CD4060BMS

CMOS 14 Stage Ripple-Carry Binary Counter/Divider and Oscillator

December 1992

Features

- High Voltage Type (20V Rating)
- Common Reset
- 12MHz Clock Rate at 15V
- Fully Static Operation
- Buffered Inputs and Outputs
- Schmitt Trigger Input Pulse Line
- Standardized, Symmetrical Output Characteristics
- 100% Tested for Quiescent Current at 20V
- 5V, 10V and 15V Parametric Ratings
- Meets All Requirements of JEDEC Tentative Standard No. 13B, "Standard Specifications for Description of 'B' Series CMOS Devices"

Oscillator Features

- All Active Components on Chip
- RC or Crystal Oscillator Configuration
- RC Oscillator Frequency of 690kHz Min. at 15V

Applications

- Control counters
- Timers
- Frequency Dividers
- Time Delay Circuits

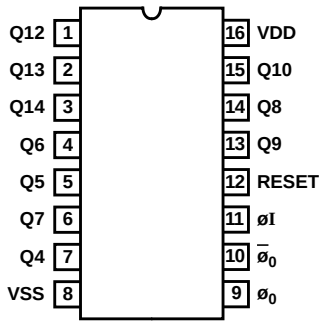
Description

CD4060BMS consists of an oscillator section and 14 ripple carry binary counter stages. The oscillator configuration allows design of either RC or crystal oscillator circuits. A RESET input is provided which resets the counter to the all O's state and disables the oscillator. A high level on the RESET line accomplishes the reset function. All counter stages are master slave flip-flops. The state of the counter is advanced one step in binary order on the negative transition of ϕI (and ϕ_0). All inputs and outputs are fully buffered. Schmitt trigger action on the input pulse line permits unlimited input pulse rise and fall times.

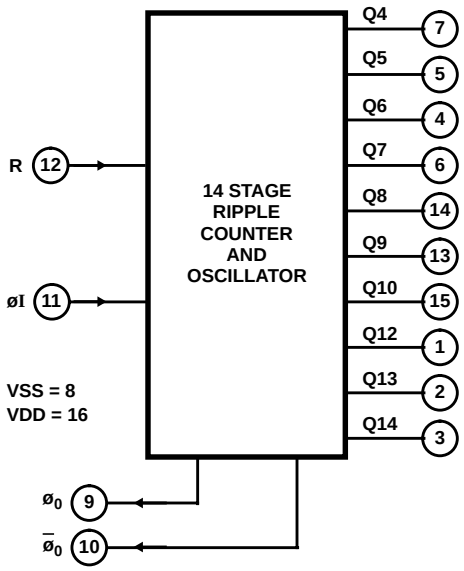
The CD4060BMS is supplied in these 16 lead outline packages:

Braze Seal DIP	H4W
Frit Seal DIP	H1F
Ceramic Flatpack	H6W

Pinout



Functional Diagram



CAUTION: These devices are sensitive to electrostatic discharge; follow proper IC Handling Procedures.
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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 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	-	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
				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) (Excluding pins 9 & 10)	IOL5	VDD = 5V, VOUT = 0.4V		1	+25°C	0.53	-	mA
	IOL10	VDD = 10V, VOUT = 0.5V		1	+25°C	1.4	-	mA
	IOL15	VDD = 15V, VOUT = 1.5V		1	+25°C	3.5	-	mA
Output Current (Source) (Excluding pins 9 & 10)	IOH5A	VDD = 5V, VOUT = 4.6V		1	+25°C	-	-0.53	mA
	IOH5B	VDD = 5V, VOUT = 2.5V		1	+25°C	-	-1.8	mA
	IOH10	VDD = 10V, VOUT = 9.5V		1	+25°C	-	-1.4	mA
	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 (NOTES 1, 2)	GROUP A SUBGROUPS	TEMPERATURE	LIMITS MIN	LIMITS MAX	UNITS
Propagation Delay Input Pulse Operation øI to Q4	TPHL1 TPLH1	VDD = 5V, VIN = VDD or GND	9	+25°C	-	740	ns
			10, 11	+125°C, -55°C	-	999	ns
Propagation Delay QN to QN + 1	TPHL2 TPLH2	VDD = 5V, VIN = VDD or GND	9	+25°C	-	200	ns
			10, 11	+125°C, -55°C	-	270	ns
Propagation Delay RESET	TPHL3	VDD = 5V, VIN = VDD or GND	9	+25°C	-	360	ns
			10, 11	+125°C, -55°C	-	486	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 Input Pulse Frequency	FØI	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	-	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) (Excluding pins 9 & 10)	IOL5	VDD = 5V, VOUT = 0.4V	1, 2	+125°C	0.36	-	mA
				-55°C	0.64	-	mA
Output Current (Sink) (Excluding pins 9 & 10)	IOL10	VDD = 10V, VOUT = 0.5V	1, 2	+125°C	0.9	-	mA
				-55°C	1.6	-	mA
Output Current (Sink) (Excluding pins 9 & 10)	IOL15	VDD = 15V, VOUT = 1.5V	1, 2	+125°C	2.4	-	mA
				-55°C	4.2	-	mA
Output Current (Source) (Excluding pins 9 & 10)	IOH5A	VDD = 5V, VOUT = 4.6V	1, 2	+125°C	-	-0.36	mA
				-55°C	-	-0.64	mA
Output Current (Source) (Excluding pins 9 & 10)	IOH5B	VDD = 5V, VOUT = 2.5V	1, 2	+125°C	-	-1.15	mA
				-55°C	-	-2.0	mA
Output Current (Source) (Excluding pins 9 & 10)	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) (Excluding pins 9 & 10)	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
Drive Current at Pin 9 Oscillator Design	IOL	VDD = 5V, VO = .4V	3	+25°C	0.16	-	mA
		VDD = 10V, VO = .5V	3	+25°C	0.42	-	mA
		VDD = 15V, VO = 1.5V	3	+25°C	-1.0	-	mA
Drive Current at Pin 9 Oscillator Design	IOH	VDD = 5V	1, 2, 3	+25°C	-	-.16	mA
		VDD = 10V	1, 2, 3	+25°C	-	-.42	mA
		VDD = 15V	1, 2, 3	+25°C	-	1.0	mA
Propagation Delay Input Pulse øI to Q4	TPHL1 TPLH1	VDD = 10V	1, 2, 3	+25°C	-	300	ns
		VDD = 15V	1, 2, 3	+25°C	-	200	ns
Propagation Delay QN to QN + 1	TPHL2 TPLH2	VDD = 10V	1, 2, 3	+25°C	-	100	ns
		VDD = 15V	1, 2, 3	+25°C	-	80	ns
Propagation Delay RESET	TPHL3	VDD = 10V	1, 2, 3	+25°C	-	160	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 Input Pulse Frequency	FØI	VDD = 10V	1, 2, 3	+25°C	8	-	MHz
		VDD = 15V	1, 2, 3	+25°C	12	-	MHz
Minimum RESET Pulse Width	TW	VDD = 5V	1, 2, 3	+25°C	-	120	ns
		VDD = 10V	1, 2, 3	+25°C	-	60	ns
		VDD = 15V	1, 2, 3	+25°C	-	40	ns
Minimum Input Pulse Width F = 100kHz	TW	VDD = 5V	1, 2, 3	+25°C	-	100	ns
		VDD = 10V	1, 2, 3	+25°C	-	40	ns
		VDD = 15V	1, 2, 3	+25°C	-	30	ns
RC Operation RX Max	RX	VDD = 5V, CX = 10µF	2, 3	+25°C	-	20	MΩ
		VDD = 10V, CX = 50µF	2, 3	+25°C	-	20	MΩ
		VDD = 15V, CX = 10µF	2, 3	+25°C	-	10	MΩ
RC Operation CX Max	CX	VDD = 5V, RX = 500kΩ	2, 3	+25°C	-	1000	µF
		VDD = 10V, RX = 300kΩ	2, 3	+25°C	-	50	µF
		VDD = 15V, RX = 300kΩ	2, 3	+25°C	-	50	µF
Maximum Oscillator Frequency (Note 4)	RX = 5kΩ CX = 15pF	VDD = 10V	2, 3	+25°C	530	810	ns
		VDD = 15V	2, 3	+25°C	690	940	ns
RC Operation Variation of Frequency (Unit-to-Unit)	CX = 200pF RS = 560K RX = 50k	VDD = 5V	2, 3	+25°C	18	25	kHz
		VDD = 10V	2, 3	+25°C	20	26	kHz
		VDD = 15V	2, 3	+25°C	21.1	27	kHz
Variation of Frequency with Voltage Change (Same Unit)	CX = 200pF RS = 560K RX = 50k	5V to 10V	2, 3	+25°C	-	2	kHz
		10V to 15V	2, 3	+25°C	-	1	kHz

TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS (Continued)

PARAMETER	SYMBOL	CONDITIONS	NOTES	TEMPERATURE	LIMITS		UNITS
					MIN	MAX	
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. RC Oscillator applications are not recommended at supply voltages below 7V for RX < 50kΩ.

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	ΔVTN	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	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-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	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

TABLE 6. APPLICABLE SUBGROUPS (Continued)

CONFORMANCE GROUP	MIL-STD-883 METHOD	GROUP A SUBGROUPS	READ AND RECORD

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

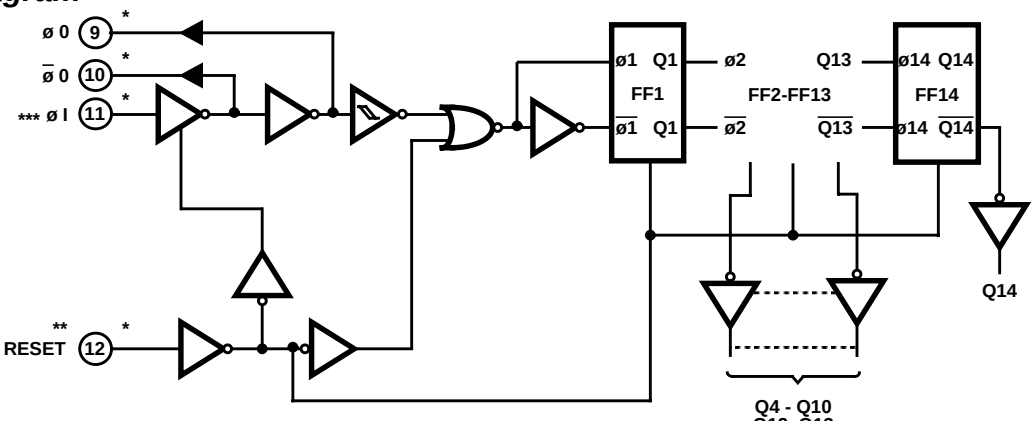
TABLE 8. BURN-IN AND IRRADIATION TEST CONNECTIONS

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

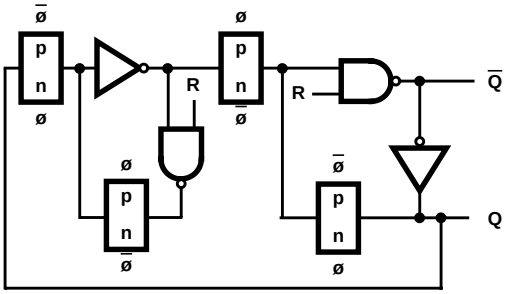
NOTES:

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



DETAIL OF TYPICAL FLIP-FLOP STAGE



Typical Performance Curves

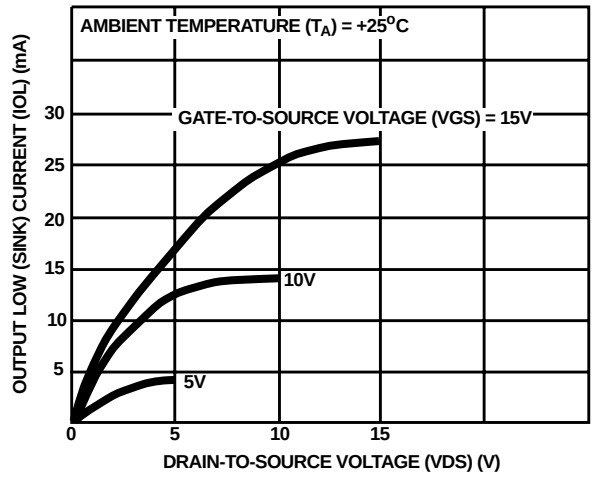


FIGURE 1. TYPICAL N-CHANNEL OUTPUT LOW SINK CURRENT CHARACTERISTICS

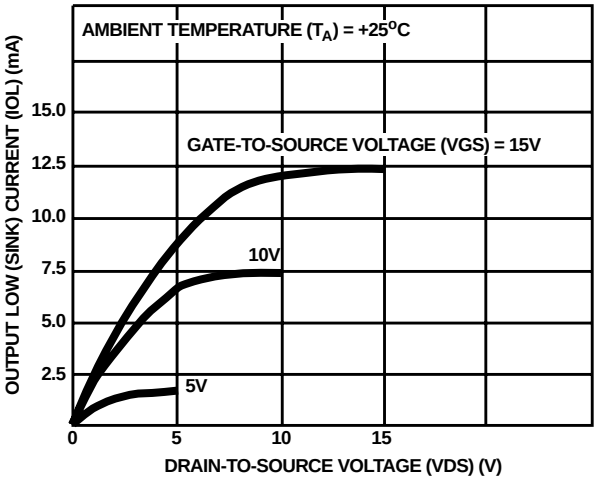


FIGURE 2. MINIMUM N-CHANNEL OUTPUT LOW (SINK) CURRENT CHARACTERISTICS

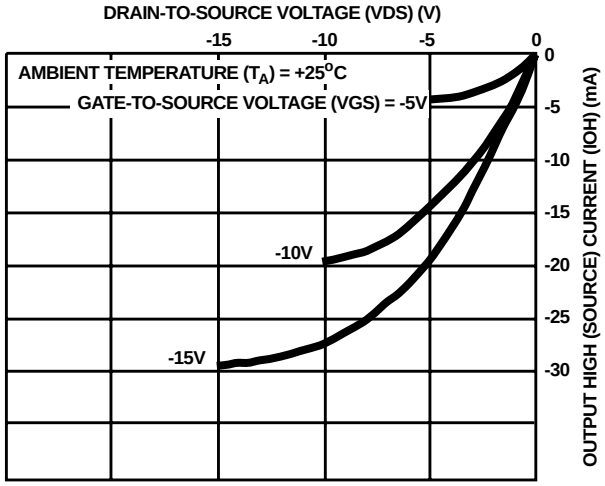


FIGURE 3. TYPICAL P-CHANNEL OUTPUT HIGH (SOURCE) CURRENT CHARACTERISTICS

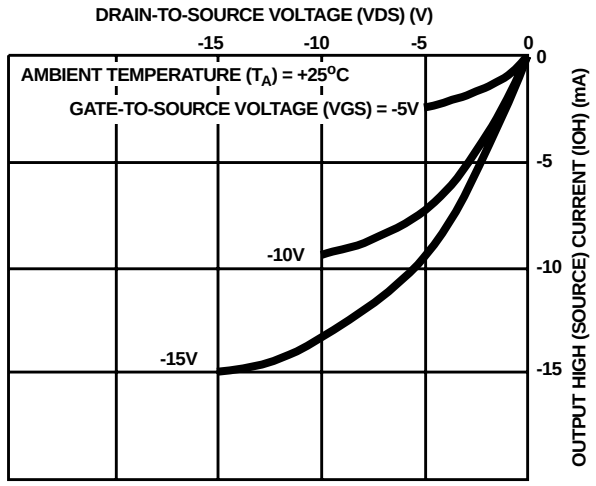


FIGURE 4. MINIMUM P-CHANNEL OUTPUT HIGH (SOURCE) CURRENT CHARACTERISTICS

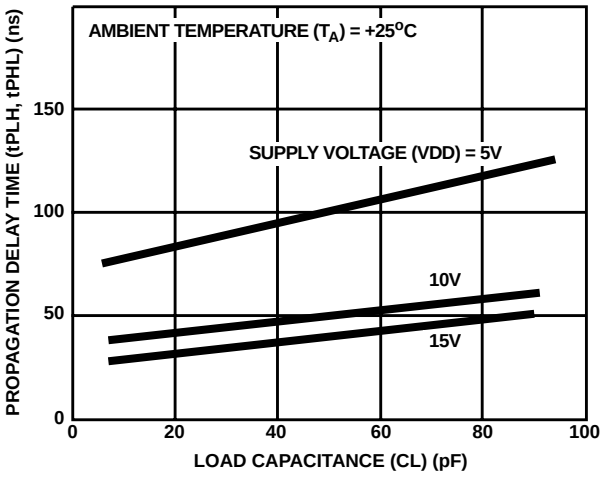


FIGURE 5. TYPICAL PROPAGATION DELAY TIME (QN TO QN+1) AS A FUNCTION OF LOAD CAPACITANCE

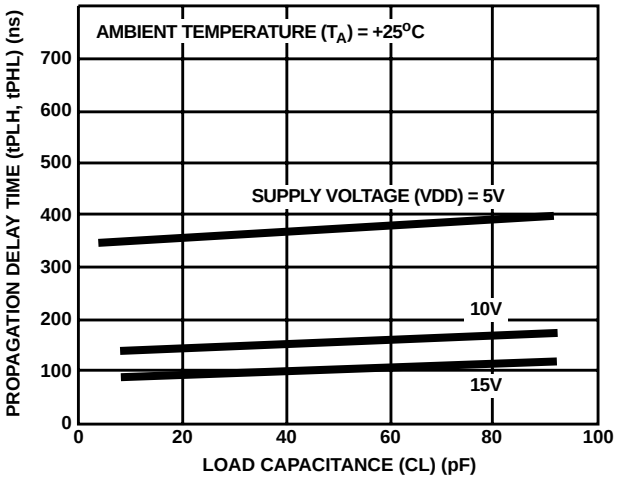


FIGURE 6. TYPICAL PROPAGATION DELAY TIME (Ø1 TO Q4 OUTPUT) AS A FUNCTION OF LOAD CAPACITANCE

Typical Performance Curves (Continued)

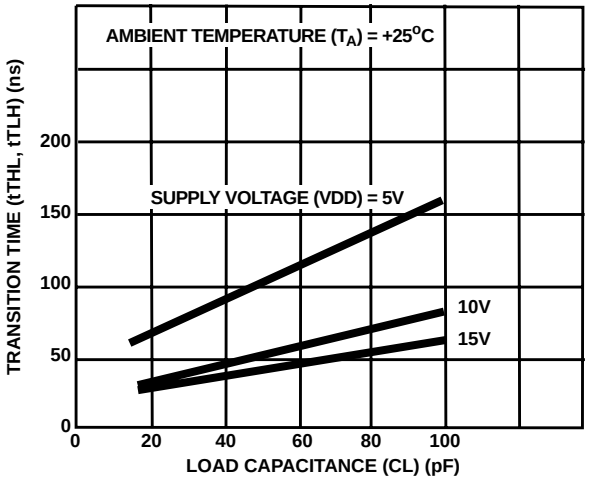


FIGURE 7. TYPICAL TRANSITION TIME AS A FUNCTION OF LOAD CAPACITANCE

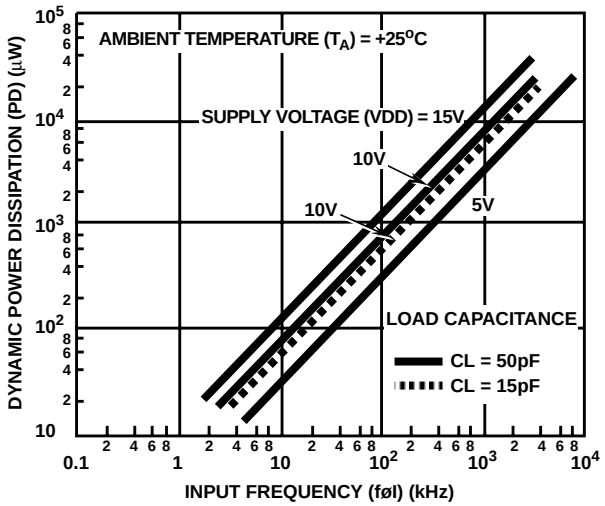


FIGURE 8. TYPICAL DYNAMIC POWER DISSIPATION AS A FUNCTION OF INPUT FREQUENCY

Test Circuits

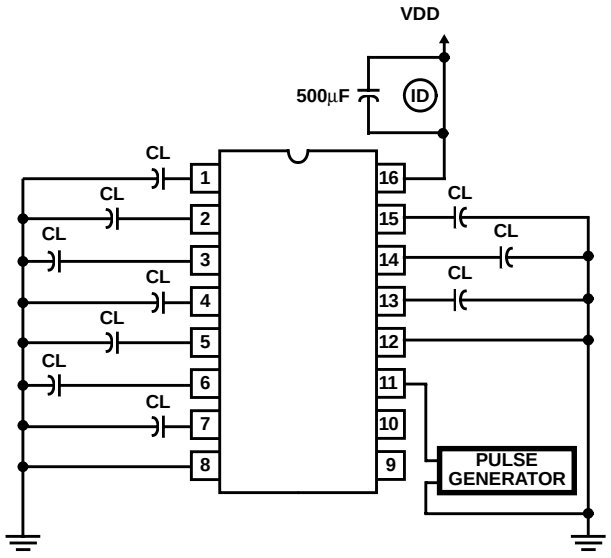


FIGURE 9. DYNAMIC POWER DISSIPATION TEST CIRCUIT

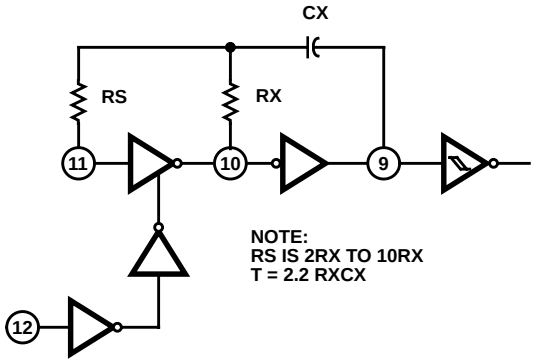
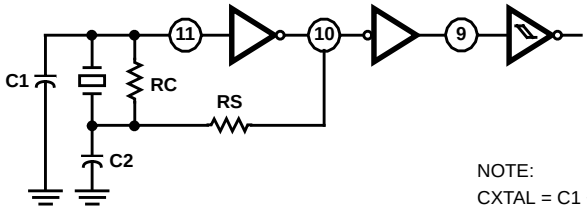


FIGURE 10. TYPICAL RC CIRCUIT

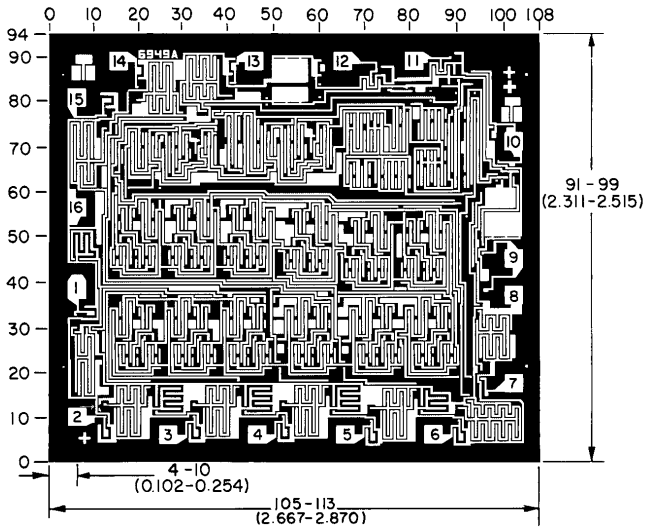
Test Circuits (Continued)



NOTE:
CXTAL = C1 + C2 + CSTRAY
RC = Broader frequency response
RS = Current limiting

FIGURE 11. TYPICAL CRYSTAL CIRCUIT

Chip Dimensions and Pad Layout



Dimension 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

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Sales Office Headquarters

NORTH AMERICA
Intersil Corporation
P. O. Box 883, Mail Stop 53-204
Melbourne, FL 32902
TEL: (321) 724-7000
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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.
Taiwan Limited
7F-6, No. 101 Fu Hsing North Road
Taipei, Taiwan
Republic of China
TEL: (886) 2 2716 9310
FAX: (886) 2 2715 3029