Data Sheet | November 1994 | File Number 3293

CMOS Hex Buffers/Converter

CD4009UBMS Hex Buffer/Converter may be used as a CMOS to TTL or DTL logic-level converter or a CMOS high-sink-current driver.

The CD4049UB is the preferred hex buffer replacement for the CD4009UBMS in all applications except multiplexers. For applications not requiring high sink current or voltage conversion, the CD4069UB Hex Inverter is recommended.

The CD4009UBMS is supplied in these 16 lead outline packages:

Braze Seal DIP	H4S
Frit Seal DIP	H1E
Ceramic Flatpack	H3X

Features

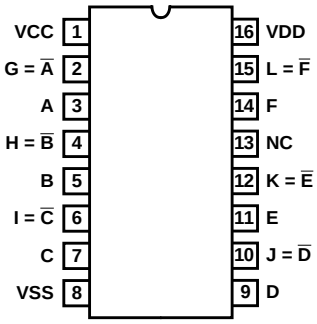
- **Inverting Type**
- **High-Voltage Type (20V Rating)**
- **100% Tested for Quiescent Current at 20V**
- **Maximum Input Current of 1μA at 18V Over Full Package-Temperature Range;**
  - **10nA at 18V and +25°C**
- **5V, 10V and 15V Parametric Ratings**

Applications

- **CMOS To DTL/TTL Hex Converter**
- **CMOS Current “Sink” or “Source” Driver**
- **CMOS High-to-Low Logic-Level Converter**
- **Multiplexer - 1 to 6 or 6 to 1**

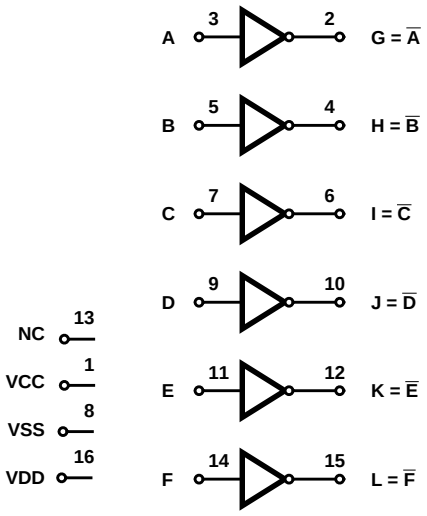
Pinout

CD4009UBMS
TOP VIEW



NC = NO CONNECTION

Functional Diagram



NC = NO CONNECTION

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^oC to $+125^oC$
Package Types D, F, K, H
Storage Temperature Range (TSTG). . . . . -65^oC to $+150^oC$
Lead Temperature (During Soldering) . . . . . $+265^oC$
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	$80^oC/W$	$20^oC/W$
Flatpack Package	$70^oC/W$	$20^oC/W$

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

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	$+25^oC$	-	2	µA
				2	$+125^oC$	-	200	µA
		VDD = 18V, VIN = VDD or GND		3	-55^oC	-	2	µA
Input Leakage Current	IIL	VIN = VDD or GND	VDD = 20	1	$+25^oC$	-100	-	nA
				2	$+125^oC$	-1000	-	nA
			VDD = 18V	3	-55^oC	-100	-	nA
Input Leakage Current	IIH	VIN = VDD or GND	VDD = 20	1	$+25^oC$	-	100	nA
				2	$+125^oC$	-	1000	nA
			VDD = 18V	3	-55^oC	-	100	nA
Output Voltage	VOL15	VDD = 15V, No Load		1, 2, 3	$+25^oC$, $+125^oC$, -55^oC	-	50	mV
Output Voltage	VOH15	VDD = 15V, No Load (Note 3)		1, 2, 3	$+25^oC$, $+125^oC$, -55^oC	14.95	-	V
Output Current (Sink)	IOL5	VDD = 5V, VOUT = 0.4V		1	$+25^oC$	3.0	-	mA
Output Current (Sink)	IOL10	VDD = 10V, VOUT = 0.5V		1	$+25^oC$	8.0	-	mA
Output Current (Sink)	IOL15	VDD = 15V, VOUT = 1.5V		1	$+25^oC$	24.0	-	mA
Output Current (Source)	IOH5A	VDD = 5V, VOUT = 4.6V		1	$+25^oC$	-	-0.2	mA
Output Current (Source)	IOH5B	VDD = 5V, VOUT = 2.5V		1	$+25^oC$	-	-0.8	mA
Output Current (Source)	IOH10	VDD = 10V, VOUT = 9.5V		1	$+25^oC$	-	-0.45	mA
Output Current (Source)	IOH15	VDD = 15V, VOUT = 13.5V		1	$+25^oC$	-	-1.5	mA
N Threshold Voltage	VNTH	VDD = 10V, ISS = -10µA		1	$+25^oC$	-2.8	-0.7	V
P Threshold Voltage	VPTH	VSS = 0V, IDD = 10µA		1	$+25^oC$	0.7	2.8	V
Functional	F	VDD = 2.8V, VIN = VDD or GND		7	$+25^oC$	VOH > VDD/2	VOL < VDD/2	V
		VDD = 20V, VIN = VDD or GND		7	$+25^oC$			
		VDD = 18V, VIN = VDD or GND		8A	$+125^oC$			
		VDD = 3V, VIN = VDD or GND		8B	-55^oC			
Input Voltage Low (Note 2)	VIL	VDD = 5V, VOH > 4.5V, VOL < 0.5V		1, 2, 3	$+25^oC$, $+125^oC$, -55^oC	-	1.0	V
Input Voltage High (Note 2)	VIH	VDD = 5V, VOH > 4.5V, VOL < 0.5V		1, 2, 3	$+25^oC$, $+125^oC$, -55^oC	4.0	-	V
Input Voltage Low (Note 2)	VIL	VDD = 15V, VOH > 13.5V, VOL < 1.5V		1, 2, 3	$+25^oC$, $+125^oC$, -55^oC	-	2.5	V
Input Voltage High (Note 2)	VIH	VDD = 15V, VOH > 13.5V, VOL < 1.5V		1, 2, 3	$+25^oC$, $+125^oC$, -55^oC	12.5	-	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		UNITS
					MIN	MAX	
Propagation Delay	TPHL	VDD = 5V, VIN = VDD or GND	9	+25°C	-	60	ns
			10, 11	+125°C, -55°C	-	81	ns
Propagation Delay	TPLH	VDD = 5V, VIN = VDD or GND	9	+25°C	-	140	ns
			10, 11	+125°C, -55°C	-	189	ns
Transition Time	TTHL	VDD = 5V, VIN = VDD or GND	9	+25°C	-	70	ns
			10, 11	+125°C, -55°C	-	95	ns
Transition Time	TTLH	VDD = 5V, VIN = VDD or GND	9	+25°C	-	350	ns
			10, 11	+125°C, -55°C	-	473	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	-	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)	IOL4	VDD = 4.5V, VOUT = 0.4V	1, 2	+25°C	2.6	-	mA
				+125°C	1.8	-	mA
				-55°C	3.2	-	mA
Output Current (Sink)	IOL5	VDD = 5V, VOUT = 0.4V	1, 2	+125°C	2.1	-	mA
				-55°C	3.75	-	mA
Output Current (Sink)	IOL10	VDD = 10V, VOUT = 0.5V	1, 2	+125°C	5.6	-	mA
				-55°C	10.0	-	mA
Output Current (Sink)	IOL15	VDD = 15V, VOUT = 1.5V	1, 2	+125°C	16.0	-	mA
				-55°C	30.0	-	mA
Output Current (Source)	IOH5A	VDD = 5V, VOUT = 4.6V	1, 2	+125°C	-	-0.15	mA
				-55°C	-	-0.25	mA
Output Current (Source)	IOH5B	VDD = 5V, VOUT = 2.5V	1, 2	+125°C	-	-0.58	mA
				-55°C	-	-1.0	mA
Output Current (Source)	IOH10	VDD = 10V, VOUT = 9.5V	1, 2	+125°C	-	-0.33	mA
				-55°C	-	-0.55	mA
Output Current (Source)	IOH15	VDD =15V, VOUT = 13.5V	1, 2	+125°C	-	-1.1	mA
				-55°C	-	-1.65	mA
Input Voltage Low	VIL	VDD = 10V, VOH > 9V, VOL < 1V	1, 2	+25°C, +125°C, -55°C	-	2	V

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	8	-	V
Propagation Delay	TPHL	VDD = 10V, VCC = 10V	1, 2, 3	+25°C	-	40	ns
		VDD = 15V, VCC = 15V	1, 2, 3	+25°C	-	30	ns
Propagation Delay	TPLH	VDD = 10V, VCC = 10V	1, 2, 3	+25°C	-	80	ns
		VDD = 15V, VCC = 15V	1, 2, 3	+25°C	-	60	ns
Propagation Delay	TPHL	VDD = 10V, VCC = 5V	1, 2, 3	+25°C	-	30	ns
		VDD = 15V, VCC = 5V	1, 2, 3	+25°C	-	20	ns
Propagation Delay	TPLH	VDD = 10V, VCC = 5V	1, 2, 3	+25°C	-	70	ns
		VDD = 15V, VCC = 5V	1, 2, 3	+25°C	-	60	ns
Transition Time	TTHL	VDD = 10V	1, 2, 3	+25°C	-	40	ns
		VDD = 15V	1, 2, 3	+25°C	-	30	ns
Transition Time	TTLH	VDD = 10V	1, 2, 3	+25°C	-	150	ns
		VDD = 15V	1, 2, 3	+25°C	-	110	ns
Input Capacitance	CIN	Any Input	1, 2	+25°C	-	22.5	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
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, VCC = 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

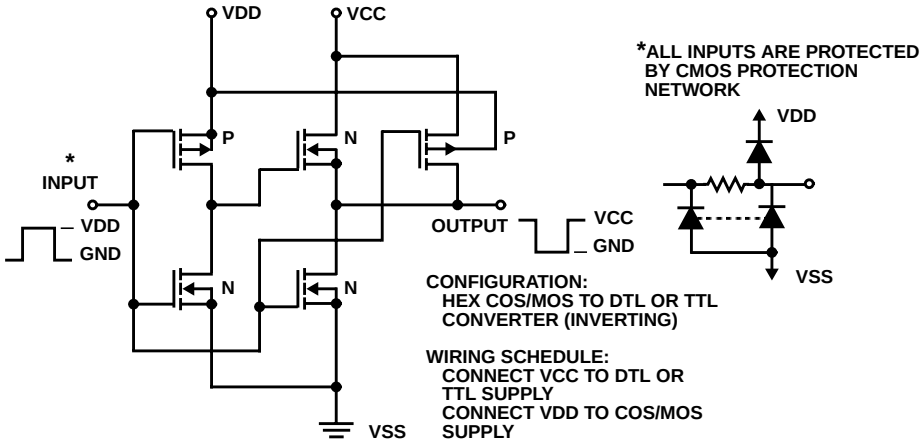
TABLE 8. BURN-IN AND IRRADIATION TEST CONNECTIONS

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

NOTE:

1. Each pin except VDD and Pin 1 and GND will have a series resistor of 10K ± 5%, VDD = 18V ± 0.5V
2. Each pin except VDD and Pin 1 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

Schematic Diagram



Typical Performance Characteristics

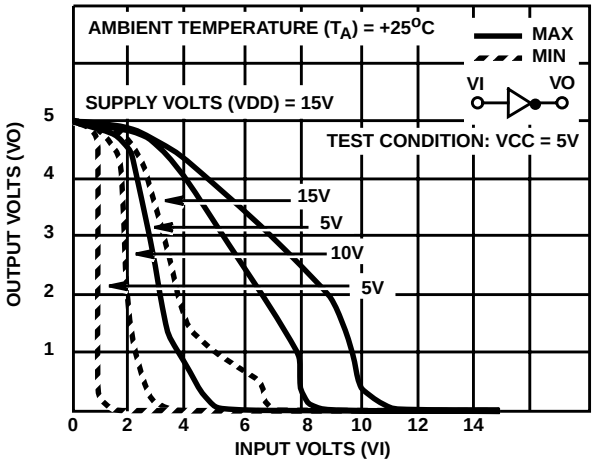


FIGURE 1. MINIMUM AND MAXIMUM VOLTAGE TRANSFER CHARACTERISTICS

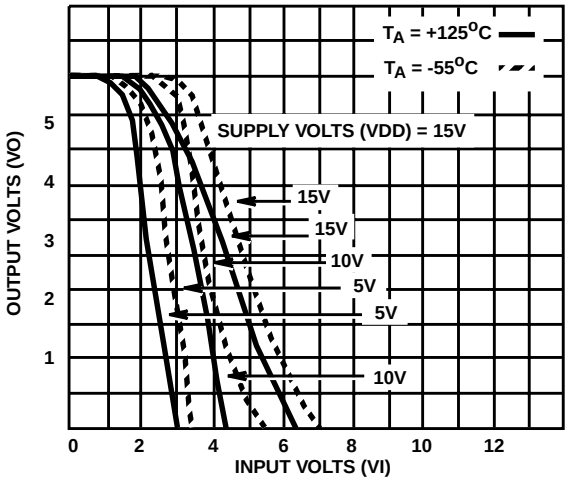


FIGURE 2. TYPICAL VOLTAGE TRANSFER CHARACTERISTICS AS FUNCTION OF TEMPERATURE

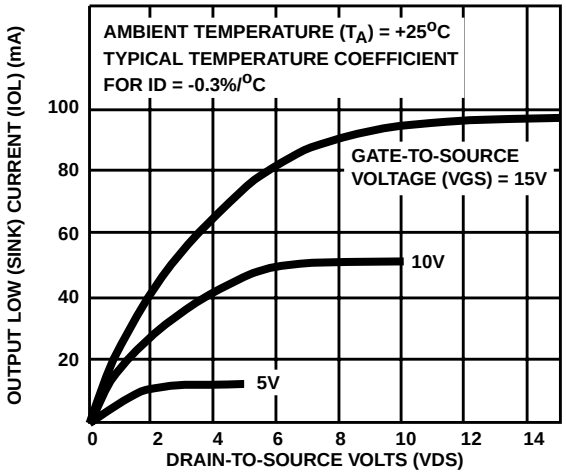


FIGURE 3. TYPICAL OUTPUT LOW (SINK) CURRENT CHARACTERISITICS

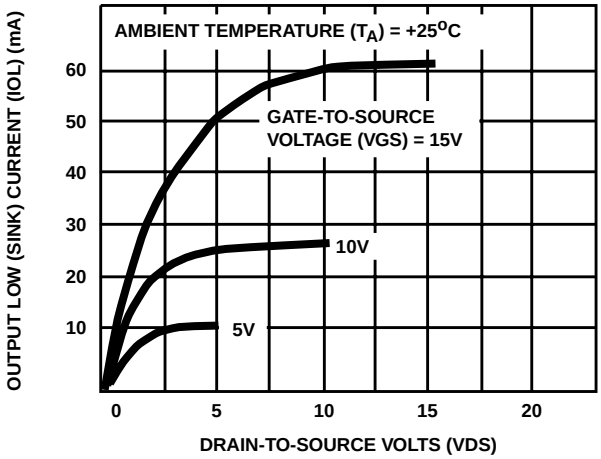


FIGURE 4. MINIMUM OUTPUT LOW (SINK) CURRENT CHARACTERISTICS

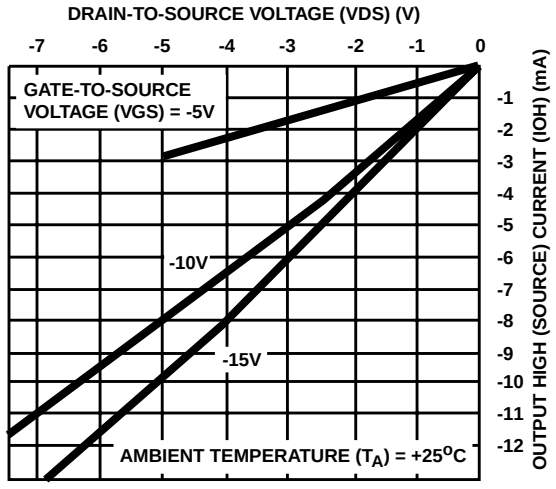


FIGURE 5. TYPICAL OUTPUT HIGH (SOURCE) CURRENT CHARACTERISTICS

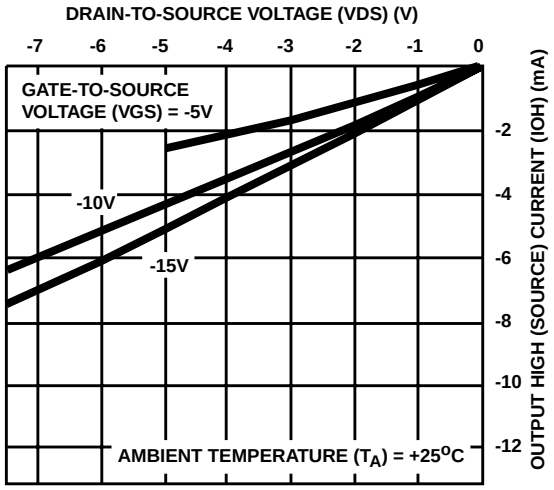


FIGURE 6. MINIMUM OUTPUT HIGH (SOURCE) CURRENT CHARACTERISTICS

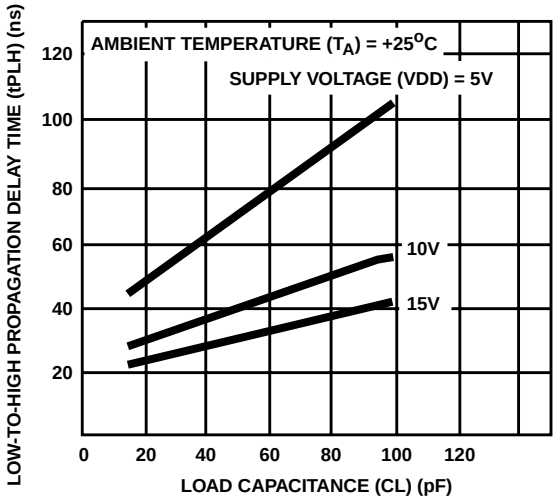


FIGURE 7. TYPICAL LOW-TO-HIGH PROPAGATION DELAY TIME vs LOAD CAPACITANCE

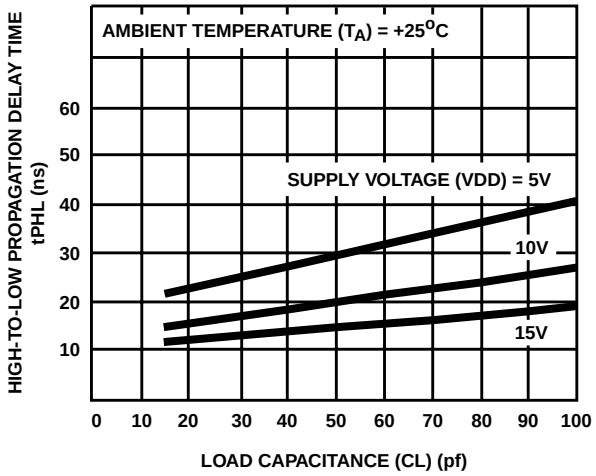


FIGURE 8. TYPICAL HIGH-TO-LOW PROPAGATION DELAY TIME vs LOAD CAPACITANCE

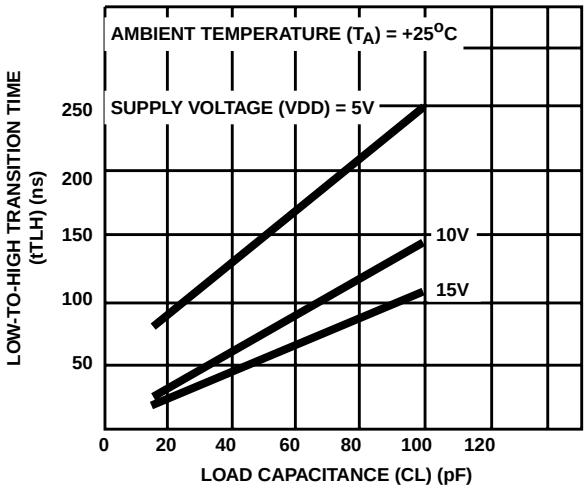


FIGURE 9. TYPICAL LOW-TO-HIGH TRANSITION TIME vs LOAD CAPACITANCE

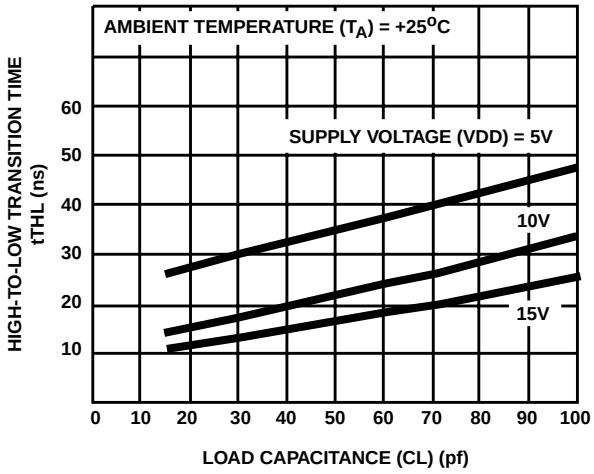


FIGURE 10. TYPICAL HIGH-TO-LOW TRANSISTION TIME vs LOAD CAPACITANCE

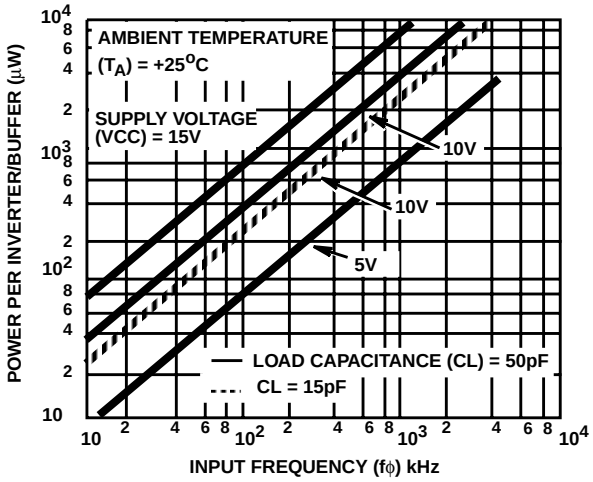
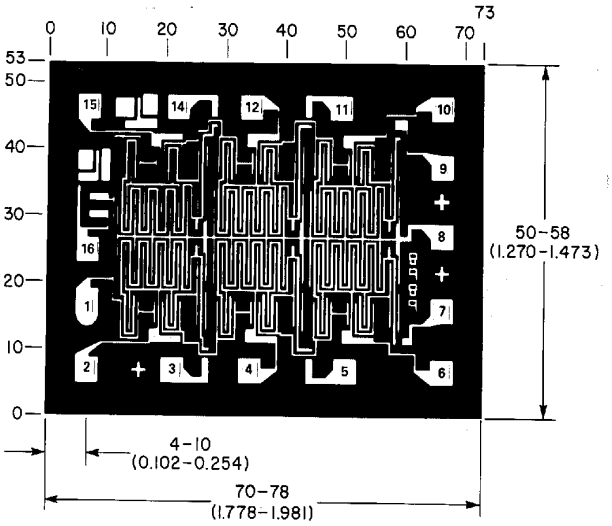


FIGURE 11. TYPICAL DISSIPATION CHARACTERISTICS

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: 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

Sales Office Headquarters

NORTH AMERICA
Intersil Corporation
P. O. Box 883, Mail Stop 53-204
Melbourne, FL 32902
TEL: (321) 724-7000
FAX: (321) 724-7240

EUROPE
Intersil SA
Mercure Center
100, Rue de la Fusee
1130 Brussels, Belgium
TEL: (32) 2.724.2111
FAX: (32) 2.724.22.05

ASIA
Intersil (Taiwan) Ltd.
7F-6, No. 101 Fu Hsing North Road
Taipei, Taiwan
Republic of China
TEL: (886) 2 2716 9310
FAX: (886) 2 2715 3029