CM4000 Series CMOS

Equivalent to RCA CD4000AE Series

GENERAL DESCRIPTION

Complementary MOS circuits are normally made on an N-type substrate, which necessitates the use of a P-type well for N-channel devices (figure 1). This well must be connected to the lowest potential of the devices in the well. If additional N-channel devices are to be operated at higher potential, separate wells are required.

All FETS are enhancement mode; transconductance (g_m) is directly proportional to mobility and channel width and inversely proportional to channel separation. Because N-channel units have a higher mobility, they have approximately twice the transconductance of an identical P-channel device. Therefore, when matching the g_m, the P-channel units will have approximately two times the channel width of the N-channel devices. A protective diode is used at all high-impedance gate inputs leading to external terminals. These diodes serve to protect the device in the event of a static charge on package terminals.

In most computer circuitry, operating speed is more important than power consumption. However, in aerospace and portable (battery operated) digital system applications operating speed is less significant than power dissipation. In applications of under 10MHz clock rates, where low power is of major importance, CMOS seems ideally suited.

Additionally, in low-power systems, only a fraction of the FETS are switching at any given time. The average digital switching element in a low-power system has an estimated duty factor of 10^{-2}. Operation of digital systems at very low powers requires a basic circuit element (or cell) which dissipates very little power in the quiescent state, i.e., when it's in the '0' or '1' condition. A capacitor is a good example of an element that dissipates very little power when either fully charged or fully discharged. It is only during the switching transient that any power is dissipated.

The total power dissipation of a switching element is the sum of both quiescent power and transient power dissipation.

The former is independent of operating speed; the latter, however, is a function of the clock rate and the voltage difference between its 'on' and its 'off' state. One other factor influencing power dissipation is the capacitance of the logic element. Usually this can be made sufficiently small to be only a small influence.

In conventional P-channel or N-channel MOS circuits most of the power dissipated is quiescent power because a resistance is used as a load for the transistor (figure 2). This is true for bipolar circuitry as well. The use of a complementary pair, in which the load resistor is replaced by a FET of opposite polarity results in appreciably lower quiescent power dissipation.

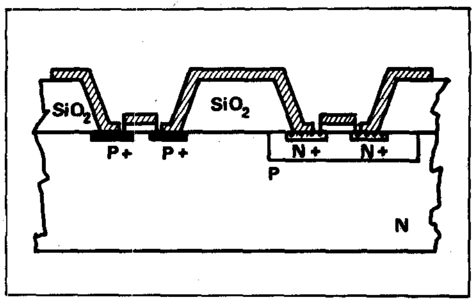

Figure 1 Complementary metal oxide semiconductor (CMOS)

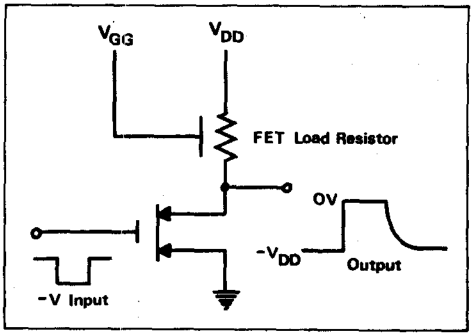

Figure 2 Typical MOSFET switching node.

Because of this low-dissipation characteristic and because operation in a complementary mode is highly tolerant of MOSFET electrical parameters, CMOS circuits are suitable for large arrays.

Integrated CMOS arrays are very well suited to logic applications. A wide range of complex functions, such as counters, memories, shift registers and random logic having excellent electrical characteristics and stability up to +125°C ambients, are feasible today. The CMOS arrays offer microwatt power quiescent operation, fast clock rates, and excellent noise immunity. In addition one power supply operation is obtained over a wide range of voltages; in some applications as low as 3V. This compares favourably to power requirements of P-channel or N-channel devices, which require 12V and more.

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CM4000 Series CMOS

TYPICAL GATE CHARACTERISTICS

Given below are details of a representative function (the CM4011AE).

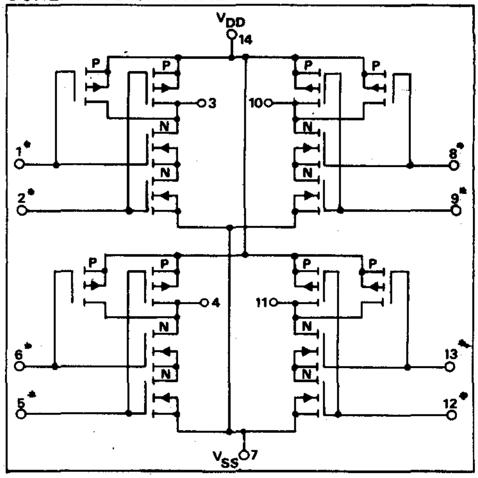
ABSOLUTE MAXIMUM RATINGS

Operating voltage (V_{DD}-V_{SS})		3 to 15V
DC supply voltage		−0.5 to +15V
All inputs		$V_{SS} \leqslant V_{IN} \leqslant V_{DD}$
Operating temperature	D	−55°C to +125°C
	E	−40°C to +85°C
Storage temperature		−65°C to +150°C
Power dissipation		200 milliwatts

SUFFIX DEFINITIONS

'A' = 3-15V operation.
'D' = Hermetic dual in line packaging
'E' = Epoxy dual in line packaging

SCHEMATIC CM4011AE



DYNAMIC ELECTRICAL CHARACTERISTICS

at T_A=25°C and C_L=15pF. Typical temperature coefficient for all values of V_{DD}=0.3%/°C

Characteristic	Symbol	Test conditions	Limits CM4011AE Min	Typ	Max	Units
Propagation delay time						
Low to high level	t_{PLH}	V_{DD}=5V		50	100	ns
		V_{DD}=10V		25	50	ns
High to low level	t_{PHL}	V_{DD}=5V		50	100	ns
		V_{DD}=10V		25	50	ns

Characteristic	Symbol	Test conditions	Limits CM4011AE Min	Typ	Max	Units
Transition time						
Low to high level	t_{TLH}	V_{DD}=5V		75	125	ns
		V_{DD}=10V		40	75	ns
High to low level	t_{THL}	V_{DD}=5V		75	150	ns
		V_{DD}=10V		50	100	ns
Input capacitance	C1	Any input		5		pF

STATIC ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Test conditions	V_{DD} Volts	LIMITS CM4011AE −40°C Min.	−40°C Typ.	−40°C Max.	25°C Min.	25°C Typ.	25°C Max.	85°C Min.	85°C Typ.	85°C Max.	Units
Quiescent device current	I_L		5	—	—	0.5	—	0.005	0.5	—	—	15	µA
			10	—	—	1	—	0.005	1	—	—	30	
Quiescent device dissipation/package	P_D		5	—	—	2.5	—	0.025	10	—	—	75	µW
			10	—	—	10	—	0.05	10	—	—	300	
Output voltage: low-level	V_{OL}		5	—	—	0.01	—	0	0.01	—	—	0.05	V
			10	—	—	0.01	—	0	0.01	—	—	0.05	
High-level	V_{OH}		5	4.99	—	—	4.99	5	—	4.95	—	—	V
			10	9.99	—	—	9.99	10	—	9.95	—	—	
Threshold voltage													
N-Channel	$V_{TH}N$	I_D=10µA		—	1.2	—	—	1.0	—	—	0.8	—	V
P-Channel	$V_{TH}P$	I_D=10µA		—	−1.9	—	—	−1.7	—	—	−1.5	—	V
Noise immunity (all inputs)	V_{NL}		5	+1.5	—	—	1.5	2.25	—	1.4	—	—	V
			10	3	—	—	3	4.5	—	2.9	—	—	
	V_{NH}		5	1.4	—	—	1.5	2.25	—	1.5	—	—	V
			10	2.9	—	—	3	4.5	—	3	—	—	
Output drive current		CM4011A	5	0.145	—	—	0.12	0.5	—	0.95	—	—	
N-Channel	I_DN		10	0.3	—	—	0.25	0.6	—	0.2	—	—	mA
P-Channel	I_DP		5	−0.145	—	—	−0.12	−0.5	—	−0.95	—	—	mA
			10	−0.35	—	—	−0.3	−1.2	—	−0.24	—	—	
Input current	I_I			—	—	—	—	10	—	—	—	—	pA

CM 4000 Series CMOS

REFERENCE TABLE (see outline drawings Nos. 123 and 124 for physical dimensions)

Code	Function	Stock No.	Connection Diagram No.
CM4000AE	Dual 3 input NOR gate plus inverter	35000X	E48
CM4001AE	Dual 2 input NOR gate	35001R	E1
CM4002AE	Dual 4 input NOR gate	35002G	E2
CM4004AE	7 stage binary counter	35116R	E3
CM4006AE	18 stage static shift register	35003E	E24
CM4007AE	Dual complementary pair plus inverter	35004C	E25
CM4008AE	Four-bit full adder	35005A	E26
CM4009AE	Hex buffer/converter (inverting)	35006X	E4
CM4010AE	Hex buffer/converter (non-inverting)	35007H	E5
CM4011AE	Quad 2-input NAND gate	35008F	E6
CM4012AE	Dual 4-input NAND gate	35009D	E7
CM4013AE	Dual "D" flip flop with set/reset	35010G	E8
CM4014AE	8-stage static shift register	35011E	E9
CM4015AE	Dual 4-stage static shift register	35012C	E27
CM4016AE	Quad bilateral switch	35013A	E10
CM4017AE	Decade counter/divider	35014X	E11
CM4018AE	Presettable divide-by-"N" counter	35015H	E28
CM4019AE	Quad AND/OR select gate	35016F	E12
CM4020AE	14 stage ripple-carry binary counter/divider	35017D	E17
CM4021AE	8 stage static shift register	35018B	E13
CM4022AE	Divide-by-8 counter/divider with 8 decoded outputs	35019X	E18
CM4023AE	Triple 3-input NAND gate	35020C	E14
CM4024AE	7 stage binary counter	35021A	E15
CM4025AE	Triple 3 input NOR gate	35022X	E19
CM4026AE	Decade counter/divider	35023H	E29
CM4027AE	Dual J-K master slave flip flop	35024F	E20
CM4028AE	BCD to decimal decoder	35025D	E30
CM4029AE	Presettable up/down counter	35026B	E31
CM4030AE	Quad exclusive—OR gate	35027X	E21
CM4032AE	Triple serial adder	35109G	E33
CM4033AE	Decade counter/7-segment driver	35028R	E34
CM4034AD	8 stage bidirectional reg. "D" input	35043X	E49
CM4035AE	4 stage in/out shift register	35029G	E16
CM4036AD	4 word × 8-bit R.A.M.	35040F	E50
CM4037AE	Triple AND/OR bi phase pairs	35030X	E35
CM4038AE	Negative logic adder	35031H	E36
CM4039AD	4 word × 8-bit R.A.M.	35089E	E51
CM4040AE	12 stage binary counter	35032F	E37
CM4041AE	Quad true/complement buffer	35033D	E38
CM4042AE	Quad clocked D latch	35034B	E39
CM4043AE	Quad NOR RS latch, 3 state outputs	35035X	E40
CM4044AE	Quad NAND RS latch, 3 stage outputs	35036R	E52
CM4045AE	21 stage ripple carry binary counter	35090H	E41
CM4047AE	Monostable/Astable multivibrator	35037G	E42
CM4048AE	Multi functional expandable 8-input gate	35091F	E53
CM4049AE	Inverting hex buffer	35038E	E22
CM4050AE	Non-inverting hex buffer	35039C	E23
*CM4051AE	Single 8 channel multiplexer	35092D	E43
*CM4052AE	Differential 4 channel multiplexer	35093B	E44
*CM4053AE	Triple 2 channel multiplexer	35094X	E45
*CM4066AE	Quad bilateral	35095R	E47
CM4102AE	3½ digit counter/decoder	35041D	E54
CM4104AE	Quad Lo-To-Hi voltage level translator	35096G	E55
CM4108AE	16 channel multiplexer	35097E	E56
*CM4511AE	BCD to 7 segment hi current driver	35098C	E57

*NOTE: These items are new products—check on availability with our sales desk.

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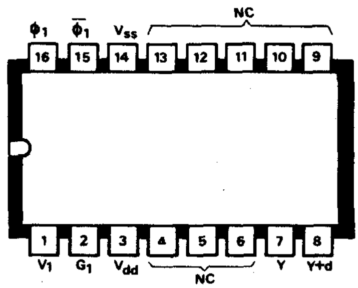
E37 **4040AE**
12 Stage Binary/Ripple Counter

E40 **4043AE**
Quad 3-state NOR R/S Latch

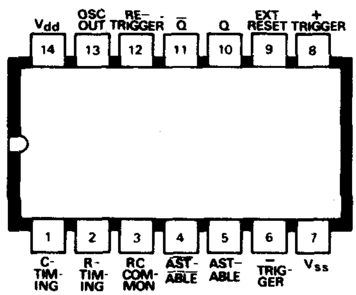
E38 **4041AE**
Quad True/Complement Buffer

E41 **4045AE**
12 Stage Counter



E39 **4042AE**
Quad Clocked 'D' Latch

E42 **4047AE**
Monostable/Astable Multivibrator



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