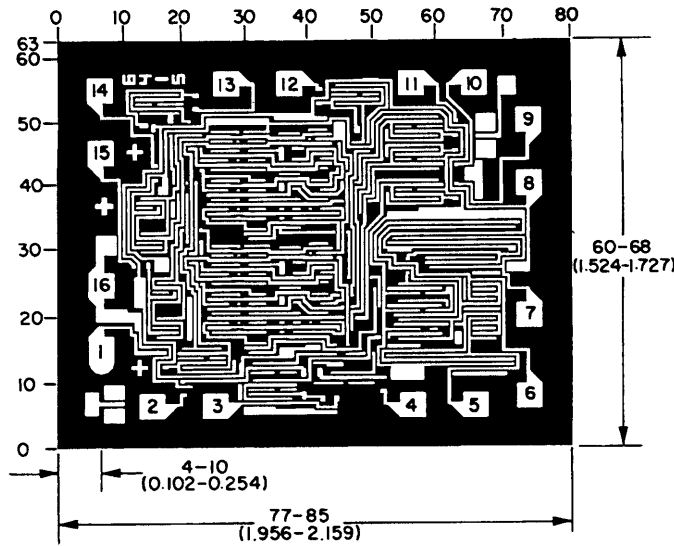


FIGURE 10. TYPICAL POWER DISSIPATION vs FREQUENCY

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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