

CMOS 4 -Stage Parallel In/Parallel Out Shift Register

December, 1992

Features

- J - \bar{K} Serial Inputs and True/Complement Outputs
- High Voltage Type (20V Rating)
- 4-Stage Clocked Shift Operation
- Synchronous Parallel Entry on All 4 Stages
- JK Inputs on First Stage
- Asynchronous True/Complement Control on All Outputs
- Static Flip-Flop Operation; Master-Slave Configuration
- Buffered Inputs and Outputs
- High Speed Operation 12MHz (Typ) at VDD = 10V
- 100% Tested for Quiescent Current at 20V
- Standardized, Symmetrical Output Characteristics
- 5V, 10V and 15V Parametric Ratings
- Meets All Requirements of JEDEC Tentative Standard Number 13A, "Standard Specifications for Description of 'B' Series CMOS Devices"

Applications

- Counters, Registers
 - Arithmetic-Unit Registers
 - Shift Left/Shift Right Registers
 - Serial-to-Parallel/Parallel-to-Serial Conversions
- Sequence Generation
- Control Circuits
- Code Conversion

Description

CD4035BMS is a four stage clocked signal serial register with provision for synchronous PARALLEL inputs to each stage and SERIAL inputs to the first stage via JK logic. Register stages 2, 3, and 4 are coupled in a serial D flip-flop configuration when the register is in the serial mode (PARALLEL/SERIAL control low).

Parallel entry into each register stage is permitted when the PARALLEL/SERIAL control is high.

In the parallel or serial mode information is transferred on positive clock transitions.

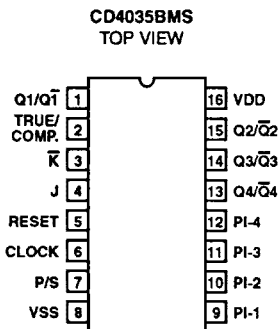
When the TRUE/COMPLEMENT control is high, the true contents of the register are available at the output terminals. When the TRUE/COMPLEMENT control is low, the outputs are the complements of the data in the register. The TRUE/COMPLEMENT control functions asynchronously with respect to the CLOCK signal.

JK input logic is provided on the first stage SERIAL input to minimize logic requirements particularly in counting and sequence-generation applications. With JK inputs connected together, the first stage becomes a D flip-flop. An asynchronous common, RESET is also provided.

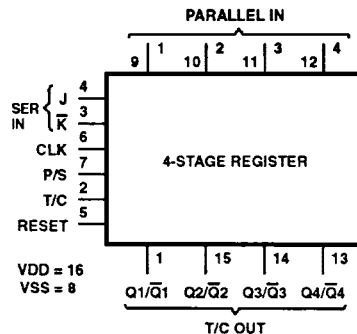
The CD4035BMS series type is supplied in these 16 lead outline packages

Braze Seal DIP	H4T
Frit Seal DIP	H1F
Ceramic Flatpack	H6W

Pinout



Functional Diagram



FIRST STAGE TRUTH TABLE

CL	tn-1 (INPUT)			tn (OUTPUT)	
	J	\bar{K}	R	Qn-1	Qn
	0	X	0	0	0
	1	X	0	0	1
	X	0	0	1	0
	1	0	0	Qn-1	Qn-1 Toggle Mode
	X	1	0	1	1
	X	X	0	Qn-1	Qn-1
X	X	X	1	X	0

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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		UNITS	
					MIN	MAX		
Supply Current	IDD	VDD = 20V, VIN = VDD or GND	1	+25°C	-	10	µA	
			2	+125°C	-	1000	µA	
		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
			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
			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 limits applied to inputs.
 3. For accuracy, voltage is measured differentially to VDD. Limit is 0.050V max.

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TABLE 2. AC ELECTRICAL PERFORMANCE CHARACTERISTICS

PARAMETER	SYMBOL	CONDITIONS (NOTE 1, 2)	GROUP A SUBGROUPS	TEMPERATURE	LIMITS		UNITS
					MIN	MAX	
Propagation Delay Clock to Q	TPHL1 TPLH1	VDD = 5V, VIN = VDD or GND	9	+25°C	-	500	ns
			10, 11	+125°C, -55°C	-	675	ns
Propagation Delay Reset to Q	TPHL2 TPLH2	VDD = 5V, VIN = VDD or GND	9	+25°C	-	460	ns
			10, 11	+125°C, -55°C	-	621	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	-	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	-	-	mA

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TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS (Continued)

PARAMETER	SYMBOL	CONDITIONS	NOTES	TEMPERATURE	LIMITS		UNITS
					MIN	MAX	
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	TPHL1 TPLH1	VDD = 10V	1, 2, 3	+25°C	-	200	ns
		VDD = 15V	1, 2, 3	+25°C	-	150	ns
Propagation Delay Reset to Q	TPHL2 TPLH2	VDD = 10V	1, 2, 3	+25°C	-	200	ns
		VDD = 15V	1, 2, 3	+25°C	-	160	ns
Transition Time	TTHL TTLH	VDD = 10V	1, 2, 3	+25°C	-	100	ns
		VDD = 15V	1, 2, 3	+25°C	-	80	ns
Minimum Reset Pulse Width	TW	VDD = 5V	1, 2, 3	+25°C	-	250	ns
		VDD = 10V	1, 2, 3	+25°C	-	110	ns
		VDD = 15V	1, 2, 3	+25°C	-	40	ns
Maximum Clock Input Frequency	FCL	VDD = 10V	1, 2, 3	+25°C	6	-	MHz
		VDD = 15V	1, 2, 3	+25°C	8	-	MHz
Maximum Clock Rise and Fall Time (Note 4)	TRCL TFCL	VDD = 5V	1, 2, 3	+25°C	-	15	μs
		VDD = 10V	1, 2, 3	+25°C	-	15	μs
		VDD = 15V	1, 2, 3	+25°C	-	15	μs
Minimum Data Setup Time J/K Lines	TS	VDD = 5V	1, 2, 3	+25°C	-	220	ns
		VDD = 10V	1, 2, 3	+25°C	-	80	ns
		VDD = 15V	1, 2, 3	+25°C	-	60	ns
Minimum Data Setup Time Parallel-In Lines	TS	VDD = 5V	1, 2, 3	+25°C	-	140	ns
		VDD = 10V	1, 2, 3	+25°C	-	50	ns
		VDD = 15V	1, 2, 3	+25°C	-	40	ns
Minimum Clock Pulse Width	TW	VDD = 5V	1, 2, 3	+25°C	-	200	ns
		VDD = 10V	1, 2, 3	+25°C	-	90	ns
		VDD = 15V	1, 2, 3	+25°C	-	60	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.

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

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TABLE 4. POST IRRADIATION ELECTRICAL PERFORMANCE CHARACTERISTICS

PARAMETER	SYMBOL	CONDITIONS	NOTES	TEMPERATURE	LIMITS		UNITS
					MIN	MAX	
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-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	1, 13 - 15	2 - 12	16			

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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 2 Note 1	1, 13 - 15	8	2 - 7, 9 - 12, 16			
Dynamic Burn-In Note 1	1, 3, 4	2, 5, 7 - 12	16	13 - 15	6	-
Irradiation Note 2	1, 13 - 15	8	2 - 7, 9 - 12, 16			

NOTE:

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

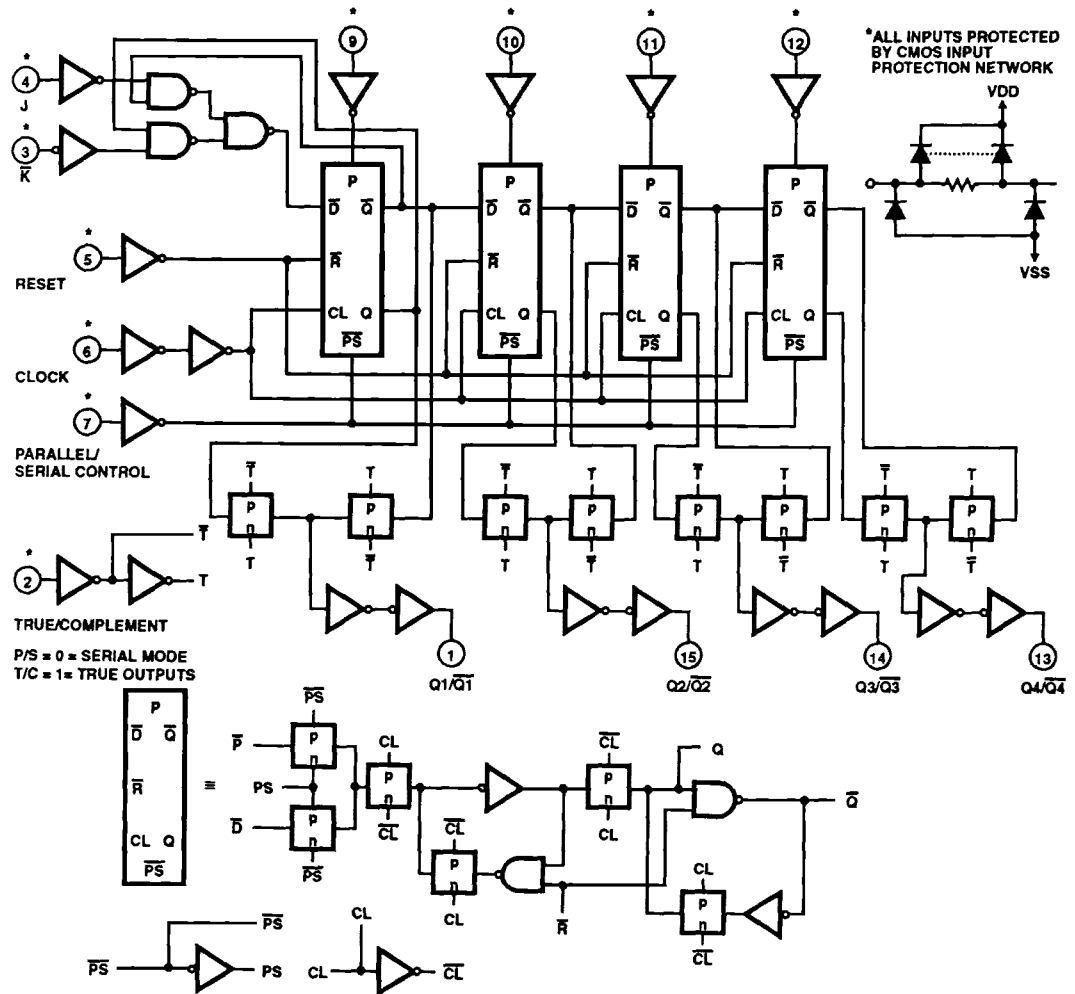


FIGURE 1. TYPICAL STAGE DETAIL LOGIC

Typical Performance Characteristics

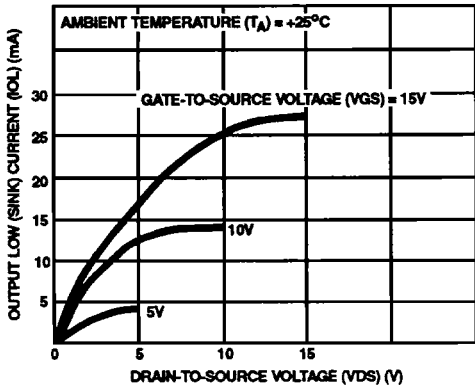


FIGURE 1. TYPICAL OUTPUT LOW (SINK) CURRENT CHARACTERISTICS

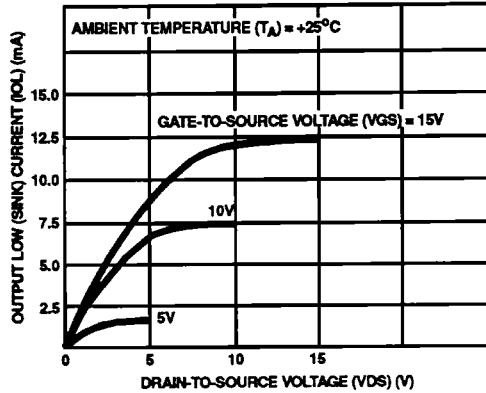


FIGURE 2. MINIMUM OUTPUT LOW (SINK) CURRENT CHARACTERISTICS

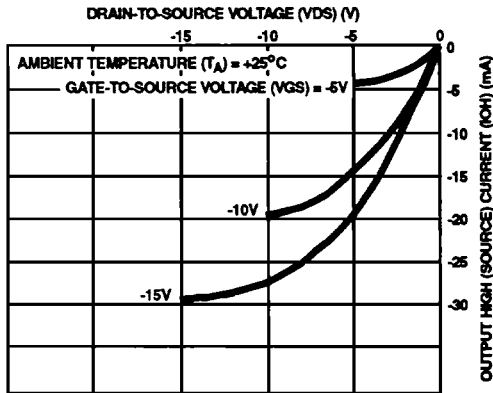


FIGURE 3. TYPICAL OUTPUT HIGH (SOURCE) CURRENT CHARACTERISTICS

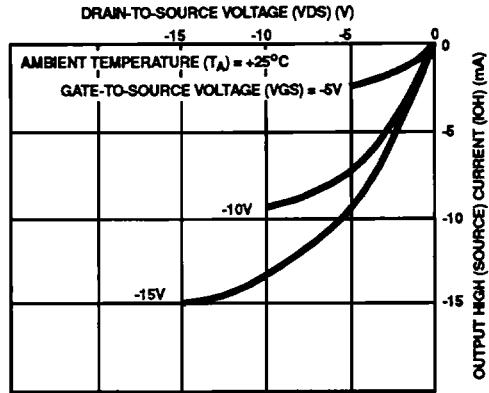


FIGURE 4. MINIMUM OUTPUT HIGH (SOURCE) CURRENT CHARACTERISTICS

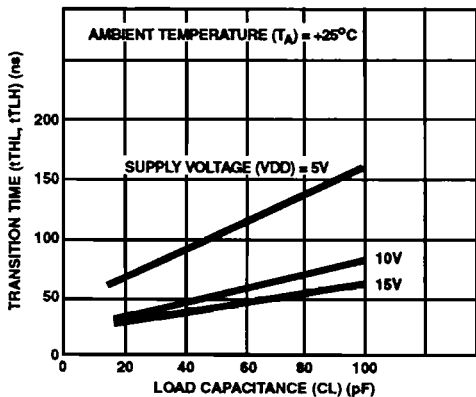


FIGURE 5. TYPICAL TRANSITION TIME AS A FUNCTION OF LOAD CAPACITANCE

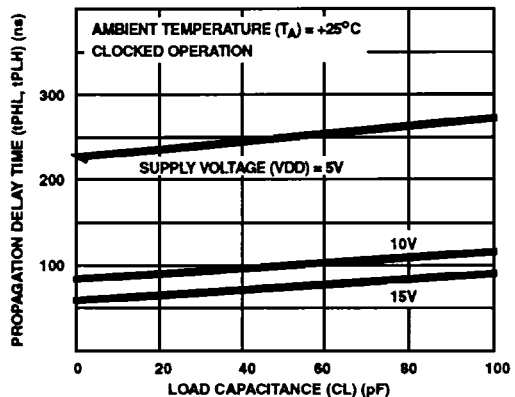


FIGURE 6. TYPICAL PROPAGATION DELAY TIME AS A FUNCTION OF LOAD CAPACITANCE (Q OUTPUT)

Typical Performance Characteristics (Continued)

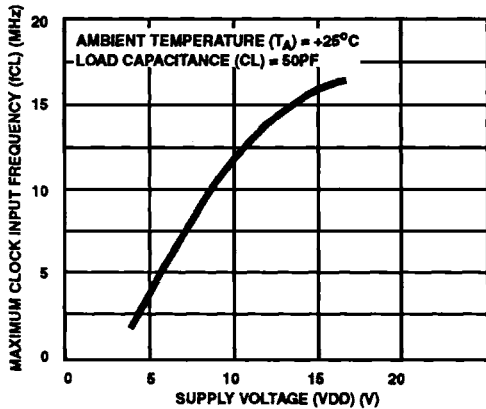


FIGURE 7. TYPICAL MAXIMUM CLOCK INPUT FREQUENCY AS A FUNCTION OF SUPPLY VOLTAGE

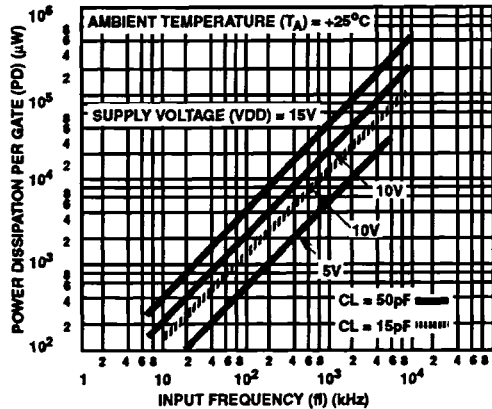


FIGURE 8. TYPICAL DYNAMIC POWER DISSIPATION AS A FUNCTION OF CLOCK INPUT FREQUENCY

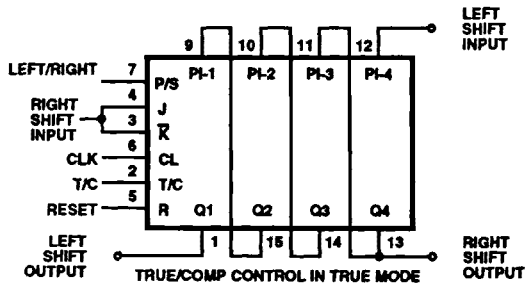
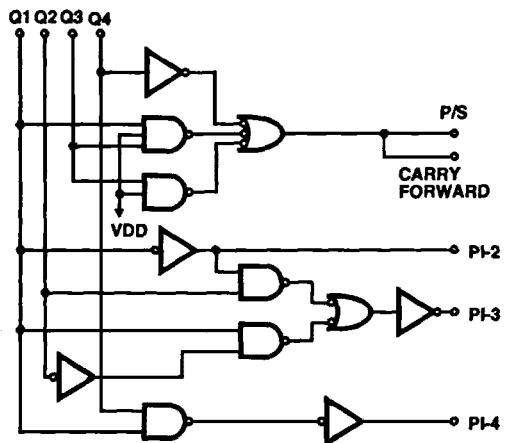


FIGURE 9. SHIFT LEFT/SHIFT RIGHT REGISTER



Using Couleur's Technique (BIDEDEC)*, a binary number (most significant bit, MSB) first is shifted and processed, such that the BCD equivalent is obtained when the last binary bit is clocked into the register. The CD4035BMS, with the correct conversion logic, can also be used as a BCD-to-binary converter.

*NOTE: The basic rule is: If a 4 or less is in a decade, shift with the next clock pulse; if a 5 or greater is in a decade, add 3 and then shift at the next clock pulse. For more information refer to "IRE TRANSACTIONS ON ELECTRONIC COMPUTERS", Dec. 1958, pages 313-316.

FIGURE 10. BIDEDEC LOGIC

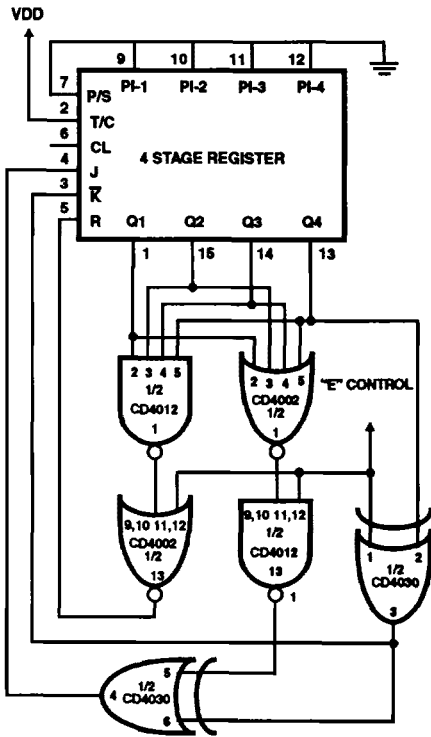


FIGURE 11(a). DOUBLE SEQUENCE GENERATOR

	Control = E = 0				1				
	Q1 A	Q2 B	Q3 C	Q4 D	Q1 A	Q2 B	Q3 C	Q4 D	
0	0	0	0	0	15	1	1	1	1
1	1	0	0	0	14	0	1	1	1
2	0	1	0	0	13	1	0	1	1
5	1	0	1	0	10	0	1	0	1
10	0	1	0	1	5	1	0	1	0
4	0	0	1	0	11	1	1	0	1
9	1	0	0	1	6	0	1	1	0
3	1	1	0	0	12	0	0	1	1
6	0	1	1	0	9	1	0	0	1
13	1	0	1	1	2	0	1	0	0
11	1	1	0	1	4	0	0	1	0
7	1	1	1	0	8	0	0	0	1
14	0	1	1	1	1	1	0	0	0
12	0	0	1	1	3	1	1	0	0
8	0	0	0	1	7	1	1	1	0

Using a control line (E) two different state sequences can be generated. For example, suppose the following two sequences are desired on command (control line E).

FIGURE 11(b). STATE SEQUENCES

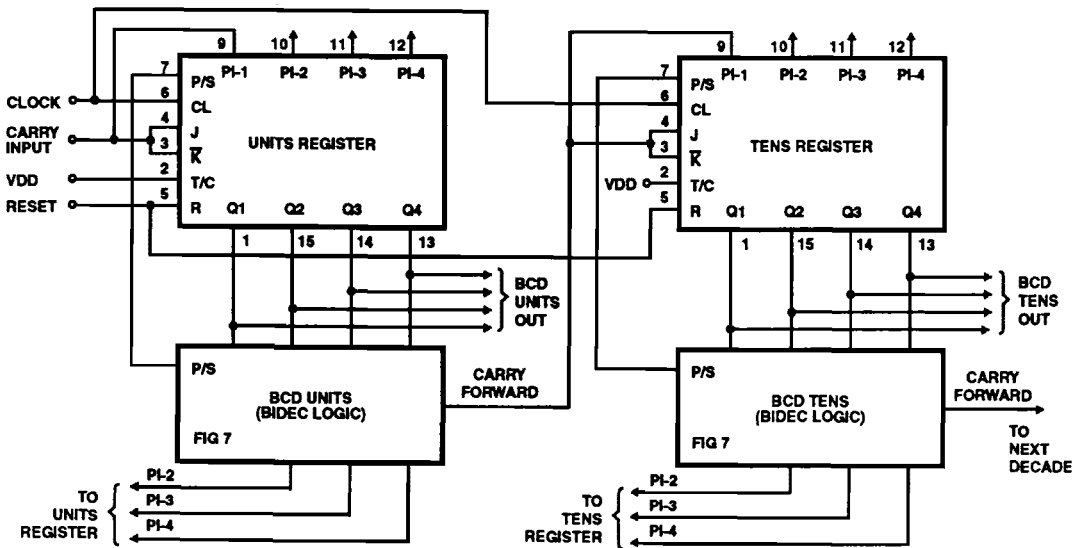
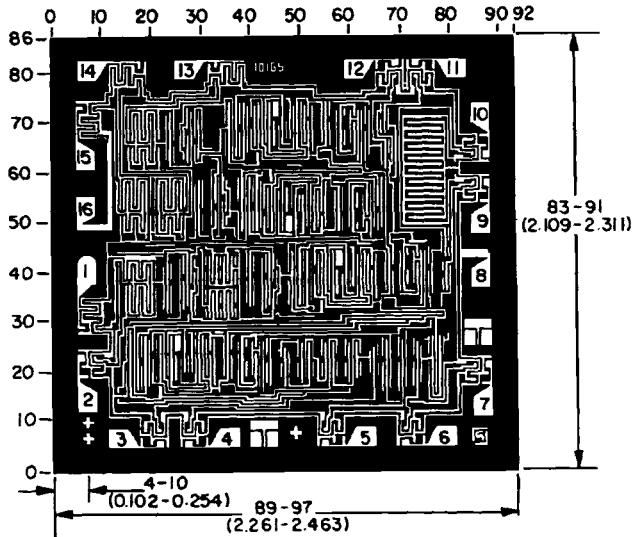


FIGURE 12. BINARY-TO-BCD CONVERTER

CD4035BMS

Chip Dimensions and Pad Layout



Dimensions in parantheses 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